DECEMBER · 1953

PRICE 75 CENTS

electronics

A McGRAW-HILL PUBLI ON

RADAR AIDS LOGISTICS

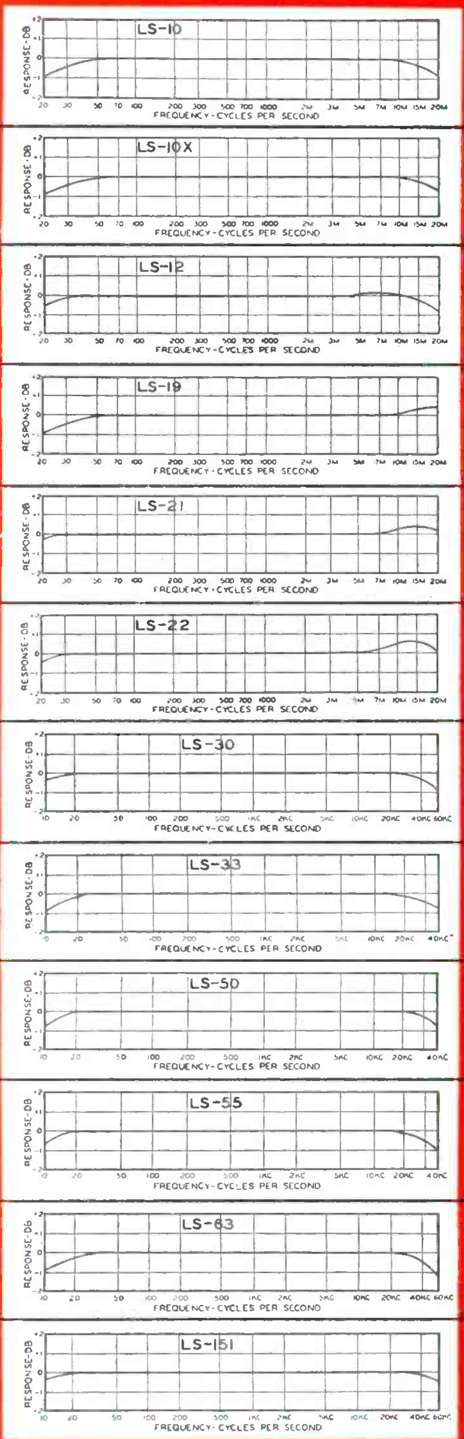
In This Issue—

What Design Engineers Need to Know About The **NTSC COLOR TELEVISION STANDARDS**

FOR Higher Fidelity*

THE Linear Standard SERIES

The ever increasing use of wide range equipment for broadcast service has reached the point where the major limiting factor is the frequency range of the transformers employed. UTC Linear Standard components represent the closest approach to the ideal transformer from the standpoint of uniform frequency response, low wave form distortion, high efficiency, thorough shielding, and dependability. Typical LS units are described below.



Case Size	LS-1	LS-2
Length	3⅛"	4 7/16"
Width	2⅝"	3½"
Height	3¼"	4 3/16"

INPUT TRANSFORMERS

Type No.	Application	Primary Impedance	Secondary Impedance	± 1 db from	Max.† Level	Relative* hum	Unbal. DC in prim'y	Case No.	List Price
LS-10	Low impedance mike, pickup, or multiple line to grid	50, 125/150, 200, 250, 333, 500/600 ohms	60,000 ohms in two sections	20-20,000	+10 DB	−74 DB	.5 MA	LS-1	$25.00
LS-10X	As above	As above	50,000 ohms	20-20,000	+10 DB	−92 DB-Q	.5 MA	LS-1	35.00
LS-12	Low impedance mike, pickup, or multiple line to push pull grids	50, 125/150, 200, 250, 333, 500/600 ohms	120,000 ohms overall, in two sections	20-20,000	+10 DB	−74 DB	.5 MA	LS-1	28.00
LS-12X	As above	As above	80,000 ohms overall, split	20-20,000	+10 DB	−92 DB-Q	.5 MA	LS-1	35.00
LS-15X	Three isolated lines or pads to one or two grids	30, 50, 200, 250 ohms each primary	60,000 ohms overall, in two sections	20-20,000	+10 DB	−92 DB-Q	.5 MA	LS-1	37.00

INTERSTAGE AND MATCHING TRANSFORMERS

Type No.	Application	Primary Impedance	Secondary Impedance	Response	Max.† Level	Relative* hum	Unbal. DC in prim'y	Case No.	List Price
LS-19	Single plate to push pull grids like 2A3, 6L6, 300A. Split secondary	15,000 ohms	95,000 ohms; 1.25:1 each side	± 1 db 20-20,000	+12 DB	−50 DB	0 MA	LS-1	$26.00
LS-21	Single plate to push pull grids. Split pri. and sec.	15,000 ohms	135,000 ohms; 3:1 overall	± 1 db 20-20,000	+10 DB	−74 DB	0 MA	LS-1	26.00
LS-25	Push pull plates to push pull grids. Medium level. Split primary and sec.	30,000 ohms plate to plate	50,000 ohms; turn ratio 1.3:1 overall	± 1 db 20-20,000	+15 DB	−74 DB	1 MA	LS-1	32.00
LS-30	Mixing, low impedance mike, pickup, or multiple line to multiple line	50, 125/150, 200, 250, 333, 500/600 ohms	50, 125/150, 200, 250, 333, 500/600 ohms	± 1 db 20-20,000	+15 DB	−74 DB	.5 MA	LS-1	26.00
LS-33	High level line matching	1.2, 2.5, 5, 7.5, 10, 15, 20, 30, 50, 125, 200, 250, 333, 500/600	50, 125, 200, 250, 333, 500/600 ohms	± .2 db 20-20,000	15 watts			LS-2	30.00

OUTPUT TRANSFORMERS

Type No.	Application	Primary Impedance	Secondary Impedance	Response	Max.† Level	Relative* hum	Unbal. DC in prim'y	Case No.	List Price
LS-50	Single plate to multiple line	15,000 ohms	50, 125/150, 200, 250, 333, 500/600	± 1 db 20-20,000	+15 DB	−74 DB	0 MA	LS-1	$26.00
LS-52	Push pull 245, 250, 6V6 or 245 A prime	8,000 ohms	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	± .2 db 25-20,000	15 watts			LS-2	35.00
LS-55	Push pull 2A3's, 6A5G's, 300A's, 275A's, 6A3's, 6L6's, 6AS7G	5,000 ohms plate to plate and 3,000 ohms plate to plate	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	± .2 db 25-20,000	20 watts			LS-2	35.00
LS-63	Push pull 6F6, class B 46's, 6AS7G, 807-TR, 1614-TR	10,000 ohms plate to plate and 6,000 ohms plate to plate	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	± .2 db 25-20,000	15 watts			LS-2	25.00
LS-151	Bridging from 50 to 500 ohm line to line	16,000 ohms, bridging	50, 125/150, 200, 250, 333, 500/600	± 1 db 15-30,000	+18 DB	−74 DB	1 MA	LS-1	27.00

The values of unbalanced DC shown will effect approximately 1.5 DB loss at 30 cycles.
* Comparison of hum balanced unit with shielding to normal uncased type. Q Multiple alloy magnetic shield.
† 6 MW as ODB reference.

* UTC LINEAR STANDARD transformers are the ONLY audio units with a GUARANTEED uniform response... ±1 DB from 20 to 20,000 cycles.

United Transformer Co.

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DECEMBER • 1953

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RADAR AIDS LOGISTICS—Civilian Signal Corps repairman adjusts antenna of pilot's radar on new Army logistical support vessel for supplying overseas installations having shallow harbors (see p 208)....................COVER

December, 1953 — ELECTRONICS — Vol. 26, No. 12

Member ABC and ABP

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electronic frequency changers

250VA and 1000VA capacity
60 ~ to 60 ~ or 60 ~ to 400 ~
accuracy to ±0.01%

- accurate control of frequency
- accurate control of voltage
- good wave shape
- portable
- no special wiring or installation

SPECIFICATIONS

Model	FCD250	FCD1000	FC1000
Input voltage	95-130VAC, 1Ø, 50-60~	208 or 230VAC, 1Ø, 50-60~	208 or 230VAC 1Ø, 50-60~
Output voltage	115VAC, 1Ø, adjustable between 110-120 volts		
Output Frequency	400 ~, adjustable ±10%	400 ~, adjustable ±10%	60 ~, adjustable between 45 and 65
Output voltage regulation	±1.0%	±1.0%	±1.0%
Output frequency regulation	±1.0% in standard models; ±0.01% with auxiliary frequency standard (output frequency is fixed when using frequency standard)		
Capacity	250VA	1000VA	1000VA
Load range	0.1 to full load		
Distortion	5% maximum		
P. F. range	Down to 0.7 F		
Time constant	0.25 seconds		
Envelope modulation	2% maximum		

These industrial and laboratory frequency changers resulted from contracts for precision inverters. They should prove useful for testing components or complete instruments that must operate over variable frequency conditions. They can also be used as sources for precision 60 ~ or 400 ~ for timing applications, or used with servo and/or gyro motors in design work.

Sorensen electronic frequency changers are also being used with field equipment such as geophysical vans, where motor generator set frequency control is often inadequate. Another use will be for checking equipment designed for 50 ~ (foreign) usage; conversely, the same instrument can be used to convert 50 ~ line to 60 ~ source.

Electronic frequency changers of other ratings are now in design. We shall be happy to send further information, or to correspond with you concerning your individual requirements. Address Sorensen & Co., Inc., 375 Fairfield Avenue, Stamford, Conn. In Europe, write directly to Sorensen A.G., Gartenstrasse 26, Zurich 2, Switzerland.

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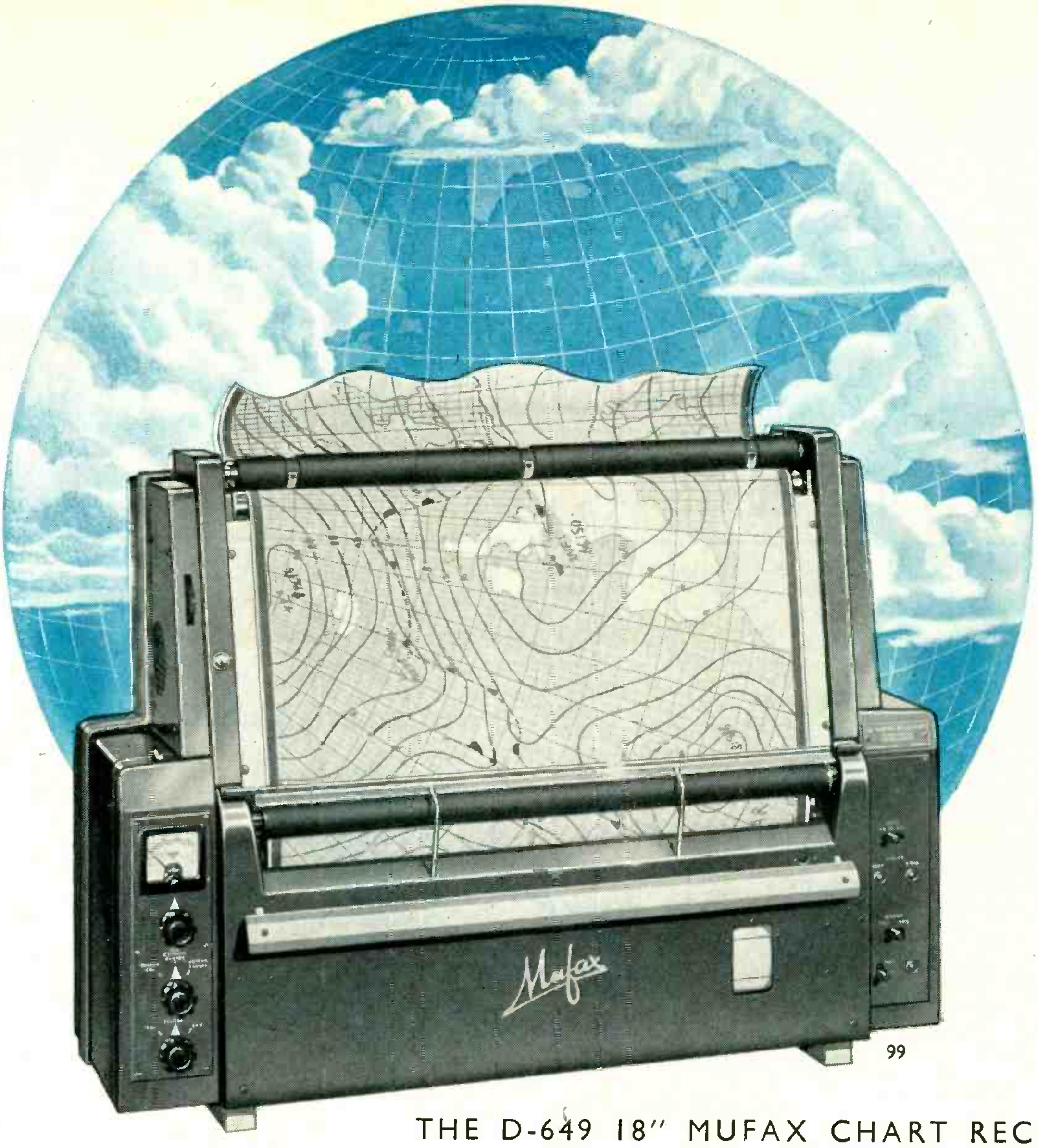

THE D-649 18″ MUFAX CHART RECORDER

All the world's weather on an 18″ Facsimile Receiver

The D-649 18″ Mufax Chart Recorder offers the most convenient method yet devised of receiving facsimile weather maps transmitted by radio or landline. It can be used side by side with American equipment on existing systems; alternatively, a private network can be set up by using it in conjunction with the D-658 18″ Mufax Chart Transmitter. Recording is on inexpensive Mufax paper supplied in 100-foot rolls, enabling the recorder to operate unattended for days at a time. The transmitted map, measuring 18″ x 22″, is received full size, and can be examined while recording is still taking place. Picture quality is better than that obtainable by any other direct recording system, even when using the double speed facility which is exclusive to Mufax equipment. The record, which is black on white, is instantly visible and requires no processing. No other system can offer these advantages—write now for full descriptive literature.

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FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Year Ago Sept. '52	Previous Month Aug. '53	Latest Month Sept. '53
Television sets	755,665	603,760	770,085
Home sets	324,786	299,939	529,427
Clock Radios	183,496	169,301	182,417
Portable sets	126,666	145,460	147,355
Auto sets	230,706	376,937	357,326

RECEIVER SALES

(Source: RETMA)	Sept. '52	Aug. '53	Sept. '53
Television sets, units	875,290	430,101	753,953
Radio sets (except auto)	892,761	491,431	650,898

RECEIVING TUBE SALES

(Source: RETMA)	Sept. '52	Aug. '53	Sept. '53
Receiv. tubes, total units	34,196,286	38,600,494	38,929,539
Receiving tubes, new sets	23,826,408	25,837,055	25,277,061
Rec. tubes, replacement	7,435,333	10,460,032	10,923,386
Receiving tubes, gov't.	2,032,539	560,565	720,081
Receiving tubes, export	902,006	1,742,842	2,009,011
Picture tubes, to mfrs.	640,793	704,495	685,666

SEMICONDUCTOR SALES

(Source: RETMA)	Sept. '52	Aug. '53	Sept. '53
Germanium Diodes	......	836,334	870,555

INDUSTRIAL TUBE SALES

Quarterly Figures (Source: NEMA)	Year Ago 2nd '52	Previous Quarter 1st '53	Latest Quarter 2nd '53
Vacuum (non-receiving)	$12,110,000	$11,340,000	$10,400,000
Gas or vapor	$3,150,000	$3,140,000	$3,300,000
Phototubes	$480,000	$930,000	$700,000
Magnetrons and velocity modulation tubes	$9,830,000	$10,070,000	$10,500,000
Gaps and T/R boxes	$2,140,000	$2,050,000	$1,700,000

TV AUDIENCE

(Source: NBC Research Dept.)	Year Ago Oct. '52	Previous Month Sept. '53	Latest Month Oct. '53
Sets in Use—total	18,711,800	25,233,000	25,690,000

BROADCAST STATIONS

(Source: FCC)	Oct. '52	Sept. '53	Oct. '53
TV Stations on Air	114	288	315
TV Stns CPs—not on air	77	246	230
TV Stns—Applications	840	415	424
AM Stations on Air	2,368	2,488	2,497
AM Stns CPs—not on air	138	113	106
AM Stns—Applications	255	183	187
FM Stations on Air	624	571	566
FM Stns CPs—not on air	17	21	20
FM Stns—Applications	8	5	5

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Sept. '52	Aug. '53	Sept. '53
Aeronautical	34,462	41,541	42,427
Marine	37,437	42,578	42,931
Police, fire, etc.	11,615	13,966	14,094
Industrial	14,761	18,364	18,868
Land Transportation	5,250	6,148	6,201
Amateur	116,629	113,341	113,909
Citizens Radio	1,767	3,937	3,987
Disaster	80	251	251
Experimental	282	469	476
Common carrier	1,026	1,287	1,327

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Aug. '52	July '53	Aug. '53
Prod. workers, comm. equip.	280,300	390,400-r	404,900
Av. wkly. earnings, comm.	$66.54	$65.67	$68.23
Av. wkly. earnings, radio	$63.11	$63.67	$65.69
Av. weekly hours, comm.	41.2	41.4 -r	41.0
Av. weekly hours, radio	40.9	39.3	40.3

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Oct. '52	Sept. '53	Oct. '53
Radio—TV & Electronics	310.9	265.5	272.1
Radio Broadcasters	288.1	263.1	272.2

p—provisional; r—revised

FIGURES OF THE YEAR

	1952 Total	TOTALS FOR THE FIRST NINE MONTHS 1952	1953	Percent Change
Television set production	6,096,279	3,670,590	5,524,370	+50.5
Radio set production	10,934,872	7,528,412	10,149,163	+34.8
Television set sales	6,144,990	3,444,674	4,300,360	+24.8
Radio set sales (except auto)	6,878,547	4,296,982	4,526,186	+05.3
Receiving tube sales	368,519,243	245,689,629	347,152,450	+41.2
Cathode-ray tube sales	6,120,292	3,120,332	5,928,802	+90.0

INDUSTRY REPORT

electronics—DECEMBER • 1953

Color Video Tape Recording Achieved

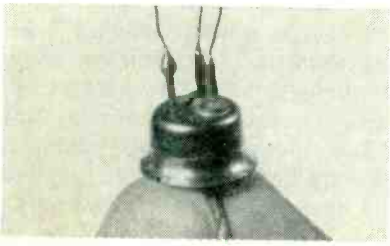
TELEVISION tape recording in color as well as in black-and-white has been accomplished by RCA, according to an announcement made in November by Brig. Gen. Sarnoff. On Dec. 1, 1953, RCA will demonstrate at the Princeton, N. J. Laboratories the present status of tape-recording of television pictures both in black-and-white and in color. For recording the wide-frequency range of the video signal the iron-oxide plastic tape is a half inch wide. It travels at a speed of approximately 200 feet per second.

Power Transistor Produces 20 Watts

EXCEEDING previous power levels by about 100 times, a new transistor represents a significant advance.

The unit, shown in the photograph, is a diffused-junction germanium transistor hermetically sealed in glass and metal and fitted with a screw mounting that permits solid connection of the metal can to a chassis or other support for cooling by conduction.

At present only enough of the 20-watt units are being produced by Minneapolis-Honeywell Regulator Co. to meet its needs for aircraft fuel gages, but some may be made available for commercial use.



Conduction-cooled 20-watt transistor

SIGNATURE of branch depositor is recorded in bank's main office by wired autograph system. Tv and intercom give access to main office records as . . .

Electronic Bank Cuts Space and Costs

CONNECTED to the accounting records of the main office by coaxial-line television, wired autograph and an intercom system, a new branch of the New York Savings Bank is capable of handling twice as many depositors in half the floor space usually required.

In addition, operating costs are estimated to be about 25 percent lower than for conventional banking methods. This saving is based on deposits of $25 million, but the new office can handle up to $50 million in deposits with no increase in equipment or staff.

▶ **Equipment**—The closed-circuit tv system, installed by Telescreen Corp., is similar to the set up installed in the main office earlier this year (ELECTRONICS, p 20, May 1953).

An intercom unit is used by the teller to identify the account to the main office two miles away. The IBM account card is placed in front of a tv camera in the accounting department. The teller can then verify the account balance and signature on a tv screen mounted in his table.

The new-accounts department has a wired autograph system in addition to a tv and intercom unit. This permits immediate recording of the new depositor's signature at the main office.

Use of the centralized accounting system relieves the tellers of the after-banking-hours job of computing interest and filing ledger cards. This permits the bank to extend banking hours without increasing working hours.

▶ **British Use**—Banks in England also look to electronics to handle routine accounting and communication jobs. A series of articles in *The Banker*, discusses the problems and possibilities of electronic banking. Use of magnetic memories, teleprinters and other electronic gear in a centralized banking system is felt to be highly practical, but requires development of specialized units suited to the amount and type of work handled in the bank.

The articles mention a tv link that has been used to connect a bank's main office in Whitehall with a ledger office twenty miles away in the suburbs.

Color TV Timetable

BROADCASTERS, engineers, set manufacturers, with notable exception of the public, seem to be sitting on edge of their chairs . . . all agree FCC will release color soon . . . certainly by year's end . . . maybe before Christmas . . .

• • •

First coast-to-coast demonstration shows how well the system can work . . . points up economic fact . . . one color studio can serve all stations of a network until system takes hold . . .

• • •

Engineers who say they know predict rash of color demonstrations across the country around first of December . . . they say signals from coaxial cable will be fed into receivers now being rushed to completion . . .

• • •

Receiver manufacturers anxious to put best color foot forward but not kill off sales of monochrome . . . one big company running advertising solicits names for advance orders . . . pitches hard for big-screen black-and-white . . .

• • •

Even amateur publications take color tv very seriously . . . one good reason . . . color information is sent on frequency spang in an amateur band . . . NTSC tests show good receivers probably will not be affected . . .

Production men who will talk agree that color sets won't roll in any quantity for several months . . . middle of April looks possible . . .

Industrial Control Applications Increase

Wartime gadgeteering grows into multi-million-dollar business serving many groups

ELECTRON TUBES are by no means newcomers to industry. In 1930, subscribers to ELECTRONICS read about tubes that counted red-hot ingots, controlled flying shears in bar mills and gaged the thickness of paper during its manufacture. However, these early applications were usually experimental; use of electronics in industry was the exception rather than the rule.

The exacting requirements of World War II munitions' production to a large extent overcame the industrialist's hesitancy to entrust his operations to a device as seemingly fragile as the electron tube was thought to be.

▶ **Forecast**—In wartime industrial applications, tubes proved useful and, when industry reconverted, the demand for control devices soon exceeded the gadgeteer's ability to produce.

By 1947, many manufacturers were active in the industrial-control field. By 1951, a variety of packaged control components was commonly available.

Electronics now has a multi-million-dollar share of the industrial-control business. Sales of control equipment are boosted by new plant construction but are not predicated exclusively on it since new applications appear each time a production line is set up. Nor does widening use of electronic equipment mean a decline in the use of pneumatic, hydraulic or mechanical systems; it reflects, rather, a broad trend toward all types of automatic devices for routine decision-making in industry.

▶ **Industries Served**—Large user of electronic control is the metal trade, where tubes control both the working and processing of metal and fabrication of parts, especially in the aircraft and automotive industries. A new magnetic-tape playback control developed by GE for machine-builder Giddings and Lewis runs a milling machine making jet-aircraft skin structures.

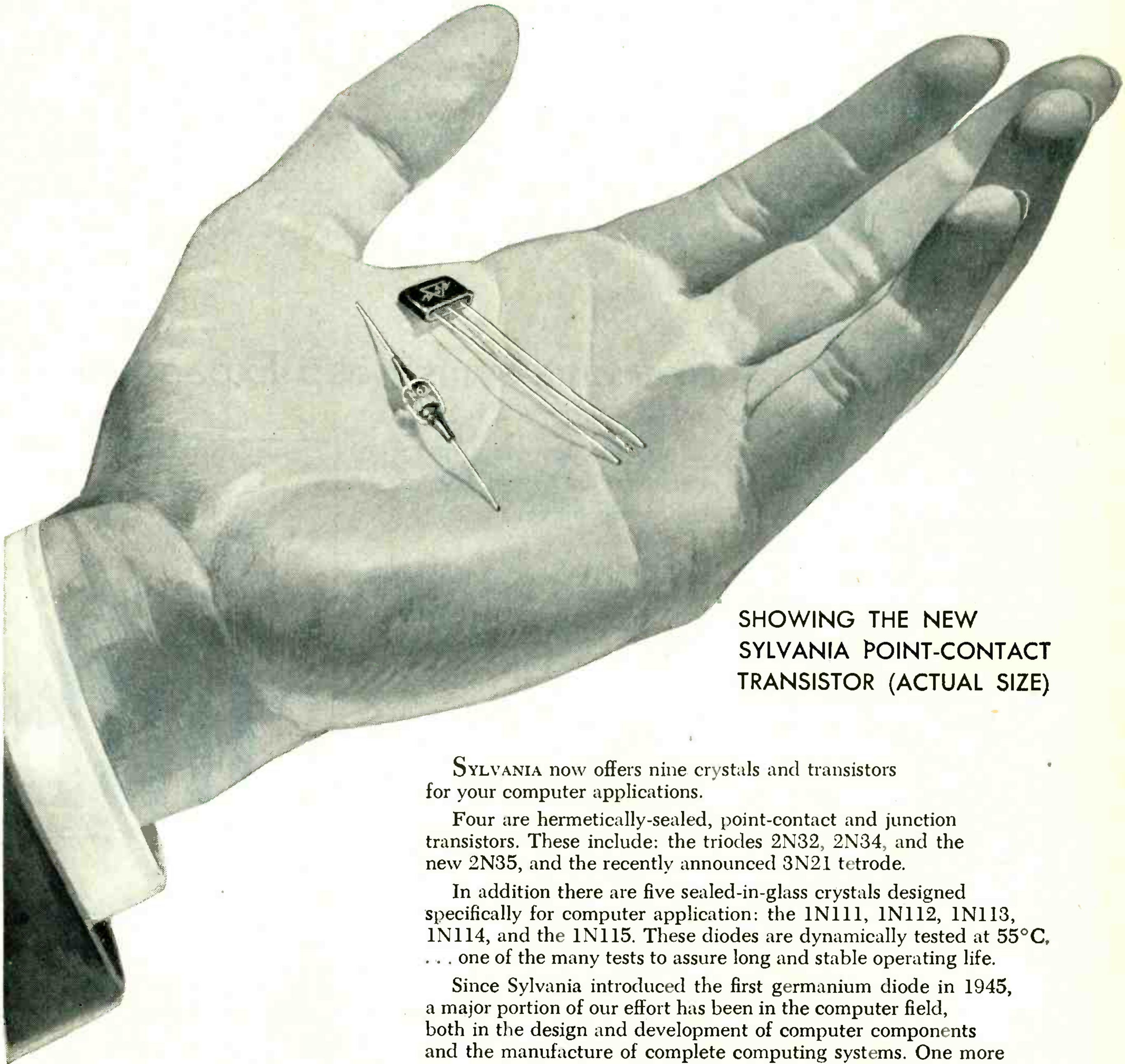
Another popular use of electronic control equipment is in the paper industry. In food processing, millions are saved annually by electronic machines that weigh and count automatically. Previously packers chose to err on the overweight side to avoid lawsuits. Electrical manufacturers use electronic devices to control such things as wire and cable making and manufacture of induction motors.

▶ **What They Do**—Specific jobs done by control units include: timing, sorting, gaging, detecting limits for size or registry control, positioning and speed control.

A control system includes a sensing element, discriminator, amplifier and actuator. The sensing element responds to changes in temperature, pressure, speed, radiation, field strength, voltage or current. The discriminator then determines what kind or control must be ap-

(Continued on page 8)

Specify Quality-tested SYLVANIA COMPUTER CRYSTALS and TRANSISTORS



SHOWING THE NEW SYLVANIA POINT-CONTACT TRANSISTOR (ACTUAL SIZE)

SYLVANIA now offers nine crystals and transistors for your computer applications.

Four are hermetically-sealed, point-contact and junction transistors. These include: the triodes 2N32, 2N34, and the new 2N35, and the recently announced 3N21 tetrode.

In addition there are five sealed-in-glass crystals designed specifically for computer application: the 1N111, 1N112, 1N113, 1N114, and the 1N115. These diodes are dynamically tested at 55°C, . . . one of the many tests to assure long and stable operating life.

Since Sylvania introduced the first germanium diode in 1945, a major portion of our effort has been in the computer field, both in the design and development of computer components and the manufacture of complete computing systems. One more reason why it pays to specify Sylvania. For full details write to: Sylvania Electric Products Inc., Dept. 3E-1012, 1740 Broadway, New York 19, N. Y.

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plied to achieve the desired result. The amplified control signal drives the actuator, which may be a relay, motor, synchro or amplidyne.

U. S. Sets Limits On Transistor Orders

Defense orders are regulated so manufacturers can accept more commercial business

LIMITATIONS have been established by the new Business and Defense Services Administration on the amount of defense orders for transistors and crystal diodes that electronic manufacturers must accept.

The move, in the form of an amendment to BDSA order M-17 (formerly NPA order M-17), was made because of inability of several manufacturers to supply certain types of these components to commercial users for experimental and development use. Government officials believe the development of new circuitry for transistors can be accomplished best by making them available to commercial users.

▶ **Percentages**—The amendment provides that where a type of transistor or crystal diode is produced by only one company, that company need not accept defense orders in excess of 50 percent of its output of that type unless specifically directed by BDSA. Required acceptance of defense rated orders for types of transistors or crystal diodes produced by more than one company is 25 percent.

Electron tube percentage limitations remain the same under the new revision of order M-17. For electron tubes produced by only one company the limitation is 50 percent. For those produced by more than one manufacturer, the limit is 25 percent.

▶ **Delivery**—The new order retains the provision that, unless specifically directed to do so by BDSA, no manufacturer will be required to deliver more than the set percentage of his production schedule for any one month at any one producing unit, or the set precentages of his average monthly base period shipments, whichever is greater.

If a defense rated order for the transistors and crystal diodes covered by order M-17 cannot be placed, a request for assistance may be filed with the Electronics Division of BDSA, specifying the manufacturer who declined the order. The applicant will then be assisted by BDSA in locating sources of supply for the components.

▶ **Rejects**—The transistors and crystal diodes covered by this revision are in the production development stage. Production of most types is on a pilot plant basis, and some are still produced in laboratories. The shrinkage in many types, according to BDSA, runs regularly as high as 98 percent, which makes it difficult for a manufacturer to accept orders for future delivery of the items.

Electronic Firms Keep Expanding

Outlays for new plant and equipment increased and are seen going higher

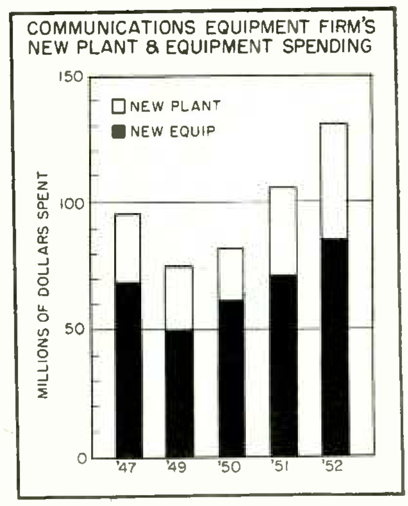
COMMUNICATIONS equipment manufacturers have spent record amounts for capital expenditures during the past few years and they expect to spend even more in the future.

Total expenditures for new plant and equipment have increased by larger amounts every year since 1949. In 1952, spending reached a total of $131.1 million, a $25.1 million increase over 1951's total, for the largest expenditure in the period.

▶ **Breakdown**—As indicated in the chart, the largest part of total capital outlays has been for new machinery and equipment. Since 1949 cost for equipment has accounted for an average of 68 percent of total expansion investment. The remainder has been for new structures and additions to plants.

Despite the large investment in machinery, as represented by communications equipment manufacturers, an industry-wide survey by the American Society of Tool Engineers indicates that 28 percent of all present production equipment and manufacturing processes are already obsolete or inadequate.

▶ **Future**—According to the U. S. Department of Commerce, new plant and equipment expenditures in electrical manufacturing for 1953, including communications equipment manufacturing, will total approximately $463 million, an increase of $87 million over last years total of $376 million.



▶ **Survey**—For 1954, a 10-percent increase in spending is planned by electrical machinery manufacturers, according to a preliminary survey of manufacturing companies made by the McGraw-Hill Department of Economics. This will bring next year's spending to a record total of $512 million.

For all manufacturing industries, an 8-percent decrease in new plant and equipment investment is expected for 1954. This decline, ac-

(Continued on page 10)

NEW!

high-current, heavy-duty capacitors for r-f noise suppression

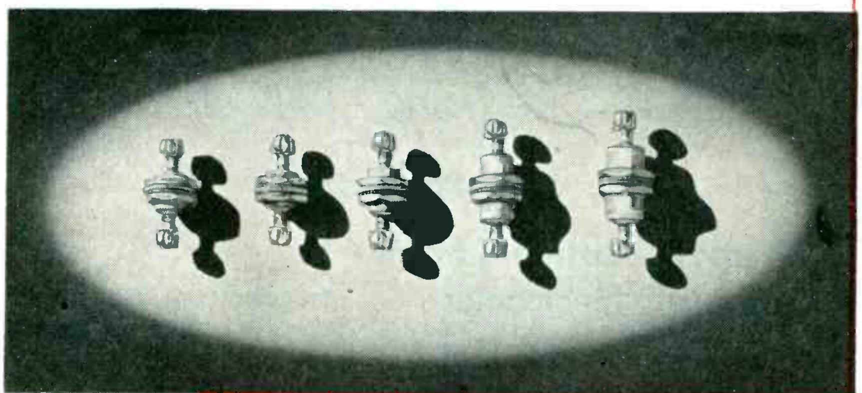
50 ampere
Vitamin Q® Impregnated
THRU-PASS®
CAPACITORS

Now you can get a really effective r-f noise suppression capacitor for use in high-current, heavy-duty applications.

Originally developed for 115/250 volt a-c lines in mobile military power units, these new Sprague Type 112P Thru-Pass capacitors have now been released for general use.

The entire shell of these capacitors is threaded except for two straddle milled flats. When mounted in a flatted circular hole in a chassis or bulkhead wall, they will not rotate and loosen under vibration. There is always a noise-leakproof closed path encircling the feed-thru conductor so that the theoretical effectiveness of these capacitors is realized in actual practice.

The typical insertion loss curves for sub-miniature Thru-Pass units shown in Bulletin 215 are also representative of these larger capacitors. Other characteristics are fully described in Engineering Bulletin No. 216. Write to Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.



Sprague, on request, will provide you with complete application engineering service for optimum results in the use of radio noise suppression capacitors.

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cording to the survey, is mostly related to the completion of defense expansion programs and there is no evidence of widespread cutbacks in anticipation of a business recession in 1954.

Mobile Radio Service Bursts Seams

Special industrial, land transportation and automobile emergency changes proposed

INCREASING GROWTH in the mobile radio services has put pressure upon FCC to provide allocations for broadened categories of licensees. The Commission now proposes to change its rules, but requests comments before Feb. 5, 1954 on industrial and transportation licenses and before Dec. 14, 1953 on automobile emergency assignments.

▶ **Petroleum Specialists**—Hitherto excluded or limited groups to be given radio service are such petroleum industry specialists as acidizers, loggers and perforators.

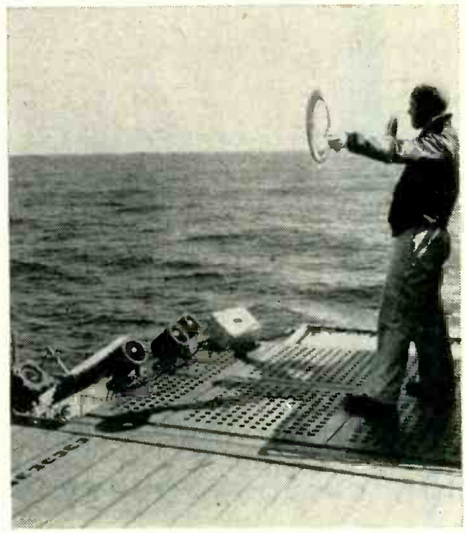
Agricultural specialists who spray or harvest crops will be assigned channels. Those who service and repair heavy construction machinery and deliverers and pourers of ready-mixed concrete will become eligible.

Professional and consulting engineers will be given on-the-job communications.

▶ **Motor Carriers**—A new service is proposed to cover use of radio in the operation of buses, street cars and trucks. Private truckers, such as those engaged in delivery of fuel oil and butane gas, will be moved into a so-called Special Industrial Radio Service.

Another change will make the frequencies 35.70 and 35.98 mc available to garages exclusively, while 452.55 and 457.55 mc will be given for sole use by auto clubs.

Any service now in operation that may be adversely affected by the proposed changes will be given an amortization period of five years from date of final action.

RADAR tracks plane to tell landing signal officer its speed is okay, as . . .

Speed Meter Checks Jet Landings

Navy's radar speed indicator enhances operating safety of carrier-based jet aircraft

LANDING jet-powered aircraft aboard U. S. Navy aircraft carriers is a risky business. Too fast a landing speed will cause the plane to overshoot the arresting cables or the entire deck while too slow a speed will cause the plane to stall in midair, plummeting out of control into the sea. Windspeed and speed of the carrier help determine proper landing speed.

▶ **Equipment**—The new radar speed measuring device watches the approach of the plane by microwave radar. Circuits determine the plane's true speed coordinating approach velocity, carrier speed and windspeed. The information is displayed on a low-mounted meter at the landing signal officer's post. The LSO then wig-wags orders to the pilot either guiding him in for a landing or waving him off for another approach.

The equipment, manufactured by Raytheon, has already been installed on several aircraft carriers and is expected to have an important effect on all-weather carrier flying.

National Business Show Features Electronics

Manufacturers displayed larger lines of electronic gear and introduced new equipment

BUSINESS EXECUTIVES looking for new ways and means of reducing clerical costs found a variety of electronic equipment at the recent National Business Show in New York City. Electronic manufacturers displayed computers, electronic printing devices, dictation equipment and intercom systems.

▶ **Computers**—On public display at the show for the first time was IBM's electronic calculator, type 607, a triple-unit computer capable of performing and checking as many as 14,000 computing operations a minute. It can handle in one operation calculations that previously required several machine operations.

▶ **Facsimile**—Four companies displayed new fax equipment with names such as Stenafax, Telefax,

(Continued on page 14)

What do these names mean to you?

These Centralab Engineered Ceramics solve electronic and industrial production problems . . . hold promise of wonders to come!

FOR MORE INFORMATION ON HOW THESE CENTRALAB ENGINEERED CERAMICS CAN OFFER YOU BIG SAVINGS, SEE NEXT TWO PAGES

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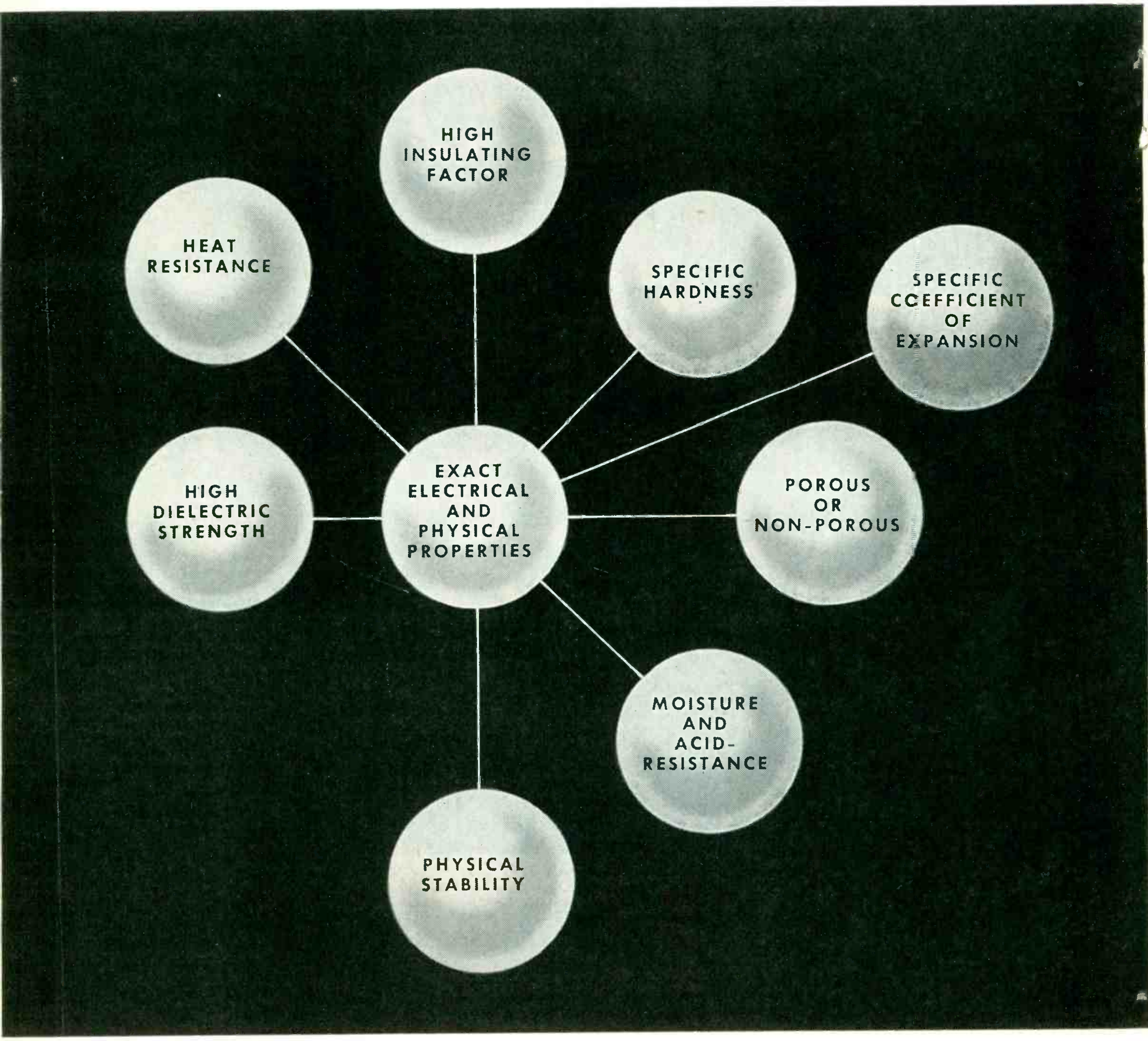

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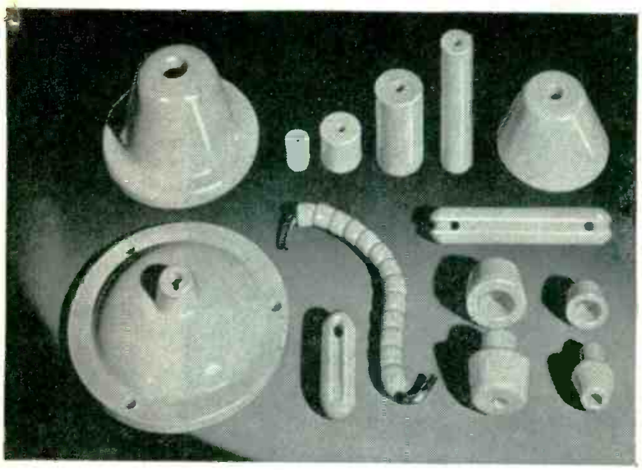
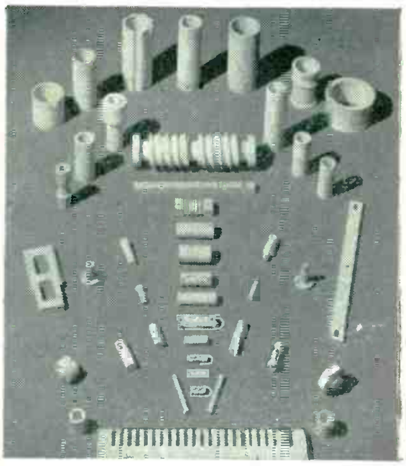
Centralab is the leader in ceramic development — making fine ceramics since 1928. Metalized ceramic material for close tolerance application was a CRL first. We have a complete staff of engineers, physicists and chemists ready to help you develop better product design through the use of Engineered Ceramics. Write for full technical details.

any of these properties, CRL Engineered Ceramics!

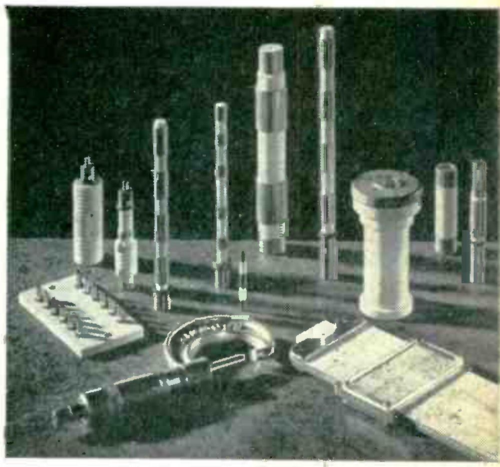
Here are examples of special Centralab Ceramics produced for structural, electrical and electronic use



Note the Standoffs illustrated, upper center. Made to government specifications, they are available commercially at a price lower than most standard units. Note the many types of specialty items.



Specialty items include forms for coils and various electronic components, such as variometer rotor and stator bars, heater coils, etc. Commercial units are available in Grade L-5 and L-6 Steatite if required.



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Centralab engineers constantly improve CRL Ceramics searching for new materials . . . developing more economical production methods. Consult Centralab on your problems.

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Faxcoa and Electronic Printer. With the exception of Telefax, the systems were designed for use in internal office copying operations.

▶ **Dictation and Intercoms**—A large amount of electronic equipment at the show was displayed by manufacturers of dictation and intercommunication systems. Compactness seemed to keynote new dictation equipment shown.

Intercommunication system manufacturers stressed time and cost savings. One company estimates that inside calls average three out of four calls on business switchboards and concludes that intercom systems can pay for themselves in two to three years. Home intercom systems were also shown and manufacturers predicted that the home market would someday be as big as the business market.

Industry Awake to TV Interference Problems

COMMISSIONER George E. Sterling of FCC speaking before RETMA, RTMA of Canada and IRE groups highlighted the problems arising from increased use of the radio frequency spectrum—particularly radiation hazards in color and uhf receivers. He reminded manufacturers of FCC's new power to crack down and cited an instance in which the manufacturer of industrial heating devices radiating energy was issued a cease-and-desist order.

▶ **Receiver Interference**—During fiscal 1953, FCC received 22,264 interference complaints. More than 12,600 resulted from spurious responses of broadcast receivers, over 6,100 being from tv receivers. Field measurements in Portland, Ore., show a high incidence of interference from improperly designed uhf receivers or converters. The 41.25-mc intermediate frequency single-conversion standard upon which FCC based its allocations has not been adhered to, Commissioner Sterling pointed out. However, he announced that 25 of 28 major companies will be using the new standard i-f by late 1953. Oscillator radiation has also been severely reduced.

▶ **Amateur TVI**—Amateurs are being continually alerted through the American Radio Relay League to television interference (tvi) problems. This is particularly important because the color subcarrier in proposed NTSC standards will be 3.579545 kc—at the low end of one of the amateur bands. For proper color reception, the transmitter must not vary from this more than 0.1 cycle per second.

Despite the Commissioner's warnings, his speech made it apparent that all concerned are aware of interference problems and are taking steps to eliminate the sources.

TRIPLE-INDICATION depth-sounder is used in . . .

Fish Finder Costing One Whale

ULTRASONIC device recently demonstrated by engineers of Minneapolis-Honeywell enables the skipper of a fishing craft to examine the ocean or harbor bottom, navigate in bad weather with the help of a radar-like underwater beam or find schools of fish that may be more than a quarter of a mile away.

Although depth-sounders and sonar underwater locating devices are not new, the so-called Sea Scanar is a modern adaptation in one package. Technically it comprises a hull unit that can be raised or lowered below the underside of the craft, a transceiver and the audio-visual indicator shown in the photograph.

Indications are: an audible ping, an oscilloscope picture of intervening layers (small circle at right) and a ppi-type presentation to indicate the closest solid obstacle.

▶ **Special Features**—The ultrasonic transducer that sends out high-frequency sound impulses and then catches their echoes from obstructions can be pointed downwards as a depth-sounder. Or, with the protective covering low-

(Continued on page 16)

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ered below the hull, a servomechanism turns the unit, pointed at right angles, now, from side to side as desired.

The return of echoes displayed upon the cathode-ray screen shows whether the obstacle is within 1,600, 800 or 400 feet and exactly how far away.

The rated minimum range is 5 feet. Any range can be scanned 180, 90 or 45 degrees.

Cost of the equipment (but not installed) is $4,900—about the price of one whale or one seine of salmon.

Transistor Activity Abroad Expands

More manufacturers enter the field as demand in overseas markets heightens

REPORTS that an electronic manufacturer abroad plans to export transistors to the U. S. in the near future has caused electronic manufacturers to take another look at the status of transistor developments overseas.

▶ **Companies**—As far as can be determined, there are 13 manufacturers in foreign countries that are actively engaged in the development and manufacture of transistors. These companies, licensees of Bell basic transistor patents, are as follows:

Company	Country
Ateliers de Constructions Electriques de Charleroi	Belgium
Automatic Telephone & Electric	England
British Thompson Houston	England
English Electric	England
Ericsson	Sweden
Felten & Guilleaume	Germany
Ferranti Electric	England
Five IT&T subsidiaries	England, France Germany
Northern Electric	Canada
Philips	England
Pye	England
Seimens & Halske	Germany
Telefunken	Germany

Four more major foreign companies are reported as planning to enter transistor manufacturing as soon as license agreements can be completed.

At least 25 companies abroad are active in work on transistor applications in radio and tv equipment.

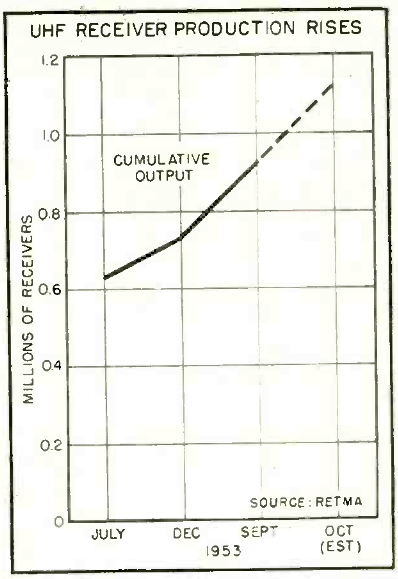
But, as far as can be determined, only one company abroad, Seimens & Halske of Germany, has offered transistors on a regular commercial basis. The other firms are reported to be in the laboratory or pilot plant stage of production.

▶ **Demand**—U. S. transistor manufacturers say they have had a substantial number of orders from foreign companies for transistors, Individual orders for as many as 50,000 units have been received here. Hearing aid companies in England and Europe are especially interested in them and plan use in their products as soon as sufficient quantities are available.

Selective Calling Cuts Flying Fatigue

ONE annoying aspect of piloting an aircraft today is the necessity for continuous monitoring of certain frequencies to intercept messages directed to individual planes. A system of selective calling has been developed by the Pacific-Alaska Division of Pan American World Airways in which the pilot answers his radio as he would answer his home telephone.

Coded signals are transmitted which activate decoders in each airplane and appropriate signalling devices. A calling signal consists of two consecutive tone pulses of two tones each lasting about 0.75 second. Up to 1,200 different combinations are available through the system, which is similar to systems now in use by many police and taxicab communications systems. The Airlines Electronic Engineering Committee has approved specifications for the selective system.



UHF TV Production Moves Ahead Faster

Increasing number of uhf markets along with low prices and more promotion bolster sales

TELEVISION receivers with uhf facilities are accounting for a larger share of total tv production. As shown in the chart, there was a total of 919,902 uhf sets produced this year through September, over 16 percent of total tv output. Monthly production for 1953 through June averaged about 110,000 a month. Production for September reached a total of 193,212, representing over 21 percent of total uhf production for the period.

▶ **Market**—According to FCC allocations, there will be uhf in nearly every major city in the U. S. Most of the cities with a 100,000 population and many of the areas with 500,000 population will have uhf stations only. Massachusetts will have all uhf stations except in Boston. New Jersey also will have all uhf stations except for one city. In Pennsylvania, New York and Vermont, 90 percent of the tv stations will operate in the uhf band.

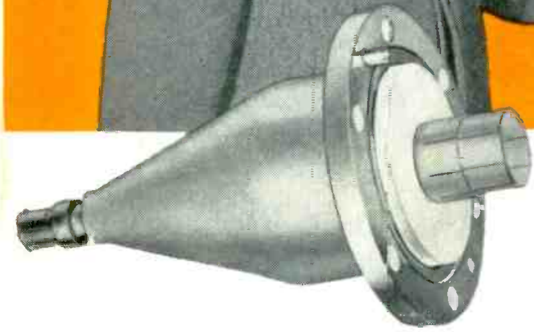
▶ **Prices**—There are indications that uhf receiver prices are coming down. Raytheon recently announced a new pricing policy that re-

(Continued on page 18)

Announcing

accurate **VHF** *and* **UHF** Transmitting Antenna Measurements

A typical example of the use of G-R coaxial measuring equipment for determining TV antenna characteristics. VSWR and impedance measurements are made rapidly and accurately with these units of the G-R integrated line of VHF and UHF instruments.



874-QU3 Adaptor . . . now enables direct connection of any G-R Coaxial Equipment to the antenna system for measurements at the operating frequency. It is a tapered unit fitted with a G-R Type 874 Connector at the small end; the other end is equipped with standard flanges for connection to 50-ohm u-h-f transmission lines. Electrical characteristics are excellent.

Price $87

G-R now makes available a *completely integrated system* for measuring the electrical uniformity of t-v transmitting antennas. With this system, VSWR and impedance of v-h-f and u-h-f antennas can be determined with ease and to the high degree of accuracy required for the most exacting applications. Antenna manufacturers can cut testing time. Every chief engineer can now periodically check for reflections in his antenna system to insure proper operation.

This equipment is compact, lightweight, and has superior electrical characteristics — it is easily operated and completely reliable in operation.

The heart of the system is the versatile G-R Type 1602-B Admittance Meter . . . a direct-reading null device, which can be used to match a load to a line, to compare directly the impedance of one component or line to that of another, and to measure impedance or VSWR. Its scales are direct reading; they are independent of both frequency and calibration of the detector.

Two G-R Unit Oscillators, with wide-range "butterfly" tuning units and double-shielded construction, provide more than adequate power for sensitive measurements. The new Type 1216-A 30 Mc I-F Amplifier (with built-in attenuator) is used as the detector. This unit, designed specifically for uhf work, has a gain of 90 db and a ¾ Mc bandwidth. The amplifier power supply also furnishes power for the local oscillator.

A *new* and important development which completes the link between measuring system and t-v transmission line is the recently announced G-R antenna adaptor. This precision-tooled unit is available in two types . . . the Type 874-QV2A which couples from the Type 874 connector to the standard 1⅝ inch, 51.5 ohm v-h-f transmission line . . . and the Type 874-QU3, which couples to the 3⅛ inch, 50.0 ohm u-h-f line. These elements are silver-plated for minimum loss and have excellent electrical characteristics . . . VSWR of the Type 874-QV2A is less than 1.02 over the complete v-h-f range when used with the Admittance Meter . . . VSWR of the Type 874-QU3 is better than 1.03 to 900 Mc.

Write in for more complete information.

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Admittance Meters ☆ Coaxial Elements ☆ Decade Capacitors ☆ Decade Inductors ☆ Decade Resistors ☆ Distortion Meters ☆ Frequency Meters ☆ Frequency Standards ☆ Impedance Bridges ☆ Modulation Meters ☆ Oscillators Variacs ☆ Light Meters ☆ Megohmmeters ☆ Motor Controls Noise Meters ☆ Null Detectors ☆ Precision Capacitors Pulse Generators ☆ Signal Generators ☆ Vibration Meters ☆ Stroboscopes ☆ Wave Filters U-H-F Measuring Equipment ☆ V-T Voltmeters ☆ Wave Analyzers ☆ Polariscopes duces the cost differential between straight vhf sets and all-channel receivers. According to the company, its all-channel receivers were repriced to stimulate activity in large metropolitan areas where uhf sales have been lagging due to wide price differentials. Converter prices seem to be holding steady but a few new models have been announced recently at reduced prices.

▶ **Future**—The policies of tv set companies in the face of growing uhf acceptance are seen in the results of a survey of receiver manufacturers made for ABC-TV by the American Research Bureau. For five manufacturers reported on, uhf production as a percentage of total tv output ranged from 3 percent to 40 percent. All five expect to raise uhf production in 1954 to percentages ranging from 60 percent to nearly 100 percent of total tv output.

Broadcasters are also planning ahead and a number of stations recently formed the Ultrahigh Frequency Association.

Junction Transistors Get Frequency Boost

Tetrodes and other special configurations extend useful range to radio and tv i-f region

THOUGH differing as to approach, several major producers of transistors appear to be on the verge of announcing availability of high-frequency transistors for use in circuits hitherto considered practical only with tubes or one-in-a-million experimental transistors.

Recently released spec sheets from Germanium Products Corp. list transistors with alpha cutoff ratings of 7 mc as typical, with useful gains at 25 mc readily attainable. In terms of transient response, this means that outputs will reach 70 percent of final value within a few tenths of a μ sec after application of a steep-front input pulse.

A response time of 0.05 μ sec has been observed.

These are conventional grown-junction germanium transistors.

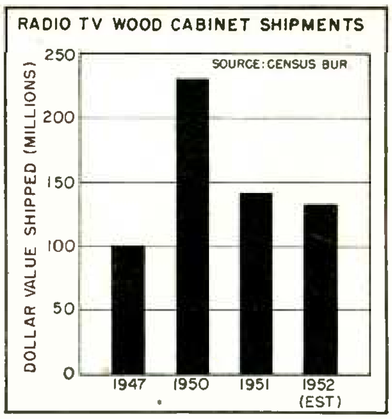
Some further frequency increases may be expected through use of special techniques such as extra base-bias leads and fat bases with carved depressions for bringing alloyed emitter and collector surfaces close together. Such techniques can raise alpha-cutoff frequencies by as much as ten times, which points out the possibility of 100-mc junction transistor amplifiers.

Rumors of commercial radio and tv applications are plentiful. Some of the more reliable of these indicate use by several companies in portable radios plus a few applications in video and i-f circuits in next year's tv models.

TV Set Makers Bypass Wood

Wood housings are giving way to plastics and metal as costs are trimmed

BIG-SCREEN tv sets require larger, more costly tv cabinets. Manufacturers, in attempting to keep big-screen tv set prices competitive, have turned to materials other than wood to cut costs on price leader sets. Statistics recently released by the Department of Commerce show the extent of the change. Value of shipments of radio, phonograph and tv wood cabinets totaled \$133.2 million in 1952, a decrease of more than \$10 million from the total of \$143.9 million in 1951. In 1950, the value of these shipments was \$231.7 million.



▶ **Plastic**—Much of the drop in the use of wood in tv cabinets has been taken up by plastic materials. The value of shipments of plastic radio, phonograph and tv cabinets last year was \$12.7 million and in 1951 totaled \$13.5 million. Practically all table model radio cabinets are plastic and nearly all of the tv table models of six major set manufacturers use the material. This year one company introduced an all-plastic console cabinet for one of its 24-inch sets.

In addition to all-plastic cabinets, a number of manufacturers are using leatherette and plastic coatings. This also may account for some of the decline in the value of wood shipments since less costly wood can be used under the coverings.

▶ **Metal**—Television cabinets made of metal also acount for some of the drop in wood cabinet shipments and may also be responsible for the slight decline in plastic cabinet shipments of last year. At least five major manufacturers use metal in nearly all of their tv table model housings. Two companies make all-metal console tv cabinets.

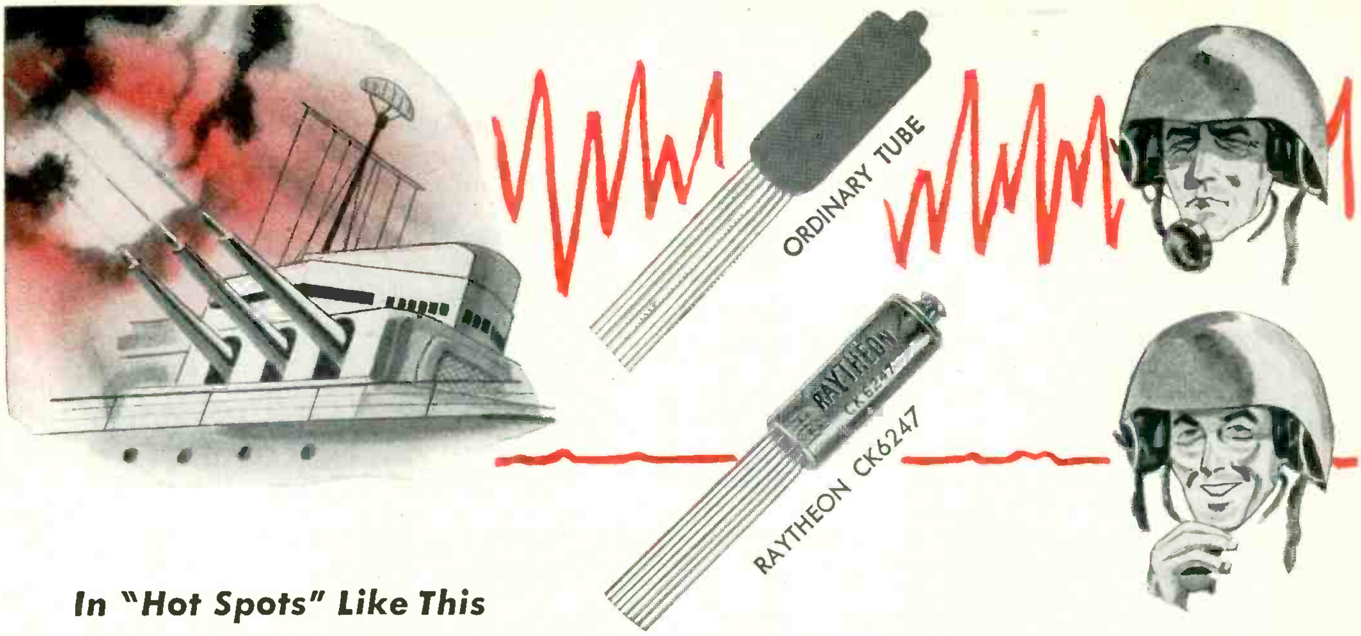
RETMA Group Probes High-Fidelity Standards

LAST SUMMER'S flurry of excitement touched off by rapid expansion of the high-fidelity audio market brought about a feeling that perhaps the Radio-Electronic-Television Manufacturers' Association should look into the matter of establishing standards in the field.

In September, the marketing group began to study the feasibility of setting minimum engineering standards for high-fidelity equipment. Actual work devolved upon SE-8, an engineering committee of the sound-equipment panel whose previous work in the field had been in standardizing audio components for ease of interconnection.

Nearly 50 manufacturers of audio

(Continued on page 20)



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for Lowest Microphonic Noise . . .

use RAYTHEON'S CK6247
Reliable Subminiature Triode

NOT MORE THAN 1 MILLIVOLT across plate resistor of 10,000 ohms with applied vibrational acceleration of 15 G at 40 cycles per second

This extraordinarily low microphonic rating is 10 times better than the next lowest (Raytheon's Type CK5703WA) — 20 times better than any other tube. It is the result of Raytheon exclusive, advanced design, not a matter of tube selection. It is produced under the same controls as the other Raytheon Reliable Subminiature Tubes, including complete mechanical tests, and 250°C high temperature life test.

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equipment including eight radio-tv setmakers participated in the committee's work. When the committee met in New York during the Audio Fair, members found themselves in substantial agreement on performance standards for f-m tuners, audio amplifiers and tape recorders. Performance measurements for phonograph pickups and loudspeakers, however, provided knotty problems.

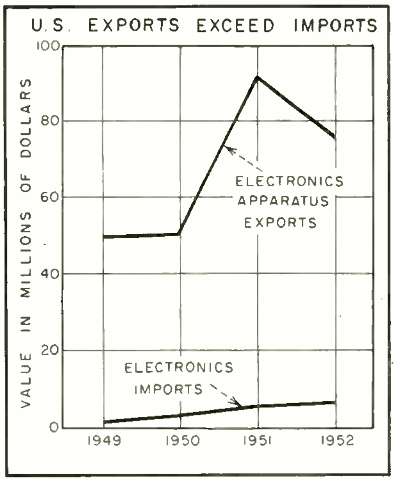
▶ **Standards**—The engineering committeemen met with their opposite numbers from RETMA's marketing section November 11 in Chicago's Palmer House intending to decide the feasibility of issuing performance standards, which would necessarily be minimum standards, and to finalize a report to the board of directors.

Some observers have sensed a changed climate of opinion from the near-hysteria that gripped hi-fi manufacturers about the time of last July's music show. A feeling currently gathering acceptance is that the best standards for high-fidelity lie in the ears of the listener and that the customer's final selection of a system will be governed largely by his listening preference and pocketbook irrespective of advertising claims.

Electronic Foreign Trade Changed

Imports continued to rise steadily but exports dipped sharply last year

FINAL figures compiled by the United Nations for 1952 U. S. imports and exports of electronic equipment show that "wireless" or electronic imports of all kinds increased to $6.4 million in 1952, exceeding the 1951 total by $1.1 million. However, as is shown in the chart, the import increase last year was the smallest of the past four years.



▶ **Exports**—For the first time since 1949, electronic exports declined in 1952, according to UN valuation figures which are based on fob prices, both for exports and imports.

Total U. S. exports last year of all electronic equipment, ranging from complete tv sets to resistors and capacitors, reached a value of $76.2 million for a $17.4 million drop from 1951's record total of $93.6 million.

▶ **Companies**—Despite the drop in export trade that the U. S. electronic industry as a whole experienced last year, it is still big business for many companies.

For example, one large company, Westinghouse, at the beginning of 1953 had 377 distributors and sales representatives marketing its products in 145 foreign countries.

Sylvania reports that its total export sales for 1952 were the third largest in the history of the company.

IT&T, with 32 manufacturing companies in 19 countries and separate research laboratories in three countries, derived 55.3 percent of its total manufacturing sales of over $350 million from foreign markets.

▶ **Trade Action**—Electronic manufacturers are keeping an eye on the U. S. to see which way it will go with respect to foreign trade. The administration has indicated that it favors more trade with foreign countries which may mean a lower tariff policy. Importers are continuing to work for freer-trade also, and have formed a new committee for a national trade policy which has started a research project to illustrate the extent to which industry and labor in the U. S. are dependent on a high level of exports.

Financial Roundup

PROFIT statements recently issued by companies in the electronics field indicate that the first nine months of this year were the best on record for the industry. Following are the net profits made during the period by 18 firms in the field:

Company	Net Profit 1953	Net Profit 1952
Admiral	$6,564,848	$3,741,107
AMF	3,053,000	2,594,000
AT&T	203,080,075	171,976,436
Avco	3,163,343	6,647,079
Clevite	2,771,221	2,432,693
CBS	5,661,343	3,618,489
DuMont	935,000	359,000
GE	116,386,000	94,750,000
Magnavox (3m)	923,353	637,827
Minnesota Mining	13,708,826	11,442,337
Motorola	6,176,837	4,079,262
RCA	25,152,018	17,847,110
Stewart-Warner	3,187,186	2,828,306
Stromberg-Carlson	1,328,391	779,614
Sylvania	7,562,941	5,031,701
Webster-Chicago	539,933	loss 350,793
Westinghouse	53,219,000	48,741,000
Zenith	4,098,074	2,576,212

▶ **Offerings**—Cook Electric offered 10,041 shares of common stock to its shareholders ($12.50 par) at $28 per share. Net proceeds will be used for working capital.

Lee Broadcasting Corp. offered 6,250 shares of 6-percent cumulative convertible preferred stock at par, $20 per share. Net proceeds will be used to buy 45 per cent of the common stock of Petersburg Television Corp. and to complete payment on its new studios.

ORRadio Industries, makers of magnetic tape, offered 149,500 shares of common stock (par 25 cents) at $2 per share. Proceeds are to be used to expand its magnetic iron oxide grinding and mixing department, to pay for advertising and promotion and for working capital.

Triad Transformer offered 10,060 shares of common (par $5) at $10 per share. Proceeds will be used for bank loans, increased inventories and for working capital.

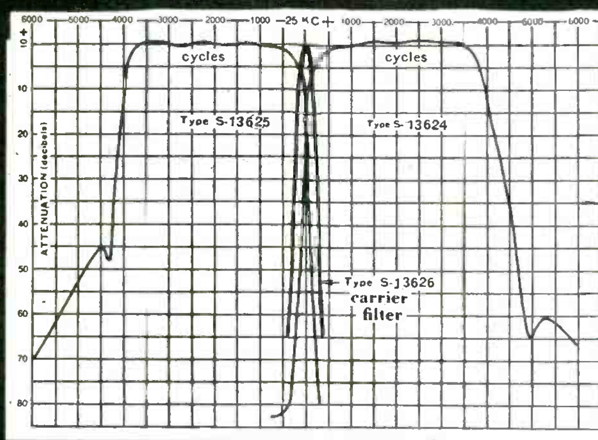
Superior Cable offered 600,000

(Continued on page 22)

RIGHT ON TOP

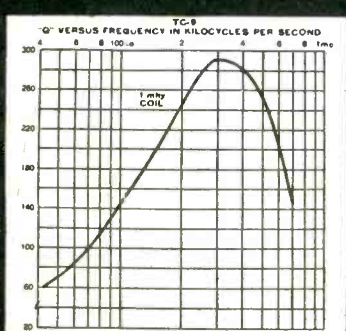
Burnell records a few of it's most recent engineering achievements in Toroids and Filter Networks.

SIDE BAND FILTERS



Our most recent engineering achievement in communications filters has already stirred the interest of the leading receiver manufacturers in the country.

Our new side band filters which eliminate, for most applications, the necessity for expensive crystal filters are expected to accelerate the advancement of single side band communications.



SUB MINIATURE TOROIDS

Toroids for intermediate frequencies of 100KC to 1 megacycle. A wide variety of coils ranging in size from ½ inch provides high Q in the frequency range between audio and RF.

The tiny toroid about the size of a dime has been welcomed by designers of sub miniature electronic equipment for the transistor, guided missile and printed circuit field.

PLUG IN DECADES

An entirely new development in inductance decades eliminating disadvantages of switch boxes. Inductance units plugged together in various combinations providing decade steps of inductance with minimum number of units required.

MINIATURE TELEMETERING FILTERS

In recognizing the need for miniaturization of the presently bulky telemetering equipment, our engineering staff has succeeded in reducing the size of telemetering filters to as little as 25 to 50% of the original volume.

BURNELL & COMPANY is very pleased to announce that it now has available a 12 page catalog which includes valuable and complete information on toroids, high quality coils, and various audio filter networks.

The catalog includes complete descriptions, attenuation and Q curves that will prove valuable for equipment design engineers.

Write for Catalog 101-A.

Burnell & Company
YONKERS 2, NEW YORK
CABLE ADDRESS "BURNELL"

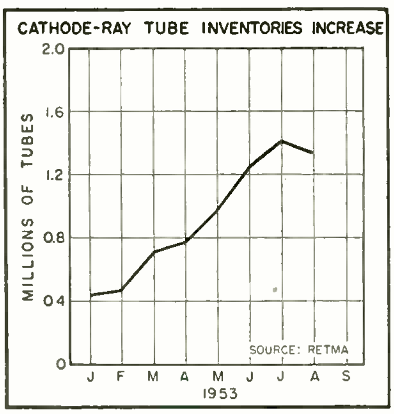
Exclusive Manufacturers of Communications Network Components

shares of common stock at $1 per share. Net proceeds will be used for working capital.

▶ **Registrations**—AT&T registered with SEC covering $625 million of convertible debentures to be offered to stockholders at $100 for each $100 debenture. Proceeds will be used to aid subsidiary plant expansions and for general corporate purposes.

General Precision Equipment registered with SEC covering 108,167 shares of $50 cumulative convertible preferred stock. Proceeds will be used to repay $3.9 million in bank loans and to increase general corporate funds.

Picture Tube Inventories Settle Back



CATHODE-RAY TUBE manufacturers put away an increasing number of tubes in their warehouses every month but August. In that month the stockpile dropped, for the first time in 1953, from 1.4 million in July to 1.3 million units valued at about $32 million.

Tube manufacturers have not been alarmed by the trend, even though the August drop made some breathe more easily. Larger inventories were to be expected because of increased production and sales. Sales this year are over double 1952 volume so that even doubled inventories are within accepted ratios.

▶ **Space**—Larger stocks have brought problems, one main one being storage space. With over 70 percent of production in 19 to 21-inch tubes, which need about 12 cubic feet of space, the industry has had to provide, for present inventory alone, over 12 million cubic feet of storage space.

As a result, nearly every major tv tube and set manufacturer has built additional tube warehouse space this year. GE's tube department alone has expanded its warehouse facilities by 171,000 sq ft so far this year.

Industry Discounts Fat Profits

Wary optimism keynotes outlook for future business; Let-up signs appear

FATTEST profits yet for any nine-month period were chalked up by many electronic manufacturers as the third quarter of 1953 ended. According to the National City Bank of New York, the net income of 21 firms in the field totaled $232.8 million for the period, a 24-percent increase over the $188.1 million taken in during the first nine months of last year. The increase for individual manufacturers ran as high as 50 percent.

Despite the record totals, many electronic companies view the future business prospects with caution.

▶ **Ahead**—Clevite president, James L. Myers, reported that his company looks for continued good business in the fourth quarter and while it is prepared to meet changing conditions by maintaining flexibility in operating plans, it is generally optimistic about the first half of 1954.

President Ralph J. Cordiner of GE said that the company saw no reason why consumer durables cannot continue to maintain a good volume with proper selling effort at all levels. He said that the cut back in personal income taxes and expiration of the excess profits tax, scheduled to take effect January 1, should help to sustain a good volume of business next year.

R. C. Tait, president of Stromberg Carlson said that indications point to continued high level of business in all divisions of the company for the final quarter of the year, and present projections for 1954 are most encouraging.

Sylvania's president, H. Ward Zimmer, said that there is every reason to believe that the firm's sales in the final quarter of the year will be the largest for any quarter of 1953. He asserted, in discussing the economic situation generally, that "it has been obvious for some time that the American economy has been running at top speed and would have to slow down a little to get its breath for the next forward move. A year or more of readjustment at a slightly slower pace will still be pretty good for most business."

▶ **Let-Up**—Signs of a slow down in the television field became evident in November. During the month six tv manufacturers announced cuts in production and employees ranging from 3 to 20 percent. The traditional fourth-quarter rush seemed to be slowing to a walk compared to 1952's record.

Russian Radio Set For Move Into Guatemala

REPRESENTATIVE of the commercial section of the USSR Embassy in Mexico visited Guatemala for the first time recently and offered table model radios, reported to be exact copies of American-made sets, at prices substantially below U. S. models. The Russian representative stressed that tubes and parts for the sets are interchangable with U. S. parts and said that the most popular radio in his line was the "Vostok" model.

▶ **Results**—Reception of the Russian offerings was less than en-

(Continued on page 24)

Save your customers 95% cooling water
Help them banish tube burn-outs

—with G.E.'s new

TEMPERATURE-CONTROLLED IGNITRONS!

Biggest ignitron advancement in 20 years!
These new G-E tubes also—

- **Keep down equipment and installation costs by eliminating cooling-water relays and interlocks.**
- **Do away with damaging tube surface-moisture condensation, or "drip".**
- **Have sealed-in optimum performance—need no adjustment for life of tube.**

CLEAN, sediment-free cooling water costs your customers money. By using G-E temperature-controlled ignitrons in your equipment, you can save customers as much as *one million gallons* in a 3-shift day, when the welder installation is a large one. You cut water use and cost to 1/20 what they were . . . you safeguard busy plants against slowdowns from city water shortages.

Equally important, these new G-E ignitrons protect automatically against tube overheating and overloading—and can extend the protection to transformers and welding electrodes. What a saving for your customers in costly replacements! It's the biggest forward step yet taken toward welder-maintenance economy.

Get full information . . . today! Write for Booklet ETD-814, just off the press, with all the facts about G.E.'s new temperature-controlled ignitrons. *Tube Department, General Electric Co., Schenectady 5, N. Y.*

NEW
GL-6347
Size C. Will replace GL-5552/FG-235-A

Also available are—

NEW GL-6346
Size B. Will replace GL-5551/FG-271

NEW GL-6348
Size D. Will replace GL-5553/FG-258-A

GENERAL ELECTRIC

163-1A10

thusiastic by Guatemalan importers and retailers and as yet no actual orders have been reported. Nevertheless, Russian-made merchandise is expected to be on display in Guatemala City before long at prices considerably below U. S., Canadian and European products.

March Named Electronic Division Administrator

COMMERCE Department has named Perrin G. March III as an assistant administrator of its new Business and Defense Services Administration in charge of activities that cover communications and electronics. He is president of the Cincinnati Shaper Co., manufacturers of metal-working machinery. W. Elmer Pothen, of Northwestern Telephone Co., continues as director of the communications equipment division. Donald S. Parris, a career government employee, named acting director of the electronics division of NPA last January, continues in that position in BDSA.

Licensing Plans Are Set For Microstrip

ENGINEERS and scientists, representing many aviation and electronic firms, were told at an all-day session at IT&T Laboratories that the company plans to make its method of microwave wiring available to users under special licensing agreements. The microstrip process is covered by more than 30 IT&T patents and applications.

► **Parts**—Two license plans are offered by the company, one for end equipment makers and the other for parts companies. Microwave plumbing manufacturers and printed circuit fabricators are offered a special limited-term license that could enable them to sell the product commercially within the next three to six months.

Comparison of the weight of the two types of equipment showed that a receiver using microstrip weighed five pounds compared to 62 pounds for a conventional set.

TV Table Model Output Is Up

Consoles and consolettes have accounted for the bulk of production but table sets gain

TYPES of television receiver models that lead in volume production have changed considerably in the past four years and indications are that further changes are in the making. Table model tv sets are gaining in importance. During the first nine months of this year, over 45 percent of total tv production has been in table sets for a six-percent increase since 1950.

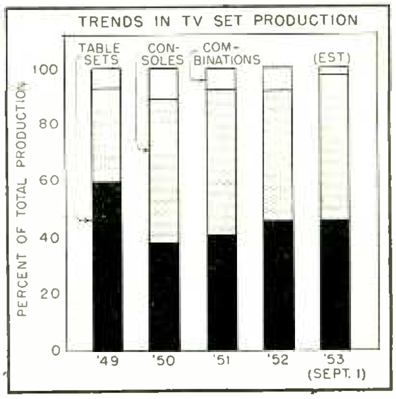
► **Large Cabinets Up**—But consoles and consolettes still account for the bulk of tv output. So far this year, they represent 52 percent of total tv production, the highest percentage on record.

Table and console model increases have been at the expense of tv phonograph combinations which, through September, have accounted for only 3 percent of total tv production, the lowest percentage on record. Last year their proportion of total output was 8 percent.

► **Reasons**—Television manufactures see a number of reasons for the production changes that have occurred. As one manufacturer put it, distributors and dealers are constantly demanding lower list prices and larger ratios of price-leader sets. This has added up to larger proportions of lower priced sets.

The growing second set and replacement markets have also been causes for changes in model production. Manufacturers have found that in older markets, such as New York City, the demand for table sets is proportionately greater than ever before. Increased hi-fi sales along with greater sales of separate phonographs have also cut big-set sales and added to the volume of table and console business. Color tv publicity is also blamed for the decline.

► **Future**—Although final industry production figures are not in yet for the last three months of 1953,



there are indications that set makers are devoting more of their output to table sets. Two major manufacturers have announced that from 60 to 70 percent of their current output is in table models.

R-F Heating Output Remains High

Automotive industry leading user; tube equipment sales exceed $20-million yearly

KEEN competition is the watchword in the r-f heating business with many new firms entering the business each year. Happily, uses expand to accommodate the increased output and everyone presumably profits.

Sales of electron-tube equipment for induction heating stand at about $20-million annually. This constitutes slightly less than half the induction-heating business; the balance is made up by motor-generator machines.

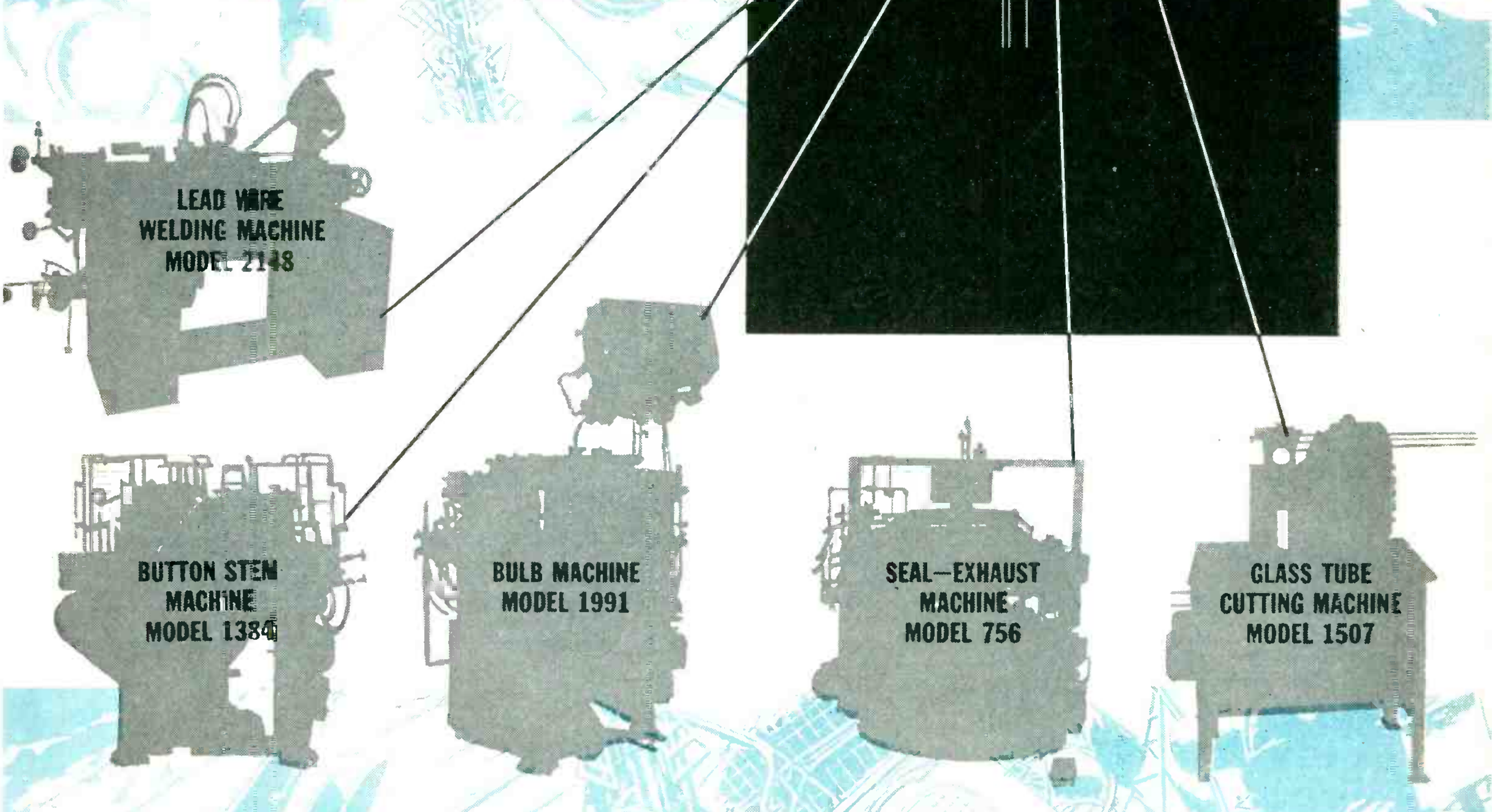
The average vacuum-tube unit is rated at 20 or 25 kw with many 5 and 10 kw being sold. Motor-generator equipment runs larger, starting at 50 kw. Units of 150 kw are popular.

► **Uses**—Largest user of induction-heating equipment is the automotive industry where it is used for selective hardening of small parts, generally not over ½-inch in diameter. The equipment is also used widely for brazing and soldering. The vacuum-tube industry is

(Continued on page 26)

AUTOMATIC TRANSISTOR MACHINERY...

you can produce 1200* EACH HOUR with KAHLE equipment



Now you can mass manufacture transistors that are *evacuated* and *sealed in glass* at the rate of 900 to 1200* per hour or more! KAHLE, the largest producer of custom machines for the glass and electronics industries, supplies the automatic equipment you need for every operation in making a transistor that is ½ of an inch long.

(Write KAHLE now for complete details!)

Kahle ENGINEERING COMPANY

1313 SEVENTH STREET NORTH BERGEN, N. J.

another important user of induction-heating equipment employing it to make both vacuum tubes and transistors. A companion to induction heating, r-f dielectric heating is also used in industry, especially for heating preforms in plastic molding.

Bigger Audio Fair Reflects Business Boom

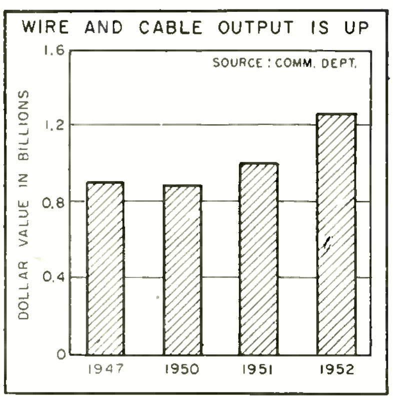
WITH both attendance and exhibition space double that of last year the fifth annual Audio Fair in New York City seems to indicate that the hi-fi field is still an expanding one.

Over 25,000 visitors looked and listened during the four-day show. The exhibits, by 150 manufacturers and distributors, took up four floors of the Hotel New Yorker.

▶ **New Lines**—New items at the show included the complete lines of hi-fi equipment shown by a number of the larger radio-tv manufacturers.

Barium titanate ceramic phonograph pickups shown by several companies got considerable attention.

Insulated Wire and Cable Output Grows



Expanding production of electronic equipment has been responsible for an important part of increased sales by insulated wire and cable manufacturers. Value of shipments has increased annually by nearly $200 million since 1950 and may total over $1.4 billion this year

MEETINGS

DEC. 1–2: Frequency Response Symposium, ASME, Hotel Statler, New York, N. Y.

DEC. 2 and 9: Symposium On A Statistical Approach To Experimentation, AIEE, Edison Auditorium, New York, N. Y.

DEC. 8–10: Joint AIEE-IRE-ACM Computer Conference and Exhibition, Statler Hotel, Washington, D. C.

DEC. 10–11: Symposium On Electronic Plethysmography or Blood Volume Measurement, sponsored by IRE Professional Group On Medical Electronics in cooperation with the University of Buffalo, Buffalo, N. Y.

DEC. 14–16: Second Annual Wire And Cable Symposium, sponsored by Signal Corps Labs and the wire and cable industry, Berkeley Carteret Hotel, Asbury Park, N. J.

JAN. 18–22, 1954: Winter Meeting of AIEE, Hotel Statler, New York, N. Y.

JAN. 26, 27, 1954: AIEE Scintillation Counters Conference, Washington, D. C.

JAN. 1954: Conference on Radio Astronomy, Carnegie Institute of Washington, California Institute of Technology and National Science Foundation, Washington, D. C.

FEB. 4–6, 1954: Sixth Annual IRE Conference And Electronics Show, Hotel Tulsa, Tulsa, Oklahoma.

FEB. 11–12, 1954: Joint IRE, AIEE, ACM West Coast Computer Conference, Ambassador Hotel, Los Angeles, Calif.

FEB. 18–19: IRE, AIEE Conference on Transistor Circuits, Philadelphia, Pa.

MAR. 22–25: IRE National Convention, Waldorf-Astoria Hotel and Kingsbridge Armory, New York, N. Y.

APRIL 22–23, 1954: AIEE Conference On Feedback Control, Claridge Hotel, Atlantic City, N. J.

APRIL 24, 1954: Eighth Annual Spring Technical Conference, Cincinnati IRE, Cincinnati, Ohio.

APRIL 27–29: AIEE Electronic Components Conference, Washington, D. C.

MAY 4–6: The 1954 Electronic Components Symposium, Department of Interior auditorium, Washington, D. C.

MAY 5–7, 1954: Third International Aviation Trade Show, 71st. Regiment Armory, New York, N. Y.

MAY 7–8: New England Radio Engineering Meeting, IRE, Sheraton Plaza Hotel, Boston, Mass.

MAY 24–26, 1954: AIEE Conference On Telemetering, Morrison Hotel, Chicago, Ill.

JULY 6–9, 1954: International Conference On Electron Microscopy, Joint Commission on Electron Microscopy of International Council of Scientific Unions, London, England.

SEPT. 1–16: Golden Jubilee Meeting of the International Electrotechnical Commission, University of Pennsylvania, Philadelphia, Pa.

SEPT. 13–24, 1954: First International Instrument Congress And Exposition, Commercial Museum and Convention Hall, Philadelphia, Pa.

SEPT. 1954: International Scientific Radio Union, Amsterdam, Netherlands.

SEPT. 30–OCT. 2, 1954: Second Annual International Sight and Sound Exposition, Palmer House Hotel, Chicago, Ill.

Industry Shorts

▶ **Sales** of GM's autronic eye for the first nine months of 1953 have ranged from 26 percent of total automobile production for one division of the company to lesser amounts for the others.

▶ **Houston** jail installed $45,000 worth of industrial tv equipment to watch inmates. Two utilities in California also installed itv to keep an eye on boiler furnaces.

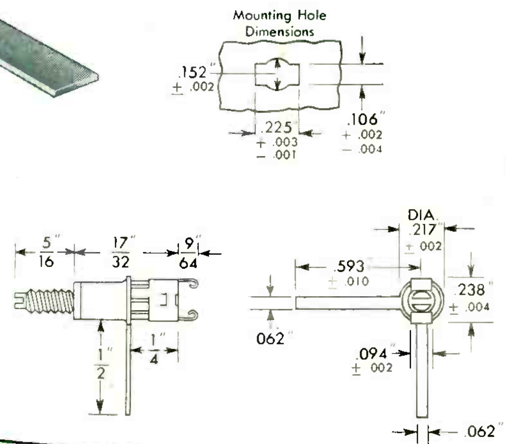
▶ **System** that detects the degree of a person's exposure to atomic radiation, now being made by U. S. electronic manufacturers, consists of a phosphate-glass detector which is sensitive to radiation and a radiac computer-indicator which measures the amount of radiation the glass has absorbed.

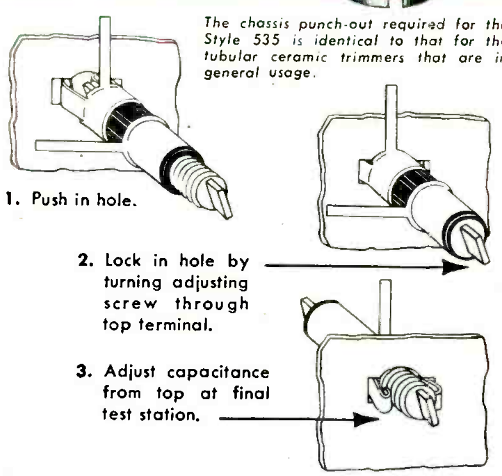
▶ **First** television manufacturer licensed to produce the Lawrence Chromatron color tube is Crosley.

▶ **Price** to tv set manufacturers of $125 for 15-inch color tv picture tube was set by CBS-Hytron.

REAL Miniaturization... PLUS Low Loss for UHF...

ERIE STYLE 535 TUBULAR TRIMMER





The capacitance adjusting plunger can be supplied with either screw driver slot shown in the large illustration, or with a milled flat end illustrated above.

Simplicity of design makes possible the extremely small size of the ERIE Style 535 Trimmer. The same simplicity of design results in very low inductance and unifrom, straight-line, noiseless adjustment. It can be mounted close to associated circuit elements, and the ribbon type leads help to minimize inductance in UHF circuits.

As shown at the left, the operator works from only one side of the chassis when installing the trimmer . . . a production cost saving feature . . . no additional hardware required for chassis mounting. Also available with adapter for free-space mounting.

The ERIE Style 535 Tubular Trimmer combines the desirable features of small size, easy mounting, stable performance and economical price. Capacity range is from 0.7 to 3.0 mmf and working voltage is 500 volts. Write for full information and samples.

ERIE components are stocked at leading electronic distributors everywhere.

25th Anniversary
TRADE ERIE MARK
RESISTOR CORP.

ERIE RESISTOR CORPORATION . . . ELECTRONICS DIVISION

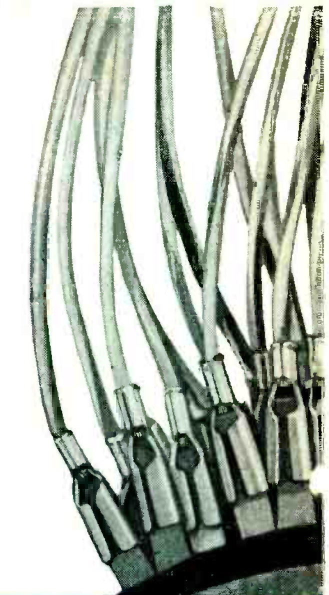
Main Offices: **ERIE, PA.**

Sales Offices: Cliffside, N. J. • Philadelphia, Pa. • Buffalo, N. Y. • Chicago, Ill. Detroit, Mich. • Cincinnati, Ohio • Los Angeles, Calif.

Factories: **ERIE, PA. • LONDON, ENGLAND • TORONTO, CANADA**

Want more information? Use post card on last page.

A NEW TERMINATION TECHNIQUE FOR . . .



- COMPUTERS
- SWITCHBOARDS AND INSIDE PLANT EQUIPMENT
- RELAYS, SWITCHES, AND MULTI-CIRCUIT COMPONENTS

AMP FLAT* TAPER

If you are concerned with the wiring of close spaced equipment, investigate the new AMP Solderless TAPER TAB RECEPTACLE for flat relay or switch tabs shown at right. It is self locking when installed on a male tab with matching 3½° taper, yet can be removed and reconnected any number of times without solder or special tools. These terminals are supplied on reels in continuous strip. Customer crimps them on wires using AMP automatic machines at speeds up to 4,000 per hour!

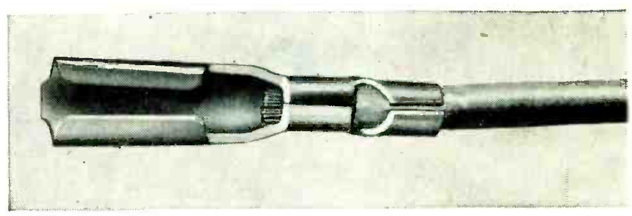
Performance of these miniature connectors meets exacting requirements for millivolt drop, corrosion resistance, and vibration. They are suited for critical low level circuits or power circuits up to several amperes.

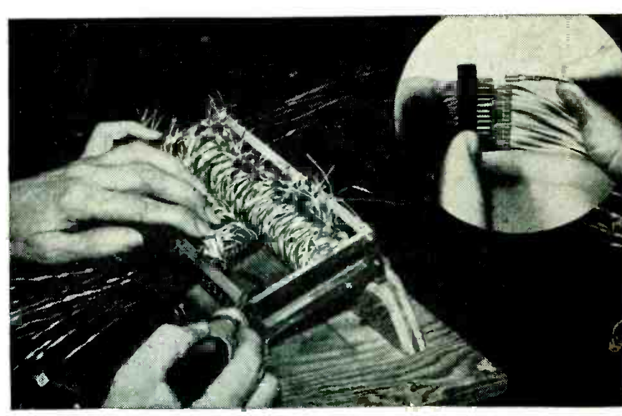
Write to AMP Electronics Division for complete information concerning AMP TAPER TAB RECEPTACLES . . . you will receive data and samples by return mail.

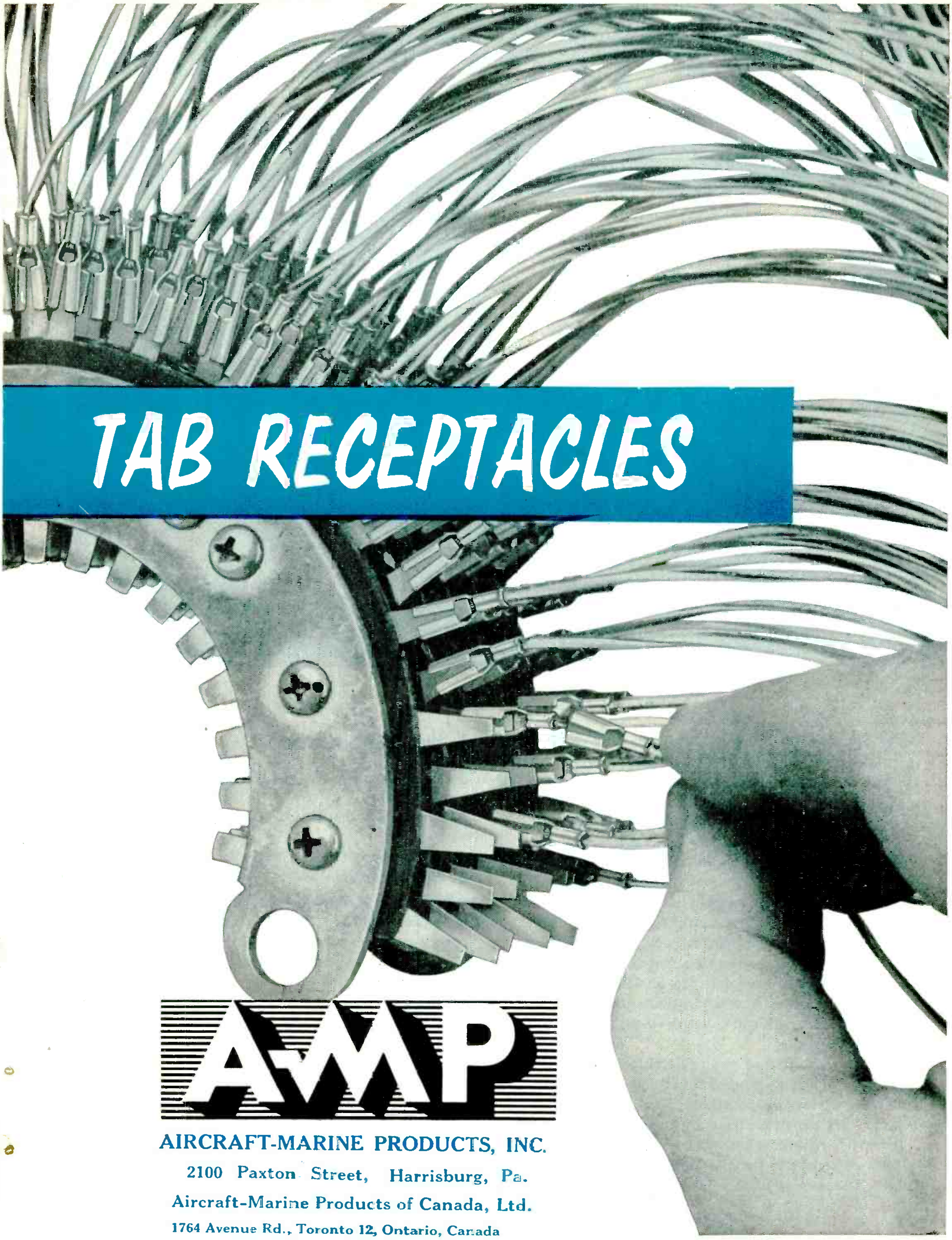
An example of the savings possible with Taper Tabs and Receptacles. This disconnect block in Remington Rand's new electronic computer had more than 1,000 wires soldered to tabs in a space approximately 5" x 9"—an assembly operation requiring two weeks' time. After tabs were modified to taper shape (See picture insert), the same operator can now assemble two blocks per day—a 20 to 1 increase—using A-MP's Taper Tab Receptacle No. 41355. There are neither loose wire ends nor drops of solder in the assembly to cause shorts nor cold or rosin joints to open up in the field. Installation is simply a mechanical operation requiring little operator skill, resulting in greater uniformity.

*For connector plugs and other applications where a round pin is more adaptable, see AMP taper pins.

PHOTO AT RIGHT SHOWS AMP SELF LOCKING TAPER TAB RECEPTACLES BEING APPLIED TO MATING TABS ON A STEPPING SWITCH. LOCKING ACTION GIVES MAXIMUM ELECTRICAL AND MECHANICAL SECURITY . . . CONNECTIONS ARE SUITABLE FOR CRITICAL LOW LEVEL CIRCUITS.






TAB RECEPTACLES
A-MP
AIRCRAFT-MARINE PRODUCTS, INC.
2100 Paxton Street, Harrisburg, Pa.
Aircraft-Marine Products of Canada, Ltd.
1764 Avenue Rd., Toronto 12, Ontario, Canada

Our Blue Ribbon Resistor—designed in 1939—was the *first* flat or strip resistor in the field. And now, though there are others of similar type, the Hardwick, Hindle Blue Ribbon still holds first place—and *is still winning "blue ribbons,"* and such comments as quoted above.

Although its basic design is the same, recent improvements assure you "the finest flat resistor made."

Our crazeless gray enamel completely eliminates the disastrous crazing which results in failure of the resistive element due to moisture penetration from humidity, salt and other severe atmospheric conditions —thus giving greater dielectric strength.

The aluminum thru-bar, in contact with the internal surface of the ceramic core, distributes the heat more uniformly along its entire length—than conventional tubular resistors.

The studs—corrosion and rust resistant—are peened to serve as mounting supports and also to permit the stacking of two or more units when space need be saved. And our unique method of fastening the tube to the thru-bar prevents loosening under vibration.

As compared to the conventional tubular resistor Blue Ribbons give you:

1. Higher wattage rating per unit space requirement.

2. Reduction in space behind the panel or mounting surface.

3. Sturdy but simple mounting, either single or stacked.

4. Lighter weight.

5. Lower induction.

Our Blue Ribbons are designed for and manufactured in accordance with JAN-R-26A specifications.

Send for our catalogue, showing these and other Hardwick, Hindle resistors of distinction.

HARDWICK, HINDLE, INC.

Rheostats and Resistors

Subsidiary of

THE NATIONAL LOCK WASHER COMPANY

Established 1886

NEWARK 5, N. J. U.S.A.

The mark of quality

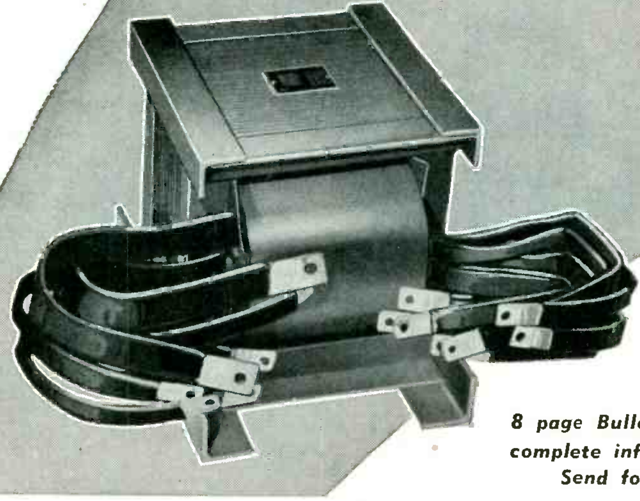
For more than a quarter of a century

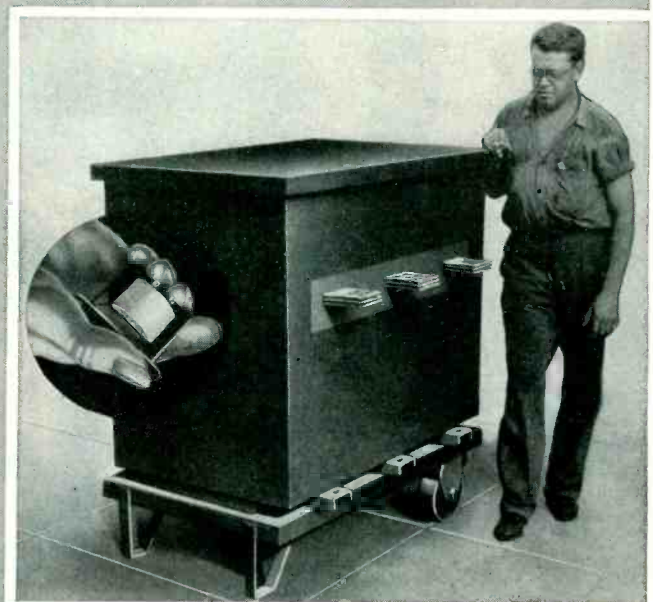
interested in **H-E** * **?** . . . . . *send for 8 page Bulletin*

YOU GET *Tops* IN *Transformer* PERFORMANCE

WHEN BUILT BY NOTHELFER

***HIGH EFFICIENCY**





8 page Bulletin gives complete information. Send for it!

NOTHELFER Transformers are superior because they are vacuum-pressure impregnated, and all joints over 10 amperes are silver-soldered. Bus leads of over 100 amperes are silver-plated, conservative copper and steel.

Laminations, oriented and most silicon steels are annealed in accurately controlled nitrogen atmosphere electric furnaces.

From 10 VA to 300 KVA Dry-Type only. Both open and encased. 1, 2, and 3 Phase. 15 to 400 Cycles.

NWL

ESTABLISHED 1920

Nothelfer **WINDING LABORATORIES**

9 ALBEMARLE AVE. TRENTON, NEW JERSEY

NATIONAL ASSOCIATION OF MANUFACTURERS MEMBER

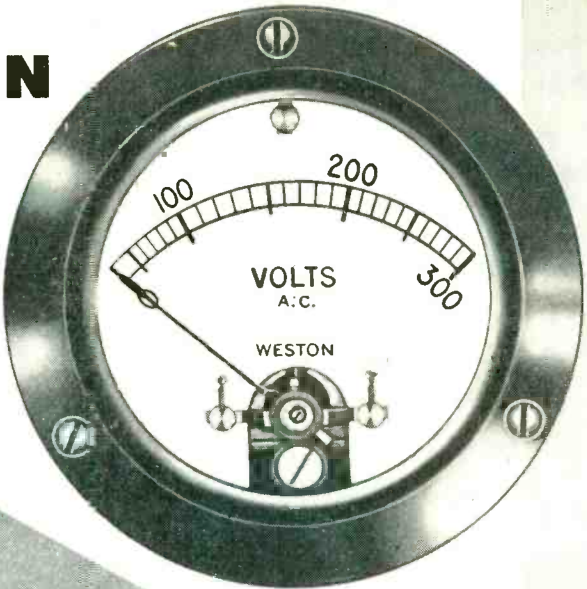
Manufacturers of Electrical Transformers— Testing Equipment

NEMA MEMBER

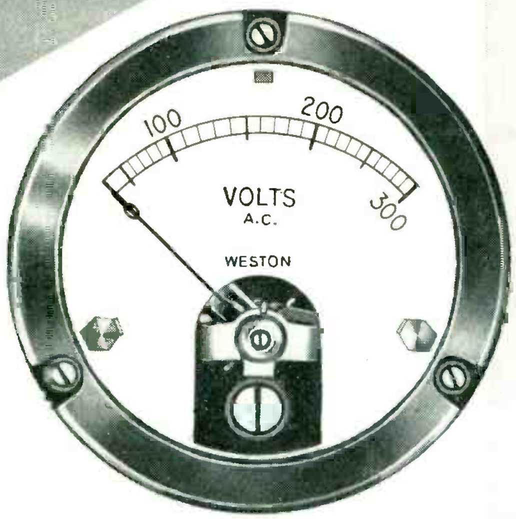
Want more information? Use post card on last page.

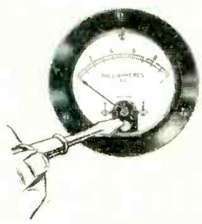
another **WESTON**

FIRST



A-C ruggedized instruments





All Weston Ruggedized instruments have externally operated sealed zero correctors.

Insulated, breakproof connection terminals are molded into internal rubber.

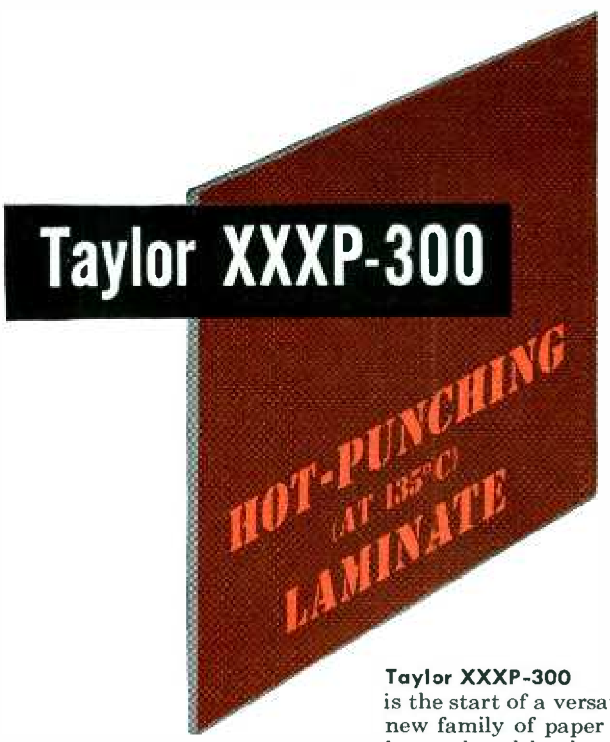
Tough, flat plastic windows are really shock resistant.

WESTON Ruggedized Instruments are available not only in D-C but in movable iron A-C, rectifier type A-C and thermo. *All* are supplied with essential sealed *zero correctors*—shock-resisting flat plastic windows—and connection terminals molded into internal rubber, *leakproof, breakproof and effectively insulated*. For complete details, write for bulletin. Weston Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

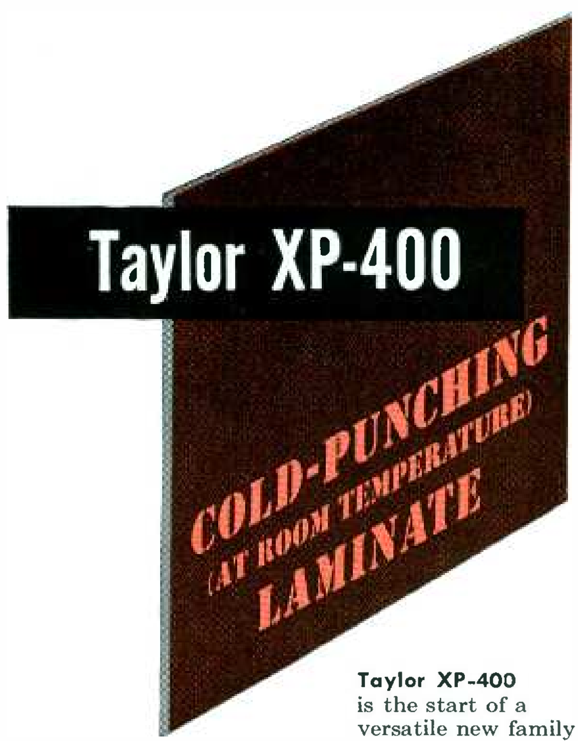
WESTON ruggedized instruments

Now...

Precision Production
Faster Fabrication
with two new series of high quality Taylor Laminated Plastics



Taylor XXXP-300 is the start of a versatile new family of paper base, phenol laminates for use in high quality electronic components requiring the ultimate in insulation resistance.



Taylor XP-400 is the start of a versatile new family of cold-punch, paper base phenol laminates having good electrical properties.

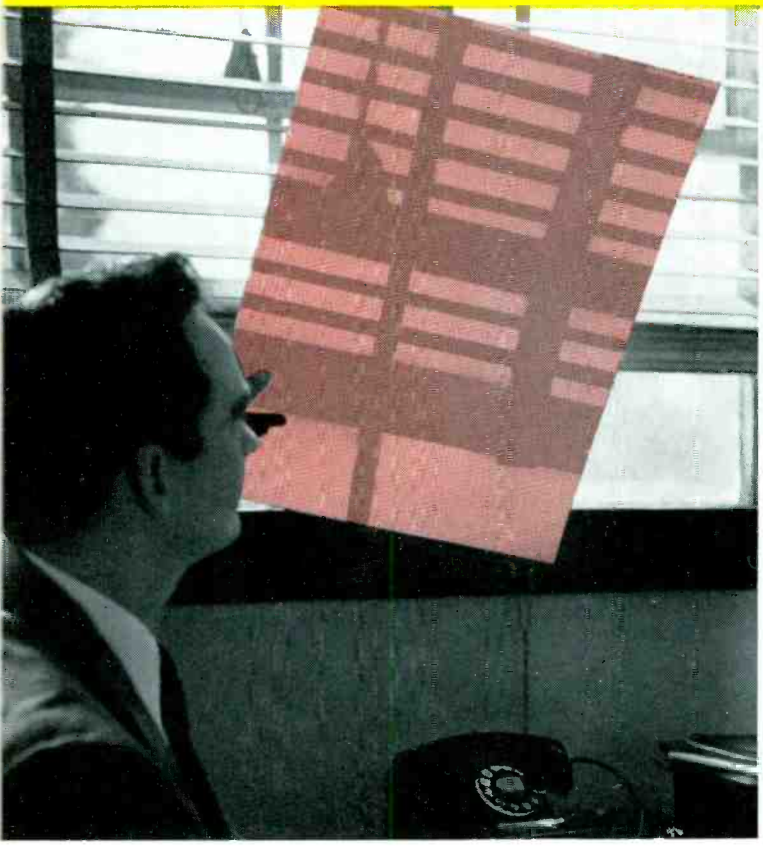
TAYLOR
Laminated Plastics
Vulcanized Fibre

Turn the page for detailed information of value to Management, Engineering, Production and Purchasing... »

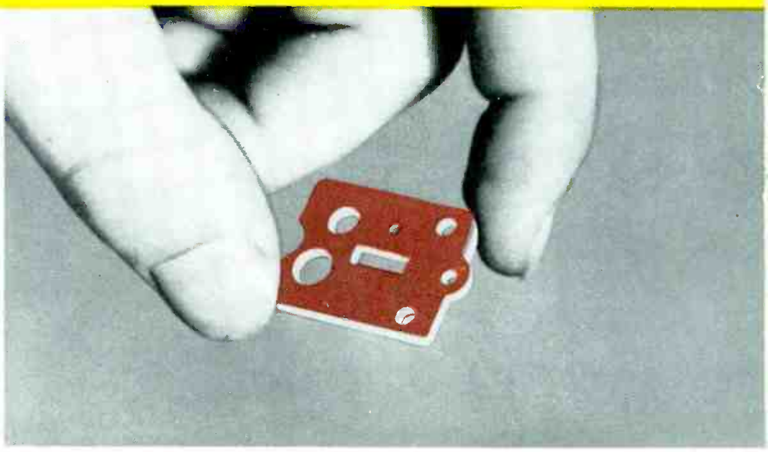
Here's why you'll want to use

XXXP-300

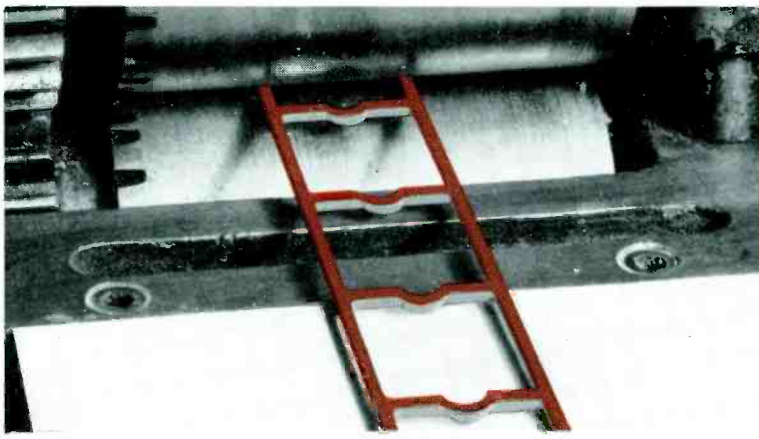
A completely new development, in both formulation and production, in the field of laminated plastics. . . . Extends the use of fabricated parts for a growing list of applications where high insulation resistance is a critical factor, yet meets the most rigorous *staking* and punching requirements. . . . Combines the most desirable specifications with an incomparable ease of fabrication that spells economy all along the line.



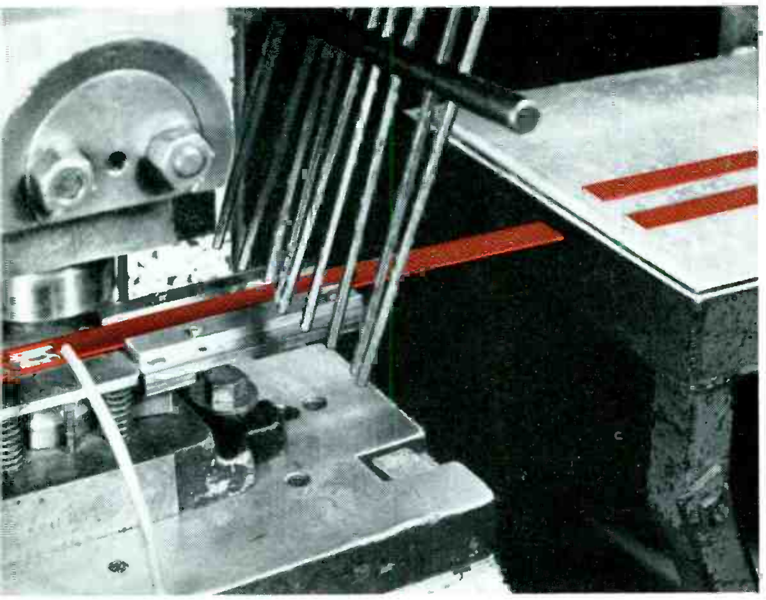
Sheet uniformity, directly related to punching quality, is demonstrated by the clear translucency of this material.



Smooth surface and clean-cut edges show absence of drag, raising, bulging and cracking with NEMA test die.*



Clean, smooth edges of unmarred ladder indicate ease of fabrication under satisfactory temperature conditions.



Continuity of good, clean punching means uninterrupted production — no waste, higher operating efficiency.

XXXP-300 *offers you*

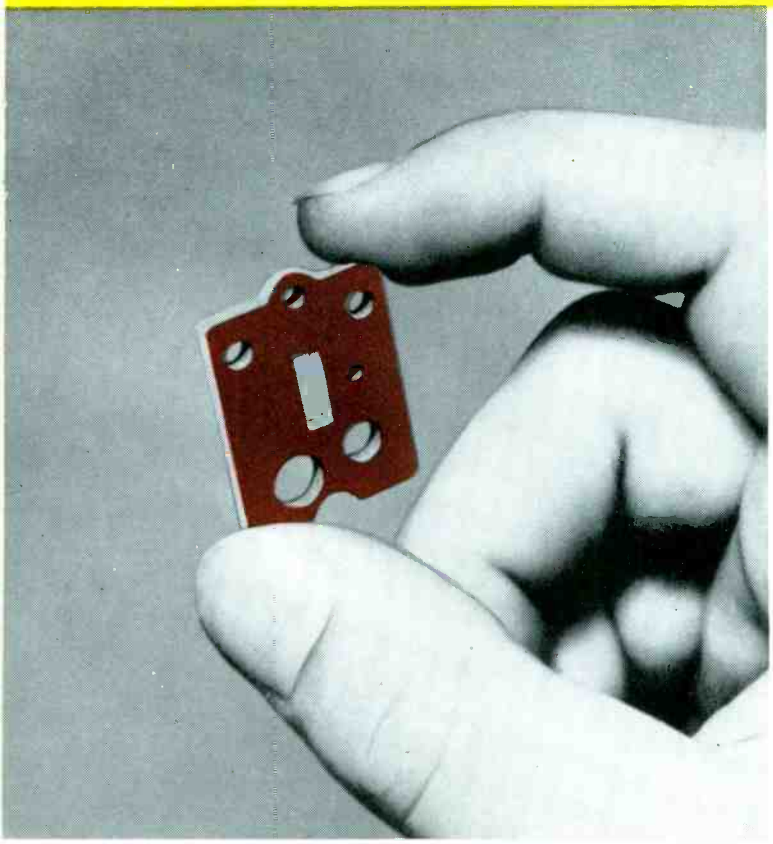
- excellent electrical properties
- low water absorption
- high dimensional stability
  —excellent *staking*
- low power factor
  —high insulation resistance
- flame retardance

and, punches perfectly at 135°C.

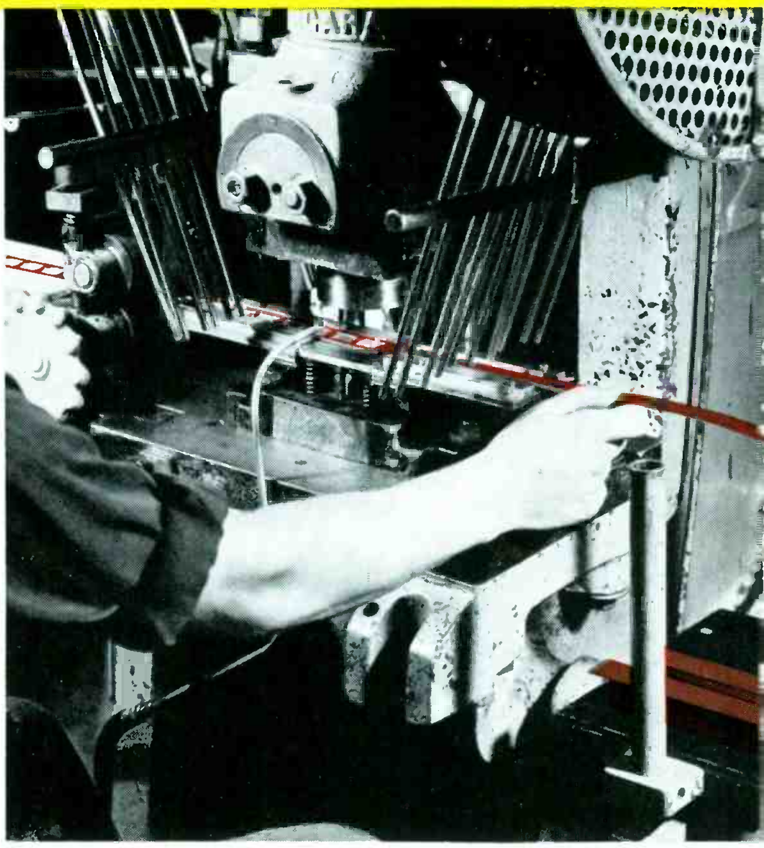
these two new Taylor Laminates

XP-400

A successful solution to the need for a true cold-punching laminate, one that actually punches without the addition of heat. . . . Brings a new ease of fabrication to the mass production of punched parts for thousands of applications. . . . Affords new opportunities for uniformity and efficiency in fabrication, resulting in a radical reduction of waste and the practical elimination of rejects.



Cold-punching from NEMA test die—holes are clean-cut, surface is smooth, edges show no chipping.*



The complete absence of heat in this operation demonstrates the practicability of true cold-punching.

XP-400 offers you

- low water absorption
- flame retardance
- excellent *staking*
- good impact strength
- high dielectric strength

and, punches perfectly at room temperature

Both of these new Taylor Laminated Plastics are the result of years of study and experience, *plus* 16 months of intensive research and development. They are now available in production quantities for applications where an outstanding combination of physical and electrical properties is required.

Sheet size: 49″ x 49″.

TAYLOR
Laminated Plastics
Vulcanized Fibre

TURN THE PAGE FOR COMPLETE SPECIFICATIONS »

*National Electrical Manufacturers' Association

Look . . . at the properties of these new materials . . . compared to NEMA standards! They are your guarantee of top performance, and it costs no more to get them

NEMA GRADE		TAYLOR GRADE	SPECIFIC GRAVITY	WATER ABSORPTION D/24/23	FLEXURAL STRENGTH THOUSANDS OF psi LW	FLEXURAL STRENGTH THOUSANDS OF psi CW	TENSILE STRENGTH THOUSANDS OF psi LW	TENSILE STRENGTH THOUSANDS OF psi CW	COMPRESSIVE STRENGTH THOUSANDS OF psi FLATWISE	IMPACT STRENGTH IN FOOT LBS. CONDITION E/48/50 LW	IMPACT STRENGTH IN FOOT LBS. CONDITION E/48/50 CW	ROCKWELL HARDNESS M SCALE	POWER FACTOR COND A 1MC	POWER FACTOR COND A 60 CYCLE	POWER FACTOR COND D/24/23 1MC	POWER FACTOR COND D/24/23 60 CYCLE	DIELECTRIC CONSTANT COND A 1MC	DIELECTRIC CONSTANT COND A 60 CYCLE	DIELECTRIC CONSTANT COND D/24/23 1MC	DIELECTRIC CONSTANT COND D/24/23 60 CYCLE	DIELECTRIC STRENGTH VPM SHORT TIME	DIELECTRIC STRENGTH VPM STEP BY STEP	DIELECTRIC STRENGTH PARALLEL KV STEP BY STEP COND A	DIELECTRIC STRENGTH PARALLEL KV STEP BY STEP COND D/48/50	INSULATION RESISTANCE CONDITION C96/35/90 MEGOHMS	FLAME RETARDANCE IN SECONDS (Run according to underwriters Lab by our own lab.) FW	FLAME RETARDANCE IN SECONDS 20 ANGLE	PUNCHING QUALITY	COLD FLOW 4000 psi FOR 24 HRS AT 50°C
P	1/16"		1.33*	2.80	13	[illegible]	12*	9*	25*	0.55	0.50	M95*									1/16" TK 650*	1/16" TK 450*	40.0	5.0					
PC	3/32"		1.34*	4.00	10	8	10*	8*	32*	0.60	0.55	M75*									1/16" TK 600*	1/16" TK 425*							
	3/32"	XP-400	1.31	.70	13	11	12	9	25	0.66	0.62	M80									698	505	62.5	16.0		2	45	GOOD	
XXXP	1/16"		1.30*	1.00	12	10	12*	9*	25*	0.35	0.30	M105*	.030		.035		4.60		4.80		650*	450*	60.0	15.0	20,000*				.8%*
	1/16"	XXXP-300	1.35	.50-	20	17	13	11	40	0.44	0.42	M105	.027	3.0%	.029	5.0%	3.72	4.18	4.75	5.15	800	670	65.+	59.+	300,000	8	40	GOOD	.6%
	1/16"	XXXP-301	1.32	.50-	18	14	13	10	31	0.47	0.44	M108	.026	2.7%	.028	6.0%	3.55	4.19	3.84	4.63	920	725	75.+	65.+	300,000 +	34	44	VERY GOOD	.6%

*NEMA engineering information only, not a standard

With these two new materials, the electrical and electronics equipment designer has new advantages he can build into his products. The production man can effect new economies through ease of shearing and punching and greater uniformity of fabricated parts with excellent *staking* characteristics. Here are two new families of Taylor made laminates each of which can be "Tailor Made" for you!

For all your requirements of Phenol, Melamine and Silicone laminates . . . as well as Vulcanized Fibre . . . try Taylor today and you'll standardize on Taylor tomorrow. The complete line of Taylor materials is available in a wide range of electrical, mechanical and physical properties. Taylor Engineers are well qualified to help your staff select the Taylor products best suited to your particular requirements . . . whether you buy raw stocks of sheets, tubes, rolls or rods . . . or specially fabricated parts.

For Your Files—Complete and comprehensive literature is available to show you how Taylor products can be put to profitable use in your products. Write today.

Taylor Fibre Co.—Plants in Norristown, Pennsylvania and La Verne, California

Branch offices in Asheville, Boston, Chicago, Cleveland, Dayton, Detroit, Indianapolis, Los Angeles, Milwaukee, New York City, Philadelphia, Pittsburgh, Rochester, St. Louis and Tolland, Connecticut. Distributors in Grand Prairie and Houston, Texas; New Orleans, Louisiana; and Toronto, Ontario.

TAYLOR
Laminated Plastics
Vulcanized Fibre

STANDARD PRECISION TIMERS

Part of the Picture

STANDARD

ESTABLISHED

1884

TIME AFTER TIME . . . in centralized control systems, and in scores of other places where the precise measurement of elapsed time is of the utmost importance, you will be sure to find Precision Timers by

STANDARD

STANDARD ELECTRIC'S precision timer is an important component of the nuclear reactor control room (shown below) at Brookhaven National Laboratory . . . as is the STANDARD ELECTRIC experimental patchboard in the Brookhaven chemistry laboratory.

The STANDARD ELECTRIC TIME CO.

97 Logan Street • Springfield 2, Massachusetts

LABORATORY PANELS
PIPELINE NETWORK ANALYZERS

PRECISION TIMERS
CHRONO-TACHOMETERS

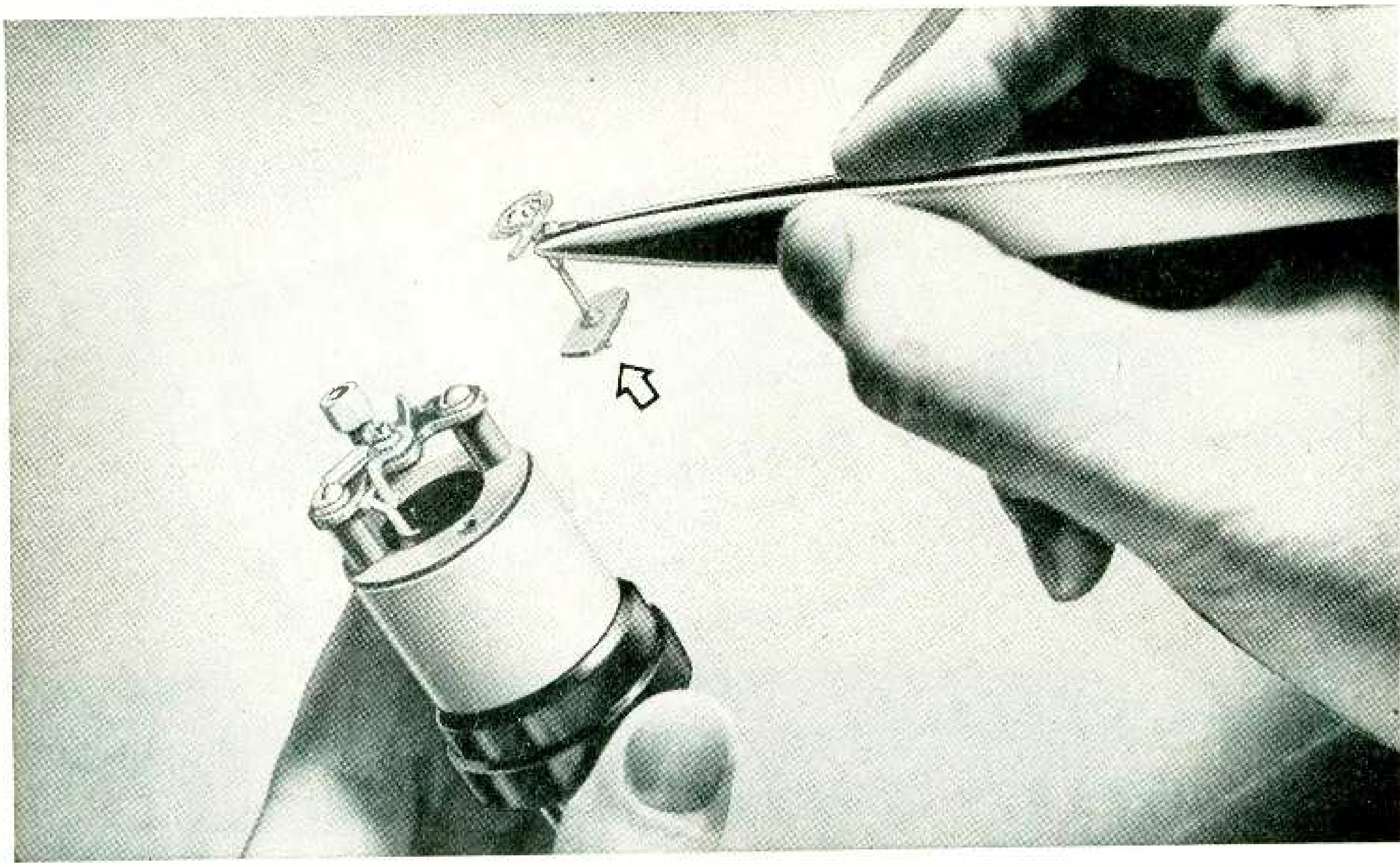
For benefits* like these, use

Here are typical benefits which you can *expect and get* by using Carboloy permanent magnets in your electrical products.

Check these case histories. Maybe a Carboloy permanent magnet can improve *your* product, too. Why not contact a Carboloy magnet engineer without delay. He'll lend you a hand in magnet design and application. His services will cost you nothing.

Carboloy permanent magnets retain their efficiency under most conditions of temperature, shock and vibration . . . high resistance to demagnetizing influence of stray magnetic fields . . . provide *powerful, lasting* magnetic energy.

Available in all sizes and shapes; can be cast or sintered to your needs. Send coupon for catalog and for design manual.



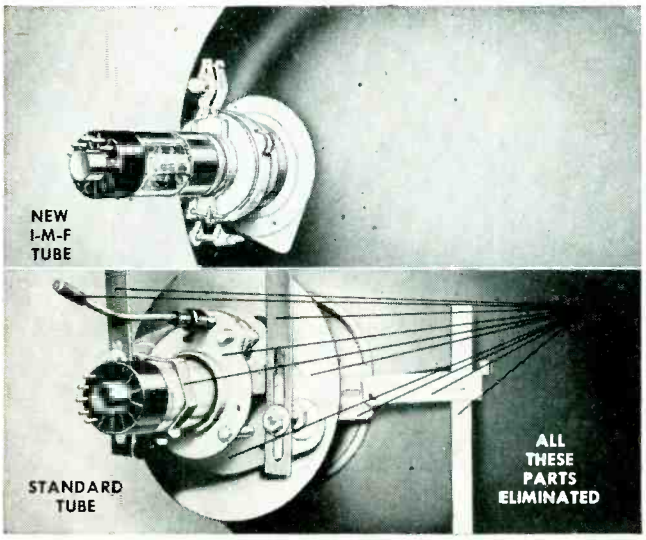
*Finer product performance

A small, powerful Carboloy permanent magnet enabled Thomas A. Edison, Inc. to design a revolutionary sensitive relay capable of operating from the current generated by a heated thermocouple. This power-packed magnet eliminated the need for electronic amplification, thus greatly simplified design of their aircraft fire-detecting system.

* YOU GET ALL THESE ADVANTAGES FROM CARBOLOY PERMANENT MAGNETS

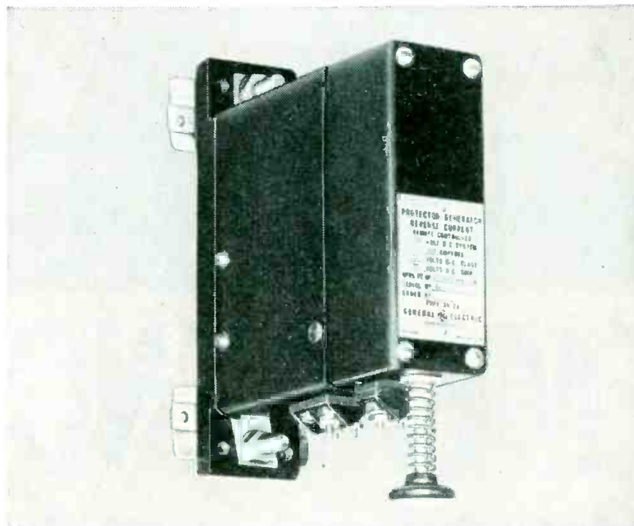
- Cool—generate no heat
- Require no electrical energy
- Cost nothing to operate
- Eliminate coils, windings, wiring, etc.
- Need no maintenance—no coils to burn out, no slip rings to clean or replace, etc.
- Simplify mechanical assemblies—exert strong tractive force for holding, lifting and separating devices that eliminates component parts, makes product design and fabrication simple
- Save space—great magnetic strength in small sizes
- Powerful—and power is constant
- Combine electrical and mechanical features—transform electrical energy into mechanical motion; mechanical motion into electrical energy
- No power failures ever
- Resist moisture—no coils to collect dampness
- Give uninterrupted operation
- Create savings—often eliminate costly, power-supplying parts
- Simple—no operating parts
- Reduce weight, product size
- Supply a permanent source of energy

Carboloy® permanent magnets



*Fewer Parts

New GE I-M-F television picture tube has its ion trap and magnetic focus device *inside end* of tube. Pictures are clearer, *prefocused* and many parts are eliminated . . . thanks to Carboloy permanent magnets.

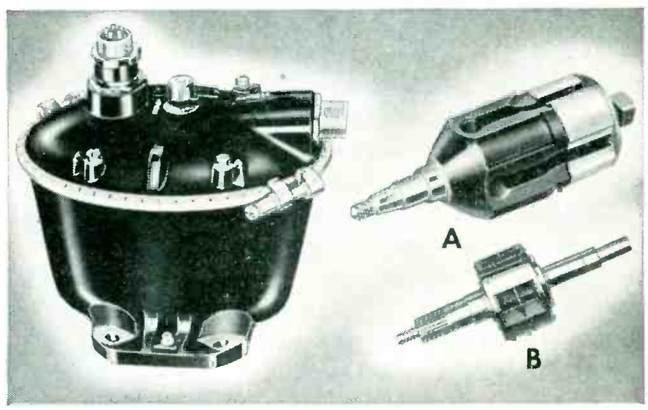


*Improved Design

In this circuit breaker a Carboloy magnet assembly simplifies the trip element. It eliminates a coil and polarizing connection . . . makes possible reverse-current tripping independent of system voltage.

*More dependability

New all-magnetic, all-transistor hearing aid (by E. A. Myers & Sons, Inc., Pitts.) uses magnets in *both* microphone and receiver. Hearing aid failure caused by operational heat and humidity is now eliminated.



*Less weight and space

Fig. A shows chrome magnet rotor once used in Scintilla aircraft magneto. It weighed 4 lbs. 9 ozs. New rotor (Fig. B) is made of Carboloy Alnico. It weighs only 2 lbs. 4 ozs., is considerably smaller.

Silver Anniversary
1928 1953
QUARTER CENTURY OF PIONEERING IN CREATED-METALS
CARBOLOY
DEPARTMENT OF GENERAL ELECTRIC COMPANY

Carboloy Department of General Electric Company
11139 E. 8 Mile Street, Detroit 32, Michigan

Rush me, without cost or obligation, copies of Permanent Magnet Design Manual PM-101 and Standard Stock Catalog PM-100.

Name__________ Position__________

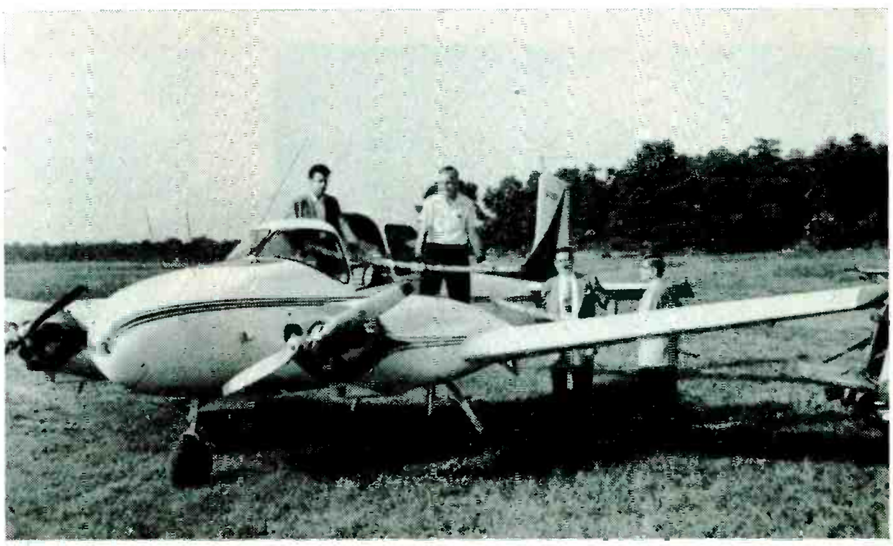
Company__________

Address__________

City__________ Zone_____ State__________

Want more information? Use post card on last page.

EMERGENCY "AIRLIFT" KEEPS 1500 AT WORK



BRISTOL, CONNECTICUT: Responding to a special appeal from an electrical manufacturing plant facing shutdown because of an unexpected failure in supply of critical material, a local brass mill flew to the rescue both literally and figuratively.

On Thursday afternoon the General Electric Company's plant in Somersworth, New Hampshire, suddenly found itself on the point of having to lay off many or all of its people because of non-delivery of a limited amount of nickel silver flatwire, made to extremely close dimensions and temper, and used in the manufacture of many small parts.

In exactly 5 days, including the week end, The Bristol Brass Corporation produced and delivered enough *brass* flatwire to meet these difficult specifications. On the following Tuesday the brass mill's truck transferred the wire to the mill's new Twin Navion plane at Bristol Airport, and less than 1 hour later the plane "delivered the goods" in New Hampshire.

General Electric's Somersworth plant management was impressed with the speed and resourcefulness with which the crisis was met and overcome by a relatively small supplier with experience and flexibility to move fast in an emergency. Well known for such service to many manufacturers throughout the country, The Bristol Brass Corporation has been making brass sheet, rod and wire here in Bristol, Connecticut since 1850, and has offices and warehouses in Boston, Chicago, Cleveland, Dayton, Detroit, Milwaukee, New York, Philadelphia, Pittsburgh, Providence, Rochester. The Bristol Brass Corporation of California, 1217 East 6th St., Los Angeles 21.

"Bristol-Fashion" means **Brass at its Best**

Never

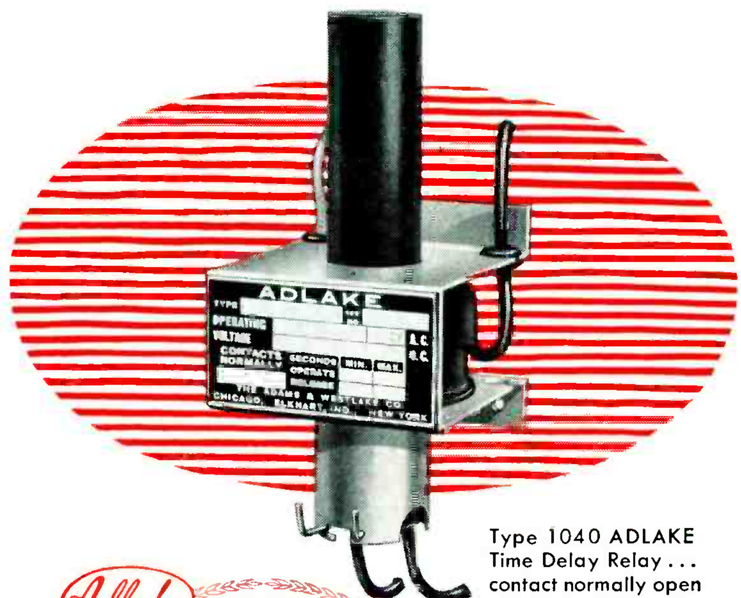
any Maintenance required with Adlake Mercury Relays!

Yes, thanks to their positive, leak-proof sealing . . . their sure-fire mercury-to-mercury contact . . . their immunity to normal vibrations and temperature changes . . . thousands of satisfied users in every branch of industry can testify that ADLAKE Relays literally require no maintenance whatever!

ADLAKE Relays have won their place by *proven dependability*—year in and year out—in jobs that conventional relays can do in an uncertain manner at best! For every ADLAKE Relay is tested—and guaranteed—to meet specifications!

Yes, in chick incubators or diesel locomotives—wherever sensitivity and dependability are required—you can always count on ADLAKE! Send for complete Relay catalog today . . . write The Adams & Westlake Company, 1171 N. Michigan, Elkhart, Indiana. In Canada, write Powerlite Devices, Ltd., Toronto.

Every ADLAKE Relay is tested...
and guaranteed...to meet
specifications!



Type 1040 ADLAKE Time Delay Relay . . . contact normally open

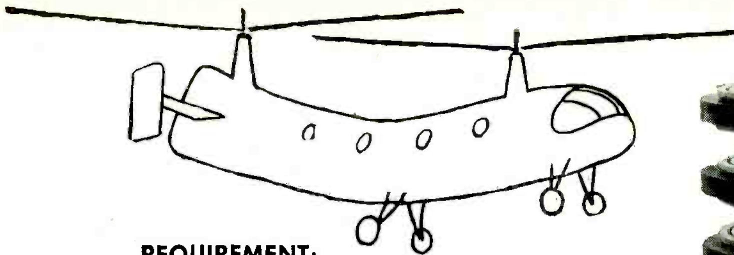
Adlake
TRADE MARK
96th year
of serving the transportation and building industries

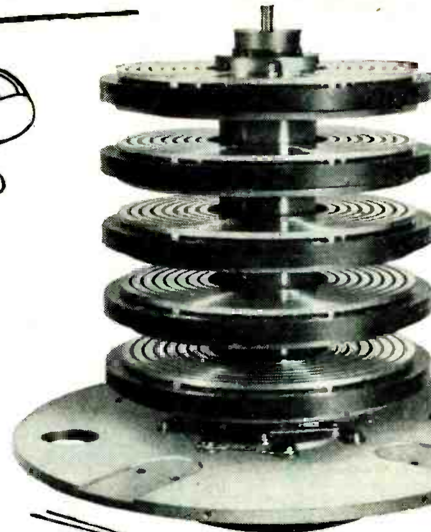
THE Adams & Westlake COMPANY

Established 1857 • ELKHART, INDIANA • New York • Chicago

Manufacturers of ADLAKE Hermetically Sealed Mercury Relays

Want more information? Use post card on last page.

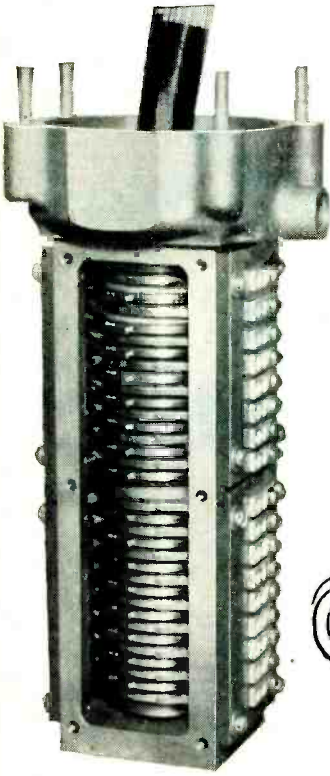


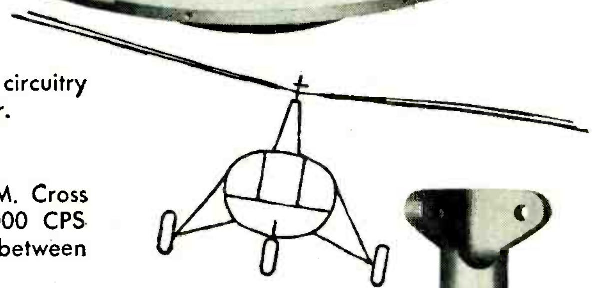


REQUIREMENT:
80-ring S.R.A. for *strain gauge* circuitry for Bell Aircraft helicopter

ACCOMPLISHMENT:
At a current of 15 milliamps at 300 RPM, no contact resistance or electrical noise detectable when measured with oscilloscope adjusted to maximum gain.

10½" total height

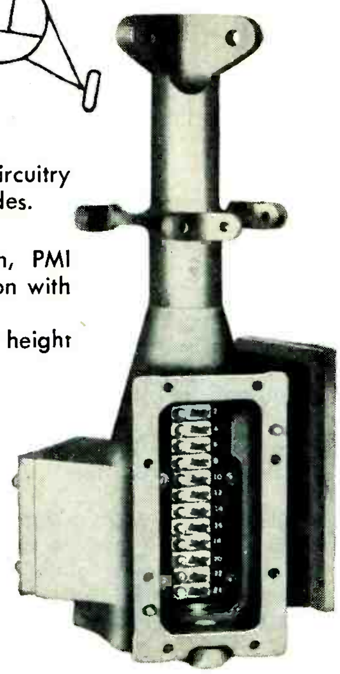




REQUIREMENT:
34-ring S.R.A. for *strain gauge* circuitry for McDonnell Aircraft helicopter.
(operating temp., 300°F.)

ACCOMPLISHMENT:
No detectable noise at 300 RPM. Cross talk at carrier frequency of 3,000 CPS held to attenuation of 60 DB between circuits.

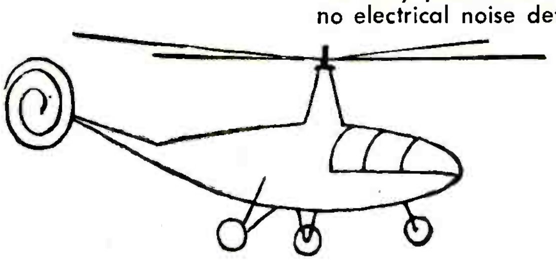
9" total height



REQUIREMENT:
25-ring S.R.A. for *thermocouple* circuitry for Prewitt Aircraft helicopter blades.

ACCOMPLISHMENT:
When tested on Mt. Washington, PMI assembly performed to specification with no electrical noise detectable.

10" mast height



slip ring assemblies —

for strain gauge instrumentation and thermocouple applications

When you require a Slip Ring Assembly to transmit low potentials through electrical systems containing sensitive instruments, PMI can be of assistance to you. The success we have had in this field has been due to the following factors:

- *Choice of brush materials*
- *Number of brush contacts per ring*
- *Choice of ring materials and finish on rings*
- *Adjustment of brush pressure to minimize voltage but still ensure long brush life*
- *Application of exacting tolerances between brushes and rings to eliminate introduction of contact resistance during rotation*

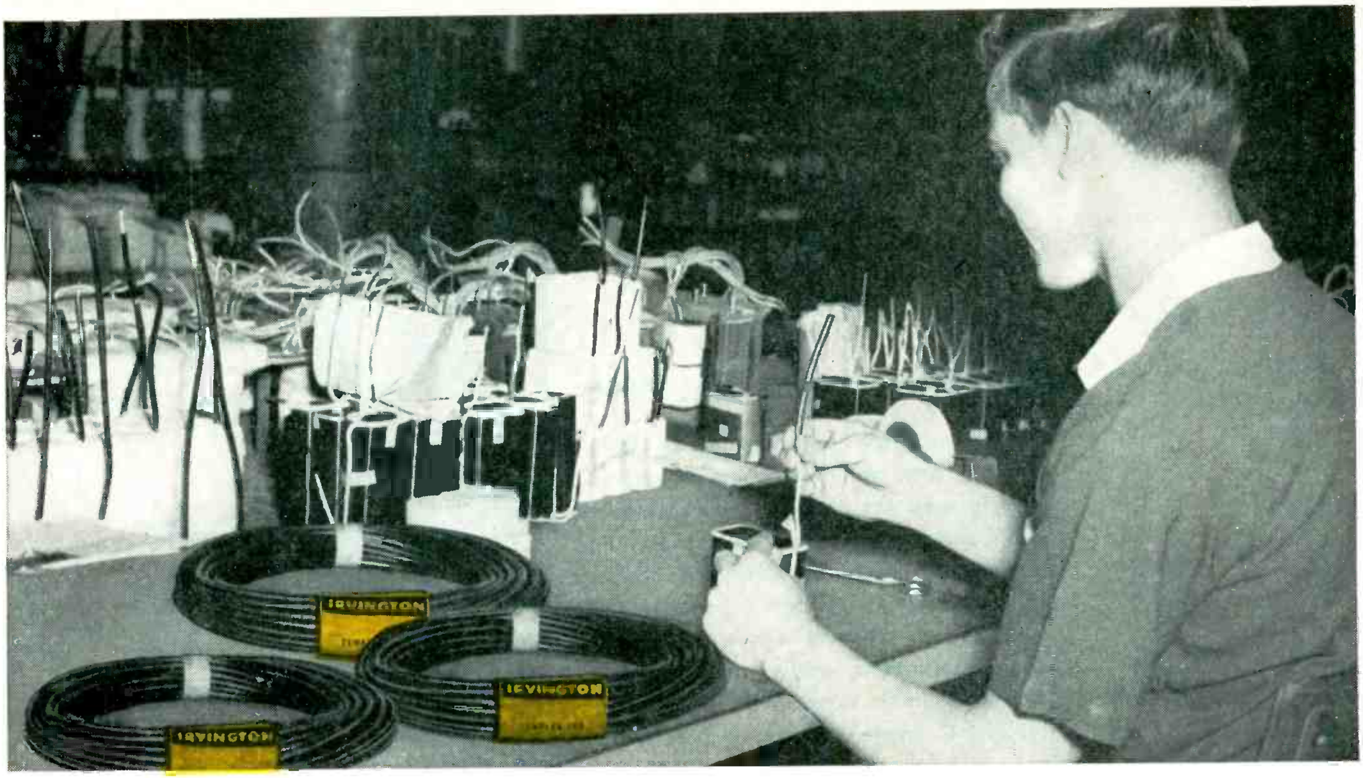
For more information on how PMI might be of assistance to you, write for our Facilities Report and our new brochure "Slip Ring Assemblies to Your Specs."

PMI

DESIGN
DEVELOPMENT
PRODUCTION

P M Industries, Inc/Stamford, Conn.

Electro-mechanical devices



"Protection up to 17,000 volts maintained by TEMFLEX* 105 TUBING," reports I-T-E

Irvington's Temflex 105 Plastic Tubing is the choice of I-T-E Circuit Breaker Company for protecting the leads of small transformers which are varnished and baked with the lead wires exposed. If the varnish insulation should crack after repeated bending, the Temflex 105 Tubing maintains protection up to 17,000 volts.

Specifically formulated for high-temperature service, this product of Irvington's Fibron division has Underwriters' Laboratories approval for *continuous* operation at 105° C. in air — *and at 90° C. in oil.*

Other advantages of Temflex 105 Tubing are its high dielectric strength, smooth interior surface which contributes to ease of assembly, attractive appearance, retention of flexibility under severe service conditions.

Temflex 105 Tubing is produced in all standard colors — and is identified by the continuously printed name on the smooth surface. Specify it by name when you buy.

Look to
for Insulation Leadership
IRVINGTON
INSULATING VARNISHES
VARNISHED CAMBRIC
VARNISHED PAPER
VARNISHED FIBERGLAS
INSULATING TUBING
CLASS "H" INSULATION

*T.M. Reg. U.S. Pat. Off.

A Technical Data Sheet gives complete information — mail the coupon for your copy

Send this convenient coupon now

Irvington

VARNISH & INSULATOR

DIV. OF MINNESOTA MINING & MANUFACTURING CO.

11 ARGYLE TERRACE, IRVINGTON 11, N. J.

Plants: Irvington, N. J.; Monrovia, Calif.; Hamilton, Ontario, Canada

Irvington Varnish & Insulator EL 12/53
Div. of Minnesota Mining & Mfg. Co.
11 Argyle Terrace, Irvington 11, N. J.

Gentlemen:

Please send me Technical Data Sheet on Temflex 105 Tubing.

Name...Title....................

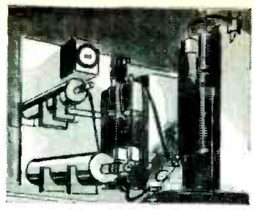
Company..

Street..

City...Zone..........State...........

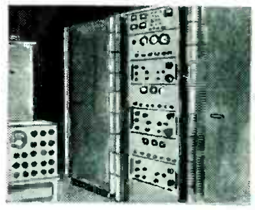
Want more information? Use post card on last page.

this timekeeper never takes time off



Laboratory life testing.

Indicates most efficient time to replace fluorescent lamps.



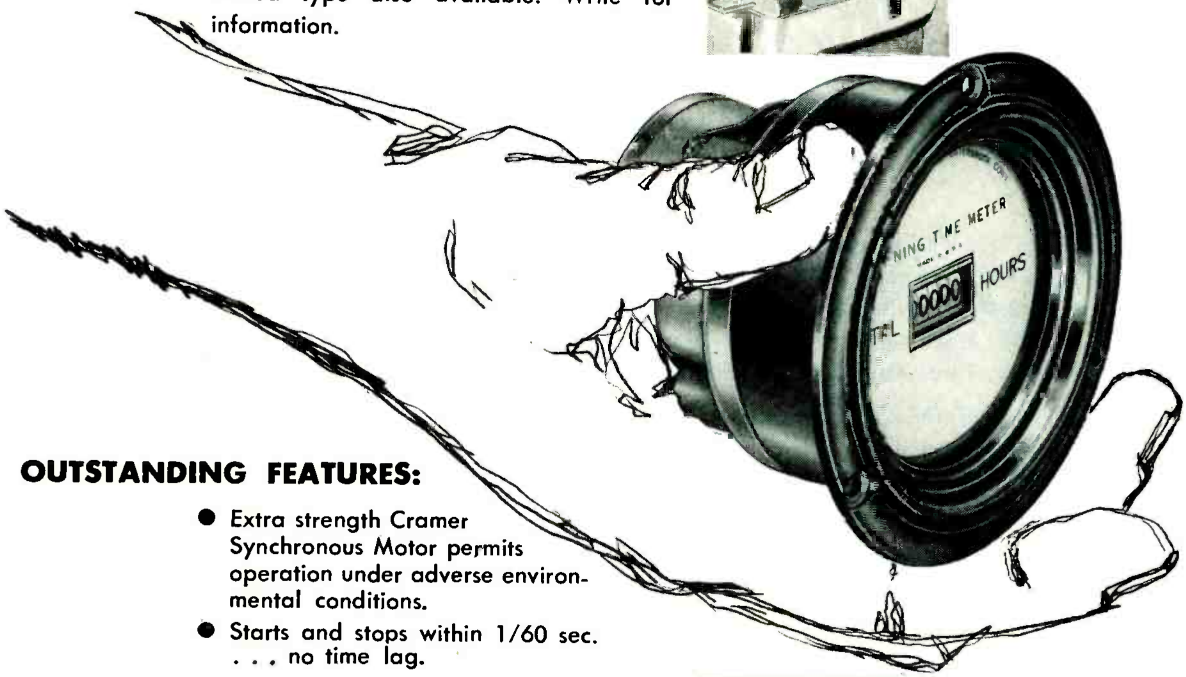
Replacement of vacuum tubes for radio transmitter.

Records down-time on automatic screw machine.

Cramer TIMING DEVICES

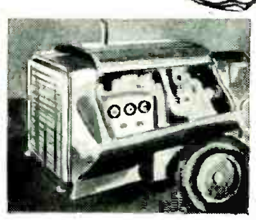
RUNNING TIME METERS

. . . record total operating time or down-time on any circuit, machine or system. Widely used for life test experimentation in laboratories and for preventive maintenance programs, especially as applied to such things as machines, power equipment, tools, vacuum tubes, fluorescent lamp installations, nuclear measurements, etc. Made in six standard 25, 50, and 60 cycle A.C. models — 400 cy., D.C. and sealed type also available. Write for information.



OUTSTANDING FEATURES:

- Extra strength Cramer Synchronous Motor permits operation under adverse environmental conditions.
- Starts and stops within 1/60 sec. . . . no time lag.
- Convenient meter-type mounting.
- Precision-built 5-digit counter.
- Reset feature if desired.



Determines need for maintenance on portable power unit.

11CR53

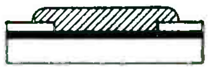
the R. W. CRAMER COMPANY • BOX 3 CENTERBROOK, CONN.
SPECIALISTS IN TIME CONTROL

Interval Timers | Time Delay Relays | Time Totalizers | Cycle Timers | Running Time Meters | Pulse Timers | Hermetically Sealed Military Timers | Synchronous Timing Motors

Every plate in Bradley rectifiers is manufactured as an individual unit. It is a precision product and not a stamping from selenium coated material. That is why Bradley rectifiers give you superior stability, efficiency at high temperatures and long life.

Vacuum-Processed Bradley Rectifiers

laboratory quality at production line cost

Multiple layers of selenium are purified and bonded to each plate, under vacuum. Impurities cannot introduce variables in rectifier performance.	Phenolic insulating pad is applied to minimize counter-electrode pressure on selenium when plates are assembled under spring tension. Efficiency of rectifier is protected.	Counter-electrode is masked away from edge of plate. Periphery of counter-electrode won't chip or dig into selenium when plates are assembled. Counter-electrode shorting is eliminated.
		

Edge shorting of the counter-electrode under vibration is a performance hazard you can't foresee. Routine tests may or may not disclose its existence. Like any flaw, if it is slight, you won't know about it until the customer complains.

A sure way to eliminate counter-electrode shorting as a threat to your circuit's operation is to specify Bradley rectifiers. They are made to prevent shorting. Does this mean you pay a premium price for Bradley rectifiers? It does not. You get laboratory quality, but you pay production line costs. Try us and see. Specify Bradley as a source when you next consider rectifiers. Special problems are welcomed.

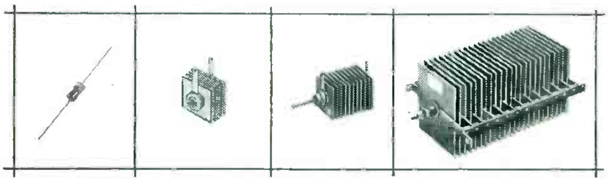
SELENIUM AND COPPER OXIDE RECTIFIERS

VACUUM PROCESSED for PERFORMANCE AS RATED

SELF-GENERATING PHOTOELECTRIC CELLS

Bradley
LABORATORIES, INC.

The complete selenium rectifier line — from microamperes to thousands of amperes



BRADLEY LABORATORIES, INC., 168E Columbus Avenue, New Haven 11, Conn.

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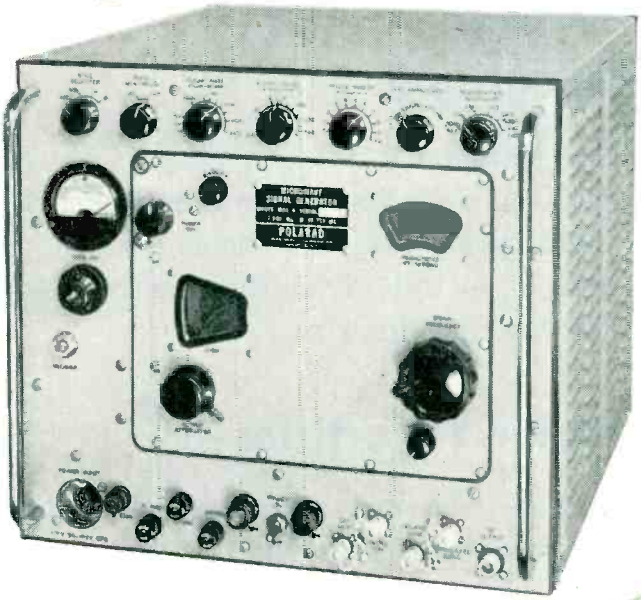
The Finest Signal Generator Of Its Kind



POLARAD'S MODEL MSG-4 IS A MASTERFUL COMBINATION OF ACCURACY—SIMPLICITY—LONGTIME RELIABILITY

Frequency Range—7000 to 10,750 mcs/sec

FEATURES:

One dial control
Temperature compensated Klystron tube
Accurate stable power measurement
Oscillator cavity employs non-contacting choke—Long life
Military ruggedness

SPECIFICATIONS:

Frequency Range—
 7000 to 10,750 mcs/sec
Frequency Accuracy—1%
Power Output—0.2 mw
Attenuator Range—120 db
Output Impedance—50 ohms
Internal Pulse Modulation
 Pulse Width—
  0.5 to 10 microseconds
 Delay—3 to 300 microseconds
 Rate—
  40 to 4000 pulses per second
 Synchronization—Internal or external, sine wave or pulse
Internal FM
 Frequency Deviation—
  ± 6 mcs/sec minimum
 Rate—40 to 4000 cps
 Synchronization—Internal or external, sine wave or pulse
External Pulse Modulation
 Polarity—Positive or Negative
 Rate—40 to 4000 pps
 Pulse Width—
  0.5 to 2500 microseconds
Output Synchronizing Pulses
 Polarity—Positive, Delayed and Undelayed
 Rate—40 to 4000 pps
 Voltage—Greater than 25 volts
 Rise Time—Less than 1 us
Tube Complement—
 OB2-2; 5R4WGY-4; 6AK6-3; 6AS7G-1; 6AU6-5; 6X4W-2; 12AT7-13; 807-3; 5651-5; 5721-1.
Power Input—
 105-125 volts, 50/1000 cps
Size—17" x 15" x 19½"
Weight—90 lbs.

An unusually accurate and reliable laboratory tool, the Model MSG-4 is invaluable in the completion of complex microwave engineering tests.

In the factory, its simplicity of operation eliminates the need of microwave specialists at a time when highest quality must be maintained and economy is essential. Result: Exacting specifications are quickly verified and there are fewer rejects . . . faster shipments . . . more satisfied customers.

In the field, the military ruggedness of this versatile Signal Generator makes it possible to conduct vital tests under the most adverse conditions with laboratory accuracy.

For long lasting reliability, exceptional accuracy and simplicity of operation—the Polarad Model MSG-4 is unsurpassed for use in factory, field or laboratory. For further details contact your nearest Polarad representative or write us direct.

IMMEDIATE DELIVERY

Polarad
Electronics Corporation

POLARAD ELECTRONICS CORPORATION
100 Metropolitan Avenue, Brooklyn 11, N.Y.

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INTERNATIONALLY SPEAKING

Two Gates 10,000 watt transmitters installed at Press Wireless, Inc., Hicksville, L. I., N. Y., one of the world's foremost companies in international communications.

When it comes to handling reams of press copy, commercial messages and facsimile on an around the clock basis—more and more, engineers are agreed that the rugged, straightforward, easy to service and dependable Gates high powered transmitters are the answer.

Date line—Bangkok, Thailand, Egypt, Norway, Dakar, Alaska, San Salvador, Korea; New York, or you name it — the best guess is — copy via Gates-made international short wave transmitters. Any Gates office will gladly participate in your planning. Overseas customers will also find a Gates representative close at hand.

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GATES RADIO COMPANY

Manufacturing Engineers Since 1922

QUINCY, ILLINOIS - - - U.S.A.

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SLANT your requirements to

INSTRUMENT CORP. OF AMERICA

for miniature

SLIP RING AND COMMUTATOR ASSEMBLIES

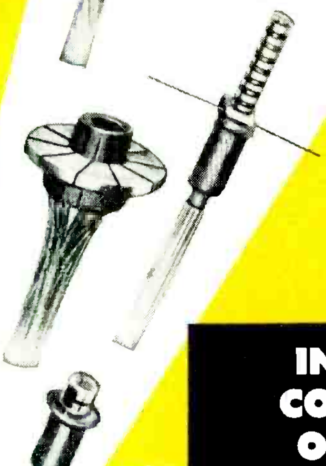
This Instrument Corporation of America plant contains the most modern and complete facilities available anywhere in the world for the exclusive production of Miniature Slip-Ring and Commutator Assemblies to precision standards. It is now in full scale production to meet your requirements in the fastest possible time at the lowest possible cost.

COMPLETE ENGINEERING AND PRODUCTION FACILITIES AVAILABLE

Our assemblies can be supplied at low cost. Quality is the highest in the industry. Dimensional accuracy and other characteristics are excellent and these units are highly recommended for instruments such as synchros, etc.

ONE PIECE ELECTRO-PLATED TYPES FOR EXTREME ACCURACY

Wherever extreme dimensional precision, accurate concentricity and high dielectric qualities are required, the electro-deposition method is recommended . . . the production of which is licensed under an exclusive arrangement with the Electro Tec Corporation.



TYPICAL SPECIFICATIONS:

Sizes: .035" to 24" Cylindrical or Flat

Cross-sections: .005 to .060" or more

Finish: Polish to 4 Micro-Inches or Better

Breakdown: 1000 V or More Hi-Pot Inter-Circuit

Ring Hardness: 75 to 90 Brinell

Rotation Speeds: To Over 12000 RPM

Surface Protection: Palladium and Rhodium or Gold Prevent Tarnish, Minimize Wear

Our engineering staff is at your service at all times for consultation

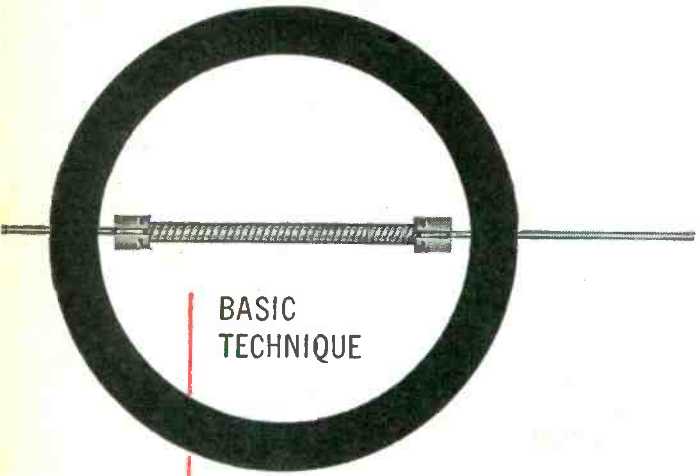
INSTRUMENT CORPORATION OF AMERICA

BLACKSBURG • VIRGINIA

UNDER EXCLUSIVE LICENSE OF ELECRO TEC CORPORATION

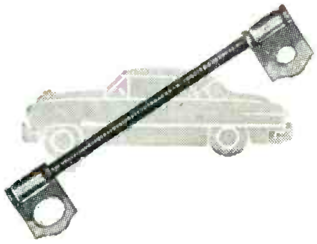
Precision, high-speed winding equipment for IRC elements

ONLY IRC WINDING SKILL OFFERS



Wire element is uniformly and tightly wound on an insulated core. Axial leads or other terminations are secured to element by automatic machinery. Insulated housing may be used or omitted.

If you seek savings in component costs,
IRC's winding skill may serve your need.
IRC's mastery of winding wire elements
dates back more than 25 years. Today,
it provides a wide variety of unique units
that offer realistic possibilities for
savings. Cost-conscious IRC engineers
will glady analyze your requirements.



14c savings per car

Type AW Wire Wound resistors save automobile manufacturers an average of 14c per car. For quantity requirements, these low-cost windings can be made specially to suit individual designs. This adaptability has proved profitable to numerous appliance manufacturers.

low cost—low wattage

Type BW insulated wire wounds offer excellent stability in low ranges—at low prices. Leading instrument manufacturers attest to their superiority. ½, 1 and 2 watt sizes are equivalent to Jan types RU-3, RU-4 and RU-6.

50% savings

IRC Insulated Chokes offer savings up to 50% over ordinary types. Available in two sizes, they are fully protected against humidity, abrasion, assembly damage and danger of shorting to chassis. A favorite source of savings for TV and radio set manufacturers.

THESE SAVINGS

inexpensive solution

4-watt Insulated Power Wire Wounds with axial leads can save several cents over conventional power resistors. Inorganic core and high-temperature plastic housing allow safe operation up to 165° C. Widely used in toys, juke boxes and amusement devices.

NEW
specifications

MIL-R-93A AMENDMENT 1

Government specifications for precision wire wound resistors have been revised. MIL-R-93A Amendment 1 is the new rigid standard.

IRC PRECISION WIRE WOUNDS

meet and beat these new specifications. They are equivalent to Mil types RB-15 through 19.

MAXIMUM STABILITY

Temperature cycling even beyond Mil requirements has only negligible effect. Send for new technical bulletin.

Boron & Deposited Carbon Precistors • Power Resistors • Voltmeter Multipliers • Low Wattage Wire Wounds • Insulated Composition Resistors • Volume Controls •

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Precision Wire Wounds • Ultra HF and Hi-Voltage Resistors • Low Value Capacitors • Selenium Rectifiers • Insulated Chokes • Hermetic Sealing Terminals •

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403 N. Broad St., Philadelphia 8, Pa.
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Send me technical data on: ☐ Precision Wire Wounds; ☐ Insulated Chokes; ☐ BW Resistors; ☐ 4-Watt Power Resistors

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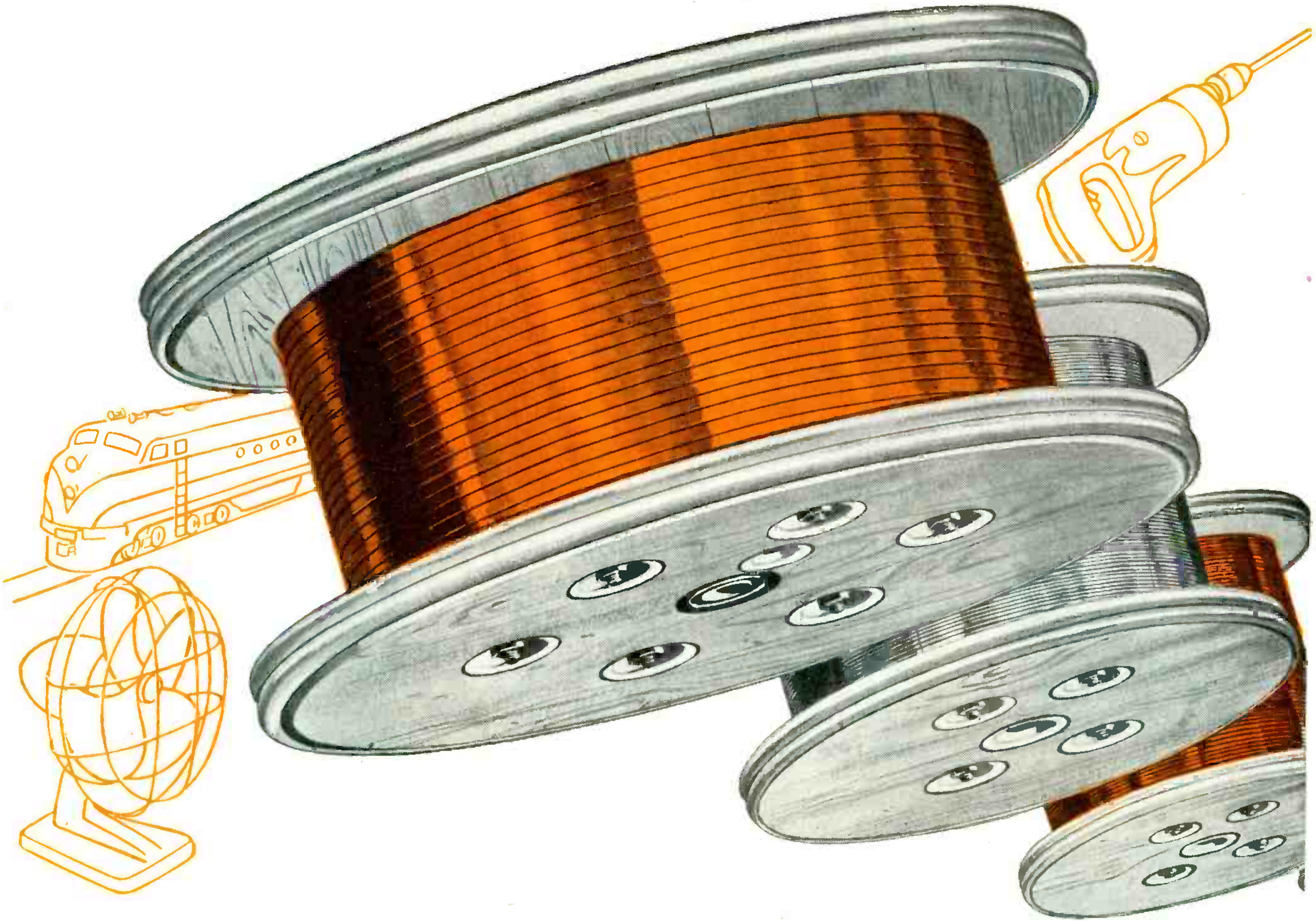
Rely on **PHELPS DODGE** for Magnet Wire and

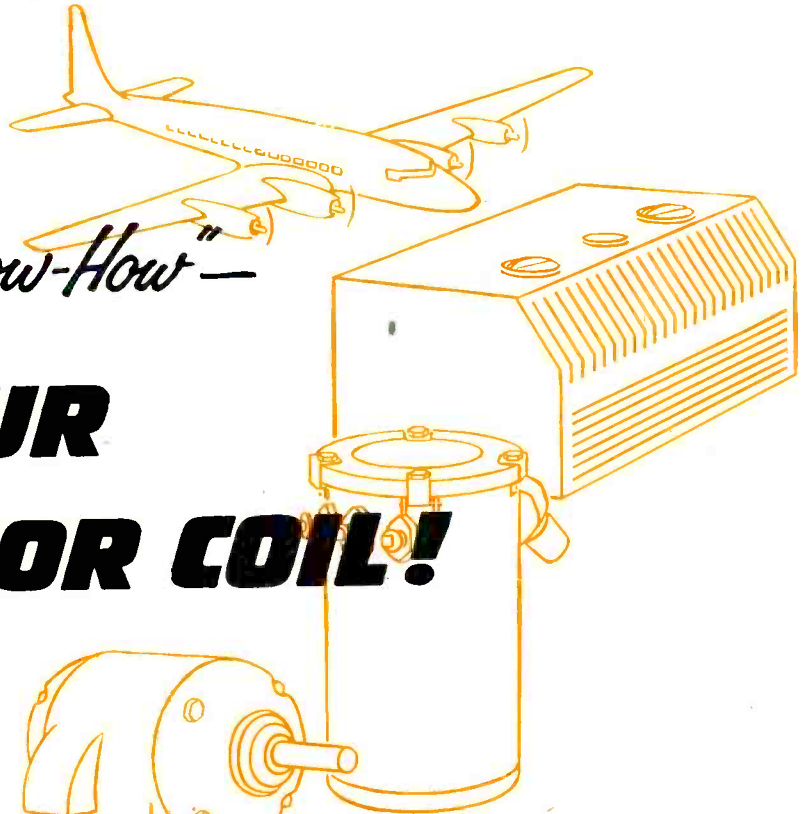
THE RIGHT WIRE TRANSFORMER,

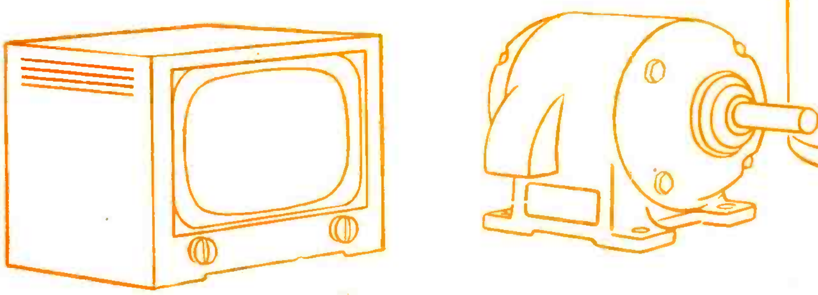


First for Lasting Quality—from Mine to Market!

Application "Know-How"—

FOR YOUR MOTOR OR COIL!





- Vast and varied experience in every field of electrical and electronic manufacture.
- Unexcelled research, manufacturing and quality control facilities—most complete and up-to-date line of magnet wire in the industry.
- Practical help in selecting correct size, shape and insulation to meet exact design specifications.

PHELPS DODGE COPPER PRODUCTS CORPORATION

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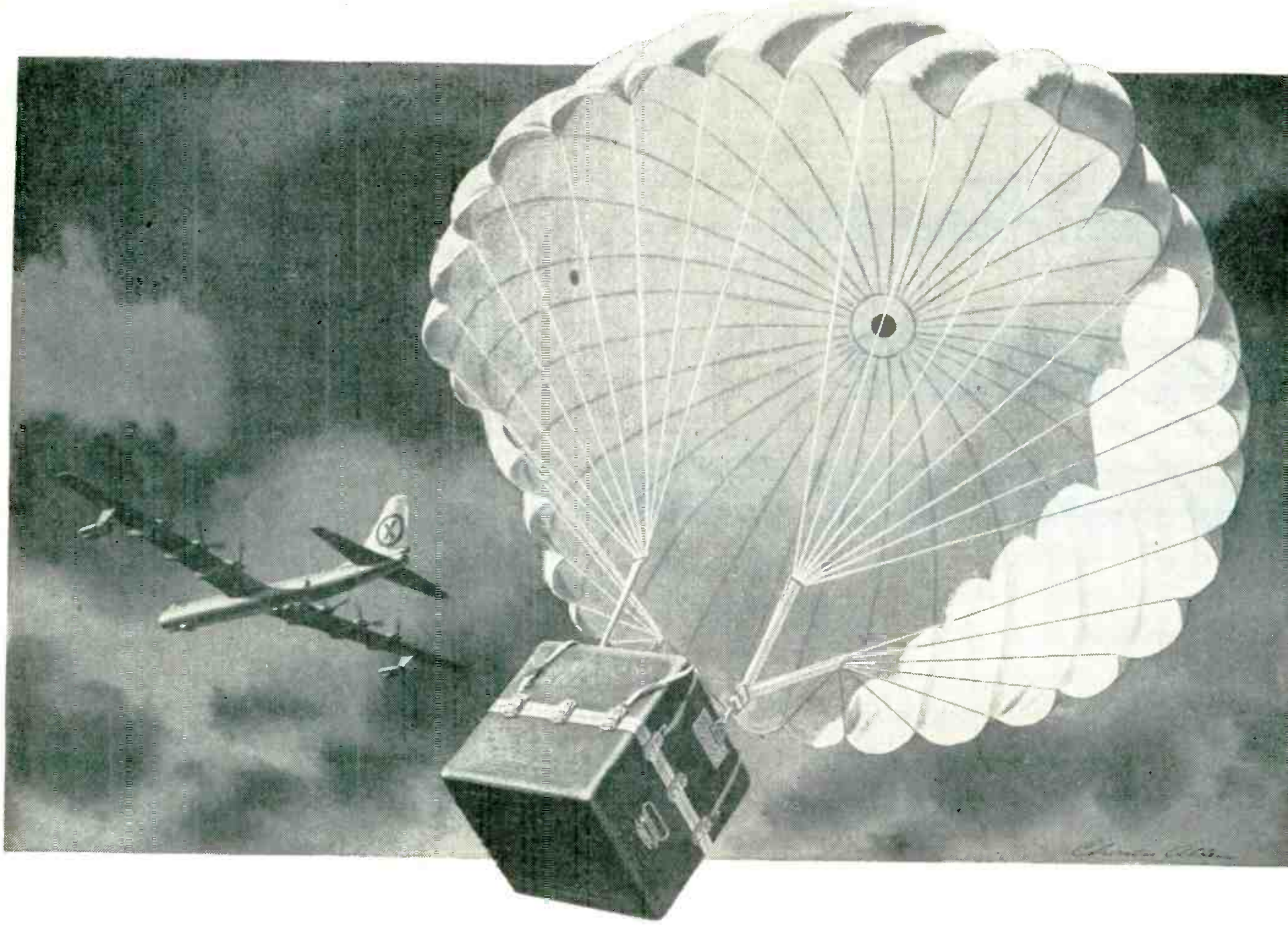
KOCH *Pioneer in Fiberglas reinforced plastics*



Here's another way your Air Force saves money

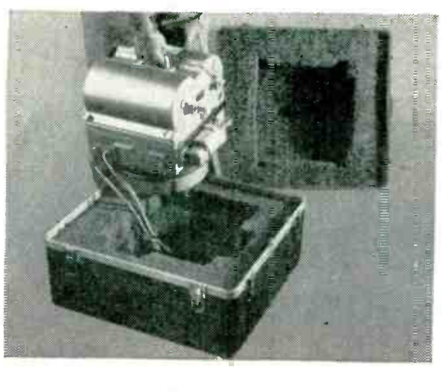
Costly aerial cameras and other precision instruments are now protected by special Fiberglas cases built to Air Force specifications by Koch of California (specification MILC 4150A-USAF).

In the roughest kind of usage, not one of the 30,000 cases used all over the world, or its contents, has been damaged. The aggregate saving to U. S. taxpayers runs into millions of dollars.

The Koch Fiberglas carrying case protects equipment in shipping, handling and long term storage. It can be submerged in 40 feet of water without leaking, or dropped from trucks without breaking or denting. Its interior is fitted with moulded cushions of hair latex pads that protect the most delicate equipment from shock.

The case doubles as both carrying case and shipping case, and can be shipped overseas without any additional packaging whatsoever. It can be re-used indefinitely.

If you manufacture a valuable product that needs maximum protection in shipment and subsequent handling or storage, it may pay you to investigate the experience and facilities of H. Koch & Sons, pioneer in Fiberglas reinforced plastics.



H. KOCH & SONS

Pioneer in Fiberglas reinforced plastics

73 BEALE STREET, SAN FRANCISCO

Originator of *Fiberglas Luggage*

small size?
long life?
and
high temperature operation?

ASTRON HY-METS*

High Temperature Metallized Paper Capacitors

Type MQL

Answer several of your capacitor and assembly problems with one quick stroke. Specify ASTRON Hy-Mets—for long life in high temperature operation. Now you can have the subminiature size of metallized paper capacitors for high temperature operation without derating.

Hermetically sealed Hy-Mets utilize ASTRON's new solid impregnant—to eliminate possibility of any oil or impregnant leakage from −55C° to +125°C. Hy-Mets offer high insulation resistance, longer life, lower power factor and exceptional stability over extremes in operating conditions. ASTRON Hy-Mets are the subminiature for the biggest job.

Available in a variety of metal tubular, cardboard and JAN case styles for voltage applications up to 600 Volts DC in a wide range of capacitance values.

Write for Bulletin AB-19 on Hy-Mets, giving complete data on sizes, ratings, mounting styles, engineering performance characteristics and test specifications.

Astron manufactures a complete line of dry electrolytic, metallized paper, plastic molded and subminiature paper capacitors, and standard and subminiature RF interference filters for every radio, television and electronic use.

Type MDL

DEPEND ON—INSIST ON

ASTRON

ASTRON CORPORATION

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Export Division: Rocke International Corp., 13 E. 40th St., N.Y.C.
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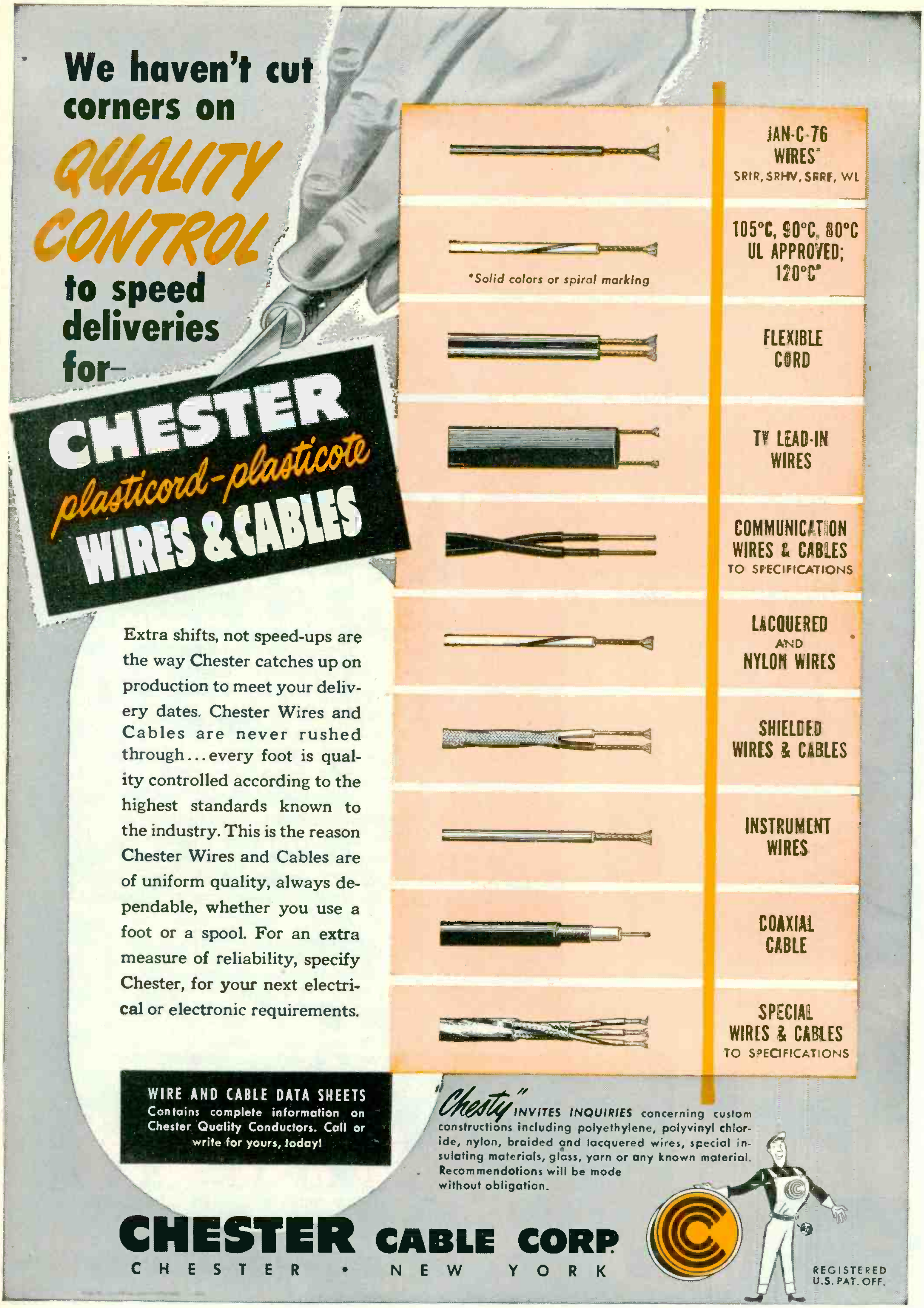
*Trade Mark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to speed deliveries for—
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Extra shifts, not speed-ups are the way Chester catches up on production to meet your delivery dates. Chester Wires and Cables are never rushed through... every foot is quality controlled according to the highest standards known to the industry. This is the reason Chester Wires and Cables are of uniform quality, always dependable, whether you use a foot or a spool. For an extra measure of reliability, specify Chester, for your next electrical or electronic requirements.
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Contains complete information on Chester Quality Conductors. Call or write for yours, today!
"Chesty" INVITES INQUIRIES concerning custom constructions including polyethylene, polyvinyl chloride, nylon, braided and lacquered wires, special insulating materials, glass, yarn or any known material. Recommendations will be made without obligation.
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CHESTER • NEW YORK
REGISTERED U.S. PAT. OFF.

when **PRECISION**

frequency control is VITAL . . .

NORTHERN RADIO *NEW*

VARIABLE MASTER OSCILLATOR

- **1 cycle per megacycle stability**
- **continuously variable to *any* frequency from 2 to 4 mc.**

In addition to accomplishing these new highs in stability with variability, Type 173 Model 1 is so easy to operate that it can be handled by completely unskilled personnel.

It is excellent as the basic control oscillator for diversity receivers, HF transmitters, and other communication devices, or as a laboratory standard. It also provides both a crystal-controlled BFO and a time base 100 kc crystal oscillator as a secondary standard; stability of the latter is 1 part in 5 million.

NORTHERN RADIO COMPANY, inc.
147 WEST 22nd ST., NEW YORK 11, NEW YORK
Pace-Setters in Quality Communication Equipment

Northern Radio has long *specialized* in the design and construction of Frequency Shift equipment of the types listed below. Their dependable performance for U. S. and Allied Commerce, Governments and Armed Forces all over the world has earned for Northern Radio a reputation for unquestioned leadership in communications engineering and precision manufacture.

Frequency Shift Keyers
Master Oscillators
Diversity Receivers
Frequency Shift Converters
Multi-Channel Tone Systems
Tone Keyers
Demodulators
Radio Multiplex Systems
Monitors
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Now—

Moldite Dependability in all 3!

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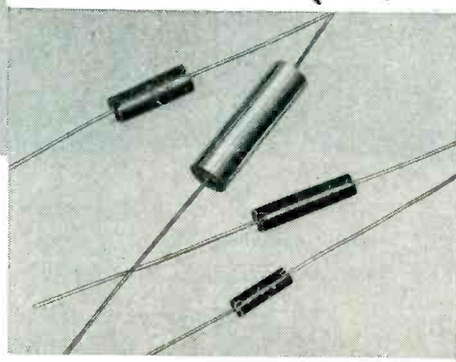
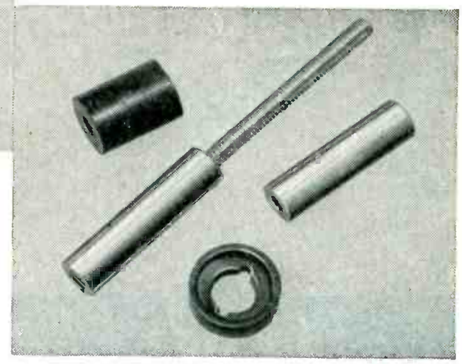


MOLDED COIL FORMS



MAGNETIC IRON CORES

Moldite's famed precision production facilities are now devoted to 3 major types of electronic components —to give the industry a superlative core or coil form for every electronic application.

Through years of continued engineering and research Moldite has produced cores of guaranteed dependability, economy, quality and uniformity. Our customers' smooth running production lines tell the story best.

Specify a Moldite core specially designed and precision made for you, with absolute uniformity from first to last.

FERRITE CORES
MOLDED COIL FORMS
(iron and phenolic)
MAGNETIC IRON CORES
FILTER CORES
THREADED CORES
SLEEVE CORES
CUP CORES

Samples promptly submitted upon request for design, pre-production, and test purposes

. . . Send for our new Catalog No. 110 — THE MOST COMPLETE LINE OF CORES IN THE INDUSTRY!

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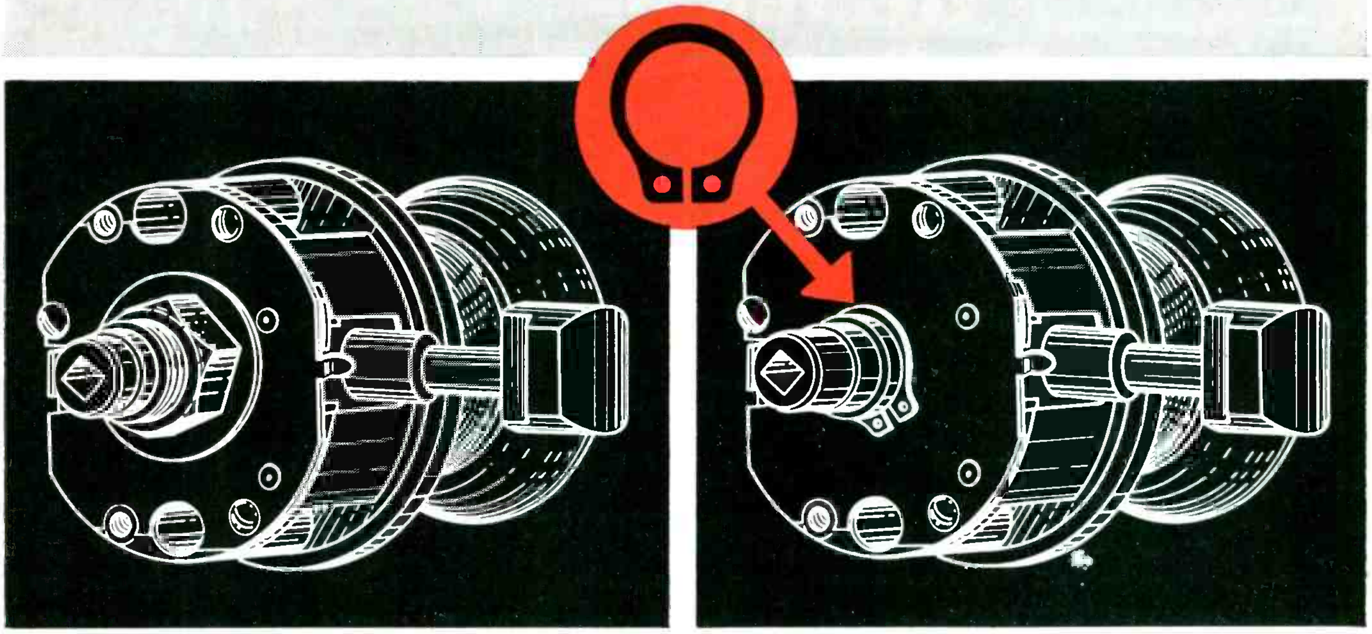
Waldes Truarc Ring Replaces Nut and Washer
...Cuts Costs $5.28 Per M...Speeds Assembly by 50%



OLD WAY. Main shaft required costly threading. Assembly was slowed by the double application of washer and nut and time-consuming tightening operation.

TRUARC WAY. Truarc Retaining Ring snaps quickly and simply over shaft. Lock assembly is secured in one fast operation. Virtually all play is eliminated from lock.

NEW DESIGN USING WALDES TRUARC RING PERMITTED THESE SAVINGS

OLD WAY

Cost of Nut	$10.00	*per thousand*
Cost of Washer	3.80	" "
Labor for Threading . . .	2.00	" "
Assembly	3.00	" "
TOTAL	$18.80	

TRUARC WAY

Cost of Truarc Ring and Grooving Operation . .	$11.52	*per thousand*
Assembly	2.00	" "
TOTAL	$13.52	

J. Chesler and Sons, Inc., Brooklyn, N.Y., manufacturers of the pre-assembled "Reddi-Mount" cylindrical lockset, uses a single Waldes Truarc Retaining Ring instead of an old fashioned nut and washer to secure the entire assembly of their lock. This new, improved fastening method enables Chesler to eliminate costly threading . . . save money on material . . . speed assembly time by 50% and produce an improved, more durable product.

You, too, can save money with Truarc Rings. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Waldes Truarc Rings are precision-engineered . . . quick and easy to assemble and disassemble.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool

SEND FOR NEW CATALOG

WALDES
TRUARC
REG. U. S. PAT. OFF.
RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,420,941; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,081; AND OTHER PATENTS PENDING.

E-125

Waldes Kohinoor, Inc., 47-16 Austel Pl., L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

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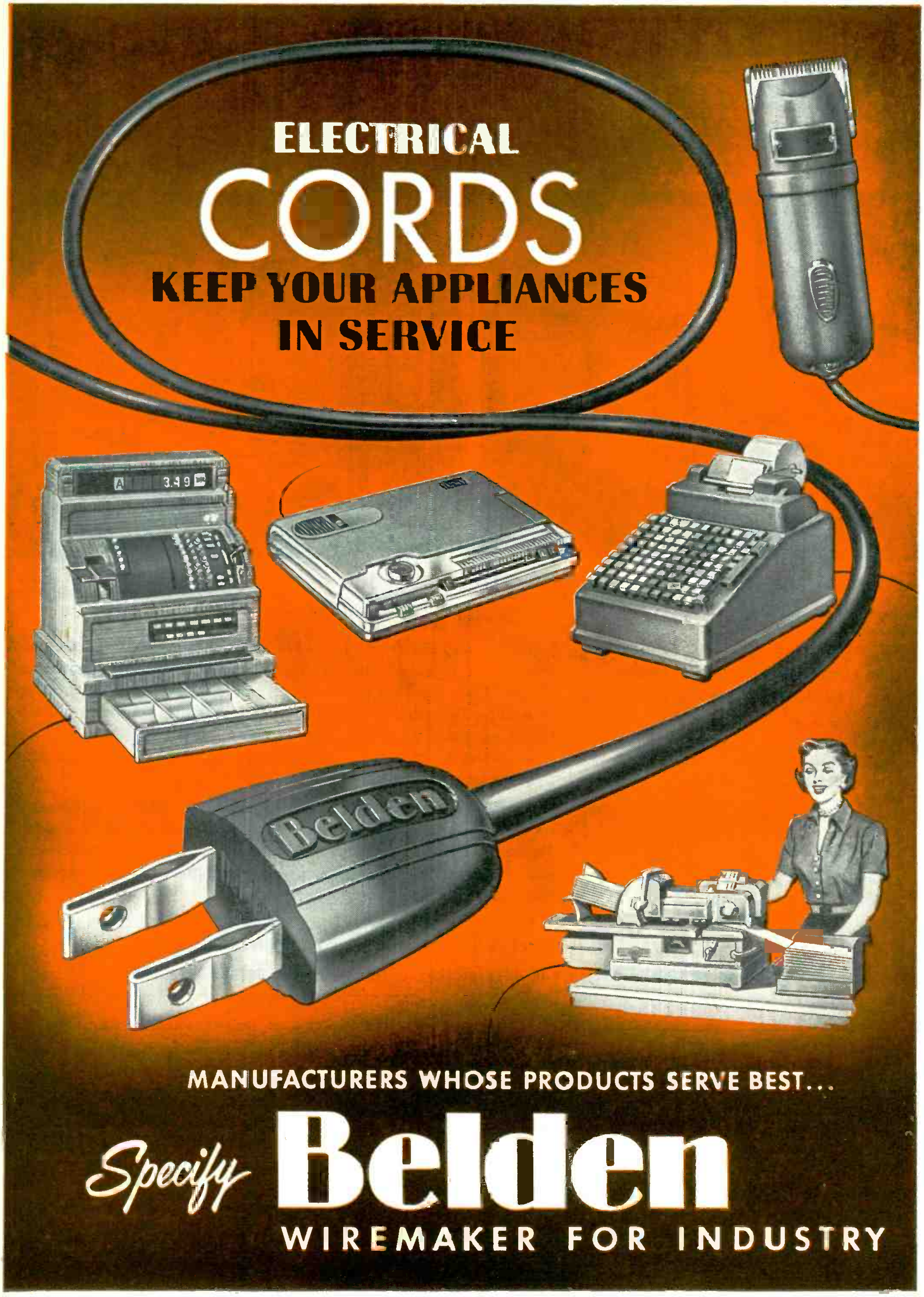
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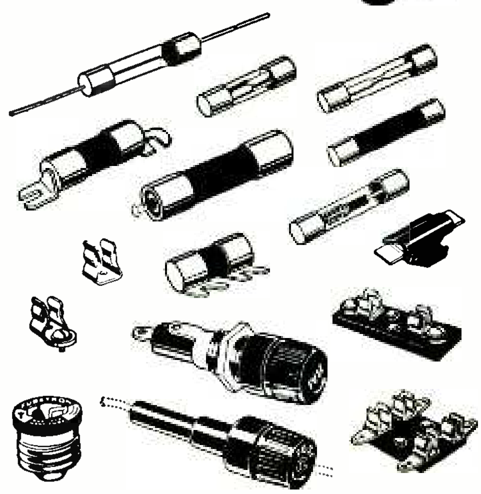
CORDS
KEEP YOUR APPLIANCES
IN SERVICE
Belden
MANUFACTURERS WHOSE PRODUCTS SERVE BEST...
Specify Belden
WIREMAKER FOR INDUSTRY

The Quality of Your Product can be no better than the Quality of its Component Parts

WHEN POOR QUALITY OR FAULTY DESIGN OF A COMPONENT PART CAUSES TROUBLE WITH YOUR DEVICE — YOU ARE MORE LIKELY TO GET THE BLAME THAN THE MAKER OF THE PART.

In Fuses the BUSS Trademark represents unquestioned High Quality!



Why take a chance with your product and your reputation when BUSS and FUSETRON Fuses are available?

To maintain highest quality ***every BUSS and FUSETRON fuse used by the electronic industries is electronically tested.*** A sensitive testing device rejects any fuse that is not correctly calibrated, properly constructed and right in all physical dimensions.

BUSS quality means dependable electrical protection under all service conditions and — BUSS quality means fuses that blow to protect — never needlessly.

That's why manufacturers for over 38 years have standardized on BUSS Fuses for dependable electrical protection.

Should you have a problem in electrical protection, BUSS places at your service the world's largest fuse research laboratory and its engineers.

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BUSS

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University at Jefferson, St. Louis 7, Mo.

Please send me bulletin SFB containing facts on BUSS small dimension fuses and fuse holders.

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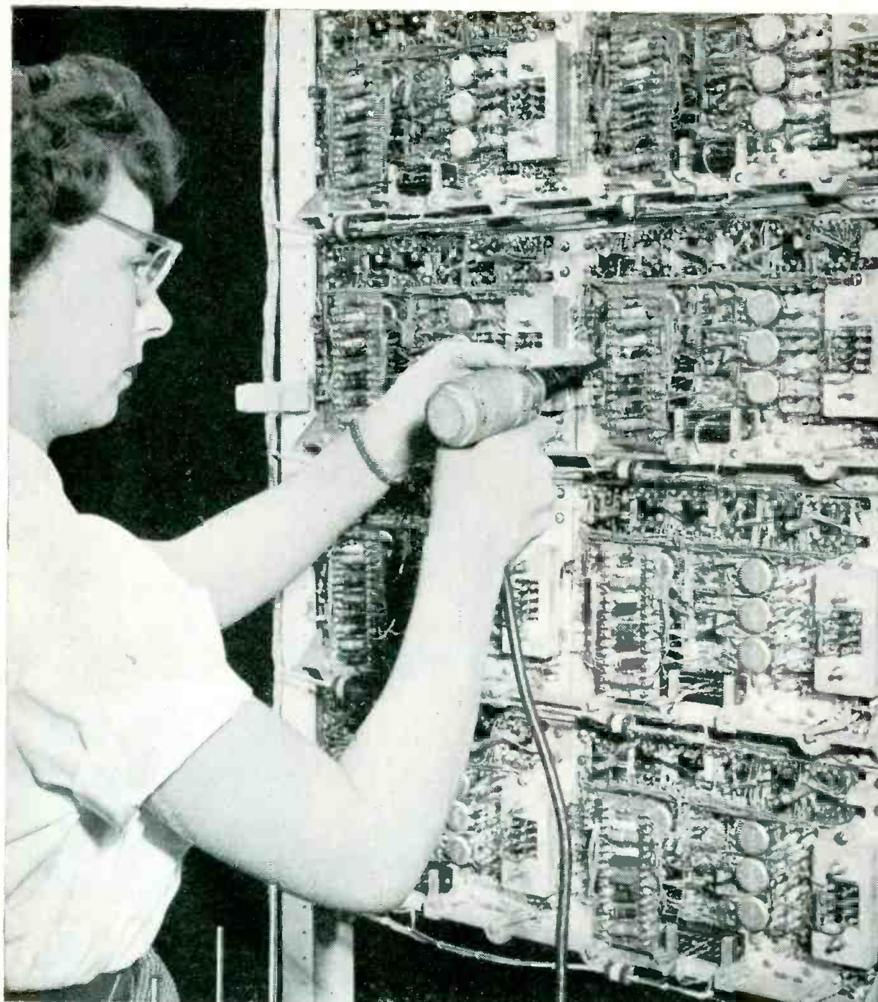
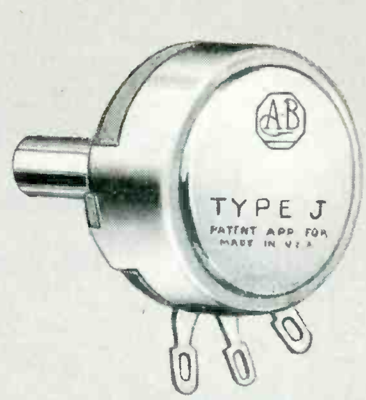




Type J Bradleyometer

For circuits requiring a high quality adjustable resistor . . . the Allen-Bradley Type J Bradleyometer is the only choice. It is not a film or paint type resistor. The resistor element is molded to satisfy your resistance rotation curve. After molding, the resistor characteristics remain permanently stabilized.

Single Frequency Signaling Units Equipped with Allen-Bradley Resistors

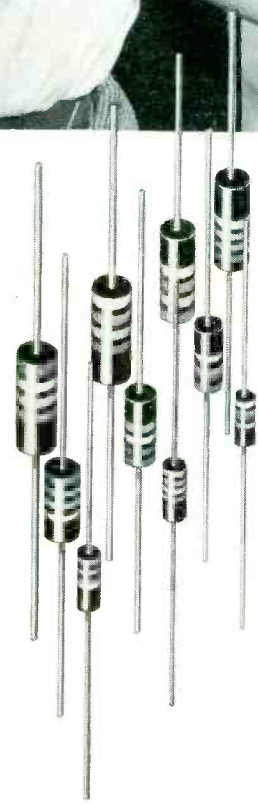
The eight Western Electric single frequency signaling units, being assembled above, transmit and receive telephone dial pulses and supervisory signals over voice circuits. They convert direct current dial impulses to 2600 cycle signal that is transmitted to alternating current apparatus on telephone lines.

Each unit utilizes 4 Bradleyometers and 23 Bradleyunits.

The resistor elements of the Bradleyunits are encased in plastic insulating shells. Hence they can be closely grouped in a compact chassis.

Since Bradleyunits are rated at 70C instead of 40C, they assure stability and permanence which are important features in long distance telephone equipment.

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis.



BRADLEYUNITS
½ - 1 - 2 Watts

Bradleyunits function perfectly through a temperature range from −60C to +70C. Changes due to humidity are negligible. Bradleyunits are corrosion resistant and will easily pass the 200 hour salt spray test.

ALLEN-BRADLEY

FIXED & ADJUSTABLE RADIO RESISTORS

Sold exclusively to manufacturers QUALITY of radio and electronic equipment

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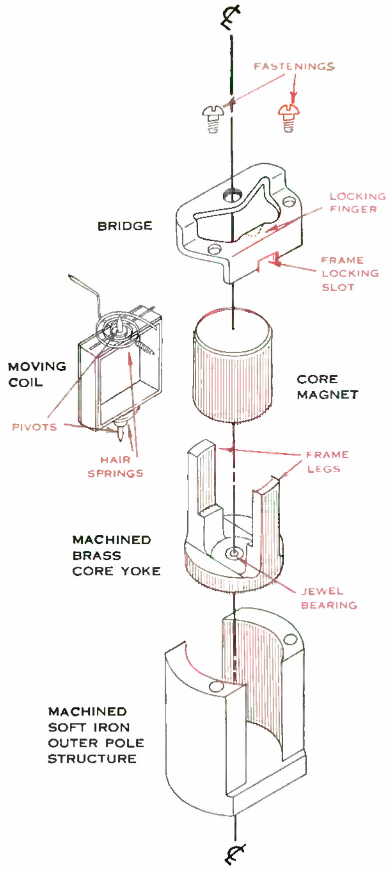
marion

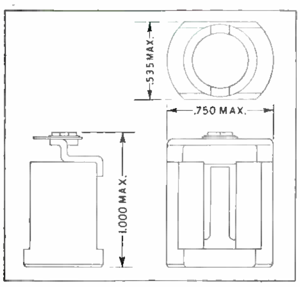
advancement in instrument design

TWO VIEWS SHOWING COAXIAL MECHANISM
ACTUAL SIZE

(Total Weight 0.8 oz.)



EXPLODED DIAGRAM SHOWING
INTERLOCKING CONSTRUCTION

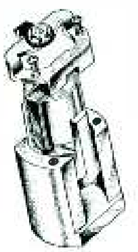


COAXIAL METER MECHANISM DESIGN* OPENS NEW FIELDS OF APPLICATION

A new Marion concept in the mechanical design of the moving coil galvanometer magnetic system has resulted in a "miniature" movement with performance characteristics and durability exceeding existing ruggedized or regular panel instruments of far greater size and weight. The Marion "Coaxial" assembly provides a magnetic field of great strength, uniformity and stability which is self-shielded. Ruggedness and stability are inherent in the basic simplicity of the design. The small size and weight make practical the application of the moving coil mechanism as a component of a great many electrical or electronic instruments or other products. This is especially pertinent in aircraft instruments where size and weight are of critical importance, yet no compromise can be made with performance and durability.

The new assembly (see exploded diagram) consists essentially of a soft iron outer pole structure, a non-magnetic yoke and a magnetized core of such diameters that the yoke fits snugly in the pole structure and the core within the yoke. The assembly is locked by attaching the bridge to the pole structure by means of two screws — the only fastenings in the entire assembly. A locking finger on the bridge holds the core and the frame in position. Rotation of the core yoke is prevented by the slot in the bridge flange which engages one of the legs of the frame. The moving coil is contained by its pivots, and bearings located in the bridge and the base of the frame.

The basic design in which all critical dimensions are machined from a common center (the bearing axis) gives far more precise and uniform alignment than is possible with stamped assemblies. The interlocked assembly assures maintenance of these close tolerances and affords far greater rigidity and strength than is available in conventional mechanisms, particularly when mass is considered.



MECHANISMS BY MARION

The Marion "Coaxial" mechanism has many applications, not only in indicating instruments, but also as a component of equipment utilizing the moving coil galvanometer principle. It is one of a number of Mechanisms by Marion that extend the field of application of moving coil galvanometers where previously size, weight or performance characteristics prevented their use.

Marion Electrical Instrument Company, 401 Canal Street, Manchester, N. H.

*Patents Pending

Reg. U. S. Pat. Off.

marion meters

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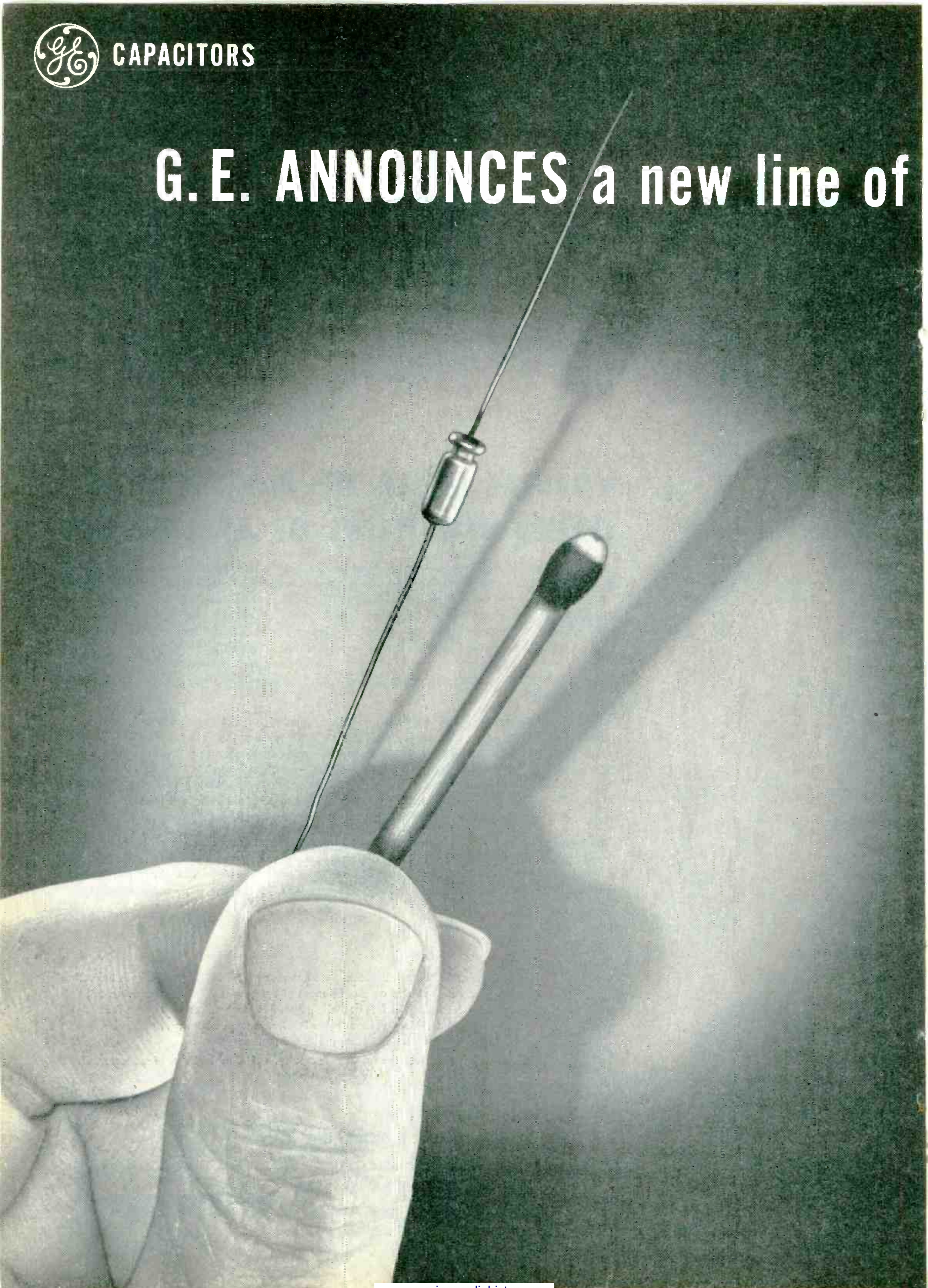

CAPACITORS
G.E. ANNOUNCES a new line of

Micro-miniature Tantalytic Capacitors

Smallest electrolytic capacitors commercially available— permit new design flexibility for low-voltage d-c applications

General Electric's new *Micro-miniature* Tantalytic capacitors combine *smaller-than-subminiature* size, large capacitance and low leakage current. They permit new design flexibility in low-voltage, d-c circuits . . . particularly transistorized subminiature assemblies where space is at a premium, such as hearing aids.

SUPERIOR PERFORMANCE. *Micro-miniature* Tantalytic capacitors outperform aluminum electrolytics in electrical stability, operating and shelf life, because of the inert characteristics of tantalum metal and the stability of its oxide. They gain added reliability from the use of silver cases, a non-acid electrolyte, and complete sealing that prevents leaking and contamination of the interior.

WIDE TEMPERATURE RANGE. *Micro-miniature* Tantalytics can operate over a −20 C to +50 C range—may be stored at −65 C. With some capacitance derating, they can operate well below −20 C. At −55 C, units rated 10 volts and above will maintain at least 65% of their 25 C value. They also perform satisfactorily above +50 C with some life limitations.

AVAILABILITY. Designed especially for non-resonant, non-critical applications such as coupling, by-pass and filtering, *Micro-miniature* Tantalytics can be obtained in sample lots 2 to 3 weeks after your order is received at the factory. Production lots can be shipped 6 to 8 weeks after your order is received. For more information, see your G-E Apparatus Sales Representative or write for bulletin GEA-6065 to General Electric Company, Section 442-13, Schenectady 5, N. Y.

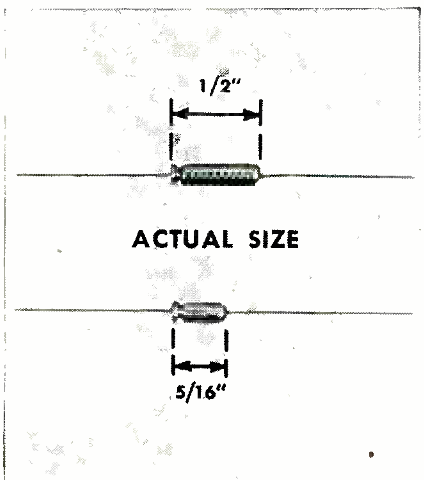
Progress is our most important product

GENERAL ELECTRIC

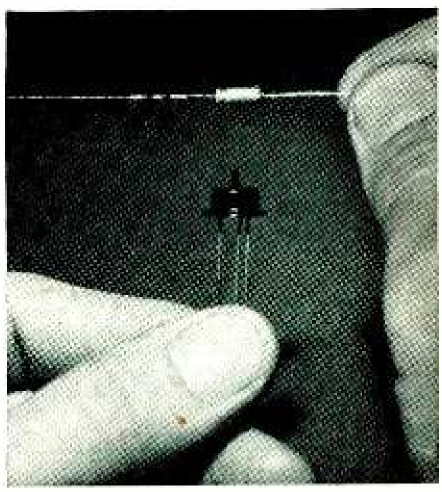
AVAILABLE RATINGS

Working volts d-c	Maximum muf	
	5/16" Length	1/2" Length
2	3.0	6.0
4	2.0	4.0
6	1.5	3.0
8	1.2	2.5
10	1.0	2.0
16	.7	1.5

These ratings are based on known muf X volt capabilities. They meet the −15% to +75% capacitance tolerance. Other ratings, particularly whole muf values, can be supplied if the muf X volt rating is not exceeded for the voltage involved.



LARGE CAPACITANCE and small size make Micro-miniature Tantalytics valuable where space is at a premium. Diameters are .125 in.



IDEAL COMPANIONS. Transistors and Micro-miniature Tantalytics make ideal companions in low-voltage d-c miniaturized assemblies.

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4. **Sold through Distributors—**Popular types available through P & B franchised Electronic Parts Distributors located in all principal cities.

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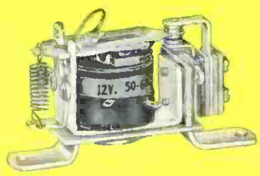
Medium duty, smaller in size. Positive wiping action and high contact pressure. From SPST to 3PDT. AC or DC actuation.

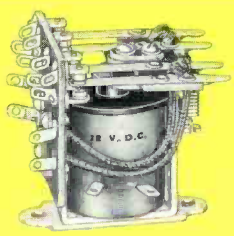


2 GENERAL PURPOSE RELAYS—Light Duty

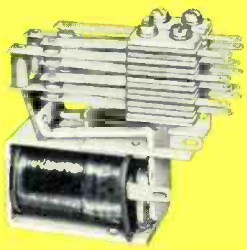
KR Series—For applications where space and weight are important. Withstand high shock and vibration. From SPST to 3PDT. AC or DC actuation.

3 MULTIPLE CONTACT RELAYS—Light Duty

KL Series—Longer actuating coil gives power to actuate additional contacts and maintain 15 gram pressure. From SPST to 4PDT. AC or DC actuation.



4 MULTIPLE LEAF RELAYS

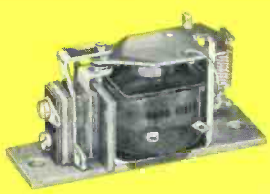


SU Series—For multiple circuit switching of power loads. Contact springs heavy tin-coated phosphor bronze. From SPST to 4PDT. AC or DC actuation.

5 LATCHING RELAYS

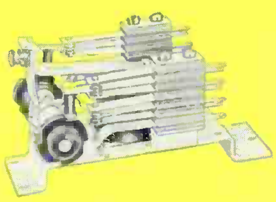
LK Series—Compact, high contact capacity, resists high vibration. Coils available for either AC or DC current or voltage operations. From SPST to 4PDT. 1/8" fine silver contacts.

6 PLATE CIRCUIT RELAYS



LM and LS Series—Actuate on a few milliwatts. Easily adjusted. Small, rugged, low in cost. From SPST to DPDT. DC coils only.

7 IMPULSE RELAYS



AP Series—Automatic stop prevents backlash or overtravel. Precise switching regardless of operating speed. Either AC or DC current or voltage actuation.

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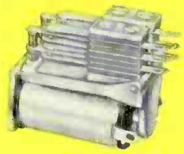
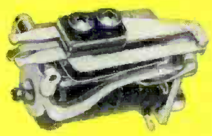
more P & B standard relays

8 TELEPHONE RELAYS

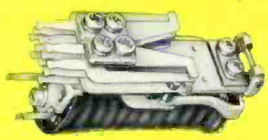


MH Series—Smallest, most versatile. Maximum coil power 22,000 ohms. High contact capacity. Maximum 16 springs. From make to double break. AC or DC actuation.

MJ Series—Longer, more flexible contact arms. Lower spring load rate. Sensitive, fast acting. Has long life. From make to double break. AC or DC actuation.



ST Series—Short type for restriced space. Standard telephone design. Fast acting—50 MW per movable pole. From make to break-make. DC actuation only.



LT Series—For DC voltage or current. Operating time of less than 10 MS can be accomplished. 50 MW per movable pole. From make to double break. DC actuation only.

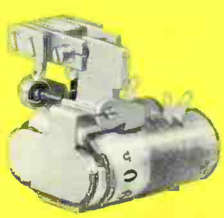
9 MOTOR STARTING RELAYS

MS Series—A voltage controlled relay insures throwout of the starting winding when motor reaches rated speed. Fast acting double break. High pull in, low pull out.

10 HEAVY DUTY—SHOCKPROOF RELAYS

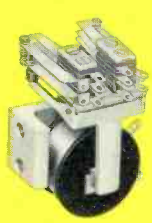
SP Series—Can be mounted in any position. Particularly resistant to vibration and shock. Rugged construction. From SPST to DPDT. AC or DC actuation.

11 SUPER SENSITIVE RELAYS



SS Series—Ultra sensitive. Operate on less than 10 MW. Dual coils, 10G vibration resistance. Wide versatility. One form C-SPDT. DC actuation. Fine silver contacts.

12 400 CYCLE AC RELAYS

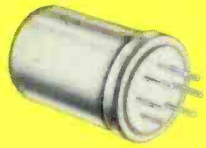


AF Series—15 gram or higher contact pressure. Withstand better than 10G shock. Heavy cast mounting foot. One form A to 2 form C. Silver or palladium contacts.

13 SUPER MIDGET RELAYS

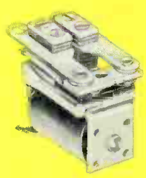
SM Series—Tiny and rugged . . . plug-in—one form C. High degree of resistance to vibration and shock. One form C-SPDT. Coined silver to rhodium plated contacts. DC actuation.

14 SUBMINIATURE SENSITIVE RELAYS



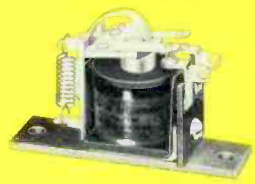
PW Series—Standard 7 pin plug-in. Ruggedized for vibration and shock. Operating power 25 MW. Contact load 2 amperes.

15 MINIATURE DC POWER CONTACTOR



MB Series—High current contact capacity and rugged construction. Contact pressure approximately 250 grams rated 60A at 28V DC.

16 SPACE SAVER RELAYS



CA Series—Small size with large current carrying capacity. Fast armature release. Fiber mounting base. SPST-NO-double break. AC or DC actuation.

17 PHOTO FLASH RELAYS

FR Series—Suitable for photo flash or high voltage requirements. Contacts carry high current surge without sticking, burning or pitting. SPST to DPDT. AC or DC actuation.

18 DUST COVERS AND HERMETIC SEALING

All P & B Standard Relays can be supplied with dust covers or hermetically sealed cans with either solder or plug-in headers.

Write Home Office in Princeton or phone your local P & B Sales Office for new master catalog illustrating and describing our wide line of basic relay structures, housings and enclosures. Samples, recommendations and quotations promptly furnished on special problems.

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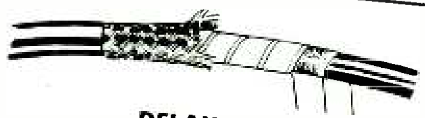

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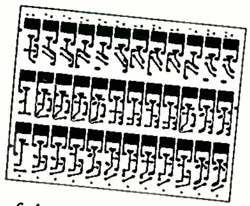

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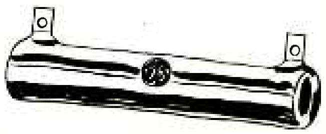

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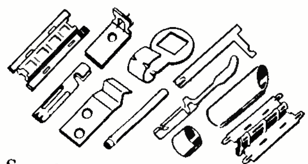

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GENERAL ELECTRIC

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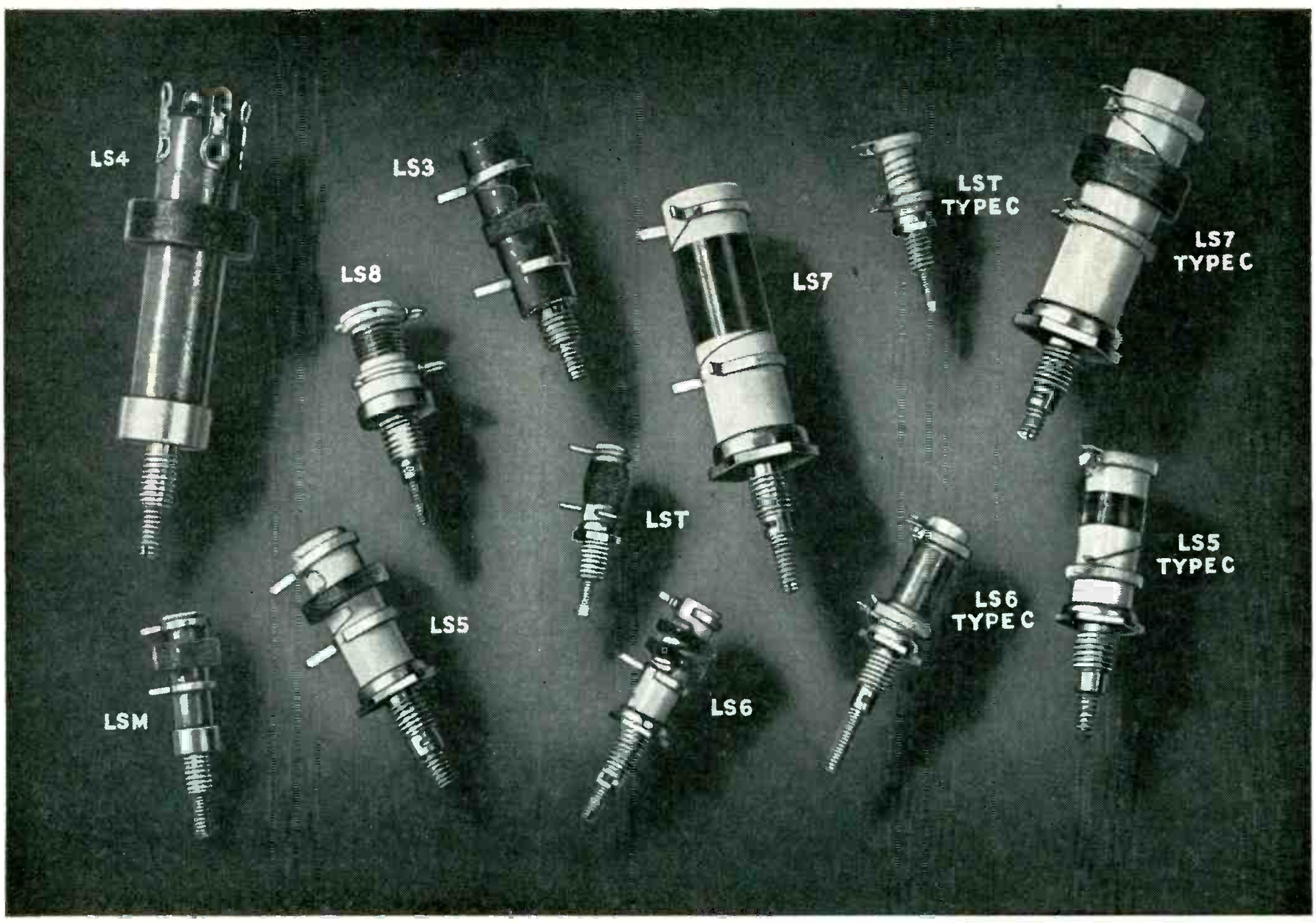

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C.T.C. coil forms are made of quality paper base phenolic or grade L-5 silicone impregnated ceramic. Mounting bushings are cadmium plated brass; ring type terminals are silver plated brass protected by water dip lacquer. Terminal retaining collars of silicone fibreglas which permit 2 to 4 terminals, are available on forms designated Type C above. Wound units can be coated with resin varnish, wax or lacquer. All units are furnished with slugs and mounting hardware.

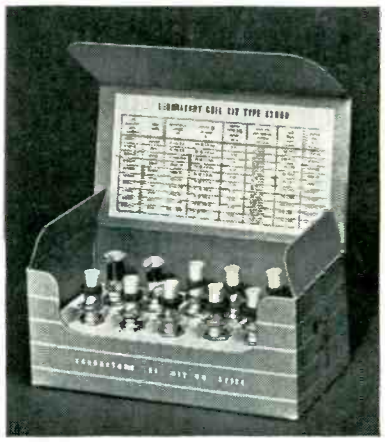
A table of frequencies and permeabilities relating to the slugs used in the coils shown above is contained in C.T.C. catalog 400. Send for your copy, and ask for prices and specifications on the coils you need. Be sure to send complete specifications for specially wound coils.

All C.T.C. materials, methods and processes meet applicable government specifications. Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West coast manufacturers contact E. V. Roberts, 5068 West Washington Blvd., Los Angeles, and 988 Market Street, San Francisco, California.

COIL FORM SPECIFICATIONS

Coil Form	Material	Mounting Stud Thread Size	Form O.D.	Mounted O. A. Height
LST	L-5 Ceramic	8-32	3/16"	19/32"
LS6	L-5 Ceramic	10-32	1/4"	27/32"
LS5	L-5 Ceramic	1/4-28	3/8"	1 1/16"
LS8	L-5 Ceramic	1/4-28	25/64"	23/32"
LS7	L-5 Ceramic	1/4-28	1/2"	1 11/16"
LSM	Paper Phenolic	8-32	1/4"	27/32"
LS3	Paper Phenolic	1/4-28	3/8"	1 1/8"
LS4	Paper Phenolic	1/4-28	1/2"	2"

NOTE: Types LS5, LS6, LS7, LS8 have slug locking spring. Type LST, available with slug locking spring as type LSTL. Type LS4 has fixed lugs — all others have adjustable ring terminals.



NEW COIL KIT X2060 for developing prototypes and pilot models contains 10 slug-tuned coils of LS6 size, type C, with silicone fibreglas collars. Range: from 2 Microhenries to 800 Microhenries, each coil slightly overlapping next coil in scale. Kit includes mounting hardware plus chart listing data of interest to designer. Coils are color-coded to chart, enabling designer to order in quantity once specifications are determined.

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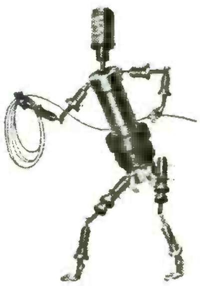
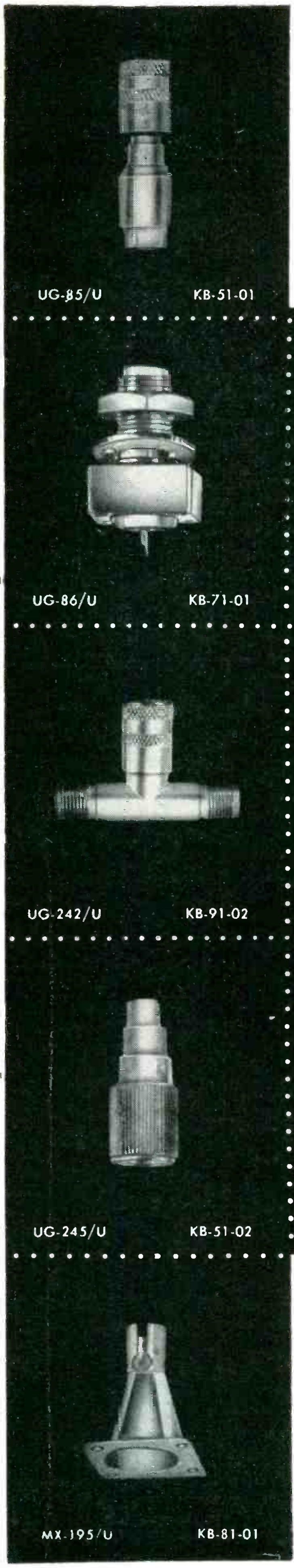
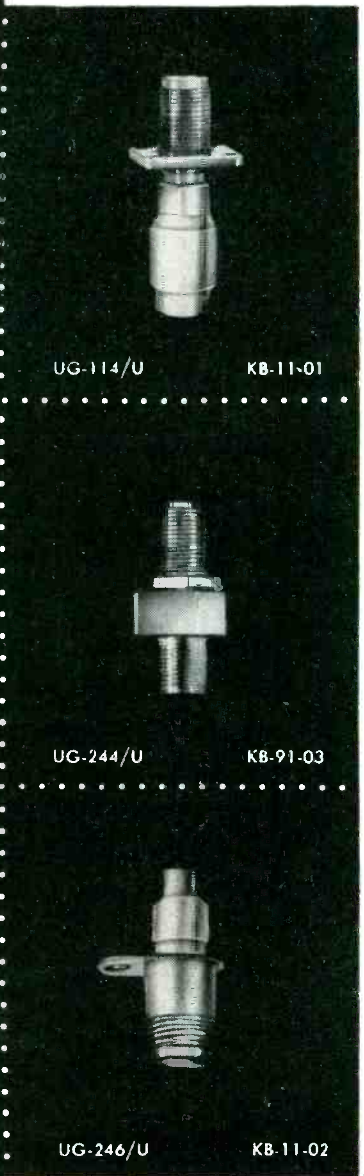


BN

CONNECTORS BY KINGS





BN Connectors are small, lightweight connectors designed for use with small cables such as RG-55/U, RG-58/U and RG-62/U. They are widely used for Video, I. F., Trigger Pulse and Low-Power R. F. applications.

During its many years of collaboration with our Armed Forces, Kings has developed engineering skills and production know-how that have won them "top-priority" with radio and electronic engineers everywhere. Constant research and rigid quality control are responsible for the increasing demand for Connectors by Kings.

Our fully-staffed engineering department is ready to serve you promptly and skillfully. You'll be glad you called on Kings first.

KINGS *Electronics* CO., INC.

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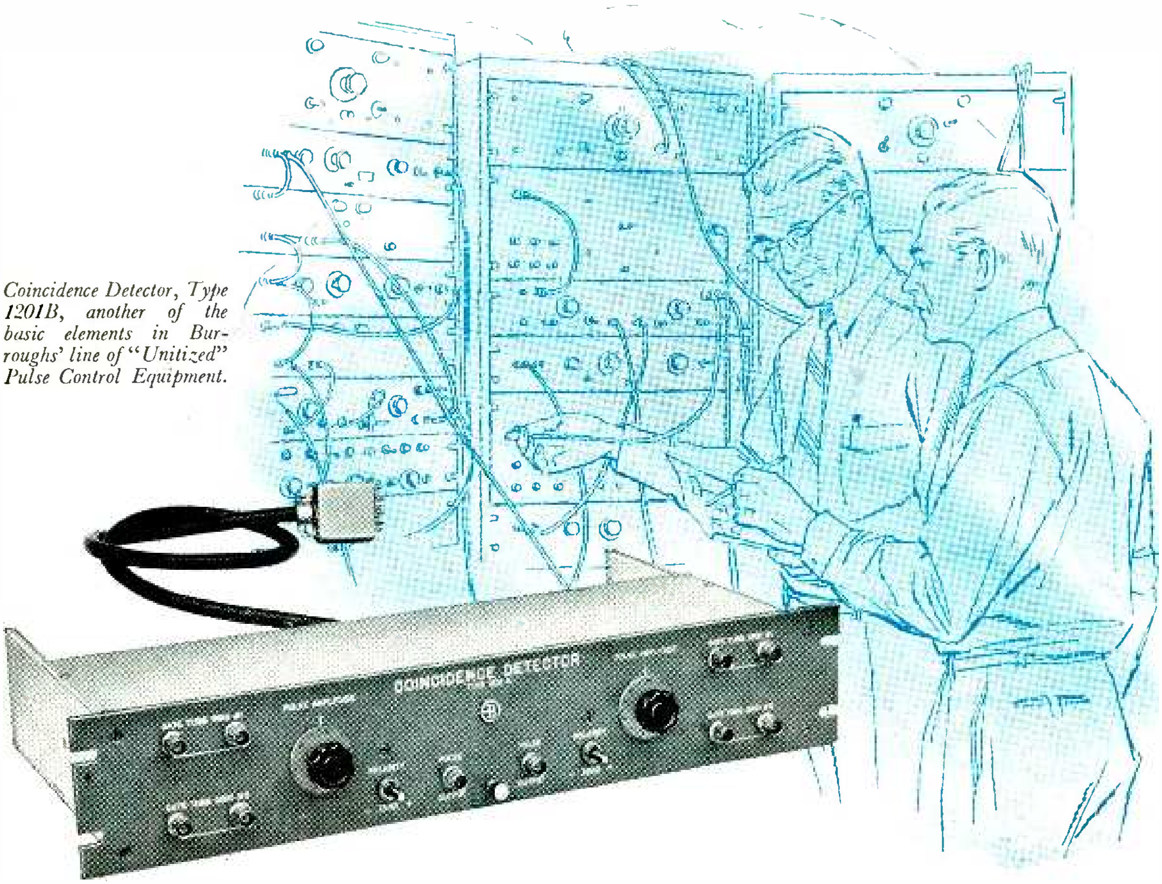
FOR APPLICATIONS IN RADAR, TELEMETERING, DIGITAL COMPUTING, TELEVISION, NUCLEAR PHYSICS



Coincidence Detector, Type 1201B, another of the basic elements in Burroughs' line of "Unitized" Pulse Control Equipment.

"Unitized" Pulse Control Equipment

permits fast, easy readaptation of electronic test circuits

Speedy assembly of electronic testing equipment is one big advantage you gain when you use versatile Burroughs pulse control units . . . but there is another tremendous advantage that *only* "Unitized" equipment offers. Since each Burroughs unit performs just *one basic operation*—such as generating, counting, mixing, gating, or delay—it's easy to *reassemble* equipment for a *different* project when one set of electronic tests is completed. You simply make a block diagram of the new circuit needed and rearrange the cables to correspond to your diagram. This flexibility permits you to quickly perform tests which otherwise might require a very long time or not be undertaken at all.

SIMPLY "PLUG IN" BURROUGHS COINCIDENCE DETECTORS

Both of the coincidence detectors offered by Burroughs demonstrate the practical one-basic-function principle that makes Burroughs "Unitized" Pulse Control Equipment so suitable to your needs.

Burroughs Coincidence Detector, Type 1201B (shown here), is designed to detect coincidence between the output signal of a flip-flop and 0.1 microsecond pulses. Two inputs are provided for each unit. One accepts 0.1 microsecond pulses with amplitudes of 12 volts or more. The other accepts the output of Burroughs Flip-Flop, Type 1101C or equivalent.

Burroughs "Unitized" pulse control assemblies have been in constant use for more than two years. Their proved dependability has led to their use by many leading electronic research organizations, including: Massachusetts Institute of Technology, Consolidated Engineering Corporation, The Catholic University of America and Magnetics Research Company.

For full information on Burroughs "Unitized" Pulse Control Equipment, write or call Department 12F, Electronic Instruments Division, Burroughs Corporation, 511 North Broad Street, Philadelphia 23, Pa.

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DIVISION OF ILLINOIS TOOL WORKS

St. Charles Road, Elgin, Illinois • Offices in principal cities

In Canada: Canada Illinois Tools Limited, Toronto, Ontario

America's Great Resources Plus A Free Economy Made This Business Possible!

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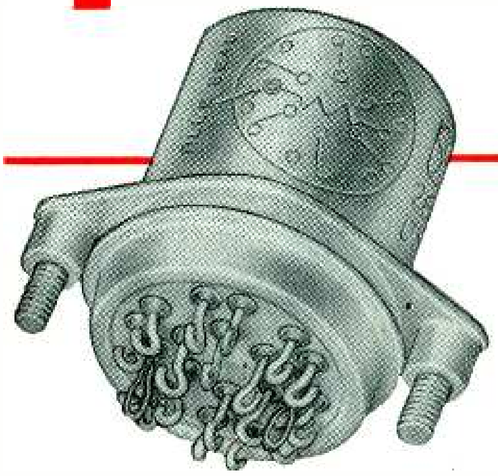
quantity—NOW!



UNION TYPE M MINIATURE RELAYS

MEET ALL REQUIREMENTS OF MILITARY SPECIFICATIONS MIL-R-5757 A & B

Now, you can buy Union type M miniature relays *in quantity*. And due to our large production facilities, you can expect a delivery date that will meet your needs. Both 6-pole and 4-pole doublethrow models are available. They meet all requirements of Military Specifications MIL-R-5757 A & B.

Here are the facts: shock load rating for the Union type M relay is 40 G's for 10 milliseconds, and this figure is obtained with the relay deenergized. This is an important point to remember, because some relays are shock-rated with the relay energized, resulting in a stiffer assembly with a higher (and non-comparable) G rating.

Breakdown voltage at sea level is 1000 volts between case and coil *or* contacts, a figure unmatched by any known comparable relay. The low 18-volt pull-in voltage is given for *maximum* rated temperature. You do not have to allow for temperature rise when you use this design figure.

This relay, weighing only 3½ ounces, is hermetically sealed containing nitrogen under pressure.

TYPICAL PERFORMANCE DATA

Service Temperature	-65°C to 125°C	-55°C to 85°C
Style FM (6-pole)	303125	303085
Coil Resistance	325 ohms	325 ohms
Nominal Voltage	26.5	26.5
Max. Pull-In Voltage at Max. Rated Temperature	18	18
Max. Drop-Out Voltage at Max. Rated Temperature	13	13

Service	Continuous
Shock	40 G's for 10 milliseconds
Vibration	10 to 55 cycles per sec.—0.060 total excursion
Life Expectancy	1,000,000 operations minimum
Contact Rating	2 amps. at 26.5 Volts—Resistive Load
Breakdown Voltage at Sea Level	1000 volts a.c. between case and contacts or coil

General Apparatus Sales Department E-67
Union Switch & Signal Division
Westinghouse Air Brake Company
Pittsburgh 18, Pa.

Please send additional information on Union type M relays.

Name .... Title ....

Company ....

Address ....

City, Zone & State ....

GENERAL APPARATUS SALES

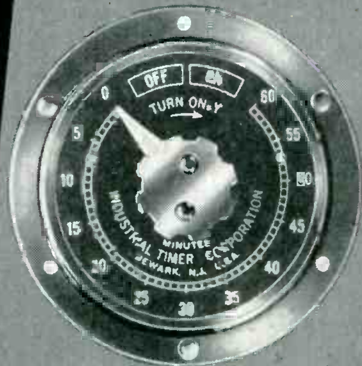
UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18 PENNSYLVANIA

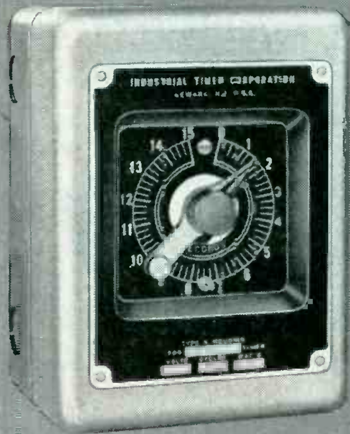
NEW YORK CHICAGO ST. LOUIS SAN FRANCISCO

Four different types of synchronous motor driven INTERVAL TIMERS



Series RS

the answer to most interval timing-control problems

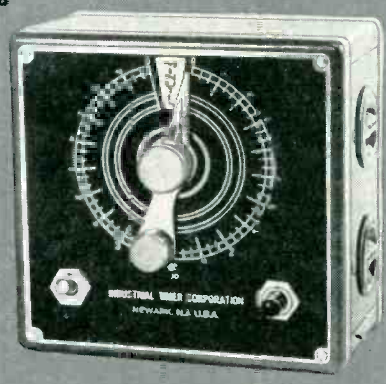

Series PAB

MANUAL SET TIMERS • Series RS

Compact, rugged construction handles high load without auxiliary relay. Heavy-duty, snap-action contacts maintain continuous pressure and wiping action. 18″ color-coded leads facilitate wire connections. 20-amp. rating—completely enclosed—2½″ dia., 3½″ length — easy-setting knob — elapsed-time indication. Time-cycle ranges, 15 min. to 12 hrs., dial calibration, 15 sec. to 15 min. 115-volt AC current, 60, 50, or 25 cycles. *Complete information in Bulletin #59*

INSTANTANEOUS RESET TIMERS • Series PAB

For process control in industry. Have automatic reset, time-setting adjustment, large numerals. Extremely accurate. Built to stand hard usage. Timing range 1/10 sec. to 5 sec. in 1/10-sec. steps (PAB-3S)—to 2 min. to 3 hrs. in 2-min. steps (PAB-3H). *Complete information in Bulletin #58*



Series P and M

AUTOMATIC RESET TIMERS • Series P and M

Series P have AC input line cord, built-in actuating start button, receptacles for plug-in remote-control and load circuits. Time cycle, 15-sec. to 5-min., dial calibration, ¼ sec. to 5 sec. 115 or 220 volt AC, 50 or 60 cycles.

Series M is similar to Series P, but start button cannot operate from remote position. Receptacle for plug-in load circuit. 60-sec. time cycle, calibrated in seconds. *Complete information in Bulletin #68*

Series S

SIGNALING TIMERS • Series S

Command eye and ear attention when time interval is completed. Automatically closes or opens circuit at end of elapsed time, and operates buzzers, bells, or lights at remote stations. 5″x5″x3″, readily attached to wall, panel, or switch box. 115 to 230 volts AC, 25, 50, or 60 cycles. Slow-speed, self-starting motor. Pure silver contacts. Interval range, 1 min. to 3 hrs., dial calibrated, 1 sec. to 5 min. *Complete information in Bulletin #98*

Manufacturers of these and other timers and controls for Industry:
AUTOMATIC RE-CYCLING TIMERS • TIME-DELAY TIMERS • RUNNING TIME METERS • INTERVAL TIMERS.

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION
131 OGDEN STREET, NEWARK 4, N. J.

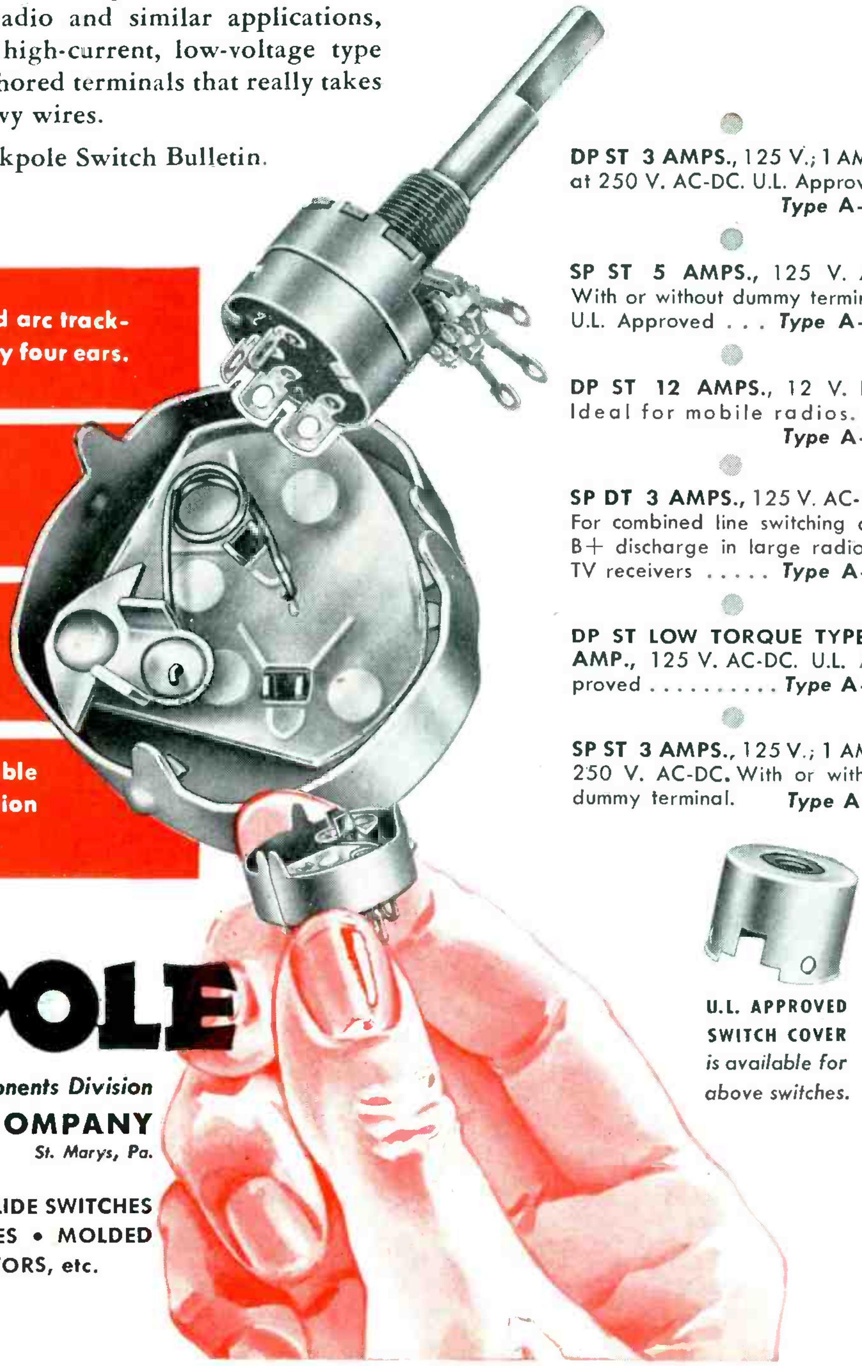
NEW ..SMALLER..

..LIGHTER WEIGHT LINE SWITCHES

Here's real line switching versatility for Stackpole Types LP, LR and other standard variable composition resistors! These little switches measure only 7/8" diameter by 9/32" deep, exclusive of terminals.

Six standard types fill virtually every line switching need—from a low torque model for midget radios with small knobs, to a heavy duty SP DT type for large combination receivers and television sets. For auto radio and similar applications, there is a new high-current, low-voltage type with doubly anchored terminals that really takes the stress of heavy wires.

Write for Stackpole Switch Bulletin.



DP ST 3 AMPS., 125 V.; 1 AMP., at 250 V. AC-DC. U.L. Approved *Type* **A-10**

SP ST 5 AMPS., 125 V. AC. With or without dummy terminal. U.L. Approved . . . *Type* **A-11**

DP ST 12 AMPS., 12 V. DC. Ideal for mobile radios. *Type* **A-12**

SP DT 3 AMPS., 125 V. AC-DC. For combined line switching and B+ discharge in large radio or TV receivers . . . . . *Type* **A-13**

DP ST LOW TORQUE TYPE, 1 AMP., 125 V. AC-DC. U.L. Approved . . . . *Type* **A-15**

SP ST 3 AMPS., 125 V.; 1 AMP., 250 V. AC-DC. With or without dummy terminal. *Type* **A-16**

Laminated Bakelite base for reduced arc tracking. Securely locked to switch case by four ears.

Unique design prevents solder from reaching switch mechanism.

Tinned terminals—doubly locked in position by ears and rivets.

Silver-plated stationary and movable contacts give increased wiping action and positive indent.

U.L. APPROVED SWITCH COVER *is available for above switches.*

STACKPOLE

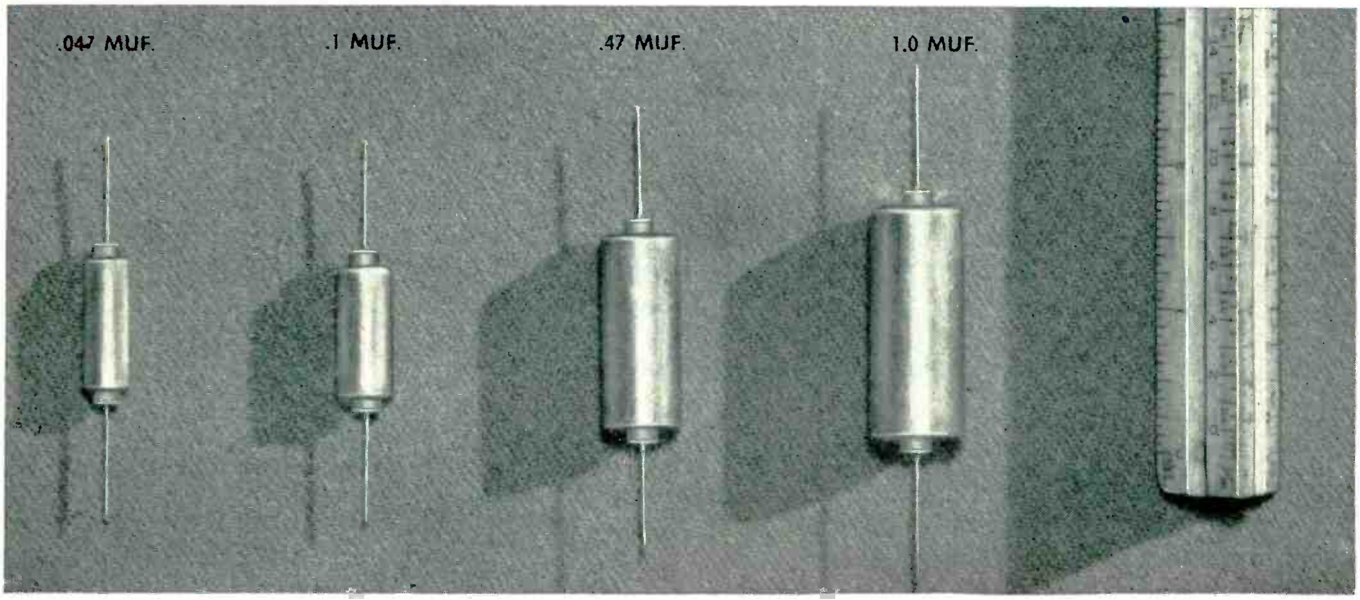
Electronic Components Division

STACKPOLE CARBON COMPANY

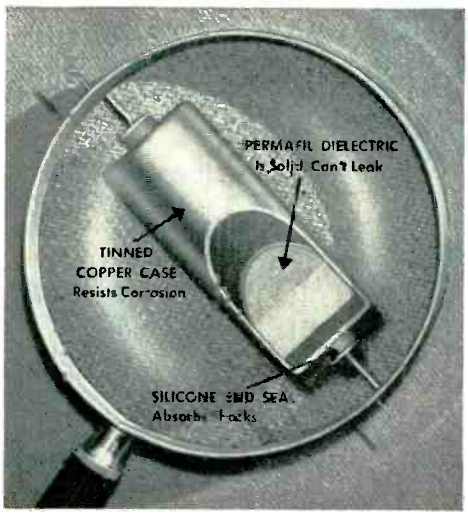
St. Marys, Pa.

FIXED & VARIABLE RESISTORS • LINE & SLIDE SWITCHES • CERAMAG® FERRITE CORES • IRON CORES • MOLDED COIL FORMS • "GIMMICK" CAPACITORS, etc.

DESIGNER'S



New metal-clad subminiature capacitors withstand extreme temperatures



RUGGEDLY CONSTRUCTED G-E subminiature metal-clad capacitors meet all requirements of JAN-C-25 and the proposed MIL-C-25.

Permafil solid dielectric permits operation up to 125C without derating

Here's a complete new line of General Electric metal-clad subminiature capacitors designed to meet difficult operating conditions. Now you need no increase in capacitor size for applications with high working temperatures.

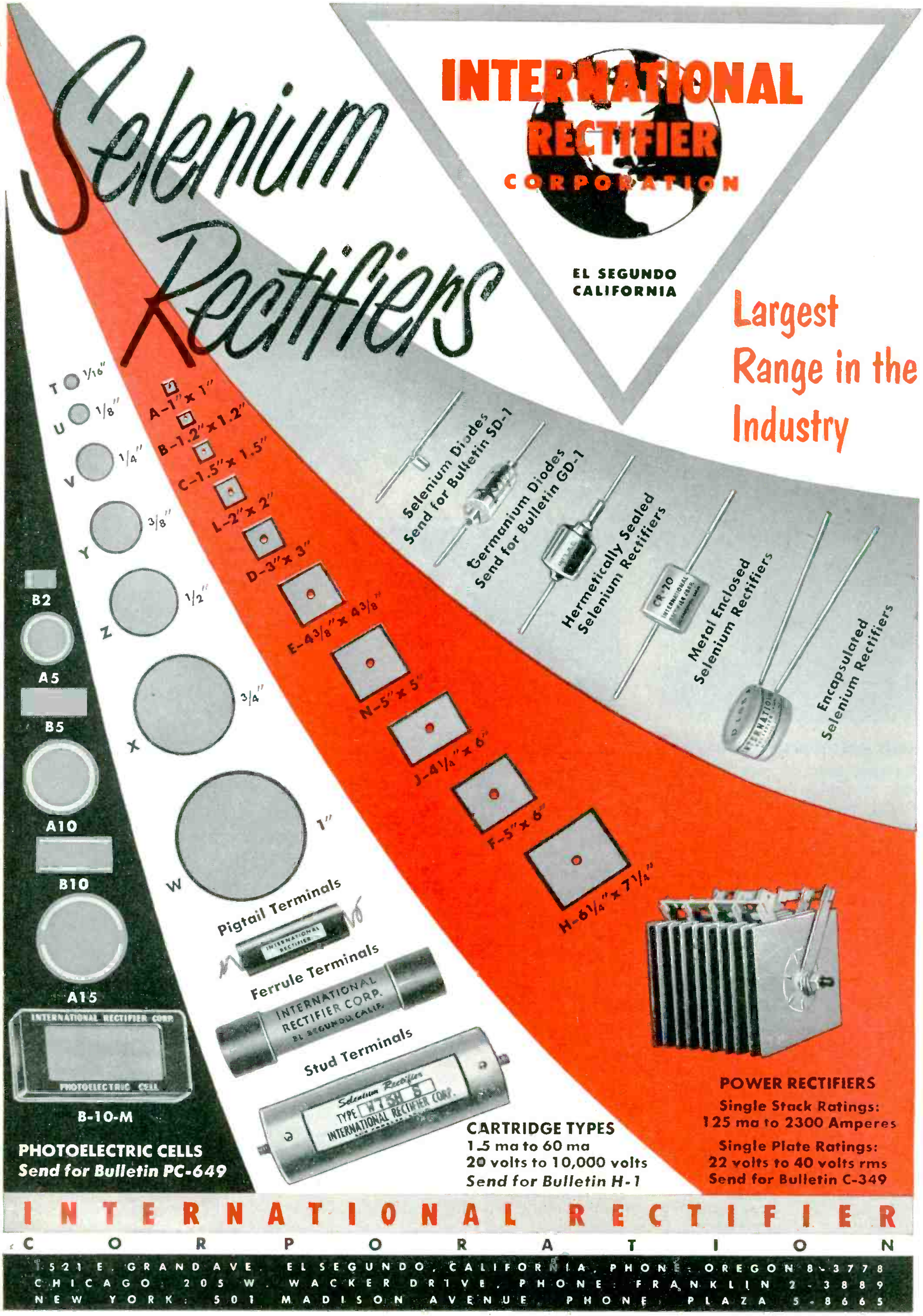
G. E.'s exclusive permafil solid dielectric eliminates the possibility of leakage without derating from −55C to +125C—and up to +150C with proper derating. Silicone bushings give high shock resistance—both thermal and physical—and leads can be soldered right up to the bushing.

Muf ratings range from .001 to 1.0 muf in 100, 200, 400 and 600 volts d-c working. They can be operated at full voltage up to altitudes of 50,000 feet.

If you need even smaller capacitors, G.E. has introduced another line of new Pyranol* (liquid-filled) metal-clad capacitors. These are designed for operation from −55C to +85C without derating and offer the same electrical advantages as their permafil cousins. For further information on permafil capacitors, send for new Bulletin GEC-987.

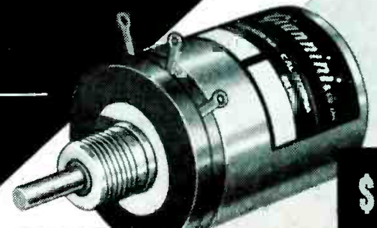
GENERAL ELECTRIC

Want more information? Use post card on last page.


Selenium Rectifiers
INTERNATIONAL RECTIFIER CORPORATION
EL SEGUNDO CALIFORNIA
Largest Range in the Industry
T 1/16"
U 1/8"
V 1/4"
Y 3/8"
Z 1/2"
X 3/4"
W 1"
A-1"x 1"
B-1.2"x 1.2"
C-1.5"x 1.5"
L-2"x 2"
D-3"x 3"
E-4 3/8"x 4 3/8"
N-5"x 5"
J-4 1/4"x 6"
F-5"x 6"
H-6 1/4"x 7 1/4"
Selenium Diodes Send for Bulletin SD-1
Germanium Diodes Send for Bulletin GD-1
Hermetically Sealed Selenium Rectifiers
Metal Enclosed Selenium Rectifiers
Encapsulated Selenium Rectifiers
B2
A5
B5
A10
B10
A15
INTERNATIONAL RECTIFIER CORP.
PHOTOELECTRIC CELL
B-10-M
PHOTOELECTRIC CELLS
Send for Bulletin PC-649
Pigtail Terminals
Ferrule Terminals
INTERNATIONAL RECTIFIER CORP. EL SEGUNDO CALIF.
Stud Terminals
CARTRIDGE TYPES
1.5 ma to 60 ma
20 volts to 10,000 volts
Send for Bulletin H-1
POWER RECTIFIERS
Single Stack Ratings:
125 ma to 2300 Amperes
Single Plate Ratings:
22 volts to 40 volts rms
Send for Bulletin C-349
INTERNATIONAL RECTIFIER CORPORATION
1521 E. GRAND AVE. EL SEGUNDO, CALIFORNIA, PHONE: OREGON 8-3778
CHICAGO: 205 W. WACKER DRIVE, PHONE: FRANKLIN 2-3889
NEW YORK: 501 MADISON AVENUE, PHONE: PLAZA 5-8665

advanced production techniques bring you...

advanced minitorque*

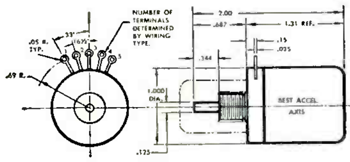


New design and advanced production techniques enable Giannini to bring you the advanced Minitorque* potentiometer at a NEW LOW PRICE. Here, from the leader in low torque potentiometer design and production, is a rugged, high accuracy unit, at half the price of comparable potentiometers.

The Minitorque* is a low torque Instrument Quality potentiometer 1" in diameter, with a stainless steel shaft and oilite sleeve bearing. Standard models with resolution from 0.06% to 0.19%, and linearities of ±0.5% are now *available for immediate delivery from stock.* The Minitorque* is especially adaptable to laboratory test equipment, computer systems, remote telemetering, and process control, where a dependable, lightweight potentiometer is required.

- Stainless Steel Shaft
- Dustproof Construction
- Positive Contact
- Low Torque Brush Design
- Moulded Plastic Body
- Platinum Alloy Wire

$20.00
Standard Model



STOCK MODEL SPECIFICATIONS**

LINEARITY: ±0.5% of total resistance, or better.
TORQUE: Starting: 0.025 oz. in.
SHAFT ROTATION: 360°.
WINDING ANGLE: 354° Minimum. (A minimum gap is provided so that brush will not short winding in region of 354° to 360°.)
TEMPERATURE COEFFICIENT: .00006 ohms/-ohm/°C max.
TEMPERATURE RATING: Operating range from −54° to +71°C.
ACCELERATION: Will function during acceleration of 50 G's applied along any axis.
VIBRATION: Will function during vibration of 0.060 in. total excursion, at frequencies varying from 10 to 55 cps applied along any axis.
VOLTAGE BREAKDOWN: Will withstand 500 v AC (rms) at 60 cps, between any terminal and shaft at sea level.
WEIGHT: 0.6 oz.

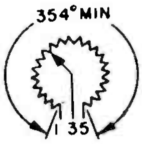
*Reg. U. S. Patent Office

These resistance values in stock for immediate shipment:

500 ohms	2K ohms	10K ohms	50K ohms
5K ohms	5K ohms	20K ohms	100K ohms

**There are twelve wiring types available, in addition to special modifications to customer's requirements.

Resistance (ohms ±5%)	Maximum Current (ma at +25°C)	Average Total Turns
100	117	525
250	81	615
500	56	760
1,000	39	770
2,000	29	1,020
5,000	20	1,190
10,000	14	1,400
20,000	8.6	1,660
50,000	5.5	1,660
100,000	3.9	1,660



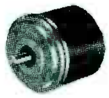
TYPE 9

Giannini

For complete information, write for Minitorque Bulletin No. 111.*

G. M. GIANNINI & CO., INC. • PASADENA 15, CALIF. • EAST ORANGE, NEW JERSEY

OTHER GIANNINI POTENTIOMETERS



MODEL 85171A SPIRALPOT

Slide-wire; infinite resolution; low noise; linearity to ±0.01%. 1.812" dia. x 1.61". 1/4" shaft. Resistances: 2 to 3750 ohms. 1 to 15 turns.

MODEL 85173A SPIRALPOT

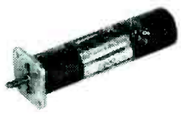
Slide-wire; infinite resolution; low noise; linearity to ±0.025%. 3.312" dia. x 2.4". 1/4" shaft. Resistances: 6 to 25,000 ohms. 1 to 40 turns.

MODEL 85111 MICROTORQUE

Extremely low torque (.003 oz.in.). Resolution to .06%; 1" dia. x 1.31"; shaft 0.031" dia.; 1.63 watts (average). Resistance: 250 to 25,000 ohms; 12 wiring types. Linearity: ±0.5% or ±0.25%.

MODEL 85193 MINIGANG

Rugged—small; resolution to .06%; 1.125" dia.; up to six sections; 2 watts per section. Resistances: 130 to 70,000 ohms. Linearities: ±0.5% or ±0.25%.

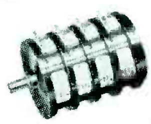


MODEL 8620 RECTIPOT

Linear motion; rigid metal case; 1" dia.; one or two elements; strokes from 0.2" to 6.0". Resistances: from 400 ohms/in. to 15,000 ohms/in.; taps available.

MODEL 85196 UNIVERSAL POTENTIOMETER

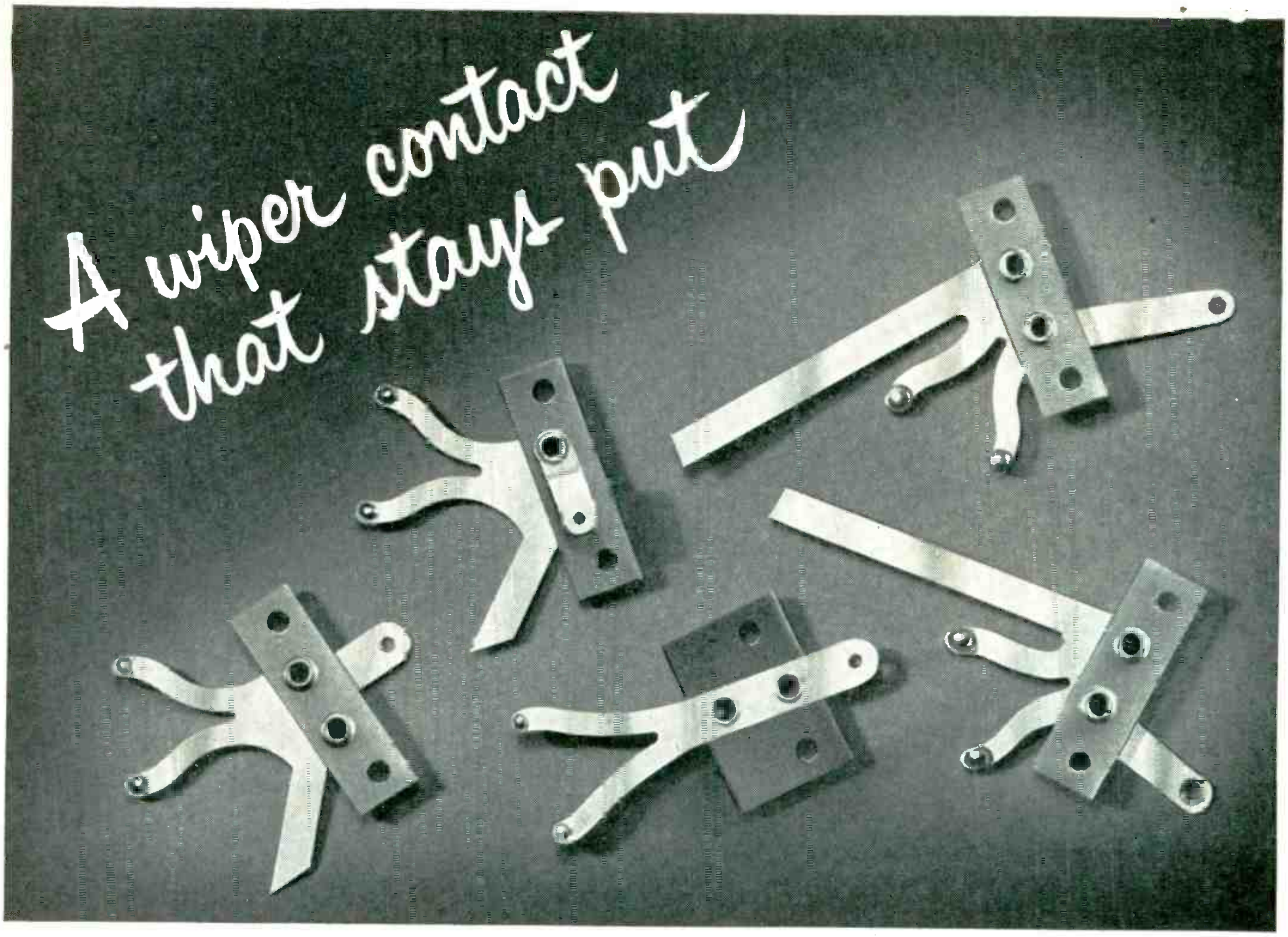
High accuracy; rugged. Resistances: 360 to 200,000 ohms. Linearities: ±0.3% to ±0.15%; 12 wiring types; sleeve or ball bearing models; 1.740" dia. x .81"; available with sine-cosine or logarithmic outputs.



MODEL 85197 UNIVERSAL GANGPOT

Up to 12 sections; 2" dia. Resistances: 360 to 200,000 ohms per section. Linearities: ±0.3% to ±0.15%; sleeve or ball bearings; sections phaseable 360°, solid shaft. Anodized aluminum case; log or sine-cosine outputs.

Want more information? Use post card on last page.



Data supplied by the Radio Condenser Company, Camden, N. J.

IT'S MADE OF BERYLCO BERYLLIUM COPPER

Why beryllium copper is specified more and more for electronic equipment is illustrated by this wiper contact for a variable condenser used in Signal Corps combat transmitting and receiving equipment. It is made of quarter hard Berylco 165 strip, .014" thick, cadmium plated. The contact buttons are silver.

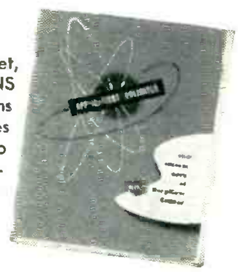
Electrical conductivity here is a must, of course. But even more important is the degree of contact the part makes with the shaft. Too little pressure will make a poor electrical contact; too great a pressure will excessively load the shaft. In production, the wiper is tested with a combination leaf spring gage and electric continuity checker to register between 40 and 70 grams of pressure.

Once this adjustment is made, the Berylco contact will exert a constant pressure, come what may. In fact, it will remain in adjustment even after hand-forming during the checking operation.

It is just this ability of Berylco to solve conflicting mechanical, electrical and service requirements that makes it valuable to designers. Here, in one alloy, are combined such properties as strength, conductivity, corrosion resistance and elasticity—a combination no other alloy gives you.

If you would like to include beryllium copper in your plans for the future, we invite you to share the know-how of the world's largest producer of this unique alloy. For engineering help or sample material, call or write any of the offices listed below.

INVALUABLE



This 16-page booklet, called APPLICATIONS UNLIMITED, contains nearly 40 case histories — shows how Berylco has solved many troublesome design and engineering problems. Send for your free copy today.

TOMORROW'S PRODUCTS ARE PLANNED TODAY...WITH BERYLCO BERYLLIUM COPPER

BERYLCO THE BERYLLIUM CORPORATION

DEPT. 3L, READING 21, PENNSYLVANIA

New York • Springfield, Mass. • Rochester, N. Y. • Philadelphia • Cleveland • Dayton • Detroit • Chicago • Minneapolis • San Francisco • Los Angeles

Representatives in principal world-trade centers

YOU helped create this superior Recording Oscillograph

NEW Type 5-119

CONSOLIDATED's new Type 5-119 Oscillograph was designed and built to customer specifications. Many major users were interviewed by our design engineers to determine the features desired in a "perfect" instrument. Foremost demand was for great dependability. Second need indicated was for high trace capacity.

Dependability is achieved by extensive warning and test circuits and by reserve lamps which assure continuous recording in the event of lamp burn-out. Indicators warn immediately of any condition which could cause data loss, while additional circuits permit quick testing of the warning system. Design of the instrument assures reliable operation under the most rigorous environmental conditions.

Standard models provide either 36 or 50 traces. Consolidated's new Series 7-300 Galvanometers provide frequency response flat to 3000 cps. Standard record width of 12″ greatly simplifies record interpretation. Only after several prototypes were successfully tested under actual field conditions did we go into production on the 5-119—the new recording oscillograph leader. Write for Bulletin CEC 1536-X7.

SPECIFICATIONS

TRACE CAPACITY	36 or 50-trace models available
TRACE IDENTIFICATION	repeated, sequential trace breaks
RECORD WIDTH	12″ standard; narrower widths adaptable
RECORD MAGAZINE	removable, integral type; holds 250′ paper or film
RECORD SPEEDS	0.10 to 100 inches per sec. through quick-change gears, instantaneous switch-actuated, 10:1 speed jump
SCANNING SYSTEM	ground-glass screen and adjustable motor-driven polygon mirror; timing lines show on viewing screen
REMOTE OPERATION	accessory control unit with all essential controls & indicators
TIMING PROVISIONS	0.10 and/or 0.01 sec. lines photographed across record
EVENT NUMBERING	high-speed flash system operates as rapidly as one number per sec.
POWER REQUIREMENTS	115 volt, 60 cycle and 26 volt d-c models
INPUT PROVISIONS	all connectors on one rear deck; individual galvanometer plugs
CONTROL PANEL	all controls and indicators on single panel
ACCESSIBILITY	all adjustments can be made from one surface

The 5-119 can be panel mounted vertically with special shockmounts.

Consolidated Engineering
CORPORATION
300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service through **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, New York, Chicago, Washington, D. C., Philadelphia, Dallas.*

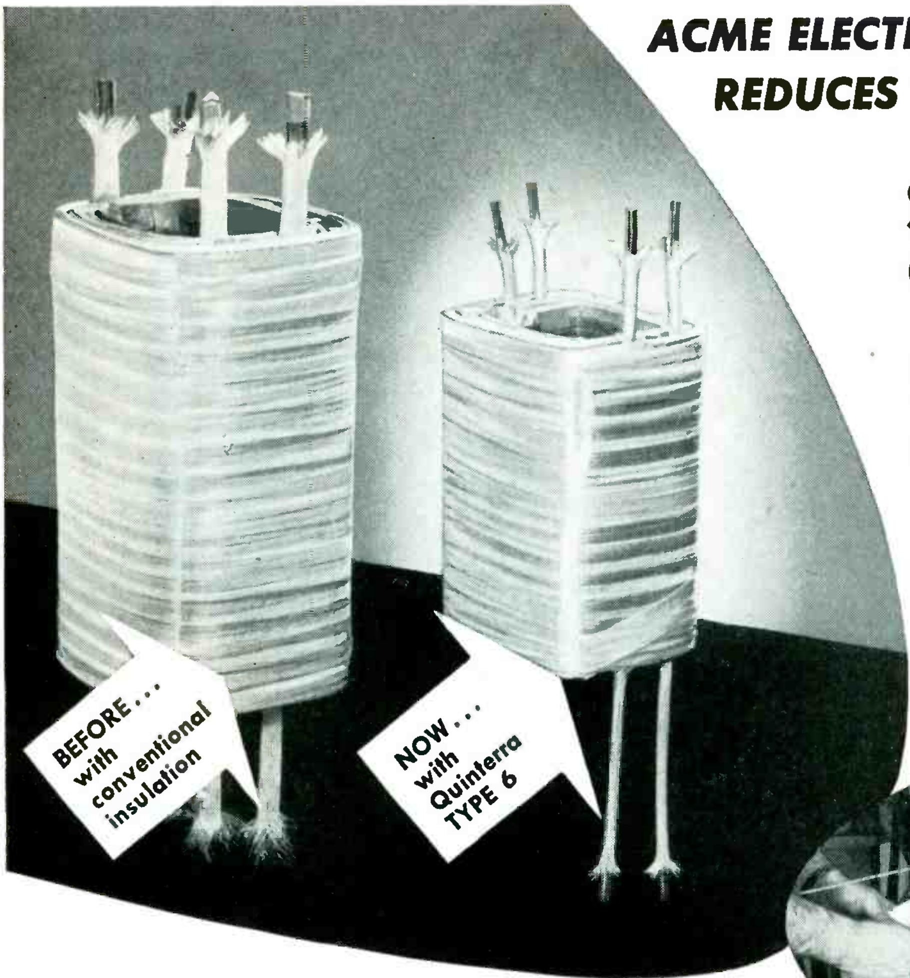
analytical instruments for science and industry

Recording Oscillographs

The Type 5-119 is the newest of 7 Consolidated Oscillographs ranging from 9 to 50 channel capacity. These versatile instruments simultaneously record any physical phenomena that can be transformed into electrical impulses. All measurements are obtained in clear, permanent form during the same operational cycle for future detailed analysis.

Want more information? Use post card on last page.

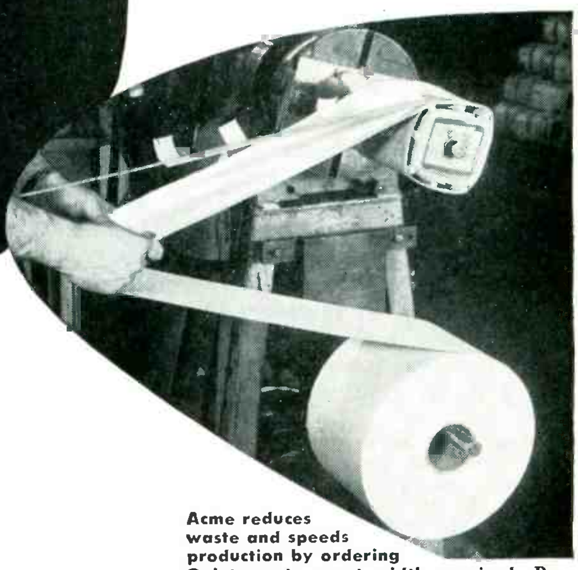
ACME ELECTRIC CORPORATION REDUCES TRANSFORMER SIZE



Saves 40% on steel...

Saves 42% on copper...

Saves 44% on weight...



Acme reduces waste and speeds production by ordering Quinterra to exact width required—Production efficiency has been increased and waste has been reduced to an absolute minimum — without equipment changeover — by using Quinterra Type 6, factory-cut to Acme's dimensional specifications.

—by insulating coils with

Quinterra® TYPE 6

the purified asbestos electrical insulation

How have these tremendous savings in critical materials, weight, space, and production time affected the quality of Acme transformers?

The manager of Acme's Dry Type Transformer Division advises that not a single failure in operation of an Acme Quinterra-insulated transformer has been reported in the two years that they have been produced. Since several thousands of these units have been manufactured in this time, their quality is evident.

Here are the reasons why this Johns-Manville purified asbestos insulation has helped the Acme Electric Corporation, and many other well-known manufacturers, turn out better products and at the same time lower production costs.

Quinterra Type 6 possesses high thermal stability and lasting dielectric strength. It is a twin-ply, polyvinyl, acetate-treated, purified asbestos insulation with a dielectric strength of 300 VPM. Even when its saturant is baked out by continuous exposure to 200 C, it retains the inherent dielectric of the base sheet which is at least 200 VPM . . . and it remains a dielectric up to 400 C.

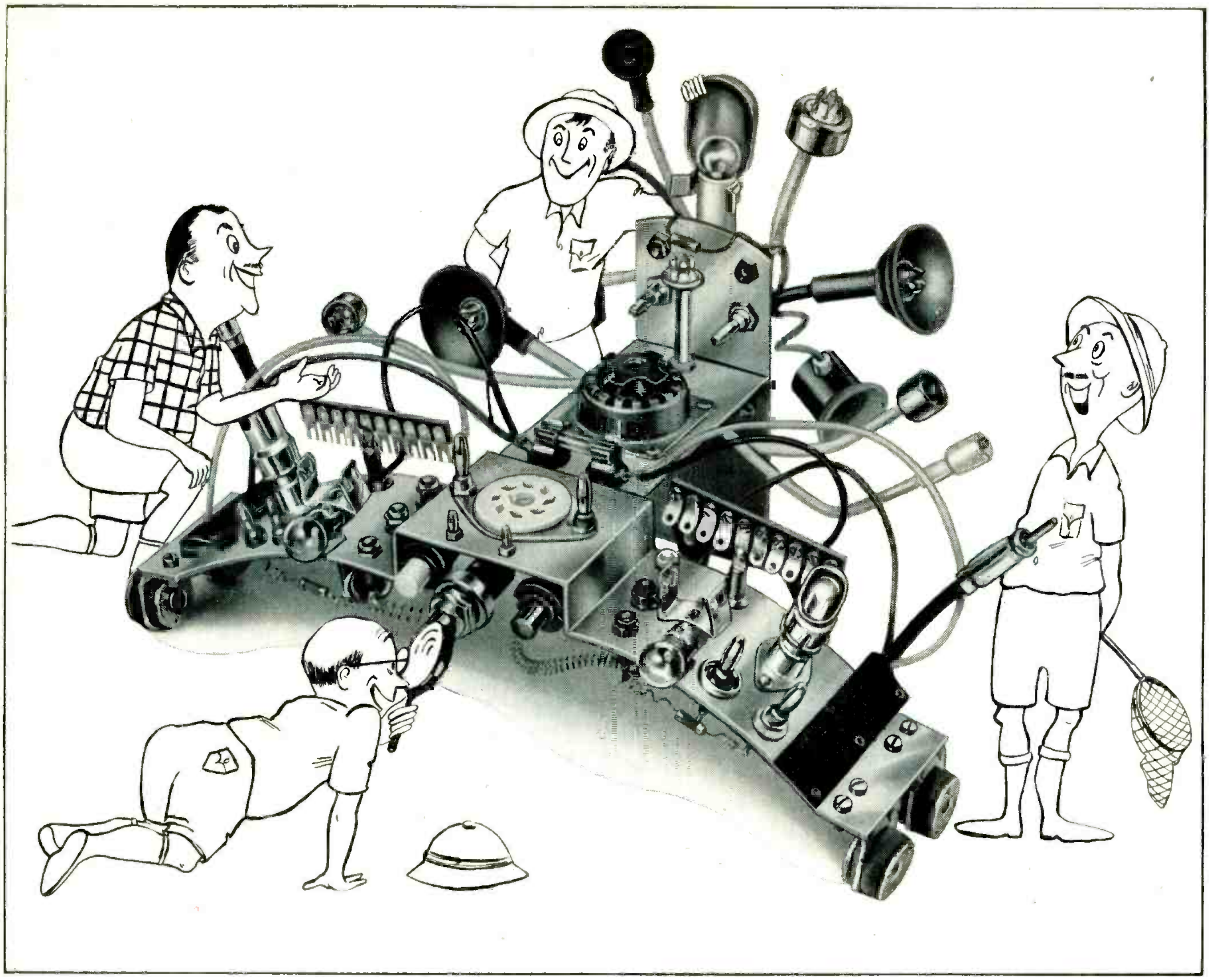
Type 6 has high mechanical strengths because it is made by combining and calendering two layers of Quinterra together into a dense, smooth-surfaced insulation. Its good tensile and bursting strengths enable operators to achieve favorable production rates. Further economies result from its large square-foot-per-dollar coverage.

If you are a manufacturer of magnetic or resistance devices, Quinterra Type 6 . . . or one of the other Quinterras . . . may enable you to lower production costs and also to improve your product's performance. For samples and additional information, write to Johns-Manville, Box 60, New York 16, New York.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville ELECTRICAL INSULATIONS

Want more information? Use post card on last page.



Dielectric Gismatron

Completely silent in operation, the Gismatron was originally designed as an aid to entomologists. It has now won the approval, however, of *electronic* bug-hunters who find that its various component parts (all of them made by Ucinite) *add reliability*, *ease of assembly* and *smoothness of operation* to various types of electronic apparatus, thereby eliminating many bugs before they have to be hunted.

With an experienced staff of design engineers, plus complete facilities for volume production, Ucinite is capable of supplying practically any need for metal or metal-and-plastics assemblies. Call your nearest Ucinite or United-Carr representative for full information or write directly to us.

ELECTRICAL ASSEMBLIES
Ucinite
RADIO AND AUTOMOTIVE

The UCINITE CO.
Newtonville 60, Mass.
Division of United-Carr Fastener Corp.

Specialists in
ELECTRICAL ASSEMBLIES, RADIO AND AUTOMOTIVE

Fishtail...

New anti-rattle fastener for NAMEPLATES and trim holds threadless studs

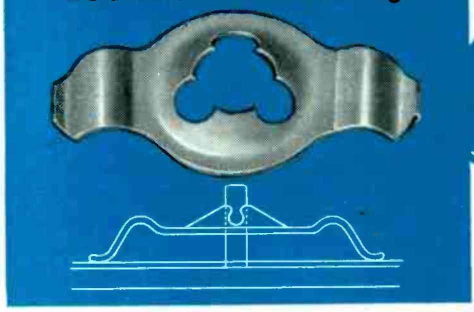
Quick, tight, permanent fastening for name-plates and other die-cast trim is now possible without nuts and washers, thanks to United-Carr's Fishtail fastener.

Easily attached with simple hand tools, its teeth actually bite into chrome-finished, threadless studs so that there is no chance of slippage or looseness.

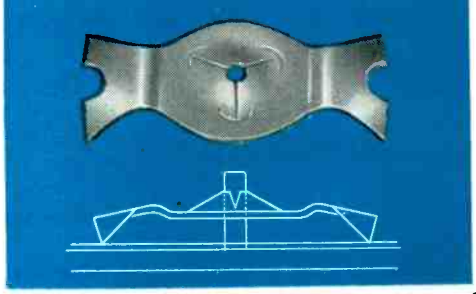
Fishtail's grip on welded, staked or extruded studs is independent of the pressure of the spring take-up legs. Leg pressure, however, allows positioning adjustments while it provides secure anchorage even when the studs protrude through oversize holes.

Fishtail fasteners can be used on flat or contoured surfaces and their cup-shaped centers hold and retain sealing compounds.

ROUND TAIL with blunt legs



FISHTAIL with sharp legs



Like thousands of other fasteners and allied devices, designed and manufactured by United-Carr, Fishtail fasteners help speed assembly and cut costs. Available in a complete range of sizes and in volume quantities; further details on request.

UNITED-CARR

MAKERS OF DOT FASTENERS

UNITED-CARR FASTENER CORPORATION, CAMBRIDGE 42, MASSACHUSETTS

Want more information? Use post card on last page.

mitchell-rand

features electrical insulating tapes

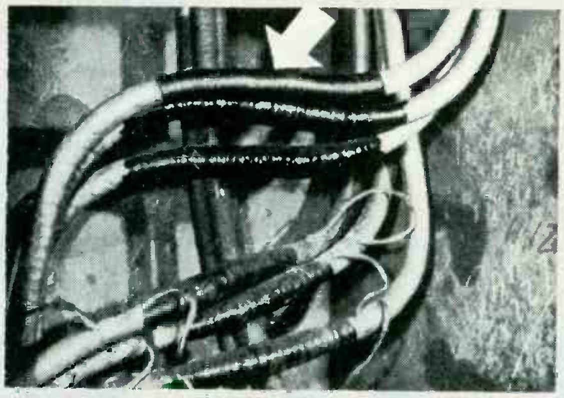
BI-SEAL

self-bonding Polyethylene, for resistance to corrosion and chemicals.

BI-PRENE

self-affixing Neoprene, for resistance to oils and chemicals.

UNAFFECTED BY LOW TEMPERATURES • SUPERIOR AGING • CORROSION-CHEMICAL OIL RESISTANT • EXCELLENT CONFORMABILITY • SELF-BONDING • MOISTURE-RESISTANT • HI-DIELECTRIC STRENGTH



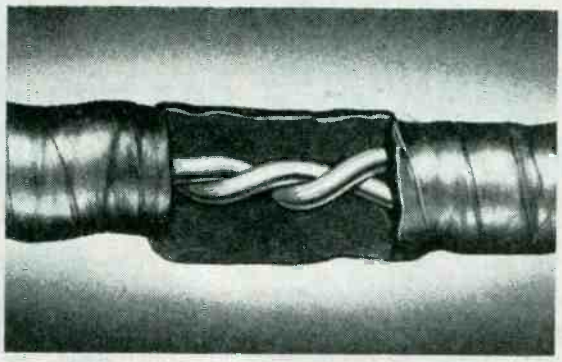
BI-SEAL INSULATION CHARACTERISTICS

Electrical Properties

Dielectric strength	1000 volts/mil avg.
Power factor	60 cycles ... 0.0006
	1000 cycles ... 0.0006
	106 cycles ... 0.0004
Dielectric constant	60 cycles ... 2.32
	1000 cycles ... 2.34
	106 cycles ... 2:13

Physical and Chemical Properties Resistance to:

Ozone	Excellent
Oxygen	Excellent
Acids	Excellent
Alkalies	Excellent
Moisture vapor transmission	Negligible
Castor Oil	Good
Commercial Hydraulic Fluids	Excellent
Aging qualities	Excellent
Operating temperatures	197°F to −67°F
Application temperatures	150°F to −40°F



BI-PRENE INSULATION CHARACTERISTICS

Physical Tests on Press Cured Slabs 10°/310°F

Tensile	1980 p.s.i.
Elongation	400%
200% Modulus	1030 p.s.i.
Ozone	6 hours to cut

Physical Properties on Aging
80°C Oxygen Bomb for 14 days
67.4% of original elongation
62.6% of original Tensile

Air Bomb at 26°F for 30 Days at 80 p.s.i.
160% of original elongation
66% of original Tensile

Oil Resistance
A. S. T. M. Reference fluid number one — 11.7% maximum swell in 24 hrs. A. S. T. M. Reference fluid number two—69.7% maximum swell in 24 hrs. 18 hr. exposure in oil at 121°C — Tensile decreased 4.5%. Elongation increased 70%.

Here are two multi-purpose electrical insulating tapes for wire or cable splicing . . . the self-bonding BI-SEAL and the self-affixing (air-curing) BI-PRENE . . . to meet the strictest requirements for unusual as well as ordinary cable splice applications for the smallest wire or the largest cable . . . wherever tape can be used for splicing.

The outstanding characteristics and excellent insulation properties, plus the feature that once applied BI-SEAL and BI-PRENE tapes fuse into a solid mass, impossible to unwrap or delaminate, enables these products to offer complete and lasting protection against moisture, acids, alkalies, oils, chemicals, sunlight, corrosion, fungus, ozone, etc.

Write for samples and detailed data

MITCHELL-RAND • SINCE 1889
Electrical Insulation Headquarters

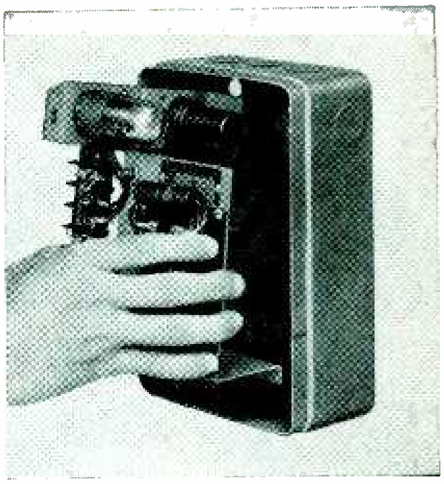
mitchell-rand INSULATION COMPANY, INC.

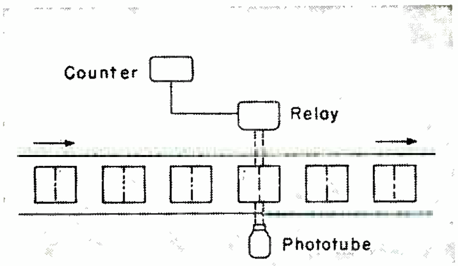
51 MURRAY ST. • COrtlandt 7-9264 • NEW YORK 7, N.Y.

MIRAGLAS VARNISHED TAPES, CLOTHS AND SLEEVINGS • MIRAGLAS TAPES, BRAIDED SLEEVINGS AND TYING CORDS • MIRAGLAS SILICONE TREATED CLOTHS, TAPES AND TUBINGS • MICA TAPES, CLOTHS AND MICA-FIBERGLAS COMBINATIONS • FIBRE, PHENOL FIBRE AND MIRALITE POLYESTER RESIN SHEET INSULATING PAPERS—DURO, FISH, PRESSBOARD, ETC. • VARNISHED CAMBRIC TAPES, CLOTH AND SLOT INSULATIONS • COTTON TAPES AND SLEEVINGS • TWINES AND TIE TAPES • ASBESTOS TAPES, SLEEVINGS AND CLOTH, TRANSITE AND ASBESTOS EBONY • ARMATURE WEDGES AND BANDING WIRE • VARNISHED TUBINGS, HYGRADE, MIRAGLAS, HYGRADE VF, MIRAGLAS SILICONE • THERMOFLEX AND FLEXITE EXTRUDED PLASTIC TUBING • PERMACEL MASKING TAPES AND ELECTRICAL TAPES • BI-SEAL, BI-PRENE; FRICTION TAPES AND RUBBER SPLICE • COMPOUNDS—TRANSFORMER, CABLE FILLING, POTHEAD, ETC. • INSULATING VARNISHES OF ALL TYPES.

Want more information? Use post card on last page.

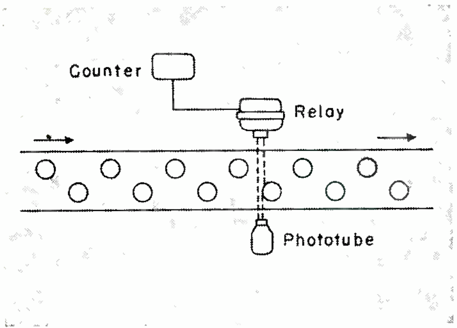
G-E Photoelectric Relays Sort, Count, Signal — Automatically





CR7505-K100
Simple, Inexpensive, Dependable

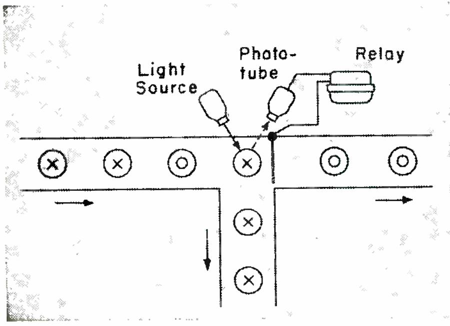
Ideal for applications not requiring extreme accuracy or extra high speeds, the K100 can relieve costly personnel for more productive jobs. A good example is the application at left, where this relay is being used to operate a counter on a conveyor line. The K100 is furnished in a sturdy NEMA Type I enclosure. *Bulletin GEA-3533D.*



CR7505-K201
High-quality, General-purpose Relay

The K201 photoelectric relay, shown at left counting small cans on a high-speed conveyor line, offers sufficient sensitivity and operating speed for most applications.

The K201 is available in either weather-resistant and dust-tight (NEMA III and V) or explosion-proof (NEMA VII) or water-tight (NEMA V). *Bulletin GEA-5920.*



CR7505-N210
High Speed, High Sensitivity

The N210 relay is an extremely sensitive device designed for operation at very high speeds.

In the example shown here, it is used on a conveyor to separate cans according to markings. It can also be used to sort unlabeled cans from correctly labeled ones. Available in same enclosure types as K201. *Bulletin GEA-5921.*

SPECIFICATIONS

Maximum operating speed:

K100: 150 per minute
K201: 450 per minute
N210: 600 per minute

Maximum operating distance:

K100: 30 feet
K201: 70 feet
N210: 210 feet

Sensitivity*:

(Minimum light intensity at phototube for successful operation)

K100: 40 fc.
K201: 3 fc.
N210: 1 fc.

* Depending on combination selected.

High contact rating

Can start f-hp motors directly, and operates all a-c motor starters through NEMA Size 4, without additional relay. Meets all NEMA standards.

ELECTRONIC TIMER CR7504-A142

Handles timing over three ranges. .06-1.2, .6-12, 6-120 seconds. Highly accurate, versatile. *Bulletin GEA-5255.*

ELECTRONIC RELAY CR7511-A126G2

A versatile new relay which operates wherever there is sufficient change in circuit resistance. *Bulletin GEA-5893.*

FOR MORE INFORMATION, contact your nearest G-E Apparatus Sales Office or authorized G-E distributor, or write General Electric Company, Section E 785-8, Schenectady 5, New York for the following bulletins:

☐ GEA-3533D, Photoelectric Relay K100
☐ GEA-5920, Photoelectric Relay K201
☐ GEA-5921, Photoelectric Relay N210
☐ GEA-5255B, Electronic Timer
☐ GEA-5893, Electronic Relay

NAME .... TITLE ....

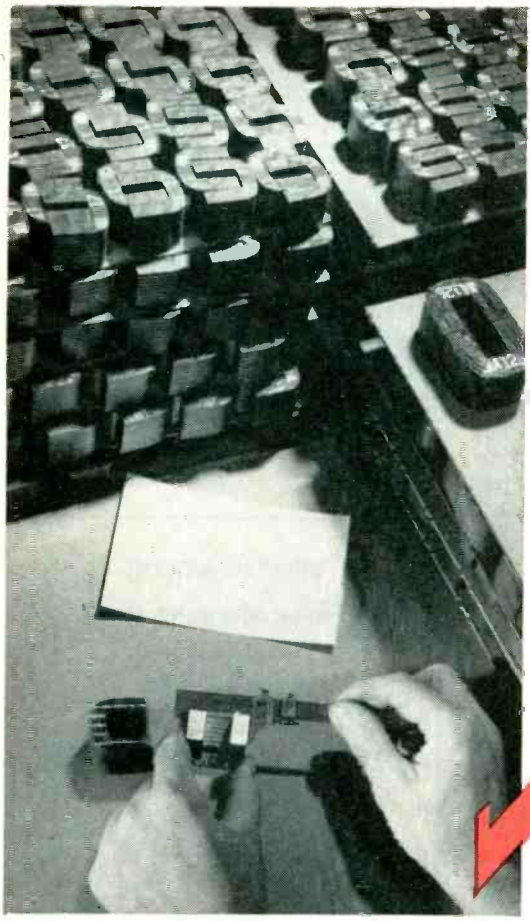
COMPANY ....

ADDRESS ....

CITY .... STATE ....

ELECTRONIC DEVICES

GENERAL ELECTRIC



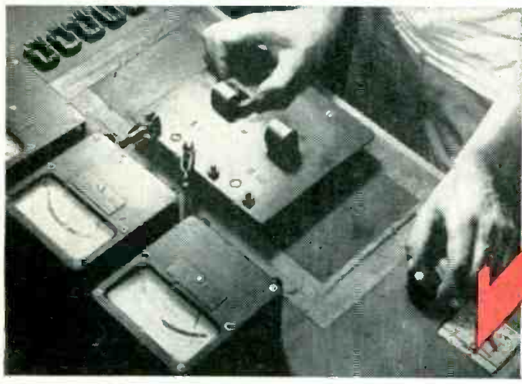
MOLONEY *HiperCore* ELECTRONIC CORES

Check and double Check

HiperCore Electronic Cores measure up to the highest standards of quality and performance. One check is not enough . . . each core undergoes at least two rigid inspections. The first makes certain that it is of the specified size . . . and the second determines that the finished cores have the desired electrical qualities. All HiperCore electronic cores *must* test well within industry tolerances. Special tests for specific operating conditions can also be made if desired.

These tests are the real proof of the superior fabrication which combines the finest materials with superior "know how". Result; electronic cores that give better performance . . . have greater flux carrying capacity and lower losses. And since Moloney Hiper-Core Electronic Cores are wound cores of cold-rolled oriented silicon steel, they are smaller and lighter.

ME53-36



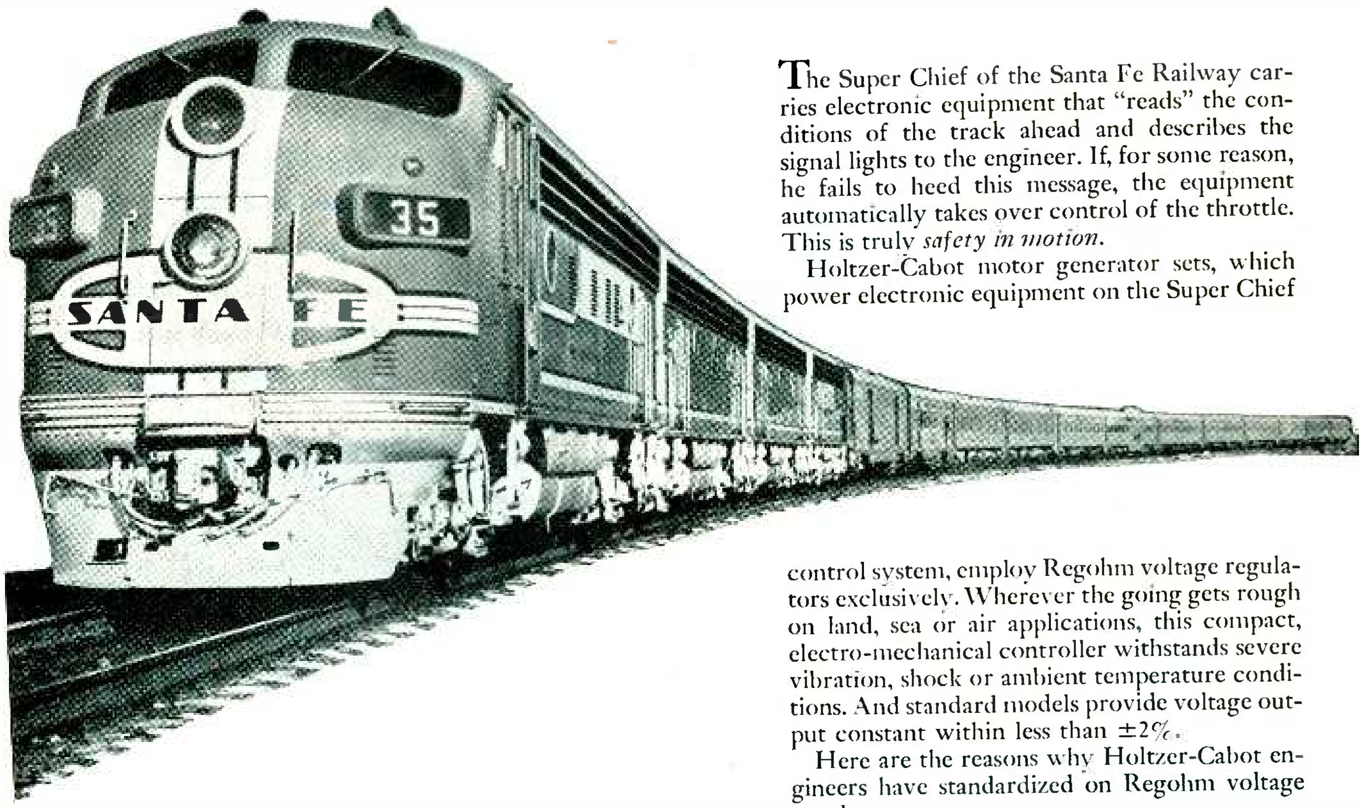
If your product requires a better electronic core and size and weight are critical, specify Moloney HiperCore Electronic Cores. Available in over 1000 standard sizes. Write today for Bulletin SR-205 containing specifications, performance data and prices.

MOLONEY ELECTRIC COMPANY

Manufacturers of Power Transformers • Distribution Transformers • Load Ratio Control Transformers • Step Voltage Regulators • Unit Substations

SALES OFFICES IN ALL PRINCIPAL CITIES • FACTORIES AT ST. LOUIS, MO. AND TORONTO, ONT., CANADA

The Iron Horse that **reads** and **heeds** with Electronic Eyes



The Super Chief of the Santa Fe Railway carries electronic equipment that "reads" the conditions of the track ahead and describes the signal lights to the engineer. If, for some reason, he fails to heed this message, the equipment automatically takes over control of the throttle. This is truly *safety in motion.*

Holtzer-Cabot motor generator sets, which power electronic equipment on the Super Chief control system, employ Regohm voltage regulators exclusively. Wherever the going gets rough on land, sea or air applications, this compact, electro-mechanical controller withstands severe vibration, shock or ambient temperature conditions. And standard models provide voltage output constant within less than ±2%.

Here are the reasons why Holtzer-Cabot engineers have standardized on Regohm voltage regulators:

1. Low Cost—Regohm costs less, does more, than the complex equipment that once was the only available solution to control problems.

2. Ruggedness—Upgrade, downgrade, working on a railroad demands the ability to "take it." Regohm has it, is sturdy and reliable.

3. Long Life—In properly engineered installations, Regohm's life is measured in years. This means low maintenance cost. Shelf-life is substantially unlimited.

4. Simplified Maintenance—Regohm's plug-in feature simplifies replacement and maintenance by unskilled crews. There are no parts to renew or lubricate.

5. Good Regulation—Regohm insures continuous control and will stabilize control systems with widely varying characteristics.

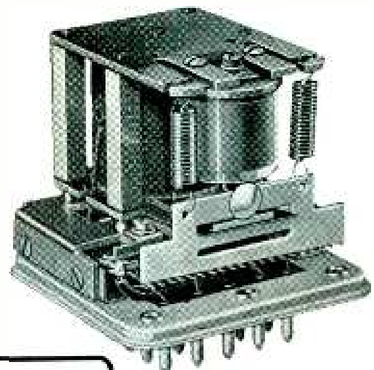
Our engineering and research staff can help you develop optimum design for your equipment and system. Learn how Regohm can help you with your regulation problem. Write for Bulletin 505.00. The address: Department E., Electric Regulator Corp., Norwalk, Conn.

Powered by Holtzer-Cabot Generators

Controlled by

Regohm

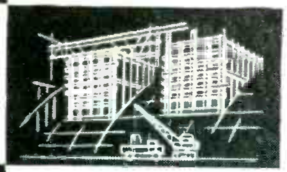
Voltage Regulators



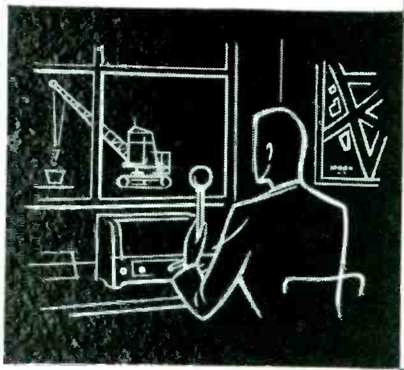
REGOHM

CONTROL COMPONENT IN: Servo systems • battery chargers • airborne controls • portable and stationary generators • marine radar • inverters • locomotive braking systems • mobile telephones • guided missiles • signal and alarm systems • telephone central station equipment • magnetic clutches • railroad communication systems.

50 watt VHF TRANSMITTER

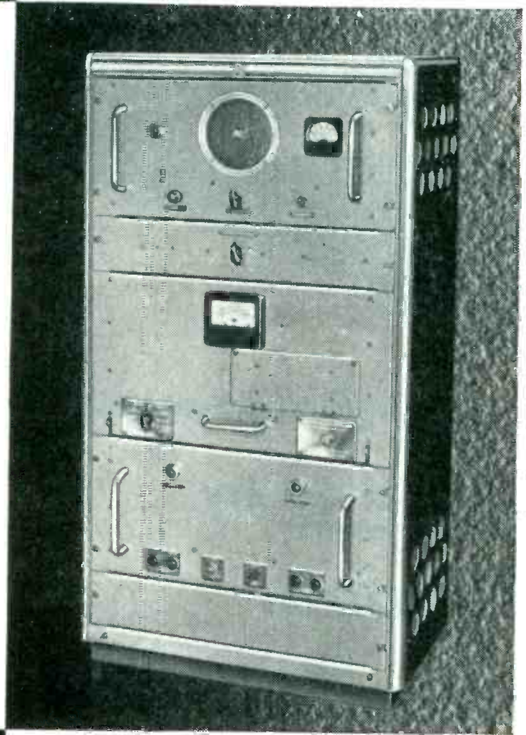


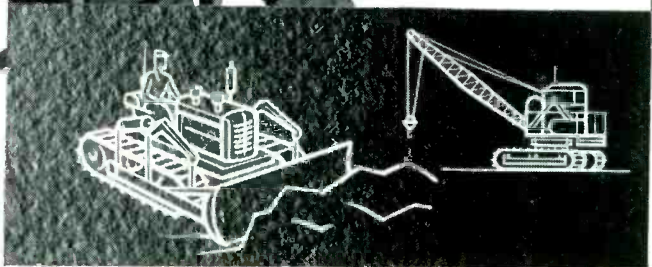
PTC 351 FOR RADIO CONTROL IN CIVIL ENGINEERING



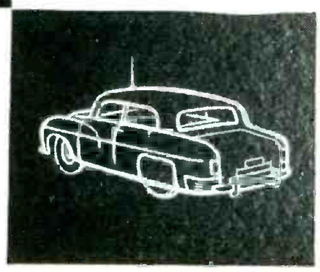
Of an advanced design using the latest techniques, the new Pye 50-watt V.H.F. Transmitter is ideal for use in normal fixed and mobile schemes where high powered transmitters are required. It may also be used for point-to-point radio-telephone links.

A further application is in the aeronautical band where the 50-watt transmitter, together with the standard Pye fixed receiver, provides one of the most efficient ground-to-air control stations at present available in the world.



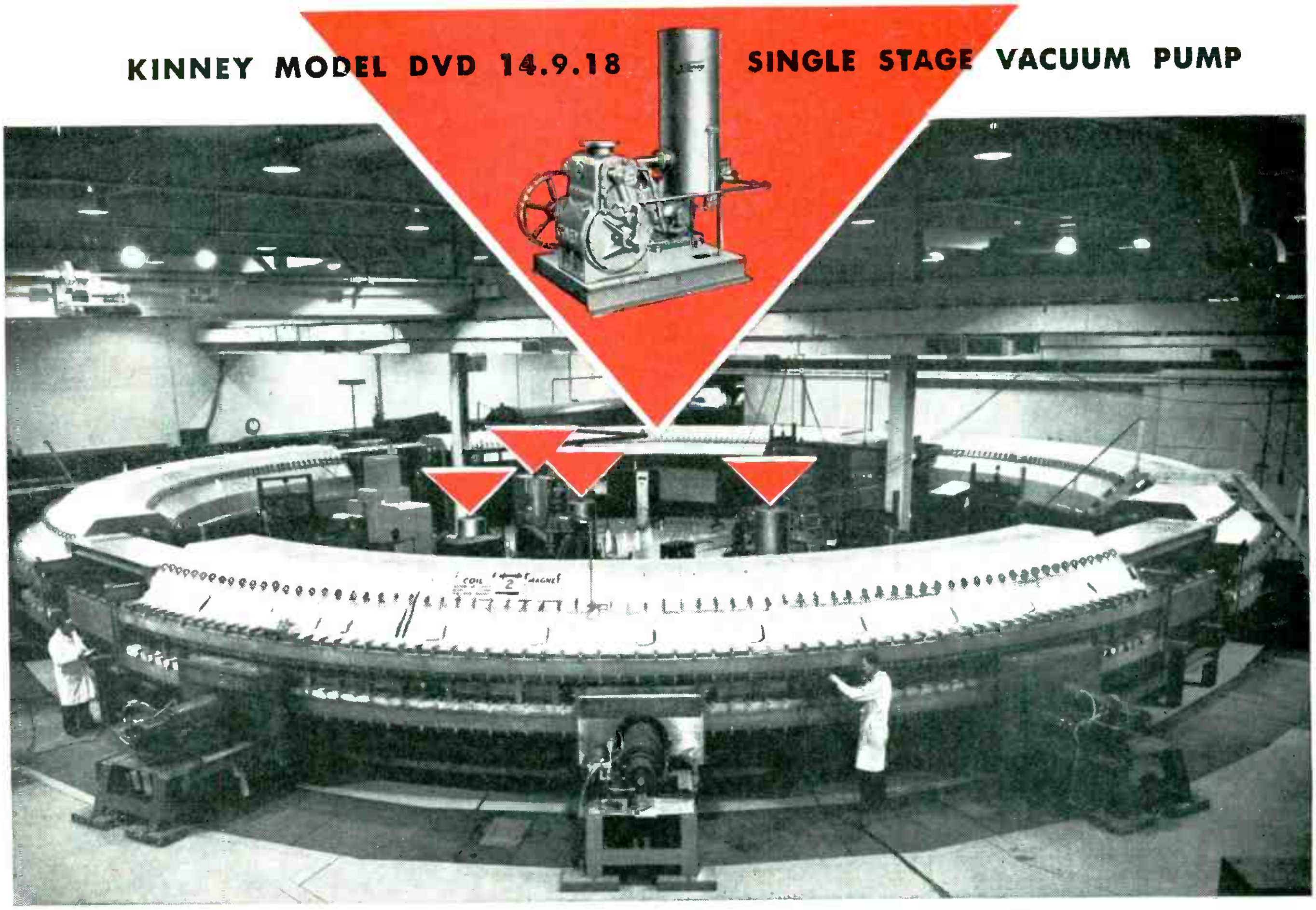


PYE Telecommunications



PYE LIMITED • CAMBRIDGE • ENGLAND

KINNEY MODEL DVD 14.9.18 SINGLE STAGE VACUUM PUMP



Good vacuum lets particles go to 2,300,000,000 electron volts

Four Kinney Model DVD 14.9.18 High Vacuum Pumps help the Brookhaven Cosmotron get down to business in a great big hurry. This gigantic magnet-type accelerator is roughed down to 50 microns in a matter of ten to fifteen minutes.

Here's a perfect example of the dependability of Kinney Vacuum Pumps. These Brookhaven Pumps have been operating continuously for over a year and have required only one oil change during this period.

Kinney High Vacuum Pumps are serving all types of industries today: electronics, electrical, pharmaceutical, food, metallurgical, research, refrigeration, and many others. Kinney engineers have a wealth of practical, on-the-job experience . . . ready to serve you. Why not call in your nearby Kinney vacuum engineer today? Kinney Manufacturing Company, 3565 Washington St., Boston 30, Mass. — manufacturers of vacuum and liquid pumps. Representatives in New York, Chicago, Detroit, Cleveland, Atlanta, Houston, New Orleans, Charleston (W. Va.), Philadelphia, Pittsburgh, Los Angeles, San Francisco, Seattle, and foreign countries.

Kinney

SUBSIDIARY OF THE NEW YORK AIR BRAKE CO.

Want more information? Use post card on last page.

KEPCO
VOLTAGE REGULATED POWER SUPPLIES

VOLTS	CURRENT	REGULATION	RIPPLE	6.3 V.† AC. CT.	MODEL
0-1500	0-200 Ma.	0.5%	20 Mv.		**1520**
0-1200	0-20 Ma.	0.1%	10 Mv.	10 Amp.	**1220**
0-1000	0-500 Ma.	0.5%	20 Mv.		**1350**
200-1000	0-500 Ma.	0.5%	20 Mv.		**1250**
0-1000	0-50 Ma.	0.1%	10 Mv.	10 Amp.	**1020**
0-600	0-3 Amp.	0.5%	10 Mv.		**780**
0-600	0-2.25 Amp.	0.5%	10 Mv.		**770**
0-600	0-1.5 Amp.	0.5%	10 Mv.		**760**
0-600	0-750 Ma.	0.5%	10 Mv.		**750**
0-600 0-150 Bias	0-300 Ma. 0-5 Ma.	0.5% *	10 Mv. 5 Mv.	10 Amp.	**615**
0-600	0-300 Ma.	0.5%	10 Mv.	10 Amp.	**500R**
#1 0-600 #2 0-600	0-200 Ma. 0-200 Ma.	0.5% 0.5%	5 Mv. 5 Mv.	10 Amp. 10 Amp.	**800**
0-600 0-150 Bias	0-200 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	10 Amp.	**815**
#1 200-500 #2 200-500	0-200 Ma. 0-200 Ma.	0.5% 0.5%	5 Mv. 5 Mv.	6 Amp. 6 Amp.	**510**
200-500	0-200 Ma.	0.5%	5 Mv.	6 Amp.	**245**
0-400 0-400 0-150 Bias	0-150 Ma. 0-150 Ma. 0-5 Ma.	0.5% 0.5% *	5 Mv. 5 Mv. 5 Mv.	10 Amp. 10 Amp.	**2400**
0-400 0-150	0-150 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	10 Amp.	**400**
100-400	0-150 Ma.	0.5%	5 Mv.	10 Amp.	**141**
100-400	0-150 Ma.	0.01%	1 Mv.	10 Amp.	**2000**
0-350	0-3 Amp.	0.5%	10 Mv.		**730**
0-350	0-2.25 Amp.	0.5%	10 Mv.		**720**
0-350	0-1.5 Amp.	0.5%	10 Mv.		**710**
0-350	0-750 Ma.	0.5%	10 Mv.		**700**
100-325 0-150 Bias	0-150 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	10 Amp.	**131**
0-300 0-150 Bias	0-150 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	5 Amp.	**315**
0-150	0-50 Ma.	0.5%	5 Mv.		**150**
3-30	0-30 Amp.	0.5%	0.1%		**3030**
1-13	0-10 Amp.	0.5%	10 Mv.		**3200**
0.3-3	0-100 Ma.	5 Mv.	1 Mv.		**3100**

MODEL 700

OUTPUT DC: 0-350 volts, 750 ma.

REGULATION: ½% for both line, 105-125 volts, and load variations, 0-750 ma.

RIPPLE: 10 millivolts.

This unit is available delivering:
- 1.50 amp.—Model 710
- 2.25 amp.—Model 720
- 3.00 amp.—Model 730

KEPCO Voltage Regulated Power Supplies are conservatively rated. The regulation specified for each unit is available under all line and load conditions within the range of the instrument.

DC POWER SUPPLY SPECIFICATIONS

REGULATION: As shown in table for both line fluctuations from 105-125 volts and load variations from minimum to maximum current.

***REGULATION FOR BIAS SUPPLIES:** 10 millivolts for line 105-125 volts. ½% for load at 150 volts.

†All AC Voltages are unregulated.

All units are metered except Models 131, 315 and 3100.

All units are designed for relay rack mounting or bench use.

WORKMANSHIP

Workmanship is of a quality with the highest existing production standards and best instrument electronic practices consistent with the intended use of the item as a continuous duty voltage regulated power supply. Oil filled paper condensers and resistor-board construction are included in the design.

FOR NEW POWER SUPPLY CATALOG—WRITE DEPT. No. 789

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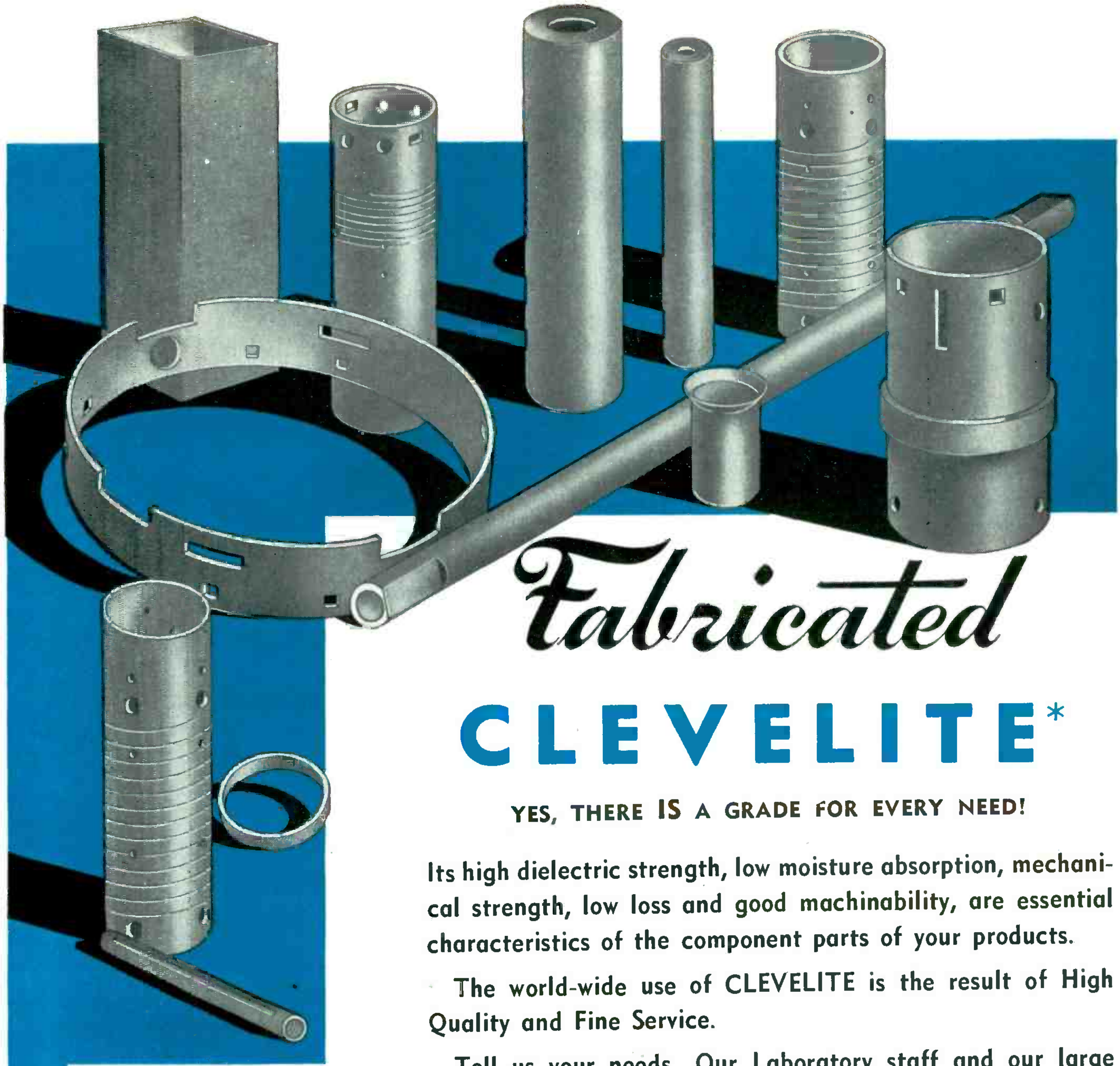

Fabricated

CLEVELITE*

YES, THERE IS A GRADE FOR EVERY NEED!

Its high dielectric strength, low moisture absorption, mechanical strength, low loss and good machinability, are essential characteristics of the component parts of your products.

The world-wide use of CLEVELITE is the result of High Quality and Fine Service.

Tell us your needs. Our Laboratory staff and our large production facilities are at your disposal.

Send for our new folder with complete details on the SEVEN GRADES of CLEVELITE and their applications.

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CLEVELITE MEANS HIGH QUALITY!

*Reg. U. S. Pat. Off.

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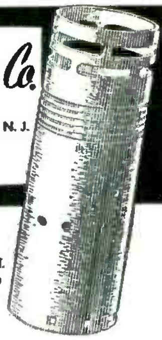
PLANTS AND SALES OFFICES at Chicago, Detroit, Memphis, Plymouth, Wisc., Ogdensburg, N. Y., Jamesburg, N. J.
ABRASIVE DIVISION at Cleveland, Ohio
CANADIAN PLANT: The Cleveland Container, Canada, Ltd., Prescott, Ontario



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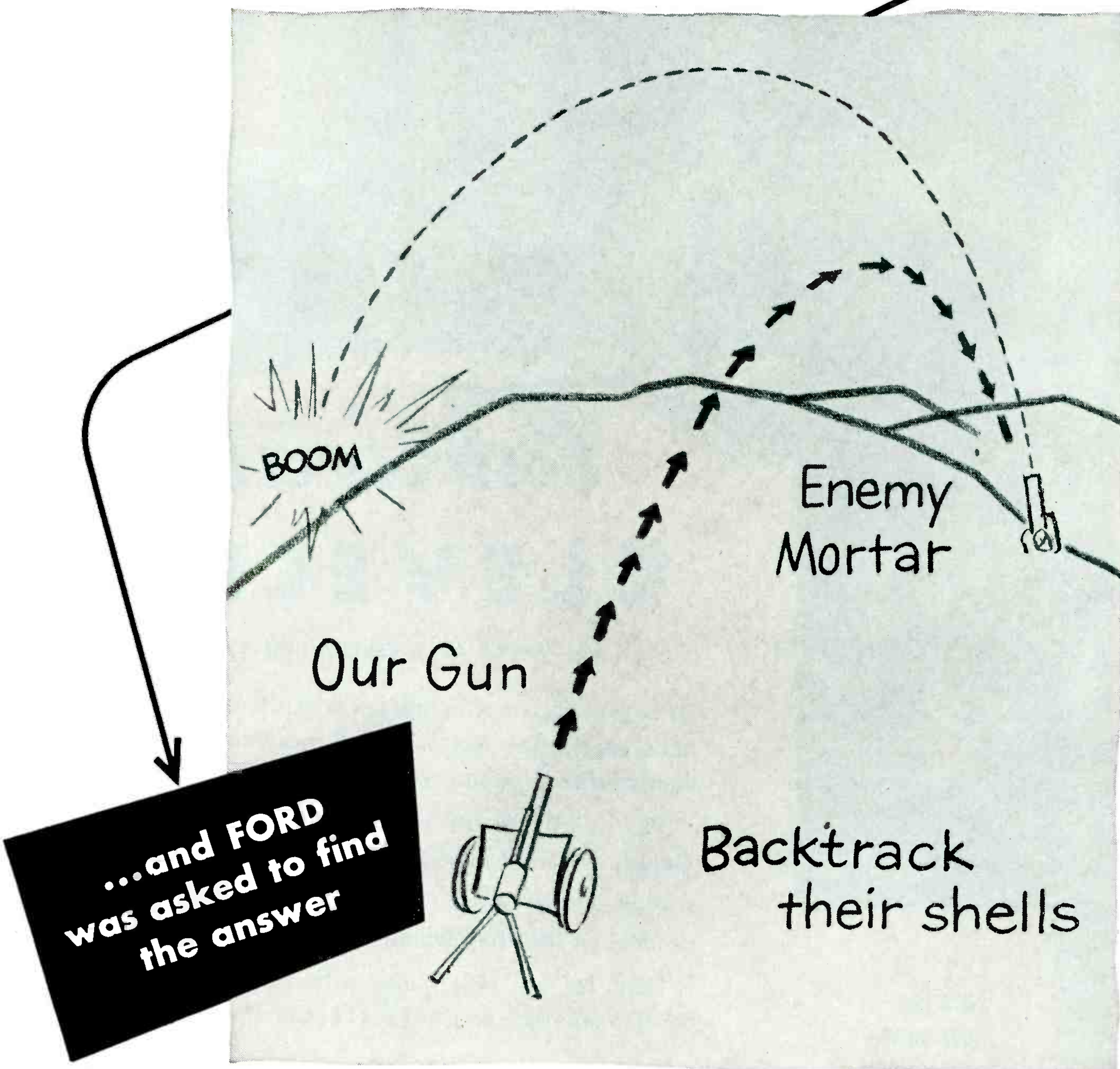
NEW ENGLAND R. S. PETTIGREW & CO., 62 LA SALLE RD., WEST HARTFORD, CONN.
CHICAGO AREA PLASTIC TUBING SALES, 5215 N. RAVENSWOOD AVE., CHICAGO
WEST COAST IRV. M. COCHRANE CO., 408 S. ALVARADO ST., LOS ANGELES

Want more information? Use post card on last page.

TO BACKTRACK SHELL TO GUN
and destroy same



Can projectiles be "seen" approaching and their flight backtracked to locate the mortar or gun that fires them? This problem was simply reconciled with special computing equipment designed to be built right into the gun. The engineering of such a computer, the handling of such ballistic data, all falls into the pattern of previous Ford achievements.

This is typical of the problems that Ford has solved since 1915. For from the vast engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic,electro-mechanical, magnetic and electronic instruments that bring us our "tomorrow" today. Control problems of both Industry and the Military are Ford specialties.

You can see why a job with Ford Instrument Company offers a challenge to young engineers. If you qualify, there may be a spot for you in automatic control development at Ford. Write for brochure about products or job opportunities. State your preference.

FORD INSTRUMENT COMPANY

DIVISION OF THE SPERRY CORPORATION

31-10 Thomson Avenue, Long Island City 1, N. Y.

Everyone Can Count on VEEDER-ROOT

REPORTER AT LARGE . . . that's what you might call this new Veeder-Root Reset Magnetic Counter . . . adaptable to remote counting from machines or processes to central boards or instrument-clusters, wherever you want to put them. NOW . . . what can your imagination do with these few facts? For the *full facts,* write:

VEEDER-ROOT INCORPORATED
"The Name That Counts"
HARTFORD 2, CONNECTICUT
Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
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"Counts Everything on Earth"

DESIGN and PRODUCTION NEWS

FOR ELECTRICAL AND ELECTRONIC ENGINEERS

Published by TECHNICAL SERVICE, Chemical Manufacturing Division, The M. W. KELLOGG Company DECEMBER 1953

Unbreakable Miniature Test Jacks of Kel-F® Eliminate Leaks in 500 Volt RMS "HF" Circuits ...Block 8,000 Volt Current Surges

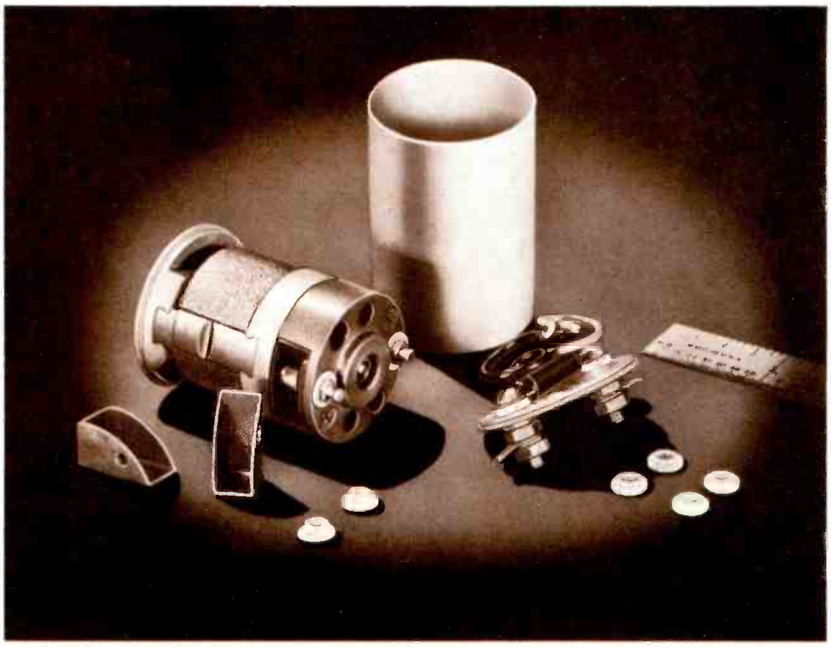
Small enough to permit mounting four to the square inch of panel area, these miniature jacks provide dependably insulated, damage-resistant test points on critical marine and aircraft electronic equipment. High insulation resistance and mechanical strength—with a minimum of bulk—are achieved by using "Kel-F" trifluorochloroethylene polymer as the insulation. The unique fluorocarbon plastic's non-wettability and zero water absorption provide protection against surface leakage and formation of conductive fungus.

Compact, hot assemblies, or where severe thermal cycling occurs, are ideal locations for the jacks because of the consistently high dielectric strength and constant of "Kel-F" over a wide temperature range (minus 320°F to plus 390°F). Dimensional stability of the insulation at high temperatures, and in contact with moisture, prevents softening or distortion, loosening or misalignment of vital contacts. High strength—impact, compressive, and flexural—of "Kel-F" precludes damage from vibration or rough handling.

Since "Kel-F" is chemically-inert, these jacks may be used successfully in equipment exposed to salt spray, oils, fuels and highly corrosive materials.

The Alden Products Company, electronic component manufacturer of Brockton, Mass., produces these "Mini-Test" point jacks. Injection molded from "Kel-F" trifluorochloroethylene polymer on special equipment designed by Alden, the jacks' mounting threads and contact slots are provided for during molding and require no finishing prior to use. The 360° spring contact of beryllium-copper is silver plated for corrosion resistance.

Refer to Report E-118



Kel-F® Guards Power Output of Miniature Motor ...Eliminates Failure Under 50 G-Plus Shock... High Humidity...Thermal Cycling

Increasing the service life and efficiency of the motor unit pictured—without increasing its size—was accomplished by using insulating brush holders and terminal washers made of "Kel-F" trifluorochloroethylene polymer plastic. Exceptionally high dielectric strength, toughness and dimensional stability over a wide temperature range and moldability to specific dimensions made "Kel-F" ideal for this critical application.

The results were higher efficiency and greater compactness.

The light, thin-section brush holders and terminal washers withstand sustained vibration, impact of 50-G shock loads and thermal cycling without becoming brittle, cracking or distortion. Under high humidity, insulation resistance is unaffected—zero water absorption, non-wettability of "Kel-F" prevent fungus formation or surface shorting.

Dimensional stability over a wide temperature range (minus 320 to plus 390°F) and a remarkably low plastic "cold flow" under compression keep terminal connections tight, prevent extrusion or loosening of vital insulators.

This miniature drive unit is produced by Globe Industries, Inc., Dayton, Ohio, for use on aircraft servos, camera guns and other devices. The insulating washers and brush holders are injection-molded from "Kel-F" by Norton Laboratories, custom plastics molders and designers of Lockport, N. Y.

Refer to Report E-117

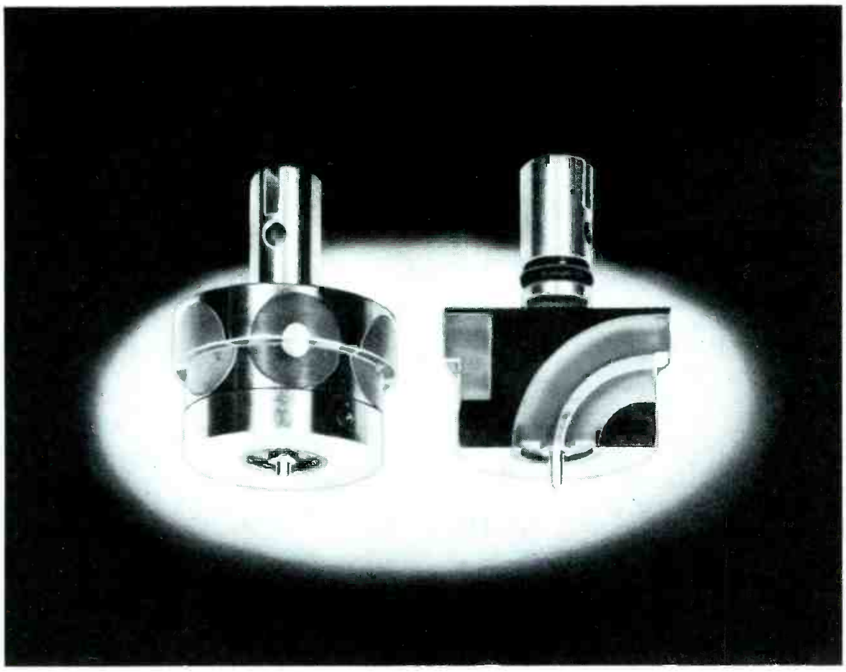
(SEE REVERSE SIDE)

® Registered trademark for The M. W. Kellogg Company's trifluorochloroethylene polymer products.

KEL-F
TRIFLUORO CHLORO ETHYLENE POLYMERS
KEL-F
MOLDING POWDERS
KEL-F
FLUORO CHLORO CARBON PLASTIC
KEL-F
DISPERSION COATINGS
KEL-F
TRIFLUORO CHLORO ETHYLENE POLYMERS
KEL-F
OILS WAXES GREASES

DESIGN and PRODUCTION NEWS

CONTINUED FROM PRECEDING PAGE



RF Switch Rotor of Kel-F® Provides Positive, Rapid Action from Minus 67°F to Plus 165°F...Up to 10,750 Mc, 500 Volts RMS

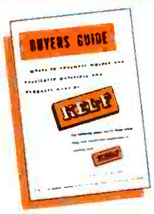
Channel selection in less than ¼ second in aircraft circuits, without leakage of RF pulses or significant attenuation or "cross-talk", is the job of the compact coaxial switch shown here. Top performance under high humidity, extremes of temperature and shock, is assured by the switch rotor insulated with "Kel-F" trifluorochloroethylene polymer. Even after thousands of cycles, the damage-resistant insulation preserves its original form and insulating properties, providing positive electrical contact and smooth, non-jamming switching action.

The dielectric strength of "Kel-F" remains consistently high at low and high temperatures, eliminating leakage of RF pulses, at even the maximum 10,750 Mc/second . . . at voltages up to 500 . . . permitting a continuous power rating of 100 watts at 3,000 megacycles. RF insulation remains high under saturation-humidity conditions due to the zero water absorption and non-hesiveness of "Kel-F" which prevent shorting or formation of conductive fungus. The plastic's dimensional stability prevents shrinkage or swelling—eliminating possibility of switch jamming.

The rotor of "Kel-F" is produced by Thompson Products, Inc. aircraft and automotive component manufacturers of Cleveland, Ohio, and used in their "Model C4N2AA" Coaxial Switch. The entire assembly weighs only 1½ pounds, consisting of the RF head and an actuator which permits remote positioning.

Performance of the switch surpasses the rigid RF and environmental requirements of the Bureau of Aeronautics.

Refer to Report E-116



New Quick-Reference "Buyers Guide" Off The Press...

Up-to-date, simplified handy directory enables you to locate instantly the nearest source of "Kel-F" polymer stock materials, finished products . . . dependable, experienced firms who offer extruding, molding and fabricating services. Get your copy from Technical Service.

Molders & Fabricators of the Month

Leading molders, extruders and fabricators specialize in the production of materials and parts made of "Kel-F" . . . each month this column will spotlight several of these companies with their principal services and products.

American Durafilm Company
Newton Lower Falls, Mass.
Dispersion Coating

Carmer Industries
Elizabeth, N. J.
Extrusion
Machining
Tube

The Connecticut Hard Rubber Company
New Haven, Conn.
Compression Molding
Gaskets, Seals
Diaphragms

Gasco Fabricated Products
Akron, Ohio
Compression Molding
Gaskets, Seals

Hydro Molding Company
Plattsburg, N. Y.
Injection Molding
Coil Forms
Electronic Components

Plastics Manufacturing, Incorporated
Orange, N. J.
Injection Molding
Electrical & Electronic Components

For complete information regarding any item mentioned in DESIGN AND PRODUCTION NEWS, ask for detailed APPLICATION REPORTS, write

Technical Service
CHEMICAL MANUFACTURING DIVISION
THE M. W. KELLOGG COMPANY
P. O. Box 469, Jersey City 3, N. J.
or offices in Boston, Chicago, Dayton, Los Angeles and New York

KELLOGG — SUBSIDIARY OF PULLMAN INCORPORATED

® Registered trademark for The M. W. Kellogg Company's trifluorochloroethylene polymer products.

Power Gain of 1000 at UHF

EIMAC 3K50,000LF
Length 49 inches
Weight 48 pounds

Eimac 3K50,000L Klystrons in typical CW operation give 10KW power output with only 10 watts drive

High power, high efficiency, ultra-high frequency Eimac type 3K50,000L klystrons, widely heralded for UHF-TV, are proving outstanding for CW. Typical CW operation of these versatile klystrons shows 40% efficiency while delivering 10 kw output with only 10 watts drive—a power gain of 30 db., or 1000 times. Furthermore service at frequencies above and below the UHF-TV band is being obtained through flexibility provided by the externally tuned cavities of Eimac klystrons.

● ***For information about Eimac type 3K50,000L klystrons contact our Application Engineering department.***

TYPICAL OPERATION
3K50,000L Klystrons

	CW	TV
D-C Beam Current	1.65	2.15 amps
D-C Beam Voltage	15	17.2 kv
Driving Power	10	55* watts
Power Output	10	12* kw
Efficiency	40%	32%*

*Peak synchronizing level (80% of saturation power)

3K50,000L KLYSTRONS
FOR UHF-TV

TYPE	FREQUENCIES
3K50,000LA	470-580 mc
3K50,000LF	580-720 mc
3K50,000LK	720-890 mc

Eimac REG. U. S. PAT. OFF.

EITEL-McCULLOUGH, INC
SAN BRUNO • CALIFORNIA

Want more information? Use post card on last page.

for measuring low level potentials–

the narrow span ElectroniK recorder

CHARACTERISTICS

Ranges—Recorders: 0-100, 0-200, 0-500 microvolts, 0-1 mv. Indicators: 0-500 microvolts 0-1.1 mv.

Stability (after warmup)—1 microvolt or less for all ranges.

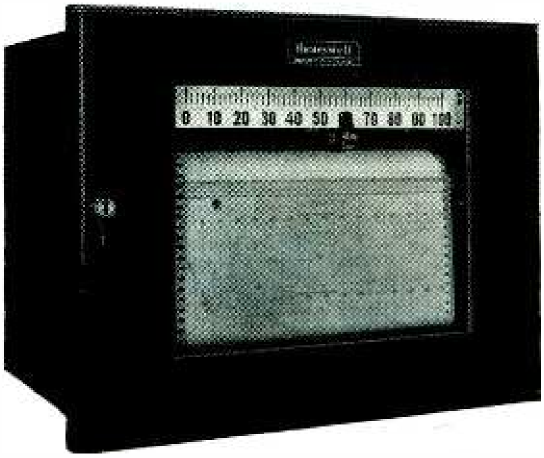
Accuracy of Adjustment—⅛% of span.

Dead Zone—0.1 microvolt or 0.006% of span, whichever is greater.

Pen Speeds—24 or 12 seconds full scale travel.

Input Impedance—3000 ohms.

Input Signal Range—(to recorder) approx. 0.05 microvolt to 1 mv.



EXTREMELY low level d-c potentials can be measured accurately . . . recorded to high resolution . . . and automatically controlled, by the self-contained narrow span *ElectroniK* potentiometer.

Ideal for radiation measurements, differential temperatures and a host of other laboratory applications, the instrument responds to signal changes as small as 0.1 microvolt. It spreads spans as low as 100 microvolts across the full width of its 11-inch chart.

Internal design practically eliminates thermal emf's and stray a-c pickup. Available models include the strip chart recorder (illustrated), Precision Indicator, and circular chart pneumatic controller. The instrument incorporates the Brown *40X* high gain amplifier, mounted right inside the recorder's case.

This high-gain amplifier is also supplied as a separate unit for use in null detection, servo circuits, or other work where its extreme sensitivity and high stability prove valuable.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4428 Wayne Ave., Philadelphia 44, Pa.

● **REFERENCE DATA: Write for Data Sheet No. 10.0-8 on the Narrow Span *ElectroniK* Recorder . . . Data Sheet No. 10.20-4 on the *40X* Amplifier . . . and for Bulletin 15-14, "Instruments Accelerate Research."**

H HONEYWELL

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

First in Controls

3 twin power triodes

...for voltage regulation

CHATHAM
TYPE 6336

NEW TWIN TRIODE FEATURING HIGH PLATE DISSIPATION

The new Chatham Type 6336 is a twin power triode with special suitability for voltage regulating applications. Used as a series tube, it will pass a minimum of 150 milliamperes per section with 40 volts, D.C. plate voltage. Special features include a hard glass envelope, an 8-pin button stem with Jumbo Octal Base.

CHARACTERISTICS *(PER SECTION)*

- **PLATE DISSIPATION: 30 WATTS**
- **AMPLIFICATION FACTOR: 2.7**
- **TRANSCONDUCTANCE: 11,000 MICROHMS**
- **PLATE RESISTANCE: 250 OHMS**
- **HEATER REQUIREMENTS: 6.3 V., 4.75 AMPS.**

The tubes shown are typical items from the complete Chatham line of general and special purpose tubes. Included in this line are Amplifiers, Mercury and Inert Gas Rectifiers, also Mercury, Inert Gas and Hydrogen Thyratrons.

Most Chatham tubes are available directly from stock and can be supplied promptly. Chatham also designs, develops and manufactures special tubes to exact customer specifications—inquiries are invited.

TYPE 6394
TWIN TRIODE

Similar to Type 6336 in every respect except for Heater Requirements which are 26.5 volts, 1.25 amps.

CHATHAM TYPE 6AS7G IMPROVED TWIN POWER TRIODE—

This Chatham Twin Triode is built to close tolerance—features plate current and GM characteristics held within ±10%, very low microphonics, improved triode balance, absence of grid current and greatly reduced plate current drift. Plate current is 125 milliamperes at 40 volts, D.C. plate voltage. The characteristics of this tube recommend it especially for voltage regulation circuits. Base is Medium Shell Octal.

CHARACTERISTICS: *(PER SECTION)*

- Plate Dissipation: 13 Watts
- Amplification Factor: 2.0
- Transconductance: 7,000 Microhms
- Plate Resistance: 280 Ohms
- Heater Requirements: 6.3 Volts
  2.5 Amps.

CHATHAM ELECTRONICS CORP.

Executive and General Offices: LIVINGSTON, NEW JERSEY
Plants and Laboratories: NEWARK and LIVINGSTON, NEW JERSEY

Want more information? Use post card on last page.

IMMEDIATE SERVICE
WILL SOLVE YOUR
INVENTORY
PROBLEMS

Everything in Electrical-Insulating Materials

INSULATION & WIRES
INCORPORATED

A COMPLETE LINE OF ELECTRICAL INSULATING MATERIALS . . . *READY FOR DELIVERY!*

- Varnished Cambric Products
- Insulating Paper
- Varnished Tubing
- Saturated Sleeving
- Insulating Varnish
- Vulcanized Fibre
- Phenolite
- Fibre Wedges
- Wood Wedges
- Built-up Mica Products
- Asbestos Insulation
- Woven Glass Insulation
- Pressure Sensitive Tape
- Cotton Tape
- Cotton Sleeving
- Commutators Built To Specifications
- Teflon
- Silicone Resins
- Silicone Insulations

• **Guard Against Production Slowdowns** caused by delayed factory shipments of insulation materials. IWI gives you fast delivery from ample stocks.

• **Keep Inventories At A Minimum** by getting seldom-used items and small production lots of essential materials quickly from your nearest IWI Warehouse.

• **Only Nationally Advertised Quality Products** are sold by IWI. All are approved and used by leading electrical manufacturers.

• **Expert Technical Assistance** on any problem involving electrical insulating materials is offered without obligation by IWI's staff of experienced Field Service Representatives.

When You're In A Hurry Phone IWI

A NATIONAL NETWORK OF WAREHOUSES SERVING ELECTRICAL MANUFACTURERS

INSULATION AND WIRES INCORPORATED

3435 Chouteau Avenue • St. Louis 3, Missouri

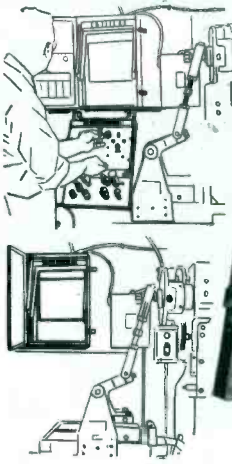
Write For The Address Of The Warehouse Nearest Your Plant

Are you designing any electronic equipment that should have —

1 Easy installation and maintenance by non-technical personnel?

2 Widest possible use by being instantly interchangeable between machines?

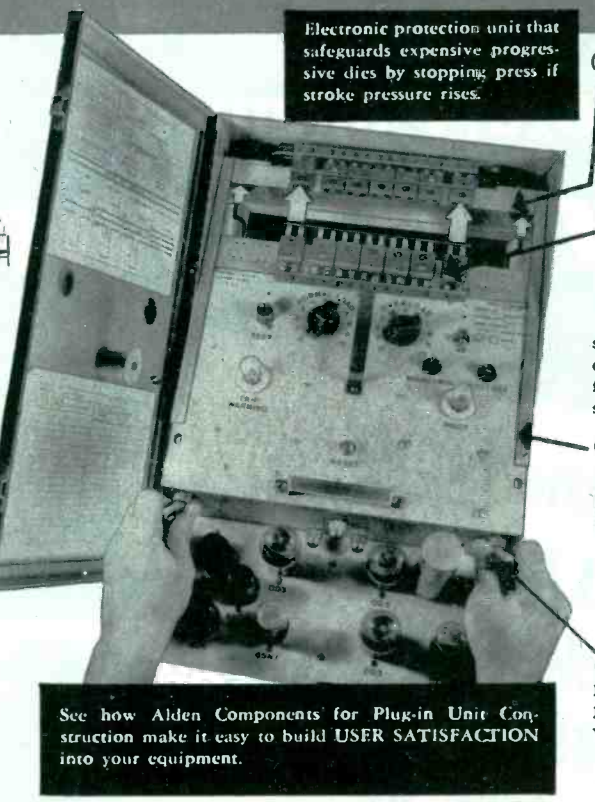
See how easily these features were built into this electronic punch press protection equipment with the Alden Serve-A-Unit Kit.



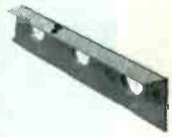
1 In 30 seconds, user's own personnel can install plug-in protection unit . . . replace with spare . . . or shift it to another machine.

2 With plug-in receptacle for electronic protection unit installed at each press, 8 actual electronic units are enough to serve the requirements of 14 presses, because all presses are not simultaneously active, and each electronic unit can instantly be moved anywhere to cover the active presses . . . or replace an inoperable unit.

Inoperable unit easily shipable air express for factory servicing.



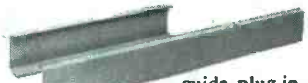
(A) ALDEN LOCK FRAME mounts mating Alden Back Connectors and engages pilot heads of Alden Serve-A-Unit Locks.



(B) ALDEN SLIDE-IN BACK CONNECTORS

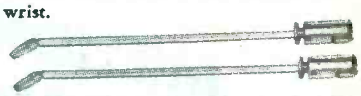
spread all leads out accessibly at central check point, color coded and symboled for easy identification and first-level service checks by user's personnel.

(C) ALDEN SIDE RAILS



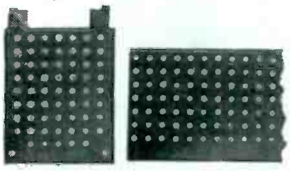
guide plug-in unit into position until pilot heads of Serve-A-Unit Locks take over.

(D) ALDEN SERVE-A-UNIT LOCKS pilot, draw in, lock and eject complete plug-in unit, with a half turn of the wrist.



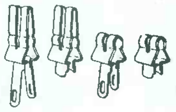
WITH ALDEN COMPONENTS, YOUR CIRCUITRY EASILY BECOMES PLUG-IN UNITS

Design your circuitry as compact vertical planes — **It's as simple as this —**



ALDEN PREPUNCHED TERMINAL MOUNTING CARDS cut to proper sizes for 7-pin, 9-pin, 11-pin and 20-pin packages. Or in 3' strips for chassis — cut it off as you require.

+



ALDEN MINIATURE STAKING TERMINALS Lay out in any pattern on Terminal Mounting Cards; ratchet slots hold elements for soldering without pliering or wrap-around.

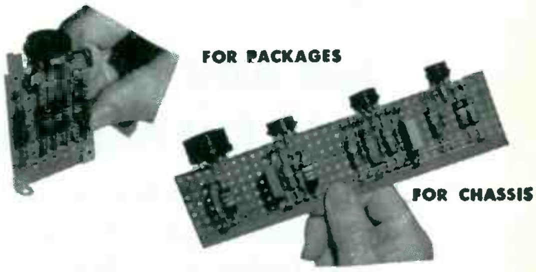
+

ALDEN JUMPER STRIP stakes right under Terminals providing common circuit without soldering.

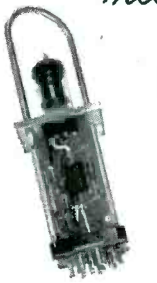
+

ALDEN CARD-MTG. TUBE SOCKETS for min. 7-pin, 9-pin and octal tubes.

=



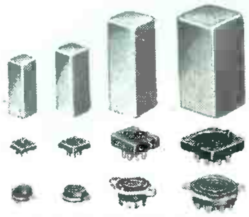
These vertical planes fit beautifully into plug-ins — **It's as simple as this —**



ALDEN PLUG-IN PACKAGE

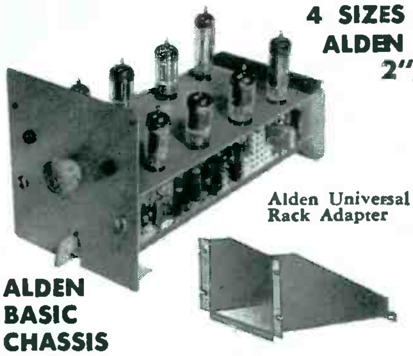
4 SIZES OF PLUG-IN PACKAGES

Alden standard Bases, Lids, Handles, Cans, Sockets for 7, 9, 11 and 20-pin packages house Terminal Card Circuitry with tremendous flexibility for endless variety of open and shielded packages. . . making it easy and inexpensive to give your equipment reliability in service with instantly replaceable plug-ins for all sub-units.



7-pin 9-pin 11-pin 20-pin

Package components and matching sockets.



ALDEN BASIC CHASSIS

Alden Universal Rack Adapter

4 SIZES OF ALDEN BASIC CHASSIS 2", 4", 8", 17"

Your circuitry on Terminal Card strips snaps right into Alden Basic Chassis. Vertical mounting and hinged front panel give beautiful accessibility and space saving. Chasses can be plugged interchangeably into Standard Racks, Alden Uni-Racks, Alden Portable Cases. Alden Rack Adapter mates Standard Rack to Chassis.

Plugged into Standard Rack with Rack Adapter

Mount in Alden Uni-Racks

Plugged into Portable Cases

-and assign to each unit a tiny tell-tale to spot trouble instantly **It's as simple as this —**

See how compact front panel easily mounts six tiny Alden Sensing Elements — specifically designed to lick the problem of having only a small amount of space. Assembled by simplest methods.

ALDEN MINI-TEST POINT JACK For checking critical voltages from front of panel.

ALDEN "PAN-i-LITE" Miniature indicator light with unbreakable 1-piece light-lens unit replaceable from front.

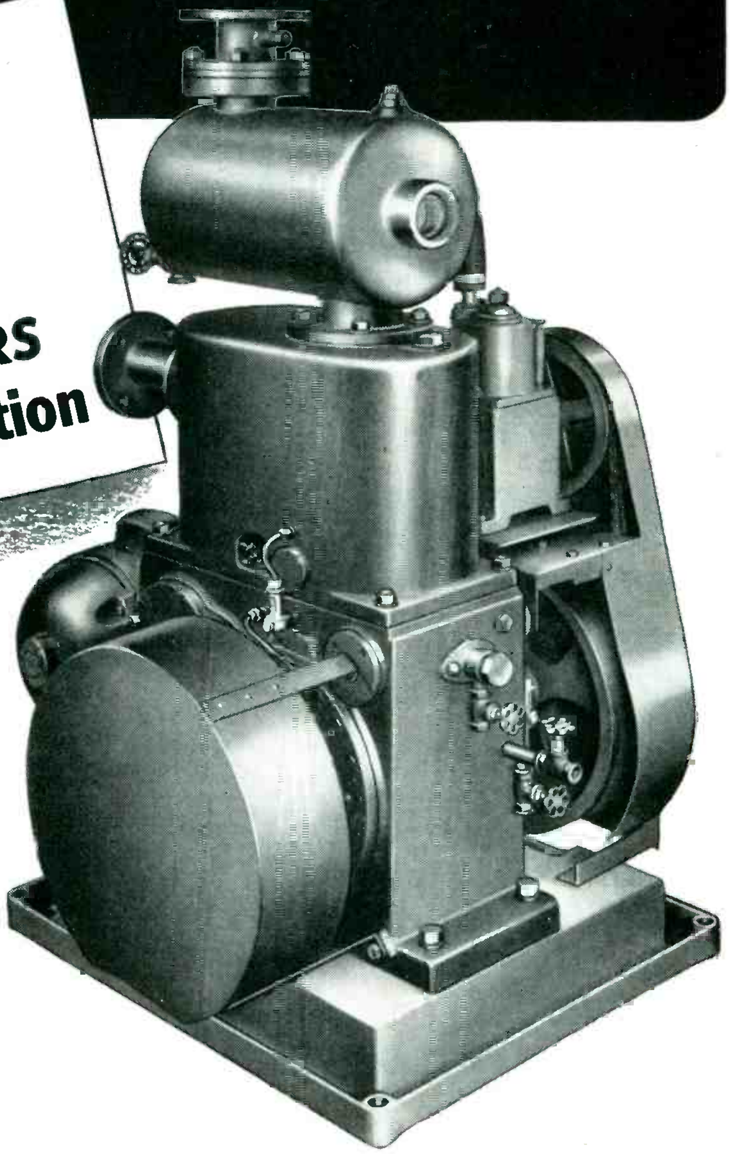
ALDEN "FUSE-LITE" Fuse blows — Lite glows. Simply unscrew 1-piece light-lens unit and blown fuse comes out with it.

GET THE COMPLETE STORY — REQUEST "ALDEN HANDBOOK" — SENT FREE

ALDEN PRODUCTS COMPANY 127 North Main Street, Brockton, Mass.

want a HIGH VACUUM rotary pump that pumps WATER VAPOR?

Here's the NEW GAS BALLAST PUMP backed by MILLIONS OF HOURS of trouble-free operation



Ends Water Vapor Trouble
Maintains Fast Pump Down Time

Eliminates Oil Reclaiming
Greater Capacity Under 1 mm Hg
Up To 80% Less Oil Charge
Capacities from 1¼ cfm to 400 cfm
Pressures Down To 10^{-5} mm Hg

Here's important news for everyone who works with high vacuum. The new NRC Rotary Gas Ballast Pump gets it for you faster — saves you time and money and is backed by millions of hours of trouble-free operation.

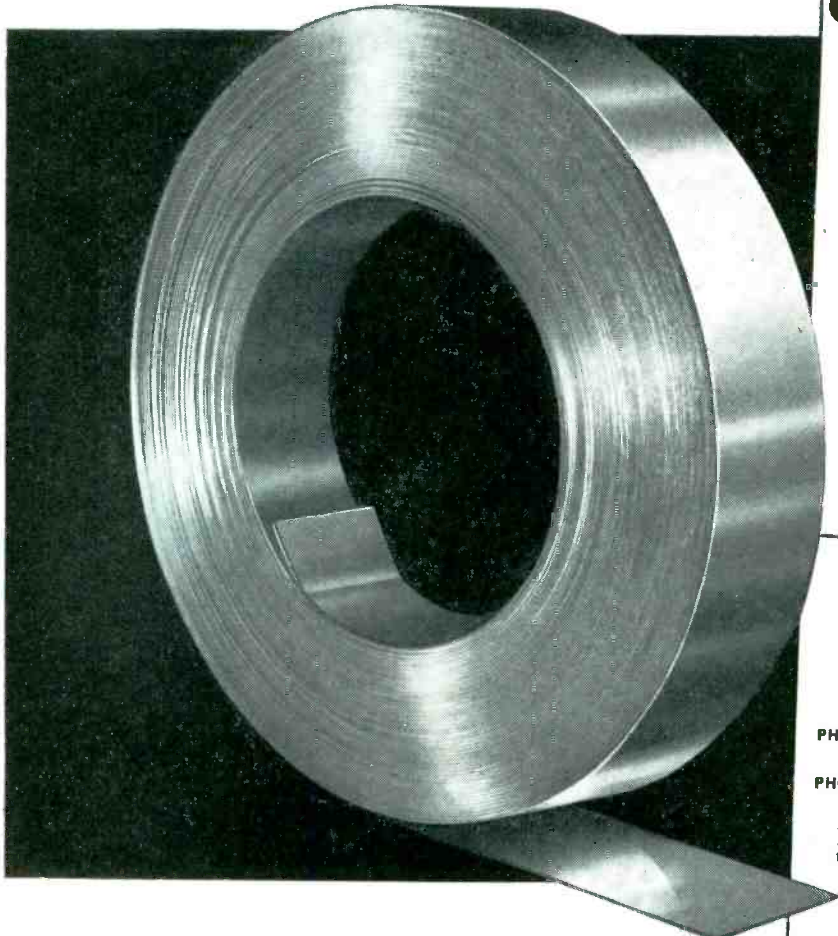
By keeping water vapor from condensing, this pump prevents contamination of the pump oil. The result—it never loses capacity like conventional rotary pumps when pumping condensable vapors. It continually maintains a fast pump down rate.

NRC Rotary Gas Ballast Pumps are available in a complete line of vane, piston-type and 2-stage pumps.

Send today for new bulletin explaining principle, construction and operation data on the NRC Rotary Gas Ballast Pump.

NRC
National Research Corporation
Equipment Division
Seventy Memorial Drive, Cambridge, Massachusetts

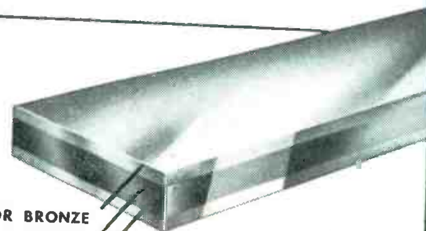
NEED SPRING MATERIALS WITH HIGH CONDUCTIVITY?



General Plate Composite Metals

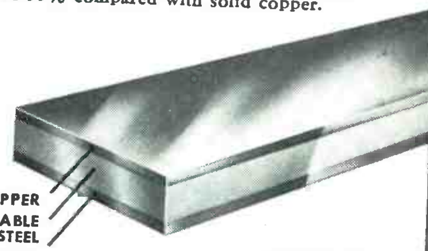
BRONCO, CONFLEX and SILVER-CLAD PHOSPHOR BRONZE

meet all requirements



BRONCO

The phosphor bronze makes an excellent spring member. The copper increases conductivity. BRONCO 25/50/25 provides an electrical conductivity of 55% compared with solid copper.



CONFLEX

Copper clad on one or both sides of hardenable steel in any thickness ratio. Its primary advantage is *low cost.* The hardenable steel provides greater stiffness than copper alloys.

SILVER-CLAD PHOSPHOR BRONZE

Silver clad on one side provides an exceptionally good electrical contact surface.... Offers higher electrical and thermal conductivity. Also available as silver-clad beryllium copper.

These General Plate composite metals, made by metallurgically bonding one metal to another, provide an economical solution to your electrical spring problems.

Each has specific physical and mechanical properties that make it better suited for certain applications. For instance, Bronco permits miniaturization, because you can reduce spring size without sacrificing conductivity. Conflex enables you to make fuse chips, flat springs, and electrical connectors at a lower cost.

No matter what your problem, it will pay you to consult with General Plate. Their vast experience in bonding any combination of malleable metals can overcome your problems . . . often reduce costs.

General Plate products include . . . precious metals clad to base metals, base metals clad to base metals, thin-gauge rolling, composite contacts, buttons and rivets, Truflex® thermostat metals, Alcuplate®, platinum fabrication and refining, #720 manganese age-hardenable alloy. Write for complete information and Catalog PR700 today.

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
312 FOREST STREET, ATTLEBORO, MASS.

A price tag
written by the experience
of Ampex users

AMPEX Magnetic Tape Recorders cost less per hour, per week and per year than any others you can buy:

BECAUSE THEY LAST MORE YEARS

Over three years ago an Ampex 300 was put on a 17 hour per day continuous music service in Honolulu. After 11,000 hours of running time, the machine was still using the original set of heads. When checked, their performance was within the published specifications for new machines. Based on the replacement price, the cost of head wear was 0.7 cents per hour.

BECAUSE THEY GIVE SUSTAINED SATISFACTION

When you buy the best, you don't soon buy a "better" machine to replace it. An Ampex Tape Recorder provides a combination of fidelity, responsiveness, timing accuracy and reliability that has no equal. Ampex owners don't make expensive trades; they keep their machines and get full value in long-time service and satisfaction.

BECAUSE THEY HOLD THEIR VALUE

It's a matter of supply and demand. Because of a well earned leadership, Ampex machines are the most wanted — but the most seldom resold. An Ampex is built to last, and after one, two or even five years, it will have far more real value left in it than any tape recorder that was "built to a price."

BECAUSE THEY'RE EASIEST TO MAINTAIN

On the New Ampex Model 350, a pivoting top plate and sliding electronics make all working parts accessible for checking even when the machine is running. Motors and other individual components have plug-in connections which make replacement extremely simple. But because the Ampex is "professional quality," it will require far fewer adjustments and parts replacements than other recorders.

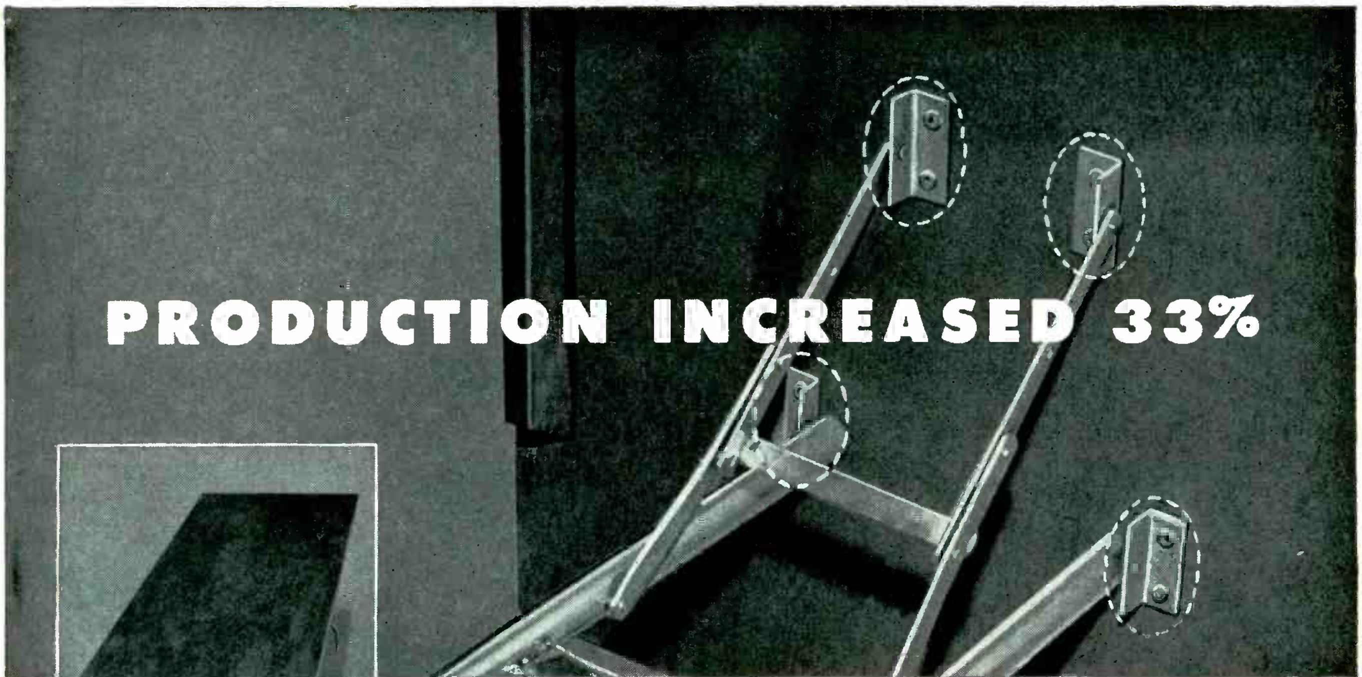
SEE THE NEW AMPEX 350

It's the newest of the best. It offers new accessibility, new convenience of operation and attractive new price. Recorders priced from $975.00; reproducers from $495.00. For further information write today to Dept. E-1472.

IF YOU PLAN
FOR TOMORROW,
BUY AMPEX TODAY

AMPEX
CORPORATION

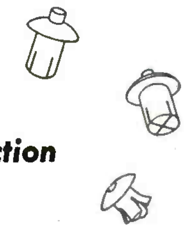
AMPEX CORPORATION
934 CHARTER STREET • REDWOOD CITY, CALIF.
Distributors in principal cities; distribution in Canada by the Canadian General Electric Company



PRODUCTION INCREASED 33%

SOUTHCO DRIVE RIVETS

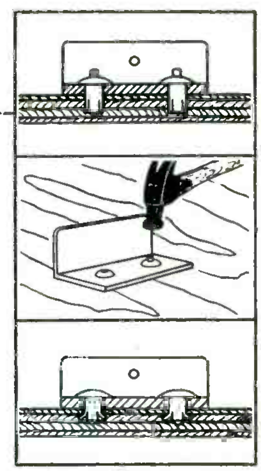
eliminate surface holes... improve appearance...speed production



A Philadelphia manufacturer of food display equipment and banquet tables fastens folding aluminum legs to ¾" plywood table tops. SOUTHCO Drive Rivets are used to fasten leg assemblies to table tops because they are fast, strong and don't mar the table top.

Previously nuts and bolts were used but these required countersunk surface holes which, even though filled and sanded smooth, still marred the surface. Wood screws were tried but they pulled out. Four assemblies are now made in time formerly required for three.

In addition, the sales manager says "SOUTHCO Rivets have increased sales value of tables immeasurably".



Place rivets in blind holes

Hit the pin . . .

Rivets expand in wood, pull-up is perfect

SOUTHCO Drive Rivets are ideal for metal-to-wood applications. Just place in a blind hole, hit the pin and the rivet's in. No special tools, no bucking, nothing to finish off, no waste of time or material. SOUTHCO automatic pull-up draws parts tightly together, makes a tough, strong joint—quickly.

How can you benefit from using SOUTHCO Drive Rivets? Write for complete details to Southco Div., South Chester Corp., 1417 Finance Building, Philadelphia 2, Pa.

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PAWL • SCREW AND SPRING • DRIVE RIVETS • ANCHOR NUTS • ENGINEERED SPECIALTIES

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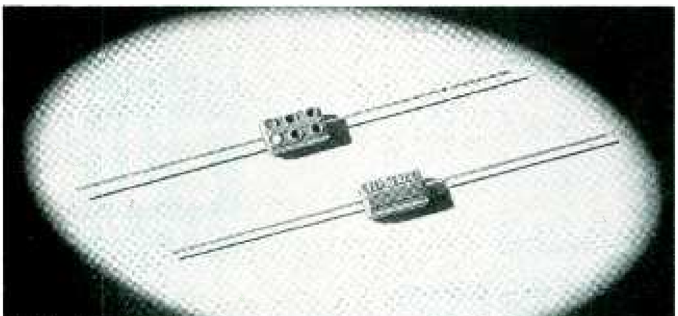
WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER, STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS

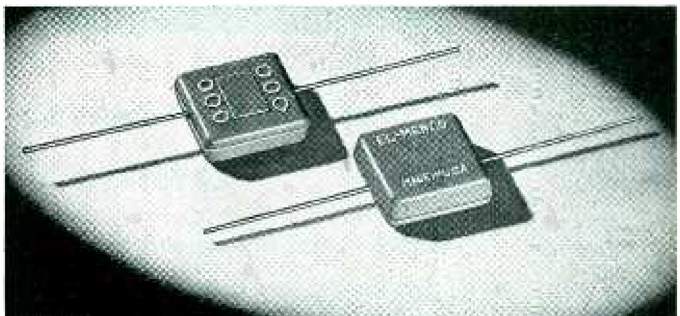
IT ISN'T LUCK THAT MAKES A WINNER...

IT'S SUPERIORITY

Though they all looked like potential Kentucky Derby winners and all had an equal opportunity, only Dark Star had the swiftness and the stamina to break the ribbon first. He *proved* his superiority.



CM-15



CM-35

AND IT ISN'T LUCK THAT MAKES A GREAT....

CAPACITOR

Don't wait to see whether you've bet on a winner. Buy El-Menco Capacitors that have already *proven* their superiority . . . because they've all been factory-tested at more than double their working voltage. Even under the most adverse conditions of application, with an El-Menco Capacitor there's a wide margin of first-class performance.

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Jobbers and distributors are requested to write for information to Arco Electronics, Inc., 103 Lafayette St., New York, N. Y. — Sole Agent for Jobbers and Distributors in U. S. and Canada.

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CAPACITORS

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. . . Put Their Confidence in

Midland CRYSTALS

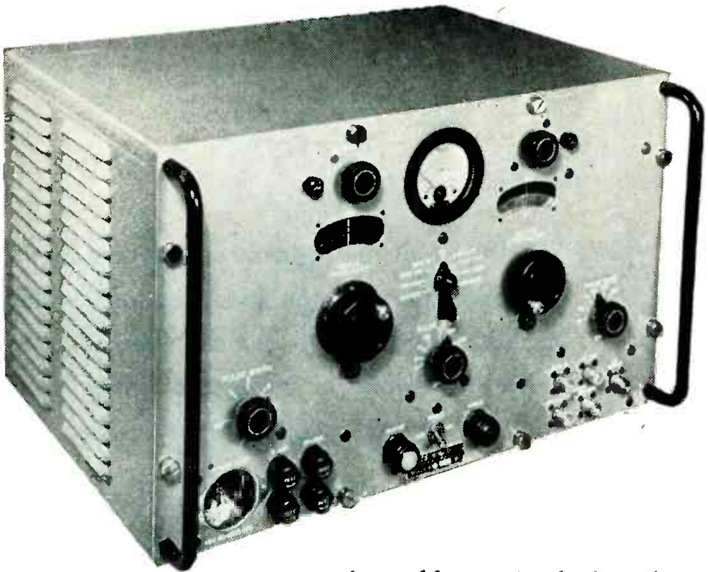
These names are synonyms for quality. The products they identify are famous for dependable, precision performance in every detail. These manufacturers must be sure that suppliers of every component have similar high-level reputations to uphold.

The fact that the great names in communications rely on Midland Crystals is evidence enough that Midland Quality Control methods of crystal production insure completely reliable frequency control.

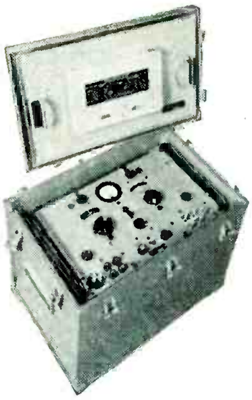
Whatever your Crystal need, conventional or highly specialized, When it has to be exactly right, contact

Midland MANUFACTURING COMPANY, INC.
3155 Fiberglas Road, Kansas City, Kansas

WORLD'S LARGEST PRODUCER OF QUARTZ CRYSTALS



TS-419/U SIGNAL GENERATOR



This compact portable Signal Generator is a self-contained, directly calibrated generator of continuous-wave or pulse modulated radio frequency signals. It is a reliable source of accurate signals for:

- testing radio and radar equipment in the frequency band from 900 to 2100 MC/S (single dial control directly calibrated to ± 1%),
- receiver measurements and other applications that require less than one milliwatt of CW or pulsed type r-f signals in this band,
- generating delayed and undelayed video pulse that can be used by external equipment,
- accurate determination of small increments of frequency, as required in certain types of selectivity and filter characteristics.

Specifications:

Frequency Range .... 900 to 2100 mc/sec in one band.
Frequency Stability .... Warm up drift less than 0.2%; ambient drift less than 0.005% per °C.
Power Output .... Zero dbm to −120 dbm continuously adjustable.
Output Impedance .... 50 ohms with VSWR of 2:1.
R. F. Pulse Shape .... (a) Rise time: less than 0.5 microseconds.
(b) Decay time: less than 0.9 microseconds.
(c) Flatness: within 10% of amplitude of initial rise.

Modulation .... (a) by external pulses, positive or negative.
(b) by internal pulse generator.
(c) by synchronization to an external pulse generator.
(d) by synchronization to an external sine wave generator.
Power Requirement .... 115 V ± 10%, 50 to 1600 cycles, single phase, 200 watts.
Size .... 17⅜ inches wide, 10½ inches high, 12 inches deep.
Weight .... 43 pounds (less transit case).

We will gladly furnish all details regarding specifications, prices and delivery.

Write, wire or telephone for information.

NORTHEASTERN ENGINEERING INC.

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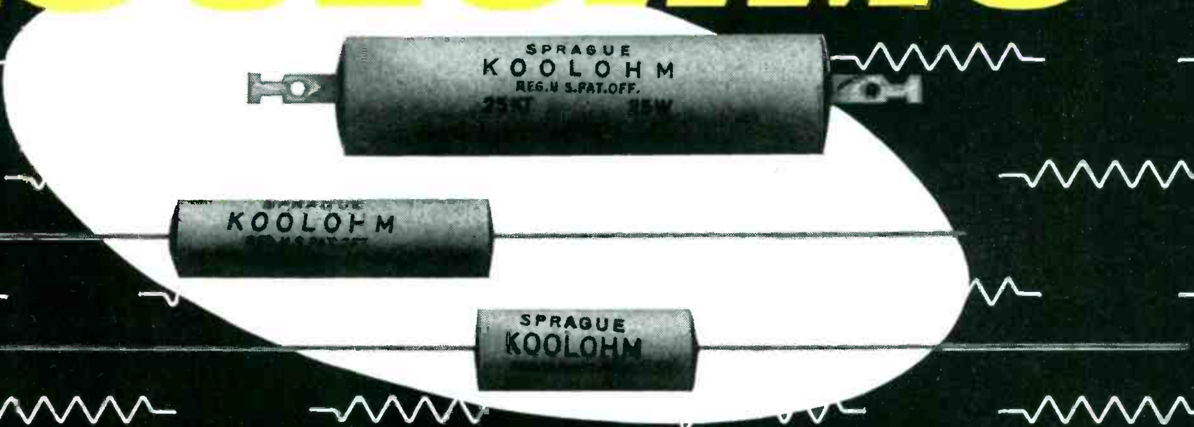
Mount them anywhere..!

KOOLOHMS®



KOOLOHM RESISTORS ARE AVAILABLE IN RATINGS FROM 5 TO 120 WATTS

You can simplify many of your production design problems because Koolohm power wire-wound resistors will fit into tight spots! They are not only small in size for their wattage ratings—but the Koolohm outer ceramic protective shell will withstand a 10,000 volt breakdown test to ground!

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Sprague's patented Ceron ceramic-insulated resistance wire makes possible the use of multilayer windings to achieve much higher top resistance values than in resistors using conventional bare wire and enamel or cement constructions. Ceron insulation permits *truly non-inductive* windings when required!

KOOLOHMS ARE UNIFORMLY DEPENDABLE!

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The second of two articles on profits

What Are PROFITS Used For?

This is the second article on the role of profits in our economy. The first was addressed to the question: "How High are Profits?" The answer was found to be: not high when compared with previous years and the present investment in corporate facilities. This second article is addressed to the equally important question: "What do corporations do with their profits?"

In 1953 corporations will earn about $20 billion *after taxes*, if the recent rate of earnings is maintained throughout the year. These profits will be used (1) to expand and improve productive capacity through purchases of new plant and equipment, (2) to finance the operations involved in a growing volume of business and (3) to reward the people who have invested their money in American industry. Of the $20 billion, the corporations will pay about $9 billion to their stockholders as dividends. They will use the $11 billion that remains to purchase new plant and equipment and to increase their working capital.

This year corporations are increasing their plant, equipment and working capital by a total of approximately $32 billion. Of this amount, about $26 billion is for new plant and equipment. The remainder is for working capital. As this article will show in greater detail, about $21 billion of this will come from depreciation allowances and sales of new securities. The other $11 billion will come from retained profits.

It is impossible to trace exactly how each dollar of retained profits is spent. This money is mixed with other money that goes into the company treasury in the form of proceeds from loans, sale of securities and depreciation allowances. *However, it is a fact that by retaining $11 billion of their profits this year, corporations have provided $11 billion toward their total capital requirements, including the money needed for expanded and improved capital equipment.*

Profits Mean New Plants

This year American industry is engaged in a very large expansion of plant facilities. This will increase the industrial capacity of the nation by about 7 per cent. Since 1950, our capacity has been increased by about 12.5 per cent. And all of this expansion has been privately financed, even though about one-third of it was certified as necessary for national defense.

The expenditure during 1953 of $26

billion for new plant and equipment—an alltime record—imposes terrific financial responsibilities on our corporations. About one-half of the amount required will come from depreciation allowances. In general, these allowances are supposed to pay for the replacement of worn-out or obsolete equipment. Another $8 billion will be raised by corporations through new security issues and long-term mortgage loans. All together, depreciation allowances, security issues and long-term loans will provide about $21 billion. But this is still $5 billion short of the $26 billion needed for new plant and equipment this year. Thus, it is retained profits that spell the difference between expansion and standing still, between growth in the productive capacity of the economy and running downhill.

As plant facilities are expanded, corporations also need more working capital. A larger volume of business requires larger inventories, larger accounts receivable and larger amounts of ready cash to meet payrolls and bills for materials. The increase in these items during 1953 is estimated at $8.5 billion, of which about $2.5 billion will be supplied by short-term bank loans. The other $6 billion will come from retained profits. Thus, retained profits provide an essential $11 billion—$6 billion for working capital, $5 billion for new plant and equipment—to meet corporate financial requirements.

Incentive for Investment

The role of the profits that are paid to stockholders as dividends or to employees under profit-sharing plans is even more important than the role played by retained profits in providing plant, equipment and working capital. Dividend payments provide the main incentive for investment in the stocks of corporations. They are the reward for risks taken by investors. Dividends paid by corporations whose common stocks are listed on the New York Stock Exchange provide an average return of about 6.5% at present prices, and dividends on preferred stocks average about 4.5% return. Dividends are distributed among 6.5 million stockholders. Also, it is estimated that 3 million employees now are covered by profit-sharing plans. These plans increase the incentives of both production workers and managers to work harder and more efficiently.

Thus, more than 9 million Americans have a *direct* financial stake in corporate profits through ownership of stock or participation in profit-sharing plans. But *all* Americans share indirectly in the rewards of a successful business year. Investment of a major part of 1953 profits in new plants and equipment means more employment opportunities and better working conditions for labor. For the nation, it means new industrial capacity that is essential both for national defense and to produce more and better goods for a rising standard of living.

Corporate profits after taxes represent about 6% of the nation's total income. But the job they do to stimulate investment and to finance industrial expansion and improvement is more far-reaching and more essential to the prosperity and well-being of the American people than would be suggested by that small figure.

McGraw-Hill Publishing Company, Inc.

How to use GLOBAR TYPE BNR RESISTORS to advantage

APPLICATION	RESULT
Oil burner ignition transformer	High voltage feed back into line is prevented.
Small motors	Arcing of governor contact points is greatly decreased.
Rectifier circuits	Peak voltages are limited thus stabilizing circuits.
Electronic devices	Successful use in voltage control circuits.
DC Circuits	Solenoid valve coils are protected.

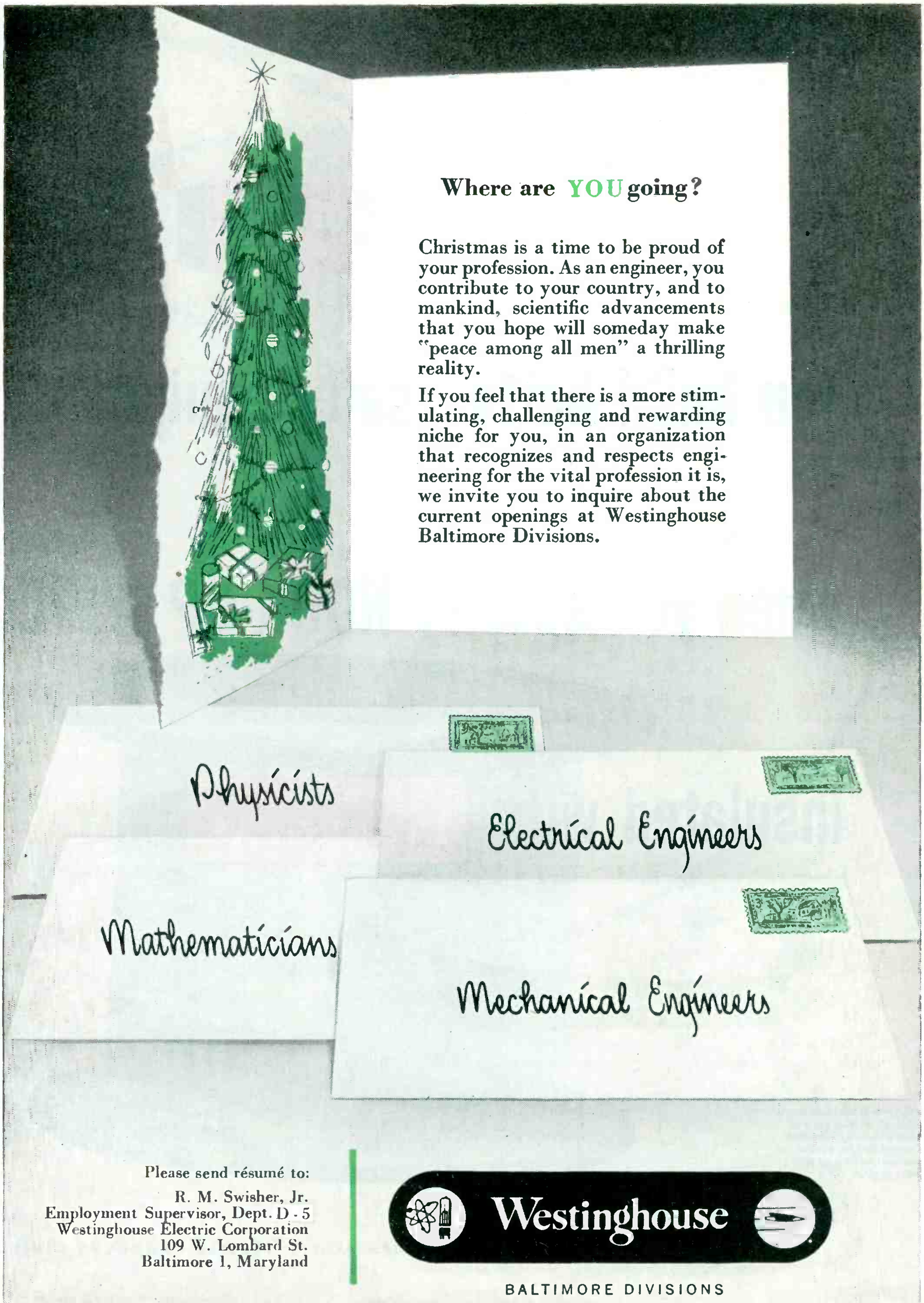
● The unusual characteristics of GLOBAR type BNR ceramic resistors make them practical for a diverse number of advantageous uses. Charted here are five typical applications where these resistors are being used to advantage at present.

Our Bulletin GR-2 contains detailed engineering data which may well suggest applications in your own products. It will give you facts that will help you decide how these ceramic resistors can be of value to you. Let us send you a copy. Write Dept. E-87-101.

GLOBAR Ceramic Resistors

BY CARBORUNDUM

TRADE MARK


Where are YOU going?
Christmas is a time to be proud of your profession. As an engineer, you contribute to your country, and to mankind, scientific advancements that you hope will someday make "peace among all men" a thrilling reality.
If you feel that there is a more stimulating, challenging and rewarding niche for you, in an organization that recognizes and respects engineering for the vital profession it is, we invite you to inquire about the current openings at Westinghouse Baltimore Divisions.
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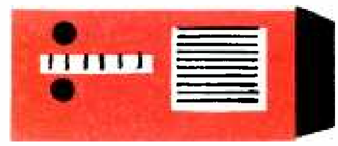
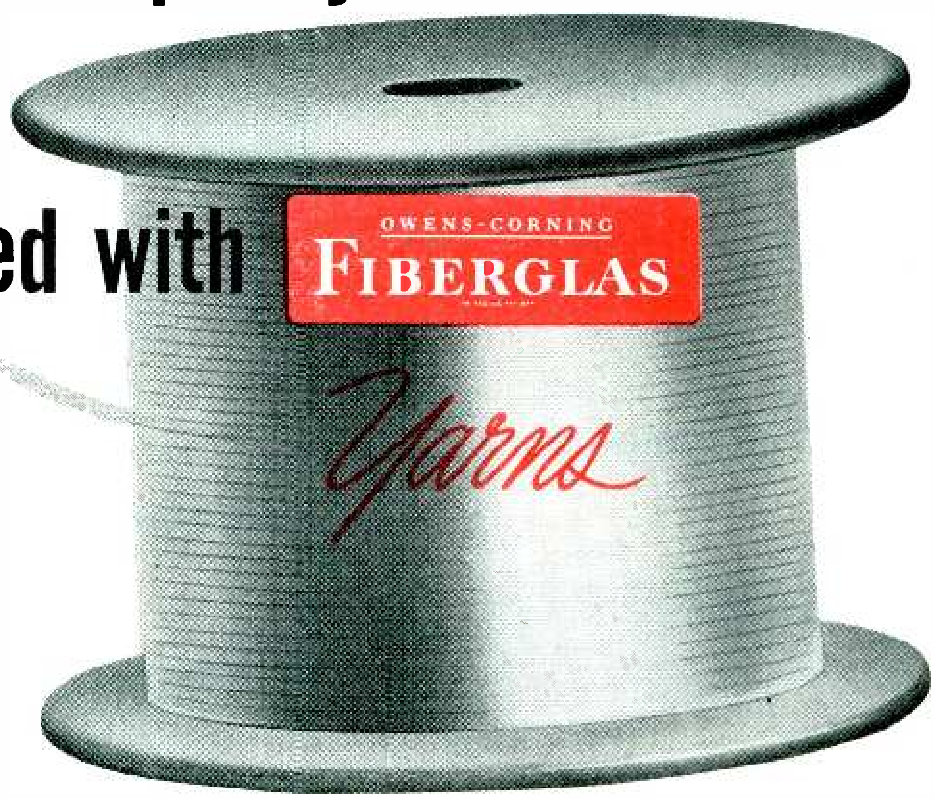
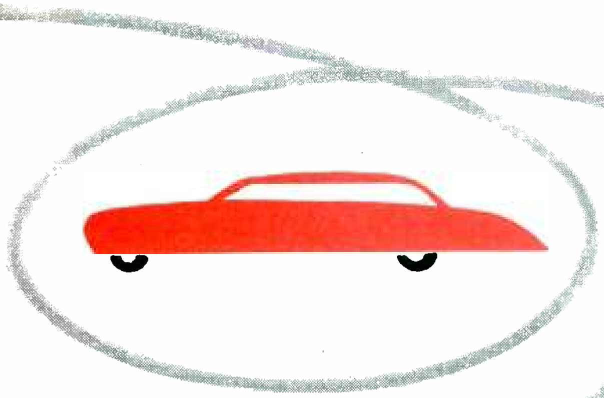


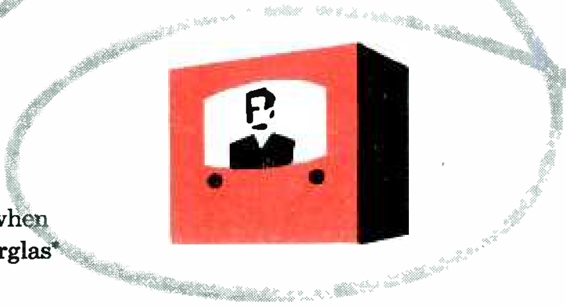
You build better, safer equipment when you specify HOOK-UP WIRE insulated with



**Fiberglas is the trade mark (Reg. U. S. Pat. Off.) of Owens-Corning Fiberglas Corporation for a variety of products made of or with fibers of glass.*

OWENS-CORNING FIBERGLAS CORPORATION • TEXTILE PRODUCTS DIVISION •

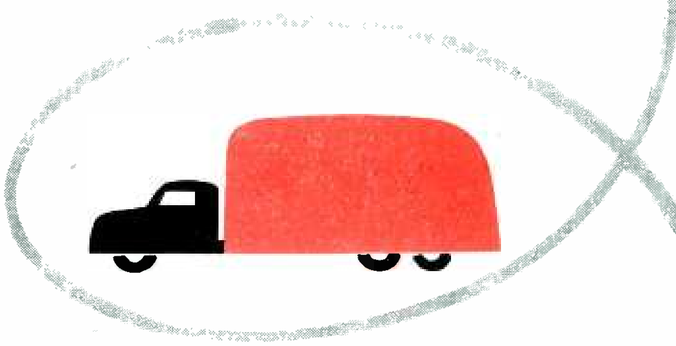




Equipment performs better, lasts longer when you use hook-up wire insulated with Fiberglas* yarns.

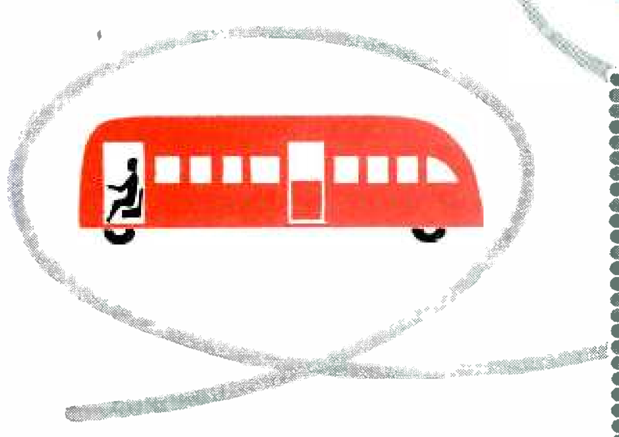
Performs better, lasts longer . . . because glass is rotproof, withstands higher temperatures, resists moisture and most chemicals.

Safer, too, because glass won't burn . . . isn't damaged by solder heat during installation . . . provides less fire hazard even under overload operating conditions.



And today you get better identification of circuits . . . because wire manufacturers are now using the *improved Treatment 023 Fiberglas Dyed Yarn* . . . with its better light fastness and superior heat and bleed resistance!

Smaller diameter, easier-to-install hook-up wire braided with Treatment 023 Fiberglas Dyed Yarn is available in all standard NEMA color grades. For further details check your supplier today—or fill in and mail the coupon below.



16 EAST 56th STREET, NEW YORK 22, N. Y.

OWENS-CORNING FIBERGLAS CORPORATION
Electrical Sales Division, Dept. 860
16 E. 56th Street, New York 22, N. Y.

☐ Please send me further information on glass-base hook-up wire.
☐ I would also like to receive a copy of your Data Kit on the complete line of Fiberglas electrical insulating materials.

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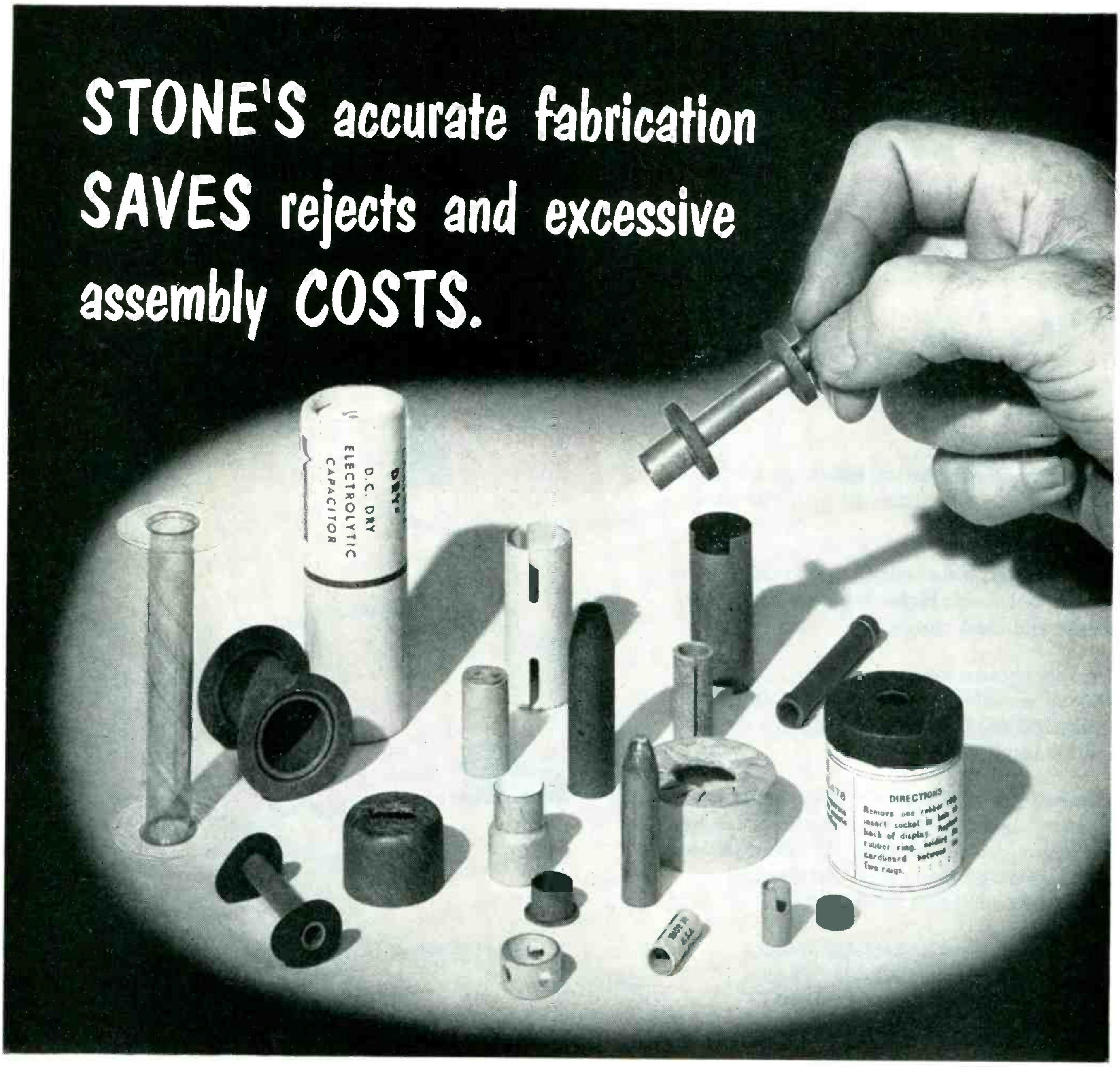

Stone's specialty has always been the manufacture of unusually small spiral wound tubes. This specialty requires extremely close tolerances and precision engineering.

Because fabrication of tubes requires this same engineering skill, we make the necessary dies for special formed ends; punched, notched or slotted tubes; bobbin and special assemblies right in our own machine shop. Even the printing plates are made and the printing done by our own craftsmen in our own shop.

It is obvious that this characteristic to "do it ourselves" makes for faster delivery and for a quality controlled end product at a lower cost.

Stone's tubes are available in such a wide variety of materials including hi-dielectric kraft, fish paper, plastic films, and phenolic impregnated that you may select the one which meets your specifications at the lowest possible cost.

A phone call or letter to us today may mean a worthwhile saving to you.

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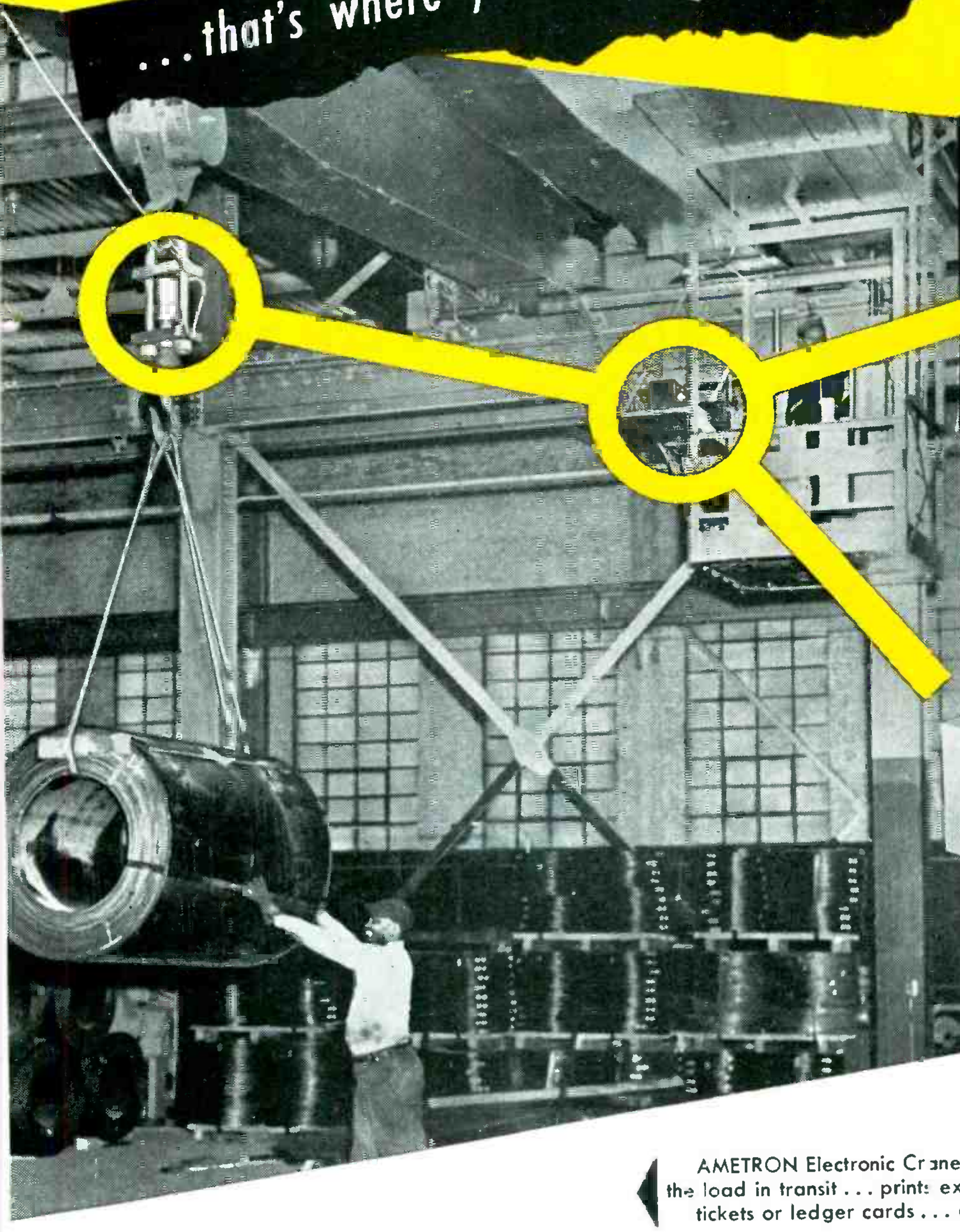
Where ordinary relays won't do...

...that's where you find CLARE RELAYS

For example—the

AMETRON

Electronic Scale



Type GAC Relay... three of which are used to control steps in weight-printing cycle.

Desk model AMETRON printer mechanism which uses CLARE GAC Relays to control precision step-cam printing system.

◀ AMETRON Electronic Crane Scale which weighs the load in transit... prints exact weight on tape, tickets or ledger cards... all in the crane cab.

Because weighing and transporting operations can be performed simultaneously, the Streeter-Amet AMETRON Electronic Scale permits tremendous savings in production time.

Such savings can only be maintained, however, because all the components of this highly specialized device can be counted on for sustained accuracy under heavy-duty operating conditions . . . with minimum maintenance requirements.

Ordinary relays would not meet such rugged operating conditions. Clare Relays were selected by Streeter-Amet engineers because of:

- ★ **Sustained accuracy of operation under difficult operating conditions.**
- ★ **Ability to withstand wide variations in temperature range.**
- ★ **Long-life dependability.**
- ★ **Small size for compact installation.**

Clare Relays have been the choice of Streeter-Amet engineers for many years in every type of electronic weighing device. If you manufacture a precise, quality product . . . one which calls for utmost relay performance . . . it will pay you to investigate Clare Relays. Sales engineers, fully experienced in every type of relay problem, are located in principal cities for consultation. Call them . . . or write C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable address: CLARELAY.

FIRST IN THE INDUSTRIAL FIELD

CLARE RELAYS

Dear

Here is some news from Hewlett-Packard we believe you'll find interesting - and helpful

HEWLETT-PACKARD COMPANY
Laboratory Instruments for Speed and Accuracy
395 PAGE MILL ROAD, PALO ALTO, CALIFORNIA

The New Look in -hp- instruments

In the near future, we will begin to supply all our instruments in new, lightweight, rugged all-metal cabinets. These cabinets are styled for good looks as well as utility; we think you'll like them. We're already supplying -*hp*- 200AB and 200CD Audio Oscillators, -*hp*- 410B Vacuum Tube Voltmeters and -*hp*- 715A Klystron Power Supplies in the new cabinets. We'll continue, of course, to offer rack mounting or end frames where desired.

Our plant is still growing

Again this past year, we've built new factory space. During 1953, new construction increased our manufacturing area by 50%. Work is now under way on still more structures.

hp INSTRUMENTS | COMPLETE COVERAGE

Sir:

HEWLETT-PACKARD COMPANY

To give you better, faster, local service, our representation in the Northeast has been reorganized

About mid-year, several of our representatives formed their own companies. Their names and faces are familiar to you; but now they have new offices, new telephone numbers, more personnel, are better equipped to help you. Here they are:

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HEWLETT-PACKARD COMPANY
395 PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U. S. A.

The Invention of Compression-Type Seals is about as Old as Grandma's Phonograph—

but Constantin's Production Facilities and Methods are as New as Tomorrow

UNITED STATES PATENT OFFICE.

WILFRED T. BIRDSALL, OF MONTCLAIR, NEW JERSEY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

COMPRESSION-TYPE SEAL.

1,184,813. Specification of Letters Patent. Patented May 30, 1916.

Application filed May 4, 1915. Serial No.

To all whom it may concern:

Be it known that I, Wilfred T. Birdsall, a citizen of the United States, and a resident of Montclair, in the county of Essex and State of New Jersey, have invented a new and useful Improvement in Compression-Type Seals, of which the following is a specification.

My invention relates to seals between substances having different coefficients of linear expansion, and it has for its object ... a device of the cha...

vacuum-tight joint between the container wall and the leading-in wire, in spite of great divergencies in the coefficients of expansion therebetween.

Referring to the accompanying drawings for a more detailed understanding of my invention, I have shown a leading-in wire at 4 in Fig. 1. The leading-in wire 4 is surrounded by, and supports, a mass of elastic material 5 formed, preferably, of glass. A band of material 6 ... body of glass 5 and is ...

The invention of compression-type seals in general is quite old as evidenced by U. S. Letters Patent No. 1,184,813, issued to Wilfred T. Birdsall and assigned to the Westinghouse Electric and Manufacturing Co. on May 30, 1916, for the original compression-type seals, expired in 1933. It is now public domain.

Yes, the idea of high compression glass to metal seals is thirty-seven years old and public domain. The compression principle can be employed by anyone, but Constantin makes the *quality* seal.

The wise buyer now is concentrating on quality of manufacture and materials. For over eight years L. L. Constantin & Company has been operating the most modern machine shop facilities for die construction, stampings, and bending—a glass department capable of compounding, tableting and sintering—latest ovens for fusing—multi-slide machines for pin fabrication. In this way, our completely self-contained plant operating all under one roof, can produce true compression seals of highest quality, in addition to our regular line of hard glass to KOVAR and RODAR alloy seals.

We at Constantin realize that adding color to the already pure white glass does not add to the strength, and for identification purposes, whether you buy green, gray, blue, brown or other colors, you will find Constantin seals to be consistently uniform and superior in strength.

Constantin can proudly say that it is not selling an idea. Constantin is selling precision engineered high compression glass-to-metal vacuum seals. See them, test them, and compare.

Seals also available in KOVAR and RODAR alloys to hard glass types.

Also manufacturers of—

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L. L. Constantin & Co.

MANUFACTURING ENGINEERS

Rt. 46 and Franklin Ave., Lodi, N. J.

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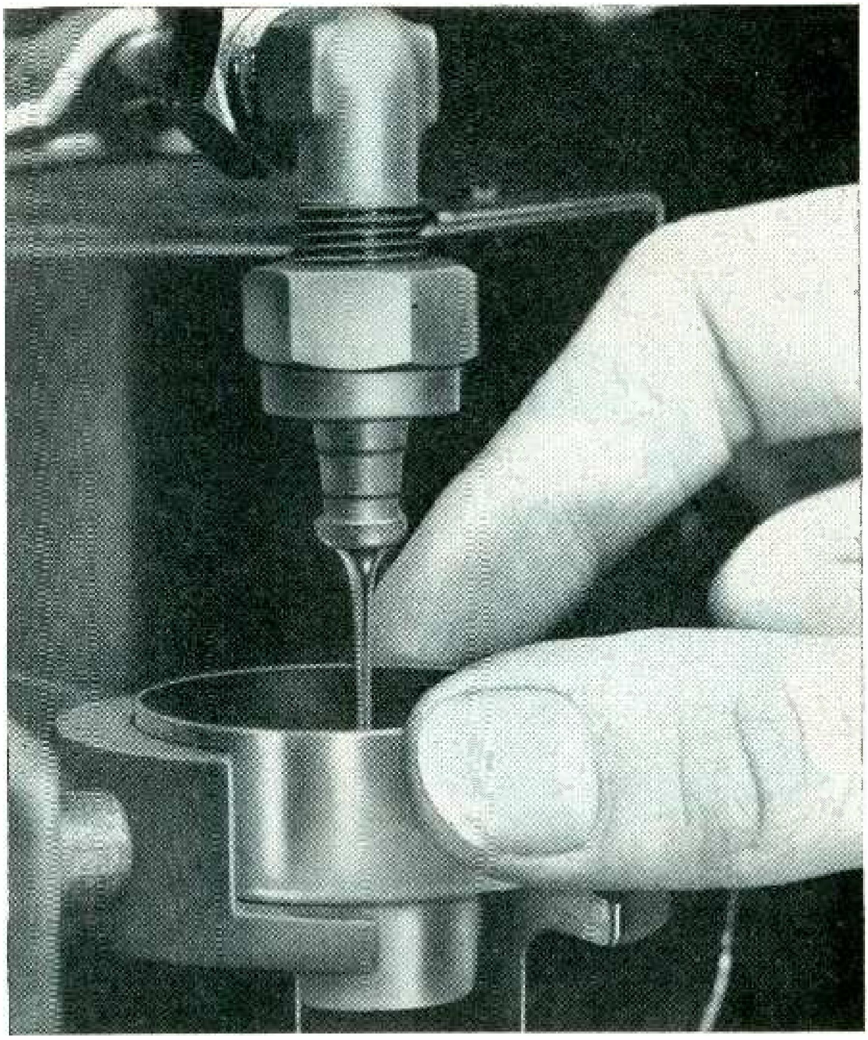

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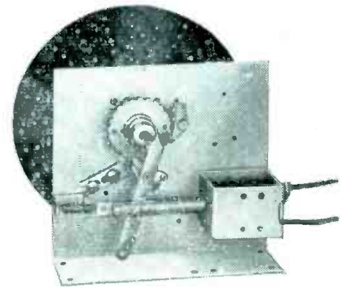

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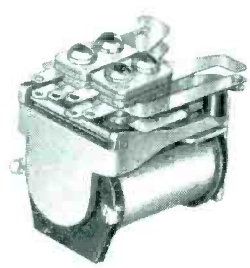

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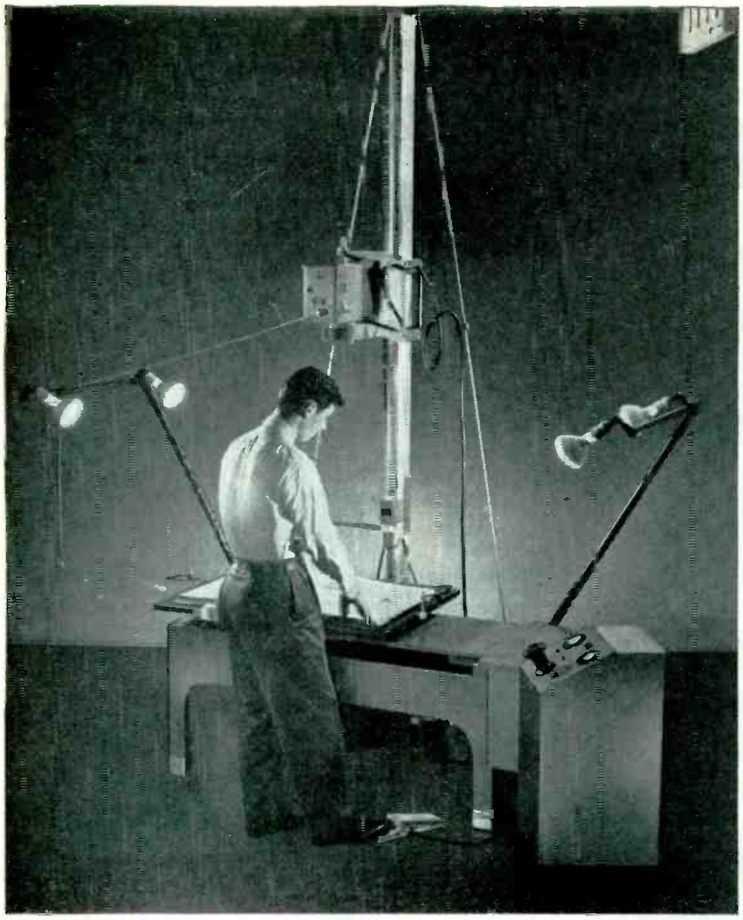
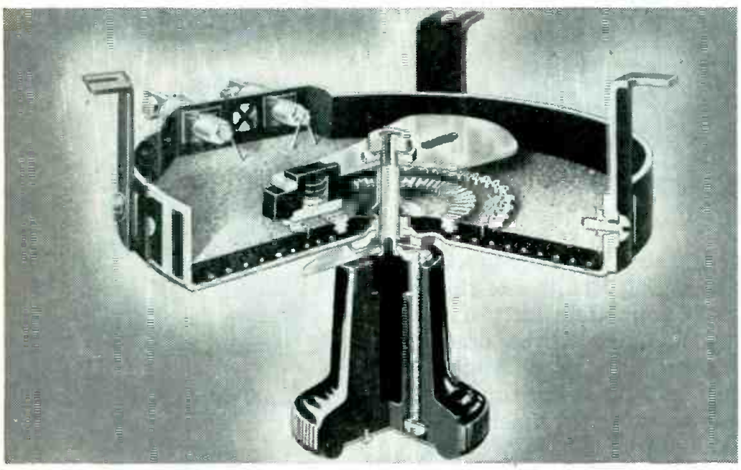


EASTMAN KODAK'S RECORDAK MICRO-FILE MACHINE can microfilm 32 acres of valuable records for storage in only 12 cubic feet of filing space. Accurate performance of Ward Leonard Vitrohm rheostat (in circle) helps to assure clear, sharp, reproduction on microfilm.



CUTAWAY VIEW OF TYPICAL WARD LEONARD RHEOSTAT. Eastman Kodak's Recordak engineers chose a 13-in. Vitrohm rheostat to control lamp voltage in the Recordak Micro-File machine. It provides 161 graduated steps of smooth, accurate, dependable control.

Recordak Corporation uses Ward Leonard rheostat for accurate light control in microfilming

• Light plays a critical role in committing billions of industry's valuable records to microfilm every year. Its intensity must be carefully controlled for each exposure on Eastman Kodak's Recordak Micro-File machine in order to make proper allowances for paper texture, color and reflectivity.

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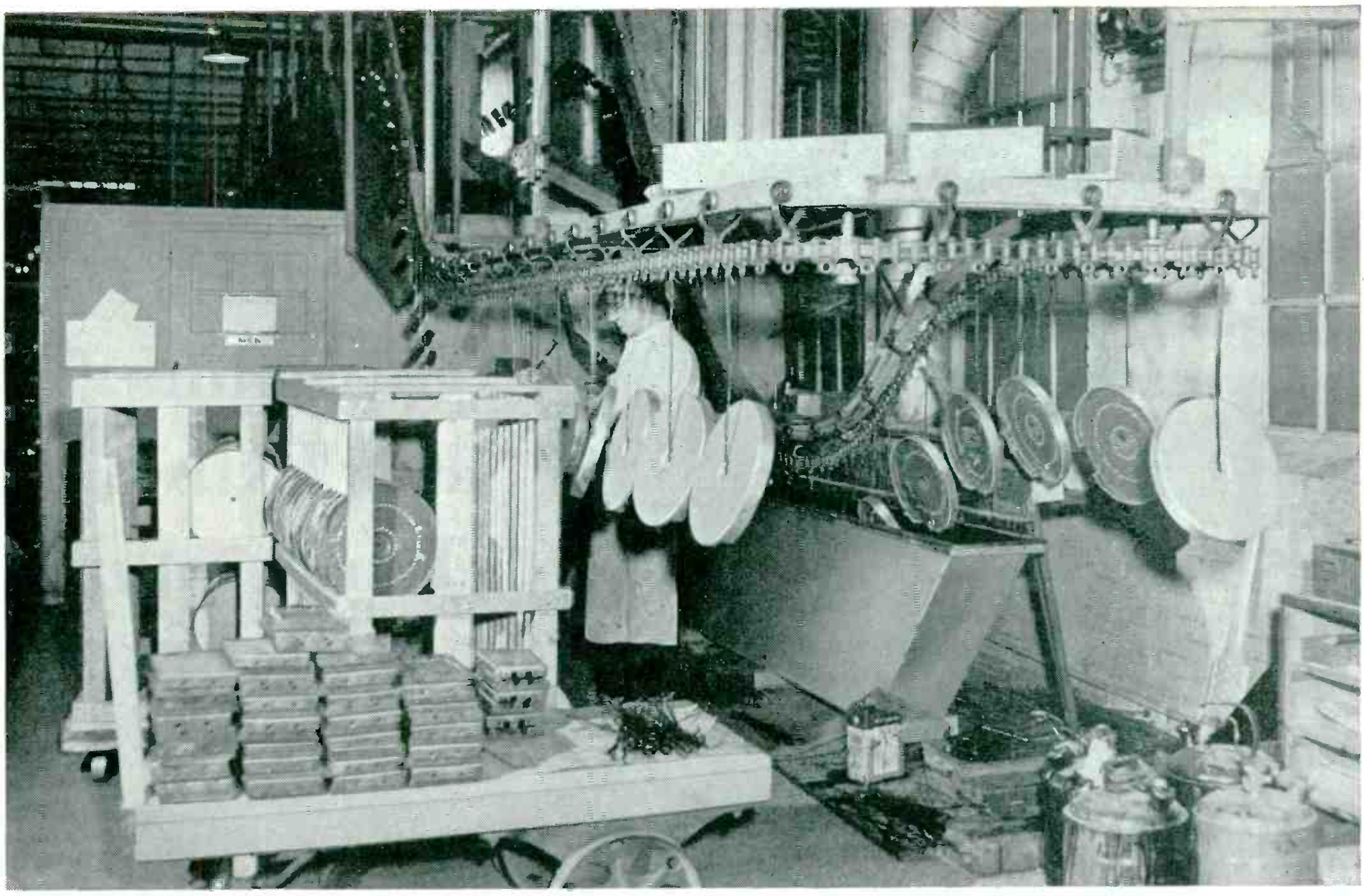

HEAT-RESISTANT FINISH is automatically applied and infra-red baked on all Vitrohm pressed steel rheostat plates.

Here's how dependable performance is built into every Ward Leonard rheostat

• All rheostat materials, from vitreous enamel frit to heat-resistant finish, as well as all manufacturing processes, are carefully controlled by Ward Leonard engineers.

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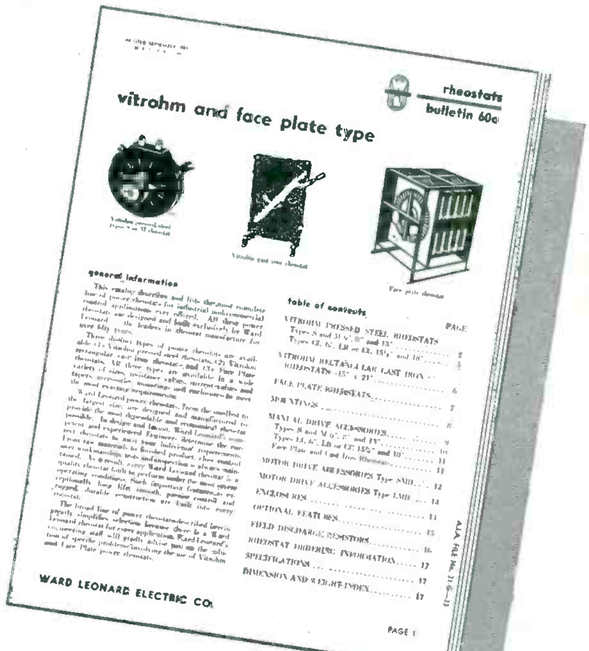
That's why you can depend on the performance of any Ward Leonard rheostat you select from the most complete line ever offered for industrial control applications.

You'll find a complete description of the entire line, including standard and special designs for all current ratings up to 400 amperes, in the new Ward Leonard Bulletin 60A shown at the right. Write for your free copy today.



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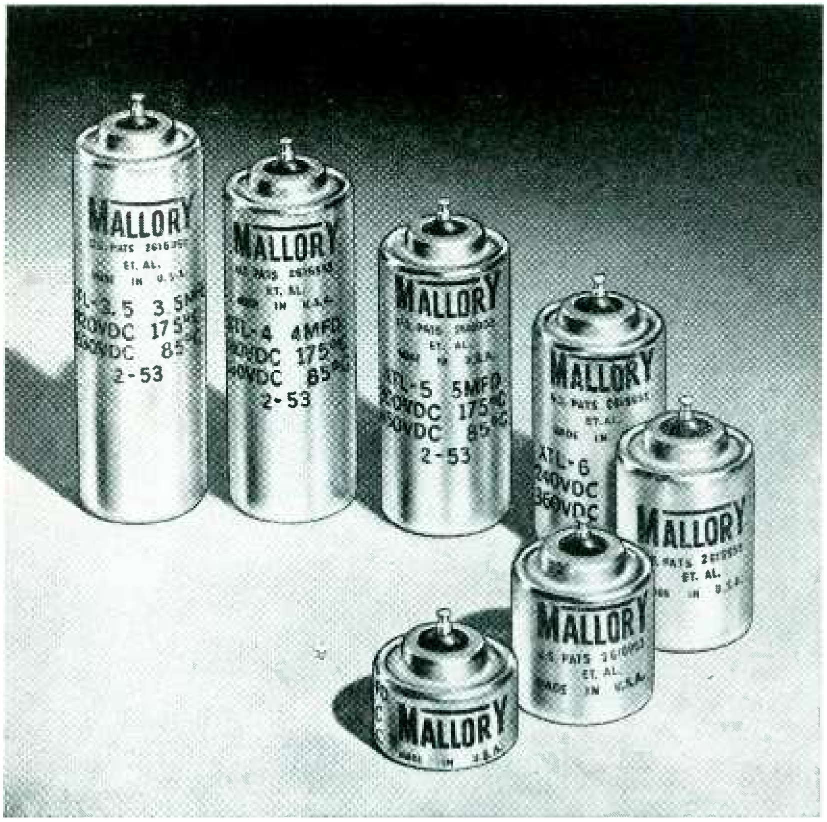

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electronics

W. W. MacDONALD, Editor

DECEMBER • 1953

CROSS TALK

▶ **FORETASTE** . . .In the year immediately ahead many of the best technical brains of our industry will be heavily concentrated upon the business of developing color television receivers at prices within the reach of the American public. Color-tv may very well be the tail destined to wag the electronics dog for some time to come.

NTSC-suggested transmission standards constitute the base upon which design engineers must build. That is why we devote 13 pages within this issue, over and above our normal editorial program, to a thoroughgoing yet easy-to-understand description of the standards and how they got that way. From this beginning ELECTRONICS embarks upon a long-term program which will present to its readers every practical circuit dealing with color-tv equipment problems that the editors can find.

▶ **RUMOR** . . . While the first color-tv sets to be seen in the market will quite probably use 15-inch picture tubes it is known that several manufacturers are working feverishly to produce larger sizes. One, at least, has publicly stated that practical 21's may be available by the end of 1954.

Considerable progress has been made in the design and production of suitable screens and masks. Somewhat less attention has so far been paid to the refinement of electron guns. It seems likely, therefore, that gun design will come in for special attention during the next twelve months.

Less well founded in fact but nevertheless possible in the more distant future is the development of shallow "picture-frame"-type tv screens utilizing an entirely different illumination principle. So far we can report only smoke, no fire.

▶ **RESEARCH** . . . The best ideas of man have frequently come straight out of the blue. That is why educators are becoming concerned with the spread of a new disease called "projectitis."

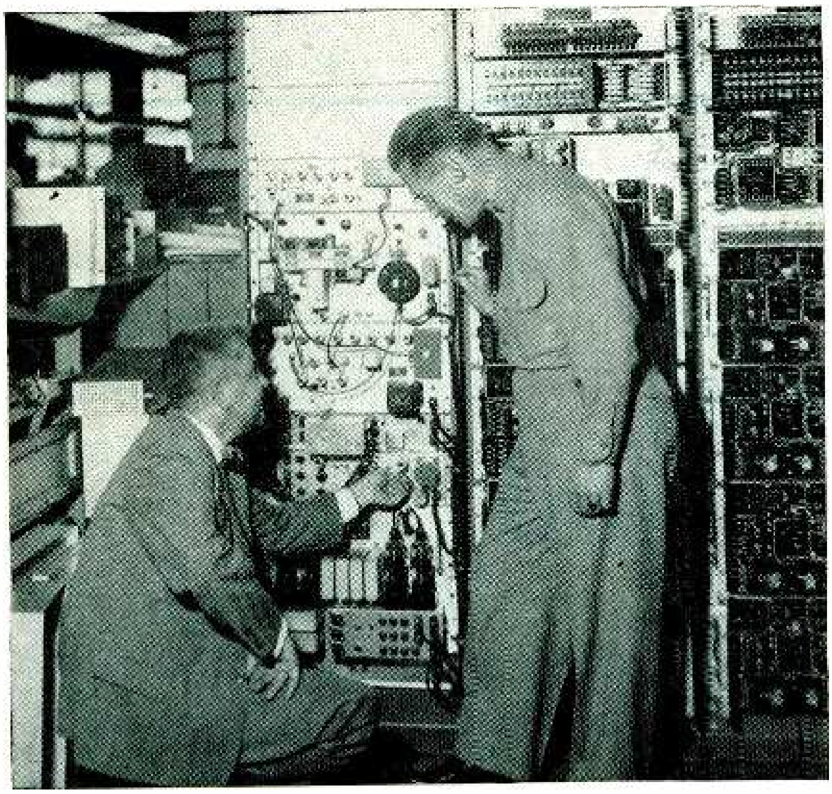
The president of a college which trains many men in electronics recently defined projectitis as "an unhappy addiction to limited objectives", expressed the opinion that grants from government and industry earmarked for certain very specific purposes were not likely to lead toward the basic discoveries that have in the past marked man's progress.

▶ **CHOICE?** . . . Engineers differ on the question: "Is unionization consistent with professional status?" We've talked with a good many men in both camps and expect to talk with a good many more before anything resembling a personal conviction results. Meanwhile, one thing does seem apparent: Any man who succeeds in obtaining all the advantages of each, and none of the disadvantages of either, will have accomplished the neatest trick of our age.

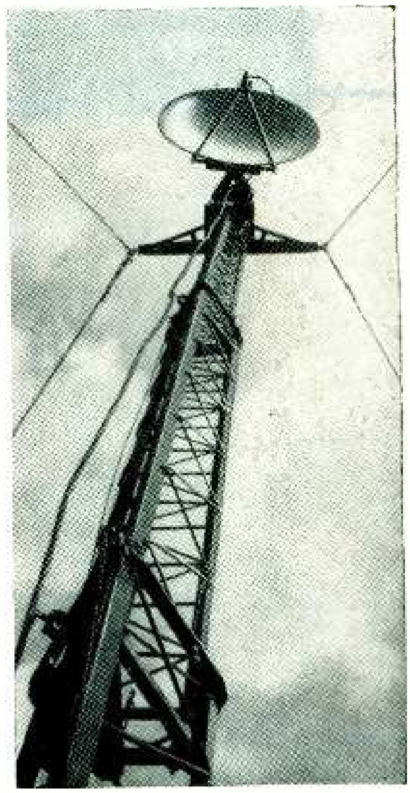
▶ **INTERFERENCE** . . . Idea being considered by the work-ridden and dollar-conscious FCC is the delegation of certain duties to local authorities. When flagrant interference is noted from, say, medical diathermy apparatus, this information might be passed along to a cooperative city attorney for prosecution under intrastate public-nuisance laws.

▶ **COMPLAINT** . . . "Why should commercial orders play second-fiddle to military orders in peacetime?" asks one of our constituents who badly needs electronic component parts.

We don't know any reason why commercial shipments should be delayed for anything except truly critical military needs but we can think of two reasons why they frequently are: Uncle Sam is a big customer and suppliers like big customers. And Uncle also has a substantial crew of expediters, some of whom do not know that the war is over.



Terminal-station equipment. Rack at left contains microwave transmitter receiver, modulator and afc circuits; multiplex equipment occupies remaining racks



This 58-ft antenna mast telescopes to 20 feet for transporting

Portable Microwave for

Truck-mounted 2,000-mc radio-relay system provides 24-channel communications links between various field headquarters of Allied Air Forces in Central Europe. Wide-band f-m signals are difficult to intercept insuring privacy for users

By M. G. STATON
Radio Corporation of America
RCA Victor Division
Camden, New Jersey

MODERN WARFARE dictates that a communications network linking important field headquarters provide ample channel capacity to meet peak traffic loads, sufficient mobility to follow the field headquarters group and security against enemy interception.

The microwave radio-relay system used by the Allied Air Forces in Central Europe provides 24 voice channels one of which may be used to carry 16 teleprinter channels. The equipment is mounted in trucks for mobility. The 2,000-mc signals are largely confined within a line-of-sight path reducing chances of enemy interception while the multiplexed f-m signal is difficult to demodulate in an intercept operation.

Basic Equipment

The system comprises seven terminal stations with 24-channel voice-band and 16-channel teleprinter multiplex, and 18 repeater stations with 5-channel voice-band and 16-channel teleprinter multiplex. Duplicate equipment is supplied at each location to insure against sabotage. The electronic equipment is installed within a military van. Two trailer-mounted power units, a 58-ft telescoping tower and antennas complete each station's equipment complement.

Microwave equipment in use during NATO maneuvers somewhere in France. Military van contains electronic equipment; 5-kv gasoline-driven generator follows in trailer

Allied Forces in Europe

A terminal station consists of one radio rack and five multiplex racks. A repeater station has one radio rack and three multiplex racks. Each group of racks is mounted on two aluminum channels under which shock mounts, four to each rack, are fastened to the truck floor. Horizontal aluminum braces with shock mounts on each end brace the center of each rack against the truck wall.

Duplex r-f filters, which permit transmission and reception with the same antenna, are mounted on an aluminum panel supported on the truck wall by four shock mounts.

Flexible coaxial cables connect the radio equipment to the duplexing filters.

The 58-ft tower is composed of three telescoping triangular sections and collapses to 20 ft for transporting. A winch and boom on the tower base pulls the collapsed tower from a horizontal to a vertical position. The winch then extends the tower to its full height by means of cables threaded through the sections.

The top of the tower is equipped with two stabilizing arms from which four guy wires radiate at right angles. The guy wires are attached to 8-inch screw-type anchors. The top section of the tower consists of a short square framework for antennas mounting in either of two positions on all four sides.

Terminal Equipment

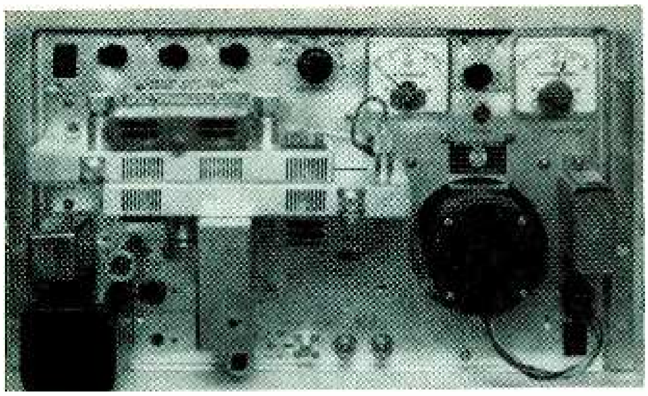
A terminal station employs one 6-ft offset-horn-feed parabolic antenna while each repeater requires two. Antennas are connected by 100-ft lengths of RG-17/U coaxial line. Physical details of the tower and antenna system are evident in the photograph.

The terminal station show is Fig. 1 consists of transmitter, receiver, power supply, automatic-frequency control unit and a baseband amplifier that links the multiplex and radio equipment.

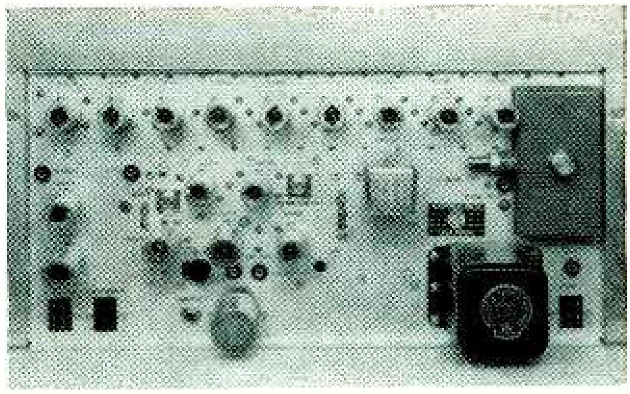
The transmitter oscillator, mixer and r-f amplifier employ 2C39 triodes. The r-f amplifier is an isolation stage that disassociates antenna and transmission-line discontinuitites from the r-f mixer.

The 2C39's are located under the hinged covers visible in the photograph of the transmitter chassis. The four large thumbscrews on the r-f subchassis tune the r-f cavities.

The receiver includes modulation circuits for the transmitter in



Microwave transmitter 2C3I triodes are mounted below hinged cover on r-f subchassis. Thumbscrews tune r-f cavities



Receiver-modulator chassis 2C3I local oscillator is housed in shielded compartment at right

addition to the 30-mc i-f strip, limiters and discriminator.

The radio equipment provides a broad-baseband modulation channel from 300 to 135,000 cps in two blocks. The lower block, 300 to 3,000 cps, is the service channel. The frequency block 4,000 to 135,000 cps transmits 24 single-sideband frequency-division-multiplex voice channels. The radio equipment contains no components or circuits requiring high stability in voltage or frequency of primary power supply. Neither temperature-controlled cavities nor crystal ovens are employed.

Automatic Frequency Control

The afc circuit continuously monitors the transmitter frequency—comparing it to a harmonic of a quartz-crystal oscillator. Should the transmitter frequency deviate from the standard, a d-c voltage is generated that adjusts the frequency of a 110-mc oscillator feeding the transmitter modulator circuits.

The baseband signal from the multiplex equipment passes through the baseband amplifier to frequency modulate a 40-mc oscillator in the receiver modulator. The modulated signal is then mixed with the 110-mc signal from the afc panel to produce 70-mc and 150-mc sidebands. The 70-mc sideband is selected, amplified and fed to a high-level mixer in the transmitter, where it is heterodyned with an r-f oscillator signal to produce the final frequency-modulated r-f carrier. The proper sideband from the high-level mixer is selected and amplified in the r-f amplifier before being passed to the transmitting filter and antenna.

The carrier is sampled at the output of the r-f amplifier for the afc circuit. Should the carrier shift, the 110-mc oscillator in the afc unit will be adjusted to bring the carrier back into agreement with the proper harmonic of the crystal. The time constant of the afc unit will not permit the frequency-control adjustment to follow the frequency modulation of the 40-mc oscillator.

Receiver Operation

The received signal from the antenna passes through the duplexing filter to the input cavity where it is heterodyned with the signal from the r-f oscillator in the transmitter to produce a 30-mc i-f signal. Most of the system amplification takes place in the 30-mc i-f strip. It is followed by limiters and a discriminator. The complex baseband signal from the discriminator is fed through the baseband amplifier to the receiving bus of the multiplex equipment.

A d-c signal is also extracted from the receiver discriminator to adjust the frequency of the transmitter r-f oscillator so that the signal produced in the receiver r-f mixer is always centered on the 30-mc pass band of the i-f strip. This control circuit has a slow time constant and no hunting is produced between the afc circuits.

Repeater Stations

The repeater station illustrated in Fig. 2 is almost identical with a terminal station. The same transmitter, receiver, power supply and baseband amplifier are connected in a slightly different manner to perform the duplex repeater function. The afc panel used in a terminal station is not required at the repeater. Since the repeater is of the heterodyne type, the frequency of the transmitted signal is determined primarily by the frequency of the received signal. The repeater station transmitted frequency is shifted 40 mc from the received frequency.

The received signal is fed from the antenna through the duplexing filter to the receiver input mixer, where it is heterodyned to 30 mc by an r-f signal from the oscillator in the associated transmitter. After being amplified the signal is heterodyned to 70 mc by the 40-mc signal from the modulator circuit in the receiver. This 40-mc oscillator is used to insert intelligence at repeater stations. As a result the 70-mc signal carries both the intelligence received from the preceding station and the intelligence inserted at the repeater.

The 70-mc signal is then fed to the transmitter where it is heterodyned in an r-f mixed with a signal from the r-f oscillator to produce the output carrier frequency that is further amplified in the transmitter r-f amplifier. Sidebands in the receiving mixer and the high-level mixer of the transmitter are so selected that variations in r-f oscillator frequency do not produce changes in the outgoing carrier. The outgoing carrier frequency is locked to the in-

MILITARY MICROWAVE

Communications between military field headquarters, usually carried over land lines, has been given a needed third dimension with the introduction of microwave radio relay. Security from intercept is provided as well as mobility and protection from the elements. In military dress too, microwave gets through when land lines come down.

Last March, when high winds and tides caused disastrous floods in the Low Countries, part of NATO'S microwave relay system was rushed to Holland to re-establish an important communications link that had been washed out. Two terminal stations provided 24 voice channels across the inundated 27-mile path from Middelharnis to Rotterdam.

Field maneuvers have attested to the ruggedness and mobility of the equipment. Recently two terminal vans completed a 1,000-mile tour of France—250 miles of which were over cobblestone roads. Despite rough handling, not a single radio or channeling unit required retuning during the trip

coming carrier frequency except for the 40-mc shift produced by the modulated oscillator used to insert intelligence.

If there is a slight shift in the received carrier frequency, the afc circuit in the repeater adjusts the r-f oscillator so that the signal produced in the input mixer is centered on the 30-mc i-f strip.

Since the outgoing carrier of the transmitter is dependent upon a received carrier, provision is included to reestablish the outgoing signal if the received signal is lost. A single-tube 110-mc oscillator is included in the receiver for this purpose. As long as a received signal is present, operation of this oscillator is blocked; absence of a received signal releases the oscillator and its output is mixed with the output from the 40-mc f-m oscillator again to produce the 70-mc signal for the transmitter. In this manner the circuit is reestablished on each side of a break.

Inserting Intelligence

Intelligence from the multiplex equipment is split in the baseband amplifier by isolating amplifiers before being sent to the modulator circuits in each half of the repeater.

Intelligence received from the discriminator in each receiver is combined through isolating amplifiers in the baseband amplifier before being sent to the receiving bus of the multiplex equipment. Therefore, intelligence inserted at a repeater carries in both directions on the system and intelligence entering the repeater on r-f carriers from both directions feeds out on a common bus to the multiplex equipment.

Intelligence inserted on the transmitting bus of the baseband amplifier does not return as side tone on the receiving bus to the multiplex equipment. This further simplifies system layout problems and provides for party-line terminations at the repeater stations.

The voice-band multiplex equipment operates on the single-sideband suppressed-carrier frequency-division principle.

Voice-frequency signals from the telephone pass from two-wire terminals through a hybird to the modulating branch of the duplex terminal unit. The modulating branch includes a balanced modulator, carrier oscillator and channel filter. In the balanced modulator, voice signals are heterodyned with the signal from the carrier oscillator to produce two sideband signals.

The filter following the balanced modulator passes one of the two

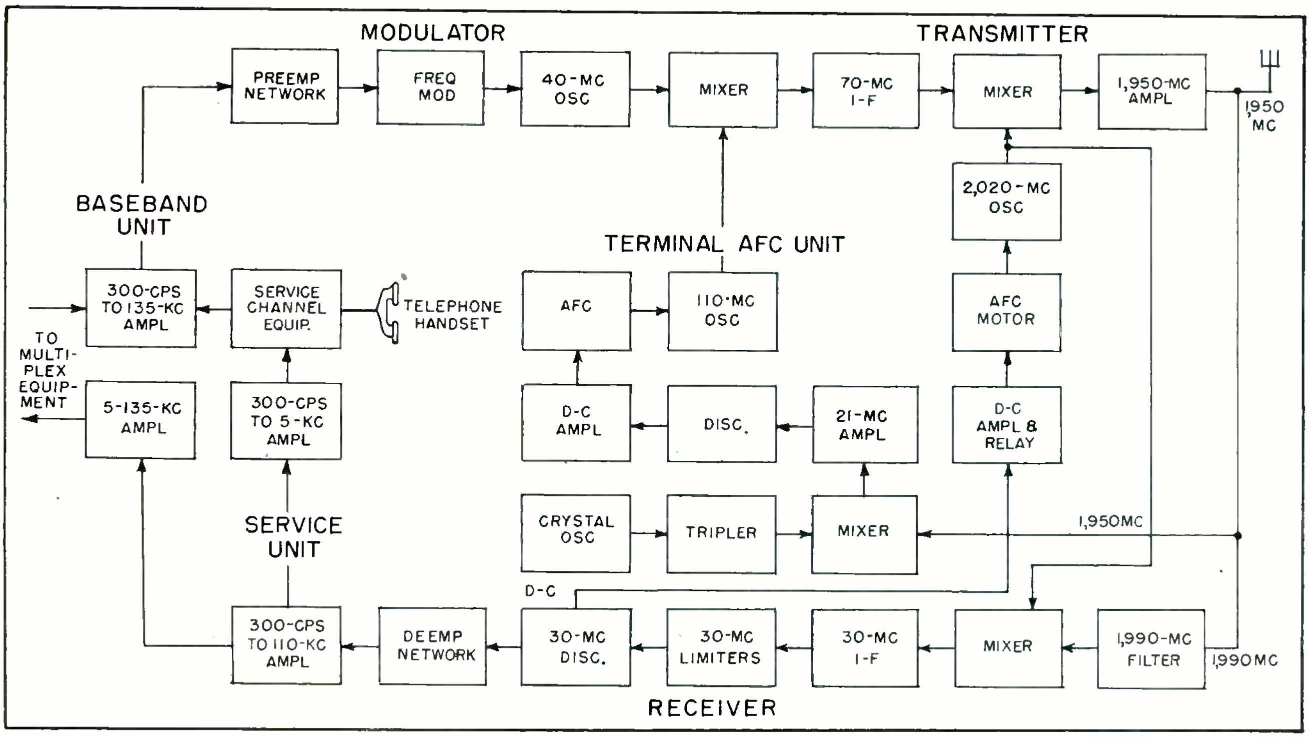


FIG. 1—Terminal station comprises transmitter, receiver-modulator, afc unit, baseband amplifiers and service-channel equipment

sidebands, rejecting the other. The carrier and voice frequencies are suppressed in the balanced modulator.

This carrier sideband is then combined with carrier sidebands produced by other duplex channel modulators and the complex signal is fed to the transmitting bus of the baseband unit.

At the remote terminal, the complex signal from the baseband amplifier is fed to demodulating branches of the multiplex equipment. A bandpass filter selects the proper sideband from the complex baseband signal. A carrier-oscillator signal is mixed with the selected sideband to reproduce the voice frequency. The demodulator is followed by a filter that passes all frequencies below 3,400 cps. The recovered voice frequencies are then passed through a hybrid to the two-wire line for telephone connection. Operation in opposite directions can take place simultaneously without interference.

Group Modulation

Twenty-four voice channels are obtained by combining three groups of eight. Carrier sidebands of the first group of eight channels are transmitted in the frequency block 10,000 to 50,000 cps. The second group of eight channels is passed through a group modulator-demodulator having a carrier frequency of 105 kc. It operates in the same manner as a voice-band modulator-demodulator except that the complex signal produced by combining eight channel sidebands is heterodyned with a 105-kc carrier to produce two sidebands. The lower sideband is selected for transmission so that the second group of eight channels is actually transmitted over the radio system in the frequency block extending from 55,000 to 95,000 cps. In a similar manner, the third group of eight channels is heterodyned in a group modulator with carrier frequency of 145,000 cps to produce a block of sideband carrier frequencies in the range of 95,000 to 135,000 cps.

At the receiving terminal, the second and third groups of eight channels are each demodulated as a block to lower each group to the frequency range 10,000 to 50,000 cps. The original voice frequencies are recovered by voice-band demodulators in the duplex terminal units.

Each station includes a 16-channel multiplex teleprinter assembly capable of providing a maximum of 18 channels spaced 170 cps apart within a single voice band.

Performance

During equipment test, voice channels were set up for 6-db loss between transmitting and receiving terminals. Each voice channel was loaded with a 1,000-cycle tone adjusted to a level of zero dbm, approximately 10 db higher than the level of an average talker. Under these conditions, the tone was removed from each channel in turn and the signal-to-noise ratio measured at the output terminal of the quiet channel with all other channels loaded. The lowest signal-to-noise ratio was 52 db, and ranged up to 58 and 60 db. To check crosstalk limits, the system was operated with plug-in receiver-modulator units taken directly from stock. Tests proved that critical parts of the system can be directly replaced with other standard units without affecting the overall operation.

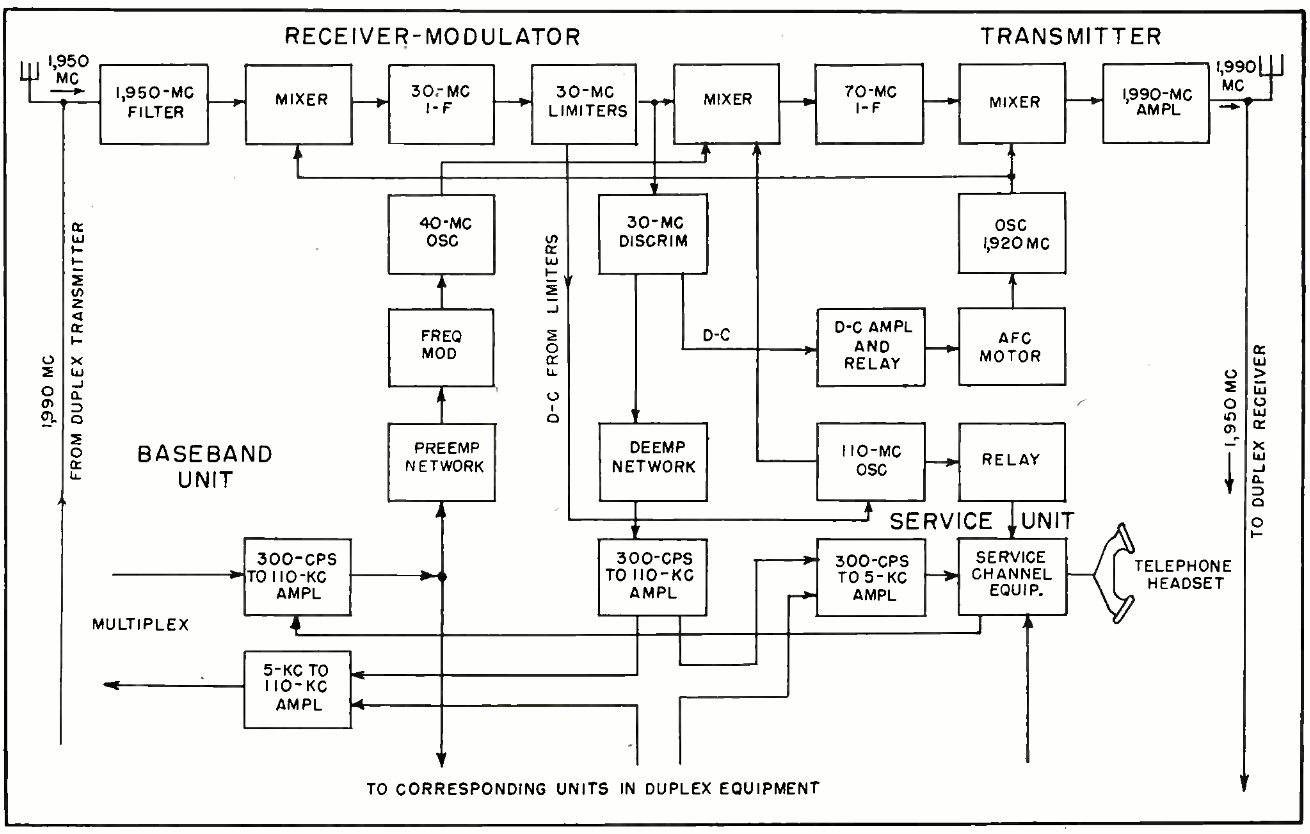
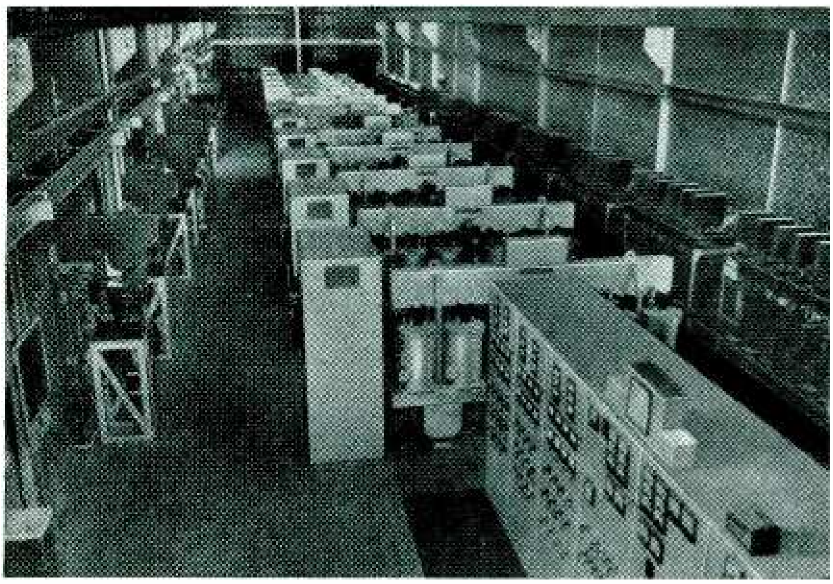


FIG. 2—Repeater stations have duplex transmitters and receiver-modulator units. Basebrand amplifiers, service-channel equipment and multiplex gear are shared



Rectifier station for an aluminum pot line. Anode and cathode circuit breakers are on right and left walls respectively. Master switchboard is in foreground

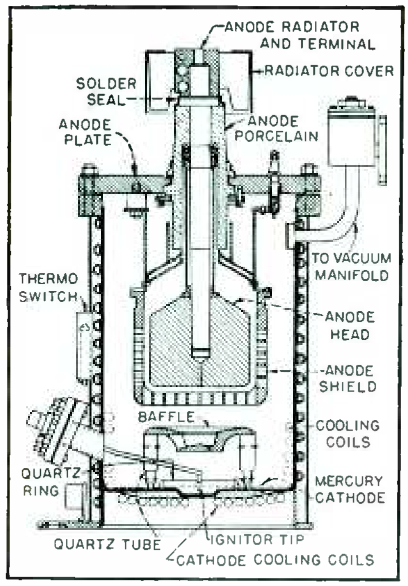


FIG. 1—Cross section of typical pumped-type ignitron

Recent Developments in Ignitrons

Growth in industries needing large blocks of d-c power conversion equipment led to the sale of 1,600,000 kw of mercury arc rectifiers from 1948 to 1952. The ignitron finds application in locomotive drive, strip mill drive and pot lines

By G. M. ZINS

Westinghouse Electric Corp.
Pittsburgh, Pa.

IGNITRONS have proved to be of great value in the industrial, electrochemical and railway applications which require conversion of large quantities of a-c power to d-c power at voltages of from 250 v d-c to 20,000 v d-c. Characterized by an ignitor which initiates the arc at the beginning of each desired conduction period, the ignitron offers high efficiency and relative freedom from arc back.

Recent design improvements have extended ignitron ratings to 150 percent of previous values and opened the door to a variety of new applications and extensions of old. Use of ignitrons as inverters for converting d-c to a-c has already been made in certain industrial applications. They have also been applied to variable-voltage electronic drives, such as required for hot-strip steel mills and paper presses.

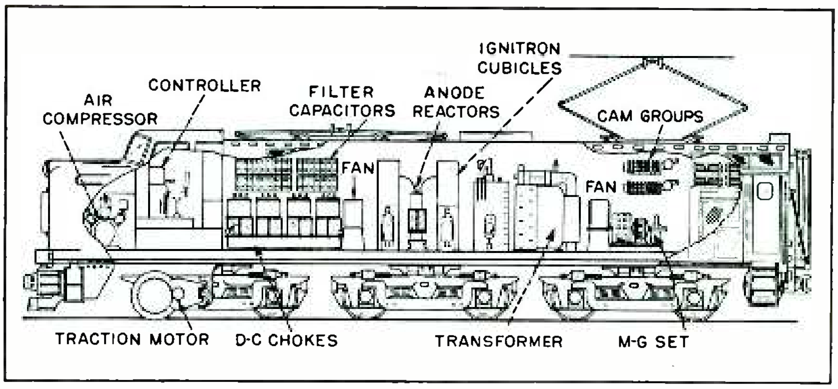
Ignitron Locomotive

Because of its inherent ruggedness, high power handling capability and high efficiency, the ignitron is well suited for use in locomotives and multiple unit railway cars. The economic advantages of an a-c trolley system can be combined with the inherent advantages of d-c traction motors.

Improvements in sealed type rectifiers have considerably accelerated the acceptance of ignitrons (Fig. 1) by the railroad industry. An intensive development program was initiated which included field studies on an experimental mobile rectifier installed on a multiple-unit car.

The many problems of mobile operation were examined, and special tubes, excitation circuits, control circuits and filters were developed specifically to meet mobile operating conditions of a single-

Locomotive ignitron cubicle houses six tubes and associated apparatus



Artist's drawing of electric locomotive shows position and relative size of ignitron cubicles located in center of cab

phase full-wave rectifier. Experience indicates ignitron locomotives have relatively low initial cost, low maintenance, low standby losses, high overall efficiency and low weight.

A typical twin-cab locomotive is rated at 6,000 hp or 3,000 hp per cab. It operates from an 11 kv, single-phase, 25-cycle trolley system. The essential equipment in each cab consists of: the main rectifier transformer which is designed for a single-phase full-wave rectifier circuit; two ignitron cubicles each containing six sealed ignitrons together with their associated excitation circuits, protective devices and switching apparatus; a water-to-air type heat exchanger; control circuits; anode reactors; and an a-c and d-c filter. Each pair of ignitrons forms a separate cathode circuit, or a total of six separate cathodes, each connected to a 500-hp series-wound d-c traction motor. The arrangement of the ignitron cubicles is shown in the photograph.

The rectifier transformer is provided with tap-changer-under-load equipment to cover the operating range required for accelerating and motoring. Vernier steps between transformer tap positions are obtained by phase control of the ignitrons. This combination of transformer taps and phase control provides 35 different notches for motoring.

Dynamic braking is also obtained. Two of the twelve ignitrons supply exciting current to all six motor fields which are connected in series for the dynamic braking operation. By varying a series resistor, changing taps on the transformer, and changing phase delay on the ignitrons, fourteen notches of braking are obtained.

Overall performance curves for the ignitron locomotive are shown in Fig. 2. These curves give an indication of the locomotive's ability to perform at low speeds and to provide a smooth no-slip start and acceleration.

Special Tubes

The ignitron tubes developed for this application contain a special baffling arrangement and special mounts to eliminate the effects of vibration in service. New firing circuits were required to provide reliable firing over a wide range of trolley voltages with the wave shape of voltage obtained from the main power transformer which was tapped to provide the necessary auxiliary voltage. One master cooling system was developed to allow one fan to cool the rectifier heat exchanger, power transformer, filter and anode reactors along with the other auxiliaries on the locomotive.

The telephone interference problem caused by the rectifier harmonics has been eliminated by a relatively simple and inexpensive a-c and d-c filter. Present tests indicate that the filters applied on these first locomotives may be materially reduced or even eliminated on future models.

Aluminum Pot Line

The original aluminum pot lines in this country were installed using 300-v synchronous converters with pot line capacities in the neighborhood of 50,000 amperes. Many of these rotory converters were later rewound for 600-v service to increase station capacity. First costs coupled with high maintenance costs left this field ripe for the mercury arc rectifier.

During World War II the ignitron completely dominated all other equipment in this field with typical pot lines consisting of twelve rectifier assemblies of twelve tubes each supplying pot-line loads of 60,000 amperes at 600 v d-c.

Improved designs of these same tubes are now being applied at 72,000 amperes and 750 v d-c. Recent improvements in protective switchgear for rectifier service are permitting the addition of even more rectifier assemblies on a single pot line, with pot lines up to 120,000 amperes now being considered at voltages of 750 v d-c. One station now in operation has power requirements in excess of 700,000 kw.

It is customary practice on these large installations to operate two twelve-tube rectifier assemblies from a common rectifier transformer with a quadruple-wye secondary connection and employing anode balance coils. The individual pot lines are now operated multiphase by employing both delta and wye connected primaries on the rectifier transformers and employing autotransformer type phase shifters to provide 30 or 36-phase operation per line. Similarly, pairs of pot lines are operated out of phase to give overall operation of 60 or 72-phase operation. With additional units now being contemplated stations may go up to 108-phase operation. Multiphase operation of this order of magnitude is required where such large blocks of power are concentrated in one station to eliminate telephone interference and improve the wave shape of the line current for the station.

Since all pot lines are attended stations the breaker control and voltage control are manual, except for the automatic reclosing of the anode breakers.

Because of the large number of units in each station, special provisions are normally made to degas the entire pot line simultaneously upon installation by supplying reduced voltage to the a-c bus. Subsequent degassing is normally done on the line since there is adequate capacity to allow removal of one unit at a time without overloading the remainder of the rectifiers.

A pot line is usually started by closing all breakers with the ignitor short circuited and then releasing the ignition on all rectifiers simultaneously. This provides reliable pickup of the pot-line load without unbalance between units.

This process must be closely controlled. If one unit were to be released in advance of the others this unit would attempt to carry the entire pot-line load and would then trip on overload. Each succeeding unit could follow and also trip out. Simultaneous release is therefore a feature essential to proper operation.

The anode and cathode breakers provide normal protection against arc backs and permit the removal of individual units from service. Normal dumping of the pot-line load is best accomplished by tripping the master a-c breaker which feeds the entire line.

Two of the most notable features of the electrochemical industry are the tremendous concentrations of power and the unvarying 100-percent load on these pot lines up to one year without shutdown. The rectifier has a well-earned reputation for reliability even on this rugged duty.

Hot Strip Mill

Although many ignitrons have been applied for hot strip mill service, most of them were used in conjunction with motor-generator sets, the motor-generator sets being used to obtain the variable voltage feature and the rectifiers being used for full-voltage service and in parallel with these motor-generators. There has been a definite trend, in recent years, to all electronic drives for hot strip mill service.

An all-electronic drive for hot strip mill service provides many interesting features. A typical hot strip mill may consist of five or six finishing stands each stand being driven by an individual compensated d-c motor. These finishing stand motors range from 2,500 to 5,000 hp per motor.

In a continuous hot strip mill, the strip may be in all stands simultaneously for periods up to 40 seconds. It is, therefore, essential that the speed of the individual stands be very closely controlled to prevent pulling or excessive looping of the strip. To control the motor speeds accurately it is necessary to regulate the rectifier bus voltage to obtain a flat voltage characteristic over the entire load range (Fig. 3). To accomplish this a magnetic-amplifier regulator is used. High speed of response and high sensitivity of the regulator used permit an extremely flat voltage characteristic to be obtained even with the impact load of the strip entering the rolls.

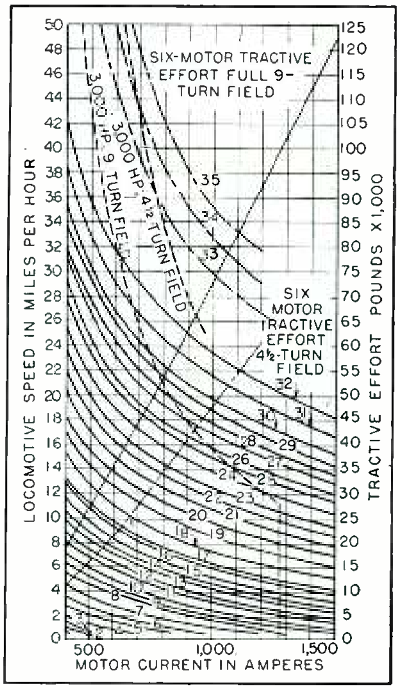


FIG. 2—Performance curves of ignitron locomotive. Speed for a given motor current is indicated by solid curves

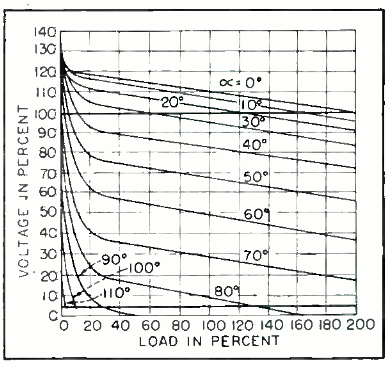


FIG. 3—Regulation curves of a typical ignitron rectifier for steel mill service. Solid sloping lines indicate inherent regulation curves for various angles of delay

Another feature which is required in a drive of this type is the inching operation. A regulated bus voltage in the order of 5 to 10 percent of rated is required. This feature is used to line up the couplings on the rolls and to calibrate the rolls by test samples.

Reduced voltage for the inching operation is obtained by phase control of the ignition point on the ignitrons. Operation of the rectifier at the high angles of delay necessary increases the probability of arc backs and sets up the possibility of forward fires occurring. To minimize these tendencies a blocking bias is applied to the ignitron grid, driving them negative with respect to the cathode. A pulsing circuit is employed to overcome this negative bias and drive the grid positive when the ignitor is fired and conduction is desired.

This inching voltage is also regulated as described previously for full-voltage operation.

Phase control is provided to allow the mill to be accelerated from inching voltage to full voltage in the prescribed time interval. It is sometimes desired that an idle run voltage be incorporated into the drive. Approximately 20 percent of rated voltage is supplied for this operation, the reduced voltage being obtained by phase control. The mill is run at this speed during extended idle periods between strips to reduce power consumption and still maintain uniform cooling of the rolls. If the mill were shut down completely during such periods heat distortion could damage the rolls.

What Design Engineers Need to Know About the

NTSC COLOR TELEVISION STANDARDS

Point-by-point discussion of the 22 color standards and the reasons why specific techniques and numerical values were chosen for transmission of color signals without disturbing reception on a monochrome receiver

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ON JULY 21, 1953, the National Television System Committee approved unanimously two documents of historical significance in the development of television. The first is a petition to the FCC, stating that the NTSC has completed the development of technical signal specifications for compatible color television and requesting the Commission to adopt them as standard for commercial television broadcasting. In the petition, the NTSC asked that the Commission adopt the compatible color system "in place of the present (field-sequential) color standards."

The second NTSC document, presented as an appendix to the petition contains the signal specifications in the form of 22 proposed standards and three diagrams. This paper reviews the background of these specifications for the benefit of television engineers unfamiliar with the detailed findings of the NTSC panels. Extensive tutorial treatment will become available[1]; the present treatment confines itself to the following questions—"What exactly is the significance of each proposed standard, and why was it chosen in the precise form given by the NTSC?"

By **DONALD G. FINK**

Director of Research
(Radio, Television, Appliances)
Philco Corporation
Philadelphia, Pa.

IN ORGANIZING the specifications for the color television signal, the editorial committee of the NTSC arranged the proposed standards in three groups, I—General Specifications, II—Sound, and III—The Complete Color Picture Signal. The first two groups contain material with which television engineers are familiar, since these specifications are similar to the present FCC monochrome standards.

The NTSC signal is a compatible signal; it must produce on existing black-and-white receivers a monochrome version of the color image of quality equal to or superior to normal monochrome reception, without any modification of the receivers. The color standards must employ the same frequency distribution (channel width, location and spacing of sound and picture carriers and their sidebands), the same types of modulation (including modulation polarity and reference levels in picture modulation, frequency deviation and preemphasis in sound modulation), the same scanning methods, and the same synchronizing signals as are used in black-and-white broadcasts.

To preserve compatibility to the fullest extent the color standards can differ from the monochrome only in two ways: the numerical values may be specified more precisely in the color system, so long as the values lie within the tolerances permitted in the FCC monochrome standards, and additional signals may be employed in the color system, so long as the effect

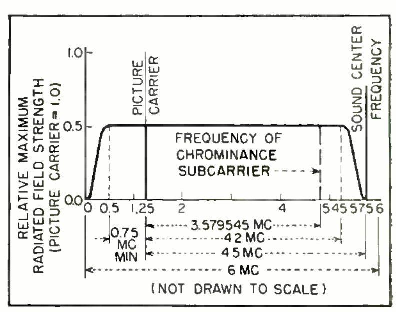


FIG. 1—Idealized picture transmission characteristic, showing relative positions of carriers (item I-D)

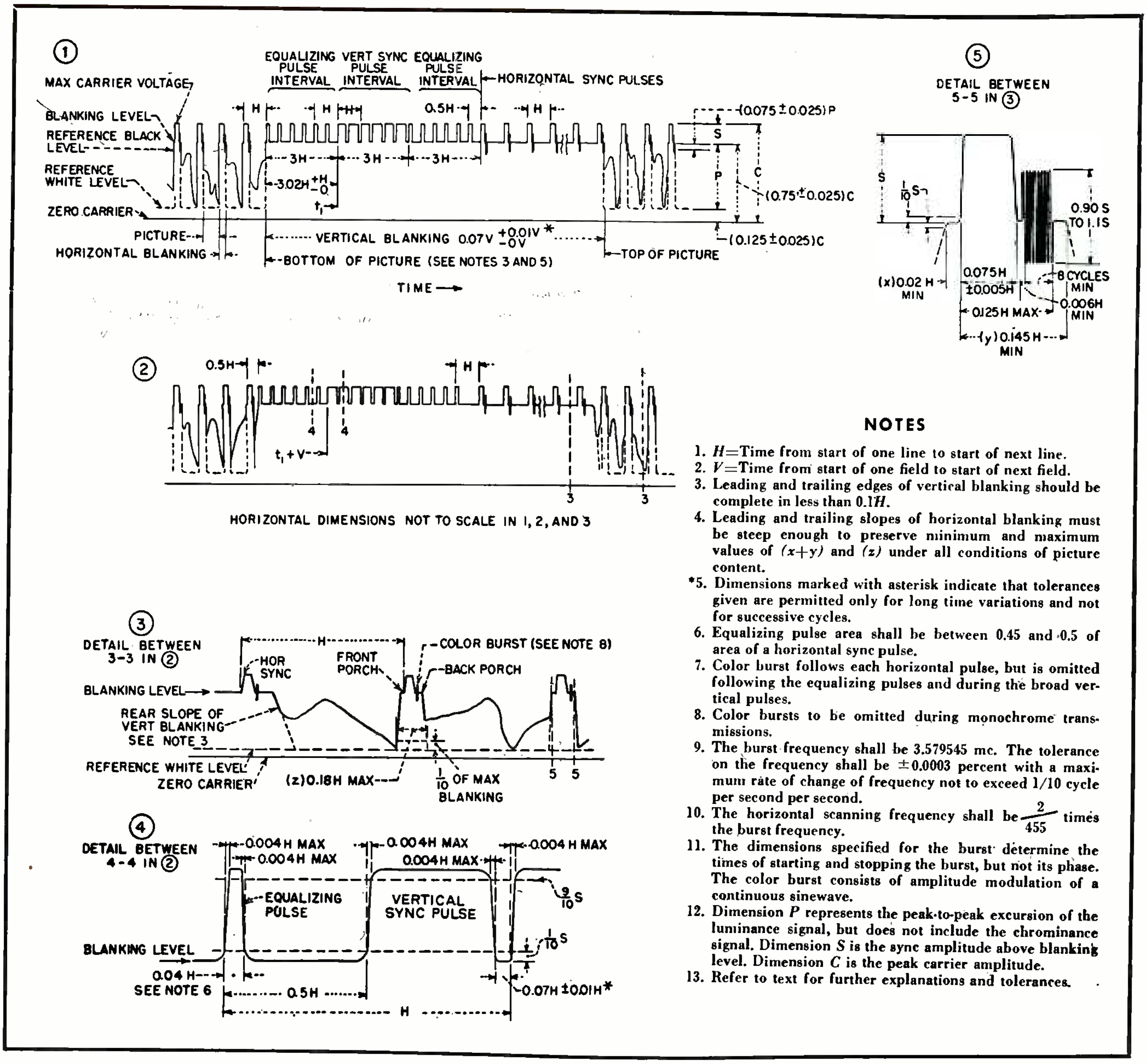


FIG. 2—Dimensions of sync signals, color burst and reference levels of proposed NTSC standards (item I-F-4)

of these signals on black-and-white sets is so small as to produce no deleterious result.

General Specifications

Referring to the general specifications (Table I), the first three specifications (I-A, I-B, and I-C), specifying the overall channel width, the position of the picture carrier and the direction of polarization, are in exact accordance with present monochrome practice.

The wording of item I-B, specifying the frequency of the picture carrier as that "assigned by the FCC to the particular station" recognizes that the picture carriers of various stations are often assigned in accordance with the offset-carrier technique. In this case, the spacing between carrier and channel edge differs from 1.25 mc by the offset frequency (typically plus or minus 10 kc). This is the practice at present in many monochrome stations; no change is contemplated for color.

Item I-D gives the distribution of carriers and sidebands in the channel, as shown in Fig. 1. The specification of the picture (luminance) and sound signals is identical to black-and-white practice, as compatibility requires. But something new has been added. An additional signal is located 3.579545 mc above the frequency of the picture carrier specified in item I-B. This signal is a picture-carrier sideband corresponding to the "chrominance subcarrier."

The term "chrominance" refers to two signals which carry color information. These signals, when added to the luminance signal, provide the hue and saturation components of the color image. The chrominance subcarrier signal is so modulated that the hue information is carried by phase modulation while the saturation is determined by the ratio of the chrominance amplitude modulation to the luminance amplitude modulation.

The dimension of the flat portion of the visual transmitter characteristic, above the picture carrier, is given as 4.2 mc. This is 0.2 mc greater than the corresponding dimension in the monochrome standard; the additional space is specified to accommodate the sidebands of the chrominance signal.

The extension of the transmitter characteristic to include the chrominance signal places a burden on the television transmitter, which must be adjusted to have excellent amplitude and phase responses in this region. The extra signal energy in this region may affect the sound reception of monochrome receivers, and this fact is taken into account in the choice of the sound carrier and chrominance subcarrier frequencies (Table II, item II-A and Table III, item III-A) and in the picture/sound power ratio (Table II, item II-C).

Scanning Standards

Item I-E, the aspect ratio, has the usual value of 4 units of width to 3 units of height, as compatibility in scanning requires.

Item I-F-1 gives the broad outline of the scanning pattern. This is identical to black-and-white practice in every respect, specifying the 525-line interlaced pattern for which 25,000,000 American monochrome sets are designed. The specification of direction of scanning from left to right and top to bottom is intended to apply to normal operation of studio facilities.

When the director wants to show performers dancing on the ceiling, artistic license permits him to use a reversing mirror or to reverse the connections to the vertical scanning coils of the camera. Such off-standard operation to produce particular artistic effects is also anticipated in the transmission of reference colors, as noted in the discussion under item III-D.

Item I-F-2 contains the first notable change from monochrome practice. The scanning frequencies are specified precisely as 15,734.264 cps horizontally and 59.94 cps vertically. These values are about 0.1 percent lower than the nominal values specified in the monochrome standards (15,750 cps and 60 cps respectively). The FCC monochrome regulations do not state a tolerance in the latter figures (although they do allow a change as great as 0.5 percent in the instantaneous horizontal frequency relative to the average frequency).

It is customary practice, permitted by the FCC, to tie the scanning frequencies to the local 60-cps power frequency when scanning film programs. The typical short-time variation of the frequency of 60-cps commercial power in automatically controlled systems is about 0.1 cps or 0.16 percent (in manually controlled power systems the variation may be 0.5 percent or more). Consequently, the actual tolerance employed by tv stations today is wider than the 0.1 percent departure of the color frequencies from the nominal monochrome frequencies.

While it is true that the scanning frequencies specified for color fall within the established tolerance of monochrome transmissions, the question still remains: Why were these frequencies not chosen to conform exactly to the previously established values of 15,750 and 60 cps? The answer lies in the relationship between the scanning frequencies and the chrominance subcarrier frequency.

The chrominance signal must be substantially invisible on monochrome receivers. Such invisibility can be achieved if the chrominance subcarrier frequency is an odd multiple of one-half the line scanning frequency (this relationship provides that the chrominance sideband frequencies are interleaved with the luminance sidebands). Conversely, then, the line frequency must be an odd submultiple of twice the chrominance subcarrier, as implied in item I-F-2.

Other Frequencies

The chrominance subcarrier frequency might be so chosen that a particular odd submultiple would produce a line frequency of precisely 15,750 cps. But there were reasons (relating to the mutual interference between chrominance, luminance and sound carriers) for choosing a chrominance subcarrier whose frequency is 0.1 percent smaller than that required for 15,750 cps.

In summary, the luminance carrier is the fundamental frequency of the system. The radiated frequency corresponding to the chrominance subcarrier is located precisely with respect to the luminance carrier, and the scanning frequen-

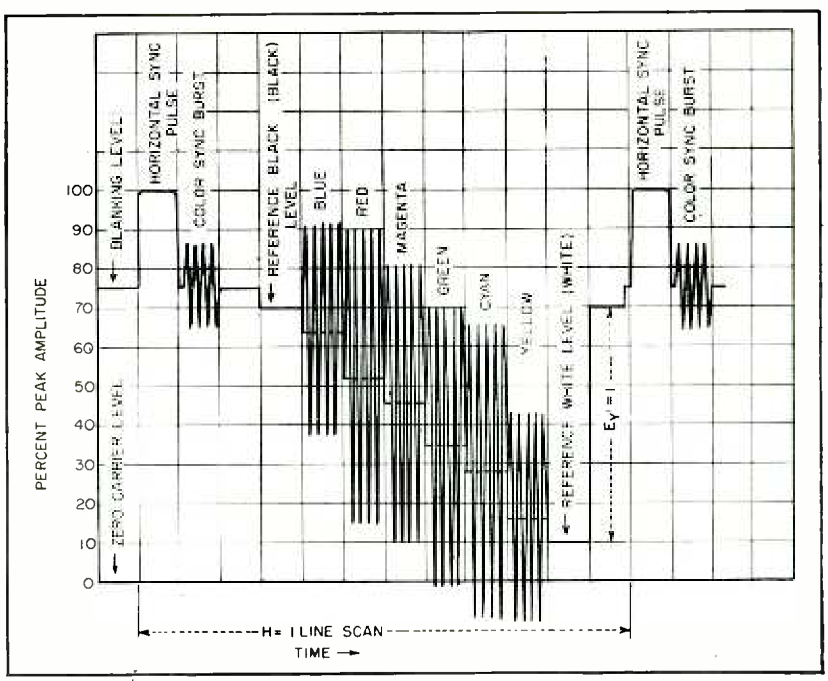


FIG. 3—Video modulation waveform resulting from scanning a single line of a bar chart containing fully saturated primary and complementary colors. The dashed line (average of chrominance oscillations) represents corresponding luminance levels. Burst and chrominance frequencies not drawn to time scale

cies are precisely derived from the chrominance subcarrier to establish the interleaved relationship between the luminance and chrominance sidebands.

The particular odd multiple relating half the line frequency and the chrominance subcarrier is 455. This was chosen because it consists of small odd factors ($455 = 5 \times 7 \times 13$), which are advantageous in the design of counter circuits to establish the frequency relationship. The relationship between twice the line frequency and the field frequency is 525, as is required for the standard 525-line picture.

Reference Levels

Item I-F-3, following monochrome practice, states that the picture signals and synchronizing signals are transmitted successively and occupy different amplitude ranges in the picture carrier envelope. But several important exceptions are noted. A portion of the color-synchronizing signal (section 5 of Fig. 2) extends below the blanking level into the picture-signal range, for reasons stated in the discussion of item I-F-4. Moreover, during the transmission of fully saturated blue, red or magenta at full luminance the chrominance signal extends above the blanking level into the synchronizing signal region.

Finally, during the transmission of fully saturated yellow and cyan at full luminance, the chrominance signal extends below the zero-carrier level and is in fact clipped off. These amplitude excursions are shown in Fig. 3. It may well be wondered how a black-and-white receiver (or a color receiver for that matter) can deal with such excessive signal excursions. Fortunately, circumstances conspire to produce an entirely satisfactory result.

Consider first the excursion of the color sync burst below the blanking level (Fig. 3 and section 5 of Fig. 2). The portions of the sinewave below the black level can brighten the viewing screen, but the brightening cannot be observed under ordinary viewing conditions. In the first place, the brightening occurs during the horizontal retrace, which in typical receivers involves a scanning velocity ten times as great as that of the active scan. This reduces the brightening due to the burst by a factor of ten in itself. Secondly, few monochrome receivers have full video response at 3.6 mc, and the attenuation present at this frequency reduces the amplitude of the color burst.

Retrace Brightening

Even in a set having full response at the burst frequency, the portion of the burst extending below the blanking level is not great, only about 10 percent of the peak signal amplitude. A portion of this amplitude is rendered invisible by the setup interval specified in item III-C-2, the visible remainder occupying only about 8 percent of the range reserved for the scale of grays, and in the blackest portion of the range at that. Finally, the transfer characteristic of the picture tube compresses the darkest grays. The net retrace brightening is a small fraction of one percent of the peak brightness, to ali intents and purposes undetectable.

The peak excursions accompanying fully saturated colors are similarly harmless. Highly saturated colors at maximum luminance almost never appear in ordinary subject material; it is practical to obtain such color signals only by artificial generation, as in a color bar chart generator. With saturation levels occurring in nature, the peak excursions lie between 12.5 percent of peak carrier and the blanking level. If the transmitter is operated for any reason at full saturation and at maximum luminance, clipping occurs (with yellow or cyan) at zero carrier and (on red, blue or magneta) the signal extends into the synchronizing region.

Fortunately, all black-and-white receivers know what to do with such unwanted information in the

Table I—General Specifications

A. Channel
The color television signal and its accompanying sound signal shall be transmitted within a 6-mc channel.

B. Picture Signal Frequency
The picture signal carrier, nominally 1.25 mc above the lower boundary of the channel, shall conform to the frequency assigned by the FCC for the particular station.

C. Polarization
The radiated signals shall be horizontally polarized.

D. Vestigial Sideband Transmission
Vestigial sideband transmission in accordance with Fig. 1 shall be employed.

E. Aspect Ratio
The aspect ratio of the scanned image shall be four units horizontally to three units vertically.

F. Scanning and Synchronization
1. The color picture signal shall correspond to the scanning of the image at uniform velocities from left to right and from top to bottom with 525 lines per frame interlaced 2:1.
2. The horizontal scanning frequency shall be 2/455 times the color subcarrier frequency; this corresponds nominally to 15,750 cps (with an actual value of $15{,}734.264 \pm 0.047$ cps.) The vertical scanning frequency is 2/525 times the horizontal scanning frequency: this corresponds nominally to 60 cps (actual value is 59.94).
3. The color television signal shall consist of color picture signals and synchronizing signals, transmitted successively and in different amplitude ranges except where the chrominance penetrates the synchronizing region, and the burst penetrates the picture region.
4. The horizontal, vertical, and color synchronizing signals shall be those specified in Fig. 2, as modified by vestigial sideband transmission specified in Fig. 1 and by the delay characteristic specified in III.B.

G. Out-of-Channel Radiation
The field strength measured at any frequency beyond the limits of the assigned channel shall be at least 60 db below the peak picture level.

sync channel. The bandwidth of the sync chain is very narrow, well below 3.6 mc, so attenuation occurs. If any residual chrominance energy should remain above blanking, the sync circuit treats it like noise and, through the normal gating and stabilizing functions of the sync system, prevents it from affecting the sync timing. Such above-blanking excursions have no effect on the picture, of course, since they extend into the infrablack region.

Item I-F-4 specifies the synchronizing signal by reference to the complete sync diagram (Fig. 2). This bears a close resemblance to the sync-signal specification of the monochrome standards, with one major difference and several minor ones. The major difference is the color synchronizing signal (color burst) mentioned, which is located on the blanking level immediately following each horizontal sync pulse. As indicated in Note 7 of Fig 2, these pulses are omitted following the equalizing pulses and during the broad vertical pulses.

Limit Maximum White

The minor differences are changes in dimensions and additional notes relating to the burst and related quantities. The minimum amplitude level for maximum white in the proposed color standard is 10 percent of peak amplitude (specified as 12.5 percent ± 2.5 percent), whereas in monochrome the maximum white level may go to zero carrier (the actual specification is 15 percent +0, −15 percent). The proposed 10-percent limit is already in effect in most monochrome stations, since this protects the quality of sound reception in intercarrier receivers. Here, again, the proposed color standard is within the monochrome tolerance and in line with present monochrome practice.

The amplitude difference between the blanking level (the pedestal at the base of the sync pulses) and the black level (corresponding to black in the intended picture) is known as the set-up interval. The monochrome standards, in the interest of providing the maximum possible amplitude range for the scale of grays, state that "the black level shall be made as nearly equal to the (blanking) pedestal as the state of the art will permit." This implies a setup of zero, but the FCC recognized that this is difficult of achievement, as proved by monochrome network operations. The regulations state that this particular standard will not be enforced for the present.

The absence of an established value of set-up is in large measure responsible for the absence of d-c restoration circuits in many recently-designed monochrome receivers, since such circuits are not effective unless the black level is under reasonably tight control. In color receivers d-c restoration is a must, so the black level and its tolerance must be established. It is hoped that the set-up tolerance will be adopted for monochrome transmissions, leading to a resumption of d-c restoration in future monochrome receivers.

The color standard for set-up, as shown in Fig. 2 and spelled out in item III-C-2, is 7.5 percent ± 2.5 percent of the video amplitude range. This mode of operation is currently used by many black-and-white broadcasters as an objective, although operating practices in studios and on the networks often prevent its attainment. In any event, close control of set-up is a strict requirement in color transmissions, so it was impossible to avoid coming to grips with the issue. In writing a definite standard, the NTSC recommends that the FCC assert jurisdiction over set-up and suggests as a standard 7.5 (± 2.5) percent.

The Color Burst

The major change in the synchronizing signal is the addition of the color burst (section 5 of Fig. 2). This burst is utilized only by color receivers; for reasons given it is not visible on monochrome receivers. Moreover, it does not affect the synchronizing of monochrome receivers because the sync circuits do not respond to the burst frequency of 3.6 mc. Thus the portion of the pedestal following the horizontal pulses (the back porch) is stripped clear of the burst oscillations as it passes through the horizontal sync chain, and the burst is replaced by its average value, which is the pedestal level itself.

At an early stage in the NTSC work, a different form of color burst was devised by Panel 14. This early specification is of more than historical interest since it represents an important step in achieving full compatibility in the NTSC system. The early form of sync pulse, recommended to the NTSC by the Panel in October 1951, is shown in Fig. 4.

This signal closely resembles the final form, with two important differences. To provide additional room on the back porch for the burst, the duration of the horizontal sync was reduced from its monochrome value of $0.08H$ to a proposed value of $0.06H$. The burst

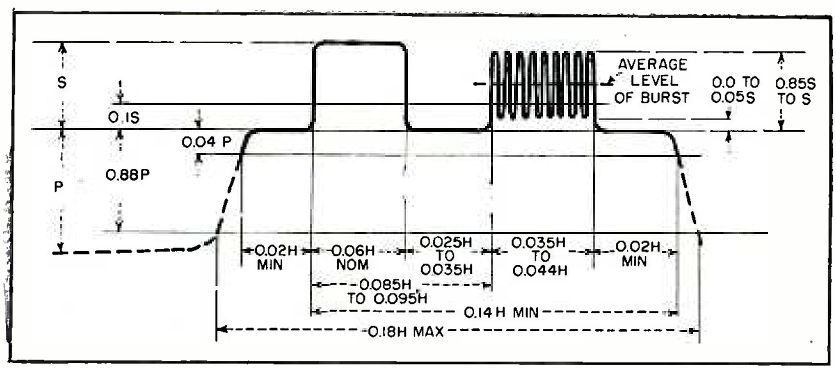


FIG. 4—Early form of color synchronizing burst, having average value above blanking. Compatibility difficultuies resulted in revision of this waveform to final form shown in (5) of Fig. 1

itself was elevated above the blanking pedestal to remove all portions of the burst from the picture portion of the amplitude range.

This early signal proved faulty on two counts, when it was tested for compatibility by Panel 15, using many models of existing monochrome receivers. Certain receivers (a small fraction of those tested but a serious matter from the compatibility standpoint) showed unstable horizontal sync. In some cases the instability could be traced to the shorter than normal duration of the horizontal sync pulses; in other cases, the trouble was found to be the average value of the color burst, which did not coincide with the blanking level, but extended, as shown in Fig. 4, upward by about 50 percent of the sync-pulse amplitude.

The majority of the receivers proved completely insensitive to the extra averaged energy in the back porch; but a significant fraction found the burst pedestal (as it was called) an attractive alternative to the horizontal sync pulses, and the sync timing wandered between the two positions. When Panel 15 reported this difficulty, Panel 14 revised the burst specification, specifying the horizontal pulse duration as 0.075*H* (which lies within the tolerance of the monochrome standard), and removing the burst pedestal, arranging the average value of the burst to coincide with the blanking pedestal).

Burst Limits

The color burst, as finally specified, consists of a minimum of eight cycles of a sinewave (maximum 11 cycles) having precisely the chrominance subcarrier frequency, and having a phase relationship to the chrominance modulation as specified in Fig. 5. The phase of each successive color burst must match that preceding and following it, as specified in Note 11 of Fig. 2.

The purpose of the color burst is to synchronize the chrominance demodulation process at the color receiver with the chrominance modulation process at the transmitter. The chrominance carrier (see discussion of item III-A and III-D) is modulated by two signals, such that phase modulation is produced to represent hue and amplitude modulation to represent saturation. If these two modulations are to be recovered independently at the receiver, synchronous demodulation must be used, and the synchronizing process must be highly precise.

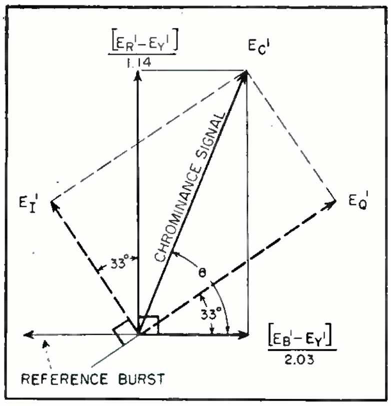


FIG. 5—Phasor diagram showing relative phase angles of color burst and chrominance components (item III-D-1)

Phase errors greater than 20 electrical degrees are readily detected as incorrect hues in the reproduced image, and the phase error should be kept below 5 degrees to insure that the corresponding hue error is undetectable in normal viewing. Any error in the phase of the color burst appears directly as an error in the recovered phase modulation of the chrominance subcarrier. The question of whether such phase accuracy could be maintained in practical receivers (5 degrees at 3.6 mc is a timing error of only 0.004 microsecond) was demonstrated by Creamer and Burgett[2] and investigated theoretically by Donald Richman for Panel 12. A summary of this work was recently published[3]; the full paper will appear[1]. The conclusion, confirmed in practice, is that a phase accuracy of 5 degrees can be maintained by simple circuits even when the signal-to-noise ratio is unity.

Item I-F-4 states that Fig. 2 represents the synchronizing signal waveform prior to its application to the transmitter proper. After emerging from the transmitter as the envelope of the picture carrier, it is modified by vestigial sideband transmission (Fig. 1) and by the delay characteristic (item III-B). These modifications are considered at length in a Panel 12 document by Fredendall and Morrison[1].

The final item in the general specifications (I-G) states that the radiation of the transmitter outside the channel shall be at least 60 db below the peak picture level. This specification conforms to the recently issued FCC regulation now applying to monochrome broadcasts.

It does not necessarily follow that a transmitter which meets this requirement when broadcasting monochrome will do so when radiating a color signal, since the chrominance subcarrier, when modulated on the picture carrier, may appear in the lower adjacent channel at a substantially higher level than the vestigial sideband filter is designed to handle. An additional notching filter will be required, in that case, at a frequency 2.33 mc below the channel edge.

The Sound Signal

The second group of specifications (Table II) comprises three items relating to the sound signal. The first (item II-A) states that the separation between picture carrier and sound carrier shall be 4.5 mc, the same as in monochrome broadcasts. There is, however, a tighter tolerance in the proposed color standard.

Current FCC regulations specify that the separation between picture and sound carriers shall be held to ± 5,000 cps, an amount small enough to insure proper operation of intercarrier receivers. The NTSC proposed standard of ± 1,000 cps is required because the sound carrier must be held in an offset-carrier relationship to the picture-signal sidebands associated with the chrominance subcarrier, to minimize mutual interference between sound and chrominance signals (see discussion of item III-A). The tolerance of offset-carrier operation must be a small portion of the offset spacing, which is approximately one-half the line scanning frequency (7,875 cps). It is evident that the existing tolerance of ± 5,000 cps is far too large a percentage of the offset interval, so the smaller value of ± 1,000 cps was chosen. One result of this tighter requirement is that the tighter spacing between sound and picture carriers should be controlled by reference to one or the other of the carriers.

Item II-B, giving the deviation and preemphasis characteristics of the sound transmission, is identical in all respects to the monochrome standard.

The power ratio, item II-C, represents another proposed color standard having a tighter tolerance than the existing monochrome standard, but still within the range of existing black-and-white practice. Present FCC rules state that the effective radiated power of the sound transmitter shall be not less than 50 percent nor more than 150 percent of the peak power of the picture transmitter. Experience has proved that the sound signal coverage exceeds the picture coverage (with receivers of current design) when the ratio is greater than 50 percent, so economy dictates that the lower limit of the ratio be used. Examination of the published power ratings of 205 vhf and uhf stations operating as of July 6, 1953, reveals that the large majority operate at 50 percent and only two of them employ ratios higher than 70 percent. Therefore, item II-C, limiting the ratio to 70 percent, represents no major change in established practice.

It was deemed advisable to set the upper limit at 70 percent to insure a minimum of sound-signal interference with the chrominance subcarrier and sidebands. If a high power ratio is used, and if the sound-signal traps have marginal attenuation (as they do in some monochrome receivers), the beat between sound signal and chrominance subcarrier may produce sound bars, shimmering horizontal bands, in the monochrome image.

Careful tuning of the receiver sometimes eliminates these bars, but to obtain a maximum of compatibility (which implies ordinary tuning of the monochrome receiver), the power ratio was given an upper limit of 70 percent, and an offset-carrier relationship was set up between sound and chrominance carriers, as previously mentioned. The offset method assures that the beat structure shall have opposite polarity on successive fields, and hence tends to integrate the visual effect to zero over many fields. This condition applies, strictly speaking, only in the absence of sound modulation, but some improvement is nevertheless noted during modulation.

The Chrominance Subcarrier

The central feature of the NTSC color system, the chrominance subcarrier and the method of modulating it, is listed in the third group of specifications (Table III). The first item in this group (III-A) states that the complete color picture signal consists of a luminance component and two chrominance components producing independent modulations of the chrominance subcarrier. The chrominance modulation is described as two amplitude modulations of a pair of subcarriers in quadrature, the subcarriers themselves being suppressed in the absence of modulation. The luminance signal and modulated chrominance subcarrier are added and the resulting composite signal is used to modulate the picture carrier.

An equivalent statement of this proposition appears in equation form in item III-D, in which the chrominance signal is given as the sum of a sine term and a cosine term of the same angular frequency and phase. These terms vanish when the modulating signals, E_Q' and E_I' respectively, vanish, that is, the carrier system is of the suppressed variety.

The suppression serves the following purpose: When white and grays having zero saturation and colors of low saturation (light pastel shades, such as flesh color) are transmitted, the chrominance signal is absent or of such low magnitude that it is invisible on monochrome receivers. Highly saturated colors, on the other hand, may produce interference, visible on very close inspection, as a fine dot structure in the images of some existing monochrome receivers. In color receivers, the 3.6-mc demodulation frequency between chrominance and luminance is removed by filtering and no dot structure due to the chrominance subcarrier is visible.

The Subcarrier Frequency

The remaining specifications in item III-A relate to the subcarrier frequency and its tolerances. There are two basic questions concerning the subcarrier frequency itself: why was it chosen in the vicinity of 3.6 mc and why was the particular value of 3.579545 mc selected?

The general location of the subcarrier in the video spectrum resulted from a compromise among several opposed factors. Initially the NTSC chose a higher value,

Table II—Sound Specification

A. Sound Signal Frequency
The frequency of the unmodulated sound carrier shall be 4.5 mc ± 1,000 cycles above the frequency actually in use for the picture carrier.

B. Sound Signal Characteristics
The sound transmission shall be by frequency modulation, with maximum deviation of ±25 kc, and with preemphasis in accordance with a 75-microsecond time constant.

C. Power Ratio
The effective radiated power of the aural-signal transmitter shall be not less than 50 percent nor more than 70 percent of the peak power of the visual signal transmitter.

3.898125 mc. A high value of subcarrier frequency has the following advantages: the dot pattern resulting from the higher beat frequency between picture and chrominance carriers is of finer texture, and hence somewhat harder to discern at normal viewing distances. The response of typical monochrome receivers falls off rapidly at video frequencies above 3.5 mc; consequently the degrading effect of the chrominance subcarrier on monochrome reception is reduced by moving the chrominance subcarrier from 3.6 to 3.9 mc; a similar reduction in the 0.9-mc beat frequency between the subcarrier sideband and the sound carrier also occurs. The choice of a high chrominance subcarrier frequency permits correspondingly high values of horizontal resolution in color receivers. This is true because the luminance response of color receivers is cut off, as a practical matter, at a value somewhat lower than the chrominance subcarrier, to avoid color errors due to crosstalk between the luminance and chrominance signals.

Table III (A-C)—The Complete Color Picture Signal

A. General Specifications

The color picture signal shall correspond to a luminance (brightness) component transmitted as amplitude modulation of the picture carrier and a simultaneous pair of chrominance (coloring) components transmitted as the amplitude modulation sidebands of a pair of suppressed subcarriers in quadrature having the common frequency relative to the picture carrier of +3.579545 mc ± 0.0003 percent with a maximum rate of change not to exceed 1/10 cycle per sec per sec.

B. Delay Specification

A sine wave, introduced at those terminals of the transmitter which are normally fed the color picture signal, shall produce a radiated signal having an envelope delay, relative to the average envelope delay between 0.05 and 0.20 mc, of zero microseconds up to a frequency of 3.0 mc; and then linearly decreasing to 4.18 mc so as to be equal to −0.17 μsec at 3.58 mc. The tolerance on the envelope delay shall be ±0.05 μsec at 3.58 mc. The tolerance shall increase linearly to ±0.1 μsec, down to 2.1 mc, and remain at ±0.1 μsec down to 0.2 mc.* The tolerance shall also increase linearly to ±0.1 μsec at 4.18 mc.

C. The Luminance Component

1. An increase in initial light intensity shall correspond to a decrease in the amplitude of the carrier envelope (negative modulation).
2. The blanking level shall be at 75 (±2.5) percent of the peak amplitude of the carrier envelope. The reference white (luminance) level shall be 12.5 (±2.5) percent of the peak carrier amplitude. The reference black level shall be separated from the blanking level by the setup interval, which shall be 7.5 (±2.5) percent of the video range from the blanking level to the reference white level.
3. The overall attenuation versus frequency of the luminance signal shall not exceed the value specified by the FCC for black and white transmission.

* Tolerances for the interval of 0.0 to 0.2 mc should not be specified in the present state of the art.

Frequency Moved

On the latter count, the change in the subcarrier frequency from its early value of 3.9 mc to the final value of 3.6 mc removes 0.3 mc from the luminance bandwidth (equal to about 25 lines of horizontal resolution) in color receivers. It does not affect the horizontal resolution of monochrome receivers, however, which utilize whatever video bandwidth they possess (the transmitter radiates a luminance signal having sidebands extending to 4.2 mc within terms of the standards, as shown in Fig. 1 and 8).

A low value of subcarrier frequency, on the other hand, has the following advantages: the spacing between subcarrier sideband and sound carrier is increased, so there is less mutual interference between them (but note the higher amplitude of the beat frequency, for the reasons mentioned), and the lower frequency permits wider chrominance sidebands within the confines of the channel. In particular, a frequency of 3.6 mc permits double-sideband reception of the chrominance signal out to 4.2 − 3.6 = 0.6 mc either side of the subcarrier, whereas a subcarrier of 3.9 mc would reduce the sideband limit to 0.3 mc. The wider band (lower chrominance subcarrier frequency) thus permits better rendition of small colored areas.

Compromise

These opposed tendencies can be summarized as follows: A low subcarrier frequency improves the color reception on color sets while a high subcarrier frequency improves compatible reception on monochrome sets. Careful study of test results by Panel 13 finally resolved the issue in favor of the lower value. Based on these tests the Panel voted that the notable improvement in color reception outweighed the slight degradation of monochrome reception.

A subcarrier frequency below 3.5 mc was suggested by the American Radio Relay League, since this would remove the carrier from the 3.5 to 4-mc amateur band and hence lower the possibility of mutual interference between color television and the amateur service. A careful study of this matter by an NTSC Ad Hoc Committee, on which ARRL was represented, revealed that such interference could be brought under control by care in receiver design and that moving the subcarrier outside the amateur band by a small amount would not materially alter the interference levels in any event. Since the 3.6 mc value was, otherwise, as low as compatibility would allow, it was finally decided upon as the approximate value of the subcarrier frequency.

Subcarrier Precision

The precise value of 3.579545 mc arose from considering the mutual interference between sound, chrominance and picture carriers in the light of the established value of the sound-picture intercarrier frequency. In the previous discussion it was shown that the chrominance carrier should be in offset relation both to the picture carrier and the sound carrier, to minimize mutual interference. The luminance-chrominance offset was provided by choosing the chrominance subcarrier as an odd multiple of half the line frequency. Similarly, the chrominance-sound offset is achieved by choosing the frequency interval as an odd multiple, such that the sum of the two frequency intervals (luminance-to-chrominance and chrominance-to-sound) equals the established picture-sound separation of 4.5 mc (item II-A). The line scanning frequency on which the calculation is based must be very close to the established monochrome value of 15,750 cps. These requirements are sufficient to define the chrominance subcarrier frequency exactly, when its general location in the channel has been selected for the reasons outlined.

To start the calculation, half the line frequency was taken as 7,875 cps. A particular odd multiple, 455, produces from this frequency a tentative chrominance subcarrier frequency of 455 × 0.007875 = 3.583125 mc. Another odd multiple had then to be found to produce the required chrominance-sound interval of roughly 4.5 − 3.6 = 0.9 mc. The closest odd multiple was found to be 117, producing an interval of 117 × 0.007875 = 0.921375 mc. The two intervals, in turn, produce a picture-sound interval of 3.583125 + 0.921375 = 4.504500 mc, which is 4,500 cps higher than the standard value of 4.5 mc.

Since many millions of intercarrier monochrome receivers had been constructed on a design-center intercarrier value of 4.5 mc, it was decided that this value should be retained exactly and that all the other frequencies in the computation should be reduced in the ratio of 4.500000/4.504500. that is, by approximately 0.1 percent. When this is done, the sound-picture intercarrier spacing retains its design-center value of exactly 4.5 mc, the chrominance subcarrier becomes 3.579545 mc, the line frequency 15,734+ cps, and the field frequency 59.94 cps. The slight change in the scanning frequencies has no practical consequence since, for reasons already outlined, all monochrome receivers are designed to accommodate a variation in scanning frequencies of not less than several tenths of a percent.

Crystal Control

The tight tolerance imposed on the subcarrier frequency (±0.0003 percent or 3 parts in a million) is intended to ease the task of the receiver in establishing the reference phase in the chrominance demodulation process. The tolerance places a corresponding burden on the transmitter studio equipment, which must employ temperature-compensated crystal control in generating the chrominance subcarrier, color burst and synchronizing signals. This is, however, a very small price to pay for the benefit obtained in receiver performance. The tolerance originally suggested by Panel 14 to the NTSC was ± 0.001 percent, but this was later reduced by a factor of three when it became clear that a substantial benefit would thereby result in the design of color receivers.

The NTSC color system will operate properly even if the chrominance subcarrier frequency departs from its specified value by several thousand cycles, so long as the scanning frequencies are derived precisely from the actual subcarrier frequency in use. The only deleterious effect, so far as the transmitted signal is concerned, would be the corresponding degraduation resulting from the shift in the offset-carrier position of the chrominance carrier with respect to picture and sound carriers. If such off-frequency operation were permitted, the receiver would have to be capable not only of following the variations in subcarrier frequency, but also of determining, to an accuracy of five electrical degrees or better, the absolute phase of the varying frequency.

Stated in other words, the phase detector which measures the phase of the color burst against that of the chrominance signal must possess a bandwidth wide enough to follow any variation in the subcarrier frequency. If the variations are great, the bandwidth must be correspondingly great, the Q of the circuits correspondingly low, and the benefit of energy storage in the circuit (fly-wheel effect) proportionately reduced.

Noise Problem

The net effect is that the phase detector would then possess poor performance in the presence of noise. Since it is desired to maintain the service range of color transmissions as closely as possible to that of monochrome, the phase detection process must operate successfully even in fringe areas. Actually the effective Q of a simple phase-establishing circuit for a signal-to-noise ratio of unity and a phase error of 5 degrees is about 30,000, and the corresponding noise bandwidth of the circuit is of the order of 150 cps.

It is evident that the subcarrier frequency tolerance must fall well within this value, since the transmitter tolerance should be only a

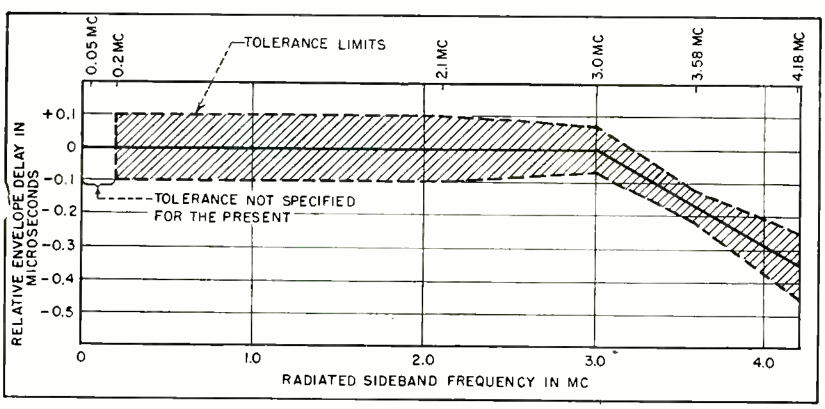


FIG. 6—Transmitter time delay specification which compensates for phase characteristic of average receiver (item III-B)

part of the system tolerance. Accordingly, the 3-parts-per-million figure was chosen (this corresponds to ± 11 cycles, or 22 cycles bandwidth).

An important aspect of the phase-synchronizing process is the question of pull-in when the color receiver is tuned from one color broadcast to another. If the chrominance subcarriers of the two transmissions are as much as 100 cps apart, the ability of the phase-detector and color oscillator to lock on to the new frequency is seriously impaired, when the Q of the system is chosen high enough to give good performance in the presence of strong random noise.

The rate of change of frequency tolerance (1/10th cps per second) in item III-A is intended to protect against sudden changes in frequency which certain color oscillator circuits might have difficulty in following while holding the 5-degree phase tolerance.

Transmitter Delay Characteristic

Item III-B gives a detailed specification of the relative time delay permitted in the transmission of the various sidebands of the luminance and chrominance carriers. Figure 6 shows the specification in graphical form. The relative timing of all the picture sideband frequencies, chrominance and luminance, must be kept under strict control if color receivers are to reproduce the colors accurately, since a small error in timing (which may alternatively be expressed as a phase angle) can produce corresponding errors affecting horizontal resolution and the hues of the image.

To coordinate this requirement, the NTSC decided to specify a time delay characteristic for the transmitter which would take into account the observed phase responses of typical receivers. The basic data on receiver phase responses includes that reported by Kell and Fredendall[4] and supplementary measurements which revealed that, at the higher video frequencies, monochrome receivers showed a remarkable similarity in their phase curves. It was assumed that color receivers would also display similar characteristics.

Tolerance

The delay characteristic is based on the average delay in the region from 0.05 to 0.2 mc, since this is a region within which the phase properties of the vestigial sideband filter are not a factor; this implies that in the cut-off region of the latter filter (corresponding to video frequencies from 0.75 to 1.25 mc) its phase characteristic must be brought in line so that the overall transmitter characteristic meets the specification. At higher frequencies, up to 4.18 mc, the proposed transmitter characteristic is intended to compensate for the average receiver characteristic.

The tolerance of 0.05 microsecond, at the most critical region (close to the color subcarrier frequency), corresponds approximately to the duration of one half a picture element. At frequencies remote from the color subcarrier, the tolerance is approximately equal to the duration of one picture element.

No specific tolerance is recommended for the video-frequency region from 0 to 0.2 mc; this corresponds to the sloping portion of the receiver i-f characteristic surrounding the picture i-f carrier (nominally at the 50-percent ampli-

Table III (D-I)—Equation of Complete Color Signal

1. The color picture signal has the following composition:

$$E_M = E_Y' + \{E_Q' \sin(\omega t + 33°) + E_I' \cos(\omega t + 33°)\}$$

where

$$E_Q' = 0.41(E_B' - E_Y') + 0.48(E_R' - E_Y')$$
$$E_I' = -0.27(E_B' - E_Y') + 0.74(E_R' - E_Y')$$
$$E_Y' = 0.30E_R' + 0.59E_G' + 0.11E_B'$$

The phase reference in the above equation is the phase of the (color burst + 180°), as shown in Fig. 5. The burst corresponds to amplitude modulation of a continuous sine wave.

Notes: For color-difference frequencies below 500 kc, the signal can be represented by

$$E_M = E_Y' + \left\{\frac{1}{1.14}\left[\frac{1}{1.78}(E_B' - E_Y')\sin\omega t + (E_R' - E_Y')\cos\omega t\right]\right\}$$

In these expressions the symbols have the following significance:

E_M is the total video voltage, corresponding to the scanning of a particular picture element, applied to the modulator of the picture transmitter.

E_Y' is the gamma-corrected voltage of the monochrome (black-and-white) portion of the color picture signal, corresponding to the given picture element.*

E_R', E_G', and E_B' are the gamma-corrected voltages corresponding to red, green, and blue signals during the scanning of the given picture element.

The gamma corrected voltages E_R', E_G', and E_B' are suitable for a color picture tube having primary colors with the following chromaticities in the CIE system of specification:

	x	y
Red (R)	0.67	0.33
Green (G)	0.21	0.71
Blue (B)	0.14	0.08

and having a transfer gradient (gamma exponent) of 2.2** associated with each primary color. The voltages E_R', E_G', and E_B' may be respectively of the form $E_R^{1/\gamma}$, $E_G^{1/\gamma}$, and $E_B^{1/\gamma}$ although other forms may be used with advances in the state of the art.

E_Q' and E_I' are the amplitudes of two orthogonal components of the chrominance signal corresponding respectively to narrow-band and wide-band axes, as specified in paragraph D.5.

The angular frequency ω is 2π times the frequency of the chrominance subcarrier.

The portion of each expression between brackets represents the chrominance subcarrier signal which carries the chrominance information.

* Forming of the high-frequency portion of the monochrome signal in a different manner is permissible and may in fact be desirable to improve the sharpness on saturated colors.

** At the present state of the art it is considered inadvisable to set a tolerance on the value of gamma and correspondingly this portion of the specification will not be enforced.

tude level). Since the performance of existing receivers varies widely in this region, it is not feasible to specify a tolerance at present. However, when this aspect of color receiver design is stabilized, it may be desirable to specify a tolerance to assume optimum color reproduction.

The Luminance Component

The items listed under III-C are proposed standards for the luminance component of the complete signal, that is, the modulation of the picture carrier. Item III-C-1, specifying negative polarity of picture modulation, is identical to the monochrome standard. Item III-C-2 spells out the reference levels (blanking, reference white and reference black) discussed in connection with Fig. 2.

Item III-C-3 states that the overall transmitter attenuation characteristic applicable to the luminance signal should not be inferior to that used in monochrome transmissions. The present FCC tolerance in this matter is rather loose (as much as 12 db attenuation is permitted at a sideband frequency of 3.5 mc). While the color system will operate with a luminance signal attenuation as great as this, the transmitter characteristic for the chrominance signal, from 2.1 to 4.18 mc, must be flat within ± 2 db (see item III-D-4). It would appear that the actual attenuation characteristic of a transmitter properly adjusted for compatible color transmissions will have a luminance attenuation characteristic substantially better than the present monochrome regulations require.

Equation of the Color Signal

The final group of specifications comprises the six items under III-D, which are concerned with the make-up of the complete color signal.

Item III-D-1 gives the complete color signal, luminance and chrominance, in equation form, defines the terms, specifies the NTSC reference primary colors, and indicates the nature of the gamma correction process. The equation of the complete color signal

$$E_M = E_Y' + \left\{ E_Q' \sin(\omega t + 33°) + E_I' \cos(\omega t + 33°) \right\} \qquad (1)$$

states that E_M, the total video modulating voltage applied to the transmitter, consists of two components: E_Y' (the luminance signal) and the terms within the brackets (the chrominance signal).

As specified in Fig. 1, the luminance component E_Y' is radiated with full video bandwidth and therefore contains the full pictorial detail of the image. It is the signal to which monochrome receivers respond; the signal which produces the detailed structure of the color image; and the signal that supplies the luminance component in color reception. When the chrominance signal has zero amplitude (when the saturation of the colors is zero), the luminance signal alone is operative. It is, in other words, intended

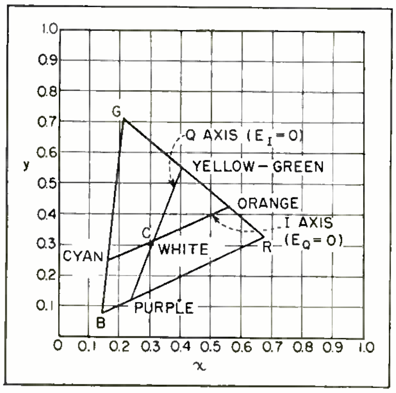


FIG. 7—The I and Q axes, showing colors reproduced when only one chrominance component is active. The color triangle RGB bounds color gamut covered by proposed NTSC primary colors (item III-D-1)

to produce an image having no saturation, that is, an image in black-and-white.

The black-and-white image of a colored scene is most realistic if the luminances in the image are directly proportional to the luminances of the corresponding colors in the scene. The make-up of the NTSC luminance signal conforms to this rule, as follows: The color camera is designed and adjusted to produce three equal signal voltages E_R' = E_G' = E_B' when viewing a reference white color (defined in item III-D-2). The luminance signal is then made up by combining the three signals in the proportions 0.30 : 0.59 : 0.11 respectively. This is stated in the definition of E_Y' given in item III-D-1 just below the basic equation

$$E_Y' = 0.30\, E_R' + 0.59\, E_G' + 0.11\, E_B'$$

These proportions represent the respective contributions to luminance of the three particular primary colors specified in the table in the notes of item 111-D-1, when these primaries are mixed to produce the reference white.

The portion of Eq. 1 between brackets consists of the two chrominance subcarriers, of angular frequency $\omega = 2\pi(3.579545)$, in quadrature (as implied by the sine and cosine forms of the terms) each having a fixed phase angle of 33 degrees, and having amplitudes E_Q' and E_I' respectively. The phase reference in the equation is related to the phase of color burst, as follows: The E_Q' signal lags the burst by 180 degrees − 33 degrees = 147 degrees while E_I' lags the burst by 90 degrees − 33 degrees = 57 degrees, as shown in Fig. 5.

Chrominance Components

What exactly are E_Q' and E_I'? In the first place, as Fig. 5 shows, they are two right-angle components of the chrominance signal. More generally, they represent two axes of the CIE color diagram[5], as shown in Fig. 7, which represents linear transmission. When only the E_Q' component is active ($E_I' = 0$), the system is capable of depicting colors only along the Q axis, which runs from yellow-green to purple. When the E_I' signal alone is active ($E_Q' = 0$), the colors depicted lie along the I axis, which runs from cyan (blue-green) to orange. When both signals are active, depending on their relative amplitudes, any point in the color triangle defined by the receiver primaries R, G, B, can be represented by the resultant chrominance signal. When gamma correction is employed, the straight-line axes of Fig. 7 are replaced by curved lines which produce the same general effect.

Thus we have three conditions: if the luminance signal E_Y' and both chrominance components E_Q' and E_I' are active, the system reproduces in three-primary (full-color) fashion; if only E_Y' and E_I' and active (E_Q' having been removed by a bandwidth restriction), the system reproduces in two-primary (orange-cyan) fashion; and finally, if both E_Q' and E_I' are removed by bandwidth limitations, only E_Y' is active and the system reproduces in monochrome.

Bandwidth Limits

The respective bandwidth limits, given by Fig. 1, and item III-D-5, are illustrated in Fig. 8. There, E_Y' has full bandwidth to 4.2 mc, E_I' has a band limit at 1.3 mc, and E_Q' has a band limit at 0.5 mc. Corresponding to these band limits are three ranges of pictorial detail. Fine details corresponding to video frequencies above 1.3 mc are reproduced in monochrome; larger areas corresponding to frequencies between 0.5 mc and 1.3 mc are reproduced in a two-color orange-cyan system; and still larger areas, corresponding to frequencies below 0.5 mc, are reproduced in a three-color red-green-blue (full-color) system. This particular division of color reproduction was found by investigation of a Panel 13 subcommittee to represent a proper compromise to assure adequate color fidelity under the bandwidth limitations of the system.

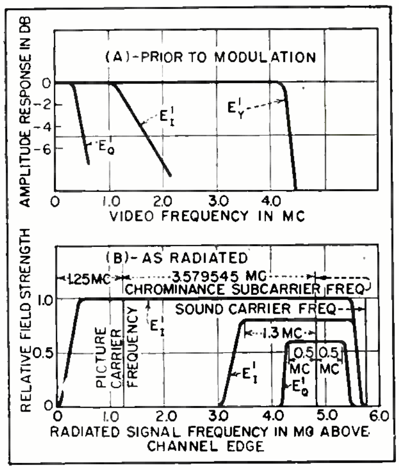


FIG. 8—Bandwiths assigned to luminance and chrominance signals (A) prior to modulation and (B) as radiated. Relative amplitudes of Y, Q and I signals shown are not significant, will vary with picture content

Table III (D-2 to D-6)—Chrominance Signal

2. The chrominance signal is so proportioned that it vanishes for the chromaticity of CIE illuminant C ($x = 0.310$, $y = 0.316$).
3. E_Y', E_Q', E_I' and the components of these signals shall match each other in time to 0.05 μsec.
4. A sine wave of 3.58 mc introduced at those terminals of the transmitter which are normally fed the color picture signal shall produce a radiated signal having an amplitude, (as measured with a diode on the r-f transmission line supplying power to the antenna) which is down 6 ($\pm$2) db with respect to a radiated signal produced by a sine wave of 200 kc. In addition, the amplitude of the radiated signal shall not vary by more than $\pm$2 db between the modulating frequencies of 2.1 and 4.18 mc.
5. The equivalent bandwidths assigned prior to modulation to the color-difference signals E_Q' and E_I' are given below.

Q-channel bandwidth
at 400 kc less than 2 db down
at 500 kc less than 6 db down
at 600 kc at least 6 db down

I- channel bandwidth
at 1.3 mc less than 2 db down
at 3.6 mc at least 20 db down

6. The angles of the subcarrier measured with respect to the burst phase, when reproducing satuated primaries and their complements at 75 percent of full amplitude, shall be within $\pm$10 degrees and their amplitudes shall be within $\pm$20 percent of the values specified above. The ratios of the measured amplitudes of the subcarrier to the luminance signal for the same saturated primaries and their complements shall fall between the limits of 0.8 and 1.2 of the values specified for their ratios. Closer tolerances may prove to be practicable with advance in the art.

Use of Sidebands

It will be noted that the E_I' signal, like the luminance signal, is transmitted by vestigial sideband; E_Q' is transmitted by double sideband. The receiver designer has the option of designing the passband of the chrominance channel so that the video frequencies of E_I' above 0.5 mc are cut off. This gives double sideband treatment to both chrominance components. In this case only two types of transmission are used: details corresponding in size to the range 0.5 mc to 4.2 mc are transmitted in monochrome; larger areas, corresponding to frequencies below 0.5 mc, are transmitted in three colors, and the two-color mode of operation is not employed.

The narrow-band case is spelled out in the first note in item III-D-1, which states that, for frequencies below 500 kc, the color signal can be represented in terms of the signals $E_B' - E_Y'$ and $E_R' - E_Y'$. These signals are seen, by reference to Fig. 5, to be another set of right-angle components of the chrominance signal, spaced 33 degrees from E_Q' and E_I' respectively. Moreover, these chrominance signals have a particularly simple relationship to the phase of the color burst (180 and 90 degrees respectively), which makes for simplicity in the design of narrowband-chrominance receivers.

Color-Difference Signals

The representations $E_B' - E_Y'$ and $E_R' - E_Y'$ reveal an important general property of the chrominance signals: they are color-difference signals. At the transmitter, subtracting the luminance signal from the blue output signal of the camera forms the blue color-difference signal; a similar operation with the red output signal forms the red color-difference signal. These may then be further combined to obtain E_I' and E_Q' as indicated in the definitions of the latter quantities in item III-D-1.

At the receiver the color-difference signals are recovered by synchronous demodulators, using the burst phase as a reference. In wideband-chrominance receivers the signals recovered are E_I' and E_Q'. From these the two color-difference signals $E_B' - E_Y'$, $E_R' - E_Y'$ are obtained by performing matrix operations inverse to those at the transmitter. In narrowband-chrominance receivers, $E_B' - E_Y'$ and $E_R' - E_Y'$ are recovered directly. From them in turn, using the relationship of Eq. 2, the third (green) color difference signal $E_G' - E_Y'$ is obtained.

When the luminance and color-difference signals are combined throughout the frequency range occupied by the color-difference signals (up to 0.5 mc in narrowband receivers, somewhat higher in wideband receivers), the luminance component is thereby cancelled out. The remaining primary signals E_R', E_G' and E_B' (corresponding to the output signals of the camera) control the formation of colors in the image. Outside the frequency range occupied by the color- difference signals, the primary color signals are absent and the luminance signal produces the fine structure of the image in monochrome.

Gamma Correction

It should be noted that all the luminance and chrominance quantities bear the prime sign (′). This indicates that gamma correction has been applied to the respective signals. Gamma correction provides that the luminances of the picture-tube primary colors shall bear a linear relationship to the corresponding luminances in the original scene, as fidelity of color reproduction requires. To achieve linearity it is necessary to take into account the fact that the luminance-vs-voltage curves of picture tubes are nonlinear, being very closely power law functions.

Studies of the transfer gradient (exponent of the power law) by Panel 13 showed that the number most nearly describing typical picture tubes is 2.2. Accordingly, this value is stated in the notes of item III-D-1.

One form of gamma correction is to pass the camera output signals individually through root-law amplifiers having output amplitudes proportional to the 2.2th root of the respective inputs. This was the form of gamma correction actually employed in the NTSC field tests, but it is recognized that other forms of gamma correction may prove desirable in the future.

Reference White

Item III-D-2 states that the chrominance subcarrier vanishes when CIE illuminant C (a reference white having the slightly bluish color of north-sky daylight) is to be reproduced. This implies that the output signals of camera should be equal when this reference white is presented to the camera. However, the actual color in the studio producing the zero-chrominance condition is left to the discretion of the producer of the program, who may wish to produce artistic effects by shifting the reference color. The proposed standard has the effect of notifying the producer that the reference color he adopts for zero chrominance will in fact be reproduced as bluish-white daylight on receivers designed in accordance with the standard.

Item III-D-3 provides that the luminance and chrominance signals (the respective carrier envelopes as radiated) shall match each other in time within about half the duration of a picture element, 0.05 microsecond. In color sets, since the luminance signal and chrominance signals pass through circuits of different bandwidth, delay circuits are required in the wideband circuits to bring the respective signals into time coincidence at the picture tube. The proposed time coincidence standard has the effect of setting a tolerance in these delay circuits.

Item III-D-4 has been previously mentioned as indicating the allowed attenuation tolerance of the transmitter sidebands in the region occupied by the chrominance signal. Since in practice both luminance and chrominance signals are radiated by the same transmitter, this specification has the effect of superseding the looser tolerance now permitted in monochrome transmitters, referred to under item III-C-3.

The "6 db" mentioned in the 6 (± 2) db tolerance merely indicates the fact that the chrominance carrier, being transmitted by single sideband, has one-half the amplitude of the 200-kc sideband, which is transmitted by double sideband. The allowable tolerance is, therefore, ±2 db throughout the region occupied by the subcarrier and its sidebands. This tolerance assures that the saturation of the colors in the image (which depends in part on the amplitude of the chrominance signal) can be held within a reasonable percentage of its nominally correct value (±2 db tolerance equals + 26 percent or − 21 percent of the nominal value).

Phase Tolerance

Item III-D-5 gives the bandwidths assigned to E_Q' and E_I' prior to modulation, as previously described under item III-D-1.

The final item, III-D-6, allows a ±10-degree tolerance on the subcarrier phase and a ±20-percent tolerance on its amplitude, under the load condition of transmitting saturated primary and complementary colors at 75 percent amplitude. The phase tolerance is somewhat wider than the 5-degree tolerance previously mentioned in the discussion of the color burst; the proposed standard mentions that closer tolerances may be required as the art advances. This item is of particular interest in that it shows the basis on which the NTSC field-test transmissions were certified as falling within the proposed standards, before conclusions were drawn by Panel 16 regarding the overall performance of the system.

References

(1) "Color Television Standards" the technical record of NTSC to be abstracted and published by McGraw-Hill Book Co. The Institute of Radio Engineers plans to publish in the January, 1954, issue of the Proceedings an extensive selection of papers from the NTSC record, including tutorial monographs produced by Panel 12 and reports on field testing.

(2) E. M. Creamer and M. I. Burgett, Performance of Carrier Synchronizing Circuits for Color Television Receivers, presented at IRE National Conv., New York, March 19, 1951.

(3) D. G. Fink, Synchronization in Color Television, ELECTRONICS, p 170, May, 1953.

(4) R. D. Kell and G. L. Fredendall, Standardization of the Transient Response of Television Transmitters, *RCA Review*, p 17, March 1949.

(5) For a discussion of colorimetric fundamentals underlying color tv, see D. G. Fink, Color Fundamentals for Television Engineers, ELECTRONICS, p 88, Dec. 1950; p 78, Jan. 1951; p 104, Feb. 1951. A complete and detailed review of the colorimetric background of the NTSC system appears in three technical monographs written by F. J. Bingley for Panel 12 (see reference 1).

Fused-Quartz Ultrasonic Delay-Line Memory

Inexpensive fused-quartz slab serves as a propagation medium. Folded-path configuration, proper transducer bonding and 40-mc carrier permit storage of digits at rates greater than 5 mc with dynamic range of 40 db for high-speed computing and data processing

By **D. A. SPAETH,**
Lincoln Laboratory, MIT
Cambridge, Mass.

T. F. ROGERS
Air Force Cambridge Research Center
and Lincoln Laboratory, MIT
Cambridge, Mass.

and S. J. JOHNSON
Andersen Laboratories, Inc.
West Hartford, Conn.

Where the computational operations are permitted to take place on a successive time sequence rather than random time bases, the delay-line type of memory affords several distinct advantages for high-speed computing and data-processing equipment. This type of memory is relatively simple, small, reliable, has high capacity and, while not as flexible as some other kinds of memories, has none of the difficulties attendant upon complex electronic circuits or mechanically moving parts.

In a delay-line memory, a compromise must be made between the access time or time delay and the number of pieces of stored information. For many purposes, a delay time of some 100 to 1,000 microseconds seems reasonable. Accepting this access time as a basic design parameter, it then becomes important to pack in as many information bits as possible.

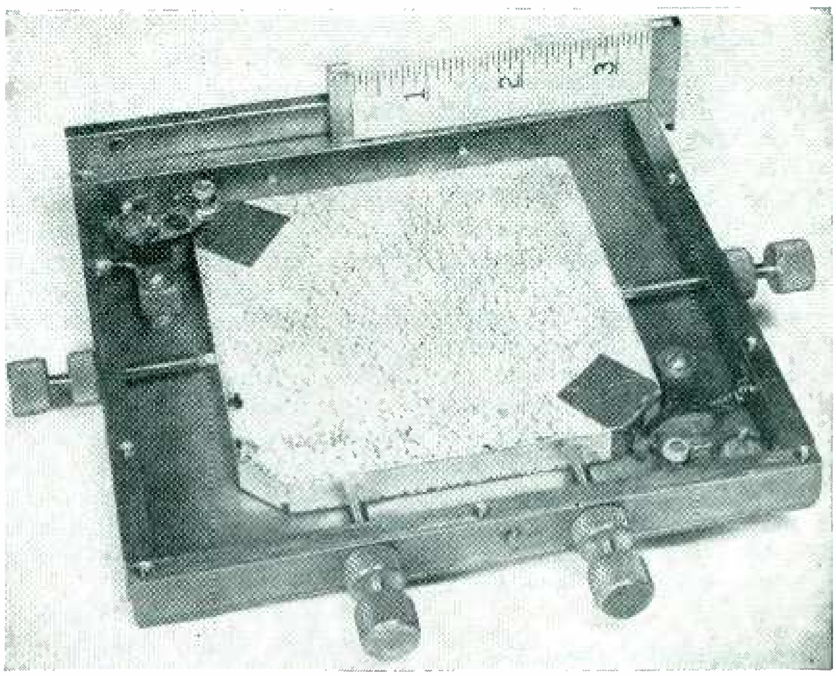
If the information is to be stored in pulse form, two ways of doing it are available. The bandwidth can be increased in order that either time or frequency spacing of the pulses may be accomplished, and/or the dynamic range can be made as large as possible in order to use pulse-amplitude discrimination.

The requirement for large bandwidth and dynamic range presents the problems of overcoming large insertion losses and lowering spurious responses within the line. When adding to this such further requirements as light weight, comparatively small size and operation over large temperature ranges, the solid type of delay medium offers the most promise.[1, 2, 3]

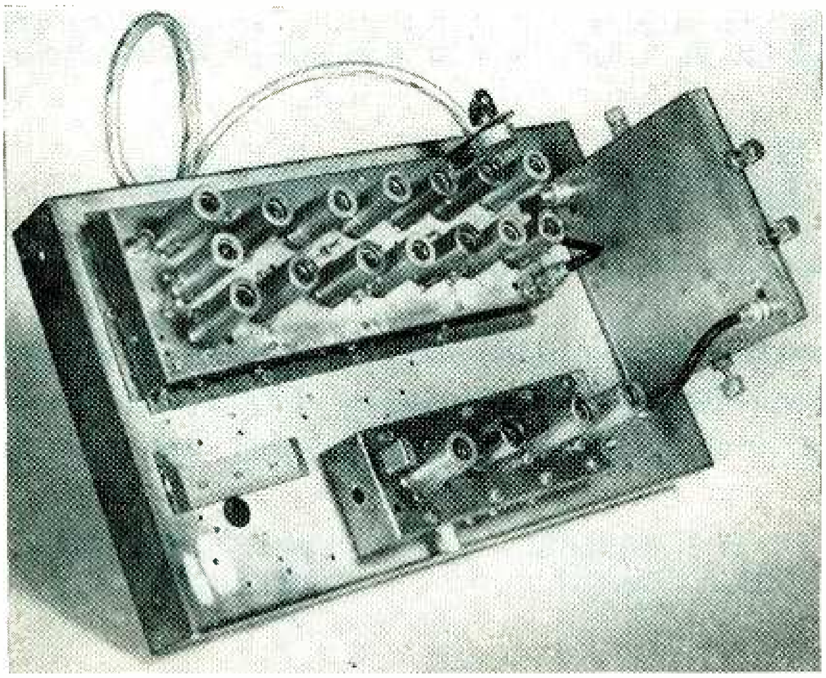
Design of Solid Lines

Solid lines are light in weight, relatively simple to construct and inexpensive to manufacture. With the proper piezoelectric crystal bonding substance and its successful application, they will work over extreme temperatures and pressure changes and will withstand large acceleration forces.

Of all the solids, the metals must be excluded because of high attenuation at the carrier frequency needed to provide a sufficiently wide



Fused-quartz slab mounted in holder for use as 400-microsecond solid ultrasonic delay-line memory, with cover removed. Inexpensive commercial-quality material can be used, as internal strains and small bubbles do not produce any spurious signals greater than 60 db down from the main received signal. Projecting knurled adjusting screws permit shifting position of quartz slab to get desired folded-path configuration and hence desired delay



Complete memory device, with quartz slab in its holder at right on chassis

bandwidth, or because of ultrasonic velocity dispersion arising from crystalline anisotropy in the metal structure. Of the other solids, fused quartz has received the most study[3, 4, 5] mainly because it has physical toughness, structural isotropy and a low ultrasonic absorption coefficient.

Fused Quartz Used

Research work at carrier frequencies around 10 mc confirmed the fact that an acceptably low total insertion loss coupled with reasonable bandwidths could be attained with ordinary fused quartz. The ratio of main delayed signal to peak spurious signals, however, was not encouraging. The reflection areas around the peripheries of many solids were traced by means of an ultrasonic probe, and the propagation paths through the media were determined. From this and other work it was concluded that the main sources of spurious responses were mode conversion at the reflection surfaces and beam spreading.

Beam-Spreading Problem

Mode conversion was eliminated by using shear crystals oriented such that the particle displacement is parallel to the quartz-air boundary reflecting surface.[6] Even after a considerable effort was devoted to the selection of proper transducer bonding materials, the method of application, curing processes, the thickness and shape of the line and the internal path configuration, the ratio of main delayed signal to peak spurious signals remained unencouraging. It was necessary, therefore, to reduce this beam spreading.

This can be done by two methods. The transducer area can be increased, which is inadvisable because it decreases the bandwidth-insertion loss ratio, or the carrier frequency can be raised, which decreases the radiated wavelength. Since for a given Q the bandwidth of the transducer is proportional to the center frequency, the latter method is helpful in two ways. A carrier frequency of 40 mc was therefore chosen. The use of acoustical trapping (absorbing) materials around the outer edges of the quartz blank caused an increased insertion loss and was regarded as unsatisfactory.

The delay time is proportional to path length. Since a delay time of several hundred microseconds is desired, and the velocity of propagation is approximately 3.76×10^5 cm per sec for transverse wave propagation in fused quartz, a total path length of several feet is needed. As with other lines of this type, the path length is folded into a small square piece of quartz, a shape chosen for its relative grinding simplicity. A compromise here must be reached between the desire to have as compact a piece of quartz as possible and the necessity of having a sufficiently loose folded-path configuration to avoid secondary paths between input and output transducers.

The delay line is used in the r-f system shown in Fig. 1. The incoming pulses to the modulator chassis are converted into pulsed r-f signals at 40 mc and sent into the delay line. They are received by the wide-band r-f amplifier, where they are amplified, detected and filtered. The signals are then fed to the synchroscope.

System Details

The four-tube modulator chassis includes a 40-mc crystal-controlled oscillator fed into a 6AS6 amplifier which is normally biased off. This amplifier is gated on by the incoming pulses. Stagger-tuned r-f voltage and power amplifiers follow. The maximum output is some 20 volts peak-to-peak. The output rise time with a step-function input measures 0.05 microsecond on a Tektronix model 513.

The delay line is encased in brass and connected to the modulator and r-f amplifier through short 50-ohm cables. The r-f section of the amplifier chassis has a grounded-cathode triode-connected 6AK5 input tube, followed by three stagger-tuned quadruples; the pulsed r-f is detected by a 1N56 crystal diode which is followed by a two-stage video amplifier. The 3-db bandwidth of the r-f amplifier is 35 mc, and the entire amplifier chassis

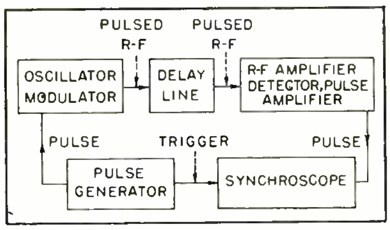


FIG. 1—Method of using delay line as memory, and associated test circuit employing pulse generator and synchroscope

does not deteriorate the modulator output to a measurable degree. The gain can be varied from 30 to 70 db by controlling the d-c voltage on the screens of the first five tubes. A delay-line insertion loss of 60 db provides an amplifier signal-to-noise ratio of about 60 db.

A number of memory units of this general type have been built, and several lines made of General Electric fused quartz have been tested. The test results appear in Table I.

The short rise times which were measured allow high pulse rates to be maintained in the memory. Figure 2 shows a 0.1-microsecond timing pulse followed by four 0.1-microsecond pulses at a 6.67-mc rate at the memory output; the second pulse in the train of four has been reduced to a level of 40 db below the other three. The spurious responses of this line are 45 db down from the main signal. With such low spurious signals, great dynamic range is possible.

The quartz used in these lines does exhibit, to wavelengths of visible light in a polariscope, the usual internal strains peculiar to its method of manufacture, and contains a number of small bubbles, but these do not contribute appreciably to the spurious signal response.

Such internal strains and small bubbles do refract the main beam away from the receiving transducer, and do scatter energy toward the highly directive receiving aperture which arrives at a time different from the main beam. At ultrasonic wavelengths however, these effects do not appear to produce spurious signals greater than 60 db down from the main received signal.

Performance Data

Figure 3 shows the same memory output with the synchroscope gain increased 30 db. The large pulses are limiting severely in the synchroscope, but the dynamic range can be clearly seen since the small second pulse, now clearly visible, is not masked by the large pulses on either side even though they are 100 times greater in amplitude.

In many digital computer applications such a large dynamic range may not in itself be necessary. However, availability of such a high bandwidth-insertion loss ratio along with such low spurious response would permit storage rates greatly in excess of the 6.67-mc rate if overlap and reshaping (slicing-gating) techniques were employed as in certain mercury-line applications.[7]

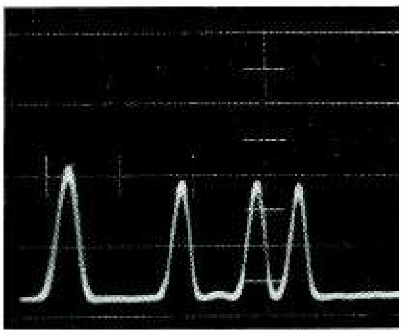


FIG. 2—Timing pulse (left) and four 0.1-microsecond pulses coming out of memory output at 6.67-mc rate, with the second of the four pulses decreased 40 db in input amplitude so that it just barely shows

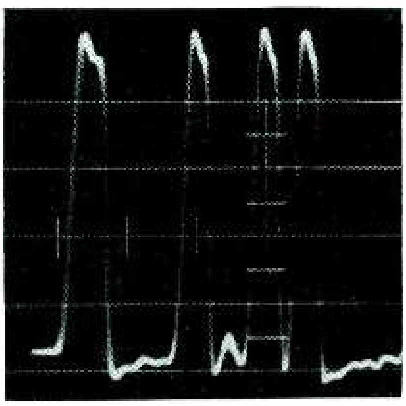


FIG. 3—Same situation as Fig. 2 but with synchroscope gain boosted 30 db so that the second of the 6.67-mc pulses shows more clearly; spurious responses of delay line are here 45 db down

Table I—Test Results Obtained with Fused-Quartz Memory Units

Delay Length	Attenuation	Spurious Signal	Rise Time or Bandwidth
300 μsec	57 db	26 db down	0.08 μsec
400 μsec	47 db	45 db down	0.08 μsec
400 μsec	59 db	40 db down	0.08 μsec
400 μsec	55 db	35 db down	12 mc

Conclusions

Summarizing, a solid ultrasonic delay line memory has been developed which is characterized by low insertion loss, wide bandwidth and large dynamic range. Relatively inexpensive commercial quality fused quartz is the propagation medium, and a folded path configuration is used. A delayed pulse rise time of appreciably less than 0.1 μsec is obtained at a total insertion loss of approximately 55 db. Spurious signals, shown to arise from spreading of the ultrasonic beam and its accompanying side lobe distribution, are effectively controlled by using shear crystals and operating at a carrier frequency in the 40-mc region; peak spurious amplitude rejections of 99 percent of the main delayed signal are achieved. Such bandwidth, insertion loss and spurious rejection values allow pulses to be stored at a greater than a 5-mc rate with 40 db dynamic range. Many advantages inherent in the use of a delay line memory are therefore realized in a small, lightweight and physically stable structure.

Acknowledgments

The research work herein described was supported jointly by the Army, Navy and Air Force under contract with the Massachusetts Institute of Technology. The authors wish to thank W. A. Andersen and F. L. McNamara for their advice and assistance. The work done by S. J. Johnson of Andersen Laboratories was supported by Air Force Contract No. AF 19(604)-281.

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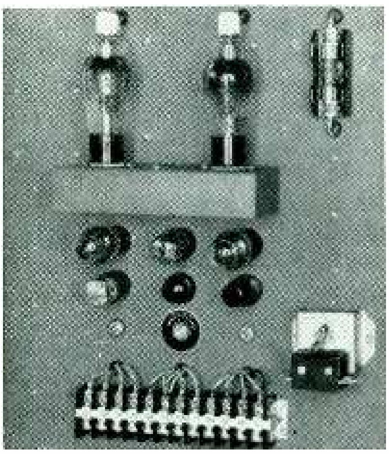
Press Control Speeds

Thyratron regulator controls drawing-press motors to obtain rapid accelerations and most efficient operating cycle. System has increased production on automobile roofs by 25 percent while cutting rejection rate. Tie-in to automatic assembly line is possible



Panel of thyratron control unit for press drive motor

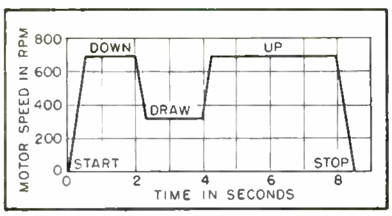


FIG. 1—Range of motor speeds required during one press cycle

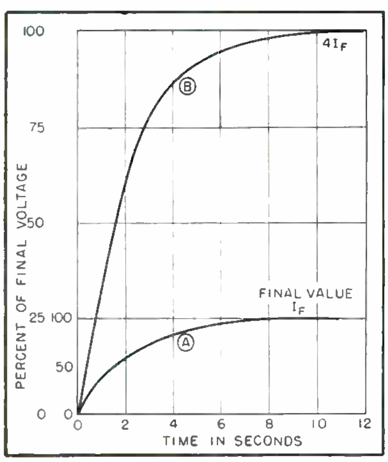


FIG. 2—Time required for field current to reach maximum value, curve *A*, is reduced by applying overvoltage, curve *B*, and cutting it off when desired value is reached

By ANTHONY P. DiVINCENZO and CHARLES E. ROBINSON

Control Development Engineer *Application Engineer*
Reliance Electric and Engineering Co.
Cleveland, Ohio

AUTOMATION and deeper drawing requirements on automobile assembly lines have required radical changes in the design of electric drives for drawing presses. As drawing operations, such as forming automobile tops from sheet steel, become deeper, conventional press drives using an a-c squirrel-cage motor, flywheel and clutch soon reached the point where flywheels of sufficient energy storage could not be accelerated rapidly from rest without burning out the rotor of the driving motor.

In drawing metal, greater effort is required to start the metal flowing than to continue the operation. If initial drawing speed is too high, the metal tears instead of flowing. Because of this, the production rate is limited by die speed at the initiation of actual drawing.

Present drives employ adjustable-speed motors. The metal is drawn at low speed and press cycle time is decreased by running at high speed during the remainder of the cycle. This permits setting the press speed to conform with automatic feed devices. Speeds can be adjusted to operate without starting and stopping the press for each piece. A press operated in this manner can produce 25 percent more pieces with reduced wear and tear, and less demand on the electrical drive machinery.

Adjustable drive speed is obtained through an adjustable-voltage, direct-current drive system. This system comprises a d-c shunt drive motor, supplied by an a-c to d-c motor-generator set. Speed is controlled by varying motor armature voltage and field current. Armature voltage, in turn, is controlled by varying generator field current.

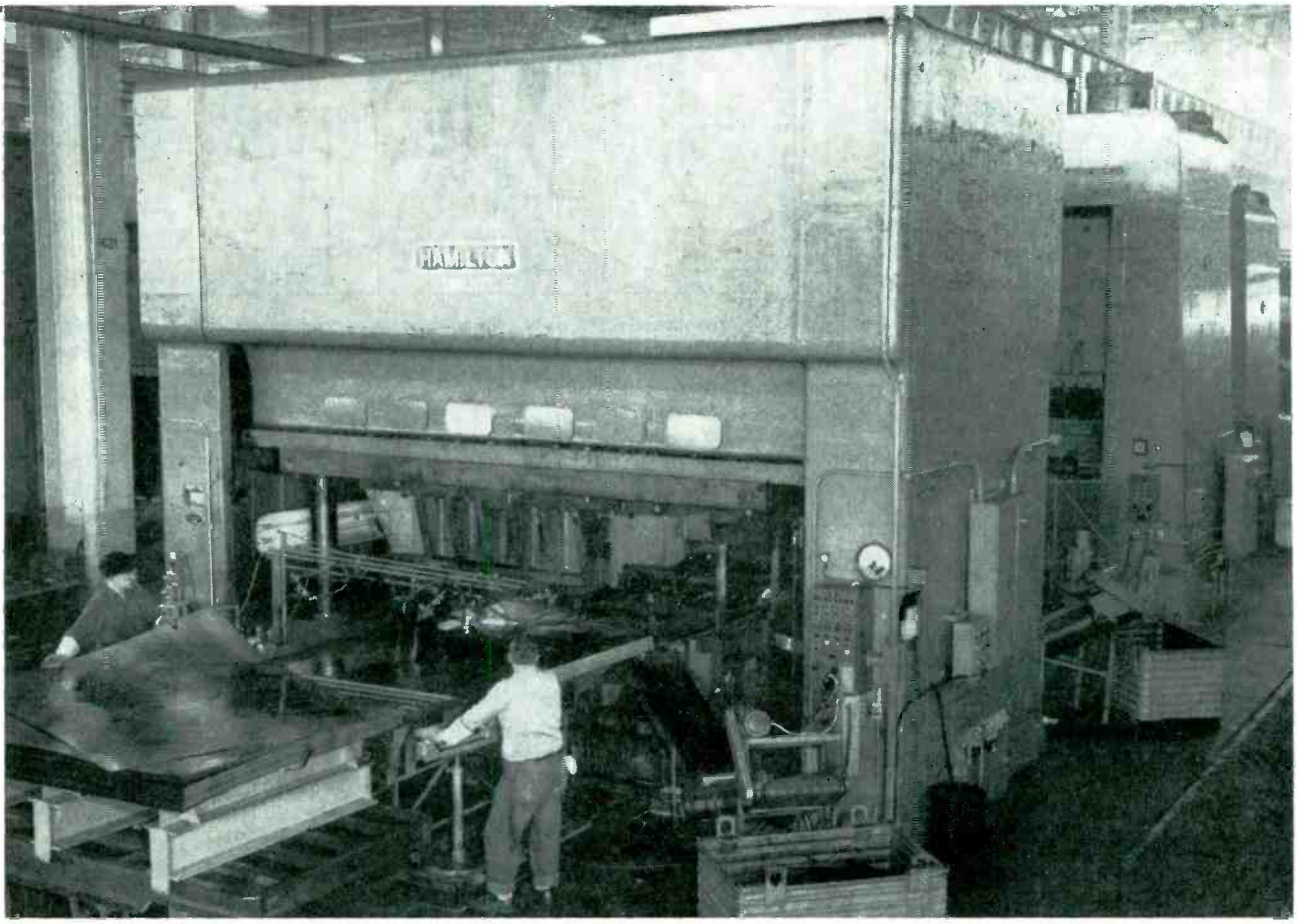
Speed requirements on a 500-horsepower drive motor for a 1,000-ton press are shown in Fig. 1. The motor must accelerate from rest to high speed in 0.5 second, decelerate to approximately half-speed in 0.3 second, reaccelerate to high speed in 0.3 second, and stop in 0.5 second.

Field Forcing

To meet these requirements, the generator and motor field currents must be changed in less time than is allotted for motor accelerating. With the d-c machines used, the time constant of the fields is 2 to 3 seconds.

Field current changes are obtained by using field forcing, as illustrated in Fig. 2. The curves show the exponential rise of field current for a field having a time constant of 2 seconds. Curve *A* is for an applied voltage which will give the required final value of I_F. It takes approximately 9 seconds to

Auto Body Production



Output of thousand-ton press has been increased 25 percent by installation of electronic drive-motor controls

reach this value. Curve B is for an applied voltage of four times the final value. In this case, the current still rises to 63.2 percent of its final value in two seconds, but takes only 0.6 second to reach I_F.

Field forcing, then, consists of applying overvoltage to the field during the time a field-current change is required and then quickly removing the overvoltage when the desired field current is reached.

The regulator system should apply as square an applied voltage as possible to the generator field. Field forcing increases the gain of the system so that stability becomes a problem and some form of stabilizing network is required. The time constant of the regulator system must be small. With the number and magnitude of time constants involved, a regulator having an appreciable time constant would require a considerable amount of antihunt signal, thereby destroying the approximate square-wave response required. A thyraton regulator will meet these requirements.

Since gain can easily be obtained in an electronic regulator, components in the stabilizing circuits become more effective and thereby smaller in size. For example, the generator regulator is stabilized with 0.08-μf and 6-μf radio-type capacitors. A nonelectronic regulator would require capacitances of hundreds of microfarads or possibly antihunt transformers.

Another requirement of the regulator is a fast-acting limit circuit to clip the initial motor accelerating-current peak and limit it at the final value. With a practically square waveform of motor accelerating current, the maximum available torque for accelerating the motor and load inertia is obtained. A high-gain, fast-acting and easy-to-stabilize limit circuit is readily available from an electronic regulator. By use of a simple anticipating or lead network in the limit circuit, the regulator prevents armature-current peaks and gives a practically square waveform accelerating current.

Basic Circuit

Figure 3 is the basic circuit of the drive, using one electronic regulator for generator or motor armature voltage and one for motor field current. Control of motor shunt-field current for partial field-weakening speed control is necessary to reduce the size of the generator. Field-weakened speeds are only required for the down and up portion of the press cycle.

The generator-voltage regulator system consists of a d-c reference voltage supply, the electronic regulator and a d-c control generator which supplies excitation to the generator field. The speed-setting potentiometers adjust the d-c reference voltage. This voltage is compared to a negative feedback voltage taken from the generator voltage being regulated. The difference voltage is applied to the regulator input. The electronic regulator supplies excitation to the control-generator field which excites the main generator to equalize the feedback and reference voltage.

An anticipating or lead network consisting of resistors R_{18}, R_{19} and capacitor C_1 stabilizes the generator voltage-regulator system. This network gives a feedback signal proportional to armature voltage plus the rate of change of armature voltages.

Use of field forcing makes the main-generator field a low-voltage, high-current field and increases current requirements beyond the practical range of the electronic regulator. A control generator or exciter is used to supply field current. Since field forcing is required on both acceleration and deceleration, the output of the control generator must be reversible. This is obtained by adding to the control generator a bias field which gives full output voltage when the electronic regulator

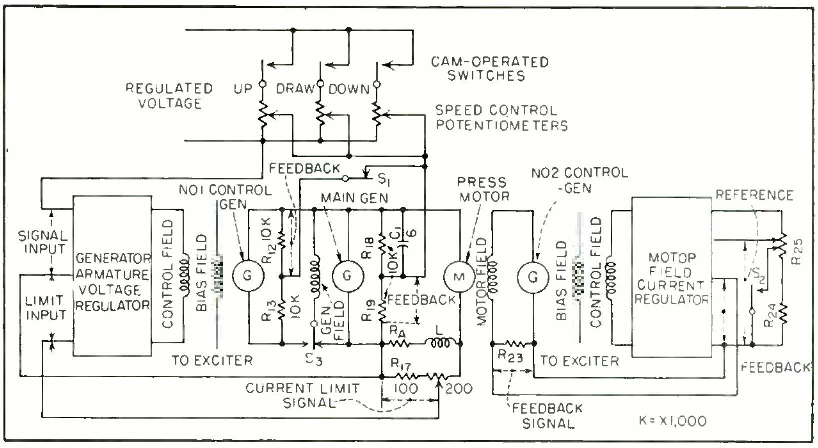


FIG. 3—Draw-press drive uses two regulator units to control generator armature voltage and motor field current. Cam-operated switches select proper reference voltage for different portions of press cycle

is completely off. When the electronic regulator is full on, the control field completely nullifies the bias field and gives full output of the generator of opposite polarity than with bias field alone.

The signal for the current-limit circuit is obtained across R_A and inductance L. This signal voltage is an anticipating signal proportional to armature current plus rate of change of armature current.

Motor Field Regulation

In the motor field regulating system, negative feedback voltage is proportional to field current, thereby regulating it and minimizing speed changes due to field heating. The regulator is similar to the generator voltage regulator but supplies its own reference voltage. Field forcing is employed to overcome the time constant of the motor field; a control generator similar to No. 1 is used.

Cam-operated relay S_2 modifies the regulator reference voltage to call for weak-field speeds during the down and up stroke of the die.

The armature loop circuit is connected in solid, eliminating a main-line contactor which would have a severe duty cycle. When stopped, the main generator residual voltage must be reduced to practically zero to prevent motor creep. In standby, contactor S_3 connects the generator field across the generator armature so that it cannot build up as a self-excited machine.

When stopped, another normally-closed contact on S_3 picks up a negative feedback signal from the No. 1 control generator. The reference voltage at this time is practically zero so that the regulator maintains the No. 1 control-generator voltage at about zero.

Electronic Regulator

The circuit of the electronic regulators is shown in Fig. 4. The regulator consists of two-stage d-c

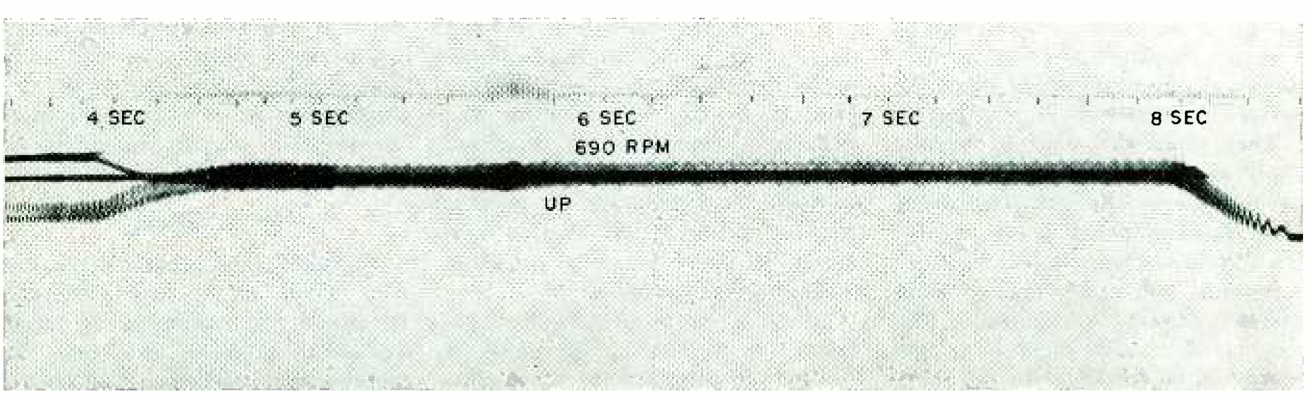


FIG. 5—Oscillogram of complete press cycle, showing rapid speed changes made possible by use of thyratron regulator system

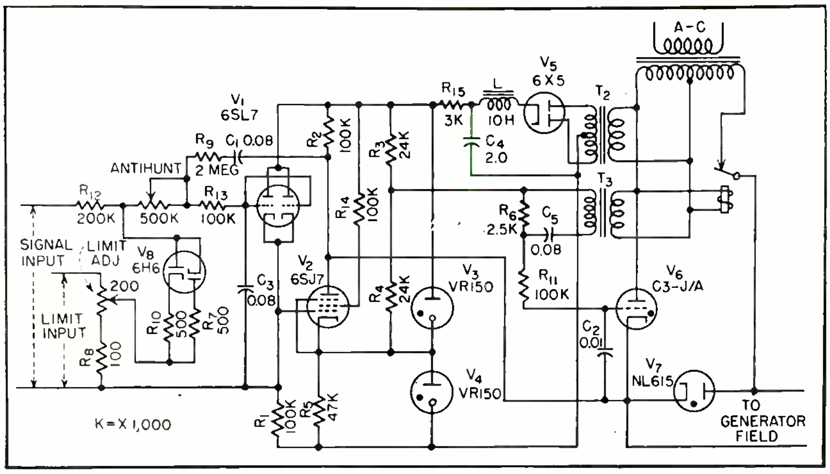


FIG. 4—Generator armature voltage regulator obtains reference voltages from external regulated source. Motor field current control is similar but obtains reference voltage internally

amplifier V_1-V_2, and thyratron rectifier combination, V_6-V_7. Input to the regulator is applied to V_1 grid.

Thyratron V_6 is controlled by a-c rider, d-c bias grid control, so that the voltage across R_2 is a positive bias tending to increase the thyratron-rectifier output while fixed negative bias across R_3 tends to turn off the thyratron.

The a-c grid rider, 90 degrees lagging the thyratron anode voltage, is obtained from transformer T_3 through C_5 and R_6. Thyratron V_6 and diode V_7 comprise a half-wave rectifier with back rectifier circuit which can be used with highly inductive loads. The self-induced voltage in the load inductance makes the diode conduct during the half-cycle that the thyratron is not supplying current to the load. Such a circuit has the advantage of using only one thyratron and making the load appear resistive, so that a practically linear d-c grid-control voltage versus output voltage characteristic is obtained.

Approximately 0.025 volt change across the signal-input terminals is sufficient to obtain a 0 to 250-volt output change. Thus, the regulator has a voltage gain of approximately 10,000 to 1, sufficient for practically any industrial application. With such a large gain the regulator requires a stabilizing or antihunt circuit to prevent flickering or definite instability. This is obtained by C_1, R_9, R_{12}, and the antihunt potentiometer. This circuit provides a negative feedback signal from V_2 to the input of V_1 proportional to the rate of change of the voltage output of V_2. The amount of the negative feedback to the grid of V_1 is adjusted by the antihunt potentiometer.

Regulator Limit Circuit

The limit circuit of the regulator is a simple and effective circuit consisting of diodes, V_8, biased so that they normally do not conduct. Bias voltage is obtained across R_{10} and R_7 which are the load resistors for a conventional selenium rectifier, not shown. The limit signal voltage is applied across the limit adjust potentiometer and R_8, and is added in series with the diodes and their bias voltages; this circuit shunts grid and cathode of V_1.

When the limit signal reaches a magnitude that overcomes either bias, then one of the diodes conducts and applies the limit signal voltage to the grid of V_1. The limit voltage overrides the signal voltage due to the low shunt impedance of the limit circuit.

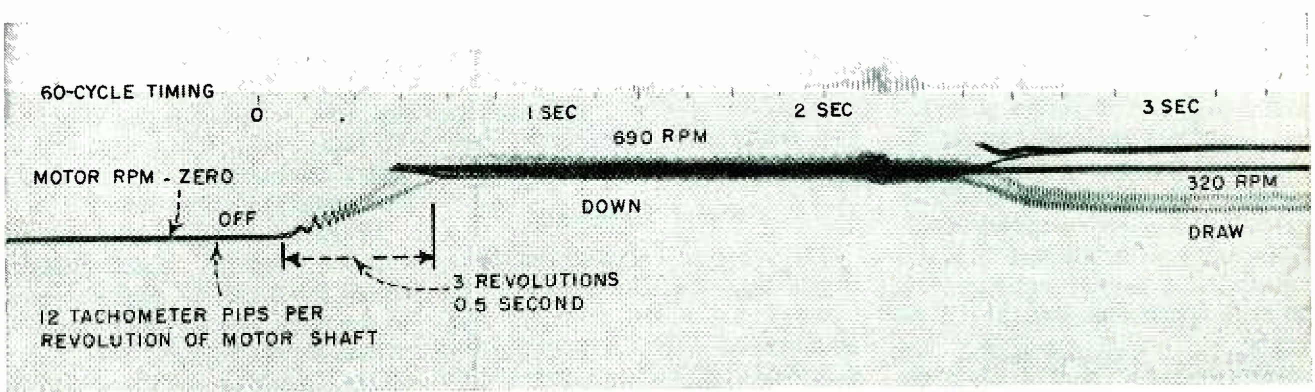
Polarity of the limit signal determines which diode conducts, turning the regulator off or on as required to limit the accelerating or regenerative motor armature currents, respectively.

Figure 5 is a speed oscillogram for the 500-hp drive. The oscillogram, as determined by tachometer commutator ripple, shows that the motor, starting from rest, attains a speed of 700 rpm in less than 3 revolutions of the shaft, or approximately 0.5 second.

Through the use of electronic control, a simple control circuit has been achieved requiring only five relays. All are small industrial-type, not required to break circuits carrying larger currents.

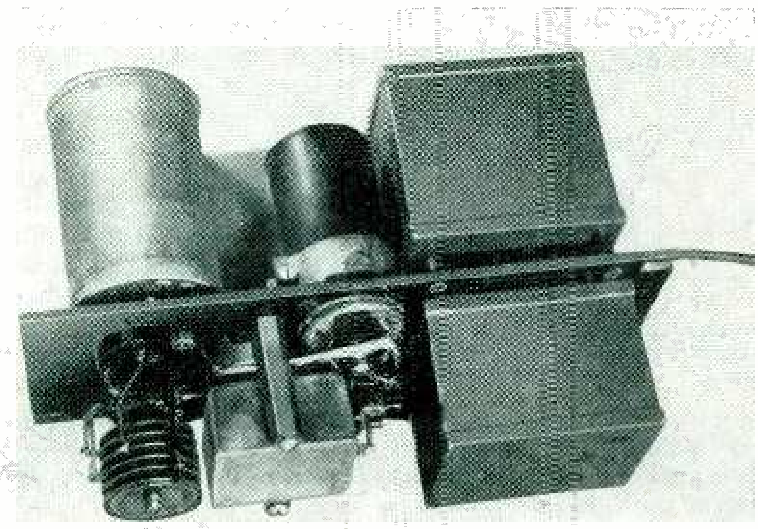
Five drives of the type described have been constructed. They have been in use for over a year with high production rates, less scrap and longer die life.

A similar drive has been applied to feeders and conveyors in a press line, tending toward complete automation of the whole production process.

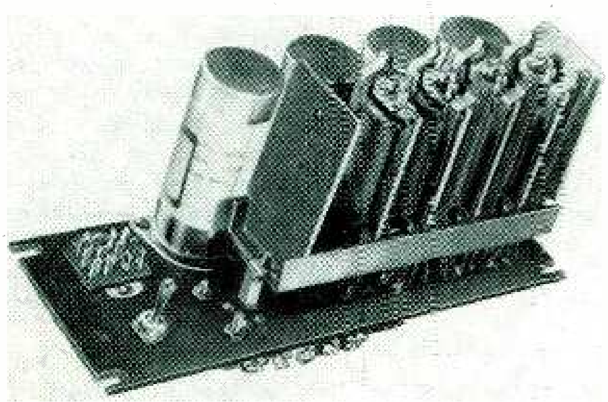


Speed can be changed from zero to 700 rpm in less than three shaft revolutions

Conelrad Switcher



Tone generator produces filtered 20-cps tone to operate transmitter control circuits as program lines are switched. Basic unit is telephone ringing vibrator



Time-delay switcher transfers audio program and control tone from one set of lines to other every 30 seconds. Large capacitors across relay coils provide delay

By N. J. THOMPSON

*Wisconsin State Broadcasting Service
Madison, Wisconsin*

EQUIPMENT DESIGNED to fulfill existing Conelrad (Control of Electromagnetic Radiation) requirements for operation of standard broadcast transmitters in the sequential mode may vary in complexity. The simple device to be described receives program audio from any source, at slightly above transmission levels; superimposes 20-cycle continuous tone at a level between 10 and 20 db below program level; switches the combined program alternately between two transmitter groups; and isolates two transmitter lines from each other within each group.

Satisfactory for two stations, the switcher described is now undergoing modifications for four-station control, using additional circuits—The Editors

Control Switching

The starting impulse can be a simple toggle switch.

Space is at a premium for switches, although facilities on the jack field used to connect the unit are ample, as is the supply of 28-v power. Thus the start circuit is made a break relay, connecting power to the timer when restored. The coil of relay K_1 is supplied with battery and returns through the CONELRAD IN jack and through one of a pair of resistors that bridge the CONELRAD IN circuit, to ground. If a make circuit on the jack were available, insertion of a plug could then be made to start the timer directly.

The isolation section, designed to provide protection against a short on any line at minimum cost and complexity, comprises series resistors in each arm of each output of the switching circuit. With the 50-ohm values (100 ohms for the combination) and with a 500-ohm source, level on one circuit drops less than 14 db when there is a short on the circuit with which it is paired. This loss can be made up at the receiving end until the short is cleared.

Relay Operation

Operation of the timer depends upon relays and storage properties of capacitors. Grounding the start lead through the top contact of K_1 prepares a circuit to the open contacts of K_3 and K_4. It completes a circuit from battery, the coil of K_3 and the 50-ohm spark suppressor through the break contacts on K_2 to ground.

After a short charging delay, K_3 operates, completing the circuit to K_4. When relay K_4 operates, it completes the circuit to K_2, and transfers audio from lines X to Y.

Operation of K_2 breaks the circuit to relay K_3, which remains closed for 15 to 20 seconds owing to the large shunt capacitance connected across its coil; then K_3 restores, breaking the circuit to K_4. De-energizing this relay shifts the

for Sequential Mode

Time-delay relay circuits establish timing interval of approximately 30 seconds during which program and control lines are switched between two pairs of broadcast transmitters. Tone control signal on program operates transmitter carrier

audio connections from lines Y to X. With opening of the right-hand contact, the circuit to K_2 opens. Relay K_2 remains closed for 15 to 20 seconds because of the large shunt capacitor across its coil, and then K_2 restores, its contacts recompleting the circuit to K_3. The cycle then repeats.

Only one contact is used on relays K_2 and K_3, the coils of which have the heavy shunt capacitance and do the actual timing. To obtain the requisite delays with the 2,500-ohm coils at hand and to avoid undue capacitor bulk, relays K_2 and K_3 are operated with all unused contacts bent free. Subnormal contact pressures are employed on the springs of the contacts in use. This arrangement necessitates an extra relay K_4 to do the actual audio switching. Relays K_2 and K_3 even with reduced spring tension operate dependably to the extent that their closing has been predicted within a second for periods up to five minutes.

Accuracy of timing is not desirable for Conelrad purposes. However, it was felt that the principal requirement was that of divorcing the time segments from the regularity of a synchronous clock motor, or from exact multiples of seconds that might be chosen in another sequential group within the country. The actual time interval in use at present approximates 30 seconds each way, made long to save wear on transmitter components. The two halves of the time interval are not the same, being dependent on spring tension of relays K_2 and K_3.

The 20-cps tone generator for which the circuit diagram appears across the top of Fig. 1 interconnects with the timer and switcher unit. This is used in the studio at

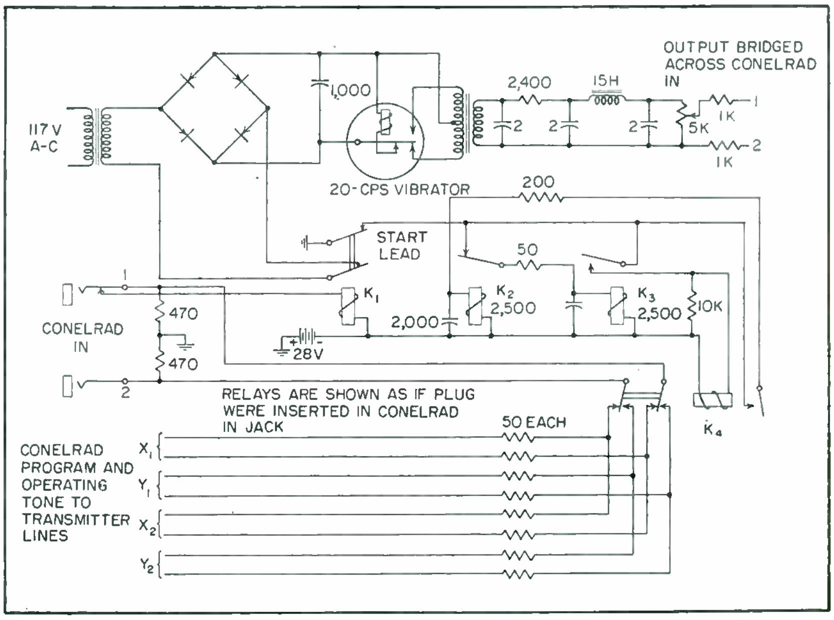


FIG. 1—Complete circuit diagram of the switcher with tone generator, relay time-delay unit and output-line isolating resistors

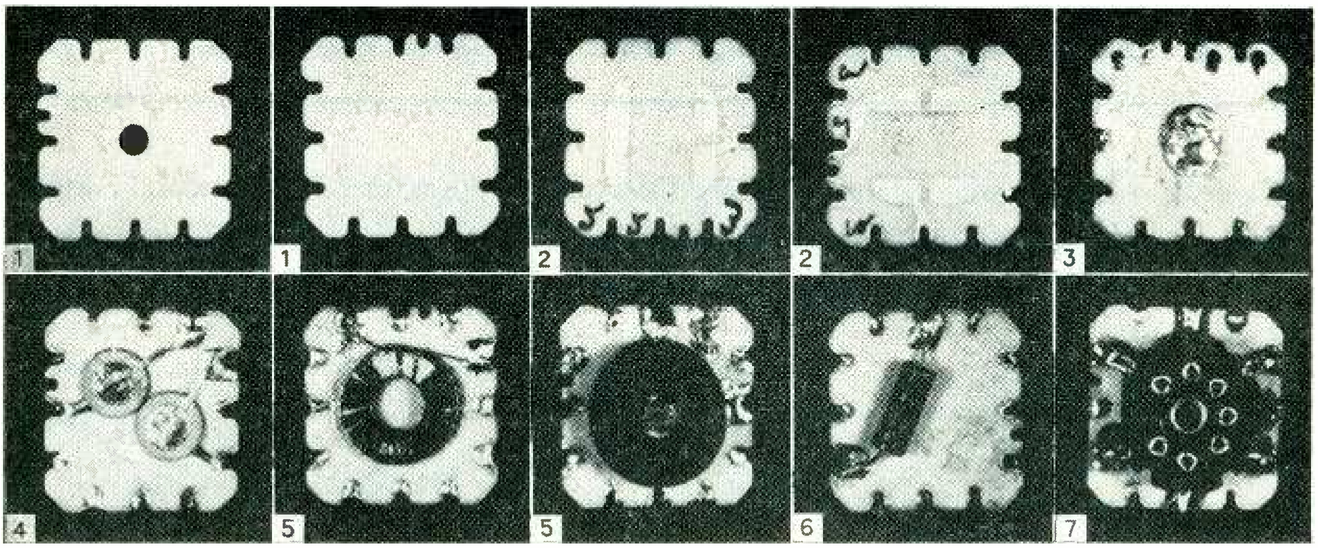
the control point to activate control relays located at the transmitters.

The purpose of the tone is to assure cyclic operation of the transmitters involved during periods when no audio information is being transmitted. These periods might be rather frequent under actual emergency conditions. In the absence of the 20-cps tone, neither transmitter of a pair would be operative if program were stopped. Listeners would hear a jumble of distant stations, and would be uncertain whether failure of the carrier was deliberate or caused by actual damage. They might tune the band searching for the carrier and thus be unavailable when information was transmitted.

Some transmitters filter the 20 cps out of the transmitted program, although poor low-frequency response may make this unnecessary. Some transmitter-relay units filter the program out and operate from 20-cps triggering signals only. Some operate on either 20-cps or speech, the latter procedure being preferable because it is independent of failure of the 20-cps generator.

The telephone-type ringing generator produces 20-cps at about 90 v a-c. Any telephone bell ringing source could be used. This one is part of a Signal Corps 101B voice-frequency ringer. The filter sections, designed to the telephone-type components at hand, reduce harmonic content to 5 percent and voltage to some 10 db below program level when bridged across the 500-ohm line and its two 600-ohm loads in parallel. Thus the harmonic content is about 36 db below program level.

The units, designed and built by the author and J. D. Kingsley of the Madison staff of the Wisconsin State Broadcasting Service, have been giving entirely satisfactory service since their installation.

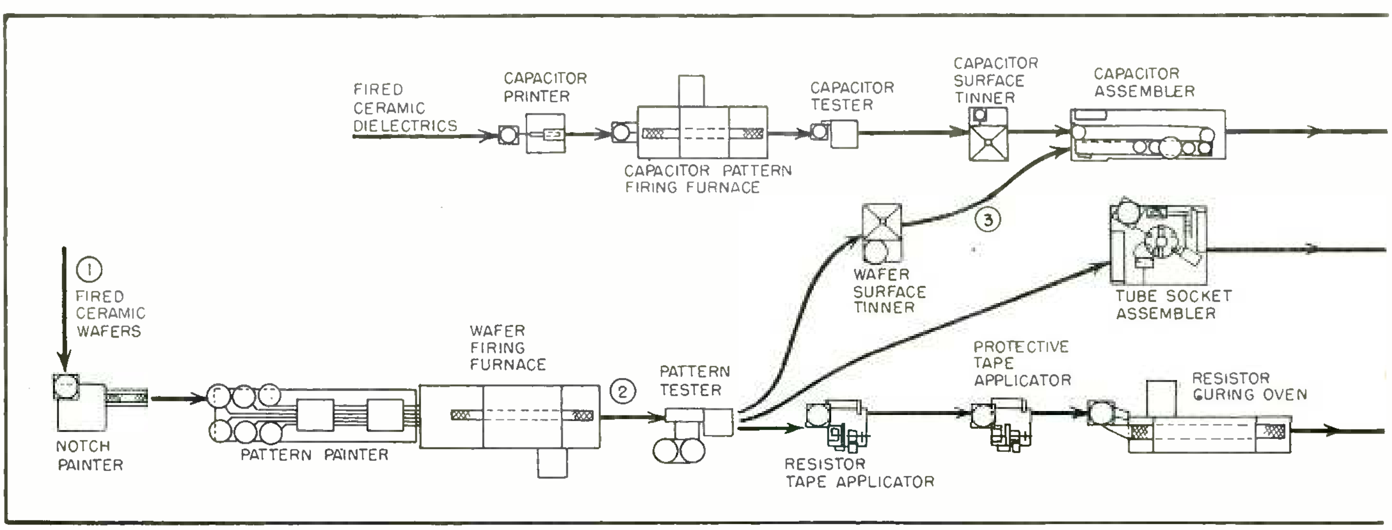


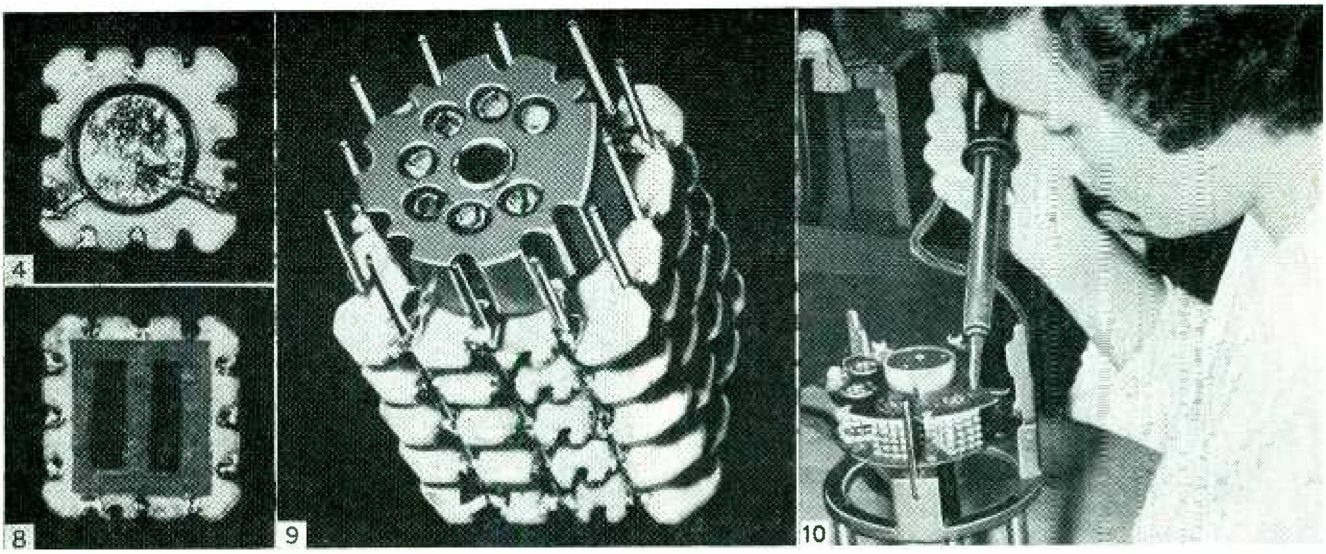
Mechanized Production of Electronic Equipment

A submarine detector is first electronic unit to go into pilot-plant production using the modular wafer design and the automatic silver-painting, tinning, dip-soldering and testing machines developed by the National Bureau of Standards

By R. L. HENRY and C. C. RAYBURN

Process Technology Section, Electronics Division
National Bureau of Standards, Washington, D. C.





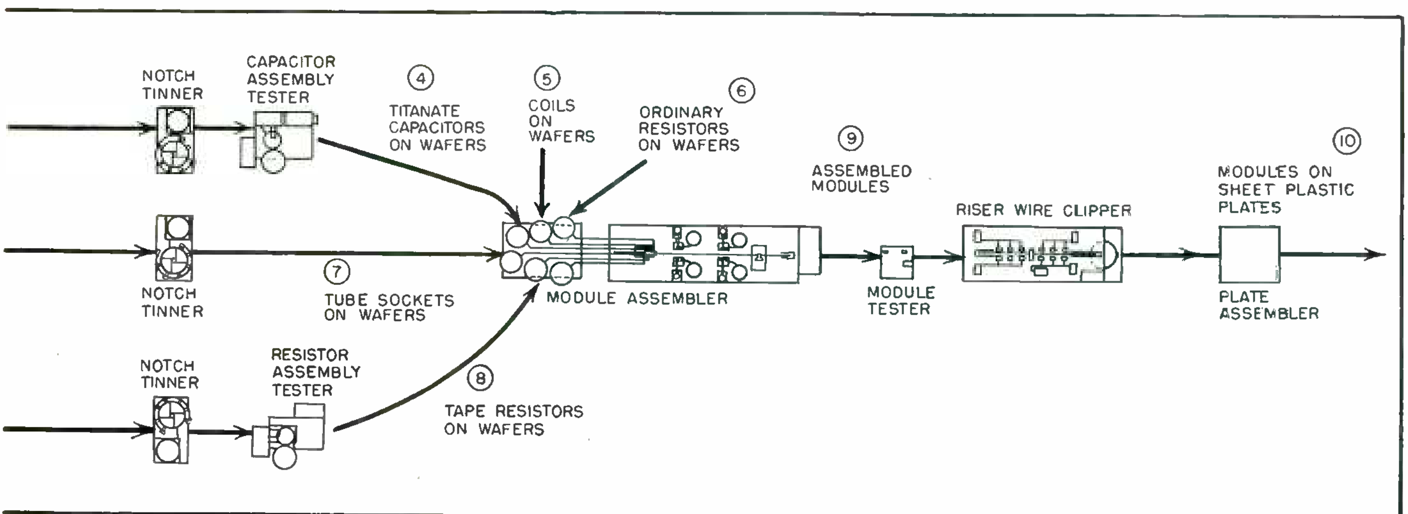
Wafers, modules, mechanized production line and (at right) the final submarine detector unit. Numbers on diagram correspond to numbers shown on photos above

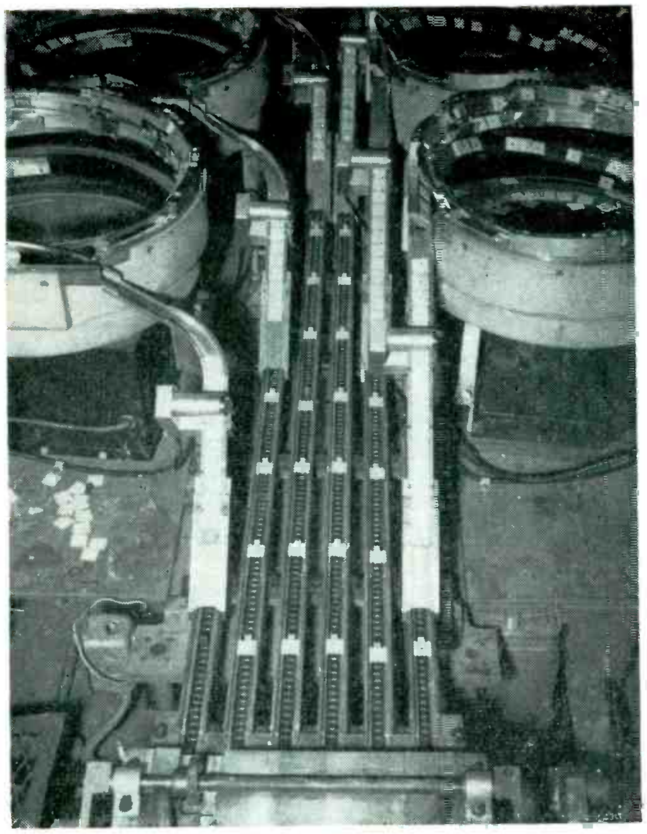
SPONSORED by the Navy Bureau of Aeronautics, the National Bureau of Standards began a study in 1950 to ascertain the feasibility of mechanizing the construction of electronic equipment. This has resulted in development of a machine line capable of building practically any type of electronic equipment, with complete versatility in converting from one equipment to another. Several types of military electronic equipment, including a submarine detection device, have already been redesigned for mechanized production and a pilot plant has been set up (ELECTRONICS, p5, Oct. 1953).

The input to the mechanized line consists largely of raw or semi-processed materials, which alleviates the necessity of obtaining completed components from many sources. Such a self-contained system has definite military significance, since from a dormant state it can be almost immediately placed in operation to produce essential electronic equipment.

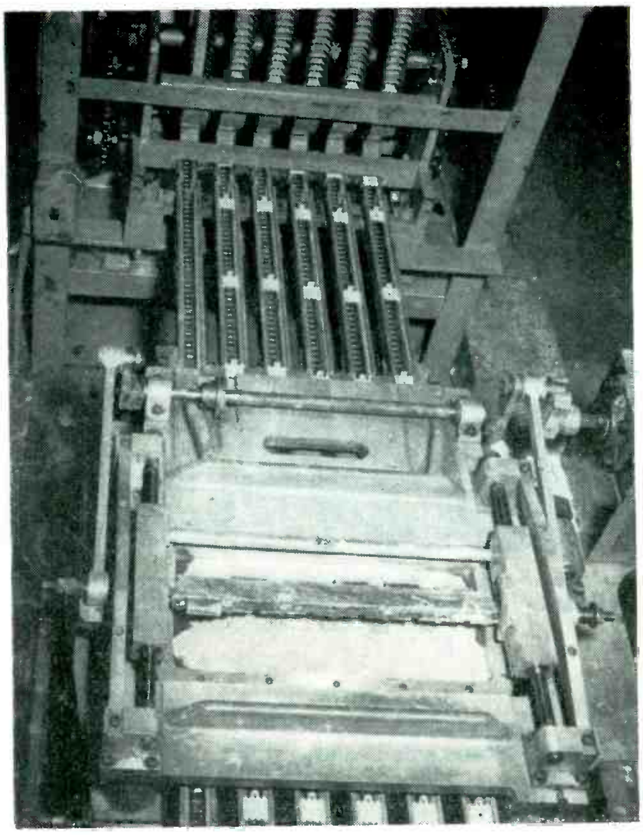
Basic Elements

To facilitate mechanical handling of all components with minimum machinery, a steatite wafer $\frac{7}{8}$ inch square by $\frac{1}{16}$ inch thick is employed as the basic modular unit on which components are machine-printed or mounted over printed wiring. Six of these wafers are automatically





PATTERN PAINTER orients molded ceramic wafers and applies required pattern of silver paint to both sides of the six different wafers that are to make up a module. At left is input to machine,



showing some of the six vibratory work feeders that sense the position of orienting notch end tip over any wafers that are upside-down. At right is output end, showing silk-screening.

selected, stacked and then joined mechanically and electrically by machine-soldered riser wires, to form a standard module which generally has a tube socket on the top wafer.

Any number of these modules can be mounted manually on plates having etched wiring, to provide the desired plate assembly for any specific application. The riser wires extend through the top and bottom wafers to serve as terminals which fit into punched holes in the etched wiring of the plates.

Ceramic capacitors, NBS tape resistors, tube sockets and terminals are compatible with this system of construction and can be produced by automation from basic bulk materials. Capacitor values are varied by changing the dielectric constant and/or electrode area on the standard size of wafer. Tube socket bodies are molded from the same steatite material as the wafers, and tube pin connectors for the socket body are formed from beryllium copper strip.

Specialized components, occurring less frequently, can also be handled. For example, the bottom wafer is molded with a center hole when a potentiometer is required. The ⅛-inch-thick miniaturized potentiometer is mounted on the top surface of the wafer, with the shaft going down through the hole.

Precision resistors are made by evaporating and adjusting a nickel-chrome alloy on a specially prepared wafer surface. Spiral and toroidal inductors are mounted on the wafers. A dielectric film and associated strips of foil are folded in a square configuration to form a high-value capacitor compatible with the modular construction system.

Production System

Central wafers of the module are sometimes removed to accommodate installation of larger components, or one component can occupy the entire space of the module. In all cases, the specialized components require initial hand work, but can be fed into the automatic line at an advanced position for completion of assembly and testing.

The entire production facility occupies approximately 10,000 square feet, with one-half of this area being allocated to the mechanized assembly line and the remainder to supplementary facilities for producing the ceramic wafers and sockets, tape resistors and etched-circuit interconnecting plates.

A standard punched control card must also be prepared beforehand for each wafer. The cards serve the following functions:

(a) Inform operators of the initiating time.
(b) Inform operators of exact quantity to initiate.
(c) Accompany parts transfer box, identifying the wafer batch as it is processed through the line.
(d) Provide machine setup information.
(e) Upon insertion in a tester, complete the tester circuitry to pass only correctly processed wafers identified by the card.
(f) Provide space to record yield information at each automatic testing station.
(g) Provide space to record each processing date and time, with operator's initials confirming completion of each process.

After all wafers of a module converge in the module assembly, their cards are filed as a permanent production report. Another punched card accompanies the batch of modules to the plate assembly. This card sets up a module tester and serves to record final production data.

Wafer Orientation

To obtain wafer orientation in the machines, an identification notch is molded in an asymmetrical position on each wafer. Feeding and orienting is achieved with a vibratory orienting feeder performing in conjunction with a standard chute, escapement and photoelectric level control. As many as 3,000 wafers may be poured into the feeder bowl at one time. The oscillatory motion forces the wafers to rotate and simultaneously move up the spiral track of the bowl to indexing segments placed around the top rim. Directly under the indexing segments is a collecting ring into which fall the correctly oriented wafers.

If the wafer orientation notch is directly over a projecting pin at the first indexing station, the wafer drops; if not, the wafer goes past and is rotated 90 degrees as it walks over a ledge to the next indexing segment. Since the wafers may lie flat in a guided track in eight possible positions, eight indexing segments are provided. A wafer that fails to go through the first four indexing segments is tumbled laterally to turn over as it travels to the fifth indexing segment, after which it gets four more chances to drop. When a backlog of about ten wafers has stacked into the inclined output chute, a phototube senses the level and interrupts the feeder motion to maintain the level.

Wafer Notch Painting

Wafer notch painting is the first metallizing operation. The wafers come down the chute from the vibratory feeder to a rotary loading device which places them on chain-driven fixtures. These lower the wafers through four sets of three cork notch-painting wheels, one on each side of the wafer passage. Constant-level paint reservoirs supply the silver paint at the bottom of each set of wheels. The peripheral velocity of the wheels and the down-travel velocity of the wafers are the same, hence there is no scraping of wheels in notches. The painted wafers fall to a belt which conveys them to a heated zone. This dries the paint sufficiently to prevent smearing during handling.

Redesign for mechanized production is done on a modular work sheet. This has top and bottom outlines of six wafers, with appropriate numbering to identify each notch in the wafer, each riser wire, and the electronic component that is to be placed on the wafer. The conventional wiring diagram for a stage is translated to modular design by marking the position of each component on its wafer and indicating how the circuits between wafers are to be connected.

Wafer Pattern Printing

The next operation is performed by the wafer pattern printing machine, which applies the appropriate conductive patterns to both sides of the wafers. The 165-mesh stainless steel printing screens can accommodate circuit patterns for as many as six wafers.

The scrambled wafers from the notch-painting oven are manually loaded in batches into six more vibratory orienting feeders, each of which feeds oriented wafers to mechanically controlled escapements that drop the wafers on a chain-driven channel chute. Upon advancing to the printer head the wafers are elevated to a position directly under the patterned screen. At this instant a squeegee drives across the screen surface, forcing silver paint through the screen pattern onto the wafer surfaces. A conveyor then carries the wafers to a heated drying zone and inverts them prior to their entry into a second printing station. After a second drying the wafers are released onto a conveyor belt which passes them through a 1,350F electric furnace which fires and fuses the silver paint to the ceramic. Time for passage through the 12-foot-long furnace is 45 minutes.

A partitioned guide at the end of the furnace distributes the six lines of wafers to six transfer boxes. Each box in turn is carried to the wafer pattern tester and dumped into its vibratory feeder, after which the punched control card for the batch is inserted in the tester. The punched card places a relay in series with each wafer interconnection, then connects the contacts of these relays in series. A correct wafer pattern is denoted by a completed circuit through the relay contacts. The test head, in its energized position, contacts the ten possible surface electrodes in addition to the twelve notches.

If wafers fail the check, they are dropped into a reject compartment. Acceptable wafers are released through a chute to the identified-wafer transfer box. When a predetermined consecutive reject count occurs, the tester automatically ceases operation and visually signals the operator while identifying its specific difficulty.

Capacitor Printer

Capacitor patterns are printed simultaneously on both sides of molded titanate dielectrics in another machine, as the first step in producing ceramic capacitors that are subsequently soldered directly to the tinned surfaces of the standard ceramic supporting wafers. Each pattern has a central electrode area and four spots that fall on the rounded corners of the titanate ceramic body. One of the faces of the dielectric piece is also provided with a bar that connects two diagonally opposite corners. When the capacitor is later assembled, this bar serves to connect the top electrode over the rounded corner and down to the surface of the standard wafer.

A small vibratory feeder discharges titanate bodies into a loaded chute. Spring-loaded fingers mounted radially on a wheel pick up the bodies and index them at the printing position. Here two rotating squeegees force silver paint through their respective screen patterns. A photoelectric monitor discontinues the printing operation if there is no piece in the holding fingers. Following printing, the capacitor is indexed through a heated paint-drying zone prior to removal from the wheel, then fired in much the same way as for wafers.

The capacitor dielectric tester first checks all silvered surfaces for continuity. The capacitor is then automatically released and falls between the contacts of a precision

1-kc comparison bridge. The output of the bridge controls three inspection circuits for accepting good capacitors and rejecting those which are above or below the specified tolerance limits.

Capacitor Tinner

Wafers for capacitors are given a thin coating of lead-tin solder with one-percent silver on their metallized areas by the wafer surface tinner. The wafers are fed into the tinner by a vibratory feeder. At the loading station they are clamped in holding fingers which are mounted around the periphery of a wheel rotating about a vertical axis. As the wheel is rotated, camming surfaces cause the parts to be lowered into baths which progressively flux, solder and wash each part.

Capacitor Assembler

In the capacitor assembler, oriented wafers and capacitors slide through chutes which load them on chain-driven holders. These insulated holders clamp the surfaces together while carrying the package through two stages of induction heating in which all contacting tinned surfaces are mechanically and electrically bonded. An unloading station is sufficiently displaced from the heating station to permit solidification of the molten solder.

Notch Tinner

Additional solder is added to the twelve peripheral notches of the wafers, to facilitate their assembly into modules, by the capacitor notch tinner. A vibratory feeder loads the capacitor assemblies into clamping fixtures, which elevate and descend as they are carried by an indexing support. In four stages, the assemblies are sequentially immersed in flux and solder, each time only immersing the bottom three notches. A fixed indexing pin causes each assembly to rotate 90 deg about its clamping axis between successive solder-dipping operations.

A capacitor value and breakdown test completes the capacitor assembly operation. This tester employs a rotary table which indexes the capacitor assemblies under the value and breakdown test positions. Four fingers elevate through the table, clamping the wafer by its corners to insert and withdraw the capacitor assemblies from the test position. Testing contact is provided by twelve spring fingers contacting the solder-filled notches.

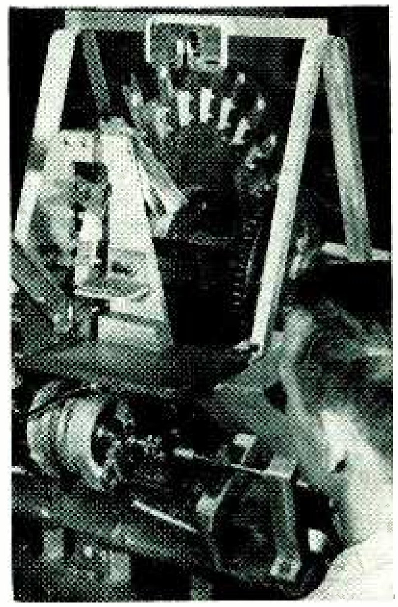
Between tests, while the assemblies are being transported and inserted, each tester automatically checks itself. Should it fail the self-test, it automatically ceases operation and alerts the operator. It also ceases operation upon attainment of a preset consecutive or cumulative reject count. Rejected and accepted yield figures are automatically tabulated by counters. The accepted wafer is now ready to be assembled into a module.

Resistor Production

The resistor tape applicator automatically applies resistor tape to both sides of printed wafers. Two rolls of tape are placed on spindles located on each side of the path along which the wafers are driven in chain-supported holders. The tape is guided along a series of rollers to an eight-sided applicator wheel. Vacuum acting through small holes in the octagonal wheel holds the tape while it is cut into ½-inch segments, indexed and pressed against the wafer surface. Two tapes are accommodated by each wheel. After receiving as many as four resistors, the wafer is indexed to a pressing position which makes the tape adhere more firmly. The wafer asembly is then ejected into a transfer box.

Next, Quinterra asbestos tape is applied over the tape resistors by the protective tape applicator. On one side of the tape is a sprayed coating of silicone resin protected by polyethylene tape. In machine operations resembling those employed in applying resistor tapes, the polyethylene tape is stripped off and the ⅝-inch wide protective tape is cut into squares and centrally pressed on each surface of the resistor-bearing wafers.

The resistor-curing oven produces and stabilizes the desired resistance value. The heat also serves to fix the tape securely to the wafer backing. A feeder distributes the wafers to ten gated channels. Cam-operated lever arms sequentially open each gate and permit single wafers to drop down between the turns of spiral coils woven into a metallic belt. The belt then conveys the rows of resistor wafers through the curing oven. Four hours later, the wafers have completed the curing cycle and fall off the conveyor belt into a container.



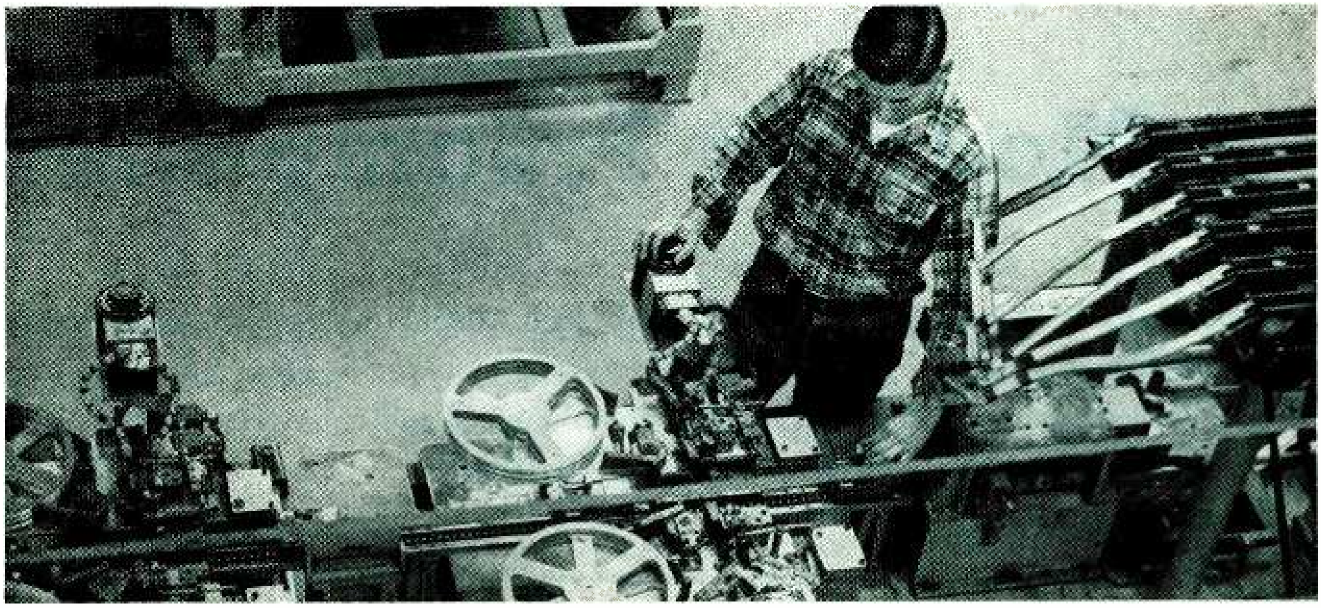
CAPACITOR PRINTER applies silver paint to both sides of titanate dielectric pieces. Blank wafers come down chute at left from vibratory feeder

After notch tinning, the resistor assembly tester provides final inspection. The bridge-type instrument is mechanically and electrically identical to the capacitor value tester.

Tube Socket Production

The ceramic facility has previously prepared 7-pin or 9-pin miniature tube socket bodies. Tube pin connectors have been formed from beryllium copper ribbon in an eleven-stage progressive die. A short narrow segment is left between the connectors to permit winding them on a reel. While on the reel, the connectors are electroplated with silver. The reel, socket bodies, tube socket wafers and eyelets to connect the socket to the wafer are all brought together at the tube socket assembler.

A vibratory feeder loads the socket bodies in an oriented posi-



MODULE ASSEMBLER receives the six different finished wafers from chutes at the right, positions them in correct sequence and stacks them correct distance apart, then presses riser wires into notches on opposite sides with heated electrodes. Machine rotates module 90 degrees at center, for soldering riser wires to remaining two sides at left-hand position. Finished modules come off at left here. The four large reels contain the heavy riser wire, which isautomatically cut to correct length as it is applied

tion into a rotary nest which carries them underneath a die position. Here the connectors are severed from the continuous string and lowered into the connector holes in the socket body. This operation continues sequentially until the socket body has been loaded with connectors. The inverted body is then indexed to the next station, at which oriented wafers are dropped on top of the loaded socket body. The next table movement brings the wafer socket unit to an eyelet hopper from which an eyelet is issued and placed in the center holes of the wafer and tube socket. The eyelet is set at the following station, making the socket and wafer a single unit. An eject mechanism removes the unit and deposits it in a transfer box.

The connector extensions and wafer notches of the tube socket assembly are next filled with solder by a notch tinner. This completes socket production, as testing is not required.

Module Assembly

For final assembly of modules, wafer assemblies are manually dumped into six vibratory feeders. From here, the wafers travel down chutes that converge and twist to vertically align the wafers in their final stacked relationships.

A holding fixture traverses directly beneath the loading position, and clamps the wafer array after it is released from above. The loaded fixtures are then chain-driven to the first soldering station. Here, six riser wires are guided from reels and stopped in the proximity of their final soldered position on opposite sides of the wafer stack. Specially designed soldering heads approach the stack, melt the notch solder and force the riser wires into the notches while simultaneously cutting the wires from the reeled supply.

The module is rotated 90 degrees as it proceeds to the second solder station, where the remaining six riser wires are applied in an identical manner. A mechanism at the exit end of the assembler removes the completed module from the holding fixture and deposits it in a transfer box.

A riser wire clipper is provided to sever riser wire segments between wafers or clip riser wire extensions which do not require connection on the plate assembly. The clipping action is accomplished by preset knives which are actuated by solenoids as the module is indexed past the clipping stations. No automatic feeding device is in current use on this or any modular processing equipment.

Prior to wire clipping and plate assembling, modules are checked by the module tester to verify the correctness of their construction. This instrument automatically operates on a 7.2-second cycle to completely test any module produced by the mechanized line. Test setup is accomplished by plugging in a standard test head and the identifying punched card. Each component and connection in the module is checked twice during the test cycle, to assure its correct placement and connection. Should any fault be detected, its location is visually indicated.

Plate Assembly

The finished modules are placed on etched copper-clad interconnecting phenolic plates by hand. Riser wire extensions are pressed through holes in a bottom plate. After applying flux to the ends of the protruding riser wires, the assembly is placed in a fixture which aligns the plate as molten solder is admitted to each joint through accurately positioned tubes. Sufficient solder remains at each junction when the solder level is withdrawn. The assembly is then turned over and the top plate is attached in an identical manner. From here, conventional production-line techniques are applied for assembly of plates into sonobuoys or other equipment.

Modified Preamplifier

Feedback cascode iconoscope preamplifier used with existing cameras enhances quality of motion-picture programs in television broadcasting by reducing noise and permitting use of low beam currents. Spurious signals are minimized and improvement is achieved in gray-scale tonal rendition

ALTHOUGH the iconoscope is one of the first camera tubes to be used extensively for television pickup purposes, its full potentialities have only recently been realized in practice. Since the early days of television, iconoscope operation has been plagued with the presence of spurious signals and the resultant pictures characterized by edge flare, uneven shading and a high noise level[1].

Furthermore, in the pickup of motion pictures (the major use of the iconoscope in present-day telecasting) the problem of video amplifier overload introduces additional picture degradation in the form of poor gray-scale rendition. This paper describes methods applicable to existing iconoscope cameras that completely remove edge flare, practically eliminate shading, materially improve signal-to-noise ratio and enhance tonal rendition.

To obtain an acceptable ratio between the noise level of the video preamplifier and the video signal, it has been common practice to operate the iconoscope in a manner to produce as great an amplitude of output signal as possible. The high levels of beam current and mosaic illumination necessary to accomplish this result in the generation of excessive flare and shading signals.

These signals are of large amplitude compared to the picture signal and they vary radically in shape and amplitude with changes in picture content. Their elimination by compensation is difficult and in some cases impossible. If the iconoscope is operated with moderate mosaic illumination and at a beam current in the order of 0.05 to 0.1 microampere, the edge flare can be eliminated easily by high-intensity edge lighting systems[2].

Spurious shading signals are reduced to a relatively low level. What is more important, they remain fairly constant for wide variations in picture content. At such small beam currents, although the signal current is practically noise free, it is of such low amplitude that both the thermal-noise current generated in the output coupling resistance and the shot noise resulting from random fluctuations of first-amplifier plate current can be of significant magnitude compared to the picture signal.

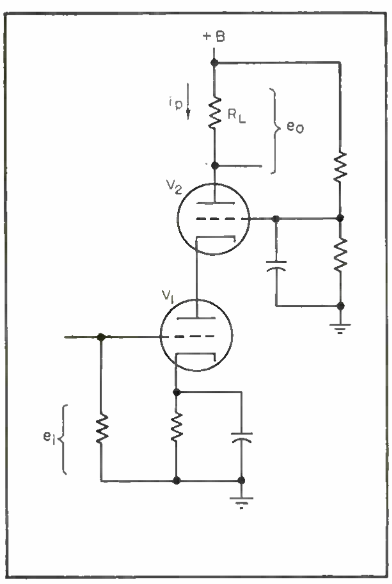


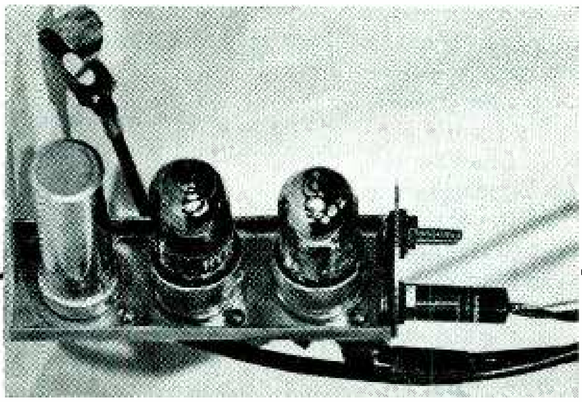
FIG. 1—Basis circuit used as preamplier for motion-picture iconoscope

Ratio

Fortunately, as postulated in the literature[3] and proved in practice, a satisfactory ratio between the signal and thermal-noise currents can be obtained where the coupling resistance is in the order of 100,000 ohms. With this high value of resistance, the signal level at low frequencies will be in the order of a few millivolts. At the higher frequencies, because of the severe capacitive loading effects, the signal level will drop to less than 100 microvolts. In the past it has been customary to compensate for this loss in a high-level stage of the associated video amplifier. In this case, the relatively low level at the higher frequencies results in an unsatisfactory signal-to-noise ratio unless the noise level of the first stage of the video amplifier is exceptionally low.

In attempts to reduce the noise effects in the camera video amplifier, the design trend has been toward the use of triode tubes, particularly those types having high transconductance at fairly low values of plate current. By using

Improves Movie Telecasts



Preamplifier is constructed on small subchassis before mounting in iconoscope camera

By K. B. BENSON

Engineering Department
Columbia Broadcasting System, Inc.
New York, N. Y.

a triode rather than a pentode of equivalent transconductance, shot noise from the screen current flow is eliminated in exchange for a small sacrifice in gain. However, without the shielding provided by the screen grid, a portion of the output voltage is fed back to the input as a reactive component.

Consequently, unless the triode amplifier is operated at very low gain, this additional reactive loading of the already heavily loaded grid-coupling resistance is appreciable. Furthermore, it will vary with changes in the transconductance resulting from grid-bias variations or aging of the amplifier tube. Thus, the additional capacitive loading of the grid circuit, because of its variable nature, not only creates an operational problem in the maintenance of correct frequency compensation, but also increases the amount of compensation required.

In other words, the ratio between amplitudes of the low and high frequency components of the video signal is increased. There is a further problem; in the transmission of motion pictures where the storage properties of the iconoscopes are used, the video signal includes a relatively high-level 60-cycle application pulse. Inability of the video amplifier to accommodate this signal often results in white or black compression.

Cascode Circuit

The desirable features in the low-noise level of the triode tube and the high-gain and negligible grid loading of the pentode are combined in the two-stage direct plate-to-cathode-coupled triode amplifier[4]. This arrangement, known to television receiver designers as the cascode circuit, has only recently been applied to video-frequency amplifiers[5]. The circuit can be examined to determine how the characteristics of a pentode are provided in a triode circuit.

As noted above, if a triode is operated at very low gain, the voltage fed back from the plate to the grid through capacitance coupling is small and the additional capacitive loading of the grid from this source also is small. Figure 1 indicates that this requirement is met. Here, the plate load for the first triode stage, V_1, consists of the low-impedance cathode circuit of the second stage, V_2. Tube V_1 operates at a little over unity gain.

The overall gain A of the amplifier may be expressed as $A = e_o/e_i$ where e_o is the output voltage and e_i is the input voltage. Since the same plate current i_p flows through both tubes, $e_i = i_p/g_m$ and $e_o = R_L i_p$ where g_m is the transconductance of the first tube and R_L the plate load of the second tube. Substituting in the expression for overall gain, $A = g_m R_L$. This is the same as the gain of a pentode, whereas a single triode amplifier has a lower value, $g_m R_L R_o/(R_p + R_L)$. Thus, the cascode amplifier has the advantageous features of high gain and low input loading of the pentode combined in a triode amplifier.

Feedback Compensation

While the cascode circuit satisfactorily solves the problem of unacceptable signal-to-noise ratio in the video amplifier, when the iconoscope is operated under conditions of low beam current several other major problems still exist. As is the case with most high-gain amplifiers, the stability and immunity from microphonics of the cascode leave much to be desired. With the usual adjustable high-pass filter as the means of compensation for the capacitive loading of the iconoscope coupling resistance, any changes in the required compensation through tube aging, drift of circuit constants, or change in the iconoscope internal impedance must be corrected by a manual adjustment. When preamplifier gain is in the order of 20 to 30, the pulse resulting from the motion-picture light application may under certain conditions reach such proportions as to overdrive a following amplifier stage.

The limitations of the cascode can be overcome without sacrificing any of its essential advantages by incorporation of inverse feedback. Preamplifier gain can thus be stabilized and virtually complete freedom from microphonic disturbances obtained.

Furthermore, if the frequency characteristic of the feedback loop is determined by the time constant of the preamplifier input circuit, the need for any manual adjustment of frequency compensation is eliminated.[6]

In addition to these factors, the large-amplitude projector application pulse is reduced at the input circuit to a level comparable to the higher-frequency picture signal components without any loss in signal-to-noise ratio. Overloading of subsequent amplifier stages is thereby avoided.

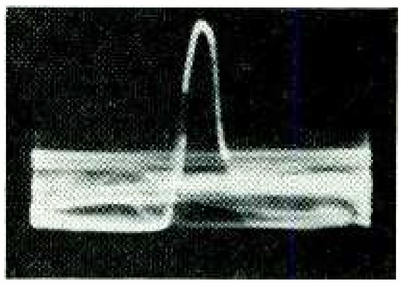
Circuit Analysis

The circuit of a cascode preamplifier incorporating inverse feedback compensation is shown in Fig. 2. Signal voltage is obtained across a parallel network consisting of the iconoscope load resistance and the distributed circuit capacitance fed from the essentially constant current source of the iconoscope.

The voltage developed across such a combination will vary with frequency in the same manner as will the feedback voltage, where the same resistance and capacitance are fed in series from a constant voltage source. Knowing the input reactance, an expression for the output voltage of the amplifier related to the iconoscope signal current can be derived in the following manner.

Where

e_o = preamplifier output voltage



Output waveform of film camera video amplifier showing large-amplitude projector-application pulse compared to useful video signal. Light horizontal band is picture video. Larger rectangle enclosing it is formed by iconoscope beam-blanking pulses. Amplifier does not distort or overload under extremes of signal level

e_i = preamplifier input voltage
e_f = feedback voltage
G = gain of amplifier without feedback
i_s = iconoscope signal current
X_c = reactance of amplifier input capacitance
R = iconoscope load resistance
B = fraction of output voltage fed back to input

The relationship including the feedback may be written

$$e_o = (e_i - e_f)\, G$$

The values of e_i and e_f depend upon R, X_c, i_s, and B as follows

$$e_i = i_s \frac{(-jX_cR)}{R - jX_c}$$

$$e_f = e_o B \frac{(-jX_c)}{R - jX_c}$$

Substituting in the expression for e_o

$$e_o = \left[i_s \frac{(-RjX_c)}{R - jX_c} - e_o B \frac{(-jX_c)}{R - jX_c} \right] G$$

Rearranging and solving for e_o

$$e_o = \frac{-i_sRjX_c}{R - jX_c + BGjX_c}$$

Since R, i_s and B are constant throughout the video band, this may be rewritten as a proportion

$$e_o \cong \frac{-jX_c}{R - jX_c + BGjX_c} \quad \text{or}$$

$$e_o \cong \frac{1}{\dfrac{R}{-jX_c} + (BG + 1)}$$

As the expression for the relative frequency and phase response for the amplifier indicates, if a low enough coupling resistance and a

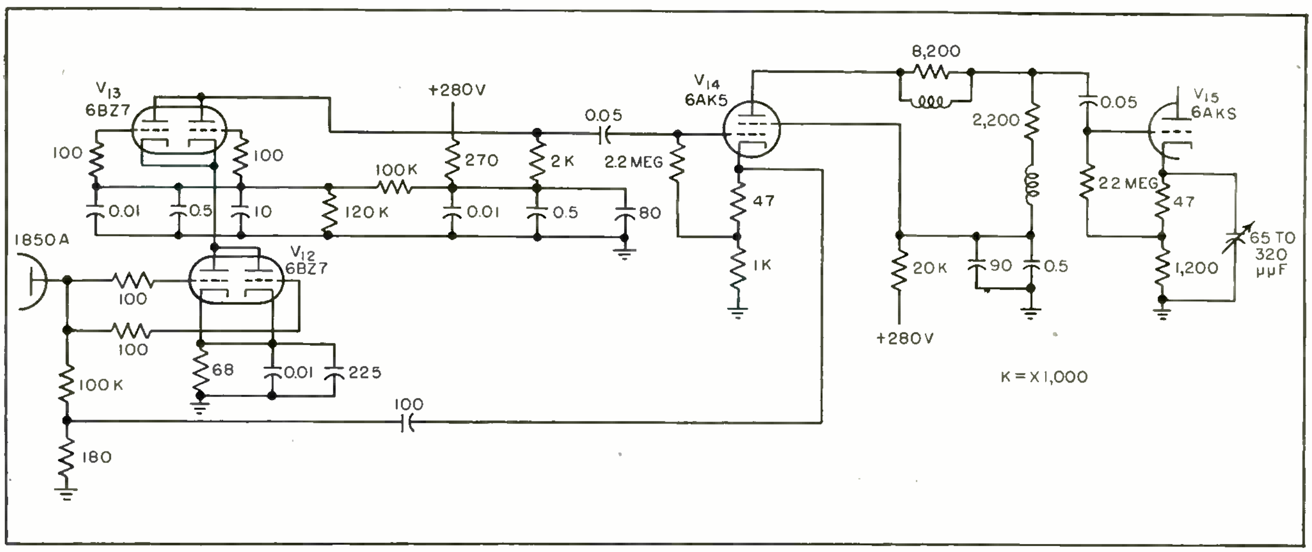


FIG. 2—Complete video amplifier circuit, showing its relation to the iconoscope output

high enough amplifier gain are employed, a feedback arrangement avoids additional compensation for loss of high-frequency response in the input coupling circuit.

Design Limitations

There are practical limits to incorporating such circuits in existing iconoscope cameras. If an acceptable signal-to-noise ratio is to be maintained in the input coupling circuit, a large value of resistance must be used. With the gain of the cascode preamplifier limited by the transconductance of available low-noise amplifier tubes from 30 to 40 times, complete compensation would require feedback over more than the input stage.

Such high-gain video feedback loops tend to be unstable because of the difficulty at the higher frequencies in keeping phase shift within acceptable limits. Excessive phase shift either through the coupling circuits or through inevitable multiple ground paths produces regeneration and non-uniform frequency response.

Compromise

Considering all these factors, a good compromise can be found in a design in which, by proper choice of load resistor and feedback voltage, the compensation is limited to the spectrum below a megacycle. In this range of frequencies, any slight variation from uniform frequency and phase response seriously affects the picture quality. Consequently, the automatic compensation provided by feedback is far superior to any manual adjustment. Inaccuracies in compensation above this range produce much less objectionable variations in picture quality. Use of techniques such as cathode degeneration are therefore entirely satisfactory.

The overall result from the combination of these two types of compensation is an exceptionally stable and flat response-frequency characteristic over a pass band of approximately seven megacycles. The only operating adjustment required is an occasional readjustment of the high-frequency peaker when preamplifier or iconoscope tubes are replaced.

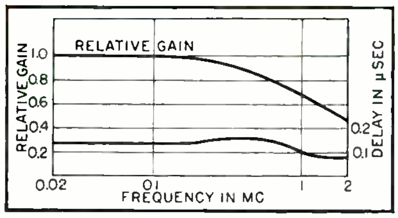


FIG. 3—Phase and amplitude characteristics of feedback-compensated preamplifier described in text

Camera Modification

Figure 2 is an example of the circuit modifications necessary to install a cascode preamplifier and degenerative compensation in the video amplifier of a commercial film camera chain. Two type 6BZ7 receiving tubes (6BQ7A or 6BK7 will give equivalent performance) are employed in a direct-coupled cascode circuit and replace the former triode-connected 6AK5 preamplifier.

Physical layout of the preamplifier is shown in the photograph. Feedback voltage taken from the cathode of the following 6AK5 amplifier V_{14} is coupled to the iconoscope load resistor through a resistance-capacitance circuit having a low-frequency loss approximately equal to that of the interstage coupling network. This characteristic is necessary to reduce the tendency so common in feedback circuits toward low-frequency damped oscillations in the order of 10 cycles or less.

Using an iconoscope load resistor of 100,000 ohms, a gain of 30 in the cascode amplifier and a feedback factor of 0.5, the relative gain of the circuit is down only 3 db at 1 mc and the phase variation over the pass band is not over 0.03 microsecond. The calculated characteristic is plotted in Fig. 3.

For compensation necessary above those frequencies covered by the feedback preamplifier, the cathode components of V_{15} are chosen to provide a rising frequency characteristic from 1 mc to approximately 7 mc. By use of the variable capacitance in this circuit, the characteristic may be adjusted to match the roll-off of the preamplifier without any variation in low-frequency gain. The measured overall characteristic of cameras employing this combination of feedback and cathode degenerative compensation has been found to be well within a db of flat response to 7 mc.

Broadcast Use

Criticisms of poor motion picture film reproduction have been unjustly leveled at the iconoscope when the faults have been either directly or indirectly a result of shortcomings in the video preamplifier. By use of the preamplifier design described, it is possible to operate the iconoscope under conditions that allow full realization of its inherent capabilities. The lower amplifier noise level permits the use of low beam currents and consequently greatly minimizes the spurious signal problem. At the same time, an improvement in gray scale is achieved. Resultant picture quality excels that obtained by application of the image orthicon to film pickup.

Preamplifiers employing this circuit have been used in iconoscope film cameras at WCBS-TV and KNXT since early in 1952. The low noise-level combined with the high degree of stability and reliability of performance provided by the inverse feedback has made possible a degree of quality of film reproduction that had not previously been realized consistently on a day-to-day operational basis.

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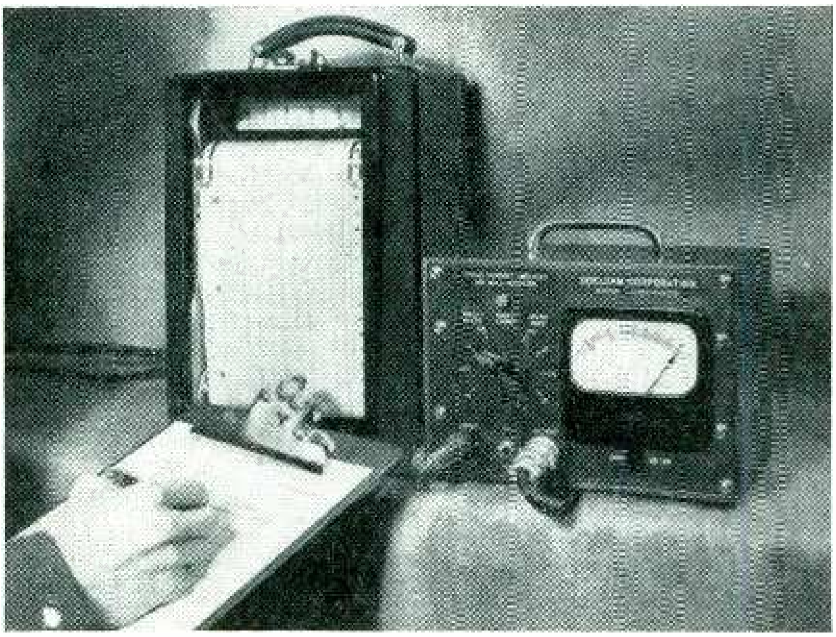
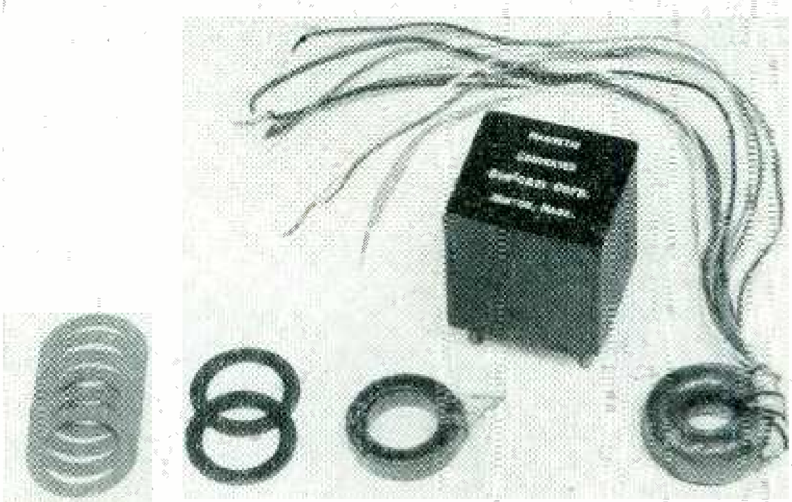
Magnetic-Converter

Second-harmonic magnetic converter with a-c amplifier can be used to amplify d-c signals as low as 2×10^{-15} watt. Long-time drift is less than 5 μv. Applications include thermocouple-operated temperature monitors and voltage-regulated power supplies



The d-c amplifier and null indicator using magnetic converter has low and high impedance outputs for recorder or control-system use. Direct-reading meter will respond to signals as low as 1 μv at 0.002 μa



Built-up cores of magnetic converter are wrapped with excitation and control windings and the entire unit is mounted in a box about 1½ in. square

By **WILLIAM A. ROTE**

Doelcam Corporation
Newton, Mass.

PROPER functioning of any servo, feedback or control system requires that the amplifier or gain-producing block possess excellent zero stability. The a-c amplifier meets this requirement admirably and hence is almost universally used in stable, high-gain systems.

There are, however many advantages to using direct current in the low-power measuring and rebalancing part of the system. By using d-c, only resistance of the line becomes a factor, and difficulties caused by phase and a-c waveform are eliminated. Since stable high-gain d-c amplifiers are difficult to attain, a converter is usually employed between the d-c measuring system and an a-c amplifier. For use in null systems there should be no a-c signal out of the converter when the d-c input is zero.

Because of their inherent stability, vibrator-type converters[1] have largely been used for this application. Difficulties with either contact or capacitor converters are mainly mechanical in nature, particularly where extended frequency response is necessary. Other nonmechanical converters have proved troublesome due to excessive drift or noise.

Magnetic Converter

A new type of d-c amplifier has been developed employing the even-

D-C Amplifier

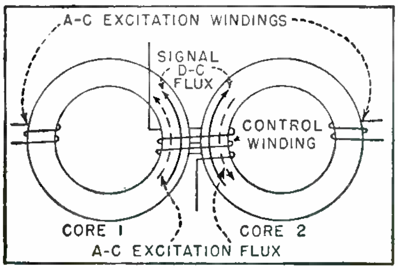


FIG. 1—Signal on d-c control winding of magnetic converter will aid the excitation flux in one core while opposing the flux in the other

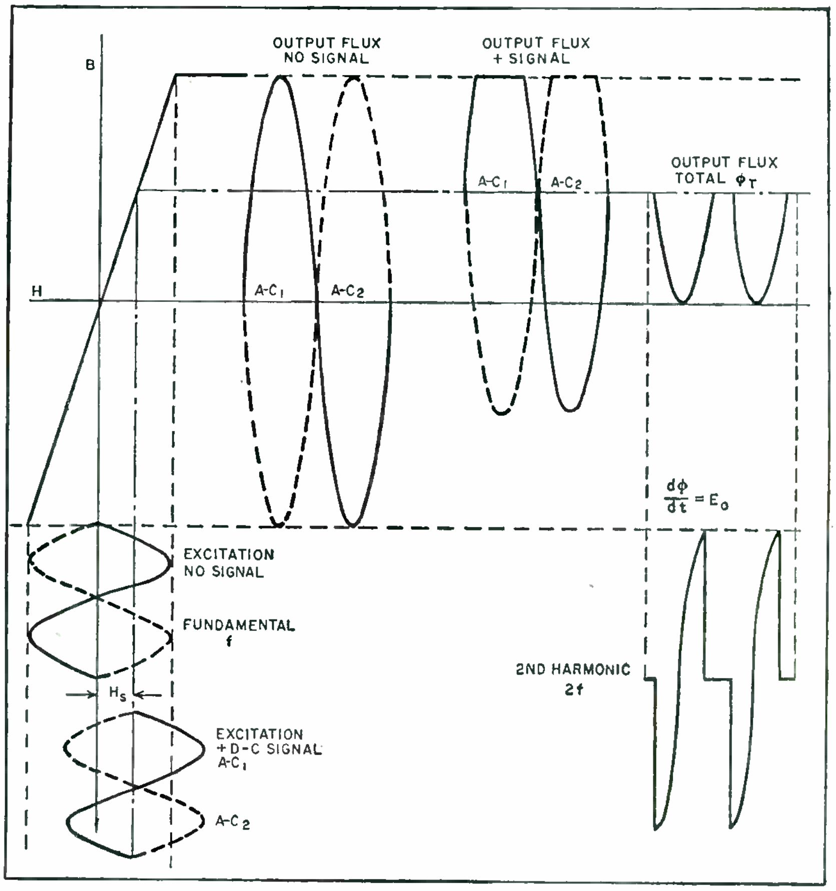


FIG. 2—Second-harmonic signal is produced in magnetic converter by displacement of the axis of symmetry by the d-c signal

harmonic converter or magnetor.

Any nonlinear element symmetrical in shape about its origin will produce only fundamental frequency or odd harmonics. However, if the axis of symmetry of a symmetrical nonlinear element can be made to shift by an external signal, even harmonics will be produced. This principle forms the basis for the converters to be described.

The nearly perfect symmetry of paramagnetic materials makes them suitable for use in converters. In addition they have the advantage of a large conversion gain when used in proper core and winding arrangement. Any even harmonic of the fundamental can be used as the signal carrier, but because of its strength, the second harmonic is generally chosen.

Construction

The second-harmonic converter used in the d-c amplifiers described here consists of two cores with signal and excitation windings. For high sensitivity, the core material must have a reasonably high permeability, and must be suitably laminated. Insulation between laminations is used to increase the resistivity of the core for reduction of eddy-current losses at higher frequencies. If high power levels are to be handled, a material having a high maximum flux density should be used. A magnetic converter in various stages of assembly is shown in the accompanying photograph.

The converter windings are arranged so that the direct-current signal flux will aid the instantaneous a-c flux in one core while opposing in the other, as shown in Fig. 1. The signal winding, which is common to both cores, may be used to couple out the resulting even-harmonic carrier or a separate secondary may be used for this purpose.

Operation

Production of the second harmonic by the opposing a-c fluxes when the axis of symmetry is disturbed by a unidirectional input signal is shown in Fig. 2. If the core loops are slightly different, some fundamental frequency will result but this is filtered out later and does not affect overall operation. If the polarity of the input d-c signal is reversed, the output second-harmonic wave will reverse in phase 180 degrees.

Stability

The greatest difficulty in balance devices of this kind is maintaining zero stability with changing ambient temperature. The principal change in core materials with temperature is permeability, and this effect may manifest itself not only as a net change in permeability but also a differential change from one matched core to another. A pronounced fundamental unbalance may occur with temperature change. However, the second-harmonic output does not depend on the slope of the magnetization curve but rather on the symmetry of the curve. This property of the materials used is stable with respect to temperature change.

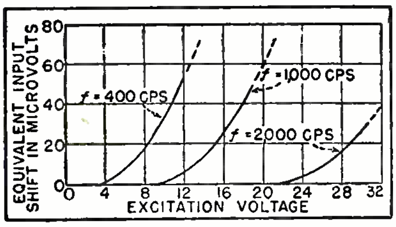


FIG. 3—Shift in zero caused by variation of excitation voltage in second-harmonic magnetic converter

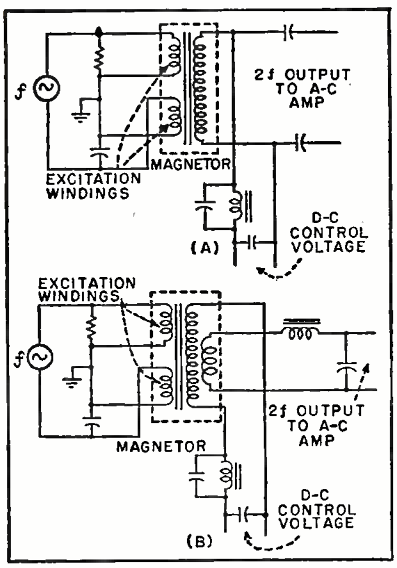


FIG. 4—Methods used for filtering fundamental from output of second-harmonic converter. Converter (B) has a separate secondary for output

Within reasonable limits, changes in a-c excitation voltage will not affect balance since the equal B_{max} characteristic of the cores will not produce the second harmonic until a signal flux destroys the symmetry. The zero shift caused by a change in excitation voltage is shown in Fig. 3. A reasonably pure sine-wave excitation current is required since harmonics contained in the excitation may appear in the output by transformer action.

Filters

The overall gain and performance of the second-harmonic converter depends to a large extent on the filters used. Since, in the practical case, large amounts of fundamental frequency as well as other harmonics will appear in the output, it is necessary to incorporate a bandpass filter characteristic in the overall device. Two filtering methods are shown in Fig. 4. The parallel-tuned high-Q filter in series with the control winding is particularly desirable since the flow of odd harmonics in the input winding will increase the output. However, second-harmonic current should be prevented from flowing in the input, and to this end, the parallel-tuned L-C filter is tuned to resonance at the second-harmonic frequency. The capacitor across the d-c input serves as a low-impedance path for harmonics and unwanted a-c in the input line.

Overrange

Two other effects which must be considered in practice are external fields and overloading. The external-field problem is easily solved since the converter is in toroidal form which inherently protects the device from external fields. Addition of one or more high-permeability shields will render the device insensitive to extremely high permanent-magnet fields.

If the converter is excited at high flux density it will stand at least 15,000-to-one overload with less than 0.1-percent zero shift when operating in a high-gain condition. Should it become overloaded by application of high voltage to the input, rezeroing may be accomplished by raising the excitation voltage till both cores are saturated and then lowering again to the operating point. The unit cannot be damaged by overloading short of the burn-out point.

The magnetic converter has been incorporated in several instrument designs for measurement and control. A multirange d-c amplifier and meter which may be used for amplification or measurement of signals as low as 2×10^{-15} watt (1 microvolt at 0.002 microamp) is shown in the photograph. Measured drift over periods of several days for this instrument did not exceed 5 microvolts (5×10^{-14} watt). Linearity of the overall amplifier is better than 0.1 percent when the input range is 10 millivolts or greater. Frequency response of such an amplifier without feedback is mainly limited by the design of the converter, the excitation frequency and the bandwidth of the filters used. Millivolt amplifiers having flat response to about one-hundred cycles, are practical at present.

Complete D-C Amplifier

A simplified schematic of the amplifier circuit is shown in Fig. 5. In this case, the a-c output of the converter is filtered by a simple series-tuned circuit and supplied to a two-stage voltage amplifier. The amplifier output is transformer-coupled to a peak-reading phase-sensitive demodulator.

The demodulator is somewhat unique in that the reference voltage is of fundamental frequency and the signal the second harmonic. A graphical explanation of its operation is shown in Fig. 6. Since the fundamental is shifted 90 degrees with respect to the second harmonic, the sum of $f + 2f$ adds to give a greater peak voltage on one side of the axis than the other as shown. Thus the circuit is phase sensitive. Capacitors C_1 and C_2, in Fig. 5, charge to the peak of the reference voltage, and the $2f$ signal adds to one side and subtracts from the other depending on the phase of the $2f$ carrier. Since the time constant of the capacitor discharge path of C_1 and C_2 is long compared to the carrier period, the peak-reading capacitors discharge very little during each cycle, and the charging diode conducts only a small portion of each cycle. This fact plus

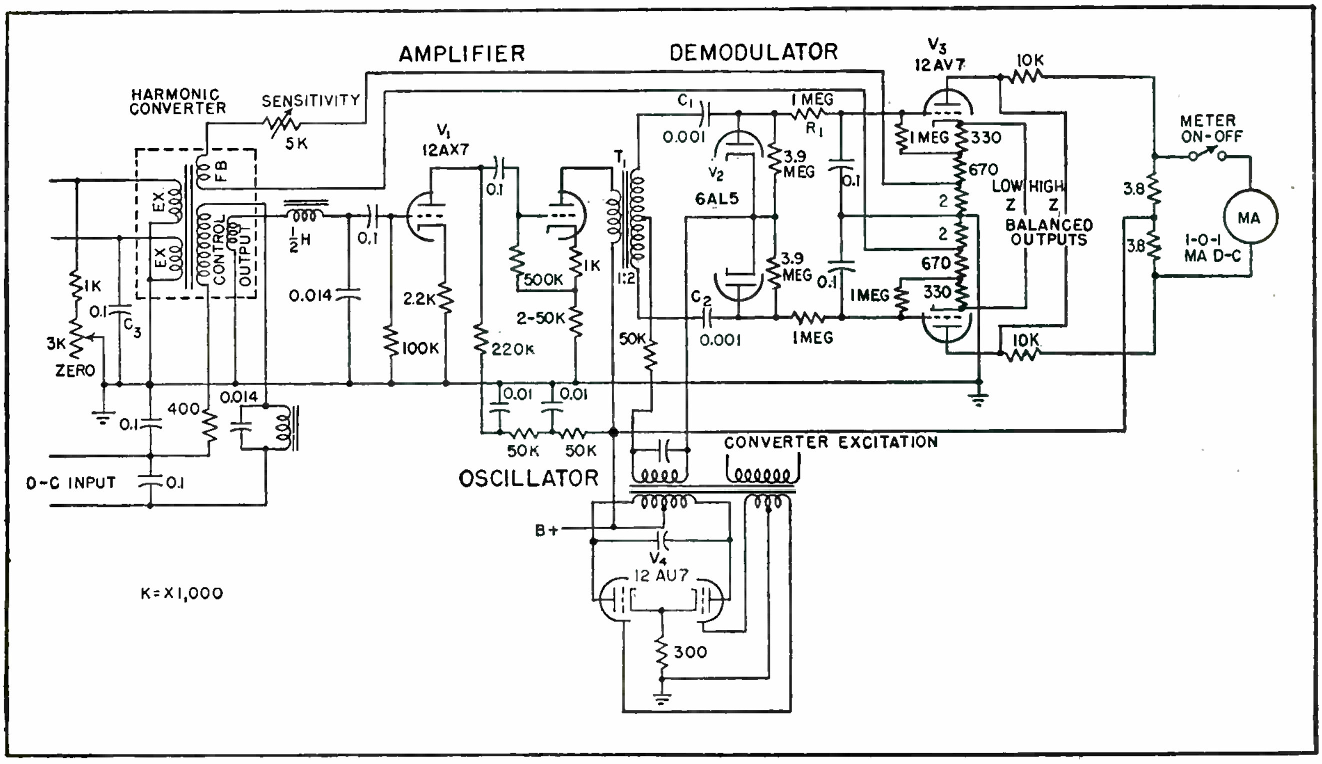


FIG. 5—Circuit of complete d-c amplifier. Balanced outputs provide for feeding either low or high impedance

the very high signal voltage makes the amplifier practically independent of diode characteristics.

The demodulated output enters a power-amplifier stage and then is applied to the output terminals or meter and feedback network, depending on the range selected. Two types of feedback circuits are used. A separate feedback winding may be provided on the converter allowing the input to the amplifier to be completely isolated but of limited input impedance. If high input impedance is desired, the feedback voltage is fed in series with the converter input and the signal source. In both cases the input impedance, stability and gain may be calculated by conventional methods used for feedback amplifiers.[4]

The new d-c amplifier is particularly suited to null-balance potentiometric or control systems. The circuit can be used in a simple temperature monitor or controller that will operate a relay from a thermocouple or resistance bridge. Reliable relay operation with a response time of 1/100 second is quite practical with this type of amplifier with an input as low as 10^{-12} watt.

The high degree of zero stability of the amplifier makes it useful in self-balancing systems such as the voltage-regulated power supply shown in Fig. 7A or 2 slide-wire potentiometer, Fig. 7B. Because of their low current drain such systems may often be operated directly from a standard cell.

While much more research remains to be done on both nonlinear elements and external circuits, the new type of converter is able to provide an inexpensive and durable amplifier, capable of wide frequency response and long-time stability.

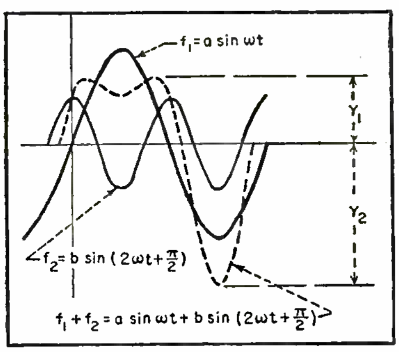


FIG. 6—Phase detector used in d-c amplifier compares second harmonic with fundamental to obtain error signal

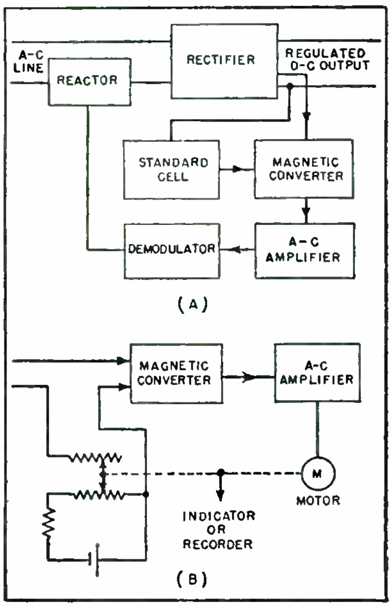


FIG. 7—Amplifier can also be used for voltage regulation (A) or in self-balancing fundamental to obtain error signal

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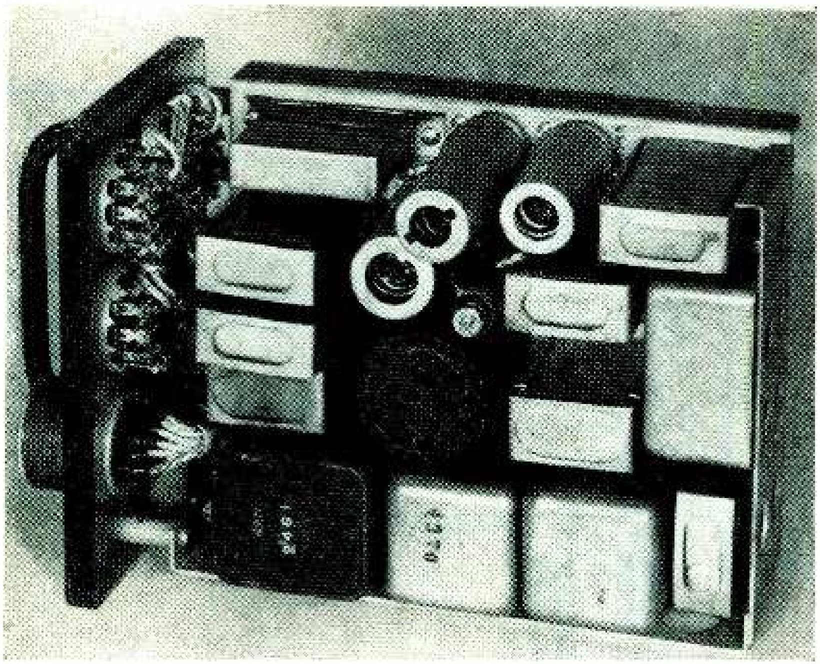


Top chassis view shows little space has been wasted in automatic pilot monitor. Fail-safe circuits monitor the monitor's activities

Monitor

By JOHN J. HESS, Jr.

Flight Control Engineer
Sperry Gyroscope Company
Great Neck, New York

WITHIN every automatic control device lies the possibility that at some time the device may cease to operate as it should. In many cases, this failure of the automatic control mechanism will do little more than delay operation of the equipment.

When the automatic control device is an aircraft automatic pilot, failure of the mechanism to operate in its prescribed manner is an entirely different matter. Certain possible malfunctions of the automatic pilot may cause it merely to cease functioning with no particularly bad results, provided the pilot makes himself aware of this situation in a reasonable amount of time.

However, if the automatic pilot should fail in a manner in which the servo output assumes a value different from zero, the amount of time the pilot has to detect such a malfunction before the aircraft attains an unsafe attitude is considerably reduced. The detection of such malfunctions is the primary purpose of the automatic pilot monitor described in this article.

Sensing Errors

Monitoring of the pitch axis of the automatic pilot is considered to be the most important from the point of view of safety. Although monitoring of the roll and yaw axes is also important, the length of time a pilot has to disengage the automatic pilot, should a malfunction occur, is considerably greater. The method of approach used in the automatic pilot monitor for the pitch axis is equally applicable to the roll and yaw axes.

The most straightforward approach to the monitoring problem would provide a duplicate automatic pilot for each axis. If, for example, the output of the two channels for the pitch axis should differ at any time, it would be an indication that a malfunction had occurred and the automatic pilot would be disengaged. The chance that the same malfunction would occur in each of the channels of the pitch axis at the same time is extremely remote.

Practical Approach

While the duplicate channel approach is conceptually a simple one, the method calls for undue duplication of equipment. It was desirable to design the monitor to be simpler than the device it was protecting and to be more reliable.

If automatic pilot malfunctions were of such a nature that the resulting servo signal was distinguishable from that due to normal operation, it would be sufficient to put a suitable detector on the servo output and detect this difference. However, in severe turbulence, the output of the servo system can be higher with less airplane motion than in the event of a malfunction. The problem, therefore, amounts to measuring the aircraft motion, computing what the servo output should be due to this motion and comparing this with the actual servo output. In this manner, it is possible to ascertain whether the servo output is correct for the motion of the aircraft.

The output of the servo system can be measured in a number of places such as the input to the control generator, the output of the control generator and the position of the servo motor. Measurement of the aircraft attitude can also be done in a number of ways, such as by a displacement gyro, a rate gyro or an angular accelerometer.

System Used

In the equipment under discussion the output of the servo system is measured at the input terminals to the servo motor, and the aircraft attitude is measured by an angular accelerometer. In turbulent air these two signals will not, in general, be equal at all times and therefore they must be suitably modified before they can be compared. Each of these signals is modified by an electrical network so that for any arbitrary motion of the aircraft in rough air, the modified servo signal and the modified angular accelerometer signal will be equal and opposite.

If these two modified signals are matched when the aircraft motion is due to turbulent air, they will not be matched when the servo and accelerometer signals appear due to a malfunction. The resulting

For Automatic Pilots

Prevents violent maneuvers as might occur if automatic pilot ceases to function properly. Coincidence-type circuits prevent monitor acting on turbulence-caused movements of aircraft. Fail-safe operation is incorporated

signal due to this mismatch is then amplified and used to release the automatic pilot electrically so the pilot can take over.

Theory of Operation

Figure 1 represents a simplified block diagram of an aircraft under automatic pilot control. The inputs shown in the diagram represent a signal θ_i, equivalent to a malfunction of the automatic pilot and a disturbing signal *M*, due to turbulence. It is shown in the following development that the response δ of the servo system for a given aircraft motion θ is different when the disturbing signal results from a malfunction and when the disturbing signal is due to turbulent air.

When the system (see Fig. 1) is disturbed by a malfunction θ_i the servo response in terms of attitude is $\delta/\theta = 1/\mu_6$. When the system is disturbed by turbulence *M* the servo response in terms of attitude is $\delta/\theta = -\mu_1\mu_2$. Comparison of these two equations shows that the relationship between servo output and attitude is different depending on the nature of the system disturbing signal. If $1/\mu_6 = -\mu_1\mu_2$ at any time, the closed-loop system would be unstable; this condition is precluded by good automatic pilot design.

Figure 2 shows in block diagram form the aircraft under automatic pilot control with the angular accelerometer and corrective networks added. To obtain satisfactory operation of the monitor in the presence of turbulence *M*, it is necessary that the network outputs be equal.

The difference signal *D* can be designed to have any desired characteristic with respect to θ_i by suitable choice of μ_6. Once μ_6 has been determined in this way, μ_6 is taken as the value that will maintain the network outputs equal in the presence of turbulence *M*.

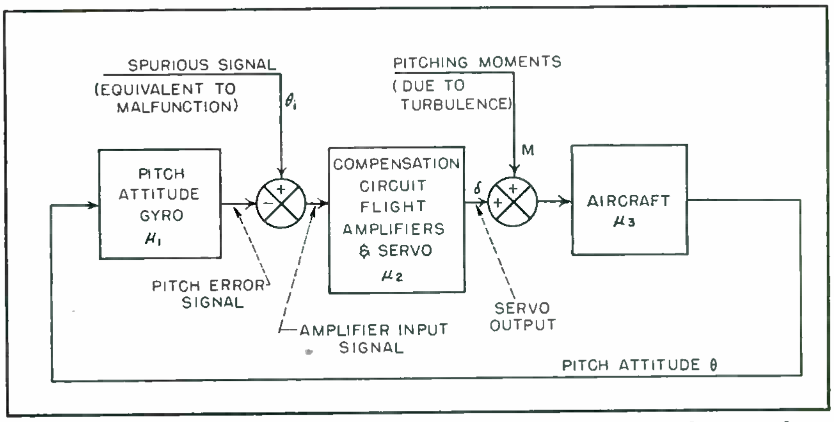


FIG. 1—Simplified block diagram of aircraft under automatic pilot control

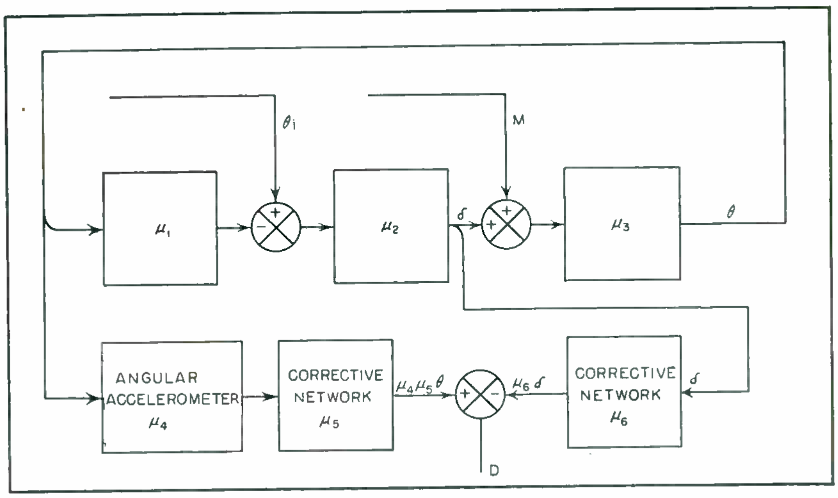


FIG. 2—Diagram shows addition of provisions for monitoring

Angular Accelerometer

The angular accelerometer consists of two linear accelerometers mounted sufficiently far apart in the aircraft. These two accelerometers are connected electrically so that the resultant signal represents the difference in linear acceleration at each accelerometer and is, therefore, a measure of the angular acceleration of the aircraft.

Each accelerometer consists of a spring-restrained pendulum with magnetic drag-cup damping. Angular displacement of the pendulum results in rotation of the electrical pickoff which in each accelerometer is a synchro. These synchros, shown schematically in Fig. 3, are connected electrically in a data transmission system, such that the output represents the difference in rotation of each synchro or the difference in linear acceleration at each accelerometer.

Servo System

The servo system of the autopilot is shown schematically in Fig. 4. It consists of an amplifier, the output of which controls the out-

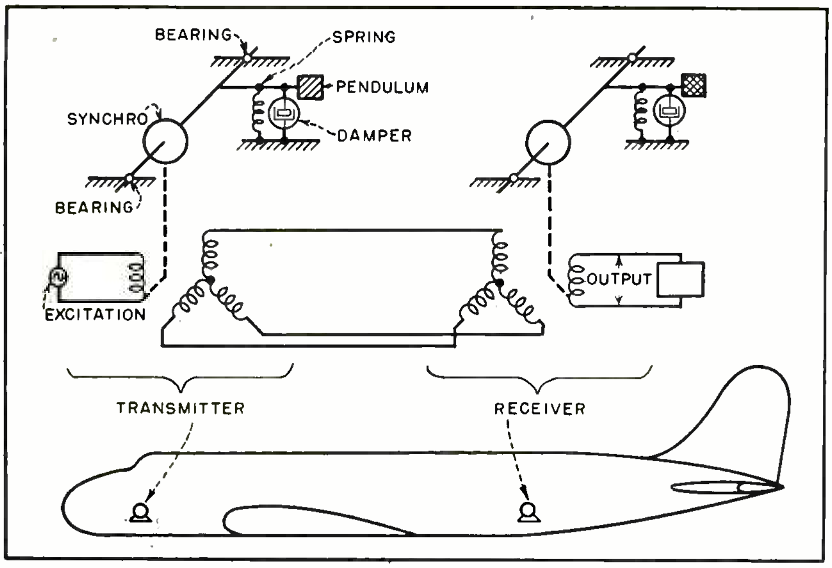


FIG. 3—Schematic diagram of angular accelerometer arrangement

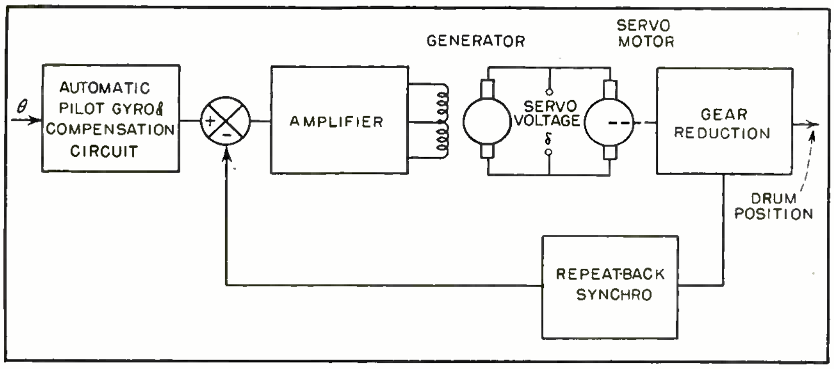


FIG. 4—Simplified diagram of automatic pilot servo system

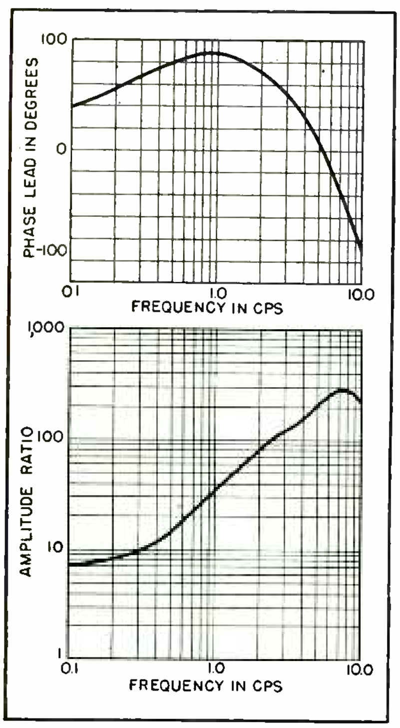


FIG. 5—Servo response versus attitude due to turbulence

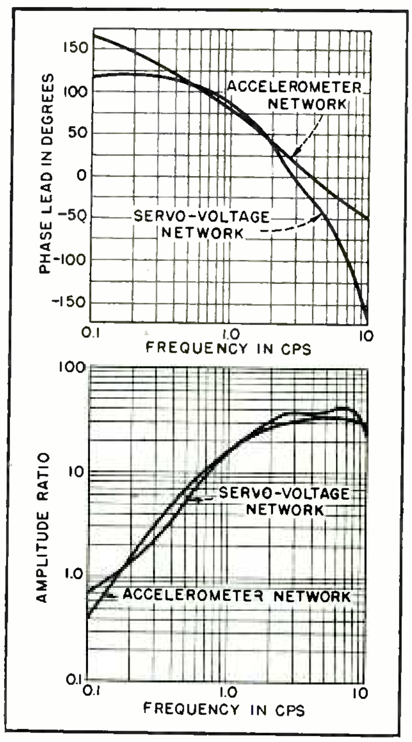


FIG. 6—Comparison of network outputs for disturbances due to turbulence

put of the generator. The output of this generator is, in turn, applied to the servo motor. The resulting motion of the servo drum is fed back to the input of the amplifier to obtain the fast response and accurate positioning characteristics of the servo system. The voltage applied to the servo motor from the generator is used as a measure of output of the servo system for the monitor. However, for the purpose of clarifying the analysis, the output of the servo system is assumed to be a moment as shown in Fig. 1 and 2.

Corrective Networks

The design approach for the corrective networks, μ_5 and μ_6, (Fig. 2) in the monitor made use of the fact that if the frequency responses of two separate systems are identical in phase and amplitude at each frequency, the transient response of each system for the same arbitrary input will also be identical. Thus if μ_5 and μ_6 are chosen so that

$$\frac{\mu_5}{\mu_6} = -\frac{\mu_1 \mu_2}{\mu_4}$$

any transient disturbance M will result in equal and opposite outputs from the two corrective networks.

The response of the aircraft was determined by flight measurements. These consisted of phase and amplitude measurements of aircraft attitude and servo system output, with respect to a forcing signal at several frequencies over a sufficiently wide range. From these measurements it was possible to determine the servo output with respect to aircraft attitude that would exist in sinusoidal turbulence. In this manner the relationship expressed in the above equation is determined.

These characteristics are shown in Fig. 5. To modify the servo and accelerometer outputs so that a perfect match would be obtained at all frequencies, it would be necessary to use resistors, capacitors and inductors in the corrective networks. For simplicity of fabrication a sufficiently good match could be obtained with resistors and capacitors only in the corrective networks.

The natural frequency of the

angular accelerometer was determined by a compromise between obtaining sufficient sensitivity in the accelerometer on one hand and a sufficiently high natural frequency so that variation in damping would not cause too large a change in the matching of the network outputs. Even though magnetic damping represents a considerable improvement over viscous fluid damping from the point of view of stability, variations in damping constant with temperature remain substantial. However, the natural frequency of the accelerometer is high enough so that these variations in damping are of no practical consequence.

Corrective networks were synthesized by establishing the minimum number of R-C meshes that would be required for each network. The resistor and capacitor values required for matching the two outputs at as many points as possible were then determined. These points were chosen in the frequency range considered to be most important, from 1/10 to 10 cycles per second.

Figure 6 shows the extent to which the network outputs, μ_4 μ_5 θ and $\mu_6\delta$ were matched for turbulent air. The calculated performance of the system is shown in Fig. 7. Curve *B* shows the attitude allowed by the cutoff at each frequency when the disturbance is due to turbulence. Curve *C* shows the ratio of *A* to *B*, which is the amount of protection afforded by the monitor.

Mismatch Signal Detector

The signal resulting for the difference between the two corrective-network outputs is at a low power level because of the relative high impedance of the networks. In amplifying this signal to a level sufficient to operate a relay, it was considered necessary that failure of the amplifier should result in a release of the automatic pilot. Thus the pilot would be made aware of any malfunction in the monitor as well as a malfunction in the automatic pilot.

The release circuit (Fig. 8) consists of an overcurrent relay and an undercurrent relay in series in the plate circuit of the relay tube. The relay tube plate current is adjusted to a value between the operating points of the relays with no signal. A signal of either polarity coming from the networks will drive the relay tube plate current either up or down, resulting in operation of either the overcurrent relay or the undercurrent relay.

If a short or an open should develop in the relay tube, the overcurrent or undercurrent relay will release the automatic pilot. To reduce relay tube current fluctuations with line voltage, the relay tube circuit is a cathode-follower circuit at very low frequencies. The plate current is established by applying an accurately known reference voltage to the grid with an accurately known resistor in the cathode circuit. This accurate reference voltage is obtained by regulating the a-c line voltage with the VR tube and rectifying the output before applying it to the grid of the relay tube.

Maneuvering Commands

The design of the monitor is such that there is no difference as far as the unit is concerned between a malfunction and a maneuvering command which is inserted in the automatic pilot by the pilot. The rate at which maneuvering commands are inserted into the automatic pilot is sufficiently low so that the resultant mismatch signal from the networks to the relay tube circuit is insufficient to release the automatic pilot. If the pilot should inadvertently insert too large or too fast a command signal into the automatic pilot, the automatic cutoff would monitor this signal and release the automatic pilot. Although it is possible to insert a switch which will disable the monitor while large maneuvering commands are being inserted, this feature has not been included.

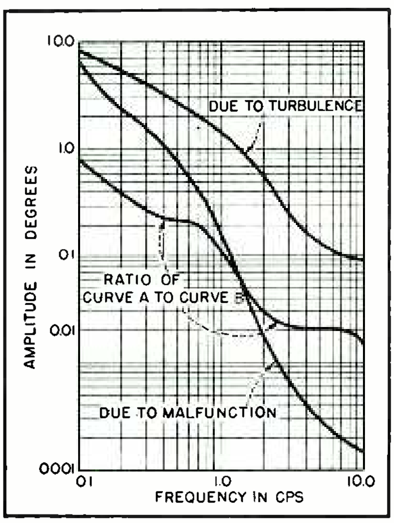


FIG. 7—Allowable aircraft motion before cutoff. From top to bottom (at 10 cps) curves are B, C and A

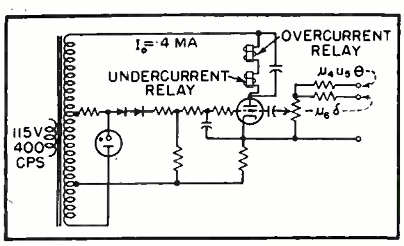


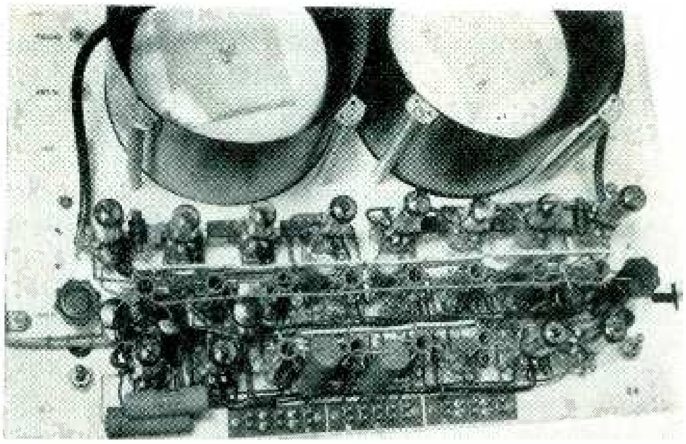
FIG. 8—Circuit of relay-tube amplifier shows fail-safe arrangement with two relays in series with plate

Test and Performance

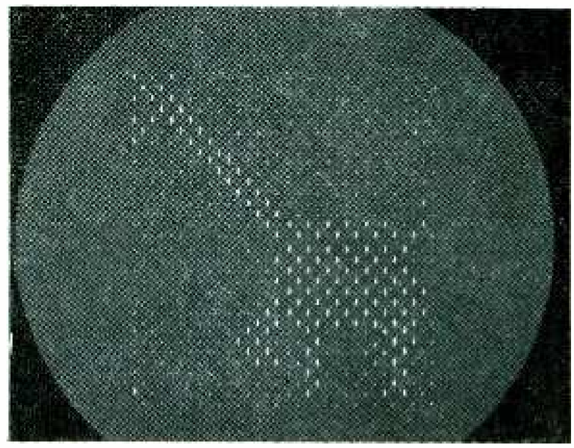
Testing of the monitor is done in three steps. In the first step the aircraft is flown in as severe turbulence as it is expected it will normally encounter. Under these conditions it can be determined whether the network matching is adequate. This procedure is followed by a test of the unit with the aircraft flying in smooth air to determine that the degree that the monitor must be desensitized to permit maneuvering commands to be put into the automatic pilot without releasing it.

After this level of sensitivity has been established, the third step consists of simulating malfunctions by inserting signals into the automatic pilot and determining the level at which the monitor will operate. The sensitivity of the monitor is such that a malfunction which would call for an abrupt attitude change of approximately two degrees is sufficient to release the automatic pilot.

The automatic cutoff described protects the aircraft from automatic pilot malfunctions of the type which are the most difficult for the pilot to detect quickly and which are potentially the most damaging or discomforting. Future developments will undoubtedly result in monitoring equipment which protects against slow malfunction as well as rapid ones. This is a necessary step toward the goal of completely automatic flight.



Shields removed from pair of tubes show copper mesh screen held to face of tubes with transparent cellulose tape. Pairs of tubes are rack-mounted (see photograph on opposite page)



Demonstration pattern of stored dots and dashes shown on monitor tube reveals pattern that would be obscured by wire screening of storage tube

Computer Memory Uses Conventional C-R Tubes

Digital computer memories with speeds up to 100,000 words a second have been constructed using the Williams system for rapid calculations. Comparable equipment in SEAC at Bureau of Standards delivers 21,000 words per second from battery of 45 c-r tubes

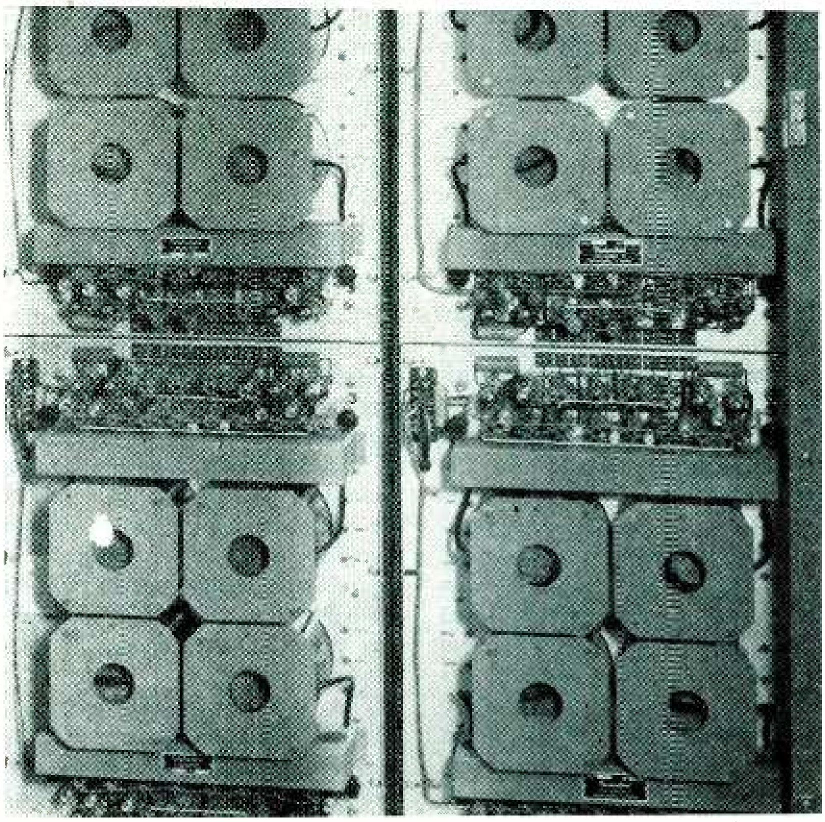
MEMORY SYSTEMS in digital computers have tended to lag behind control, arithmetic and input-output elements in their speed capabilities. The many memory devices now in use—punched paper tape, magnetic tape, magnetic drums, magnetic toroids, acoustic delay lines, bistable flip flops, capacitors and several types of cathode-ray tubes—are generally the limiting factor in the overall speed of computation.

Especially promising at the present time is the so-called Williams electrostatic memory system, the invention of F. C. Williams and T. Kilburn of the University of Manchester in England. Using the ordinary oscilloscope type of cathode-ray tube, the Williams technique combines low cost with unusually rapid access to any of a large number of stored digits. An ingenious aspect of the system is the way in which stored numbers are read. A piece of ordinary metal screen is fastened to the face of the cathode-ray tube.

By capacitive pickup it is able to respond to the small changes in the charge on the inside of the face that take place when the electron beam in the tube strikes a selected storage position. The Williams system is inherently fast because of the great speed with which the electron beam can be directed to any of the storage positions on the face of the tube. Because the charge pattern tends to leak off, each of the storage points must be regenerated—read and then rewritten—at a rate of about 100 times a second.

Although there are a number of ways of producing suitable charge patterns on the phosphor, most of the new Williams-type machines in the United States, such as the NBS SEAC, are using the dot-dash method, or slight variations on it. This method derives its name from the fact that one of the two binary choices (all present electronic computers use binary symbols rather than decimal symbols) looks like a dot when stored on the face of a cathode-ray tube, and the other looks like a dash.

In the dot-dash method the electron gun can be aimed at any one of a number of positions, or ad-



Partial view of four-tube rack assemblies showing shields over tube faces. There are three four-tube units in each rack for the SEAC computer at National Bureau of Standards in Washington, D. C.

By A. W. HOLT and W. W. DAVIS
Electronic Computers Laboratory
National Bureau of Standards, Washington, D. C.

dresses, on the phosphor. If a dot is to be written at a particular position, the beam is directed to the position and left on for 0.5 microsecond. If a dash is to be written, the beam is held on for a longer time—about three microseconds—and is deflected about one spot diameter during this time. To read the information at some later time, the same procedure is followed as in writing a dot; when the beam is turned on, a negative signal appears on the pickup screen if the information was a dot. If the information was a dash the output signal is positive. However, the reading operation changes any dash to a dot. Therefore, if a dash is to be kept in storage, it must be rewritten immediately after being read for proper operation.

Operation thus depends on the fact that, in reading, the beam gives a negative signal when it hits a dot but a positive signal when it hits a dash. The reason why a cathode-ray tube behaves in this way is not easily explained, and attempts at analysis indicate that rather complicated phenomena are involved.

A simple explanation based on well-known behavior of secondary-emitting surfaces was proposed by Williams and Kilburn in their original paper[1], but it soon appeared that there were some phenomena not explained by their theory. Among those who have contributed more recently to the theory are: C. V. Parker[2], J. Kates[3], L. Brillouin[4] and A. W. Holt[5]. Although it must be emphasized that no complete theory of Williams storage is yet thoroughly established, the mechanism as it is presently understood is as follows.

Assume that the phosphor of a cathode-ray tube, connected as shown in Fig. 1, is initially at ground potential. When a well-focused beam is turned on a spot near the center of the tube, the following progression of events occurs, as shown diagramatically in Fig. 2.

First, a current of secondary electrons greater than the incoming beam current is emitted from the surface under primary bombardment (Fig. 2A). The secondary electrons have an average energy of about two volts. These low-energy electrons fall back on the insulating surface, charging it negatively with respect to the third anode (Fig. 2B). In the initial stage few electrons have the proper energy and direction to reach the third anode. As the potential of the emitting spot drops lower and lower, more and more secondaries are collected at the third anode (Fig. 2C). It is apparent that a point of equilibrium must exist, because if ever the current away from the emitting spot (total secondaries minus returning secondaries) exceeds the primary current, then the potential of the emitting spot must rise.

Finally, the equilibrium distribution of potential across the face of the tube at which the third anode current is equal to the incoming primary current is attained (Fig. 2D). The negative ring around the bombarded spot is caused by the space-charge minimum, which in turn is caused by the emission velocities of the secondaries. Using a one-microampere beam current, this equilibrium is attained in a time of the order of milliseconds.

If the beam is turned off, the potential of the phosphor will rise towards ground, mostly by leakage through the glass face to the pickup screen. For a five-inch tube made of high-resistance glass this time constant is of the order of seconds.

Assuming the foregoing mechanism and equilibrium potential distribution, the source of the negative and positive signals which form the basis of the Williams storage system can be explained.

Negative (or Dot) Signal

Consider that the waveforms of Fig. 3A have been applied to the equipment shown in Fig. 1 for a long enough time so that the equilibrium potential distribution is assured. Assume also that the phosphor charge does not leak appreciably during the time between pulses. There appears at the pickup screen during each pulse of beam current a negative signal that

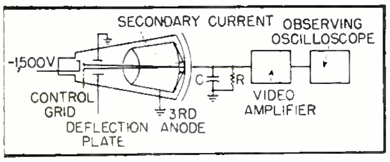


FIG. 1—Elements of Williams storage

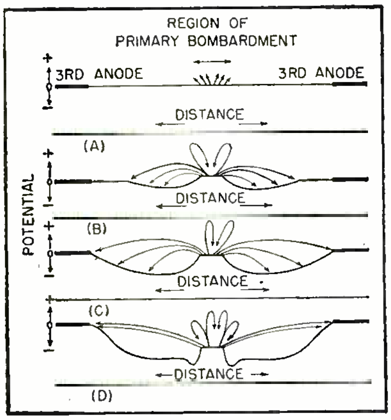


FIG. 2—Potential diagrams show distribution across tube face. Successive steps in charging of screen when beam is turned on a single spot

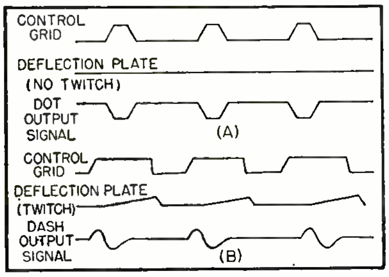


FIG. 3—Waveforms for observing dot signal (A) and dash output (B)

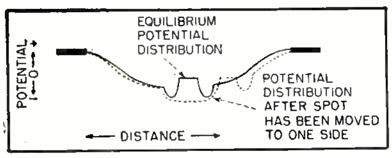


FIG. 4—Effect of splash upon potential distribution when spot is moved

is caused by the sheet of secondary electrons flowing radially from the bombarded spot to the third anode. This current is at all times equal to the primary current, and the resulting negative signal is directly proportional to the beam current. The potential of the phosphor does not change.

If the spot is moved to one side or twitched while the beam is on, as shown in Fig. 3B, a small perturbation is produced in the equilibrium as illustrated on Fig. 4.

Secondary electrons from the new spot simply splash onto the old plateau and thus push down the potential of that part of the phosphor until it reaches the potential of the space charge minimum. The beam is turned off in the deflected position. The next time the beam is turned on the original spot, the potential rises quickly to its equilibrium value, thus producing a positive signal on the pickup screen. The signal, in this case, is due to a change in phosphor potential and is not, as in the dot case, due to a sheet of secondary electrons.

NBS Version

The dot-dash mode of operation was chosen for the full-scale experimental Williams system that has been built at the National Bureau of Standards. The NBS memory, like most Williams memories that have been designed in the United States, is fully parallel in its operation. The binary digits (bits) of a number are stored in corresponding positions on different cathode-ray tubes, one digit (dot or dash) per tube. Forty-five cathode-ray tubes are used, permitting storage of words, each consisting of 45 binary digits. Each tube has 512 storage positions, or addresses, so that 512 45-digit words can be stored simultaneously.

The block diagram for the NBS Williams memory is shown in Fig. 5. The dominating consideration in the design of the control system is the fact that the two functions of regeneration and access by the computer must be intermixed. A binary counter, with parallel output, supplies the address of the next position to be regenerated. The address register supplies the address to which the computer desires access. The outputs of the counter and address register are accepted by the staticizer according to the following plan. Every memory cycle is 12 microseconds long regardless of whether it is used for regeneration or for access. So long as the computer does not call for access, regeneration takes place at a rate of one address every 12 microseconds. This means that each address will be regenerated once every 6,144 microseconds since there are 512 addresses. Each regeneration cycle follows the pattern of Fig. 5. Every fourth cycle may be an access cycle, but if no demand for access is made, another regeneration takes place. The synchronizer provides control pulses to the counter and staticizer in such a way that the intermixing function is performed.

The output of the staticizer, which is held stable for 6 microseconds, is utilized by the deflection generator to provide proper voltage levels for the deflection plates of all 45 cathode-ray tubes, which are fed in parallel. Design of the deflection generator is highly critical, because it must be able to drive 1,200 micromicrofarads through a 100-volt swing and stabilize to ±0.05 volt in three microseconds.

Timing Cycle

Figure 6 shows a complete timing cycle of writing, reading, or regenerating. The top pulse, marked staticizer output, is the transformer-coupled 6-microsecond pulse originating in the staticizer. The waveform immediately below represents the waveform actually applied to the deflection plates. This waveform, which determines the beam position, has a precisely determined amplitude corresponding to the location of the information to be examined. The process of sensing and regenerating a dot or a dash in the tube is as follows. Three microseconds after the beginning of the original staticizer pulse, the beam is turned on by the third waveform (Fig. 6C). This is a 0.5-microsecond pulse. Approximately 0.25 microsecond later, the strobe pulse is applied. If a positive output is sensed during this strobe interval, the spot being examined is recognized as storing

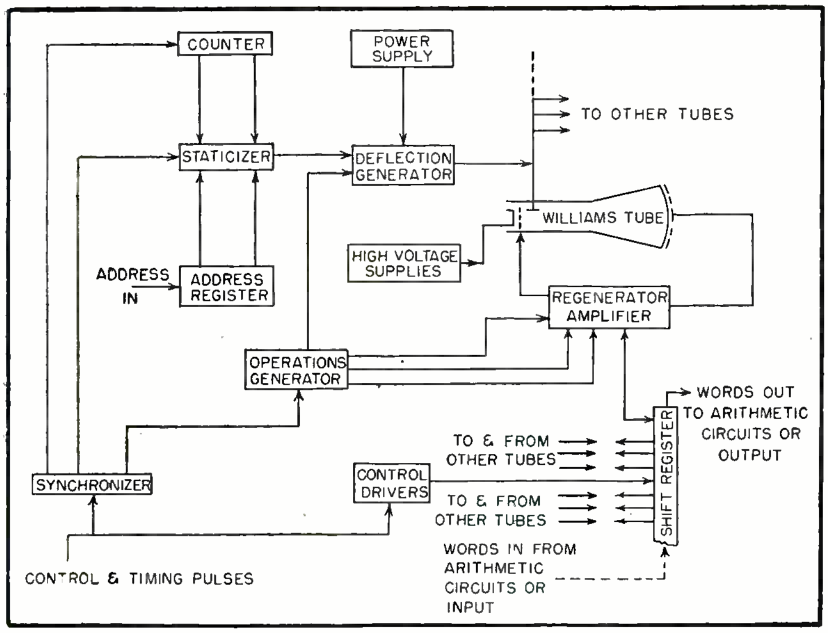


FIG. 5—Block diagram of electrostatic memory system using modified conventional cathode-ray tube

a dash, and the fourth waveform (Fig. 6D) locks in and holds the beam on for two more microseconds. The pulse marked twitch causes the beam to deflect slightly during this later period, thus rewriting a dash into the tube. The beam is deliberately held in the deflected position for an extra 0.5 microsecond, until it is thoroughly turned off. The next 6-microsecond period is left inactive so that the staticizer transformers may recover.

If no positive output is sensed, the spot is recognized as storing a dot, and the beam is turned off immediately. Although the twitch remains on the deflection plate, it has no effect since the beam is off.

To illustrate the functions of the units shown in the block diagram of Fig. 5, a typical word can be followed from computer input through a Williams memory. The word, composed of 45 binary digits, enters the shift register from Teletype or magnetic tape at some rather slow speed, perhaps one digit per millisecond, and is shifted serially through the register until all 45 flip-flops are properly set to represent the complete word. At this instant the address register is given the information from machine control that the incoming word is to be written into a certain address, such as position 346, and all 45 electron guns are aimed at position 346. During the next six microseconds a Williams write cycle occurs. The write cycle is exactly the same as the regeneration cycle, except that the output of each shift register flip-flop is substituted for the amplifier output of its corresponding Williams tube. At those tubes that receive a shift register pulse, a dash will be written into address 346; all others have the dot written automatically.

When the computer desires to read address 346, it demands access to this position, and during the next access period all guns are aimed at this address. The Williams read cycle is identical to the regeneration cycle as far as the memory is concerned. The only difference occurs in the shift register, which has each stage set to a one or a zero according to whether its corresponding Williams tube senses a dash or a dot at address 346.

A general idea of the physical construction used in the SEAC Williams system can be obtained from the photograph, which shows some of the mounts. Twenty-four tubes of various types (5UP1, 5UP11, and 3KP1 types are all satisfactory) are in operating position under the square shields; each of the long rectangular shields contains two video amplifiers. The shift register (not shown) is to the right of these relay racks.

Physical details of the tube, amplifier and gating assembly are shown in another photograph. The pickup screen is nothing more elegant than $\frac{1}{16}$-inch-mesh copper screening wire, held on by transparent cellulose tape. The critical controls of focus, astigmatism and intensity are all brought out to the front.

Gating Function

Figure 7 shows some of the electrical details of the gating amplifier. The amplifier gain control, although available, is always set at full-gain position, since the two-polarity input signal makes the system (at least theoretically) insensitive to variations in amplification so long as there is at least a certain minimum gain. Full gain is about 30,000. The twin problems of amplifier recovery and microphonism are both solved by using a one-megacycle resonant circuit as plate load for the first stage. The gating functions of the gating amplifier can be followed by referring to Fig. 6 and 7.

The negative pulse $-T$ turns the grid driver tube off, delivering a positive pulse to the grid of the crt. The pickup screen at the front of the crt receives a positive or negative signal depending on whether the spot interrogated was a dash or dot; this signal is amplified and fed to the AND gate 1 where it is gated with the strobe pulse. If a positive amplifier signal is coincident with the strobe, a positive pulse is delived to the OR gate, through which it passes and turns

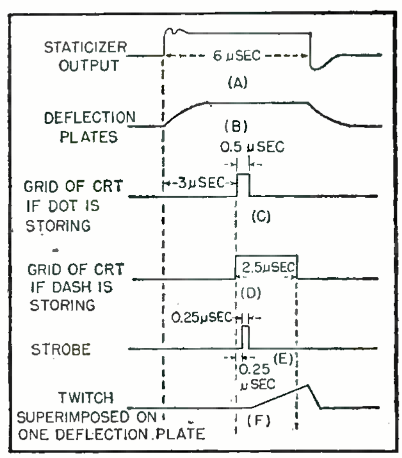


FIG. 6—Timing of the memory cycle is explained in text

on the tube-transformer unit. The positive output of this unit is fed back to AND gate 2, and the output from AND gate 2 serves as a positive feedback loop to the grid as long as H stays up, thus acting as a pulse-stretcher for the original short signal output from AND gate 1. The positive output from the tube-transformer unit also serves to indicate to the shift register that a 1 was stored in the address just read. In order that the dash be rewritten, the negative output of the tube-transformer unit is fed to the grid driver tube. The grid of the crt is held on for the total duration of H, during which time the beam is twitched sideways, thus rewriting the dash.

If, instead of a positive signal, the amplifier delivers a negative signal to AND gate 1, there will be no output from the gate, the tube will not be turned on, the information sent to the shift register will be a zero, and the grid of the crt will be turned off at the end of the $-T$ pulse. During a write cycle the information from the shift register is substituted for the amplifier output. The strobe is inhibited and the lead labeled WRITE INTO WILLIAMS is pulsed. Coincidence of the two inputs to AND gate 3 results in a dash being written; a zero signal labeled as information to be written results in the dot condition being written.

Deflection System

Some details of the deflection generator are shown in Fig. 8. The equipment shown drives 45 deflection plates, each one in a separate tube. This particular chassis may be thought of as driving the positive X direction in an oscilloscope tube. There are three other generators, one for the negative X, one for the positive Y, and one for the negative Y. The equipment shown has four binary inputs and is therefore limited to 16 possible voltage levels at the output. The Y deflection generators, on the other hand, have five binary inputs and 32 possible outputs. The product of 16 by 32 gives 512 possible storage locations.

Evaluation

The speed of the system may be defined as the number of words per second that can be delivered from random addresses to the arithmetic unit. In the SEAC Williams system this speed is about 21,000 words per second, comparing favorably with the speed of the SEAC acoustic delay line memory—about 6,000 words per second. Other Williams systems being designed have speeds up to 100,000 words per second, but when speeds this high are used, another important factor comes into operation.

This factor is the interaction between adjacent storage elements, and it is particularly severe if the same address is demanded by the computer several hundred times in a row, before neighboring elements are regenerated. In this case all the storage elements close to this address receive excessive secondary electron splash, which has the same effect as if these elements were being deliberately written to the dash condition, and errors are thus produced. It is noted, therefore, that the splash that makes storage possible is also the phenomenon limiting the application. Difficulties resulting from interaction can be decreased by careful programming, by the addition of equipment for selective regeneration, and by improvement of the storage tube itself.

Aside from interaction, the primary sources of error are external interference such as machine relays and high-frequency induction heaters, small variations in d-c voltages and imperfectly manufactured or deteriorated cathode-ray tubes. Blemishes are a serious problem; these are nonuniformities in the phosphor surface that prevent storage at certain points. Although the difficulty can be partially sidestepped by careful selection of tubes, this is not a fully satisfactory solution because the irregularities tend to get worse as the tube is used.

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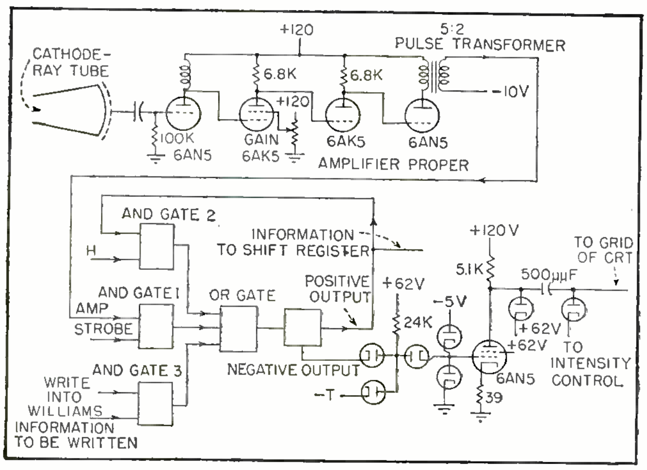


FIG. 7—Gating-amplifier circuit employed in Williams system for Bureau of Standards SEAC computer

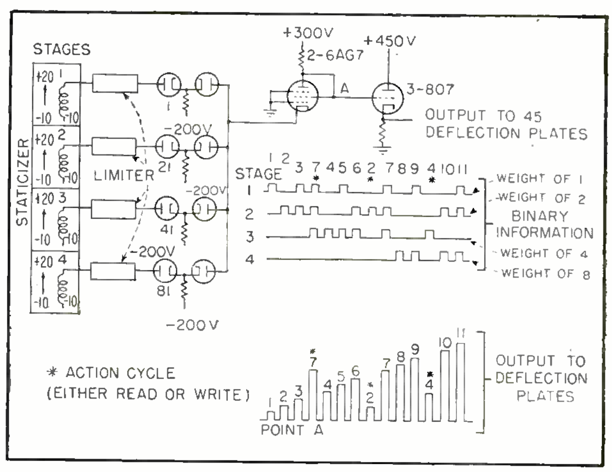
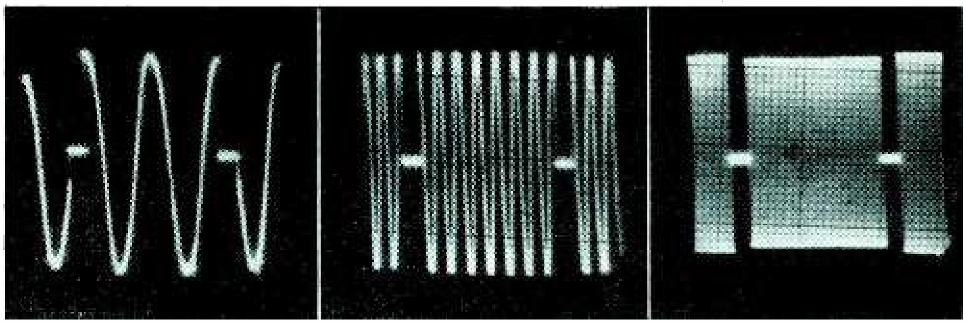


FIG. 8—Binary address digits are converted to weighted currents and summed before being applied to plates



Vibrator output terminal 1 (Fig. 2) with 200 cps, 1 kc and 25 kc, respectively fed to inputs. The 25-kc input signals are unequal by 4 percent

Signal Comparator

Method for measuring small steady-state voltage changes is illustrated by reference to circuits useful in the audio-frequency range. Developed to check frequency response of passive networks in analog computers, the voltage comparator comprises a clipper amplifier with two inputs and single output to a c-r tube

By RALPH ZITO, Jr.

Research Division
New York University
New York, N. Y.

MEASUREMENT of very small voltage or current changes presents a number of problems. Most voltage-reading instruments are capable of giving readings to an accuracy of about 1 percent. When a measurement of 0.01 or 0.10-percent change in voltage level is desired, most conventional test equipments prove inadequate.

If a direct-reading meter is used for this purpose, the instrument must have inherent stability and regulation to a comparable order of magnitude. Since such stability and reproducible accuracy is difficult to maintain, the method to be described was developed. It has been used to check attenuation required to be constant within 0.10 percent over a given frequency interval in the pass band of a network.

Principle of Operation

The voltage comparator is essentially a clipper-amplifier with two inputs and a single output. The two inputs include a reference signal and a signal whose amplitude variations are to be measured. The comparator output is placed across the vertical-deflection plates of a cathode-ray oscilloscope. Since only small changes in signal amplitude are of interest, most of the signal is thrown away in the clipping stages, with only the peaks of the signals retained.

By the use of appropriate auxiliary circuits, changes in frequency, phase and modulation may also be measured. Suppose it is desired to determine the response of a passive network with respect to frequency. The input to the network is used as a test or reference signal, and the output furnishes the second signal. The frequency of the network input signal can be varied over the range of interest. The comparator output then provides a means for measuring the change in the network amplitude with respect to frequency.

By comparing the network output with its input, the factor of network input variations with respect to time and frequency is automatically eliminated. In addition, the frequency response and gain fluctuation of the comparator are eliminated because the electrical path for both signals is the same.

The only factor that must be considered is the loading effect of the minimum input impedance of the comparator, about 200,000 ohms, during signal transfer. Signal transfer is that part of the cycle in which the signal appears at the comparator output.

A block diagram of the system is shown in Fig. 1. As an example of the basic procedure, assume that the network attenuation increases as the signal frequency increases. The input and output of the net-

The work described was carried out while the author was employed at General Precision Laboratories, Pleasantville, N. Y.

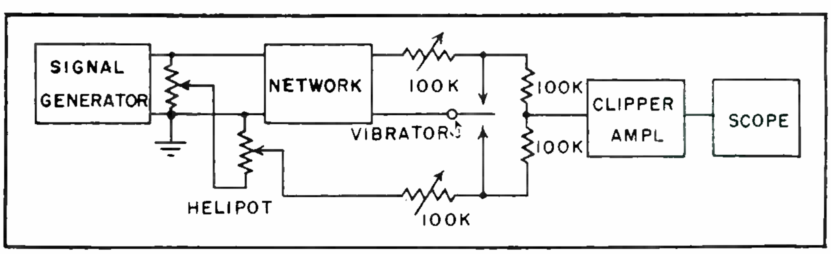
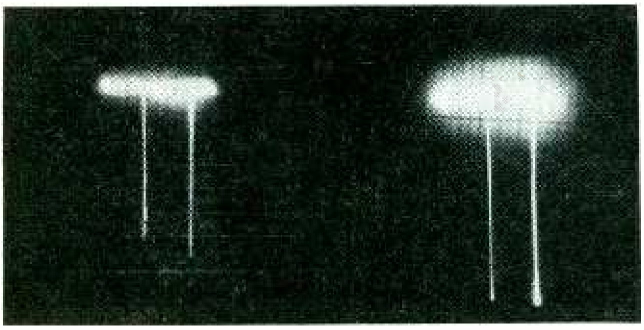
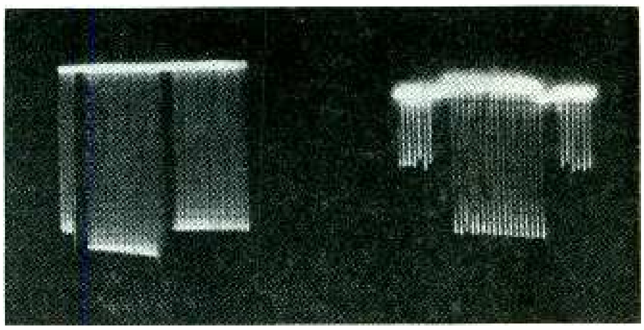


FIG. 1—Block form of the signal comparator



Clipped output signal 3 (Fig. 2) with two d-c inputs unequal by 0.10 percent (left) and by 0.05 percent (right)



Two 2-kc inputs unequal by 0.8 percent gives stage 2 (Fig. 2) output (left) and stage 3 output (right)

work are set equal at the low end of the frequency range by means of the two 100,000-ohm rheostats with the Helipot in its zero-attenuation position. As the frequency is increased, the signals as seen on the oscilloscope will become unequal. The Helipot is moved until the signals are again equal.

The amount of attenuation necessary for this rebalancing of relative amplitudes gives the percentage change the network output signal has undergone from the first to the second frequency. The process is repeated for other values of frequency. The instrument is usable for d-c input signals in the same manner as for a-c. Direct input voltages appear as pulses whose amplitudes are proportional to the value of their d-c level.

Circuit Description

The two input signals are monitored by the 60-cycle mechanical vibrator that alternately grounds each input signal through a 100,000-ohm resistance in Fig. 2. Operation is make-before-break. The signal that is permitted to pass through one half the vibrator cycle is amplified by the first stage, one half a type 12AX7. The amplified signal is then clipped by the first diode, a half 6AL5, whose cathode is positively biased at a level determined by the setting of a 20,000-ohm potentiometer.

The final output signal gives a visual comparison of the peaks of one signal against a standard. The standard may be any signal that is convenient.

During that part of the cycle in which the input signal is transmitted through the comparator, its circuit consists of a 100,000-ohm rheostat in series with two 100,000-ohm resistors to ground. The signal appears on the grid of the first 12AX7 across the second 100,000-ohm resistor.

The circuit for the reference-signal branch is similar, with an additional 20,000-ohm Helipot across the terminals as shown. The two 100,000-ohm rheostats are a rough control for setting the two signals equal at some reference point. With the Helipot set at maximum excursion, approximately one-third the amplitude shows at first stage grid.

Amplification and clipping occur again through the second half 12AX7 and half 6AL5. Here the diode polarity is reversed to maintain the same sense of clipping and the biasing occurs in the same manner as before. The last half 12AX7 is the final stage of amplification.

The three stages of amplification are necessary not only to maintain a high signal-to-noise ratio, but also to diminish the effects of contact potential within the diodes. A regu-

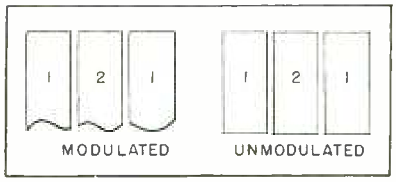


FIG. 3—Modulation on input (left) results in distortion, whereas clean signals (right) allow easy comparison

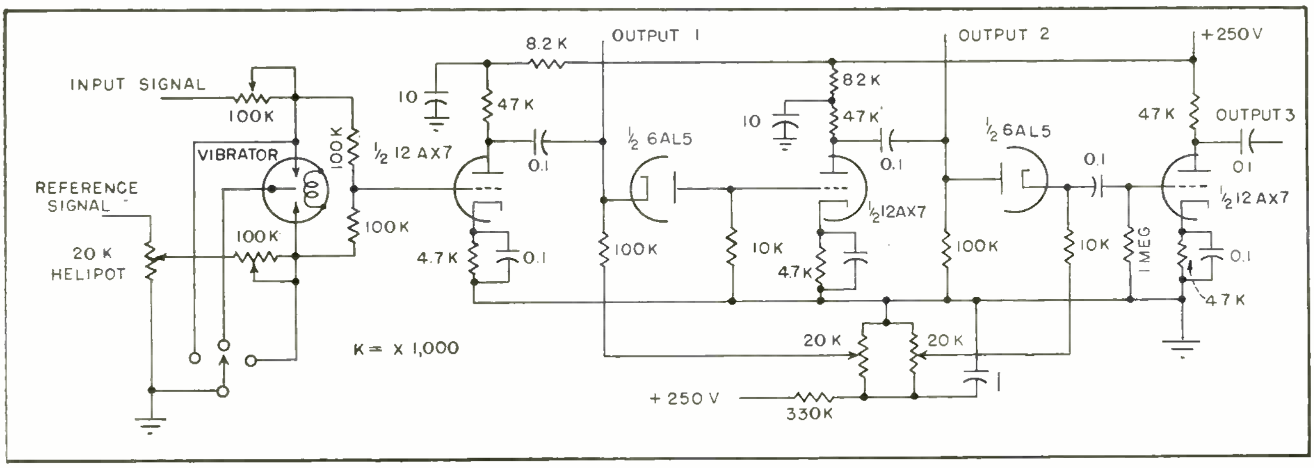


FIG. 2—Fundamental circuit of the clipper-amplifier comparator that can be used with either d-c or a-c inputs

lated power supply is required because variations in gain during operation have a greatly magnified effect on the output-signal amplitude.

Performance

Slight variations in diode bias or amplifier gain cause a magnified change in output signal level. Any ripple from the power supply also appears as modulation of the output signal. The degree of modulation produced by the ripple is directly proportional to the degree of clipping.

The same effect is noticed with any 60-cycle pickup at the input of the comparator. Most of this 60-cycle pickup occurs at the vibrator terminals; hence, the need for relatively low input and output impedances at the vibrator. If the ratio of the 60-cycle pickup amplitude to the input-signal amplitude is 0.001 and the clipping ratio is 100 to 1, the resulting output signal is 100 × 0.001 or 10 percent 60-cycle modulated.

As seen in Fig. 3 this modulation is undesirable for one main reason. If the signals appear modulated, it becomes difficult to determine the exact point of their equality on the oscilloscope. Thus, care must be taken to reduce hum and pickup to a greater than normal degree.

If the system undergoing measurement permits the use of detector stages at the two inputs to the comparator, the effects of modulation and hum may be eliminated. Alternating-current signals then appear as narrow pulses in which the effects of superimposed hum are greatly reduced.

A means of regulation of the comparator input signal level should be provided for ease of measurement.

Variations in overall input signal level do not affect the accuracy, but small input variations result in large output fluctuations.

A practical range of input level to the comparator of Fig. 2 is from 2.5 to 0.25 v rms. If the input signal amplitude exceeds 3 volts, the first amplifier stage begins to limit, causing erroneous readings in voltage change. A set of experimental values of diode bias and signal input level at both recommended extremes of operation are

Signal Input	Diode 1 Bias	Diode 2 Bias
2.5 v rms	+18 v	+1.7 v
0.25 v rms	+ 9.4 v	+3 v

For the above settings a 1.0 percent change in relative amplitude of two signals will be seen as a 25 percent change in amplitude on the oscilloscope. This resolution may be increased somewhat by resetting the bias control levels. As the signal level decreases more of the clipping occurs at the second diode. This condition is desirable to maintain as high a signal level as possible throughout the system.

Since small changes in input level manifest themselves as large changes in the output, a 2 or 3-percent loss in amplitude can cause a complete loss of output signal. Therefore, a means must be provided at the signal source for changing the overall level whenever the two signals are equalized. This level should be adjusted such that the same scope area is always utilized without changing the gain controls on the scope. This readjustment procedure maintains a constant degree of sensitivity in the comparator. The instrument in its present form is usable from 0 to about 40 kc.

Figure 4 is a modified circuit of the comparator in which the shape of the clipped wave is improved and the input impedance is increased. In order to achieve sharper clipping additional diodes are introduced in the shunt legs of the clipping stages. This creates the effect of a near-zero-impedance shunt leg and near-infinite-impedance series arm L-section during the rejected part of the cycle and the inverse during the transmitted portion of the signal cycle.

The two cathode followers at the signal inputs serve the purpose of high input impedance. However, with this gain in higher input impedance level the factor of identity in electrical paths is sacrificed, and only a-c input signals may be compared.

An additional advantage of the cathode followers is the elimination of the change in input impedance as seen by the circuit undergoing measurement during alternate parts of the vibrator cycle. For some circuits this isolated input impedance will reduce errors due to loading or transient response effects.

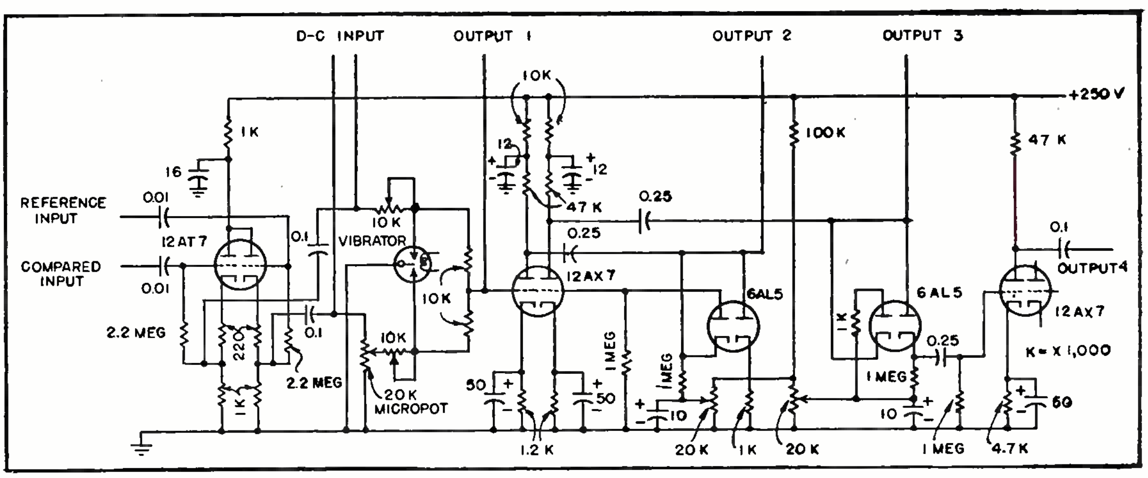


FIG. 4—Modified design comparator is superior to circuit of Fig. 2 but requires special input for d-c signals

Switching Circuits

Part X

By ABRAHAM COBLENZ and HARRY L. OWENS
Signal Corps Engineering Laboratories
Fort Monmouth, New Jersey

SO FAR in this series emphasis has been placed on the small-signal characteristics of transistors and their operation in circuits where stability was essential. In this article, attention will be focused on large-signal characteristics, and the behavior of the transistor in portions of its *V-I* characteristics where it is unstable. Large-signal behavior is important in switching operations as well as in class-C operation, particularly where the unit is used as an oscillator, or in clipping or pulse forming. In switching, the instability of the transistor is used to advantage, and circuit rearrangements are made to bring the device into and out of its unstable region.

Large-Signal Theory

No true large-signal theory for transistors that can be applied directly by the design engineer exists today.

The small-signal parameters may be used to describe large-signal operation—at least in the case of switching circuits. The region of operation is divided into three main parts where the small-signal parameters may be applied. The switching characteristic for transistors is extremely nonlinear, and the division of the overall characteristic into three regions is intended to bring the curve for each region, nearer to linearity. In general, even in the three regions into which the operation is divided, (these regions are illustrated in Fig. 7) small-signal theory cannot truly be said to apply, because relatively large signals are involved in each of the three regions. The use of the small-signal parameters implies that in each of the three regions, the characteristics being used depart to a negligible extent only from true linearity. This assumption, in general, is an approximation at best.

Several of the voltage-current characteristics considered in previous articles of this series are suitable for analysis of switching action. The V_e-I_e characteristic, modified according to the following ideas, will be used for the analysis because of its simplicity. It is also possible to use V_e-I_b or V_c-I_c characteristic, but in any case the common factor that must be possessed by the curve is that it shall have a region where the slope is negative; or, since the slope is V/I, a resistance, it must display a negative-resistance portion.

On-Off Condition

In vacuum-tube switching circuits an external system, to sense whether the switching tube is ON or OFF, must be able to distinguish between several megohms and, say, 20,000 ohms or less.

Table I—Typical Transistor Parameters

	Point Contact	Junction
r_e	150 ohms	25 ohms
r_b	120 ohms	500 ohms
r_m	35 kilohms	0.96 meg
r_c	15 kilohms	1.0 meg
R_g	500 ohms	500 ohms
R_L	20 kilohms	0.1 meg
α	2.3	0.96

To distinguish between ON and OFF conditions for transistors, a circuit must sense, unambiguously, a change from 20,000 ohms to perhaps a thousand ohms. The OFF condition focuses interest on I_{co}, the parameter which expresses collector current for emitter open or biased into its reverse current region.

Often the switching analysis is carried on in the emitter circuit, and the sensing circuit connected as a load in the collector circuit. Experience with switching circuits indicates that the effect of a collector load resistance is very nearly the same as that of the emitter load resistance. In any case, since the resistance presented by the circuit in the OFF condition is V_c/I_{co}, one can see why it is desirable to make I_{co} small.

Thus it is seen that the switching circuit involves two unambiguous conditions, ON and OFF. The transition from one operating point to the other should be as fast as possible. Not only does rapid switching increase the maximum possible repetition rate for switching, but in addition it decreases the duty cycle so that larger transient pulses are permissible.

The system must be capable of setting and resetting itself, not merely following an impressed signal. Thus one can easily apply a pulse to the emitter which brings the transistor operating point from a region where transistor action occurs to one where there is none. But then the rate of switch-over for a nonswitching system is a function of the pulse applied, and the

Using the Transistor

Negative resistance characteristics of point-contact transistors provide wide variety of switching applications such as counters, computers, relaxation oscillators of all kinds and data transmission systems

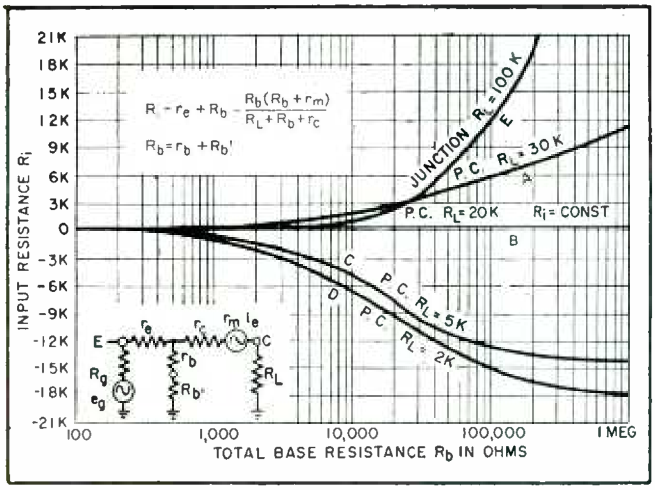


FIG. 1—Variation of input resistance of the grounded-base transistor with total base resistance

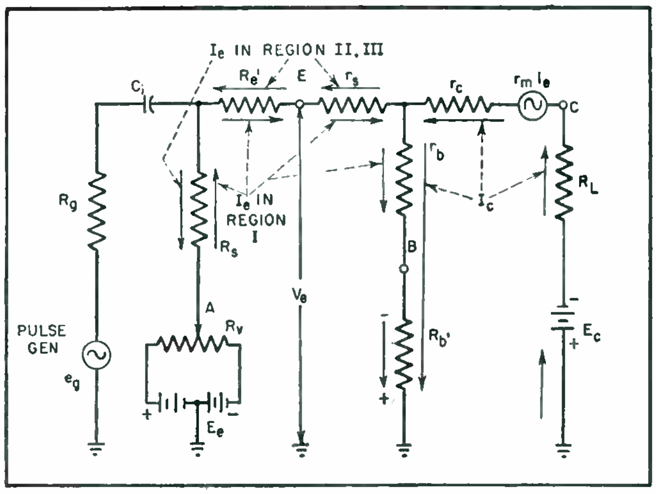


FIG. 2—Basic point-contact switching circuit for bistable operation. Regions are defined in Fig. 7

system will not stay in the OFF position when the pulse is past.

Base Resistor

In previous articles of this series several cases have been encountered where R_i or R_o was negative, but in such cases fortuitous combinations of parameters might give a positive resistance. For switching action, a controlled method is needed to be sure of getting the desired negative resistance. For the grounded-base connection, the input resistance is given by[1]

$$R_i = r_e + r_b - \frac{r_b(r_b + r_m)}{R_L + r_b + r_c} \qquad (1)$$

Assuming other parameters in Eq. 1 constant, R_i is plotted as a function of R_b in Fig. 1 for both point-contact and junction transistors, using the typical values in Table I. Here R_b represents the r_b of Table I plus added series resistance to bring the total to the value shown in the abscissae. Curves *A* through *D* are for point-contact transistors, with various values of R_L, and curve *E* represents a junction unit. For the point-contact units, after R_b reaches approximately 200 ohms, R_i is negative; but for the junction units, R_i *never* goes negative. We may infer two significent facts from this information:

(1) It is possible, by addition of series resistance into the base, to force the point-contact transistor connected grounded base to exhibit a negative resistance characteristic. It can be shown that this characteristic is associated with alphas greater than unity.

(2) It is not possible, by addition of series resistance, to bring a junction transistor into a negative-resistance range; thus it is unconditionally stable. According to Table II of Part IX of this series,[2] junction transistors are stable not only in the grounded-base connection, but in the grounded-emitter and grounded-collector connections as well. This explains why junction transistors, with average or typical values of parameters, are not ordinarily suitable for switching. Combinations of *pnp* and *npn* transistors can be made to exhibit negative resistance characteristics[3], and considerable attention is now being given to this application for junction units.

Switching Action

In Fig. 2 is shown a basic transistor switching circuit using the grounded-base connection.

The input load resistance R_e is usually considered to include the internal pulse generator resistance

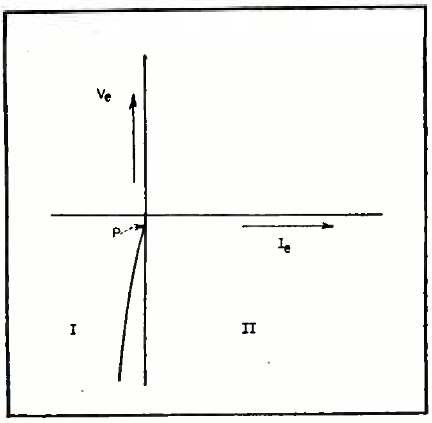


FIG. 3—Emitter characteristic curve in region I, before any switching action takes place

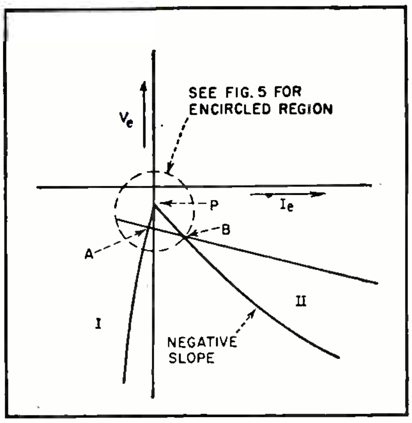


FIG. 4—Emitter characteristic curve in regions I and II. Note negative slope in region II

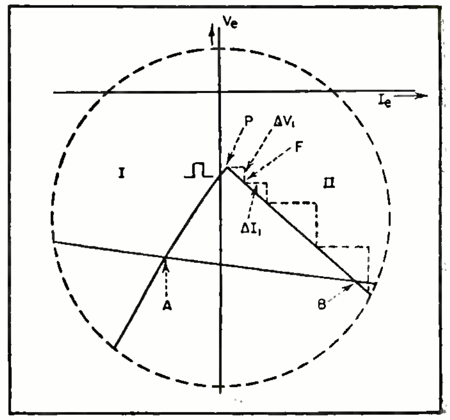


FIG. 5—Magnified portion of characteristics encircled in Fig. 4 around turn-over point

R_g. In Fig. 1 there is a transition point between the regions of positive and negative resistance where $R_i = 0$. In the negative-resistance region beginning at $R_i = 0$, i_1 can easily become high enough to damage the unit—assuming, as usual a recurrent phenomenon—and one of the principal functions of R_e is to limit this current to permissible values.

The addition of the external base resistance R_b' is indicated in Fig. 2. As the curves of Fig. 1 shows, for R_L greater than 20K, R_i never goes negative; for R_L = 20K, $R_i = r_b$ and is constant; for R_L less than 20K, values of R_b greater than a few hundred ohms bring the input characteristic to a negative-resistance region. A typical value of R_b is 10,000 ohms.

In the OFF condition, as mentioned, the emitter is biased in its reverse or high-resistance direction. Emitter bias potentiometer R_v is adjusted so that the amplitude of the pulse is just sufficient to shift the emitter diode operating point from the reverse to the forward current region where transistor action can take place. For many purposes, it is convenient to consider the transistor as consisting of emitter and collector diodes.[4]

Circuit Details

Insofar as the triggering action is concerned, the transistor requires only that the leading edge of the triggering pulse bring the emitter diode operating point into the forward current region. However, if freedom from jitter is desired, steep leading edges and well-formed pulses must be used for triggering. Regarding repetition rates, 100,000 pps is an average value easily attainable from available switching transistors. Rates of 1 mc and greater are obtainable from new high-speed switching transistors.

In Fig. 2, R_e provides d-c bias. Replacing R_e with an inductance to provide a high a-c shunt impedance may be impractical because inductance at critical frequencies may markedly affect the operation of the switching transistor.

As shown in Fig. 3, in region I the emitter bias is such that the emitter diode is biased in the reverse direction and, at least for the region of primary interest, the current varies approximately linearly with the voltage.

The point of transition P is not in the plus V_e region nor even at $V_e = 0$. The criterion for determination of whether the emitter is biased forward or reverse is the polarity of emitter voltage with respect to the base. When the emitter is positive with respect to the base[5], and a forward current of 50 μa or more flows, transistor action may be initiated. From Fig. 2 it will be observed that the collector current, flowing through the added base resistance R_b', biases the emitter positive with respect to the base. Thus the measured emitter voltage, which is the ordinate in Fig. 3, may be negative, and yet the emitter is actually biased in the forward direction to permit transistor action to take place.

Region I corresponds to the switching transistor OFF condition, when the emitter diode is biased in the reverse direction. It is desirable for the emitter diode resistance to be as high as possible to reduce loading effects. When the transistor is in the OFF condition, the collector current is I_{co}. For switching applications, transistors with low I_{co} are desirable to limit the I^2R loss. A low value of I_{co} tends to make the ON and OFF conditions more readily distinguishable. A typical value of emitter diode reverse resistance is 100K, and for the collector diode, 20K.

The straight line relationship (Fig. 3), particularly at low current values, is only an approximation. Germanium diodes exhibit a nonlinear decrease of resistance in the neighborhood of $V = 0$. This points up further desideratum for the emitter diode; a high order of linearity for low current values in the reverse direction, at least near the turnover point P. The penalty for marked deviations from true linearity is unreliable or ambiguous switching, where the start of the next portion of the V-I characteristic, in region II, cannot be predicted with certainty. This rounding off of the transition point, as well as a gradually-rising pulse, may lead to jitter.

Typical Values

In Table II are shown the values of the parameters used to characterize point-contact transistors when operating in region I.

Note 1. When the transistor is first assembled, the collector diode

Table II—Region I Parameters

r_e	100K	Reverse resistance of emitter diode
r_b	120	Nearly independent of operating point
r_c	25K	See Note 1 below
r_m	0	See Note 2 below
α	0	See Note 2 below
R_e'	2k	Added series emitter load (Fig. 1)
R_b'	10K	Added (Fig. 1) to obtain negative resistance
R_L	2K	Compare with 20K for amplifier use (Table I). Small values insure positive switching action (Fig. 1)
R_g	500	

may have a reverse resistance of the same order of magnitude as that of the emitter. To make a satisfactory transistor the collector point must be formed. This is achieved by pulsing with a relatively high current for a short interval, using a specified polarity, (point−, base+). In this process, the collector diode resistance may drop by half or more. When the device is operating as a transistor[5], holes injected at the emitter modify the collector resistance, and hence for $I_e = 0$, (no hole injection) the collector diode resistance is somewhat higher than r_c of Table I.

Note 2. Since there is no hole injection in region I there is no transistor action and therefore no current gain. Since $\alpha = r_m/r_c$ has no significance in this region, r_m similarly has none.

Assigning the definitions

$$R_b = R_b' + r_b \qquad (2)$$

$$R_e = R_e' + r_e \qquad (3)$$

the expression for R_i becomes

$$R_i = R_e + R_b - \frac{R_b\,(R_b + r_m)}{R_L + R_b + r_c} \qquad (4)$$

and using the values of Table II $R_i = 109$ K indicating that in the no-transistor-action region, region I, the input resistance is of the order of the emitter diode reverse resistance.

The output resistance is

$$R_o = r_c + R_b - \frac{R_b\,(R_b + r_m)}{R_g + R_e + R_b} \qquad (5)$$

$$= 34{,}000 \text{ ohms}$$

Region II

Assume a quiescent operating point at A in Fig. 4. Since further switching action is to occur in the right-hand portion of Fig. 4, we infer that a positive pulse will be required to bring the circuit into region II.

When the initiating pulse brings the operating point far enough over to the right so that the emitter can inject holes into the bulk material, transistor action is instituted, and the operating values are those of Table I, except that R_L = 2K as noted in Table II. Equations 2 and 3 also apply since the circuit of Fig. 2 is still being used. Using the typical values of Table I

$$R_i = -4{,}600 \text{ ohms}$$

The negative input resistance in region II is shown in Fig. 4. For subsequent application we shall also need R_o, the output resistance:

$$R_o = -10{,}700 \text{ ohms}$$

To facilitate analysis near the turn-over point P the encircled region of Fig. 4 is redrawn in Fig. 5 to a larger scale.

In a typical transistor for which measurements were made the turnover point was very nearly at V_e = −8 volts for the parameter values shown in Table II.

Consider the action in the input circuit after turnover point P, bearing in mind that R_i, the input circuit resistance, is negative in this region. Note that the load line intersects at point A in region I, R_e = 2K, and represents a stable operating point since R_i is positive in this region; in region II, the point of intersection is B, a nonstable point since R_i is negative.

The input pulse shifts the instantaneous operating point from A to B along APB. After point P has been reached, transistor action commences, and I_e goes positive. By observing the direction of I_e in region II as indicated in Fig. 2, it can be seen that once transistor action has started, all current is supplied by the collector battery E_c. The polarity of E_c makes the emitter negative with respect to ground.

In Fig. 6A is shown the equivalent circuit seen by the battery E_c in region II, and R_o is negative. The transistor internal resistance from emitter to collector is represented by R', and E_e' is the potential at point A in Fig. 2, and represents the net potential at the negative terminal of R_e, so that the internal resistance of E_e' is zero.

The ordinate in Fig. 5, V_e, is measured from point E of Fig. 6A to ground, and I_e, the abscissa is the current through R_e', the series load in the emitter circuit. While the pulse lasts, some of the current through R_e' is needed to charge capacitor C_i (Fig. 2), but when the pulse is past, the d-c paths are indicated in Fig. 2; the circuit is then equivalent to that in Fig. 6A insofar as the collector battery is concerned.

In Fig. 6B (equivalent to Fig. 6A) two principal effects must be observed: (1) E_e' has zero internal resistance by definition and therefore the return of R_o may be made as shown without error. (2) The current through R_o is reversed with respect to the current in R_e' and R'. Therefore, the current in R_e' is increased by the presence of R_o when it is negative. When R_o is paral-

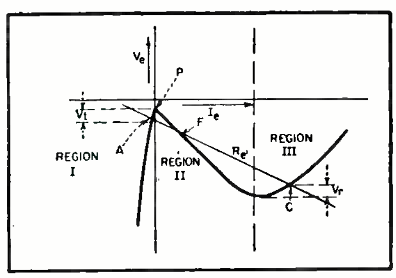


FIG. 7—Emitter characteristic in regions I, II and III. The emitter current and voltage vary along the N-shaped line indicated, with stable points at A and C

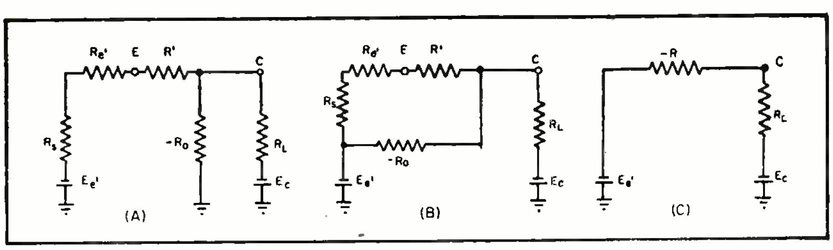


FIG. 6—Equivalent circuit in region II as seen by the load

leled with R_e' and R' the circuit which is equivalent to Fig. 6B is shown in Fig. 6C, and the circuit as seen by the collector battery consists of R_L in series with an equivalent negative resistance R. The current in this loop is

$$I = \frac{E_c}{(R_L - R)} \qquad (6)$$

The voltage V_e is measured from point E of Fig. 6B to ground. When I_1 has been made to increase by virtue of the pulse applied, the voltage at point E would normally drop, due to the drop in R'. But, because R_o is negative, the voltage at point C, Fig. 6C, will rise (in the negative direction), because

$$V_e = (-R)\, I \qquad (7)$$

If V_c increases, V_e will also increase. Hence, the effect of the negative resistance is to increase loop current I and at the same time, decrease the drops so that V_e increases. This is represented by point F in Fig. 5. When V_c (and V_e) increases, the potential acting in the loop of Fig. 6C increases, and I increases again, but this time without benefit of the outside pulse. Thus the increase in current in the negative resistance region causes an increase in voltage V_e which in turn causes a further increase in current, and so on.

The opposing effects are a decrease of alpha, and emitter-current saturation (with no further increase in V_e).

Region III

When I_e becomes very large, the transistor operating point is such that the parameter values given in Table I and Table II no longer apply. The negative resistance of region II exists only if alpha is greater than 1, and this is why junction units, without special arrangements, will not switch (see Fig. 1). When I_e becomes high,

Table III—Region III Parameters

r_e	100	Function of forward biased emitter diode resistance
r_b	120	See Table II
r_c	1,000	Large I_e lowers collector diode resistance
r_m	100	With I_e high, alpha is small.

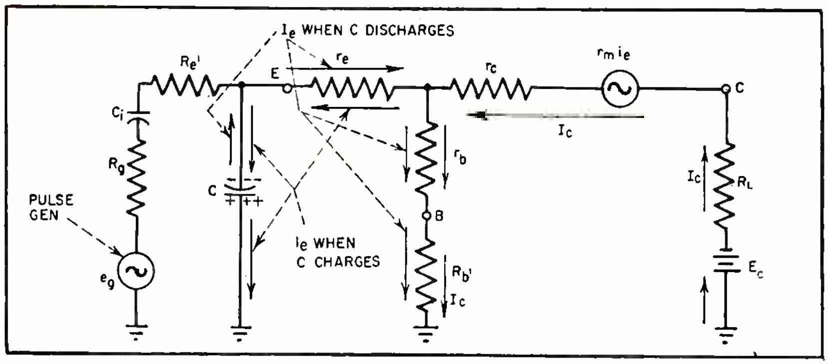


FIG. 8—Basic circuit for one-shot transistor action, where a trigger pulse causes the operating point to move to region III and return to region I without a second triggering pulse

$r_m/r_e \cong 0.1$. The effect on the remaining parameters may be seen by examination of Table III.

Other parameters have the same values as in Table II. With the values of parameters as in Table III, the input resistance is no longer negative.

$$R_i = r_e + R_b - \frac{R_b\,(R_b + r_m)}{R_L + R_b + r_c}$$
$$= 2{,}000 \text{ ohms}$$

The operating point goes briefly through a point G (see Fig. 9) of zero resistance and settles at the new equilibrium point C. The reason why the system settles down at point C is that for the value of positive input (and output) resistance at C, current I_{ec} flows when V_e is given by V_{ec} as in any d-c circuit. Note how R_e' is in series with the circuit where emitter current flows and therefore determines the operating point C. Here the emitter current is high, of the order of several milliamperes, and the input resistance relatively low, of the order of 2K, compared to 109K for region I.

Reverse Process

When at point C, a negative trigger such as V_r in Fig. 7 brings the operating point once more to a negative-resistance region. When I_e decreases, V_e decreases, Eq. 6 and 7, and the decrease in V_e still further lowers I_e so that the action is cumulative and avalanches to the nearest equilibrium point, point A, and a switching cycle is complete. In general, the angle at point P is much more acute than that at point G, which, without special precautions, tends to become obtuse. The effect is that triggering from point C is not so well controllable as from point A.

One-Shot Switching

Where one-shot switching or monostable switching is desired, as opposed to counter type switching, the circuit may be made to return to the starting point by use of a capacitor across the emitter. When the sudden change of V_e occurs in the negative-resistance region, the capacitor presents a short circuit load line. (load line of 0 slope in Fig. 9). The capacitor therefore holds the terminal voltage constant, while a large value of I_e flows to charge the capacitor.

At point H, the value of I_e is so large that transistor action is poor (region III). Point H, Fig. 9, is reached along the straight line PH. While the transistor is internally changing to operating point H, values of V_e corresponding to points $PGCH$ are not observed, of course, due to the capacitor C, so that this curve must be considered merely auxiliary to the discussion, and not a realizable path for the circuit of Fig. 8.

The current I_e is supplied by the collector battery, as before, and at point H it is as high as the transistor parameters will permit it to rise. This action is extremely rapid, and no appreciable charging of the capacitor occurs until region HG, where the voltage across C, which is V_e, rises as the capacitor charges through r_e and r_c. When point G is reached, operation is again in a negative-resistance region. The transistor moves rapidly through this region, but V_e cannot follow, and again voltage inertia

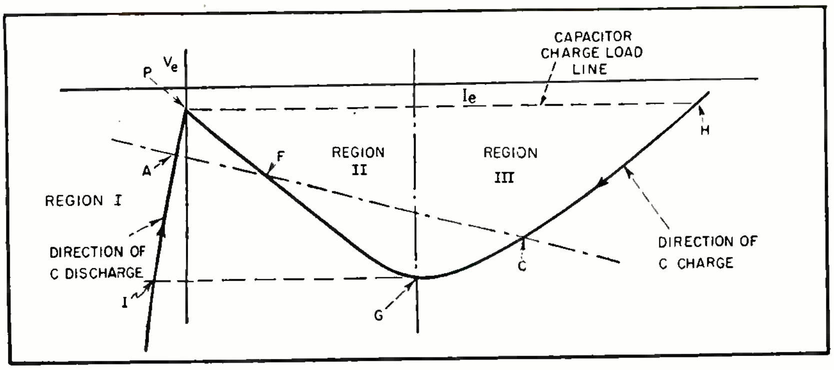


FIG. 9—Emitter characteristic curve for monostable operation of the circuit in Fig 8. Capacitor C charges from point *P* to *H* and to *G*, then discharges from point *I* back to *A*

causes the V_e-I_e curve to go along a horizontal line, *GI*, until the current is negative and small, and determined by the series resistance of the emitter diode.

The charge and discharge paths indicated in Fig. 8 determine the time constant and therefore the pulse width. The flat top of the pulse begins when *C* begins charging, at *H*, and the width of the pulse is a function of r_e and R_L. The circuit started at point *A* and went through a complete cycle back to *A* with the application of a single pulse. This is typical of the monostable type of switching circuit operation.

Refinements

One of the difficulties presently encountered in transistor switching circuits is concerned with the interchangeability of units. To improve the reliability in switching stabilization of operating points is achievable by suitable circuit techniques. Added series resistance, separate bias supplies, and a biased diode in the base lead have been successfully used to effect a marked stabilization of operating points and obtain a high order of interchangeability in switching transistors.[6,7]

While such circuit information as switching points, magnitudes of V_e and I_e involved, and required amplitude of trigger pulse may be obtained from V_e-I_e characteristic, to predict waveform it is necessary to use in addition the I_c-I_e curves.[8]

Since the discharge path of the capacitor is through r_e and the latter is high in region I, see Fig. 8, the time constant is high, and the repetition rate is reduced. To circumvent the high emitter path resistance during the interval when the operating point moves from point *I* to *A* of Fig. 9, a diode may be used across the emitter circuit, so placed that when V_e is greater than a preassigned (negative) value, the diode presents a low-impedance path. In this way the repetition rate can be noticeably increased.

The width of the pulse obtained at the output has already been shown to depend on the time involved in going from point *H* to *G*. It turns out that it is almost equally sensitive to changes in alpha and temperature (r_c decreases with T)[9]. Closest control of this width is obtained if a transmission line is used.[8]

If multivibrator action (astable) is desired, inductance or capacitance may be used to get a free-running action. The inductance or capacitance charge or discharge sets up the initiating trigger pulse.[10]

Using the grounded-base connection, either a positive trigger may be used in the emitter or, to achieve the equivalent result, a negative trigger pulse may be used in the base.

Where the triggering source is seriously disturbed by the negative resistance input of the transistor, an isolating diode may be placed in series. The diode is so biased that after passing the triggering pulse in the low-resistance direction, the added current, as the input resistance turns negative, reverses the diode and it exhibits a high resistance.

An interesting and important phenomenon connected with transistors for switching applications is that of hole storage. In region II (Fig. 8) holes are injected and sent on their way to the collector. After point *H*, the unit should switch back rapidly and return to the OFF condition, either due to an applied trigger, or due to the capacitor action described. Unfortunately the desired effect is not always observed. It seems that holes are trapped[11] or stored during regions II and III and keep moving to the collector after point *H* has been passed in time, keeping the circuit ON for a few microseconds.[12] Such an effect can seriously disturb normal circuit operation and acts to decrease the maximum possible switching rate.

Also, if accurately controlled switching times are essential, the triggering pulse must extend into the turn-off time, since the storage effects are at present neither too well understood nor predictable. Since turn-off time for different types may vary between one and twenty microseconds, this phenomenon is important and is receiving considerable study. For low-frequency applications, however, it does not introduce any special problems.

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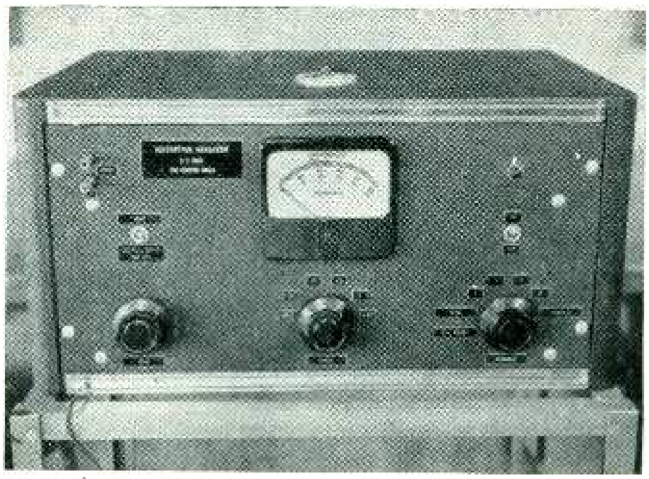
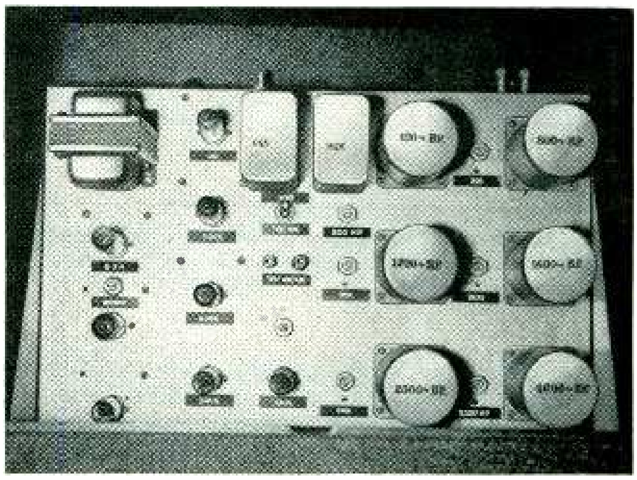
Single-Frequency



Front control panel of harmonic analyzer has adjustment for input amplitude, meter-range selector and harmonic selector



Layout of shielding filters and tubes on analyzer chassis. Screw-driver-adjusted potentiometers equalize insertion losses of filters

Bandpass filters in 400-cps harmonic series provide inexpensive analyzer for laboratory measurements of distortion versus load-resistance characteristics of tubes. Information on non-frequency-dependent harmonics can be obtained more rapidly than with conventional wave-analyzer method

By JESSE B. SHERMAN
Electrical Engineering Dept.
The Cooper Union
New York, N. Y.

MEASUREMENT of harmonic and intermodulation distortion in an audio system usually calls for data taken over an extensive frequency range. There are occasions, however, when a considerable amount of non-frequency-dependent harmonic information is required. An example is the preparation of distortion versus load-resistance data furnished by tube manufacturers. In such a case, the apparatus to be described will measure the individual harmonic amplitudes much more rapidly than will the usual wave analyzer.

The device uses a set of bandpass filters in a 400-cycle harmonic series, which are successively switched between the signal under test and a suitably calibrated vacuum-tube voltmeter. A low-distortion amplifier precedes the filters.

Method of Measurement

Operation of the analyzer consists of switching the fundamental filter into the circuit, tuning the signal generator for maximum deflection and setting the input voltage for full scale. The filter selector switch is then turned to the desired harmonic and the amplitude is read directly on the meter as a percentage of the fundamental frequency.

Provision is made for reading the second, third, fourth and fifth harmonics. Total of harmonics above the fifth is obtained by means of a 2,400-cycle high-pass filter. An 800-cycle high-pass filter is used to measure total distortion. Figure 1 and the photographs show respectively the circuit and external and internal views of the equipment.

The bandpass filters have attenuation greater than 80 db per octave. Under practically any conceivable set of conditions, this permits reading individual harmonic amplitudes down to the limit imposed by the input amplifier, which develops second and third harmonics, each below 0.02 percent. The filters are sufficiently well aligned

Harmonic Analyzer

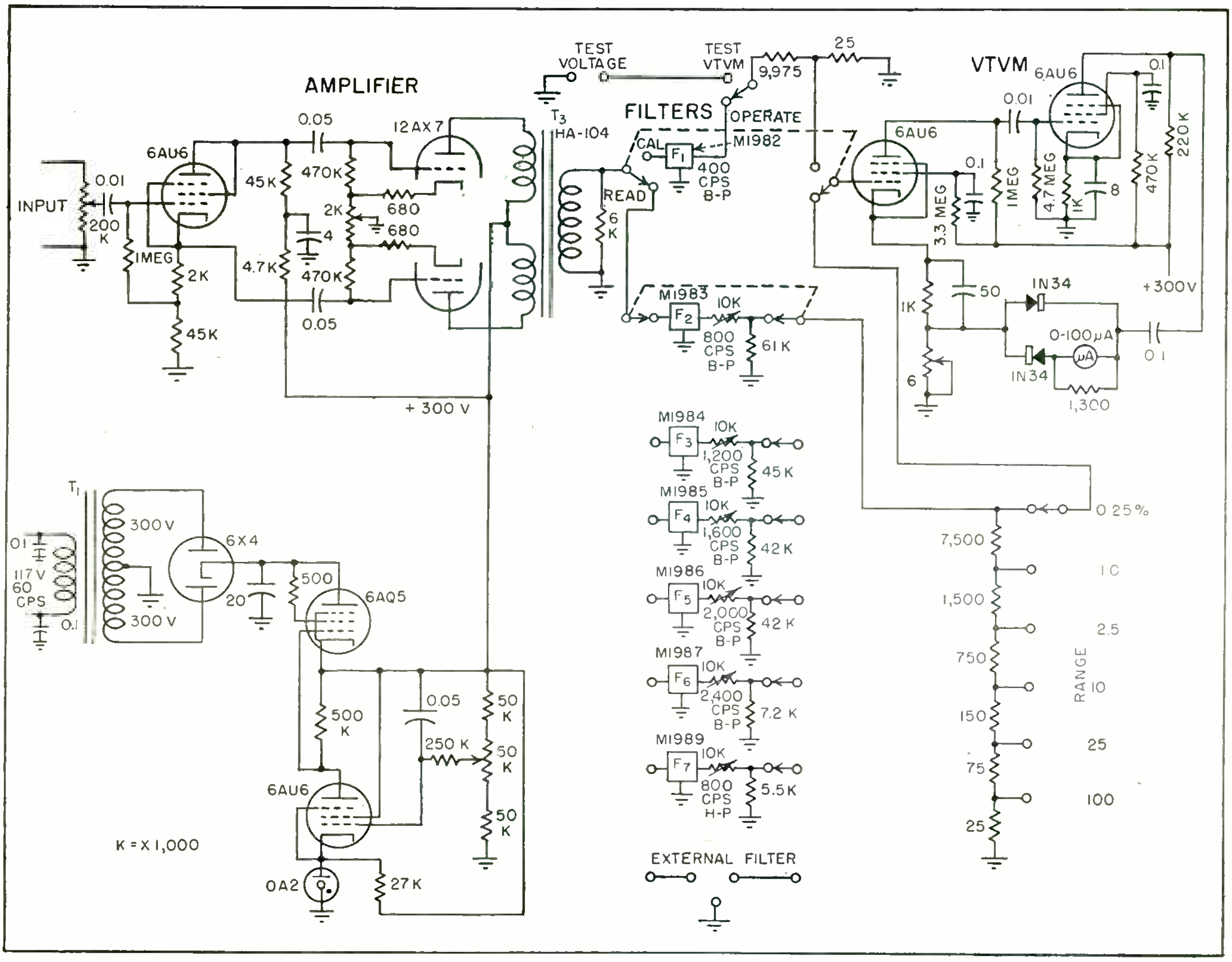


FIG. 1—Circuit of harmonic analyzer. Bandpass filters are placed between signal and vtvm calibrated in percent

so that the only tuning necessary is accomplished at the fundamental. Because the filters have different insertion losses, decreasing with increasing harmonic order, a compensating pad is connected at the output of each filter above the fundamental.

The vacuum-tube voltmeter is of the average-reading rectifier-feedback type and has a full-scale sensitivity of 1 millivolt. Six ranges are provided from 0.25 percent to 100 percent. The indicating meter is shunted for approximately critical damping.

Overall frequency-response with no filter between the input amplifier and the vacuum-tube voltmeter is flat ±1 db from 50 cps to 44 kc. This permits connection of filters other than the internal set and also allows the apparatus to be used as an a-f voltmeter.

The accuracy of the analyzer is limited by slight nonlinearity of the filters. Because this varies among the filters, direct correction of the meter scale is not feasible. There is also slight nonlinearity of the vtvm itself which tends to oppose that of the filters and is not corrected. Maximum error due to these effects does not exceed ±2 percent of full scale for the measurement of any individual harmonic. For the total and residue readings, there is present the usual variable error dependent on waveform, resulting from the use of a voltmeter which indicates average rather than rms values.

Making the reference adjustment at the fundamental is facilitated by a CALIBRATE-READ switch which in the CALIBRATE position disables all panel controls except the input potentiometer.

The input impedance of the analyzer is 200,000 ohms, and the minimum input required for full-scale setting at the fundamental is 0.35 volt.

The author acknowledges the cooperation of Theodore Craige of the United Transformer Company in developing the filters used.

Sound—Projector Amplifier

By J. A. RODGERS
Project Engineer
Eastman Kodak Co.
Rochester, New York

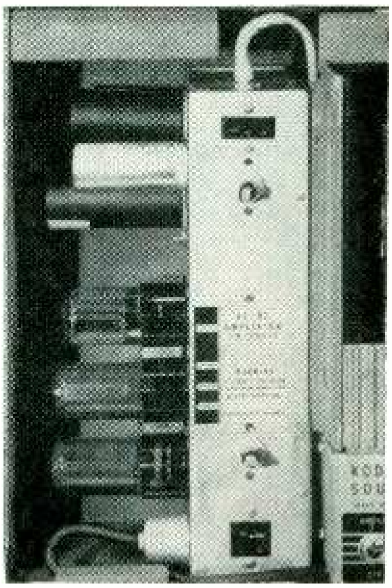
DESIGNED FOR A-C/D-C operation, the 16-mm sound-projector amplifier described here incorporates a high-gain low-distortion input stage that compensates for widely varying phototube signals obtained from different sound tracks. The amplifier has special treble-boost characteristics built into it to overcome high-frequency losses inherent in sound-projector systems. Other features include a d-c exciter-lamp supply and insulated microphone with a three-wire connection.

Response Characteristics

Projector amplifiers require special audio-response characteristics to compensate for high-frequency losses in the system. These losses are caused by shunt capacitance in the high-impedance phototube circuit, limited definition in the sound track and the time constant of the phototube itself. In this design, the increase in the amplifier gain at treble frequencies is accomplished in two circuits. Cathode capacitor C_1 was selected to afford by-passing at the higher frequencies while providing degeneration at the lower frequencies. Capacitor C_2 performs the same function in the following stage but produces an additional increase in the treble frequencies by a reduction of the inverse feedback voltage from the output stage. The amplifier gain from these two effects increases up to about 8,000 cycles where resistor R_1 imposes a limitation on the rise.

Sensitivity

An amplifier of this type must have high gain because the signal from the phototube is quite small and actually covers a considerable range in level. Black-and-white film sound tracks of the variable-area type may provide as much as 50 millivolts of signal at the input of the amplifier, while some of the tracks reproduced with colored film may furnish as little as 3 millivolts.



Kodascope Pageant project cabinet showing vertical mounting of a-c/d-c amplifier chassis behind operating mechanism

In the design it therefore became necessary to provide sufficient sensitivity for the weak sound tracks and yet design the input stage for low distortion for the larger signals.

For this purpose the 12AY7 dual triode was selected because it provides more gain than can be obtained with a pentode and it generates less distortion.

Hum and microphonics are satisfactorily low, an important factor when the amplifier must be mounted in the same case with an electric motor and an intermittent film-moving mechanism that produce vibrations difficult to isolate from the tubes.

Microphone Input

Occasionally it becomes desirable to use a microphone with the projector for spot announcements or to amplify a commentary for silent films. This becomes a problem because the a-c/d-c circuits do not allow isolation from the power line and the danger of serious shock exists unless special precautions are taken.

By using a three-terminal connector and a special insulated microphone the unit was connected properly into the circuit for minimum hum pickup yet providing full safety for the user. The circuit diagram shows how the signal from the microphone entering on terminal 1 of the input socket is reduced by the dividing resistors before being applied to the grid of the first tube. A jumper wire in the microphone plug connects socket terminals 2 and 3 together shorting out the film sound coming from the phototube. Also it further reduces the microphone voltage applied to the first tube grid.

Power Supply

The amplifier power supply consists of a 250-milliampere selenium rectifier SR_1 (Fig. 1) and a 150-μf 150-volt electrolytic capacitor C_3. The d-c voltage is supplied to all the amplifier circuits with the exception of the output-tube plates, which are raised to 250 volts by the second rectifier that serves as a voltage doubler during operation on a-c power lines; 150 milliamperes d-c flow through the series string of tube heaters, the special negative temperature coefficient resistor R_2, and the exciter lamp. The additional 50 milliamperes required by the exciter lamp is furnished by the plate circuits of the amplifier tubes. Capacitor C_4 completes the filtering of the direct current supplied to the exciter lamp so that the scanning beam is constant in light amplitude.

Resistor R_2 has an initial resistance when cold of about 700 ohms, which, in series with the tube heaters that have a low resist-

for 16-mm Motion Pictures

Four-tube amplifier operates on either a-c or d-c power. Circuit provides high gain with low distortion and a treble-boost characteristic peaking at 8,000 cps; d-c exciter-lamp supply reduces unwanted output variations

ance when cold, limits the current to 150 milliamperes. After the warm-up period the resistor stabilizes at 150 ohms. The adjustable resistor R_3 sets the lamp current to exactly 200 milliamperes. Resistor R_2 also acts as a regulator, tending to keep the current fairly constant in spite of line-voltage fluctuations. This prolongs the life of the exciter lamp while reducing variations in the light output.

Hum

To maintain the hum in the amplifier output at a satisfactorily low level, the d-c voltage applied to the plate of the first amplifier stage and to the phototube must have a low ripple voltage. A small choke was used to provide most of the ripple-voltage reduction with negligible drop in the d-c voltage. This also permitted the use of a simple voltage divider to establish the potential for the phototube. The arrangement, however, is carefully controlled since too high a voltage would cause ionization of the gas with consequent distortion and frequently, destruction of the active surface, while too low voltage will result in loss of output signal through insufficient gas amplification.

Voltage Doubler

Neither a full-wave nor the common half-wave doubler circuit will work on a d-c line because there is either a capacitor or a backward rectifier to block the current flow.

In this circuit, the power line is connected as shown. For d-c operation, polarity must be observed. Under these circumstances, rectifier SR_2, which acts as a doubler by rectifying line current on the alternate half of the wave during operation on a-c lines, now blocks the current flow to the output-tube plates by being connected into the circuit backwards. By adding rectifier SR_3 current is permitted to flow to the output-tube plates from the circuit of rectifier SR_1. On a-c lines rectifier SR_3 has a reverse potential developed by the doubler rectifier SR_2.

On a d-c line, the low plate voltage provides an audio-output power of only two watts, while the doubled plate voltage obtained during operation on a-c lines raises the output power to over seven watts.

Power Line Isolation

Capacitor C_5 is connected between the amplifier-circuit ground and the chassis, which must be tied down to serve as a shield for the circuits.

To reduce shock hazard, résistor (3.3 meg) has been added to maintain the chassis at the power-line potential with respect to d-c charges that might otherwise accumulate. The 0.10 μf value of C_5 keeps the shock current within the limits established by the Underwriters' Laboratories.

Exciter-Lamp Supply

Since sound tracks are usually scanned by projecting a narrow beam of light on the track and converting the resultant light modulation on the other side of the film to electrical variations by a phototube, all variations in the amplitude of the light result in signal voltages. It becomes important therefore to select a light source that has essentially constant amplitude. A direct-current supply offers several advantages, even though it makes necessary a fairly high-current power supply. Its greatest advantage is that d-c heater current is desirable from a hum reduction standpoint, particularly for the first amplifier tube. Tube heaters can be used to drop the voltage as necessary.

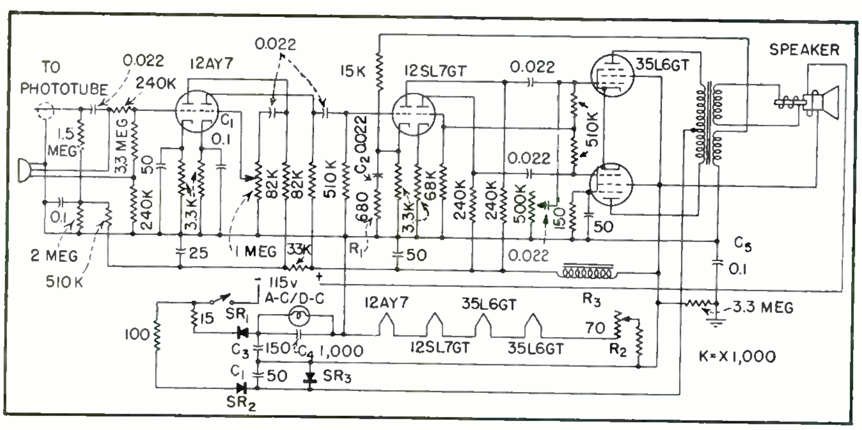


FIG. 1—Circuit of amplifier: d-c to filaments and exciter lamp reduces both light fluctuations and hum

Precision Measurement

Standing-wave measurements permit accurate determination of waveguide attenuation values as low as 0.001 decibel. Techniques and equipment described are useful in selecting optimum waveguide fabrication, plating and finishing processes

By JOSEPH H. VOGELMAN

Chief, Electronic Warfare Center
Rome Air Development Center
Griffiss Air Force Base
Rome, New York

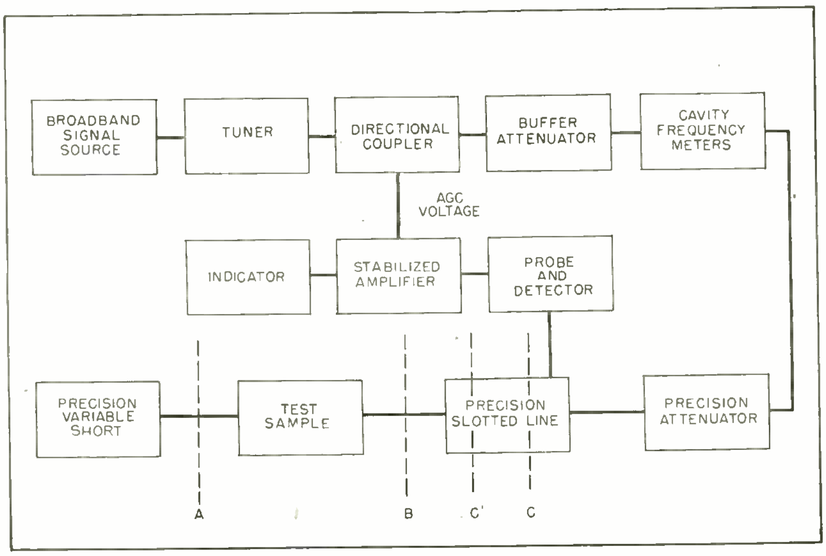


FIG. 1—Equipment setup for millidecibel attenuation measurements

PRECISE ATTENUATION measurements of four-terminal waveguide structures having very small losses are necessary to furnish quantitative data on waveguide structures fabricated by different methods and with various finishes, platings and surfaces.

The method to be described permits accurate measurement of attenuation values between 0.01 and 0.5 db. Measurements with decreasing accuracy can be made down to 0.001 db. Errors due to detector nonlinearity, reflections from the sample, noise in detector amplifiers, long-line effects and attenuation in the measuring line are minimized.

Quantities Measured

The measurements are based upon the relationship between attenuation and the resultant voltage standing wave at the input terminal when the output is terminated in a short. Two physical lengths are measured: displacement between points in the standing wave 3 db above minimum and distance between minima.

Measuring Equipment

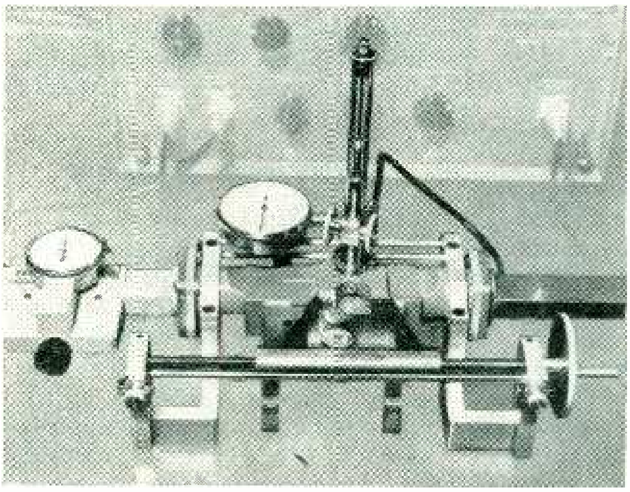
A block diagram of the equipment required for millidecibel attenuation measurement is shown in Fig. 1. The broadband signal source is an external-cavity klystron, square-wave modulated at 1,000 cps by a square-wave generator built into the power supply. The rise and decay times of the modulation pulse are continuously monitored on an oscilloscope to insure minimum frequency modulation of the r-f signal. The output of the signal source is fed into a directional coupler through a tuner.

A small fraction of the energy is removed by the coupler for use in stabilizing the overall system. The major portion of the r-f energy is fed through a buffer attenuator to a pair of reaction-type cavity frequency meters. The frequency meters cover the 40-percent normal operating range of the waveguide; each meter covers half the range. The output is then fed through a precision attenuator calibrated precisely at 0 and 3 decibels to a precision slotted line used to measure the vswr. The signal then goes through the sample under test to a precision variable short.

The output of the probe in the slotted line is fed to a narrow bandwidth, high-gain, low-noise amplifier after detection by a crystal or bolometer. The amplifier is stabilized against fluctuations in the r-f signal source by agc voltage derived from the portion of the signal removed from the directional coupler. The signal is detected, amplified, then rectified and filtered in the monitor channel of the amplifier.

The resultant d-c voltage, proportional to the output of the signal source, is used to control the amplifier gain. Thus the output voltage

# of Waveguide Attenuation



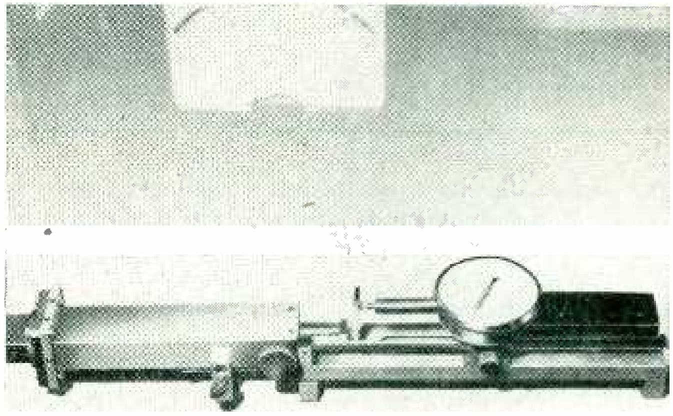


FIG. 2—Left, precision-drive slotted line and attenuator; also x-band precision variable short with finite, calibrated loss, at right

from the amplifier remains constant though the r-f power fluctuates. The rectified signal from the amplifier is fed to an indicating meter. This meter is biased by a battery to permit zeroing in the presence of amplifier noise.

If a receiver for the frequency of the test is available, the need for good square-wave modulation can be eliminated. The signal source is then operated continuous wave and the d-c output of the receiver second detector can be used as an indication of the slotted-line probe output.

Theoretical Considerations

A transmission line when terminated in a perfect short circuit will show a vswr that is a function of the energy dissipated in the line. If a line has a loss factor S then a unit-voltage magnitude at the input will result in a magnitude S at the short circuit. The reflected wave with voltage magnitude S at the short circuit will be reduced to S^2 at the input. Resulting vswr r is

$$r = (1 + S^2)/(1 - S^2) \qquad (1)$$
$$S = [(r - 1)/(r + 1)]^{1/2}$$

Defining the one-way attenuation in decibels α as

$$\alpha = 20 \log_{10} (1/S) \qquad (2)$$

The attenuation in terms of vswr is

$$\alpha = 10 \log_{10} [(r + 1)/(r - 1)] \qquad (3)$$

In any practical case the wave impedance of the sample and that of the slotted line are not identical. Thus a reflected wave is set up by the discontinuity at the input to the sample. This reflected wave will add in some arbitrary phase to the reflected wave from the short circuit.

The minimum and maximum measured attenuation will occur when the reflected waves either add in phase or 180° out of phase. From the maximum and minimum measured attenuations the true attenuation is

$$\alpha = (\alpha_{max} + \alpha_{min})/2 \qquad (4)$$

Table I—Attenuation Error Due to Inaccuracies in Measuring Displacement

Attenuation in db	Attenuation error in percent λ_g = 30 cm	λ_g = 10 cm	λ_g = 1 cm
0.005	0.78	0.26	2.34
0.010	0.52	0.16	1.57
0.100	0.16	0.05	0.91

For small losses in the structure under test, the resultant vswr's are large and ultimate accuracy depends on the determination of the relative magnitude of the minimum with respect to the easily determined maximum. To minimize the errors due to nonlinearity of detectors or inaccuracy in variable attenuators over large attenuation ranges, the vswr is determined by measuring the double-power points or the displacement between points 3.01 decibels above the minimum in the standing-wave pattern. A mechanically precise attenuator calibrated at the 0 and 3-db points is used to set this level to eliminate errors in the detector and indicator.

Knowing the relative amplitude of the standing wave at the minimum, the position of the 3-db points can be determined. The displacement between two 3-db points about a minimum and the distance between minima can be converted into vswr by

$$r^2 = 1 + \frac{1}{\sin^2[(\pi \Delta X_p/2)/(\lambda_g/2)]} \qquad (5)$$

where r is the vswr ΔX_p is displacement between 3-db points and $\lambda_g/2$ is distance between minima.

The attenuator and precision-

Table II—Total Attenuation Error in Percent

	λ_g = 30 cm		λ_g = 10 cm		λ_g = 1 cm	
Attenuation in db	Absolute Error	Resettability Error	Absolute Error	Resettability Error	Absolute Error	Resettability Error
0.001	15	10	15	10	30	15
0.010	5	2.5	5	2.5	10	5
0.100	5	2.5	5	2.5	10	5

drive slotted line shown at the left of Fig. 2, are commercial equipments modified for this application. The attenuator is equipped with a pair of stops corresponding to 3.01 and 0-db attenuation respectively. The slotted line is adjusted for a negligible slope along its longitudinal axis and it is equipped with a micrometer-drive screw of 40 threads per inch, friction coupled to the roller of the carriage. A dial-type depth gage with adjustable zeroing and positioning is mounted on a pair of guide rods and is used to measure displacement between 3.01-db points. This particular design was used since it does not affect the inherent precision of the ball-bearing probe carriage and at the same time provides for precise positioning of the probe and measurement of displacement.

The precision variable short, Fig. 2, incorporates that amount of inherent loss which will result in a standing wave whose minima are sufficiently above the noise level to permit accurate measurement with available power sources. A dial-type depth gage is mounted on the short to permit accurate setting of positions a quarter wavelength apart.

The internal construction of the variable short is shown in Fig. 3. Finite attenuation, excellent resettability and stability are achieved in the variable short by mounting the shorting plunger on roller bearings placed at points of low electric field and spacing it approximately 0.001 inch from the walls of the waveguide. The walls of the plunger and the waveguide form a low-impedance coaxial transmission line.

This line is terminated in its own impedance with a lossy carbonized cloth. The plunger is slotted and the slots filled with attenuating material to suppress higher-order modes. The energy dissipated in the coaxial lines determines the attenuation of the short. The spacing between the plunger and the waveguide walls is designed to give a coaxial line impedance that will result in the desired attenuation.

The roller bearings in the top of the shorting plunger are spring loaded to eliminate variations due to gravity. The inside dimensions of the short-circuit waveguide and the slotted line are made as nearly identical as possible to eliminate discontinuities.

Measurement Technique

The first two minima C and C' that give the lowest amplitude for the minimum are located by setting the variable short. This is the case where the reflection coefficient of the variable short and the composite reflection coefficient of the test sample due to discontinuities at A and B in Fig. 1 add in phase. The precision attenuator is set to 0 db and the amplifier adjusted for a convenient reference level on the indicator. The attenuator is switched to the 3.01-db setting and the probe carriage moved to the points giving the reference indication about the minimum at C'.

The distance between the 3.01-db points and between the minima C and C' are the values required. The measurement is repeated at C. The variable short is then moved a quarter wavelength and the displacement measurements made again. From these measurements the combined attenuation of the slotted line, short and test sample can be determined at points C and

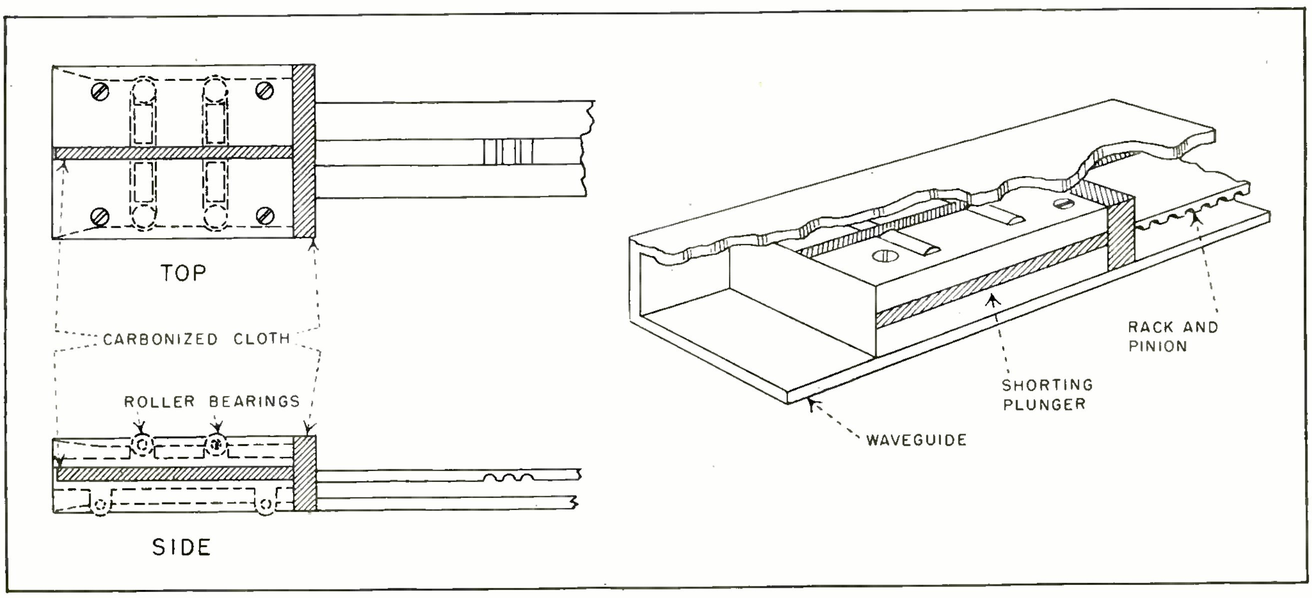
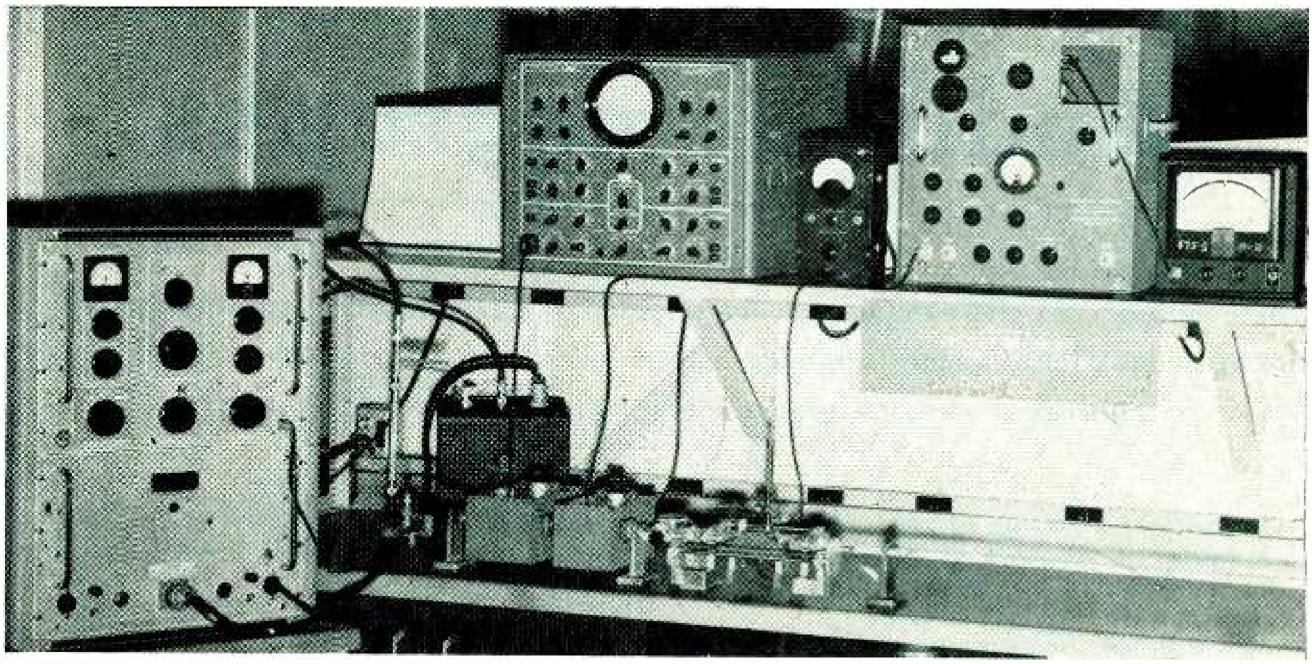


FIG. 3—Construction of shorting plunger shows how carbonized cloth is used to provide finite, calibrated loss



Millidecibel test setup. Equipment on shelf includes: monitor scope, agc voltmeter, amplifier and indicator. Lower deck holds: power supply, signal source, tuner and directional coupler, buffer attenuator, two cavity wavemeters, precision attenuator and slotted line and test sample. Variable short is not shown

C' from Eq. 3, 4 and 5.

The difference between the attenuations at C and C' gives the attenuation per half wavelength in the slotted section. By subtracting the slotted line and short attenuations from the total measured attenuation, the attenuation of the test sample is determined. The variable short is calibrated for various settings in the same manner. In general, the attenuation in the slotted line is negligibly small in comparison to that of the test sample. Thus, it is necessary to make measurements at only one of the minima for two positions of the variable short, a quarter wavelength apart.

Sources of Error

The amplitude and frequency variation of the signal source will radically affect the accuracy of measurement. The amplitude-variation error is reduced to less than 1 percent by using a rectified portion of the signal output to control the amplifier gain. The f-m is reduced to a minimum by fast-rise-time square waves and is continuously monitored to insure optimum operation. Residual f-m causes a broadening of the standing-wave voltage curve about the minima. The resultant error, however, has been reduced to less than 1 percent.

The precision attenuator will determine the 3.01-db points to an absolute accuracy of better than $\pm$ 0.2 db over a 40-percent waveguide bandwidth without individual frequency calibration. The resultant inaccuracy is less than 1.9 percent. Resettability is considerably better and the inaccuracy in relative attenuation measurements is less than 0.5 percent.

The displacement measurements with the available slotted lines are accurate to + 0.0001 cm for waveguide wavelengths between 1 and 20 cm and + 0.001 cm for waveguide wavelength greater than 20 cm. This causes the attenuation errors given in Table I.

The error due to the mismatch caused by the discontinuities between the test sample and the slotted line and variable short is removed by measuring the maximum and minimum attenuations for phase addition and subtracting the reflections from the mismatch and the short. The attenuation error due to movement of the short over a quarter wavelength is less than 0.0005 db and the calibration error can also be held below this value by taking the average of a series of repeated measurements. The relative error resulting from the use of any particular short is in the order of 0.0002 db. The error due to amplifier noise is minimized by using the attenuation designed into the short to bring the minimum of the voltage standing wave well above the noise.

Table II summarizes the total inaccuracy of this measurement.

Conclusion

The technique has proved capable of determining differences in finishes and surface conditions not detectable visually. Tests on the general run of commercially available silver-plated waveguide has shown that the silver plating is so crystalline and porous that the resultant attenuation is not significantly less than for unplated brass.

One silver-plating technique known as the periodic-reverse process has resulted in silver-plated waveguides with greatly improved attenuation characteristics as indicated by measurements made on a limited number of samples. Further work is in progress at the general engineering laboratory of Griffiss Air Force Base, to evaluate the effects of scratch marks and various surface treatments on the attenuation of waveguides.

Audio Nomographs

Three nomographs give component values needed to obtain desired gain and bandwidth in a pentode audio-frequency amplifier, without use of sliderule. Method involves use of equivalent circuits for high, low and middle frequency ranges

By JOSEPH F. SODARO
Los Angeles, Calif.

DESIGN of a pentode a-f amplifier is simplified by reducing the basic circuit to equivalent circuits for mid-range, high and low frequencies[1], as shown in Fig. 1. Optimum values of circuit components can be obtained directly from the nomograph in Fig. 2, 3 and 4. An actual example will serve to illustrate the design procedure, after which the condensed instructions alongside Fig. 4 should suffice for practical use.

Example. Design an amplifier having 40 db (100 times) voltage gain with a —3 db passband of 50 to 20,000 cps. This is to drive a 6V6 self-biased power amplifier, for which a 500,000-ohm grid resistor R_g is recommended for self-biased operation.

Choose a pentode that will give the required gain. Here the 6SJ7 would seem to be a good choice since it has high transconductance and the same heater voltage requirement as the 6V6. Reference to a tube manual gives a g_m of 1,600 micromhos and $R_p = 1$ meg for 250 plate volts and —3 grid volts.

To find R_L, first locate 40 db (or 100 times) on the *A* scale and 1,600 on the g_m scale of Fig. 2. Draw a straight line through these points and read 63,000 ohms for R_{equiv}. Draw a second straight line from R_{equiv} to 0.5 meg on R_g, to intersect R_L at 75,000 ohms. Use 82,000 ohms, the closest 10-percent RETMA value, as the plate load resistance.

To check the upper 3-db-down frequency limit f_1, add 7 $\mu\mu$f for the 6SJ7 output capacitance C_o, 9.5 $\mu\mu$f for the 6V6 input capacitance C_i and an estimated 13.5 $\mu\mu$f for stray and wiring capacitance C_w to get 30 $\mu\mu$f for C_s. (A safe guess for C_w in conventional circuits is 10 to 15 $\mu\mu$f.) Draw a line from 63,000 on R_{equiv} (Fig. 3) to 30 on C_s and read 83,000 cps on f_1. Thus, the upper 3-db-down frequency f_1 is

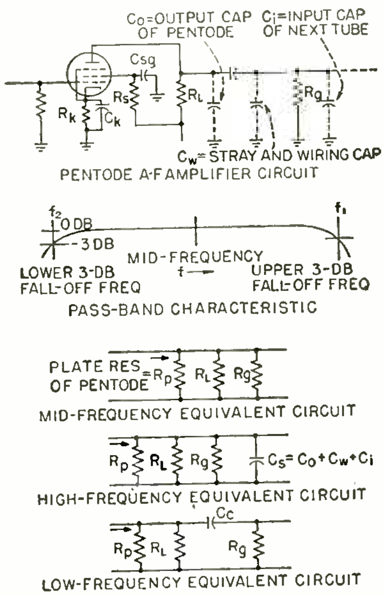


FIG. 1—Basic circuit, characteristic response curve and equivalent versions for three different regions of the audio spectrum

more than adequate with the estimated shunt capacitance. If f_1 is too low, the shunt capacitance or R_L must be reduced. Lower R_L will reduce the mid-frequency gain, however.

To determine the minimum allowable coupling capacitance C_c, add 500,000 and 82,000 to get 582,000 ohms for $R_g + R_L$. Draw a line on Fig. 4 from this to 50 cps on f_2 and read 0.0055 μf on C_c as the minimum allowable coupling value. The reactance of this capacitance equals $R_g + R_L$ at the lower 3-db-down frequency f_2. Use 0.006 or 0.01 μf.

Next, determine the minimum allowable screen bypass capacitance. From tube and circuit data, choose 370,000 ohms for screen dropping resistor R_s. Divide $f_2 = 50$ by 10 to get 5 for f_3. Draw a line through these R_s and f_3 values on Fig. 4, and read 0.09 μf on C_{sg}. Use 0.1 μf.

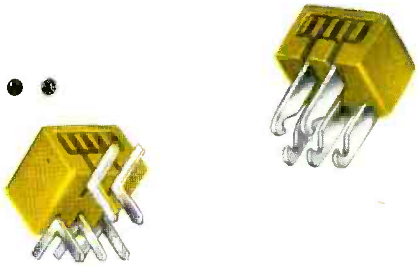
Finally, determine the minimum allowable cathode bypass capacitance. From tube and circuit data, choose 680 ohms for R_k. Multiply this by $G_m = 1{,}600 \times 10^{-6}$ mhos to get 1.08, which is approximately one. According to the tabulation alongside Fig. 4, f_4 is then $f_2 \div 10$, or 5. Connect 680 on R_k with 5 on f_4 and read 47 μf on C_k as minimum allowable cathode bypass capacitance.

REFERENCE

(1) F. E. Terman, "Radio Engineers' Handbook," McGraw-Hill Book Co., New York, 1943, p 354-366.

(Continued on p 202)

"FIRST" IN METAL PLASTIC ENGINEERING... STANDARD IN USE



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Audio Nomographs (continued from page 200)

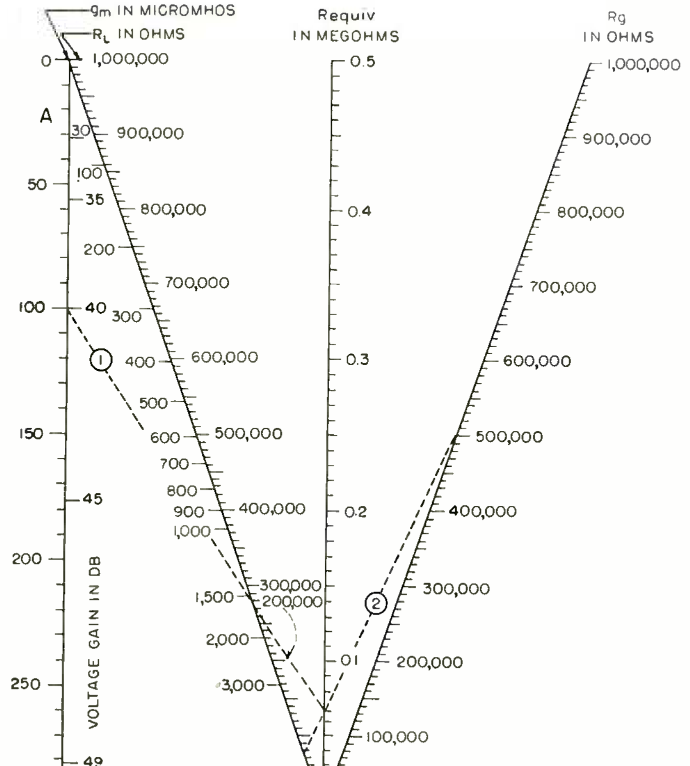

FIG. 2
MID-FREQUENCY

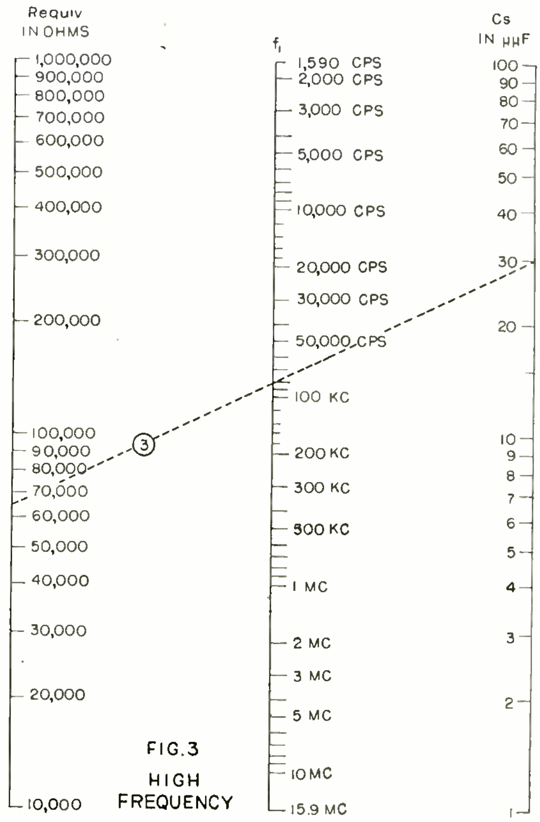

FIG. 3
HIGH FREQUENCY

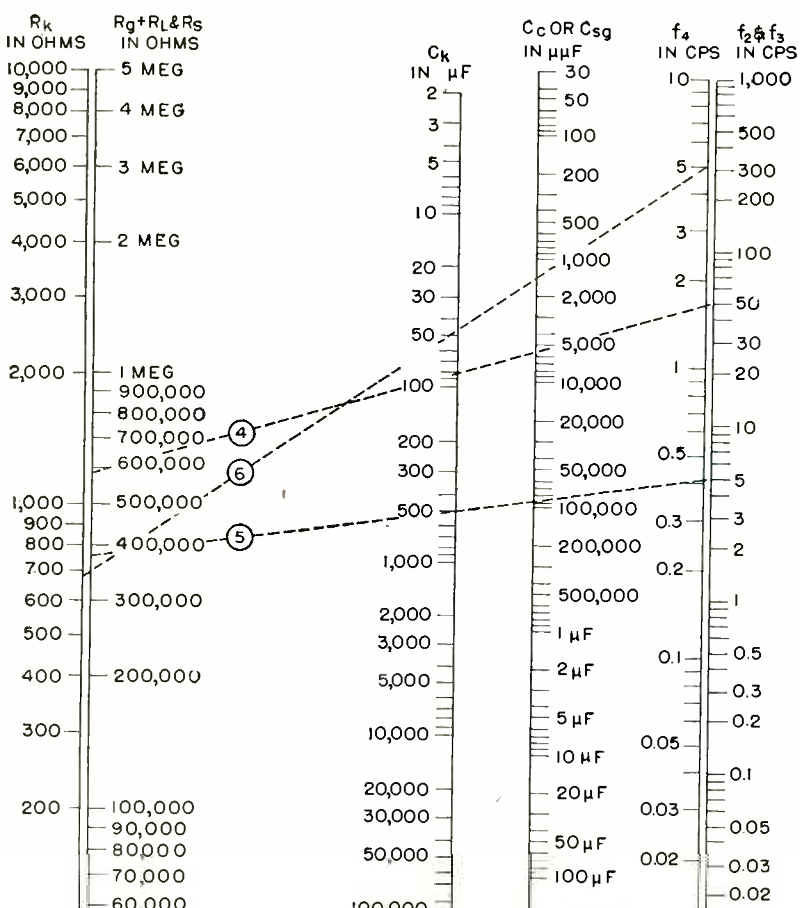

FIG. 4
LOW FREQUENCY

HOW TO USE:

GIVEN: A AND PASSBAND LIMITS f_1 AND f_2
FIND g_m FROM TUBE MANUAL

(1) FROM A AND g_m, READ R_{equiv}
FIND R_g FROM TUBE MANUAL

(2) FROM R_{equiv} AND R_g, READ R_L
FIND C_o, C_i AND C_w, AND ADD TO GET C_s

(3) FROM R_{equiv} AND C_s, READ f_1
ADD R_g AND R_L

(4) FROM R_g+R_L AND f_2, READ C_c
CHOOSE VALUE FOR R_s
DIVIDE f_2 BY 10 TO GET f_3

(5) FROM R_s AND f_3, READ C_{sg}
CHOOSE VALUE FOR R_k
MULTIPLY R_k BY g_m
FROM $R_k g_m$, FIND x:

IF $0 < R_k g_m \leq 1$, $x = 10$
IF $1 < R_k g_m \leq 3$, $x = 20$
IF $3 < R_k g_m \leq 5$, $x = 30$
IF $5 < R_k g_m \leq 10$, $x = 70$
IF $10 < R_k g_m \leq 20$, $x = 100$
IF $20 < R_k g_m \leq 50$, $x = 300$

DIVIDE f_2 BY x TO GET f_4

(6) FROM R_k AND f_4, READ C_k

What a Combination!

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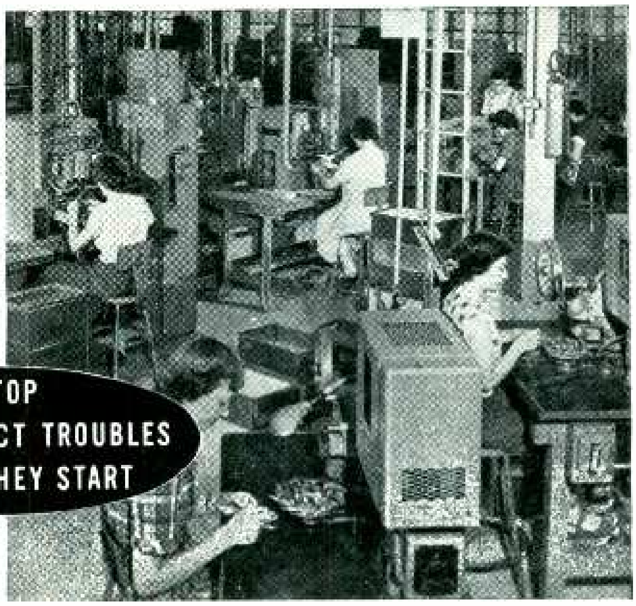
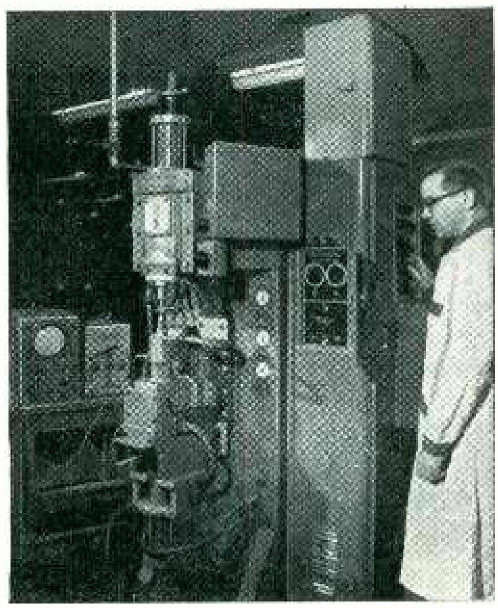
FACILITIES—include complete resistance welding equipment.

STOP YOUR CONTACT TROUBLES BEFORE THEY START



These resistance welders occupy a part of 100,000 feet of floor space devoted to contact production.



Resistance welding machine in the Mallory Contact Engineering Laboratory.

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ELECTRONS AT WORK

Including INDUSTRIAL CONTROL

Edited by ALEXANDER A. McKENZIE

OTHER DEPARTMENTS featured in this issue:

Pi Matching Networks

R. W. JOHNSON
Electronic Engineer
Pasadena, Calif.

USUAL SOLUTIONS for the circuit parameters of pi matching networks require reference to charts or curves, or substitution in quadratic formulas. This article will discuss a simplified approach based on transmission-line analogy.

A transmission line of arbitrary electrical length θ can be represented by a pi equivalent network, for the purposes of analysis. The equivalence, while not valid for all considerations, is exact for the present discussion. The equivalent for a lossless line is shown in Fig. 1A on this page.

In a transmission line an odd number of quarter-wavelengths long, an impedance transformation takes place between input and output terminals. The input impedance is given by Z_o^2/Z_L, where Z_o is the characteristic impedance of the line and Z_L is the load impedance. The pi equivalent of Fig. 1A reduces to either the network of Fig. 1B, or Fig. 1C for the odd-quarter-wave case.

The selection of the parameters of a lumped-constant pi network can be made by calculating the required Z_o as the square root of the input-output impedance product, and using reactances of this value in Fig. 1B and Fig. 1C. Where

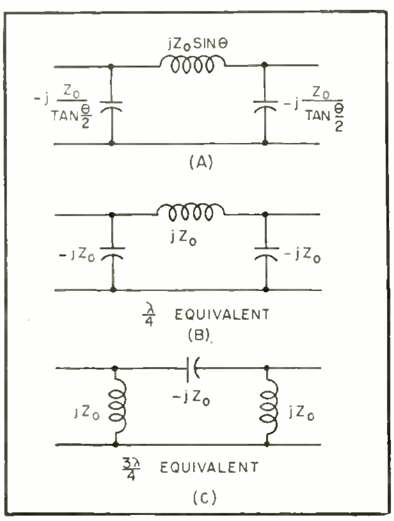
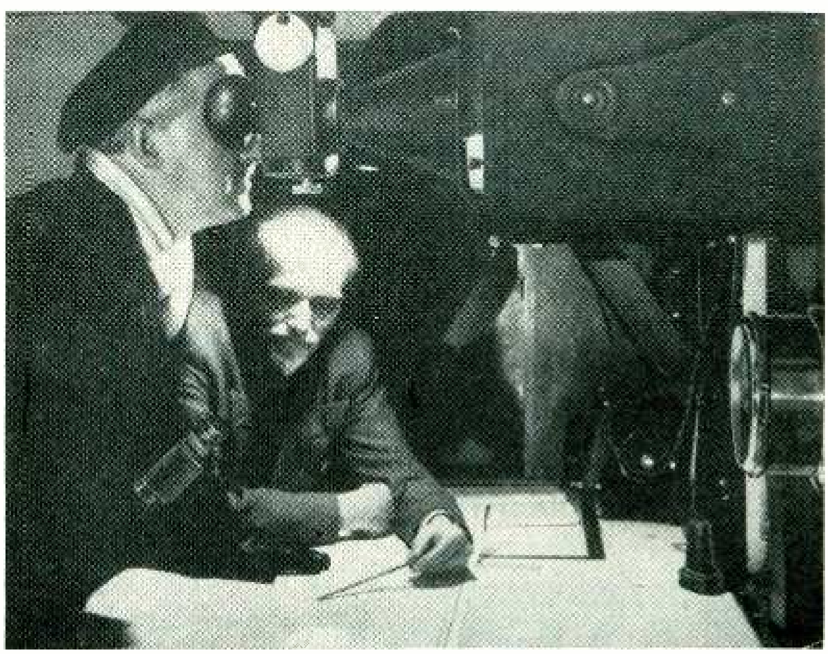


FIG. 1—Pi network equivalent for a lossless line (A) reduces to (B), or to (C) for odd-quarter-wave cases

RADAR CHART COMPARATOR



Identification of light blobs on a radar screen, indicating objects surrounding a ship, is often difficult for a navigator. A British invention makes it possible to superimpose the radar display upon a standard chart of the area. The chart comparison unit, which is attached to the radar indicator, also projects an arrow upon the chart below to show the navigator his position and heading

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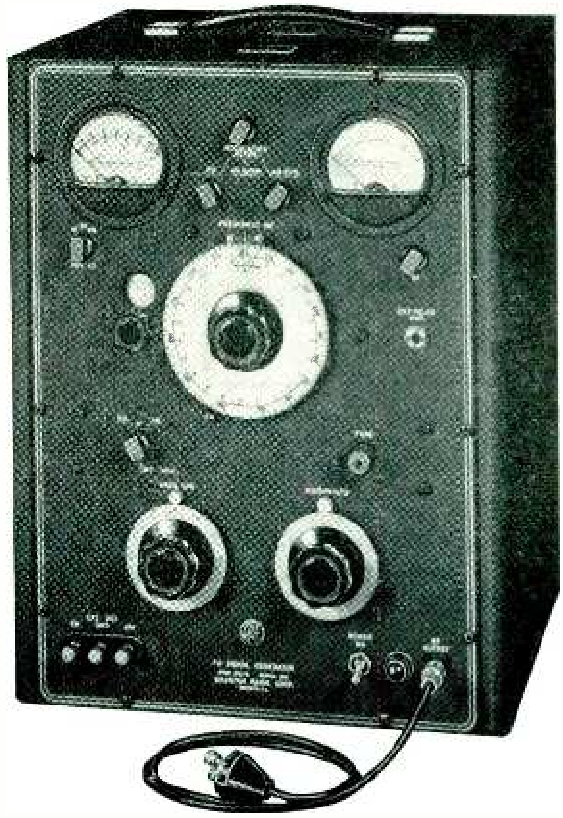
Frequency Range 175-250 mc.



With the type 202-D Signal Generator, you can quickly and accurately test, analyze and evaluate the performance of telemetering receivers and associated equipment. Note that the frequency coverage of the instrument is provided in a single range between 175-250 mc.

SPECIFICATIONS:

RF RANGE: 175-250 megacycles in one range, accurate to ± 0.5%. Main frequency dial also calibrated in 24 equal divisions for use with vernier frequency dial.

VERNIER FREQUENCY DIAL: This dial is divided into approximately 100 equal scale divisions and is coupled to the main frequency dial by a 24:1 gear train. The approximate frequency change per vernier division is 35 kc.

FREQUENCY MODULATION (DEVIATION): The FM deviation is continuously variable from zero to 240 kc. The modulation meter is calibrated in three FM ranges (1) 0-24 kc., (2) 0-80 kc., and (3) 0-240 kc. deviation.

AMPLITUDE MODULATION: Utilizing the internal audio oscillator amplitude modulation may be obtained over the range of 0-50% with meter calibration points of 30% and 50%. By means of an external audio oscillator the RF carrier may be amplitude modulated to substantially 100%. A front panel jack is provided which permits direct connection of an external modulating voltage source to the final stage for pulse and square wave modulation. Under these conditions the rise time of the modulated carrier is less than 0.25 microseconds and the decay time less than 0.8 microseconds.

MODULATION CONTROLS: Separate potentiometers are provided for continuous control of FM and AM levels.

MODULATING OSCILLATOR: The internal AF oscillator may be switched to provide either frequency or amplitude modulation. It may also be switched off. Eight fixed frequencies between 50 cycles and 15 kilocycles are available, any one of which may be selected by a rotary type switch.

RF OUTPUT VOLTAGE: The RF output voltage is continuously variable over a range from 0.1 microvolt to 0.2 volts at the terminals of the output cable. The impedance of the RF output jack, looking into the instrument, is 53 ohms resistive.

DISTORTION: FM: The overall FM distortion at 75 kc. is less than 2% and at 240 kc. less than 10%.

AM: The distortion present at the RF output for 30% amplitude modulation is less than 3% and for 50% AM less than 6.5. At 100% the distortion is 12% to 15% depending upon the modulating frequency.

SPURIOUS RF OUTPUT: All spurious RF output voltages are at least 25 db. below the desired fundamental. Total RMS spurious FM from the 60 cycles power source is down more than 50 db., with 75 kc. deviation as a reference level.

EXTERNAL MODULATION REQUIREMENTS:

Frequency Modulation: The deviation sensitivity is 50 kc. per volt. For external FM the input impedance is 1500 ohms.

Amplitude Modulation: Approximately 45 volts are required for 50% modulation and 100 volts for 100% modulation. For external AM the input impedance is 7500 ohms.

Audio Voltage for External Use: There is available at the FM external oscillator binding posts about 5 volts a.c. maximum and at the AM external oscillator binding posts, 50 volts maximum.

DIMENSIONS AND WEIGHT: Outside cabinet dimensions: 17" high, 13½" wide, 11½" deep. Weight: 35 pounds.

Price: $980.00 F.O.B. Boonton, N. J.

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the load is made up of a parallel combination of resistance and reactance, the shunt susceptance need only be properly combined with the susceptance of the corresponding shunt arm of Fig. 1B to maintain a resistive input impedance.

General Unbalanced Case

The general pi network shown in Fig. 2A can be considered as made up of a balanced pi with ad-

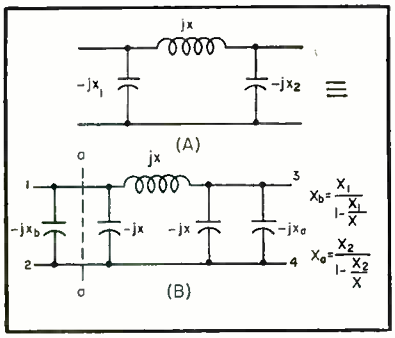


FIG. 2—General pi network (A) can be considered as a balanced pi network with added reactances (B)

ditional reactances shunting both input and output, as shown in Fig. 2B. A similar equivalent can be constructed for reactances of opposite sign and can be used to examine the effects of changing frequency.

In this case, the impedance seen looking to the right of line *a-a*, when a load impedance Z_L is connected across terminals 3-4, is $X^2/Z_L + jX^2/X_a$. This is a series combination of resistance and inductive reactance when Z_L is resistive and X_a is capacitive. This series combination is then shunted by the capacitive reactance X_b similar to an ordinary parallel tuned circuit of finite Q.

It is evident that a value of X_b can be found for which this total combination, which is the input impedance at terminals 1-2, becomes resistive. This value of X_b, however, depends on resistance R_L, and so the input impedance will be resistive only for a given value of R_L. This is another way of saying that the exact resonant frequency of a parallel resonant circuit depends on the Q of the circuit. In the balanced case previously considered, where all three reactances are equal, the input impedance is a pure resistance for any value of R_L, as long as frequency remains constant. Where a variable pure resistance is to be transformed, therefore, the balanced pi offers obvious advantages over the unbalanced pi, at any given frequency.

Tandem Networks

An interesting property of matching networks arises when such networks are connected in tandem, as shown in Fig. 3. This connection is analogous to the tandem stub-matching system commonly used in antenna work. The impedance seen looking to the right of section *a-a* is Z_{01}^2/Z_L. This impedance is the load for the second network, and so the input impedance Z becomes $Z = Z_L\,(Z_{02}/Z_{01})^2$. The double transformation cancels the usual reciprocal relationship, as will any even number of quarter-wave sections. Here, the transformation ratio between Z and Z_L depends only upon the ratio of Z_{02} to Z_{01}, and not upon their actual values, in this lossless case. This property has considerable utility when the desired transformation ratio is large, and would require an abnormally high value of Z_0 for the single case.

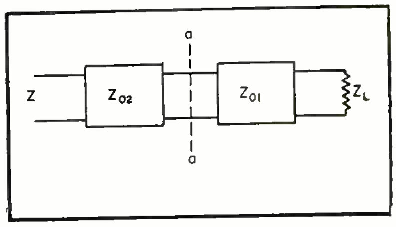
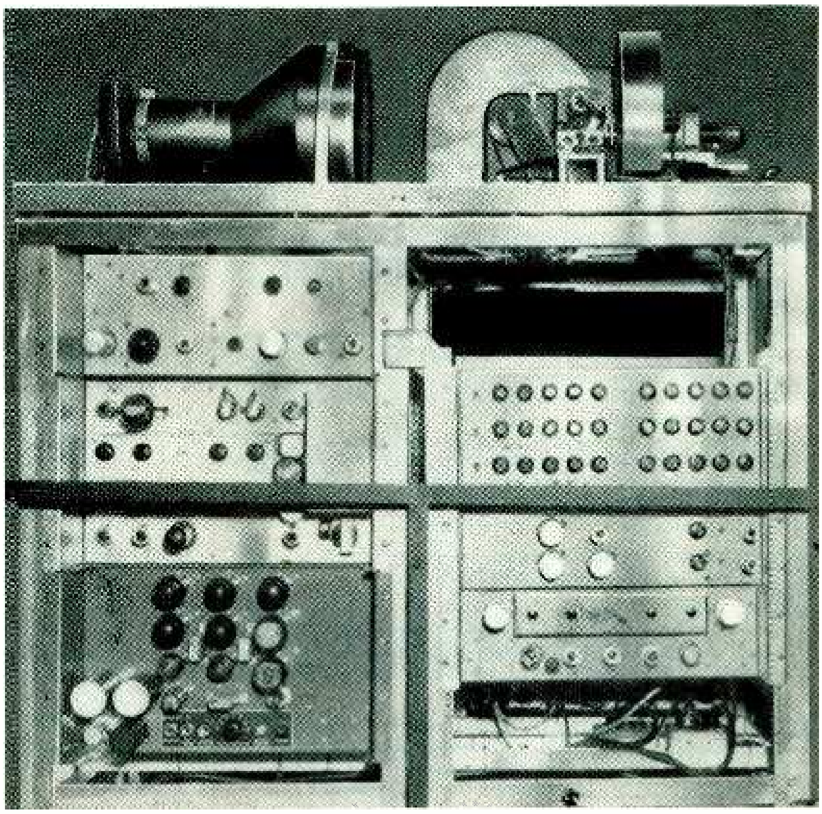


FIG. 3—Tandem network has transformation ratio dependent only on the ratio of the impedances

Transformations of much greater than 10 to 1 are easily possible with the tandem circuit. The same principle can be extended for more tandem sections, and in the limiting case, is analogous to a tapered transmission line.

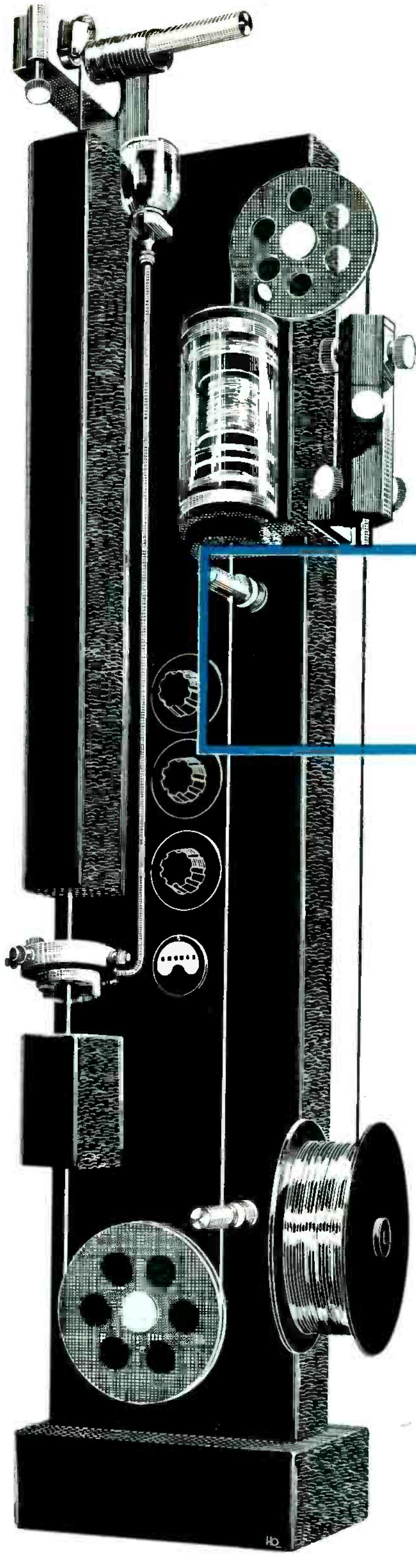
(Continued on p 208)

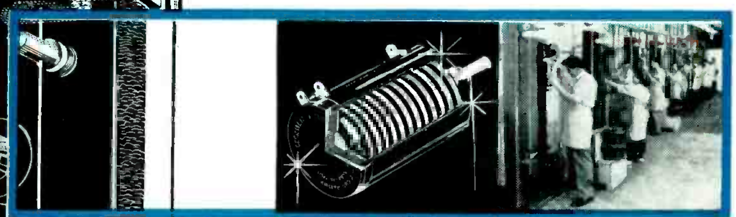
ONE-TUBE COLOR CAMERA



Color television pickup using only one camera tube is accomplished with the CBS Chromacoder. The picture is viewed first with a field-sequential camera using a single image orthicon. The 525-line, 180-field picture is then displayed on the monochrome picture tube at the left. The red, blue and green fields are then scanned by each of three Vidicons (right) according to NTSC-proposed standards. The outputs of the three Vidicons are then encoded in the manner normally used to produce an NTSC color signal

HOW TO **WIND UP** WITH A BETTER COIL!





The first characteristic which the user has a right to expect in a precision potentiometer is accurate performance...and in precision potentiometers, performance depends upon the coil.

In an accurate linear potentiometer, any given amount of slider travel must result in a corresponding voltage change...no matter which portion of the coil is traversed.

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The wire travels on...through a small pre-heater...then past jets which coat it with just the right amount of insulating varnish...and through an infrared oven to dry the varnish. Finally, the wire is coiled into a helix of the correct diameter by another set of rollers...and cut to the desired length of one to forty turns.

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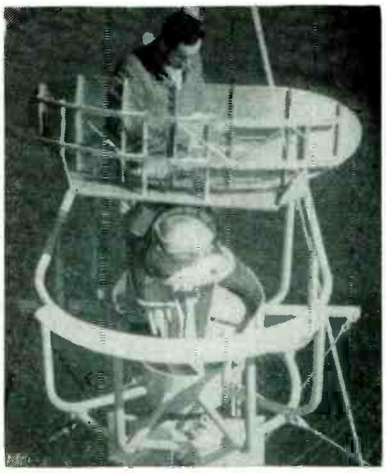


THE FRONT COVER

COMMERCIAL-TYPE RADAR is used on new Army craft designed to traverse shallow rivers, harbors and waterways. Prototype of the new 220-foot barge was launched last month. It will be employed in overseas military installations. Navigator's display screen in pilot's room will enable maneuvering among buoys, banks of rivers and channel markers in dark or foggy weather.

Similar electronic equipment is used on countless military craft, the exact number being classified. More than 2,300 merchant craft, which require radar licenses from FCC, are so equipped.

Stabilized Transistor Audio Oscillator

THE AUDIO-FREQUENCY oscillator circuit shown in Fig. 1 uses two transistors in push-pull class-C operation. Overall efficiency is on the order of 75 percent. Distortion is low, and signal-to-noise ratio of the oscillator is better than 100 db.

Amplitude is stabilized to about 1 percent over a wide range of supply voltages, output loads and temperatures by making use of silicon junction diodes that exhibit Zener effect. The Zener effect is the property of a semiconductor junction that causes a sharp decrease from thousands of megohms to a few hundred ohms in the back resistance of a diode when the applied voltage reaches a certain value. This voltage is called the Zener voltage.

The action is similar to the sharp increase in conduction in a gas-discharge voltage-regulator tube. In the circuit shown, Zener diode is used in place of a reference battery. Series and shunt thermistors make compensation for changes in the temperature-sensitive Zener diode. Diodes D_1 and D_2 supply d-c voltages for compensation.

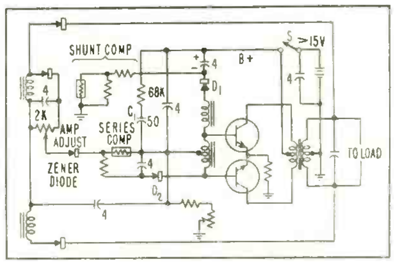
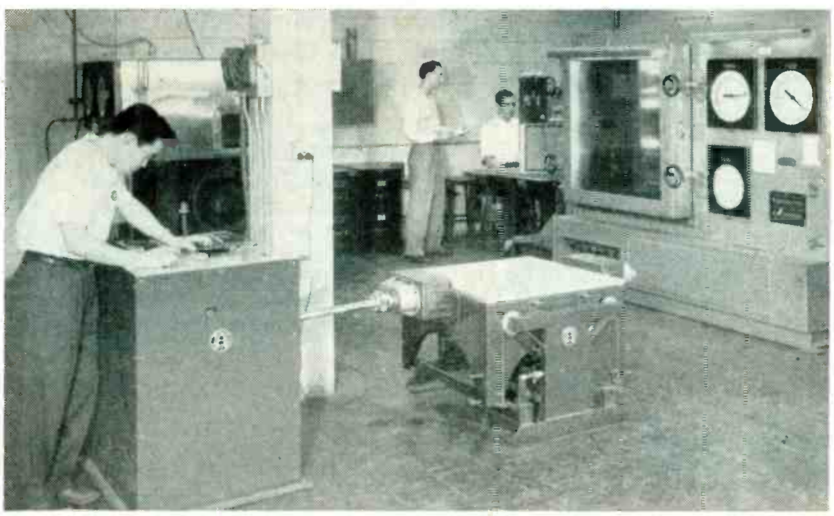


FIG. 1—Audio oscillator circuit uses temperature-compensated Zener diode for stabilization. All transformers windings are on a common core

Capacitor C_1 and the 68,000-ohm series resistor supply a surge of current to the base winding when switch S is closed. This is needed to start oscillations since zero bias would cause cutoff.

This article has been abstracted from a paper "An Amplitude Stabilized Transistor Oscillator" by E. R. Kretzmer, presented at the National Electronics Conference, September 1953.

ENVIRONMENTAL TESTING LAB



Environmental testing laboratory of the Admiral Corp. in Chicago, Ill includes vibration table in foreground and weather simulating unit at right. The vibration table produces 4,000 vibrations a minute for testing aircraft and shipboard electronic equipment. Climatic-test chambers can subject equipment to a temperature range from —100 to 185 F. Relative humidity can be varied from 20 to 98 percent. For testing aircraft equipment, altitudes from sea level to 80,000 feet can be simulated

Magnetic-Amplifier Phase-Shift Corrector

ONE OF THE problems in servomechanism work is the provision of satisfactory compensating or phase-correcting networks for a-c carrier-type systems. The problem arises from the fact that such networks must shift the phase of the envelope of a suppressed-carrier amplitude-modulated signal without shifting the phase of the carrier. Some difficulty is encountered in meeting these requirements without excessive attenuation

The circuit shown in Fig. 1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maintains output carrier in phase with input carrier within 20 degrees. Carrier frequency is not allowed to vary more than 10 percent and attenuation is held to a minimum. A suppressed-carrier signal E_s is applied at T_1. The

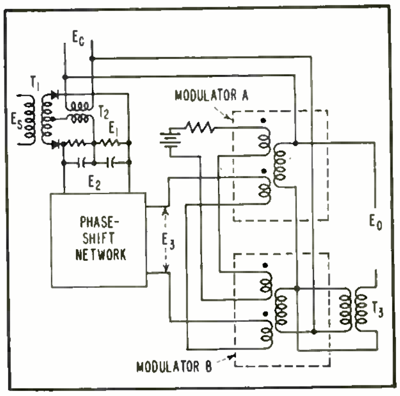

FIG. 1—Two magnetic modulators are used in circuit to maintain input carrier in phase with output carrier

carrier is injected by the secondary of T_2 providing an a-m carrier E_1 to the phase-shift network. This is demodulated and E_2 appears as an a-c voltage of signal frequency.

If no d-c phase-shift circuit is used E_2 will equal E_3 and the input to the modulators. The low-frequency input of each modulator is used to vary the output of the modulators. Carrier output of modulator B is reversed in phase by transformer T_3, having its secondary in series with the output of modulator A.

Using this arrangement the output is a suppressed carrier at the same signal frequency as the input. Desired lead or lag characteristics can be introduced by the d-c lead or lag network.

This article has been abstracted from a paper "The Magnetic Modulator in A-C Servo Corrective Networks" presented at National Electronics Conference by C. Voltz.

Magnetron Power Indicator

BY MARCUS NOWOGRODSKI AND VICTOR J. STEIN

Amperex Electronics Corp. Hicksville, N. Y.

THE HIGH PEAK power levels generated by pulsed magnetron oscillators make possible the use of gas-discharge devices for detection of r-f energy in the magnetron output transmission line. When these visual-indication devices are used in conjunction with measuring instruments, they may appreciably reduce testing time, particularly on production-type test stations.

In the instrument to be described, the extinction properties of the plasma discharge in neon bulbs are used.

Equal concentrations of electrons and positive ions exist in the plasma. If these equal distributions are destroyed by causing electrons to drift unidirectionally forming regions of positive-ion accumulation within the plasma, the discharge can be locally extinguished. This is the mechanism of the formation of the series of striations frequently observed in the positive columns of gas-discharge tubes.

An NE-2 neon lamp is loop-coupled to the waveguide transmission line so that one of its electrodes is at the waveguide potential for low-frequency signals. The coupling is very loose, so that the r-f energy reaching the neon bulb is just capable of sustaining a plasma discharge within the tube. If a d-c, or low-frequency a-c, potential difference is applied between the two electrodes of the neon lamp, the glow will extinguish. The voltage required to extinguish the discharge is proportional to the pulse power in the waveguide transmission line.

The upper limit of power levels for which the device will operate is determined by the coupled energy level for which no extinction occurs, while the lower limit of operation occurs at energy levels for which no continuous discharge can be sustained. Thus the coupling must be adjusted for the desired range of power levels in the waveguide. This is not a serious limitation, as the instrument is meant to be calibrated and used for measurements of output power of a specific magnetron type.

It was found advantageous to decouple the neon lamp from the waveguide to the point where the propagated energy levels are insufficient to start the discharge

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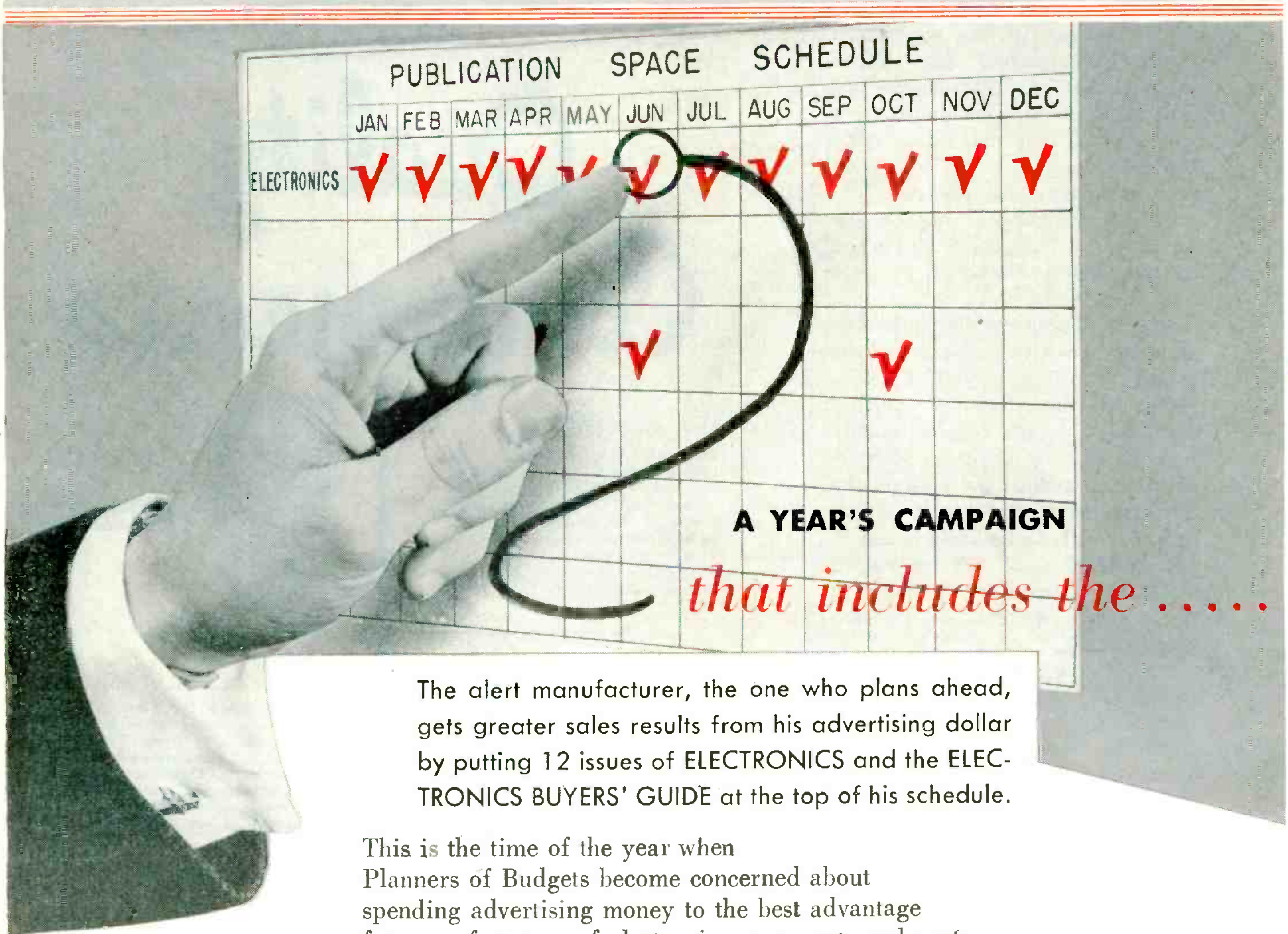

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without additional priming with momentary application of low-frequency potential difference to start the glow. This priming feature, while easily accomplished in practice, greatly extended the range of powers for which the instrument performed reliably. Since the energy required to sustain the discharge is lower than that required to start it, the neon lamp, once

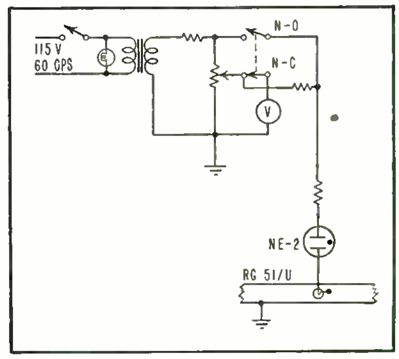

FIG. 1—Magnetron pulsed-power indicator uses extinction point of NE-2 lamp to measure power

primed, remains lit until the application of the metered extinguishing voltage across its electrodes.

Priming can also be accomplished by momentarily increasing the coupling between the waveguide and the neon lamp. This can be done mechanically by a spring-loaded metallic post movable across the coupling iris in the waveguide wall.

The unit described is capable of measuring pulse-power levels of approximately 20 to 75 kilowatts, is shown in Fig. 1. The device consists of a short section of RG51/U waveguide with a coupling iris in its narrow side, to which is coupled a NE-2 neon lamp. An isolation transformer is used so that the waveguide can be maintained at ground potential. A pushbutton switch applies the priming a-c voltage to the neon lamp, while at the same time opening the voltmeter circuit. An rms-reading a-c voltmeter is used for monitoring the extinction voltage.

A calibration chart of the instrument against a water load is shown in Fig. 2. For the coupling arrangement used, the neon lamp fails to extinguish when pulse-power levels exceed 75 kw, and the discharge is not reliably sustained

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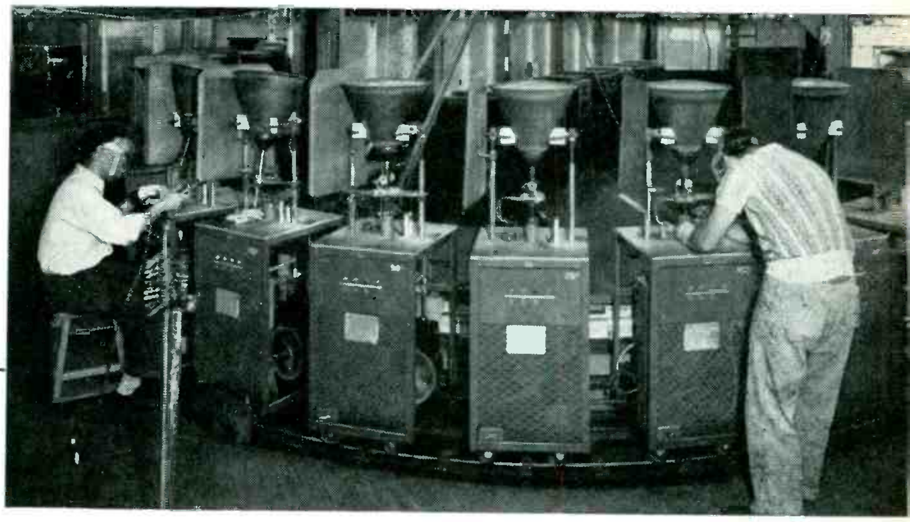

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for levels below 20 kw. Repeatability of readings is excellent, and the overall accuracy is of the order of 5 percent.

The instrument was constructed for a magnetron operating in the 9,375 ± 30-mc band. The vswr introduced by the unit was less than

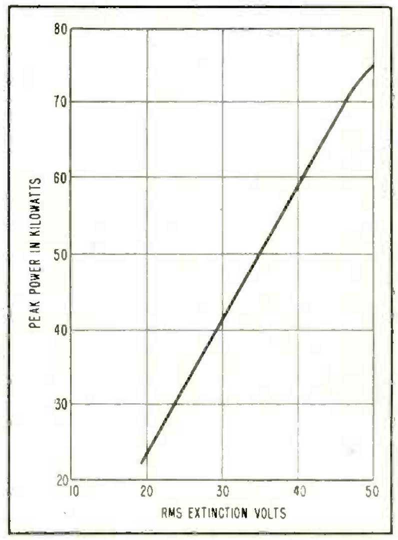


FIG. 2—Plot of power against extinction voltage of NE-2 bulb shows good linearity

1.1:1 over the range of 9,255 to 9,500 mc.

In addition to its use in the bench-testing of magnetrons, the device, owing to the simplicity of the associated circuitry, could possibly be incorporated in the output transmission line of a radar set, providing a quick and easy check on the transmitted power. With a visual-indication wavemeter also incorporated in the line, power and frequency of the radar transmitter could be monitored at will.

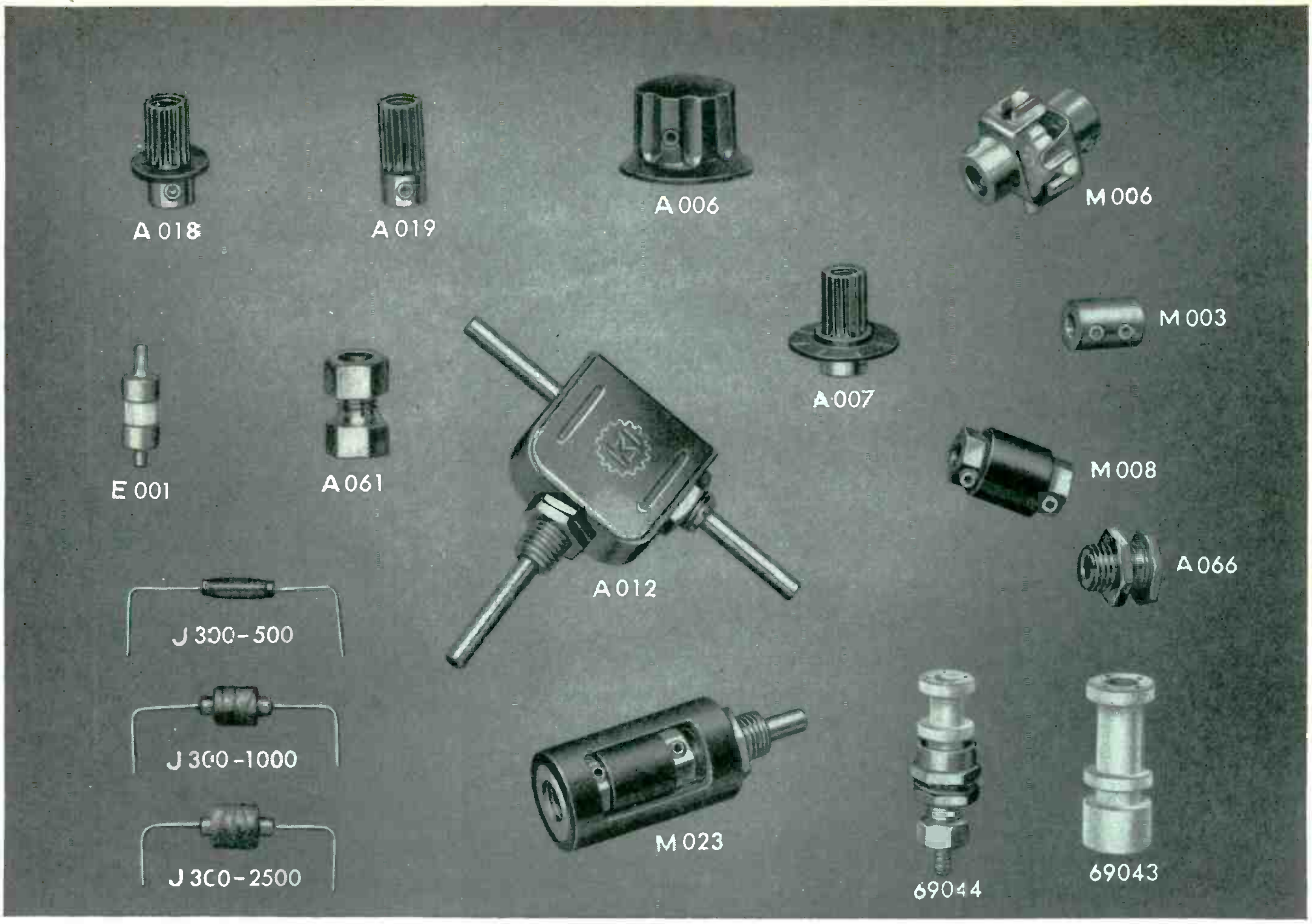
Vest-Pocket Transistor-Alpha Meter

By Branch P. Kerfoot

Government Radar Section
RCA-Victor Division
Camden, N. J.

RAPID AND ACCURATE checks of the current-gain property, alpha, of junction transistors such as the type 2N34, when used in a base-input circuit, can be made with the circuit shown in Fig. 1.

A need exists in breadboard development work occasionally to check transistors suspected of appreciable change of behavior due to aging or overload. Base-to-collector current gain provides a use-



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CODE	DESCRIPTION	NET PRICE
A006	Matches standard knobs in style. Black plastic with brass insert. For ⅛" shaft. Overall height ½". Diameter ¾".	$ .42
A007	Same as A018 except for ⅝" diameter plastic dial with 5 index lines.	.48
A012	Right angle drive. ⅛" diameter shafts. Single hole mounting bushing ¼"–32 diameter.	3.90
A018	¼" diameter black plastic knob with brass insert for ⅛" shaft. Skirt diameter ⅜". Overall height ⅝". Unique design has screwdriver slot in top.	.39

CODE	DESCRIPTION	NET PRICE
A019	Similar to A018, but without flange.	$ .36
A061	Shaft lock for ⅛" diameter shaft. ¼"–32 bushing. Nickle plated brass.	.39
A066	Shaft bearing for ⅛" diameter shafts. Nickle plated brass. Fits 17/64" diameter hole.	.36
E001	Steatite standoff or tie-point integral mounting eyelet. .205 overall diameter. Box of five.	.90
J300–500	Iron core RF choke 500 uh.	.42
J300–1000	Iron core RF choke 1000 uh.	.42
J300–2500	Iron core RF choke 2½ mh.	.42
M003	Solid coupling for ⅛" diameter shaft. Nickle plated brass.	.30
M006	Universal joint style flexible coupling. Spring finger. Steatite insulation. Nickle plated brass for ⅛" diameter shafts.	.75
M008	Insulated coupling, with nickle plated brass inserts for ⅛" diameter shafts.	.48
M023	Insulated shaft extension for mounting sub miniature potentiometer with ⅛" diameter shafts and ¼"–32 bushing.	1.35
69043	Steatite coil form. Adjustable core. Top tuned. Tapped 4–40 hole in case for mounting. Winding space ¼" diameter x 13/32" length.	.84
69044	Steatite coil form. Adjustable brass core. Bottom tuned. Mounting by No. 1D-32 brass base. Winding space .187 diameter by 3/16" length.	.84

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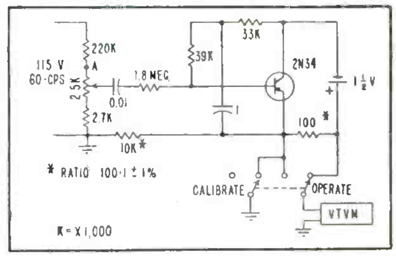
ful indication of gain capabilities for the amplifier circuits normally used. As a morale factor, as well, each engineer likes to know frequently where he stands as to the quality of transistors around which he is attempting to build an operating circuit. Circuits built around irregular transistors make it difficult to duplicate the circuit properties using normal units, unless the direction of the irregularity is accurately known. The following circuit provides a qualitative picture, and, with care, it may be read quantitatively to within approximately 3 percent of the exact alpha of normally encountered units.



Alpha-measuring circuit for type 2N34 transistor uses plug-in vtvm to avoid tying up expensive equipment

When wired as shown, operation consists simply of plugging in the transistor and reading alpha from the dial of a Ballantine model 300 vacuum-tube voltmeter, or similar instrument. A line-power signal is applied to the circuit continually, and the d-c circuit is only completed by the presence of the transistor.

The operating procedure requires a calibration adjustment upon installation, and possibly again to compensate for line changes when a series of precise readings is desired. When a transistor is inserted for the first measurement, the dpdt switch is used to connect the vtvm across the 10K current-measuring resistor in the base-emitter loop. The signal is adjusted for just 0.01 volt rms, and then the meter is switched to the operating position across the 100-ohm collector-emitter resistor. Alpha is read from the 0.001-to-0.01 volt scale, which indicates alpha between 10 and 100 directly. For alphas from 100 to 1,000 the next higher scale is used. It is presumed that substandard alphas, below 10, are not of interest for

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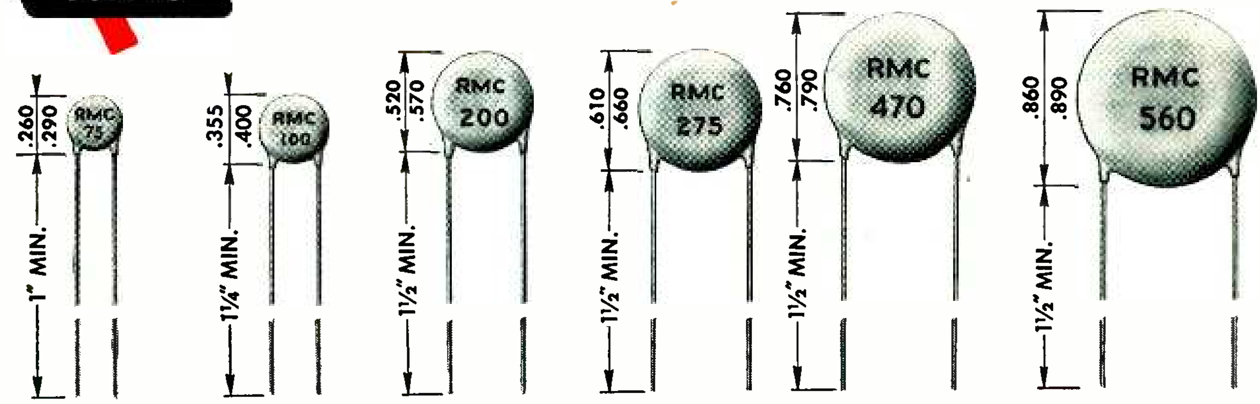

TC	1/4 Dia.	5/16 Dia.	1/2 Dia.	5/8 Dia.	3/4 Dia.	7/8 Dia.
P-100	1- 3 MMF	4- 9 MMF	10- 30 MMF	—	—	—
NPO	2- 12	13- 27	28- 60	61- 75 MMF	76-100 MMF	101-150 MMF
N- 33	2- 15	16- 27	28- 60	61- 75	76-100	101-150
N- 80	2- 15	16- 27	28- 60	61- 75	76-120	121-150
N- 150	2- 15	16- 30	31- 60	61- 75	76-140	141-150
N- 220	3- 15	16- 30	31- 75	76-100	101-150	151-190
N- 330	3- 15	16- 30	31- 75	76-100	101-150	151-190
N- 470	3- 20	21- 40	41- 80	80-120	121-200	201-240
N- 750	5- 25	26- 56	57-150	151-200	201-280	281-350
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this particular type transistor.

Essentially a ground-emitter circuit is synthesized for measurement of base-to-collector current gain under an approximately short-circuited load condition. A large series resistance to the base input provides a constant-current signal that is relatively independent of the exact transistor input resistance of individual units. In fact, even a large current-measuring resistor, such as the 10K unit used, does not appreciably alter accuracy when switched in or out of the input loop. Although a collector bias supply of only 1½ volts is used here, it is found to give values of alpha agreeing with measurements by more precise equipment where a 6-volt supply was used. Base bias of 20 microamperes places operation in a representative area of the 2N34 characteristics.

The signal is one microampere rms at the transistor input. Because the circuit may be wired compactly, and because impedance levels to ground are low, simple precautions adequately prevent contamination by stray pickup signals. On all units measured so far, the noise signal of the transistor has not contributed noticeably to the output signal reading. It should be emphasized that good, soldered grounding of all indicated points is essential.

There are two ways in which it is desirable to extend the usefulness of this simple piece of test equipment. First, this test of alpha (cb) at many frequencies will define regions of useful response. Second, the quantity of alpha (cb) is equally useful for other types of transistors, such as the 2N35 *npn* type. Emitter-to-collector alpha (ce) for point-contact transistors is also desirable to indicate relative stability and other properties.

The simple circuit, as shown, has an attenuator at the input from the 115-volt line. A two volt rms signal of another frequency could equally well be applied directly at the point *A*, with certain modifications, to yield direct readings of alpha at that frequency. The circuit was designed for either 60 or 400-cps input; for lower frequencies the capacitances must be increased proportionally. For higher

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Project TINKERTOY is the code name for a development by the National Bureau of Standards. It consists of a design system and automatic machinery for the **MECHANIZED PRODUCTION OF ELECTRONIC EQUIPMENT.** This program was sponsored by the Navy Bureau of Aeronautics as an industrial preparedness measure in production research.

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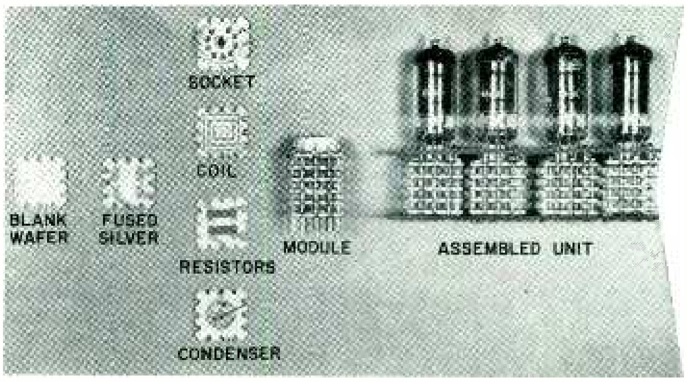
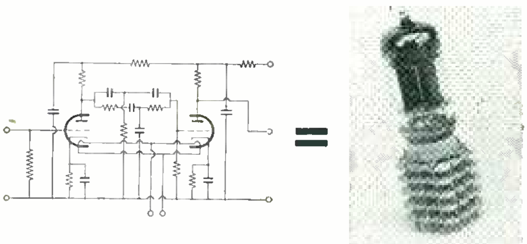
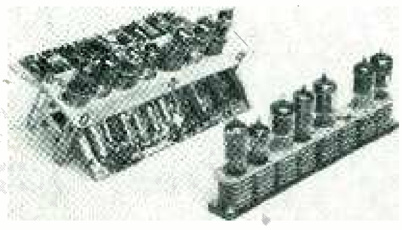


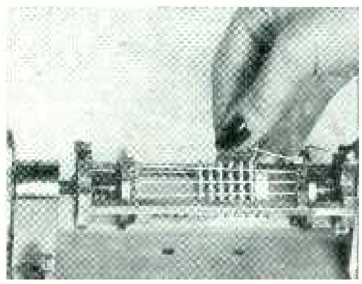
The heart of the N.B.S. system is the "module", consisting of half a dozen ceramic wafers interconnected by a dozen "riser" wires. Each wafer can contain as many as four tape resistors, ceramic disk condensers, or a tube socket, plus silvered connections to the proper riser wire. A single module can contain an entire circuit including a tube socket and twenty components as illustrated below left. Coils and other miscellaneous components can also be included. Several modules can be sandwiched between two photo-etched circuits providing a complete package. Audio, video, IF and RF amplifiers; oscillators, sweep circuits and counters have been made by this method. Tests by Sanders Associates have shown this equipment capable of withstanding environmental conditions beyond Military requirements.



This entire circuit can be contained in one module



Section of radio altimeter before and after adaptation to Project TINKERTOY by Sanders Associates



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frequencies greater wiring care may be necessary, as well as adding shielded input and output leads and possibly bypassing the 1½-volt dry cell used.

A vtvm that is accurately responsive to the test frequency is necessary. There seems to be no reason that the physical layout and choice of components cannot be arranged for signals approaching one megacycle in frequency.

To use this circuit for similar *npn* transistors, such as the type 2N35, it is merely necessary to reverse the terminals of the 1½-volt cell.

Point-contact transistors such as the type 2N32, require more elaborate changes, and these are dictated by the specific types to be tested. It will probably be necessary to raise the collector bias (*npn* polarity), use the grounded-base circuit, provide d-c emitter bias, increase test signal amplitude (perhaps by ten times) and reduce the emitter current-measuring resistor perhaps to a tenth. Alpha (ce) will then be read in the 1 to 10 range.

Stability of readings depends directly on constancy of signal voltage whether from the a-c line or from a frequency generator.

Accuracy of readings is limited by the accuracy with which the two measured metering resistors possess the desired ratio (here 100 to 1) and by the linearity but not the absolute accuracy of the vtvm itself. It is expected that these resistors will preserve their ratio with temperature changes.

Tests made on sample junction transistors agree closely with previous measurements of alpha (cb) made under laboratory conditions. For alphas between 10 and 200 in value this circuit gives readings within approximately 5 percent of the other values, even though time and use of the transistors have occurred between the measurements.

Better accuracy is possible by further care in the choice of two measured components and in the calibration. Because the meter reading is relative to its calibration at full-scale deflection, overall reading accuracy is limited by the tracking accuracy of the instrument rel-

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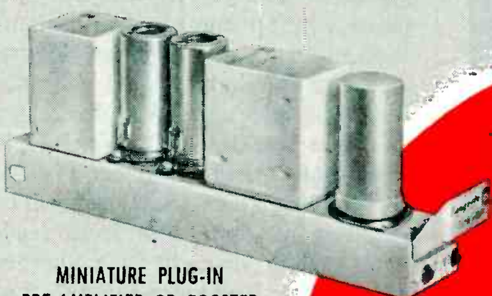

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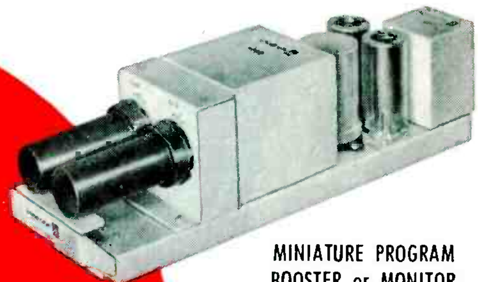

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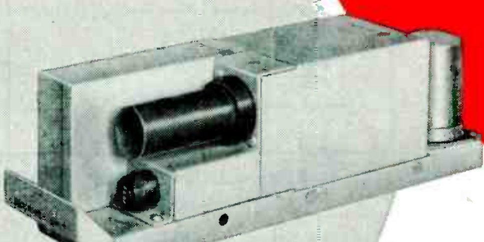

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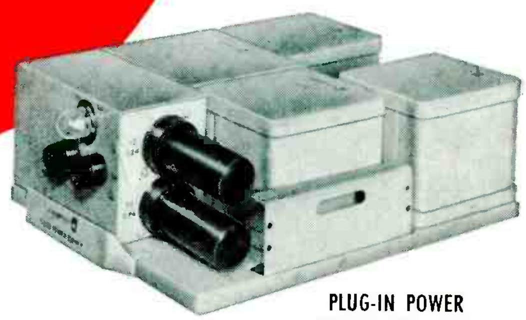

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ative to its scale markings, not by absolute meter accuracy.

High Output Oscillator Converter

THE NEED FOR an electrometer amplifier with several hundred volts output emphasizes the advantages of some form of converter to transform the direct-voltage input to an alternating voltage. Experience with an electronic relay had shown that large changes in the amplitude of an oscillator could be obtained by small changes in the ratio of plate-to-grid voltage by the mechanical movement of a light metal vane. It was a simple matter to vary the feedback electronically and a rough amplifier working on this principle was made with surprising ease. Getting high sensitivity, speed of response, and stability in a feedback system, brought in a number of problems that were far different from those encountered in direct-coupled amplifiers.

The principle of operation is straightforward. In a perfectly linear oscillator, an infinitesimal change in the feedback ratio could

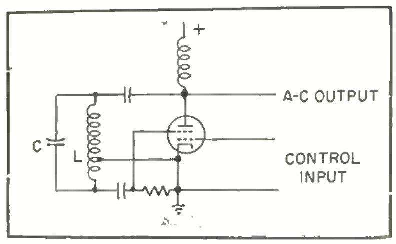
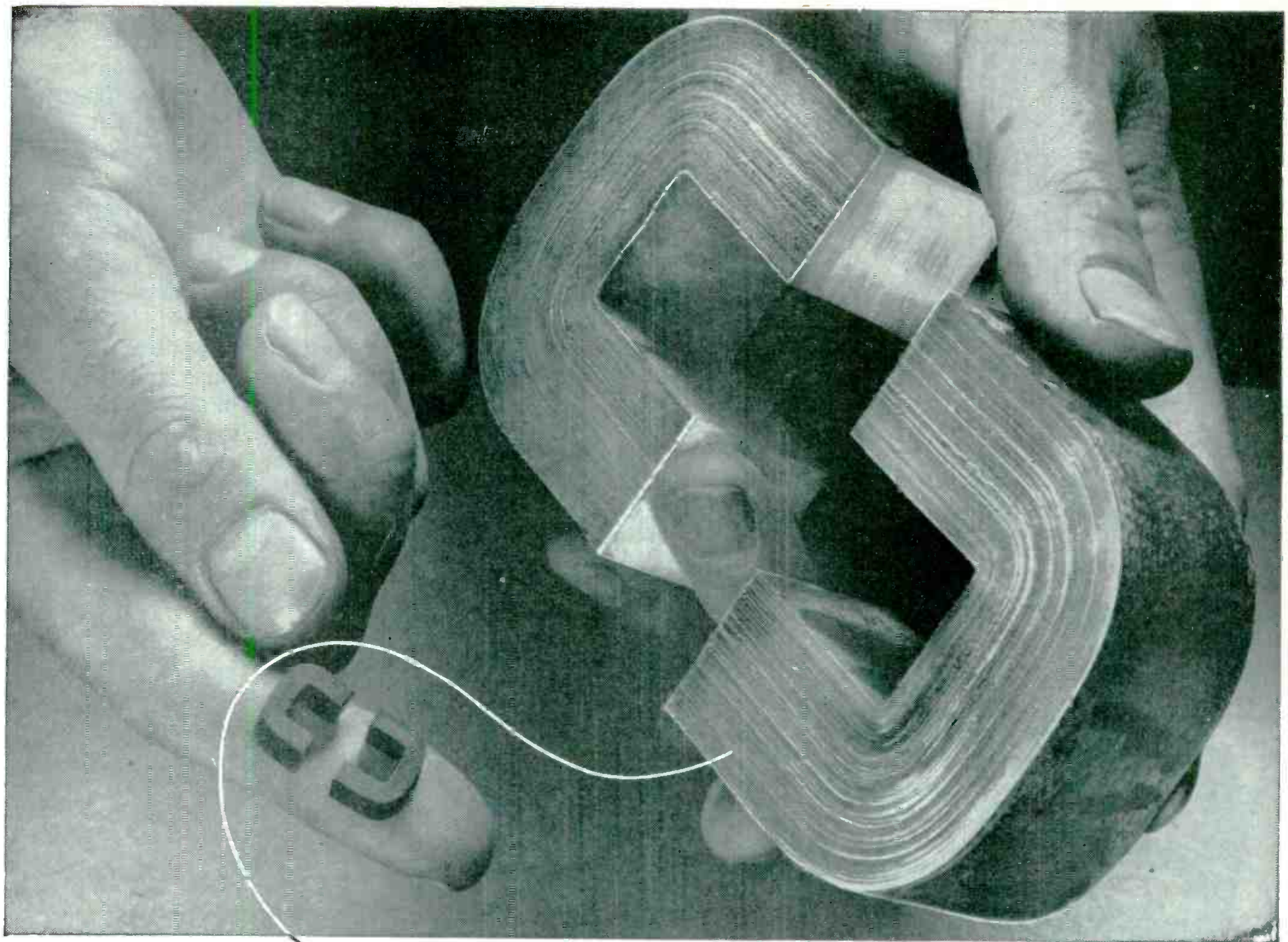


FIG. 1—Basic oscillator circuit for d-c conversion

start or stop oscillations so the ratio of a-c output to d-c input (gain) is infinite. Such a hypothetical oscillator is shown in Fig. 1 in which a Hartley circuit is used with a tetrode. Voltage on the control grid will change the gain of the second grid. At the frequency determined by L and C, a maximum of voltage of proper phase will be supplied to grid 2 to control tube current to energize the L-C circuit. If the gain around this circuit is exactly 1 and it is oscillating at a certain amplitude, it will continue to oscillate at that level indefinitely. If the circuit components are all linear, it would oscillate at constant amplitude at any other level at which it was started since gain



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would remain at a value of 1.

In this tube, oscillation frequency is applied only to grid 2 for amplification, and grid 1 is varied by an input to control gain from grid 2 to plate. With the input at 0 volts, assume for illustration that tube gain is such as to give loop gain of exactly 1. As explained, oscillation level will not change. If the input changes slightly positive, loop gain will exceed 1 and amplitude will build up indefinitely. The converse applies if the input is negative. The character of the change is logarithmic, since each cycle must differ from the preceding one by a constant ratio as in Fig. 2.

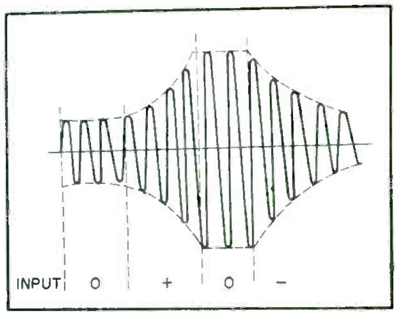

FIG. 2—Response of oscillator output to input signal

In actual tubes, the parameters are not linear and gains will not be infinite. If loop gain falls off with increasing amplitude, it will require an ever increasing input voltage, and there will be a definite, but not necessarily constant, value of gain between d-c input and a-c output. The d-c to a-c gain depends upon the rate of change of tube gain but not upon actual gain. A tube with a gain of less than unity is not inherently any less sensitive than one with a gain of a thousand.

The frequency of the carrier is limited by tube characteristics, but there is no limitation due to the method of conversion.

Lack of drift in this circuit depends upon gain characteristics and not on steady-state values of any potential except the control grid-cathode contact potential. This contact potential is indistinguishable from a signal and can cause as much trouble here as in direct-coupled amplifiers.

Response of the circuit at higher frequencies will be limited even though the d-c gain is infinite. Analysis indicates that the gain *for* Bridgeport *Service*

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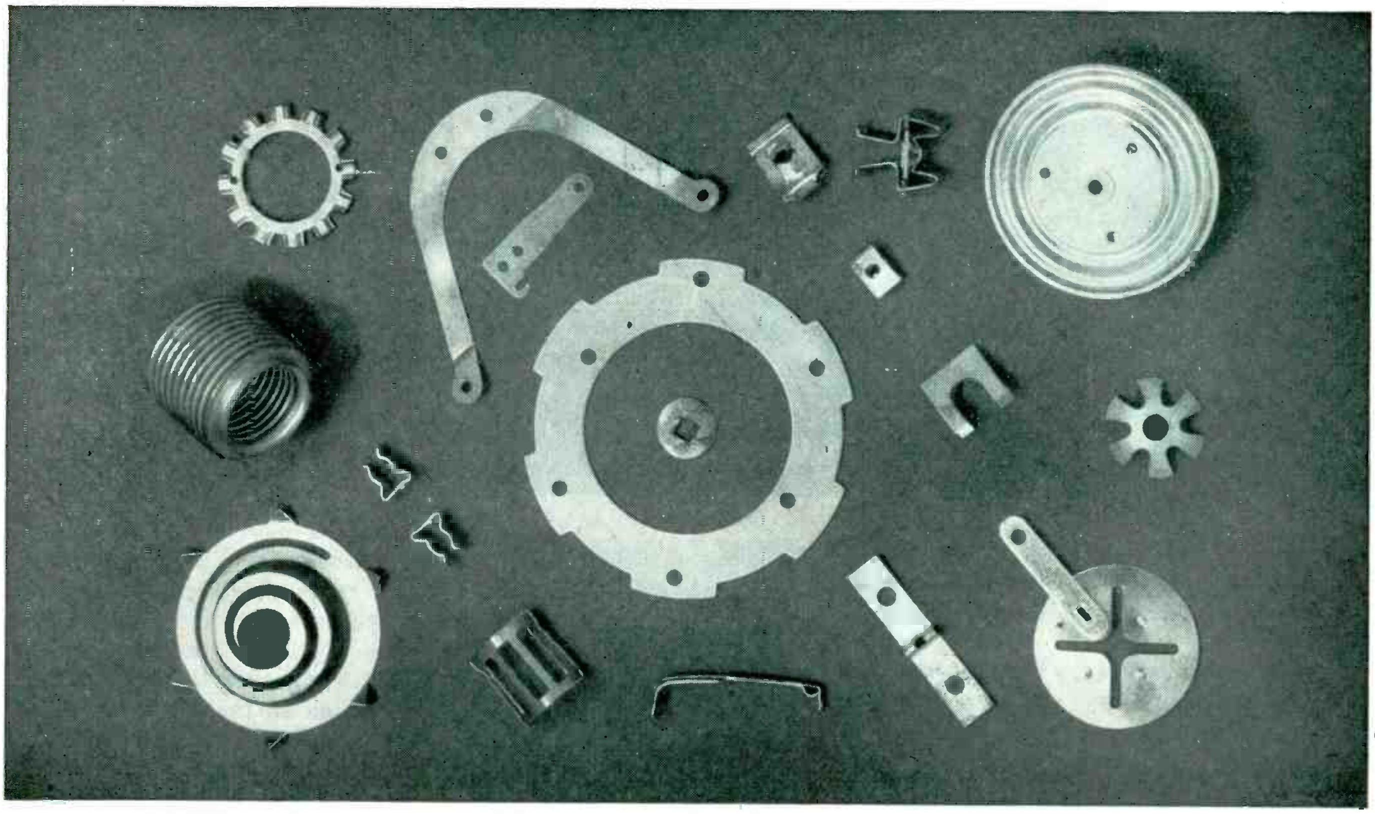

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drops to unity for a signal frequency equal to half the carrier frequency even though the steady-state gain might be infinite.

Besides nonlinearity of the tubes in the oscillator, gain may be limited by other forms of nonlinearity. If oscillation-frequency voltage from later amplifier stages or the rectified output gets back to the oscillator this voltage may oppose oscillation, requiring an increase of input. An increase in output rectifier efficiency with increasing amplitude reduces Miller-effect loading by the last stage on the next to last stage which then increases Miller-effect loading on the stage before and so on to the oscillator.

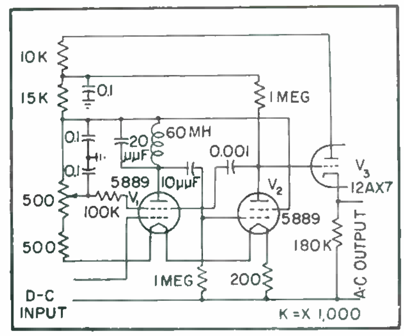

FIG. 3—Circuit of oscillator converter

Precautions taken to achieve high gain include operating the oscillator at a low level, filtering power supply and feedback leads into the oscillator section, and isolating the following amplifier stages by a cathode follower.

Figure 3 shows a converter in which two type 5889 tubes are used. Heaters are supplied from a regulated supply to avoid gain changes. The first tube is operated at low voltages and conditions for low grid current and high gain sensitivity, and the second is at conditions for slight power gain, so that the screen grid of the first may be driven. Oscillation frequency of about 80 kc is determined by a parallel L-C circuit. The first tube is tuned so that stray capacitance will not load its high-impedance output. A cathode follower isolates the oscillator from the variable loading effects of later stages.

In this converter, the ratio of peak-to-peak changes in a-c to the d-c change depends upon the curvature of the tube characteristics with

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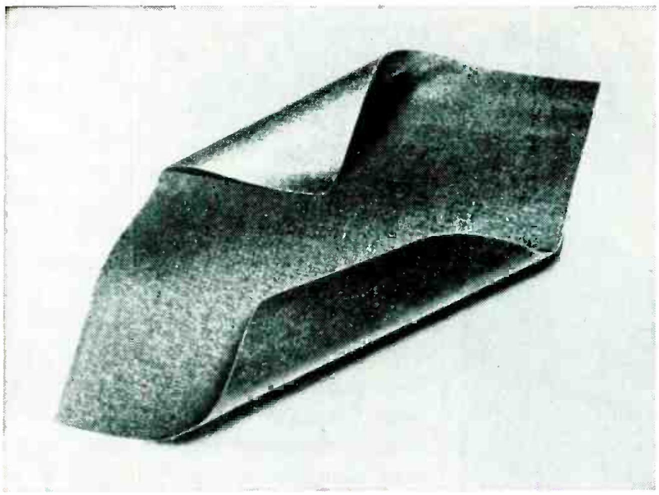

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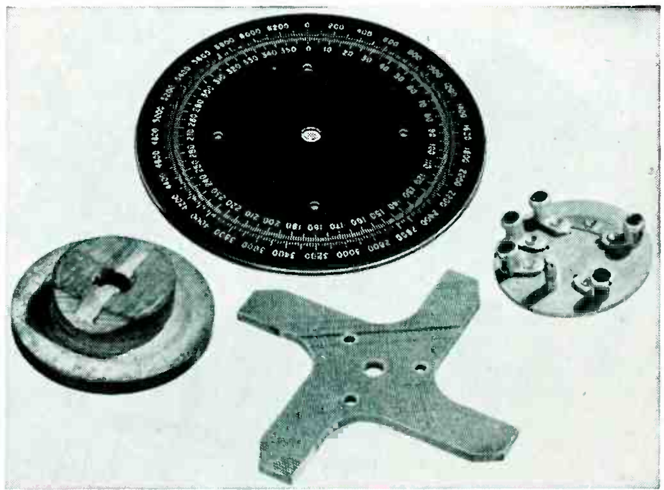

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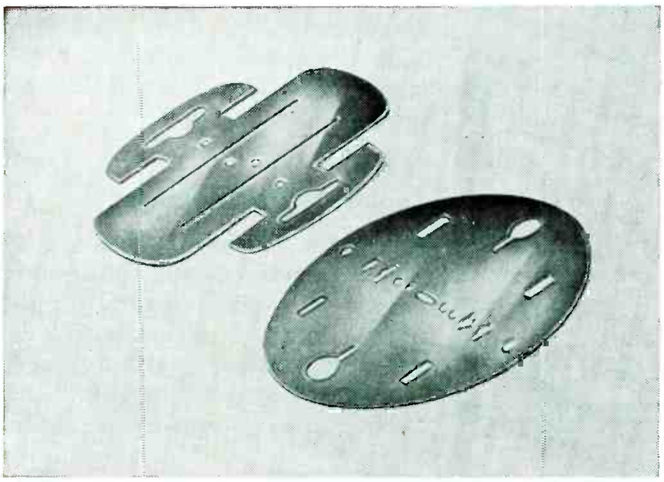

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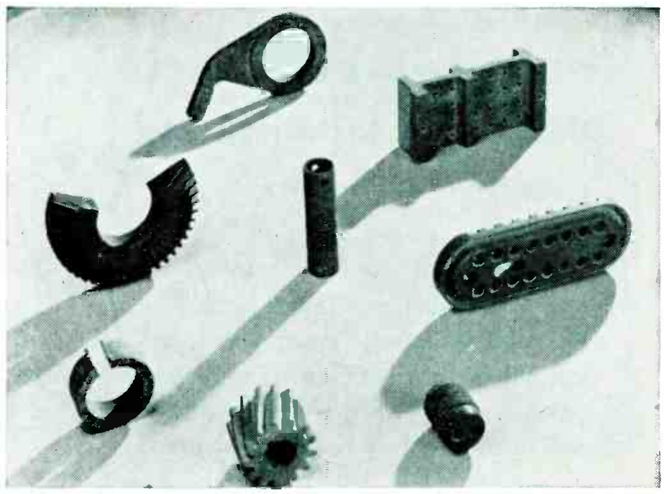

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amplitude. A ratio of at least 1,000 should be obtained with 100-mv peak-to-peak output. The converter will normally be used with additional amplification, rectification, filtering and feedback.

With the converter shown and a stage of voltage amplification driving a push-pull output stage, an output of +3 to −10 volts and a gain of 10^5 can be obtained with an input grid current of less than 10^{-14} amperes. The unit is stable with a 10^{13}-ohm resistor and an input capacitance of 5,000 μμf and has a time constant of four seconds.

This converter has the advantage of getting conversion with gain at a relatively high carrier frequency with an all electronic circuit. While it has been described in relation to d-c amplifiers, it will be found a useful tool in many diverse applications.

This article has been abstracted from a paper entitled An Oscillator Electrometer, by T. A. Rich and J. E. Bigelow of the General Electric General Engineering Laboratory.

Sensitive Photorelay

PHOTOELECTRIC RELAYS for operation in semidarkness or under conditions of average indoor, nighttime illumination generally require either an external rectified voltage source or a stage of amplification.

The circuit shown in Fig. 1 can be made to control 12.5 amperes at 117 volts by a photocell illumination as low as one foot-candle. It operates on house current. Tube *V* is a type 2D21 gas-filled miniature thyratron; *K* is a 117-v a-c relay. Damper diode *D* used to quench the inductive kick of the coil and eliminate chattering is a type RS65T. It must be properly poled

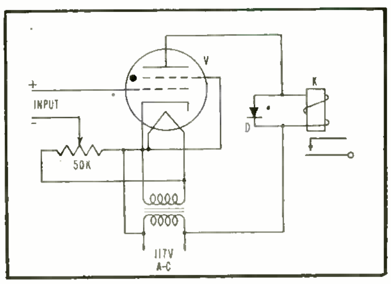

Fig. 1—Circuit of the photocell amplifier

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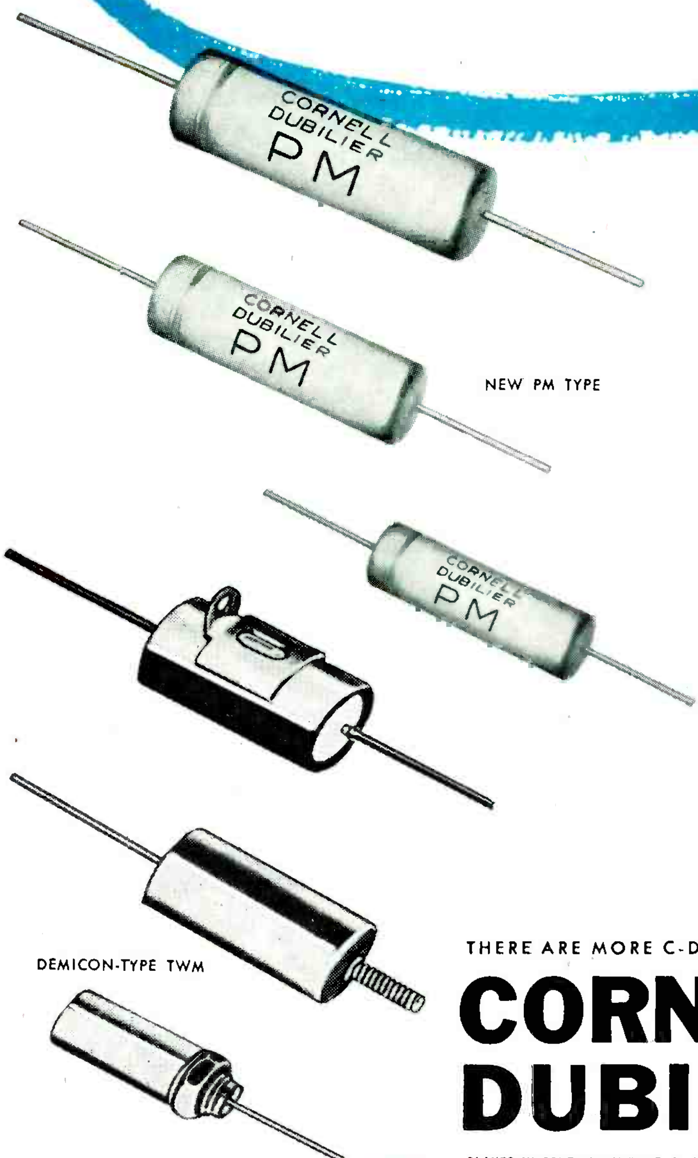

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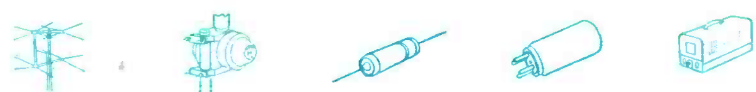

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or the thyratron tube will instantly blow out. Proper connection is made when positive voltage is blocked from the tube plate. A type DP-2 photocell was used during the development of this circuit.

This material was abstracted with permission from *International Rectifier News*.

Water Load For High Power UHF

By R. G. Talpey
Tube Department
Radio Corp. of America
Harrison, N. J.

A HIGH-POWER WATER LOAD suitable for measurement of r-f power of the order of 20 kilowatts in the frequency band from 500 to 1,000 megacycles has been built. Its action is based on the relationship $P = 0.26\,F\Delta T$ where P = power in kilowatts, F = water flow in gallons per minute, and ΔT = temperature rise in degrees centigrade. The most important characteristic of a good water load is its ability to accept all of the power fed to it over a wide frequency band. For tube development work it is also desirable that the input standing-wave ratio be less than 1.1.

The water load, constructed to mate with $3\frac{1}{8}$-inch, 51.5-ohm coaxial fittings, is one in which a coaxial line is filled with circulating water. Bandwidth requirement precludes the use of any frequency-sensitive matching sections between the air-filled line and the

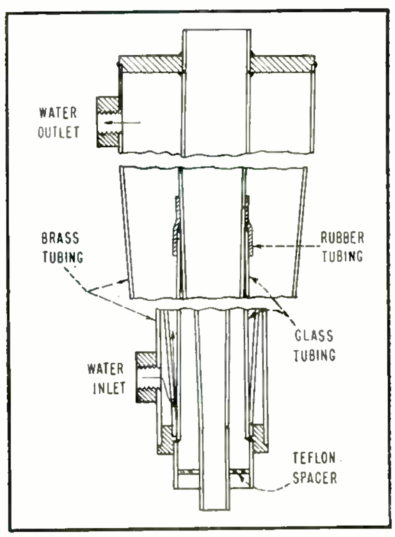

FIG. 1 — Cross-section of high-power water load

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	1N68A	130	100	3.0	0.625 @ −100 v
High Back Resistance	1N67A	100	80	4.0	0.005 @ −5 v; 0.050 @ −50 v
	1N99	100	80	10.0	0.005 @ −5 v; 0.050 @ −50 v
	1N100	100	80	20.0	0.005 @ −5 v; 0.050 @ −50 v
High Back Resistance	1N89	100	80	3.5	0.008 @ −5 v; 0.100 @ −50 v
	1N97	100	80	10.0	0.008 @ −5 v; 0.100 @ −50 v
	1N98	100	80	20.0	0.008 @ −5 v; 0.100 @ −50 v
High Back Resistance	1N116	75	60	5.0	0.100 @ −50 v
	1N117	75	60	10.0	0.100 @ −50 v
	1N118	75	60	20.0	0.100 @ −50 v
General Purpose	1N90	75	60	5.0	0.800 @ −50 v
	1N95	75	60	10.0	0.800 @ −50 v
	1N96	75	60	20.0	0.800 @ −50 v
JAN Types	1N126**	75	60	5.0	0.050 @ −10 v; 0.850 @ −50 v
	1N127†	125	100	3.0	0.025 @ −10 v; 0.300 @ −50 v
	1N128‡	50	40	3.0	0.010 @ −10 v

*That voltage at which dynamic resistance is zero under specified conditions. Each Hughes Diode is subjected to a voltage rising linearly at 90 volts per second.

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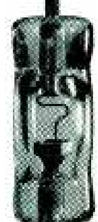

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water section. A tapered water-filled line is used to effect the transition. Figure 1 shows a cross section of the device with dimensions exaggerated to show the details. A piece of Pyrex glass tubing fits the inner diameter of the coaxial line and serves as the barrier between air and water. Because it is difficult to fabricate this tubing in a tapered shape, the transmission-line conductors are tapered instead.

Although it would be desirable to maintain constant impedance in the entire load, the high dielectric constant of the water would require impracticable dimensions. An impedance of about 6 ohms, therefore, was chosen for the water-filled line. This arrangement represents a compromise between electrical requirements and practical physical dimensions. The taper section is made long enough to accommodate this impedance change at the lowest frequency of operation. The results obtained with this empirical design were better than

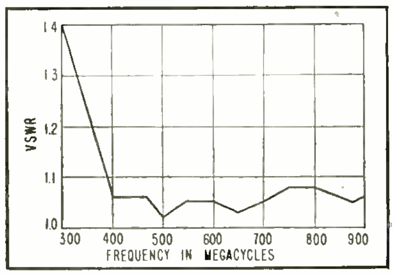

FIG. 2—Graph of vswr over operating range of water load

would normally be expected from an initial trial. A plot of the vswr as a function of frequency is shown in Fig. 2.

Mechanical Construction

The coaxial-line conductors of the water load are made from a copper sheet cut to the developed shape, rolled into tapered cylindrical shape and brazed at the seam. The cylinders are spun to their final dimensions on a mandrel. The end sections and manifold are machined from brass, and soldered to the cylinders. The hollow center conductor is used to conduct air for cooling the seals of experimental tubes. Pyrex glass tubing is selected to fit closely at

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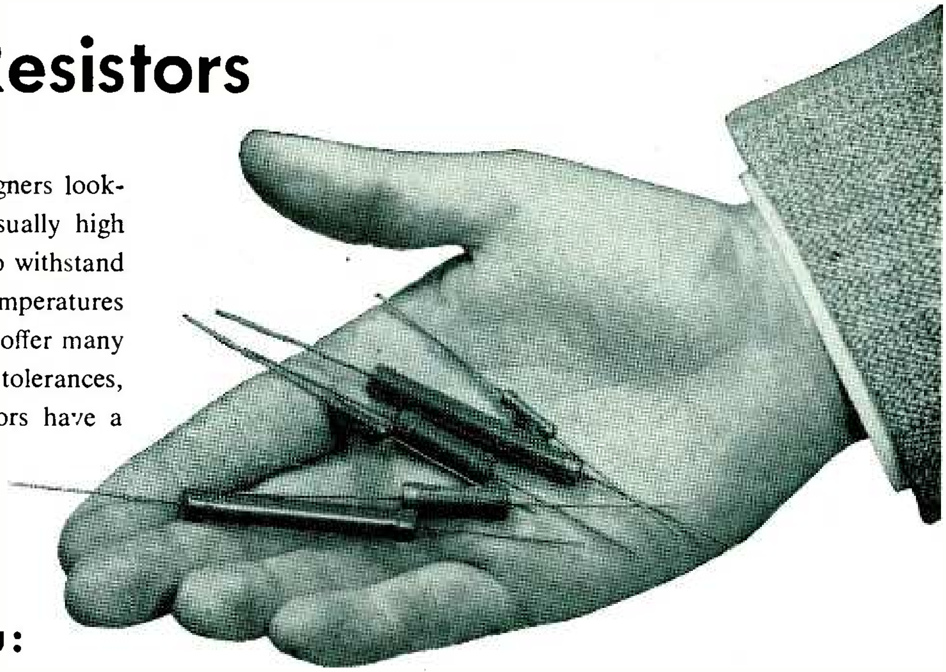

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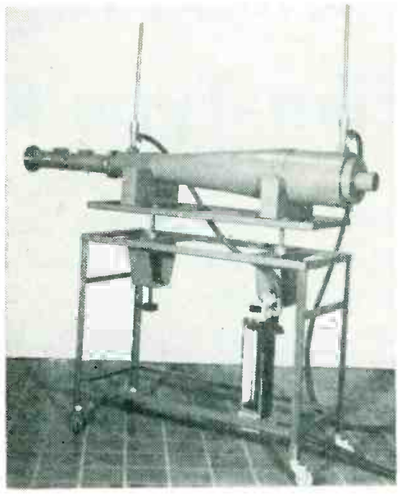
the seals. The rear seal is made by slipping a piece of soft rubber tubing over the glass. The compressional force of the water pressure on this tubing maintains a tight seal. The forward seal was originally made with high-temperature wax. In a second model a thermosetting plastic cement seal was successfully used. Water flows into the forward manifold and then through a circumferential series of holes in the outer conductor. The holes are small enough to preclude an appreciable discontinuity in the transmission line.

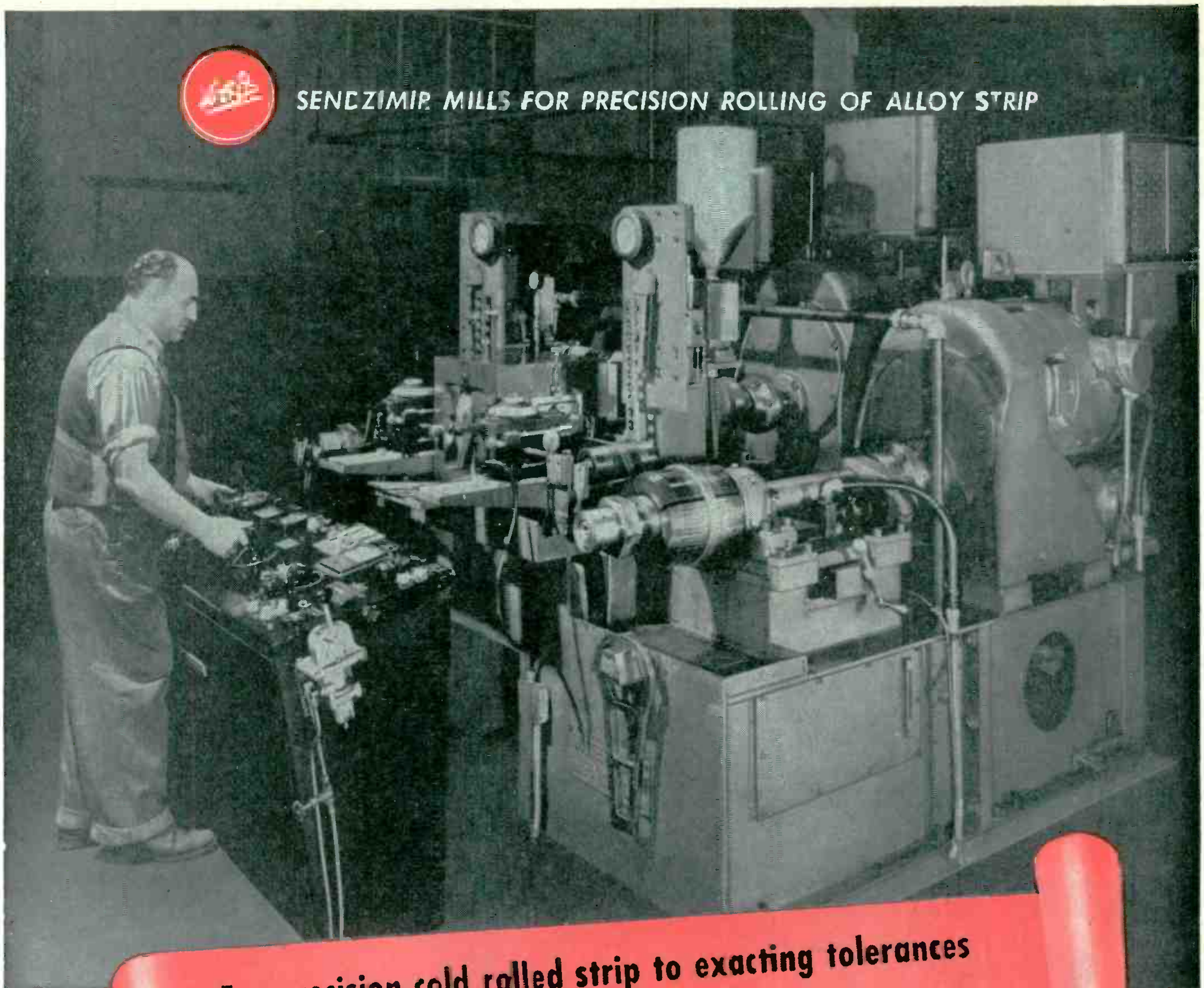


Water load for uhf. Flowmeter is located under table

The water entrance holes must be close to the junction of the glass barrier and the tapered outer conductor to prevent dead spots in the water stream. Because of the large inside volume of the load, some internal convection exists, causing the upper part of the outside conductor to become slightly warm. The effect of this power loss is not serious but nevertheless, should be corrected.

When available water-flow rates are 5 gallons per minute or less, the overall temperature rise approaches 30 deg C, which is higher than is desirable. The convection problem can be solved by increasing the flow rate or by changing the flow path through the load by means of deflecting vanes or relocation of the water output line.

The photograph shows the physical arrangement of the load and its accessories. The load is approximately 48 inches long includ-



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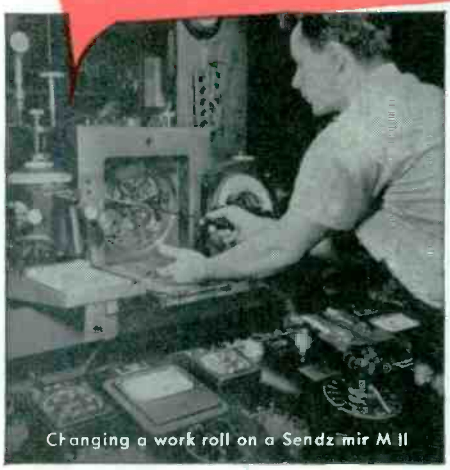
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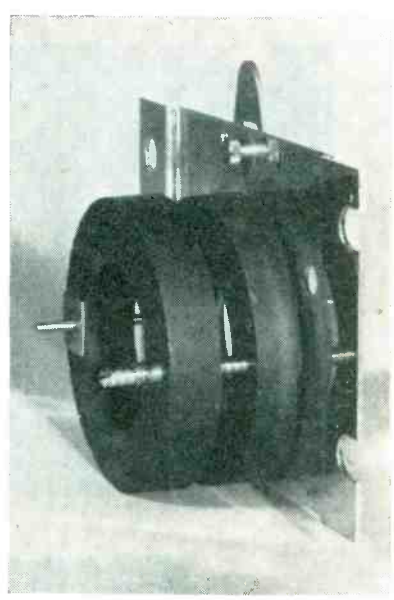
ing end sections and water connections. The water-temperature thermometers are mounted in stub sections of the water pipe with the bulb immersed in the water stream. The flowmeter is mounted under the table top. The load uses ordinary tap water and withstands ordinary water-supply pressures adequately. The provision for horizontal mounting permits the use of shorter line lengths to the tube than those required for some commercial loads which must be mounted vertically and, therefore, require bends in the transmission line.

This water load has been in use for over two years and has provided constant and reproducible readings. No trouble has been experienced due to breakdown under high powers. Although the load has been tested only to r-f powers of 20 kilowatts, it is estimated that it will safely dissipate 50 kilowatts or more if proper water flow is provided.

Ceramic Magnets Focus TV Tubes

BY J. A. VERHOEF
Television Receiver Design Laboratory N. V. Philips' Gloeilampenfabrieken, Eindhoven, Netherlands

ON A SHORT-NECK television picture-tube the stray field of a per-



Screw adjustments on ceramic focusing unit permit adjustment of focus by changing spacing between magnets

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"But there is no emergency. Within 24 hours, the watch is delivered via Air Express. On graduation day, daughter proudly sports her new Waltham—thanks to Dad and a wide-awake jeweler!

"We use Air Express day in and day out to ship fast-moving styles from current lines, and to get new sample lines to wholesalers where every hour saved is important.

"Going back into our records for the past five years, I found that *not a single shipment* handled by Air Express had been lost or damaged. Yet most of these shipments cost us *less* by Air Express than by any other commercial air service!"

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manent-magnet focusing unit interferes with the field of the ion-trap magnet and with the deflection field.

A focusing unit comprising two flat annular permanent magnets with opposed magnetization has a weaker stray field than the usual single focusing magnet. This construction is made possible by the development of Ferroxdure ceramic permanent-magnet materials.

The field intensity, H_z, in the axis of a permanent-magnet electron-lens is appreciable just where the ion-trap magnet and the scanning yoke are placed, while the field of a focusing coil falls away rapidly outside the focusing region.

The focusing coil is completely enclosed in a soft-iron can except for the air gap inside the yoke, and the magnetic field crosses only this air gap.

A permanent magnet of the type shown in Fig. 1A would be short-circuited by such a can. An air gap must be left on the outside of the permanent magnet. This air gap is also crossed by magnetic lines of force resulting in the negative stray field as shown in Fig. 1B. This field intensity curve is particularly undesirable as the negative peaks occur near the ion-trap magnet and the deflection coils. It would be desirable to modify this shape so that the negative portions of the curve are either confined to a more restricted region, or spread out over a much wider region and

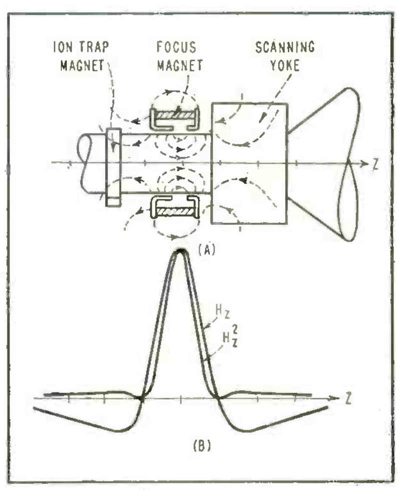
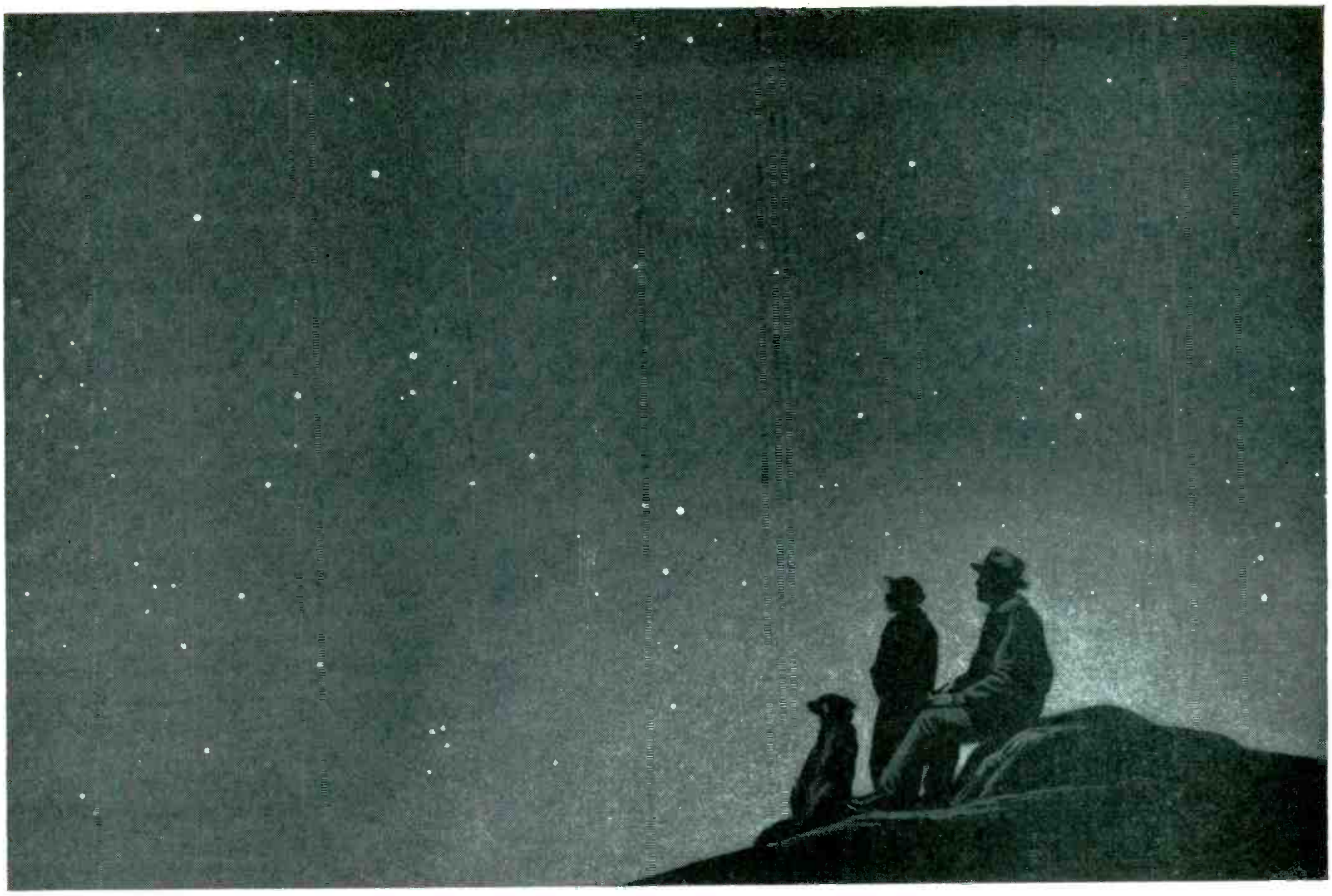
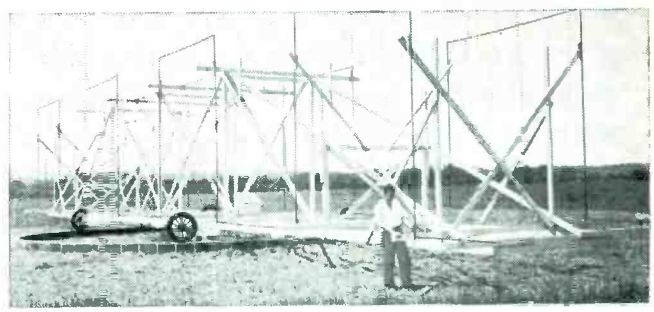


FIG. 1—Permanent-magnet focusing unit (A), and graph of magnetic field intensity (B)



How silent is the night?



Directional radio antenna used by Karl G. Jansky, in the discovery of stellar radio signals at the Holmdel, New Jersey, branch of Bell Telephone Laboratories. In 1932 he detected waves of 14.6 meters coming from the direction of Sagittarius in the Milky Way.

Watching the serenity of Christmas skies, we are conscious of deep silence. Yet the stars are talking to us all the while—talking in radio waves that are full of meaning to scientists probing the depths of space.

The important discovery that some stars produce radio waves was made by a Bell Laboratories scientist while exploring atmospheric disturbances which might interfere with transoceanic telephone service.

His discovery marked the birth of the fast-growing science of radio astronomy. It is telling us of mysterious lightless stars that broadcast radio waves, and it promises new and exciting revelations about the vast regions of space concealed by clouds of cosmic dust.

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at the same time reduced in magnitude.

Restricting the region of the focusing field plus stray fields by making the focusing ring as short as possible has been tried with little success. Apparently the internal diameter rather than the length of the focusing magnet sets a lower limit to the region occupied by the positive and negative portions of the H_z curve. Flattening out the negative portions of the curve required impractical magnetic shielding.

If two p-m lenses with opposite polarities, of the type shown in Fig. 2A, are placed on the tube neck as close to each other as possible, their focusing strengths will add rather than subtract, while their stray fields will oppose each other to a certain extent.

If the field intensity curves could be added, the result would be more satisfactory than the curve of a single magnet. The total area under the combined H_z curve would still be zero and the area under the H_z^2 curve would indicate a useful focal length. In the neighborhood of the ion-trap magnet and of the deflection coils the value of H_z would be low and would exhibit a shape comparable to that of Fig. 2B. For a focusing unit of this kind the annular permanent magnets would have to be quite short and still give sufficient magnetic flux. A permanent-magnet material with a high coercivity would be required for such rings.

The use of ceramic permanent-magnets has made it possible to construct a focusing unit meeting these requirements. The demagnetisation curve of Ferroxdure is compared to metallic permanent-magnet material in Fig. 3. The remanent induction is about 2,100 gauss and its coercivity is in the order of 1,700 oersted. The demagnetization curve is almost completely reversible. A ceramic magnet can be subjected to a reverse field of the order of the coercivity and recover almost to its original value of magnetization.

The focusing unit consisting of two ceramic rings with opposed axial magnetization has an H_z curve that approaches closely the ideal. The

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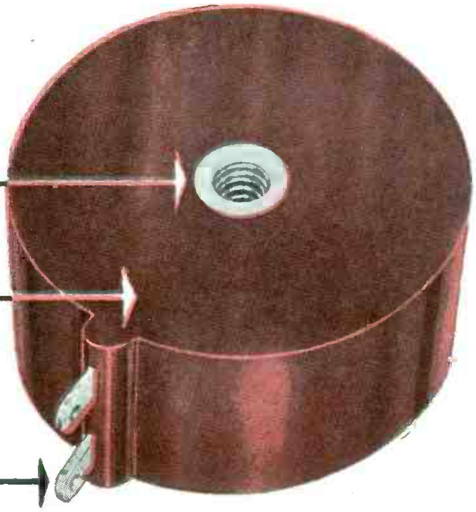
THROW AWAY the special washers and tubings used in your present mechanical mountings of toroids. C-A-C Advanced Design provides a molded-in brass bushing with center hole sizes to clear (type A) or tapped (type B) for a 6/32 screw.

PRESSURE ENCAPSULATION in low loss plastic provides a dense molding of extremely uniform dimension. We've cycled them from —73° C to 150° C—boiled them for hours in salt water—without any significant change.

TERMINALS are brass, silver-plated. Located for ease of connection. Any reasonable number of terminals may be provided. Units may be stacked and mounted with a single screw.



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Via C.A.C. Beechcraft, we are only hours away from you—we solicit the invitation to discuss your problems across your own desk.

TOROIDAL INDUCTORS
Data For Standard Types

	Type	Normal Lmax.	Appr. Size O.D. x H	Useful Freq. Range	Qmax @ Freq.	T.C.	Iac-ma
*	206	3.0 Hy	.90x .40	Up to 15 KC	140 @ 9 KC	1	23
**	930	17.5 Hy	1.20x .60	Up to 15 KC	170 @ 7.5 KC	1	42
	254	35 Hy	1.85x .85	Up to 15 KC	220 @ 5 KC	1	67
	466	60 Hy	2.15x1.00	Up to 15 KC	260 @ 5 KC	3	95
*	848	1.4 Hy	.90x .40	10- 50 KC	170 @ 20 KC	1	33
**	395	8.0 Hy	1.20x .60	10- 50 KC	220 @ 20 KC	1	61
	381	17.0 Hy	1.55x .65	10- 50 KC	250 @ 17.5 KC	3	71
*	608	600 Mh	.90x .40	30- 75 KC	165 @ 60 KC	3	50
	579	7.5 Hy	1.55x .65	30- 75 KC	185 @ 30 KC	2	110
*	041	320 Mh	.90x .40	50-200 KC	115 @ 120 KC	3	68
	013	4.0 Hy	1.55x .65	50-200 KC	145 @ 70 KC	3	150

REMARKS

Qmax—Values taken at approx. .01 Iac. Q decreases with increasing current to about .50 Qmax at 1.0 Iac—higher inductance values have lower Qmax at lower frequency due to dielectric losses of winding distributed capacity. All values are for inductors wound with Heavy Formex wire.

T.C.—Temperature characteristics as follows:
1—approx. 100 ppm/°F
2— = .1% 55 to 90°F
3— = .1% 30 to 130°F
(most types with temp. characteristic 1 are available with characteristic 3 at no sacrifice in performance)

Iac—r.m.s. current which raises 0.1 Hy inductor to max. (2% above initial) inductance — (1% increase occurs at approx 0.35 Iac.

* FINISHED SIZE — 1-1/16" O. D. x 1/2" THICK
** FINISHED SIZE — 1-5/16" O. D. x 11/16" THICK

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measured H_z curve is shown in Fig. 2B. As the distance between the two rings is increased the strength of the electron lens also increases and the region occupied by the field widens.

The magnetic inductance in the

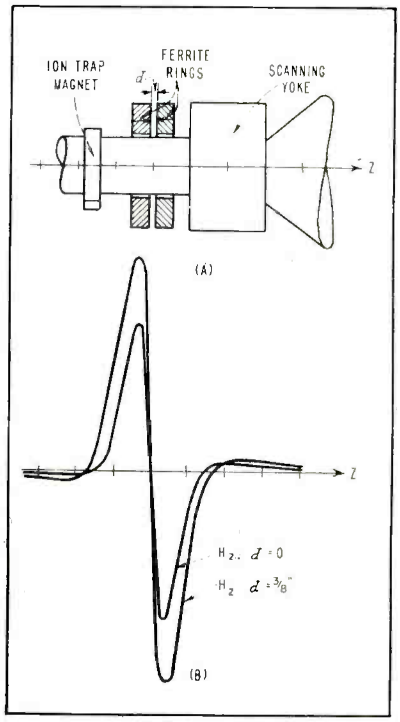

FIG. 2—Ceramic focusing unit (A) uses two ceramic rings to obtain field intensity plot (B)

rings is approximately 400 gauss when the distance between the rings is zero, and rises to approximately 500 gauss for a distance of half an inch. The temperature coefficient is therefore near its minimum.

The fact that the strength of the lens varies fairly steeply with the distance between the two rings makes a simple focusing adjustment possible. One of the rings is fixed and the other can be shifted over a distance from zero to half an inch with respect to the fixed ring. In one instance the range for which the electron beam in a picture-tube could be focused was from 10 to 20 kv. This range depends on the type of tube, the position of the lens on the tube neck, the internal diameter and thickness of the ceramic rings. The rings show no sign of permanent demagnetization, even when moved with respect to each other through a great number of cycles.

The homogeneity of the ceramic

for MICROSCOPIC precision

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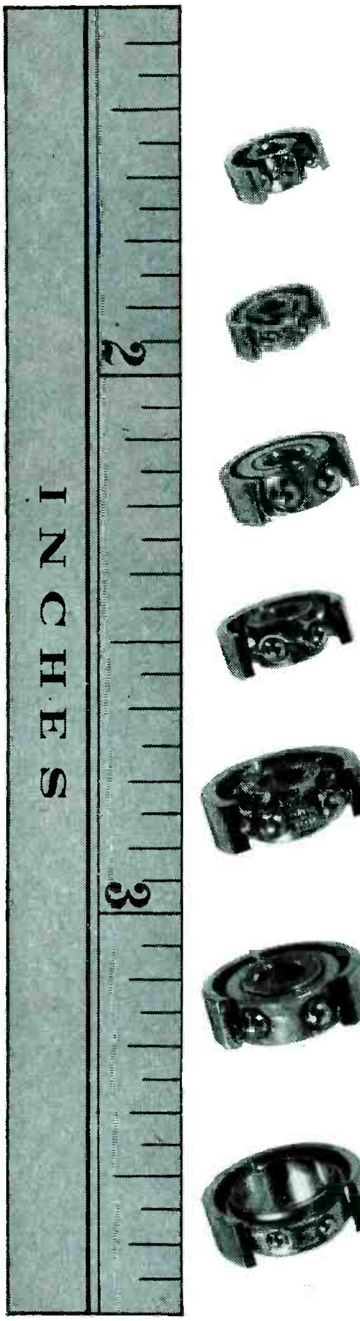

FULL RACE — for most rugged duty in MICRO size range, increased load capacity.

CONRAD RETAINER — for low friction, high speed RADIAL and THRUST loads.

SELF-ALIGNING — for misalignment between shafts and housings up to 10 degrees.

RIBBON RETAINER — for smoother running, and lower friction.

SPRING SEPARATOR — for minimum starting or breakaway torque. Speeds — low to moderate.

ANGULAR CONTACT — for axial positioning of shafts with opposed pairs lightly preloaded.

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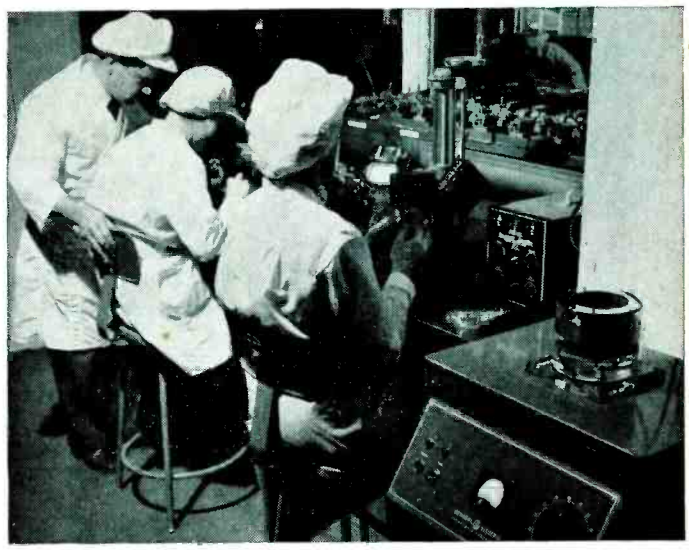

Hidden to the naked eye is the probable life of a precision bearing. This life depends on measurements by microscopic instruments and on microscopic cleanliness.

Common and accepted practice in some industries is to manufacture for 'LIMITED LIFE.' However, human lives often depend on **MICRO** bearings showing no signs of 'fatigue,' to which they are constantly exposed.

Our emphasis in manufacturing is for 'LONG LIFE' through microscopic accuracy including all accepted practices and inspection techniques.

MICRO is constantly developing new instruments for measuring minutely all dimensional and operating qualities.

Our inspections include surface finish and geometry of raceways and balls, running torque, and other features not yet covered by standards.

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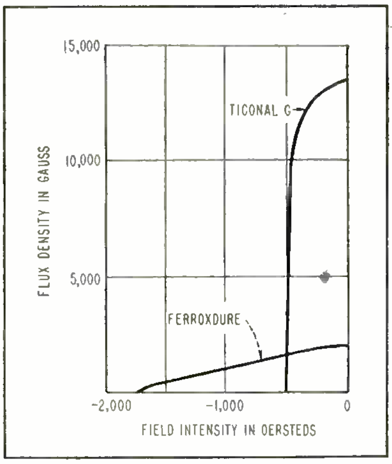

FIG. 3—Demagnetization curve of a ceramic material and a metallic permanent magnet material

material makes it unnecessary to use soft-iron pole-pieces. The rings are simply brought close to the tube neck.

The author wishes to thank W. G. Amesz who assisted in the development of the unit, M. J. Groenenberg for designing the mechanical construction and B. Tent who measured the H_z curves.

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J. J. Went, G. W. Rathenau, E. W. Gorter and G. W. van Oosterhout, Ferroxdure, A Class of New Permanent Magnet Materials, *Philips Technical Review* 13, No. 7, p 194.

High-Speed Facsimile

INTENDED for military purposes, but applicable to commercial uses, a new facsimile system has been developed by RCA and the Haloid Co. for Navy's Bureau of Ships. It transmits ten 8½ by 11 pages of copy a minute. Copy fed into the machine requires no processing. Delivered copy can be directly reproduced by offset printing.

Transmission can be by radio or coaxial cable circuits capable of passing a band of 100 kc. Demonstrations by radio have used a carrier frequency of 600 kc.

Incoming copy is fed through a vacuum transport system past a flying-spot scanner operating at a horizontal rate of 240 lines a second. Vertical scanning is pro-

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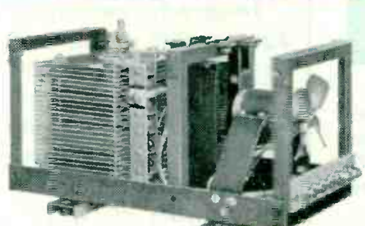
Federal supplies the 50-Amp. Transformer-Rectifier unit used in the Stratofortress... "America's new double-edged weapon"



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- **AC Input:** 195-210 volts; 380-420 cycles; 3 phase.
- **DC Output:** 50 amps.; 24-31 volts; resistive-inductive load.
- **Ripple:** 5% maximum
- **Weight:** 19 pounds
- **Dimensions:** 15⅛" long; 9" wide; 8¼" high.

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Federal's 3146-BS is only one of a complete line of rugged, compact and efficient airborne and ground power supplies developed to meet aviation's growing trend from *generated* DC to 400-cycle AC...to furnish *dependable* DC power where required. Federal equipments are designed without expendable parts that require frequent replacement. And all are powered by Federal Selenium Rectifiers...*first* in the field...outstanding for long service life and trouble-free performance!

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vided by continuous motion of the copy.

Light reflected from the copy is received by a multiplier phototube and the resulting signal modulates a carrier that is transmitted by either wire line or radio circuit.

High-speed facsimile receiver for transmission of Navy documents

At the receiver, synchronizing pulses are separated and used to control the scanning rate of another flying-spot scanner. The signal modulates the intensity of the light spot to correspond with that of the transmitter.

Images focused upon a sensitized xerographic drum cause variations in the surface electrical charge of the exposed parts of the drum. After exposure, a cloud of electrostatically charged dye-powder developer is sprinkled on the drum. The powder sticks proportionately to the magnitude of charge.

When the drum is brought into contact with the paper, dye powder is transferred and later sealed by infrared heat. A black-on-white facsimile is thus produced.

PERTINENT PATENTS

IT HAS BEEN FOUND that in electrical precipitators of the Cottrell or other sparking types efficiency of operation increases with the rate of sparking up to an optimum be-

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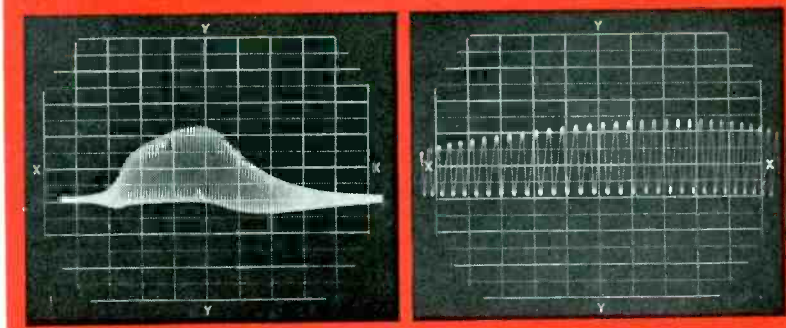
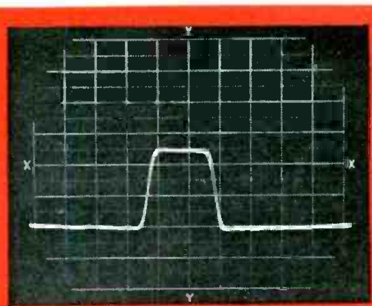
30 Mc Pulsed I.F. 2 μ sec long, 10 Kc Rep. rate



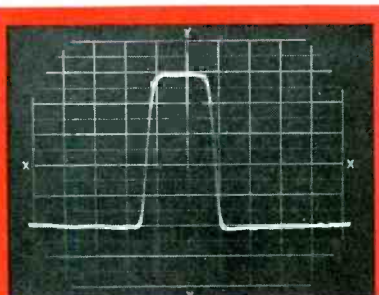
Sweep – 0.4 μ sec/cm   Sweep – 0.1 μ sec/cm Pulse Center Expanded

HIGH SENSITIVITY AND WIDE FREQUENCY RESPONSE OF Y-AXIS AMPLIFIER

The vertical amplifier of the 401 provides uniform frequency response and high sensitivity from D-C. Coupled with a sensitivity of 15 Mv./cm peak to peak at *both D-C* and A-C is a response characteristic which is 3 db. down at 10 Mc. and 12 db. at 20 Mc. Alignment of the amplifier is for best transient response, resulting in no overshoot for pulses of short duration and fast rise time. An example of the wide band response of the amplifier is shown in the accompanying photographs.



37.5 Mv., 0.2 μ sec width, 1 μ sec sweep full scale



75 Mv., 0.2 μ sec width, 1 μ sec sweep full scale

LINEARITY OF VERTICAL DEFLECTION The vertical amplifier provides up to 2.5 inches positive or negative uni-polar deflection without serious compression; at 3 inches, the compression is approximately 15%. The accompanying photographs illustrate transient response and linearity of deflection.

SWEEP DELAY The accurately calibrated delay of the 401 provides means for measuring pulse widths, time intervals between pulses, accurately calibrating sweeps and other useful applications wherein accurate time measurements are required.

The absolute value of delay is accurate to within 1% of the full scale calibration. The incremental accuracy is good to within 0.1% of full scale calibration.

SPECIFICATIONS

Y-Axis

Deflection Sens. — 15 Mv./cm, p-p
Frequency Response — DC to 10 Mc
Transient Response — Rise Time (10%-90%) 0.035 μ sec
Signal Delay — 0.25 μ sec
Input line terminations — 52, 72 or 93 ohms, or no termination
Input Imp. — Direct — 1 megohm, 30 μ μ f
Probe — 10 megohms, 10 μ μ f

X-Axis

Sweep Range — 0.01 sec/cm to 0.1 μ sec/cm
Delay Sweep Range — 5-5000 μ sec in three adjustable ranges.
Triggers — Internal or External, + and −, trigger generator, or 60 cycles, undelayed or delayed triggers may be used.
Built-in trigger generator with repetition rate from 500-5000 cps.

General

Low Capacity probe
Functionally colored control knobs
Folding stand for better viewing
Adjustable scale lighting
Facilities for mounting cameras

PRICE: $895.00

Additional Features:

TRIGGER GENERATOR with variable repetition rate from 500 to 5000 cps.

POSITIVE & NEGATIVE UNDELAYED TRIGGERS and a **POSITIVE DELAYED TRIGGER** are externally available.

An **INPUT TERMINATION SWITCH** for terminating transmission lines at the oscilloscope.

A **FOLDING STAND** for convenient viewing.

FUNCTIONALLY COLORED KNOBS for easier location of controls.

Designed and built *for* electronic engineers, the 401, with its high gain and wide band characteristics, and its versatility, satisfies the ever-increasing requirements of the rapidly growing electronics industry for the ideal medium priced oscilloscope.

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yond which the efficiency decreases.

Precipitator Energizer

A system for controlling the sparking rate at optimum value has been invented by P. C. Backer and Harold E. Van Hoesen. This invention has been granted patent number 2,642,149. The patent is assigned to Research Corporation, New York, N. Y.

Arrangement of the invention is shown in Fig. 1. A precipitator supplied by a high-voltage recti-

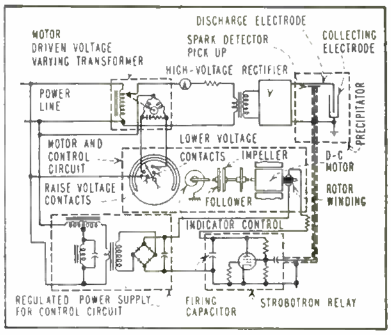


FIG. 1—Sparking rate of electrical precipitator is electronically controlled

fier is under the control of a strobotron relay circuit as follows. A pickup is capacitively coupled to the discharge electrode connection of the precipitator. Pulses are developed by the pickup for each spark discharge of the precipitator.

These pulses trigger the strobotron relay and cause a firing capacitor in the anode-to-ground circuit to discharge through the rotor winding of a d-c motor. The motor is driven by these pulses and in turn drives a switching mechanism spring loaded to provide a counter torque against the motor torque to maintain a part of the switching control at a predetermined balanced condition. When the pulse rate exceeds or falls below the balance maintaining value, the switching mechanism operates a motor-driven device that appears to resemble a Variac, for raising or lowering the voltage applied to the primary of the high-voltage rectifier source for the precipitator.

The resulting higher and lower rectified voltage applied to the precipitator create higher and lower

rates of discharge in the precipitator sparking mechanism. Equilibrium condition of the control is set up for the sparking rate that provides maximum efficiency of precipitator operation.

C-R Oscillator

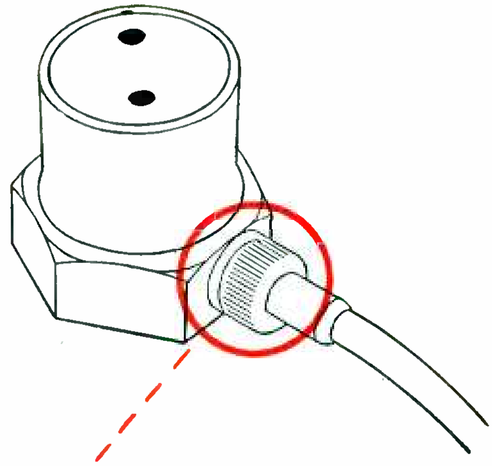
A cathode-ray oscillator tube has been granted U. S. patent 2,638,561, issued to George C. Szik-lai, and assigned to the Radio Corporation of America.

As can be seen in Fig. 2A and 2B, a beam produced by the electron gun is deflected or directed through a control electrode at such an angle that the beam will be modulated by any signals applied to the control electrodes. The beam will also have imparted to it a radial component that results in the beam's impinging upon the target electrodes in a circular pattern. Figures 2C and 2D show types of target electrode patterns that may be employed.

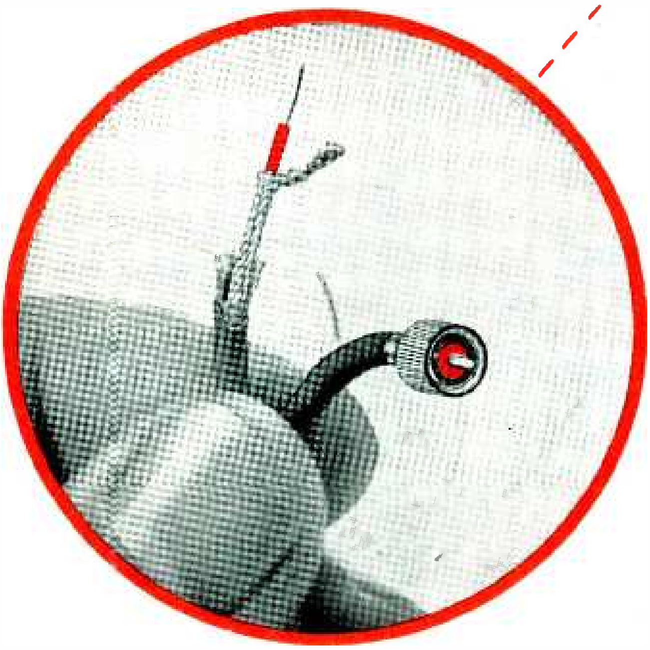
Signals to the control electrode or control cavity may be frequency modulated, and will produce a varying high-frequency field in a portion of the electron-beam path. The beam is thereby velocity modulated and the spiral paths are compressed and expanded in synchronism with the f-m signal variations. The landing of the electrons on the target electrodes is thus varied so that the frequency of the output is varied. In this way an input signal of low power is amplified at the output.

The operation of the oscillator amplifier of Fig. 2B is described by the inventor as follows: "The beam of electrons of a range of velocities, according to the Maxwellian law, is subjected to the electric field of plates which deflect them along curved paths. The fast electrons are deflected least and the slow ones are deflected most. This causes the electrons of different velocities to enter the field of the cavity resonator (input) in such position that they are equally acted upon by the field."

"This is because the converging screens vary the field inversely with the velocity of the electrons therein. The electrons after leaving the input cavity resonator drift in the accelerating field and



Du Pont TEFLON* provides excellent dielectric properties...



...heat resistance and strength in new miniature parts

Coaxial connectors and cable made by Microdot Division, Felts Corporation, S. Pasadena, Calif.

The demand for micro-miniature components in scale with miniaturized circuit designs has created an insulating problem. Miniature circuits often develop high heat and carry an increased electrical load that can result in failure of these tiny components.

The Felts Corporation faced such a problem with its miniature coaxial connector. They needed a material for the connector and primary wire insulation that had good dielectric properties and a wide resistance to heat, chemicals and corrosion. It also had to be moisture-resistant and strong.

After testing many materials, they chose Du Pont "Teflon" tetrafluoroethylene resin. "Teflon" is an excellent insulator. It has a dielectric constant of 2.0 and a loss factor of 0.0005. Its power factor is less than 0.05% even at frequencies as high as 30,000 megacycles. And these dielectric properties are unaffected by temperatures from -80°F. to 500°F. Du Pont "Teflon" is inert to all chemicals except molten alkali metals and fluorine. It is tough and durable—will not crack or arc. "Teflon" has zero water absorption and helps reduce self-generated noise at high termination impedances.

Du Pont "Teflon" serves many uses in electrical equipment—stand-off and feed-thru insulator terminals, insulation for wire, cables and motor windings, and other parts where high temperatures, dielectric strength and durability are required. Perhaps "Teflon" can help you improve or develop a product. For full information, write: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 2212T, Du Pont Bldg., Wilmington 98, Delaware.

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the slow electrons fall behind and bunch up with the succeeding electrons so that they arrive together at the output cavity resonator, which is correctly positioned for the purpose."

"The oscillation frequency of the beam is controlled by the f-m input signal." The weak f-m signals here, too, are amplified to strong signals at the output coil.

The four-section target illustrated in Fig. 2D, if employed, results in frequency doubling of the signal originally impressed on the tube.

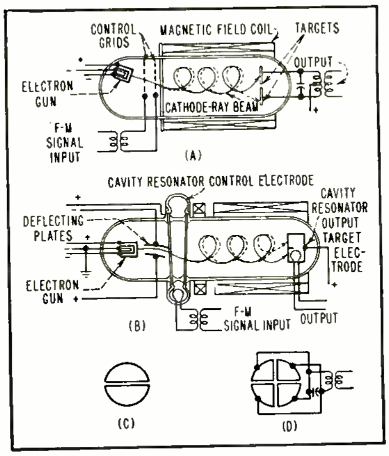


FIG. 2—Cathode-ray oscillator in two forms (A) and (B) uses two different target electrodes (C) for frequency doubling (D)

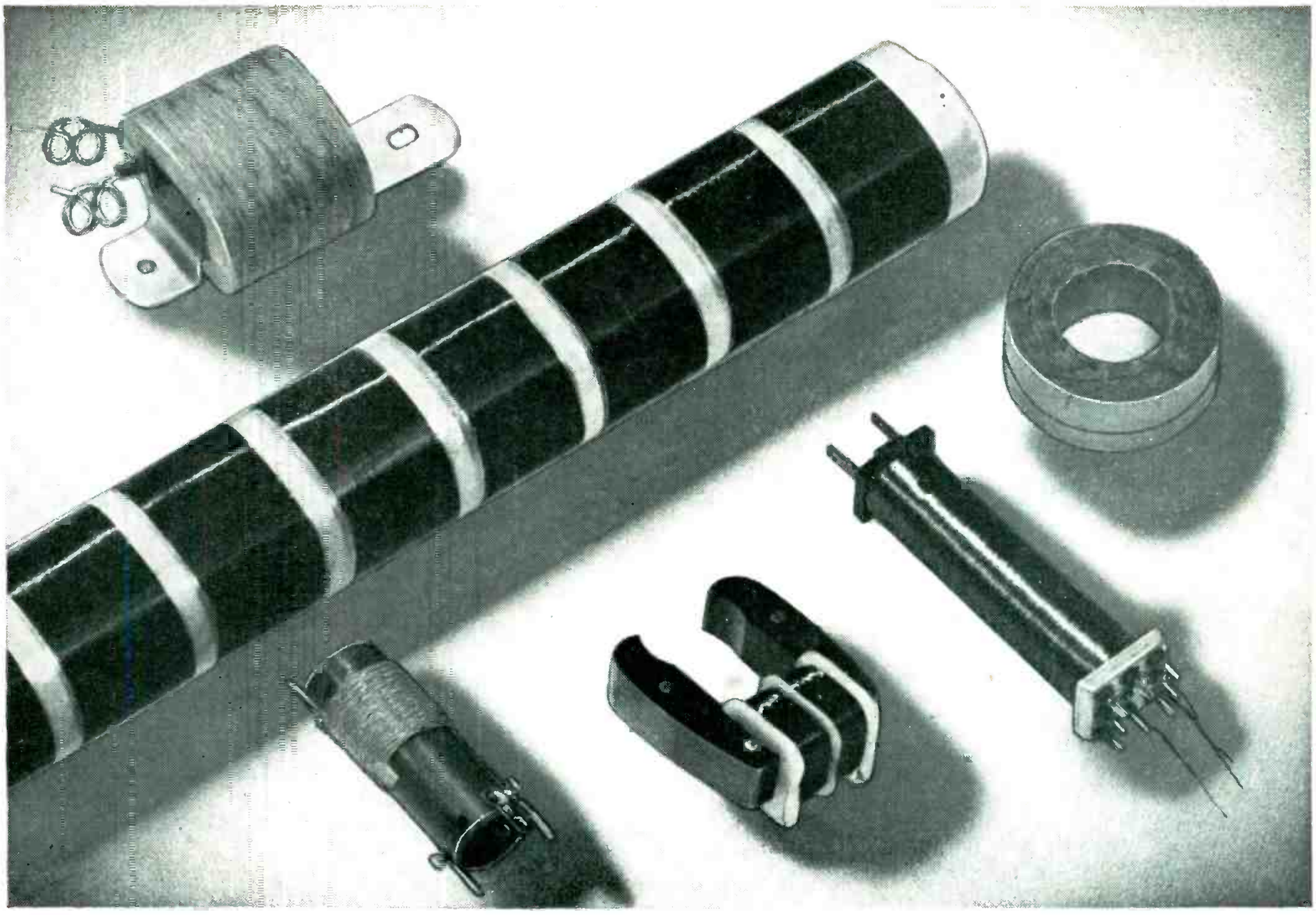
Phase Detector

A phase detector particularly applicable to high-frequency circuits has been granted patent 2,640,939, issued to the inventors, L. Staschover and L. Rosenberg, and assigned to International Standard Electric Corp., of New York.

Phase detectors generally require balanced voltages necessitating the use of balanced transformers for applying the energy to the circuit. At very high frequencies it is difficult to obtain balanced voltages from a transformer because structural imperfections in such transformers tend to cause unbalance.

The phase detector of this invention is claimed to be particularly useful at vhf and uhf and does not require balanced voltages to be applied to it.

This phase detector incorpo-



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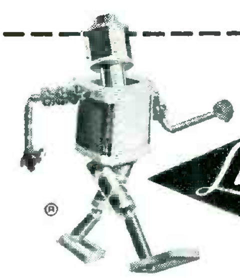

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rates a circuit for deriving a d-c voltage equivalent to the vector sum of the voltages being compared. The vector sum varies in magnitude within certain limits dependent upon the angle of the applied voltages. A d-c voltage is derived from one or both sources intermediate between the limits of the vector sum.

The two derived voltages are combined in phase opposition so that variations in magnitude representing the vector sum of the voltages above and below the second derived voltage will produce output voltages of different polarity having amplitudes dependent upon the degree of departure from equality between the two derived voltages.

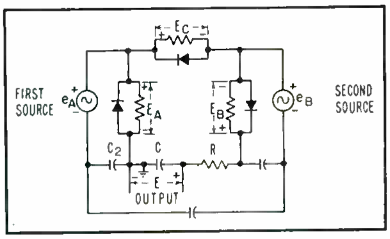

FIG. 3—Phase detector for uhf does not require balanced voltages

The circuit is independent of whether the compared voltage sources are balanced or unbalanced and there is negligible effect upon the zero-output condition from any changes in the source voltages.

The circuit of Fig. 3 shows an embodiment of the invention wherein the source voltages e_A and e_B are rectified to produce E_A and E_B, d-c potentials of opposing polarities corresponding to the input voltages and a component e_C corresponding to the phase angle θ between the input voltages produces a d-c voltage E_C.

The output voltage E across ca-

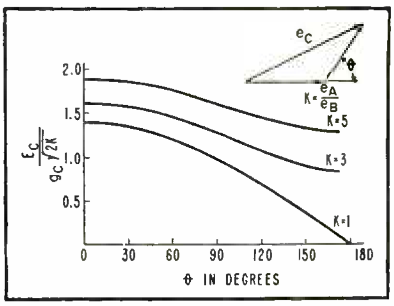

FIG. 4—Characteristics of phase detector described in text

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pacitor C will be equal to $E_A + E_B - E_C$ as can be seen from the polarity indications across the respective rectifiers.

Voltages E_A and E_B are independent of the angle θ (Fig. 4) but are proportional in amplitude to the peak input sources, respectively. Components C_2 and R comprise a low-pass filter so the output voltage E is determined entirely by E_C.

A more detailed analysis, operating curves and several variations of the circuit shown in Fig. 3 are found in the patent.

Amplifier Tube

Patent 2,633,505, issued to Alfred Lerbs, of Paris, France, Assignor to Compagnie Generale de Telegraphie Sans Fil, describes an improved "Ultra-Short Wave Transmitting and Amplifying Tube."

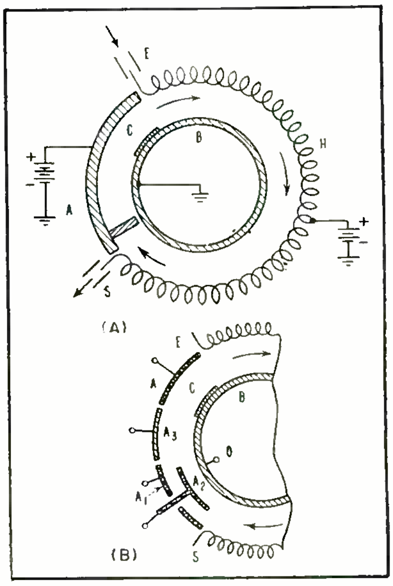

FIG. 5—Circular traveling-wave tube (A) and improved version (B)

A diagram of the original tube is shown in Fig. 5A. The improved version is given in Fig. 5B.

In the tube of Fig. 5A, a cathode B emits electrons that travel in a stream through the path shown by the arrows toward anode 1. Energy at uhf is applied at E and is carried through the circular traveling waveguide H. The waveguide H is in the form of a spiral and has a positive potential with respect to the cathode, as has the

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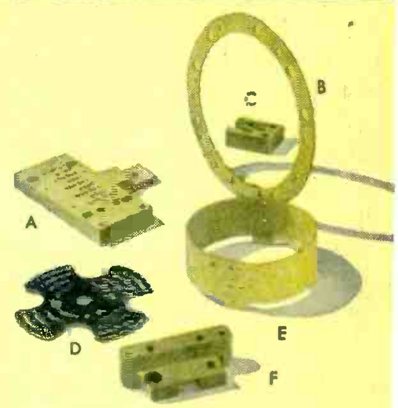

Synthane . . . in Aviation

- A Propeller brush block base
- B Separator ring for propeller hub
- C Propeller brake plug base
- D Brush carrier
- E Cord drum
- F Propeller brush block base

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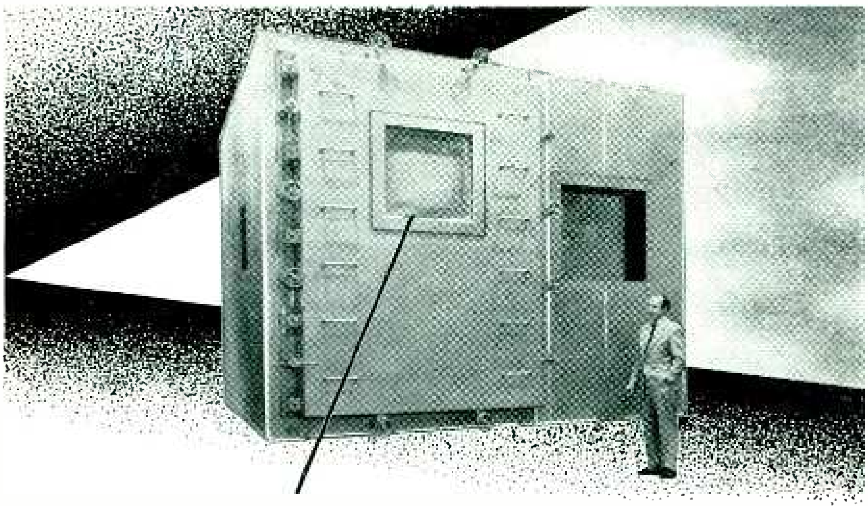

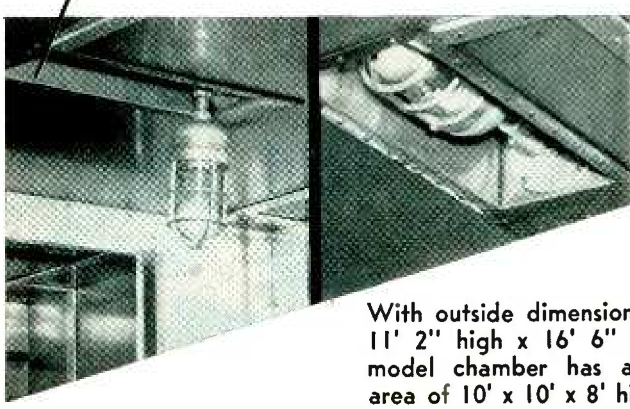

anode. The amplified out-put energy is extracted at S.

The improvement was developed because the inventor discovered that whereas all of the electrons were intended to interact with the high-frequency energy in the drift space in the helix as the electron stream and the uhf energy approached anode 1, there were some electrons that were brought around to the anode without having interacted with the uhf energy and so the tube was inefficient. The improvement whereby all electrons in the drift space interact with the uhf energy is shown in Fig. 5B where only a part of the circular path is shown.

In the improvement, the target 1, has been eliminated and instead two electrodes A_1 and A_2 have been arranged between anode A and cathode B, which are connected to a positive potential. The cathode is at a zero potential. Potential of A_1 and A_2 is adjustable with respect to anode A to vary the speed of the electrons and thereby the number of electrons collected.

Electrons that have interacted and are generally located in the region of anode A are collected by the additional anode A_1, whereas A_2 is located on an equipotential line and does not alter the distribution of the field.

Element A_2 forms with the cathode a duct through which the electrons that have not participated in the interaction at all or have incompletely interacted are again directed towards the electromagnetic field. The second time around the electrons are again directed into the helical winding.

To increase efficiency and prevent self-oscillation the phase of the electrons re-entering at E is adjusted with respect to the uhf energy. This is accomplished by the transit-time relation between the the input and output terminals E and S. This is defined by the path length between S and E.

For a given length, the phase may be adjusted by acting on the speed. This can be done by change in intensity of the electric field over the electron path or a part of the path, or by the intensity of the magnetic field. Electrode A_3 prevents self-oscillation.

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Production Techniques

Edited by JOHN MARKUS

OTHER DEPARTMENTS featured in this issue:

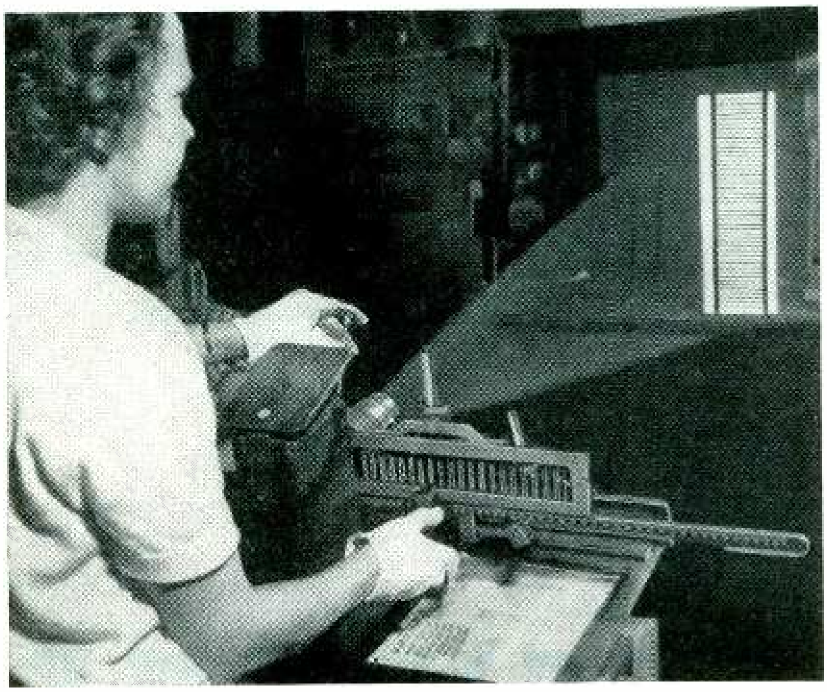
Inspecting Tube Grids with Slide Projector

SIMPLE modification of a standard Kodachrome slide projector permits sliding in vacuum-tube grids in place of transparencies. This enables the operator to see the grids projected onto a screen in ten times their normal size, for ready detection of bent wires or deviation in spacing. This technique is used for 100-percent inspection of grids in the Bloomfield, N. J. tube plant of Tung-Sol Electric Inc.

In preparation for a carbonizing spray to supress grid emission, the grids are loaded into open rectangular metal frames. Inspection is carried out after this carbonizing operation, while the grids are still in their frames. The slide projector (made by Three Dimension Co., Chicago) is modified to accommodate this frame in place of the regular slide carrier.

The operator inserts a frame of grids in the projector and slowly pushes it through by turning the knob of a rack-and-gear arrangement on which the frame rests. Each grid in turn is thus projected onto a screen mounted on a nearby wall.

When a defective grid is observed, the operator pushes a rod mounted on the projector. This rod obviously mangles the defective grid, so that it will be noted and thrown out later when the grids are unloaded from the frame.



Modified slide projector throws ten-times enlargement of tube grid on screen as shown, during 100-percent inspection for pushed, spread or damaged turns. Right hand is on knob of rack-and-gear arrangement for moving grid carrying frame through projector. Left hand is on rod used for mangling defective grids

Exhaust and Bake-out Oven for Picture Tubes

PICTURE tubes ranging from 21 inches to 27 inches in size travel nearly 300 feet on individual pumping carts while automatically receiving the processing required during various parts of the exhaust cycle in Raytheon's new picture-tube plant. Glass strains and bulb breakage are minimized because the unusually long lengths of the bake-out ovens allow for precise temperature control and permit the tubes to emerge at a temperature only slightly above that of the room.

Tubes are loaded and unloaded with the aid of vacuum lifters suspended from counterbalanced overhead supports. Two hose lines, with valves on the control handle, are

S'matter, Swami, won't it work?

Near-sighted or not, our snake charmer friend should know he can get more out of a wire if it has a well soldered connection. How do we know that? Well, making the right kind of flux core solder for every application has been Kester's sole business for more than 50 years. There's no mystery about Kester Solder, no secret ingredients either. With Kester, quality is the paramount feature . . . the same today as it's always been.

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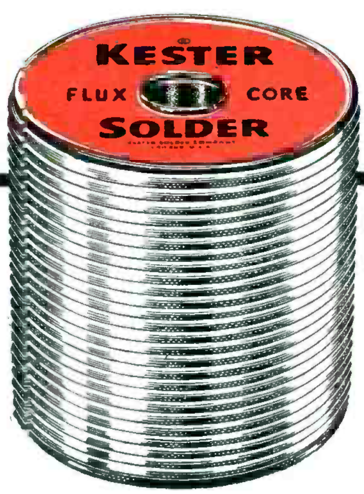

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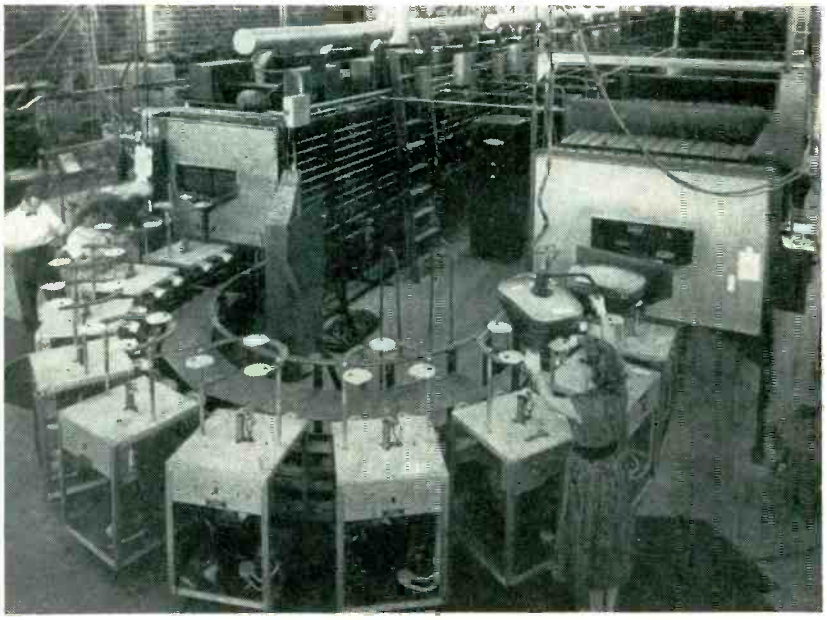


Loading and unloading end of picture-tube exhaust machine. Trolley wheels at top rear of each cart run on steel rail to guide caster-mounted carts on their 300-foot round trip through the U-shaped oven. Power trolleys on each cart pick up power for pumps and other cycling functions required during bake-out. Motorized conveyor chain keeps carts equally spaced as it moves them

used; one is a vacuum line for picking up the tube and the other an air line for releasing the tube.

Air drafts in the ovens are minimized by using doors shaped like the cross-section of a picture tube, and arranged to open and close automatically for carts.

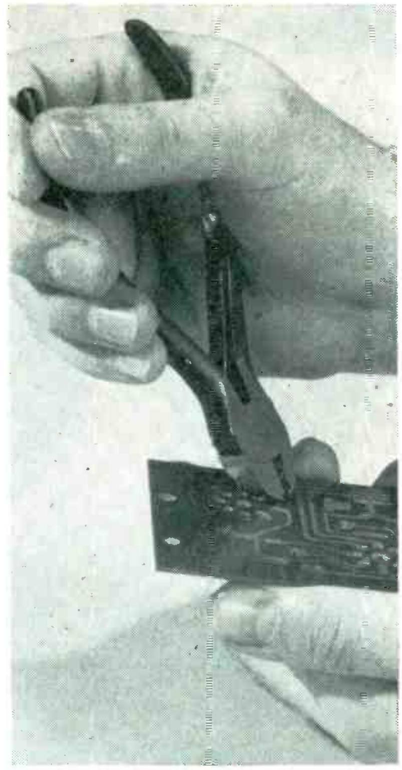
Electric Oven Setup for Deposited Carbon Resistors

UP TO 3,200 tiny ceramic cylinders at a time are uniformily coated with carbon in an electric oven arrangement providing a precisely controlled gas atmosphere at a temperature of 1,000 C in the Radell Corp. plant at San Juan, Puerto Rico.

The ceramic blanks and a carefully screened fine sand are loaded into a ceramic cylinder mounted at an angle on the end of a rotating arbor. This arbor with its electric drive motor and gas-line fittings is mounted on a carriage that slides into and out of the oven on ball-bearing rails originally designed for supporting drawers. The oven doors are opened by means of an electric motor drive over them, and the carriage is pushed forward until the wobbling ceramic container is inside the oven.

Nitrogen gas is fed into the rotating chamber at a pressure carefully controlled by a Brooks

Removing ceramic container filled with resistor blanks, after coating with carbon in electric oven at left. A chain drive wobbles the container while inside the oven to give tumbling action



Method of holding new pliers to get optimum visibility while cutting and crimping leads. Replaceable tempered-steel springs keep pliers open, ready for immediate use

save production time and eliminate the short-circuits obtained with the former method of pulling the wire through the hole and bending it over before cutting it off. The short hook left with this older method did hold the wire in position, but often caused shorts to adjacent etched conductors. The new

Examples of crimped terminals on panel employing etched wiring

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is extremely tough . . . has high dielectric strength and excellent bending qualities . . . its hard surface resists abrasion from contact with rough spots in slots.

Want to make something of it?

Make it into armature slot insulation, armature end laminations, field coil insulation, metal box liners, washers, arc shields, formed slot wedges, formed specialties . . . or any other applications requiring excellent electrical characteristics. Color: gray.

Make it from sheets and rolls . . . or ribbon rolls for automatic machines.

SPECIFICATIONS

Thickness range . . . . .005″ to 1/8″
Finish. Calendered or uncalendered
Punching . . . . Up to 1/8″
Sheet size . . . . 56″ x 90″

Roll width 56″ in thicknesses of .005″ through .090″. Coils down to 1/4″ for thicknesses of .005″ through .090″.

PROPERTIES

Mechanical

Tensile Strength, psi

(Lengthwise)	14000 min.
(Crosswise)	6000 min.

Elmendorf Tearing Strength, grams

	*MD	*CD
.005″	100	120
.007″	190	220
.010″	250	300
.015″	375	450

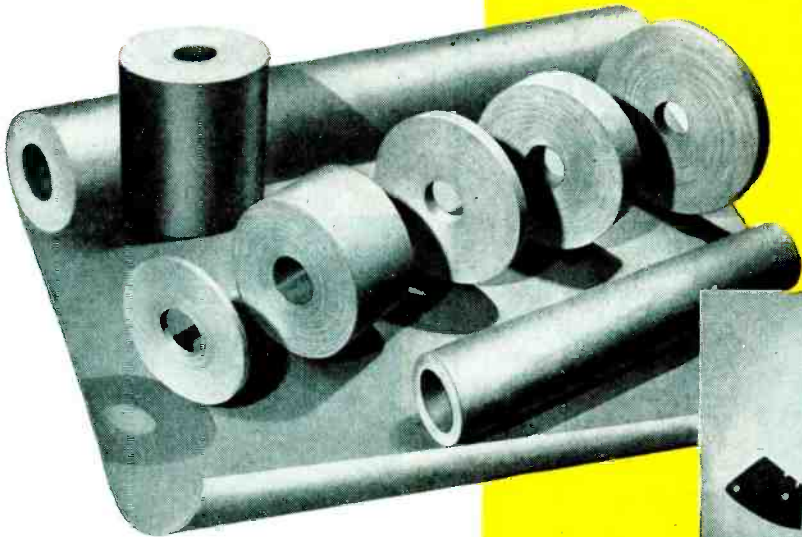
*MD—Machine Direction
*CD—Cross Machine Direction

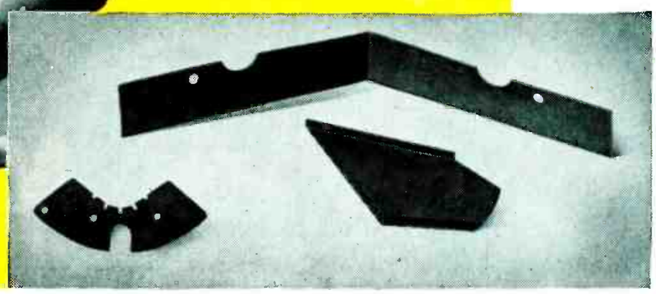
Electrical

Dielectric Strength, vpm
Short Time Test

.004″—.005″	200 min.
Over .005″—.015″ incl.	300 min.
Over .015″—.040″ incl.	250 min.
Over .040″—.060″ incl.	175 min.

Arc Resistance, seconds 100





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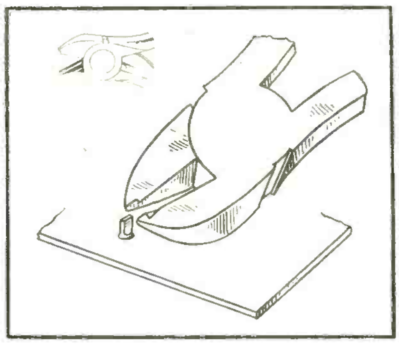
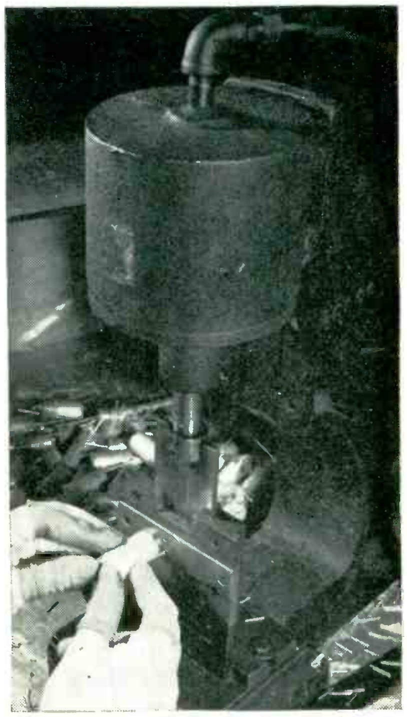


Closeup views of pliers, showing combination cutting and crimping jaws and shape of crimped terminal

tool does the job in one operation, leaving the wire upright and short so it cannot possibly touch other conductors.

Trimming and Crimping Capacitor Leads

HEAVY bus-bar internal leads of plug-in electrolytic capacitor units are accurately trimmed to length with an air-actuated shearing blade at Pyramid. The operator inserts the leads in two holes in the fixture, pushes the roll of foil against the fixture, then steps on a foot pedal



Holding leads of electrolytic unit in position for shearing ends to correct length. Foot-operated valve actuates diaphragm that drives shearing blade downward

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Permits continuous operation at 800° F. or over. Plug and receptacle keyed for positive polarization. Lava inserts.

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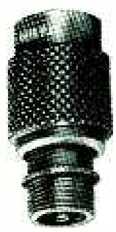
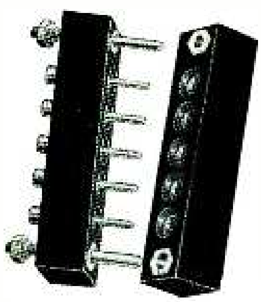
Simply push plug and receptacle together to engage. Pull sleeve on plug shell for instant disconnect. No unscrewing or twisting. Self-polarizing.





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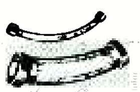

Flexible Metal Tubing

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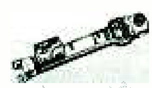

Actuators

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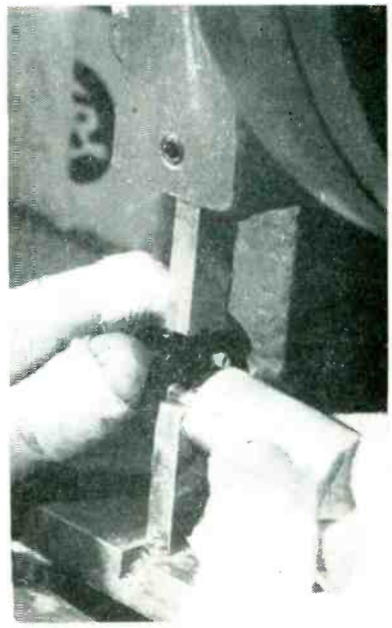


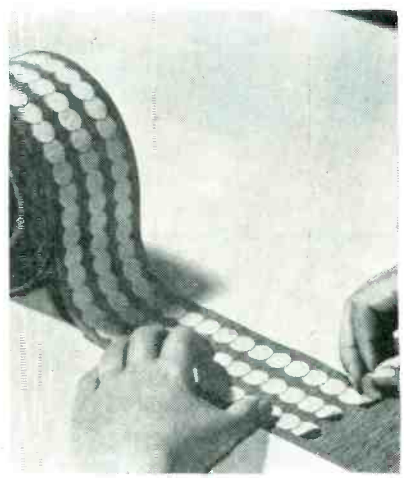
Method of crimping capacitor lead to pin of octal base

to apply air pressure that drives down the shearing blade.

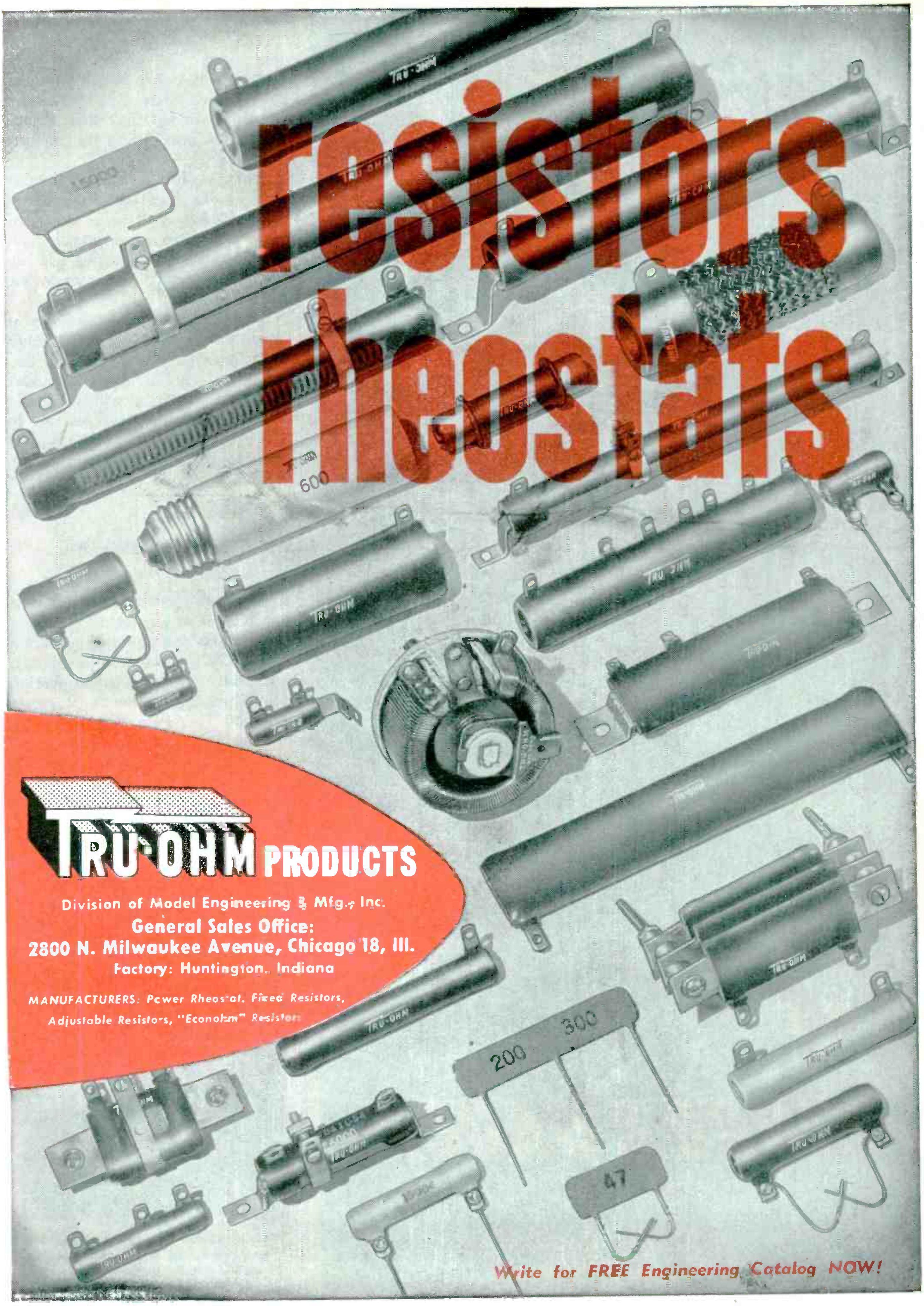
After shearing, the leads are inserted in drilled holes in the solid ends of a modified octal base, and each pin in turn is held on the anvil of a motor-operated punch press which crimps the pin securely around the lead.

Masking Disc for Spray Painting

A NEW method of mounting self-adhesive masking discs on crepe paper cuts costs of preparing chassis and housing units of electronic equipment for spray paint-



Method of removing masking disc from crepe paper liner



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ing. Each disc is slightly overlapped by the next. When the operator removes one disc, this automatically raises the edge of the next, thus providing a lip for easy grasping.

When several discs of the same size are required, the operator can just as easily pull up a string of discs from the crepe paper liner and apply them as fast as she can press each dot down with her thumb.

The new discs are available in diameters from ¼ inch to 4 inches by sixteenths, from By-Buk Co., 4314 West Pico Blvd., Los Angeles 19, Calif. The discs will withstand oven baking temperatures up to 325 F for 30 minutes without leaving troublesome adhesive on the work.

Flattening and Piercing Rocket Nose Terminals

A STANDARD four-ton turntable-type punch press was adapted to perform a flattening and piercing operation on special ceramic feed-through terminals in mass-production quantities in the plant of Bennett Products Co., Palo Alto, Calif.

The ring on the punch-press turntable has 30 milled slots, with corresponding guide pins set up to hold terminals in position while an

Press setup for flattening and piercing nose terminals for Mighty-Mouse rocket. Turntable rotates clockwise. Operation is entirely automatic

Midget with the giant brain

The Problem

To design and build a computer for airborne automatic control systems—with severe restrictions imposed on size, weight and operation under extreme environmental conditions; in short, a computer that would be small, simple, reliable, rugged—and easy to build and maintain.

AT HUGHES RESEARCH and Development Laboratories this problem was examined exhaustively, and it was concluded that a digital computer offered the best means for satisfying the requirements because of its ability to solve complex problems accurately and quickly.

Because the requirements of this application could not be met by existing digital computers, owing to their large size, the following developments were undertaken:

1. Simplification of the logical structure of the computer through the use of a mathematical theory of computer design based on Boolean algebra—but with retention of the operational versatility of a general-purpose computer.

2. Development of ingenious circuitry to utilize the new logical designs.

3. Achievement of minimum size by the use of subminiature techniques, including germanium diodes, subminiature tubes, and etched circuits.

4. Employment of unitized construction: plug-in units of flip-flop circuits and diode networks.

Need for subminiaturization, then, was a governing factor. Consequently, entire new techniques for making things not only vastly smaller, but at the same time easier to build and service, were developed by Hughes. This is a continuing process and there is indication of even more significant advancement in miniaturization for the future.

A major effort at Hughes is also devoted to adapting electronic digital computer techniques to business data processing and related applications—destined for far-reaching peacetime uses.

One of the subminiature switching circuits from the Hughes airborne electronic digital computer is examined by Dr. Eugene M. Grabbe (right), Associate Head, Computer Systems Department, Advanced Electronics Laboratory, and Phil A. Adamson of the Technical Staff, Radar Laboratory.

ENGINEERS AND PHYSICISTS

Activities at Hughes in the computer field are creating some new positions in the Laboratories. Experience in the design and application of electronic digital computers is desirable, but not essential. Engineers and physicists with backgrounds of component development or system engineering are invited to apply.

Assurance is required that the relocation of the applicant will not cause the disruption of an urgent military project.

ADDRESS: *Scientific and Engineering Staff*

Hughes
RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California

Closeup of turntable, showing method of mounting U-shaped Alnico magnet on swinging arm for picking up each part as table indexes, swinging it off to rear and knocking it off against chute

anvil flattens the end of the terminal rod and a die set pierces another rod simultaneously. There are guides at the flattening and piercing stations which hold the terminal part consistently in the proper position so that punched holes will not vary more than ±0.002 inch. This tolerance is also maintained for the thickness of the flattened area of the rod.

The ejection mechanism is a wedge which pries the terminal from the pin on the turntable. A magnetic arm is levered to pass over the terminal, raise the part clear of the slot, swing away from the table and bump the part off into a chute which leads to a material-handling container.

The average output capacity of this machine is 18,000 terminals for every 8-hour shift. The Benchmaster punch press was remodelled by the Boudreau Machine Co., Modesto, California.

Testing Cathode Sleeves

Two simple shop-made fixtures are used for testing the lock seams of raw cathode sleeves in the quality-control department of Tung-Sol Electric Inc., Bloomfield, N. J.

The bend tester is used to measure the torque in gram-cm at which the lock seam bends inward and the seam collapses. The end of the sleeve is inserted in the jaws of a

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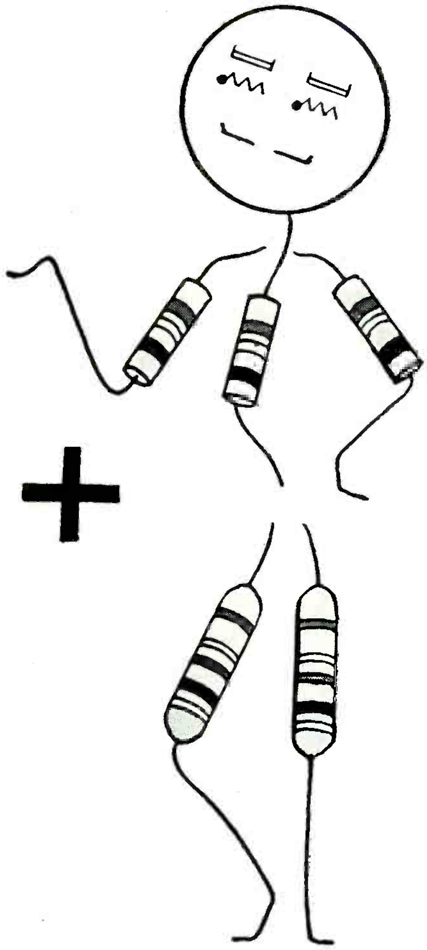
The PERFECT *Wedding*



TYPE 2003 FREQUENCY STANDARD

The Type 2003 contains, in addition to the tuning fork, all circuit components which are selected or critical.—The tube and remaining components — three resistors and two .01 capacitors — are external and can be laid out and integrated with your equipment.

TUNING FORK STANDARD, hermetically sealed.

SIZE — 4½ inches long. 1½ inches diameter.

SIMPLE EXTERNAL CIRCUIT, 1 tube, 3 resistors, 2 capacitors.

TUBE — Choice of 12AT7, 6201, 5751, 6BF7, 6BG7 or 6021.

POWER REQUIRED, 75 to 300 V at 1 to 5 m.a. — 6.3 V at 300 or 350 m.a.

AVAILABLE — in 400 or 500 cycles

ACCURACY guaranteed to .002%, 15° to 35° C.

Write for descriptive literature, specifying Type 2003.

Also TYPE 2007

(4½″ x 1½″)

COMPLETELY SELF-CONTAINED INCLUDING VACUUM TUBE

Manufacturer of high precision frequency and timing instruments controlled by tuning fork oscillators.

American Time Products, Inc.

580 Fifth Avenue **New York 36, N. Y.**

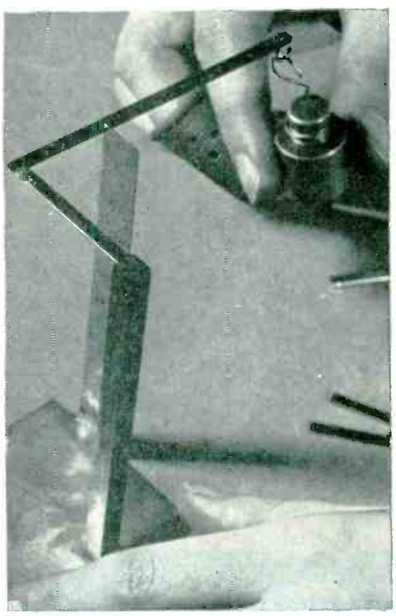
OPERATING UNDER PATENTS OF THE WESTERN ELECTRIC COMPANY

Setup for bending cathode sleeves to destruction during sampling tests for quality control. Left hand of operator is on lever of cam-type vise, and right hand has just released beam-locking lever

cam-operated vise at the top of the tester. While the far end of the scale beam is held by a lever, a trial weight is hooked on. The beam is then released to see if the sleeve will bend under the pressure of the metal peg that is bolted to the beam. Two different weights in different holes are used to get in-between values of torque. Since the holes in the scale beam are spaced one cm apart, with the first exactly 1 cm from the vise, torque is easily computed.

For longer cathodes, the metal force-applying peg can be moved to any other beam hole. A knurled nut makes moving of the peg simple. Weights are applied or moved only while the beam is locked at its far end.

The force needed to twist a flat-

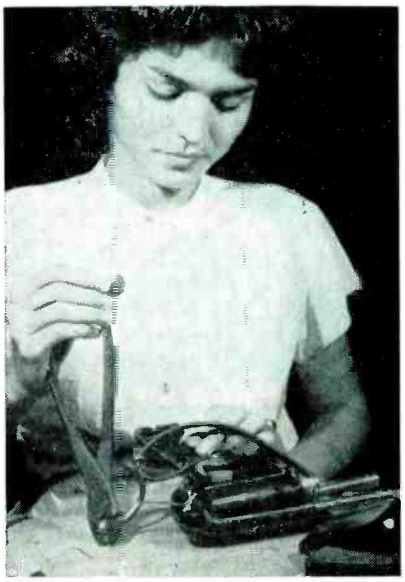


Twisting cathode sleeve to check strength of lock seam

tened tubular cathode sleeve is measured with a simple test stand. The sleeve is pushed over a correspondingly shaped projection on a vertical metal upright, and a lever arm with a corresponding metal stud at right angles is inserted in the other end of the cathode sleeve. A 50-gram weight is hooked into the far end of the arm, 9 cm from the sleeve, to give a twisting torque of 450 gram-cm. A millimeter scale welded to the side of the fixture base, with scale zero at top, measures mm of drop.

Crimping Tool

IN THE FINAL ASSEMBLY of soldering guns at the Bayamon, Puerto Rico plant of Weller Mfg. Co., use



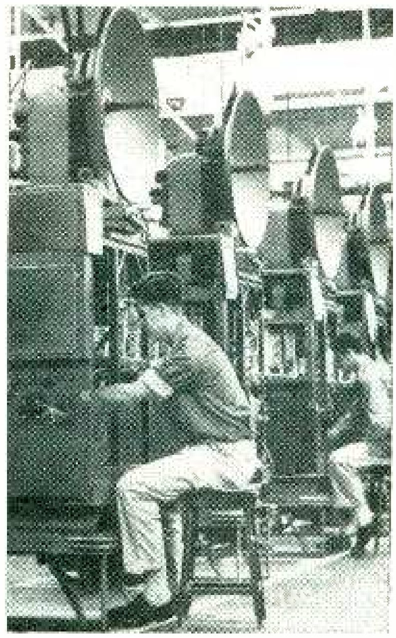
Method of using crimping tool to speed assembly of soldering gun

of Sta-Kon No. 8 insulated connectors and a Sta-Kon crimping tool speed up connecting the line cord to one of the primary leads. The single crimping operation replaces soldering and tape insulating that would otherwise be required when connecting two leads together.

Radar Packaging

PROBLEMS of packaging, handling and transporting large complex assemblies for Army Ordnance have been solved by Sperry Gyroscope Co. through the use of unique reusable steel containers. The Skysweeper fire-control system for the 75-mm artillery machine gun consists of several component parts which are assembled on arrival at military destinations. Because the unit is large—weighing about 3 tons—and contains fragile parts, packaging was a real problem.

The answer was found to be welded steel Transportainers, originally developed by Dravo Corp., Neville Island, Pittsburgh, Pa. for cargo protection in transoceanic shipping. These were modified in dimension from the standard model, and fitted with special channels and frame work to receive the component parts of the units.



Skyscraper radar production line. Entire unit is later packaged in single steel container for shipment

If components of the assembly were packaged and crated separately, a packing crew would spend approximately two days to prepare one unit for shipment. Using the new container, the same crew performs the operation in 3½ hours.

In addition to this saving in time, there have been substantial economies in packaging materials. No part of the assembly has to be wrapped or crated. Plastic covers are used for dust protection. The container serves as a master package for all parts. No lumber, nails, staples, paper or any other packaging materials are used. The containers are stored outside, tiered two and three high, while awaiting use.

Chances for errors in packing

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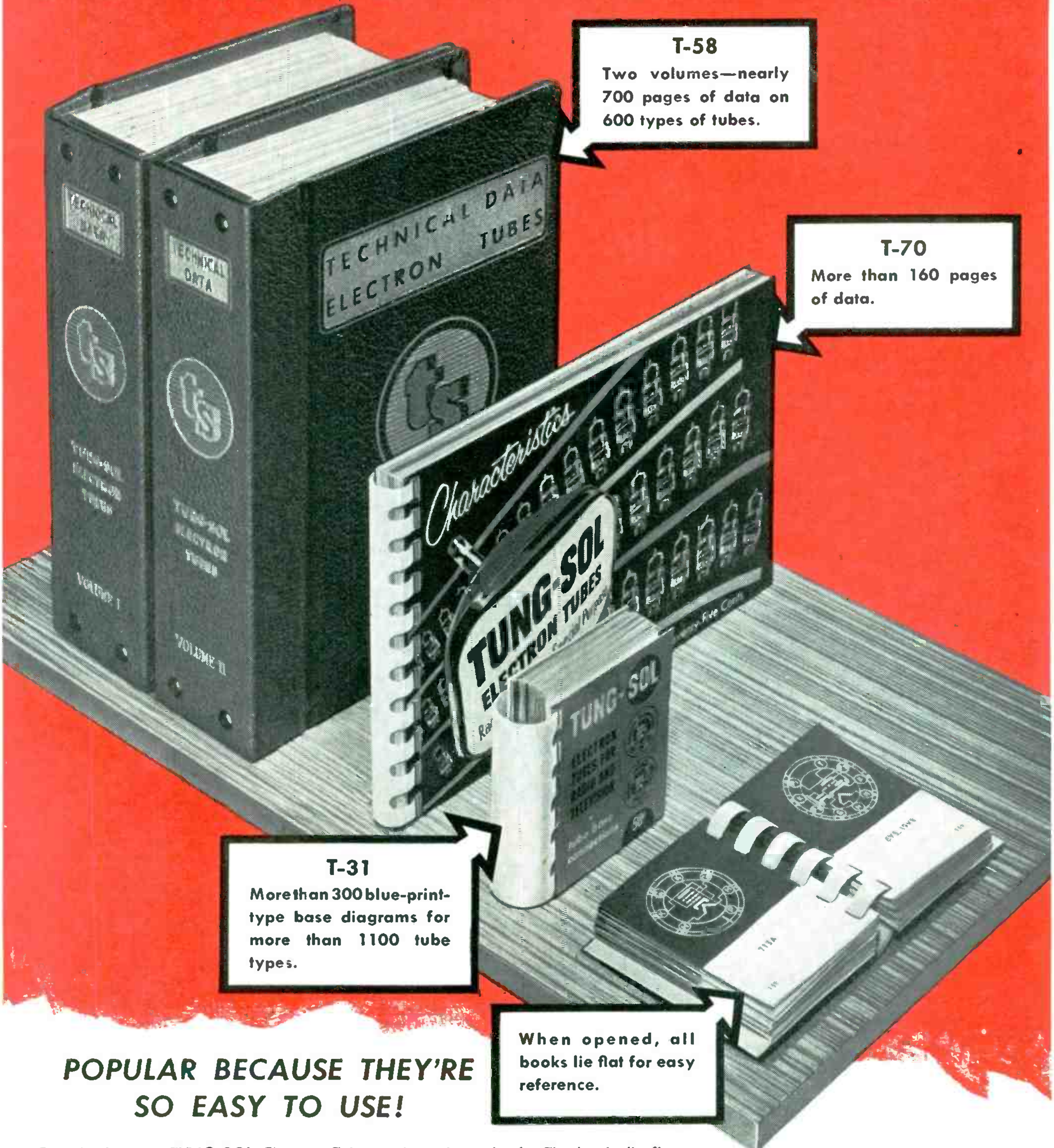

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parts of the assembly have been eliminated by this method. Channels, metal baskets and other fittings are numbered to correspond with the parts they are designed to hold, and physical design of fittings is such that they can be used only for the parts they accommodate. Parts are placed in the container in numerical sequence, hence there is little possibility that an assembly could be shipped incomplete.

With all integral parts of the unit

Using fork truck to move plastic-wrapped section of radar unit into reusable steel shipping container, especially designed to receive one complete fire-control unit

clearly marked and identified within the container, they can be removed at destination in proper sequence for immediate assembly. This not only eliminates time and expense of uncrating individual parts at destination—during which some of the parts could be damaged—but it also does away with much sorting and checking. The plastic bags also are numbered to correspond with the parts they cover.

Once a container is loaded with the complete assembly, the entire unit is moved in a single operation by one lift truck. Each container is fitted with heavy-duty, wide-flange wheels on the two rear corners for easy moving by the lift truck. The container also has lifting lugs at the four top corners for handling with a crane and sling.

Although the steel containers are reshipped or dead-headed back to the plant from the ordnance depot after the assemblies have been removed, total cost of shipping

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Over 2 years of laboratory development and testing were required to achieve a sealed resistor design up to Mepco's standard of quality. No sacrifice of our standard time-proven features has been made in order to perfect this sealed resistor.

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All requirements of MIL-R-93A and JAN-R-93 are exceeded.

The operating temperature is —65°C to +125°C. Temperature coefficients of ±.003%/°C to ±.017%/°C depending upon your requirements. (Refer to MIL-R-93A).

Other sizes available on special order.

MIL-R-93A JAN-R-93 STANDARD TYPES

Our standard time proven JAN, MIL and Commercial lug terminal resistor.

Manufactured and 100% tested in accordance with the applicable specifications, these resistors are used by every major electronic equipment manufacturer in the country.

Reversed and balanced PI-windings for low inductance, with use of only the finest resistance alloys.

Impregnated with approval fungus, moisture and salt waterproofing compounds.

JAN approved non-hydroscopic steatite bobbin, specially treated prior to winding in order to provide additional protection for fine enameled wire.

Protective fungi resistant acetate label.

Rigid hot solder coated brass terminals for easier soldering.

WIRE TERMINAL TYPES

Designed for direct connection into circuit without use of additional leads.

These resistors are of the same basic construction and materials as standard JAN and MIL types therefore providing equal dependability and long life.

Low Temperature Coefficient alloys provide ±.003%/°C from —65°C to +125°C unless otherwise specified by your requirements.

Resistance tolerances range from ±1% down to ±.02%. Sets of matched resistors can be supplied ±.005% or lower.

Special types not shown can be manufactured to your exact specifications.

JAN-R-29 METER MULTIPLIERS

Surpass all requirements of JAN-R-29

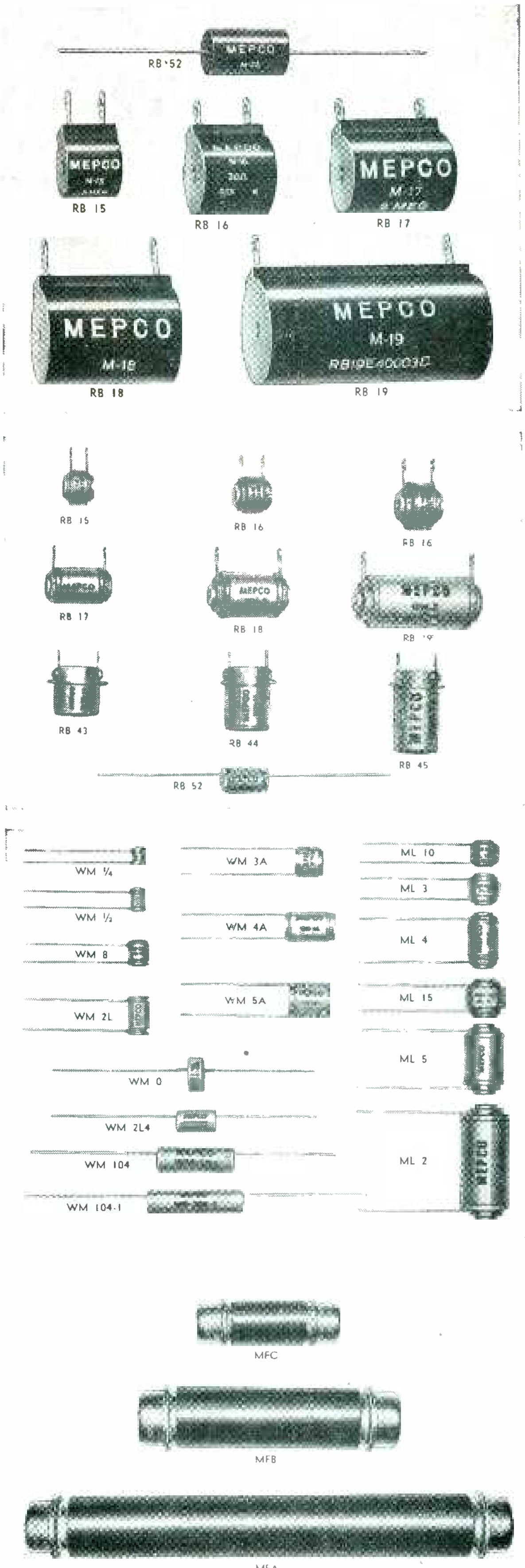
HERMETICALLY SEALED: Insures dependable operation under most severe moisture conditions.

STEATITE PROTECTIVE CASING: Glazed surface prevents high voltage leakage.

WINDINGS: "Certified" low temperature coefficient resistance alloys properly "aged" to provide long term stability.

REPLACEABLE INTERNAL SECTIONS: Eliminate complete loss of unit if damaged.

FERRULE TERMINALS: Heavy nickel plated brass. Corrosive resistant. Fit standard fuse clips.



MEPCO, INC. MORRISTOWN, N. J.

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Appearance of Transportainer after all parts have been put in. When doors are closed and locked, equipment is protected just about as well as if in a safety-deposit vault. Parts are loaded in such a way that they can be removed in the correct numerical sequence for quick and easy assembly

them both ways does not differ appreciably from an ordinary one-way shipment. Measuring the round-trip shipping costs against the many savings resulting from the use of the container, extra expense of the return shipment is negligible.

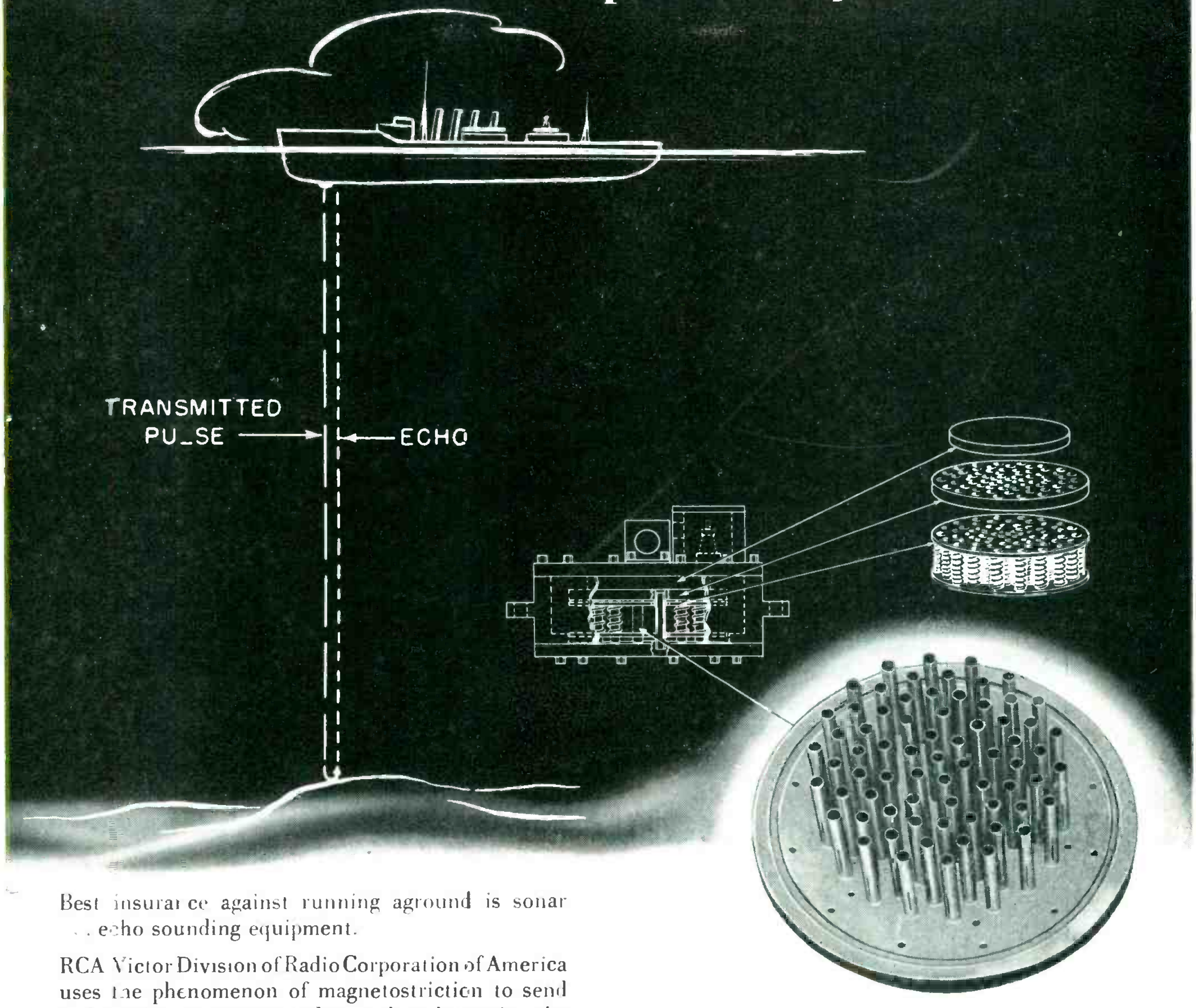
The container also serves to safeguard military information about the assembly. When locked and sealed, the container virtually is a jumbo safety-deposit vault. It does not have to be identified outside as wooden crates would have to be, and there is no chance for pilferage of any small parts or packages.

Standard model Transportainers have 275 cu-ft capacity, are 7¾ ft long, 6 ft 5 in. wide and 6 ft 5½ in. high. Walls are made of 14-gage steel, with vertical corrugations for reinforcing. The floor is double-thickness 14-gage steel, and the roof utilizes 16- and 18-gage steel. Although weather-proof, the container is not air tight.

Two-Hand Press Control

PRODUCTION of manually operated power presses and other machines can be increased up to 25 percent without impairing the safety of operators and set-up men, by add-

How to measure the depth of D. Jones' locker



Best insurance against running aground is sonar . . . echo sounding equipment.

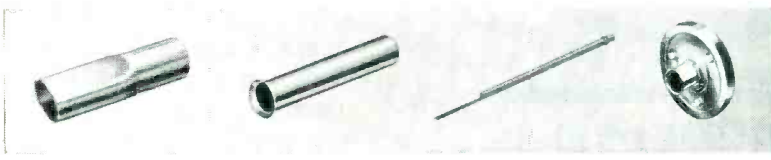
RCA Victor Division of Radio Corporation of America uses the phenomenon of magnetostriction to send and receive supersonic pulses and so determine the distance to a submerged object on the ocean's floor.

Magnetostriction—the familiar "Joule Effect" of your textbook days—is the ability of a ferromagnetic metal to change dimensions when magnetized. The metal of RCA echo sounding equipment is Superior Grade "A" nickel tubing.

70 pieces of Superior seamless nickel tubing, cold drawn to 3/8" O.D. x .020" wall thickness and cut to 1/4 of the wave length of the alternating current signal, are soldered to a plate. Each length is enclosed by a coil.

Energizing the coil with alternating current, the tube expands and contracts, creating a piston effect on plate and diaphragm, sending out a supersonic wave. Likewise, reception of the echo wave by the diaphragm again causes the nickel tubes to pulsate and induce a current in the coil.

RCA Victor looks to Superior for accuracy and uniformity of analysis, precision drawing and cutting in large quantities. For cathodes, anodes, or tubing specialties, and tubing technology—ask Superior. Superior Tube Company, 2500 Germantown Avenue, Norristown, Pa.



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Seamless Nickel Anode. Flattened one end. .500" O.D. x .025" Wall x 1.625" long.

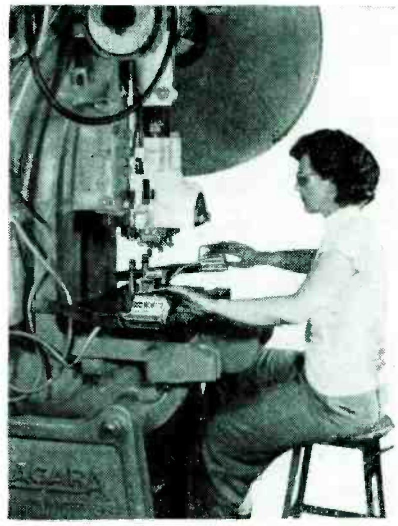
Seamless Nickel Cathode. Round, flanged one end, .070"/.072" I.D. x .0025" Wall. .295" long.

Lockseam* Nickel Cathode. Round, tabbed, single bead, .045" O.D. x .0021" Wall. 27 mm long.

Disc Cathode .121" O.D. .312" long.

Many types of nickel cathodes—made in Lockseam* from nickel strip, disc cathodes, and a wide variety of anodes, grip cups and other tubular fabricated parts are available from Superior. For information and Free Bulletin, address Superior Tube Company, Electronics Division, 2500 Germantown Avenue, Norristown, Pa.

*Manufactured under U.S. Patents.



Typical installation of two-hand clutch control on Niagara punch press used in producing electronic components

ing a two-hand clutch control that is available as a packaged accessory. The equipment is made by the Micro Division of Minneapolis-Honeywell Regulator Co., Freeport, Illinois.

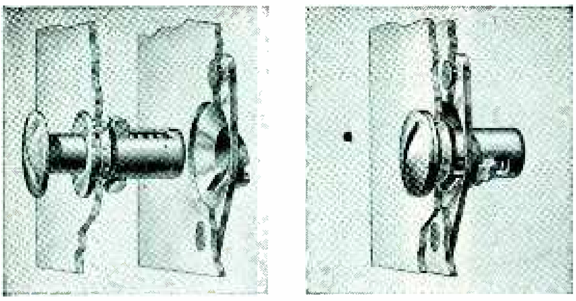
The device prevents cheating or tieing down the controls because both of its control switches must be pressed simultaneously to operate the press. With these switches on opposite sides, the operator is forced to keep her hands out of the descending press head. If one switch is pressed before the other, or held down, the tripping mechanism becomes inoperative and must be reset by pushing a button on the control box.

Roll-Forming of Lightweight Waveguides

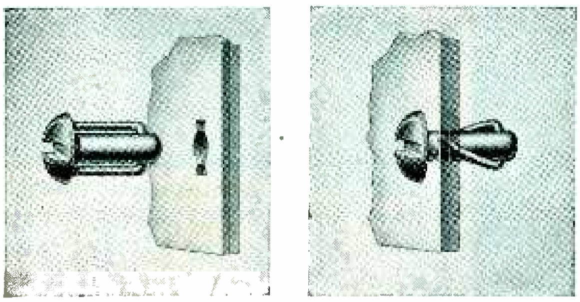
AN INVESTIGATION into the possibility of reducing waveguide cost and weight by roll-forming from thin silvered stainless steel sheet involved consideration of electrical conductivity, commercial availability in the silver-clad combination, and suitability for plating, forming and welding operations.

Silver on stainless steel was preferred over copper on stainless steel because of the superior electrical conductivity and corrosion resistance of silver. Type 302 stainless steel was chosen because of its corrosion resistance and high strength, which permitted the use of thin-gage sheet to meet the

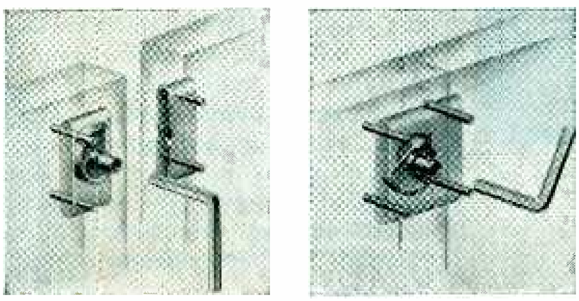
3 ways to save on assembly costs



QUICK-LOCK For fastening removable access doors and panels. Because of its ease of installation, QUICK-LOCK is ideal for assembling removable panels. A 90° turn locks it in place. Stud is self-ejecting when unlocked; visual inspection shows whether fastener is locked. Spring loading takes initial load; solid supports carry increased load. Available in a wide range of sizes.



SPRING-LOCK One-piece fastener for blind holes has load-carrying steel spring wire. Spring steel arms lock fastener securely, prevent loosening under vibration. SPRING-LOCK will work with varying panel thicknesses, locks with a twist of the wrist. SPRING-LOCK is now available in high-impact plastic. The molded design permits heads to be made in various shapes for refrigerator shelf supports, washer knobs, brackets. Available in a wide variety of shapes and sizes, and also in custom designs.



ROTO-LOCK Serrated, tapered cam is engaged by formed lug as fastener is locked. Cam action draws panels together tightly, insures locking even under conditions of misalignment. Opens easily for demounting. ROTO-LOCK carries heavy tension and shear loads; can be used for air and water-tight seals; recesses completely into panels. Solidly built without springs or delicate mechanical parts, unaffected by arctic temperatures or field service.

Simmons

QUICK-LOCK
SPRING-LOCK
ROTO-LOCK
LINK-LOCK
DUAL-LOCK

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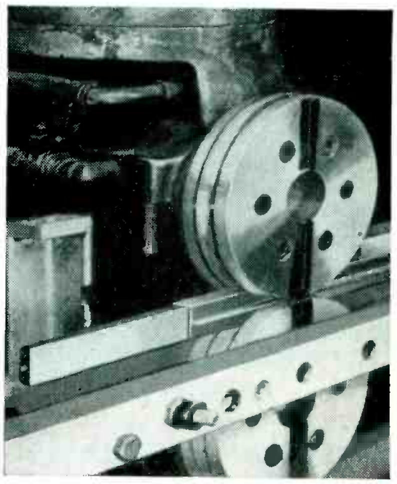
sional accuracy possible and because of the long length of waveguide that may be produced, a roll-former is better suited to waveguide fabrication than any of the other commercial forming operations. The roll-former was purchased from Maplewood Machinery Co., Chicago, Ill. to form waveguide halves from 0.010-in. stainless steel strip. Lower pressures are required in roll-forming than is the case with other methods such as the press-brake. This, and the fact that the machine is equipped with chrome-plated roller dies, greatly lessens the danger of scratching or tearing the silver plate.



Double-seam welding setup, showing waveguide just emerging from between the welding electrode wheels and the mandrel projecting beyond the waveguide to the left

The chromium-plated roller dies on this machine are designed to form the 52U waveguide. Changing the roller dies would permit possibly two other waveguide sections to be formed on the same machine. Three or four roll-formers with the necessary roller dies could produce all waveguide sections from 53U to the 69U.

The operation of the roll-former is very simple. Strips of stock which have been slit to the proper width are fed into the machine at the starting end, and the formed sections are taken out at the delivery end. A straightening device is located at the delivery end, so that any bow or twist can be eliminated by proper adjustment.

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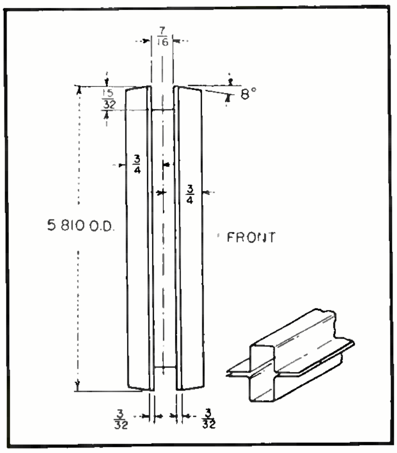


Electrode wheels used for double-seam welding of waveguides, and sketch showing shape of finished waveguide

cause dents to be pressed into the section. For this reason, the machine should be carefully cleaned each time before using and should be kept covered when not in use.

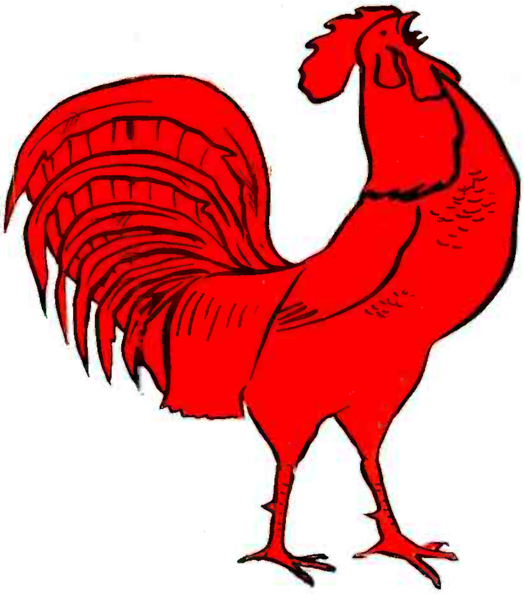
Welding of Waveguide Sections

The seam welding of two waveguide sections to form a length of 52U waveguide was performed on a Sciaky Bros. 280-kva type PMM 2 T-3 three-phase-single-phase electric resistance seam welder. In this type of machine an ignitron rectifier in each phase of the power supply furnishes d-c voltage which is applied to the primary of the welding transformer. The resulting current has a sharp exponential rise which induces a current of similar characteristics in the secondary. At the peak of this current the primary current is interrupted and the decay of this current induces another like current in the secondary. The rise and decay of current constitutes one current impulse. Current control is by a phase-shift circuit applied to the ignitrons.

It was found necessary to weld both seams simultaneously. Two electrode wheels were selected, and a slot was machined in the middle to accommodate the waveguide with mandrel inside.

The electrode wheels must be accurately aligned in the axial direction so that the sides of the upper and lower halves of the guide will be in line. End play of the electrode wheels should also be at a minimum.

The waveguide halves are as-



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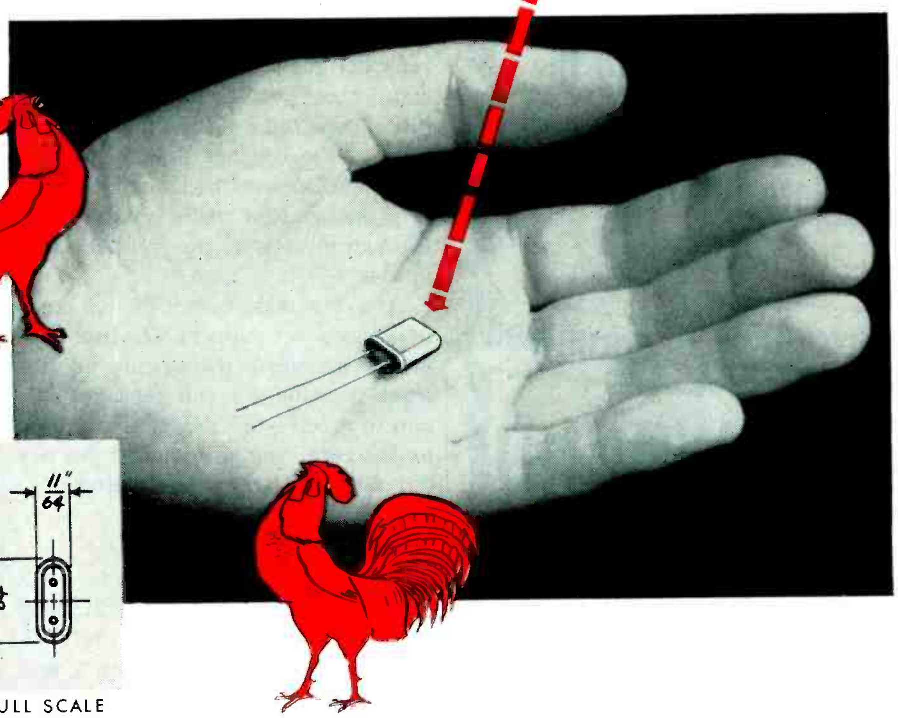
TYPE BX

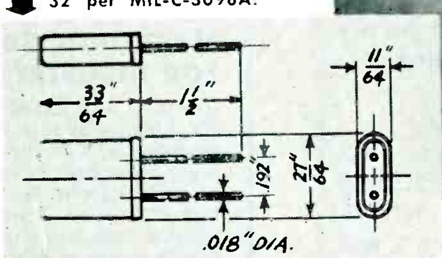
Precision Performance In Sub-Miniature



BLILEY TYPE BX

FREQ. RANGE: 15mc-100mc

A sub-miniature hermetically sealed unit with wire leads. Available with performance characteristics as MIL types CR-23 or CR-32 per MIL-C-3098A.



FULL SCALE

The *Bliley* BANTAM presents new possibilities for compact multi-channel design in the communications and frequency control field. The BANTAM may be wired into a miniature selector switch assembly or plugged into a sub-miniature tube socket.

Design engineers are invited to request quotations for prototype purposes

Bliley CRYSTALS

BLILEY ELECTRIC COMPANY

UNION STATION BUILDING • ERIE, PENNSYLVANIA sembled on the mandrel, one of them being reversed in order to have the edges in alignment. The mandrel is anchored at the outer end so that the waveguide sections are pulled over it when the welder is in operation. No attempt is made to guide the work through the electrode wheels except by the mandrel. Proper contour of the slots in the electrode wheels is one of the main factors in producing unbowed waveguides.

It was found that the least amount of bowing occurred when the axis of the lower electrode wheel was 0.013 in. behind the axis of the upper wheel in the direction of travel through the welder. This movement was probably required to correct for an error in the positioning of the feed table, too small to be detected. There is no apparent reason for not obtaining the straightest waveguides when the pieces are fed on the common tangent at the contact point. This adjustment appears to be oritical, and is probably best made on the basis of examination of the welded waveguides.

A table was provided, of such height as to support the mandrel and assembled waveguide in the level position on the feeding side and to receive the welded waveguide on the receiving side so that gravity did not tend to cause bowing.

Electrode Wheels

The material selected for the slotted electrode wheels was Mallory 100, which comes under RWMA classification Group A, Class 3, and is commonly used for welding 18-8 stainless steels and other alloys having high electrical resistance. Its hardness is quite high among electrode materials, so that it does not require frequent dressing to retain its contour.

Welding both seams at one time would offer no difficulties if a series circuit were used, having the welding current pass through a spot on one seam and then through a spot on the other. Such an arrangement would call for extensive changes in the welder available. It was decided, therefore, to try to make the welds simultaneously by dividing the welding circuit into two paths by means of slotted

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electrode wheels. In this case, in order to have the two welds of equal strength it is necessary to have nearly equal resistances in the current paths. Pressures on the two seams must be equal, which means that the diameters of the two contact circles on each wheel must be the same. Even though there was a slight difference in diameters, a few runs with high electrode pressure would bring them to the same diameter without too great enlargement of the contact area o nthe larger ring. Welding speed was 15 in. per min. and electrode pressure was about 900 lb.

Brazing of Flanges

In order to make performance tests of the waveguides, it was necessary that flanges be attached to them. Standard flanges could not be used because this waveguide, having been formed to the inside dimensions of the 52U, had outer dimensions considerably smaller than those of the brass waveguide. Another feature of the stainless steel waveguide was the projections of approximately ¼ in. at the center of each broad side, which complicated attachment to a standard flange.

In order to facilitate testing of the waveguides, modified waveguide flanges were obtained. These are flush-type flanges, as the choke flanges were not required for test purposes.

Besides making a satisfactory brazed joint in attaching the flanges to the waveguide, attention had to be paid to maintaining accurate alignment, including perpendicularity of the flush surface of the flange to the longitudinal axis of the waveguide. For these reasons and because it was desirable to keep the temperature as low as possible, salt bath brazing appeared to be the most suitable.

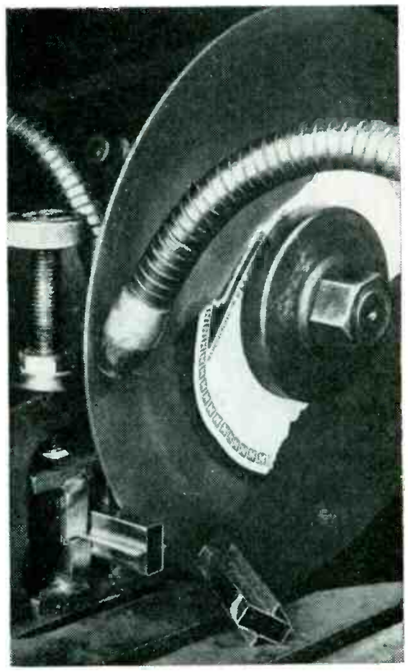
The heating salt used was Liquid Heat 900, furnished by E. F. Houghton and Co. It is a mixture of sodium, potassium and barium chlorides with a working range of 1,100-1,650 F.

The heating furnace was a small one with a capacity of about 5 pounds of salt. Heating was by resistance units surrounding the salt container, and the bath tempera-

ture was controlled automatically.

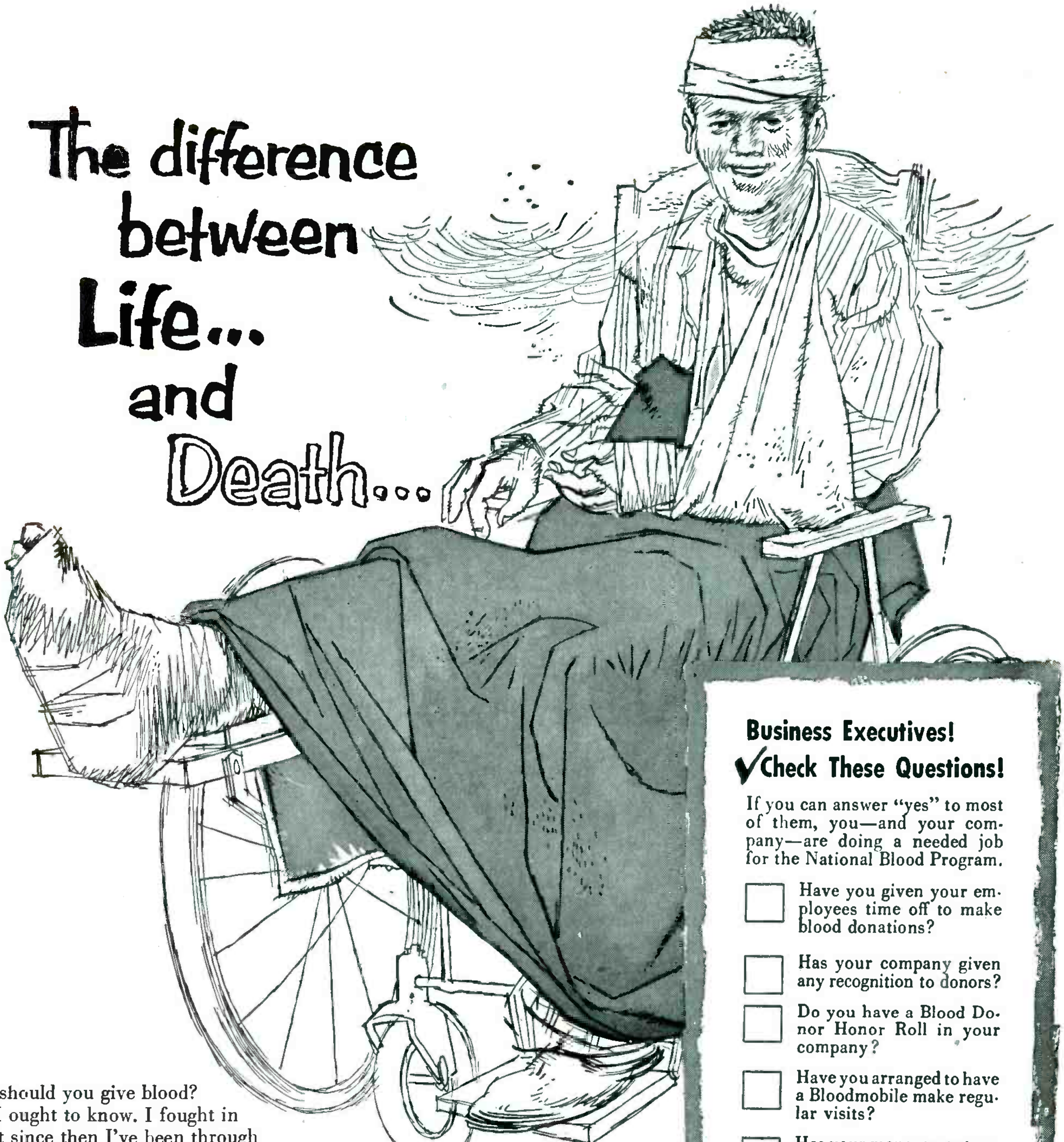
Easy-Flo silver solder in wire form, 3/64 in. diameter, was chosen as the brazing alloy. It has a low flow point of 1,175 F, is corrosion-resistant and has a narrow melting range.

A fixture was constructed to hold the flanges securely in position on the waveguide throughout the brazing operation, which was performed by holding the assembly vertically and dipping the end into the molten salt. Prior to heating, liberal quantities of Handy & Harman Handy Flux were applied to the surfaces of the flange and waveguide just above the joint, after which formed pieces of wire brazing alloy were placed along the joint, where they were lightly held by the flux. One end of the clamped assembly was then held slightly above the surface of the molten salt until the flux had first dried out and then melted, which requires about 4 minutes. As soon as the flux had melted, the assembly was lowered into the salt bath until all of the flange was submerged, and was held there for 60 seconds. On removal from the bath, the excess salt was poured back into the container by tipping the assembly to one side, after which



Method of cutting roll-formed waveguide to length with abrasive cut-off disk on shaft of power saw

The difference between Life... and Death...



"Why should you give blood? Ask me—I ought to know. I fought in Korea. But since then I've been through the biggest battle of all—the battle for life itself. And it was blood—and blood alone—that saved me. Don't know when I'll be in a position to start repaying my debt by giving some blood of my own. But I will—some day. You can count on it!"

All kinds of people give blood—for all kinds of reasons. But every reason for giving blood is a *special* reason . . . just as every American life that can be saved at any time and at any place . . . is special. So whatever *your* reason for giving blood, this you can be sure of: Whether it goes to a combat area, a local hospital, or for Civil Defense needs—this priceless, painless gift will some day save an American life!

Business Executives!
✓Check These Questions!

If you can answer "yes" to most of them, you—and your company—are doing a needed job for the National Blood Program.

- ☐ Have you given your employees time off to make blood donations?
- ☐ Has your company given any recognition to donors?
- ☐ Do you have a Blood Donor Honor Roll in your company?
- ☐ Have you arranged to have a Bloodmobile make regular visits?
- ☐ Has your management endorsed the local Blood Donor Program?
- ☐ Have you informed employees of your company's plan of co-operation?
- ☐ Was this information given through Plant Bulletin or House Magazine?
- ☐ Have you conducted a Donor Pledge Campaign in your company?
- ☐ Have you set up a list of volunteers so that efficient plans can be made for scheduling donors?

Remember, as long as a *single* pint of blood may mean the difference between life and death for *any* American . . . the need for blood is *urgent!*

Give Blood Now

CALL YOUR RED CROSS TODAY!

NATIONAL BLOOD PROGRAM

A PUBLIC SERVICE PROJECT · THE ADVERTISING COUNCIL it was allowed to cool in air for one minute before quenching in hot water to remove salt residue. The same operations were then repeated in brazing the flange to the other end of the waveguide section.

Care must be exercised to see that no moisture is allowed to drop into the bath, such as would occur if the assembly were dipped into the bath before the flux had dried out.

Trimming to Size

After welding and before attaching the flanges, it was necessary to trim the waveguide sections to the exact length desired. As stated previously, the stainless steel strips were plated and welded in 37-in. lengths, thus leaving ½ in. to be trimmed off each end.

An abrasive cut-off machine was set up for this purpose and equipped with a vise for gripping the waveguide section by the projections along each broad side where the welds are located. The vise was accurately fixed in position to make the cut perpendicular to the longitudinal axis of the waveguide section.

Special abrasive cut-off disks designed to leave the cut free of burrs were purchased from the Norton Co. under the designation A80U10-R29. Cutting is performed, under a flow of water, at a rate that will not cause overheating.

After trimming off approximately ½ in. from one end of the waveguide section it is turned end for end, accurately measured to length, and the remaining end is cut. What few burrs remain on the ends are easily removed with a metal scraper.

Finishing

Some cleaning of the inside surfaces of the waveguide is necessary to remove traces of salt and the loosely adhering particles deposited through spitting during welding. This is accomplished by washing in hot water, followed by polishing with soft cloths and rouge. The outer surfaces of the waveguide are also cleaned and may be given whatever degree of finish is desired.

Slight amounts of bowing in either the flatwise or edgewise

NOW ...a Compact, DISC-SEALED, Rugged Triode

with low back-pressure radiator

Only tube in "KW" class made in U. S. A. with a grid-disc seal! Adds strength. Reduces inductance and grid circuit losses to a minimum by shortening the current path to the electrodes.

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5923/AX-9904—WATER COOLED

5924/AX-9904R—FORCED AIR COOLED

6.9 KW at 75 MC

For radio communications and TV up to 220 MC, as well as for industrial applications. 5 KW dissipation. Ideal for the rigorous requirements of induction and dielectric heating with high efficiency.

R. F. AMPLIFIER, CLASS B—TV SERVICE

TYPICAL OPERATION IN TV SERVICE AT 216 MC., ONE TUBE IN A COAXIAL CAVITY

(Bandwidth obtained by critical coupling to identical dummy cavity)

D. C. Plate Voltage	4500	volts
D. C. Grid Voltage	—125	volts
Peak R. F. Grid Voltage		
Synchronization Level	405	volts
Black Level	305	volts
White Level	0	volts
D. C. Plate Current		
Synchronization Level	1.59	amps
Black Level	1.3	amps
White Level	0.4	amps
D. C. Grid Current		
Synchronization Level	0.4	amps
Black Level	0.15	amps
White Level	0	amps
Driving Power at Synchronization Level (approximately — Minimum)	150	watts
Power Output (approx.)		
Synchronization Level	5	KW
Black Level	3	KW
Power Input		
Synchronization Level	7.15	KW
Black Level	5.85	KW

ACCESSORIES	Water Jacket	Grid Connector	Pin Connector	Air Flow Chamber
5923/AX-9904	S-3712	S-3706	S-3707	S-3705
5924/AX-9904R		S-3706	S-3707	

OSCILLATOR—CLASS C

(With rectified, unfiltered, single-phase, full-wave plate supply)

TYPICAL OPERATION	CCS	
Transformer Voltage	6000	volts rms
D. C. Plate Voltage	5.4	KV
D. C. Plate Current	1.35	amps
D. C. Grid Current	0.31	amps
Grid Resistor	1300	ohms
Plate Input	9	KW
Plate Dissipation	2.3	KW
Driving Power at Tube (Approx.)	210	Watts
Power Output (Approx.)	6.5	KW
Frequency (Max.)	75	mc
Airflow Required: (3 kw Dissipation)	Approx. 200 cfm at 1" of water	
Tube Height (Approx.)	7¾"	
Low Direct Interelectrode Capacitances		
Grid to Plate	11	uuf
Grid to Filament	16	uuf
Plate to Filament	0.3	uuf

LIST PRICES

5923/AX-9904	$150.00
5924/AX-9904R	210.00

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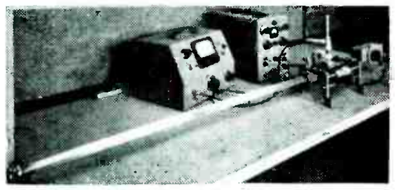
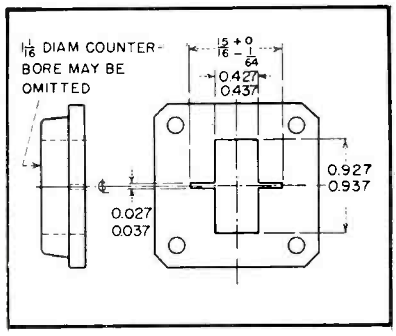
direction may be removed by supporting the guide and applying pressure in the direction indicated. Likewise, a small degree of twist can be removed by clamping the flange at one end of the waveguide section in a vise, inserting a mandrel in the other end and twisting the section by means of a wrench on the mandrel.

Testing

Finished waveguides were tested for bowing by placing them on a surface plate and measuring the



Test setup employed for checking electrical performance of finished lightweight waveguides

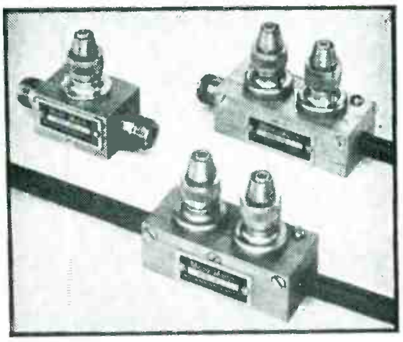


Modifications made in standard UG39U flange for testing lightweight 52U waveguide

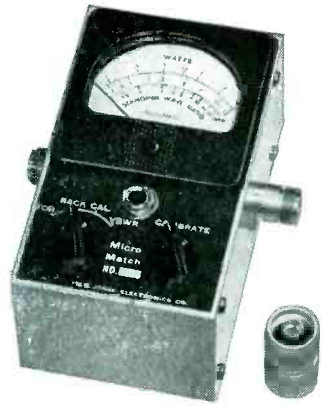
clearance with a feeler gage. If the clearance in either the E or H plane was more than is permissible, the ends of the guide were supported on blocks and pressure applied by hand at points along the guide, after which it was again checked on the surface plate. This procedure was continued until there was no bowing in either plane.

The presence of twist in the guide was determined after the flanges had been affixed. The guide was placed on the surface plate resting on the flanges. Holding one flange securely on the plate, the degree of twist was determined by measuring the amount of clearance of a corner of the opposite flange. To remove twist from a waveguide.

VSWR and RF WATTMETER



MM 570 SERIES



MM 700 SERIES

MicroMatch models are available as components for incorporating directly into transmitters or as complete independent test equipments for measuring RF power and VSWR from 500 KCS. to over 4,000 MCS., and power levels from 10 milliwatts to 120 kilowatts. These instruments are being used as test and monitoring equipment by Government Agencies, transmitter manufacturers, FM & TV Stations, Laboratories, Mobile Communication Agencies, etc.

Write for complete literature on: THE MICROMATCH ● RF ABSORPTION TYPE WATTMETERS ● DUMMY LOAD RESISTORS ● STATION GUARDIAN FOR TRANSMITTER PROTECTION ● DIRECTIONAL COUPLERS.

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one flange was clamped in a vise and a mandrel inserted in the other end, leaving an inch or so projecting beyond the flange. By applying a wrench to the mandrel, the small amount of twist occasionally found in a waveguide was easily removed.

The work performed in this project demonstrates that the production of lightweight waveguides of roll-formed, clad-metal construction is entirely feasible. With the possible exception of some innovations in the silver plating of stainless steel and in the welding of the waveguide sections, only well known manufacturing methods were used.

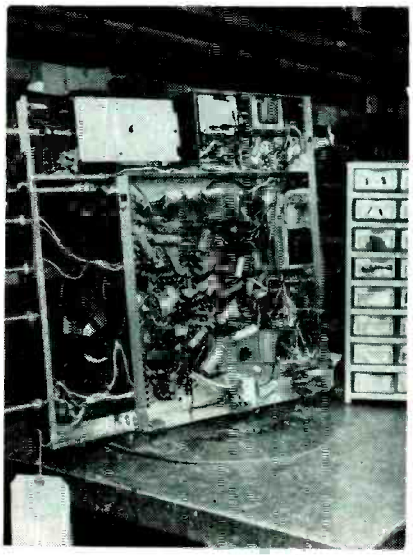
The weight of one of the test flanges is 0.15 lb, and the weight of one foot of 52U waveguide is 0.115 lb. Thus the total weight of a 3-ft section of 52U waveguide would be 0.645 lb, of which 0.3 lb would be due to the two flanges. Since the reduction of weight is one of the objects of this research, it would seem that a study should be made of ways in which the weight of the flanges could be lowered.

The report "Lightweight Waveguides" from which this material has been abstracted was prepared by the Armour Research Foundation of Illinois Institute of Technology on Air Materiel Command Contract No. AF 33(038)-23588, Project No. 90-1027 B, April 1, 1951 to June 30, 1952. Work was administered under the direction of the Components and Systems Laboratory, Weapons Component Division, Wright Air Development Center, Wright-Patterson Air Force Base, with G. F. Duree acting as project engineer.

Among those contributing to the development were John M. Parks, supervisor, Welding Research Section, R. R. Banks, S. I. Cohn, J. H. DeBoo, A. F. DeViney, W. Hanus, A. J. Hoehn and A. J. Jean.

Chassis Turntable For Repair Positions

WELDING of a metal shaft to a simple bracket-type television receiver chassis holder gives a handy turntable for use at the repair station alongside each GE television receiver assembly line. A hole is drilled into the work table to receive the shaft. Once in position on



Method of using chassis turntable at repair position alongside assembly line for dip-soldered television receivers at G-E plant in Electronics Park, Syracuse. Edges of table are covered with tempered Pressdwood, same as on top

the turntable, a chassis can be easily rotated to any desired position for making repairs. Wood cleats attached to the turntable support the chassis at the desired angle and prevent it from slipping out from under the three welded steel brackets.

Construction details of chassis turntable. Coiled soldering iron cord comes out of hole in table at upper left

Loudspeaker Magnetizer

A NEW 2½-ton magnetizing unit has been placed in operation in the loudspeaker assembly line of the Stromberg-Carlson plant in Rochester, N. Y. This electromagnet was designed especially for magnetizing the 10½- pound piece of Alnico V that serves as the permanent mag-

Assembly line for high-fidelity loudspeakers, with 2½-ton magnetizer straddling conveyor belt that runs over top of bench. Light beam goes diagonally through magnetizer from right front of bench to phototube at left rear. Surge-absorbing lamps are on top of magnetizer frame.

net in a new 15-inch high-fidelity loudspeaker. It also serves for magnetizing the company's smaller units.

The magnetizing unit consists of a steel yoke supporting the two pole pieces, each one foot in diameter. Each of the pole pieces is wound with three coils. Each coil contains 1,450 turns of No. 12 cotton-enamel copper wire. The complete assembly weighs slightly over 5,000 pounds. Special supports had to be built into the plant floor before it could be installed.

The electromagnet is activated by a self-excited generator which supplies 50 amperes at 300 volts. The density of the magnetic flux in the air gap is 10,000 gauss. When one of the 15-inch speakers is introduced into the gap, the flux density rises to 14,000 gauss. A slow-moving endless belt, which glides directly over the face of the magnet's lower pole at the same height as the assembly-line bench, carries the loudspeakers through the magnetic flux.

Activation of the electromagnet coils is controlled by a photoelectric relay. A speaker passing through the magnet gap interrupts the beam of light as the unit approaches the center of the gap. This switches current into the coils. A time switch, which can be adjusted to different intervals, cuts the power off.

Several tungsten lamps and two heating coils have been wired into the circuit, in parallel with the coils of the magnet, to absorb power surges and to bleed off residual current.

Roller-Jaw Pliers

NEW SIDE-CUTTING pliers having a free-turning steel roller on the upper half of one jaw have three different special functions in electronic assembly work.

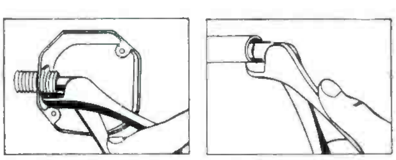
New roller-jaw side-cutting pliers for electronic assembly work

For tightening locknuts and bushings inside standard outlet boxes, the roller jaw rotates freely inside the cable fitting and the other jaw catches and turns the locknut. This tool gives tighter locknuts, insuring a permanently grounded electrical system for industrial control equipment as well as other electronic equipment that is directly connected to power lines.

Burrs on metal tubing are removed with the tool simply by twisting the tubing between the roller jaw and the fixed jaw. The fixed jaw has two cutting edges which scrape off the excess metal.

Rubber insulation can readily be skinned from wire by pulling the wire between the roller and the fixed jaw. The spacing here insures that this can be done without damaging the wire itself.

These new angle locknut pliers are made by Utica Drop Forge & Tool Corp., Utica, N. Y.



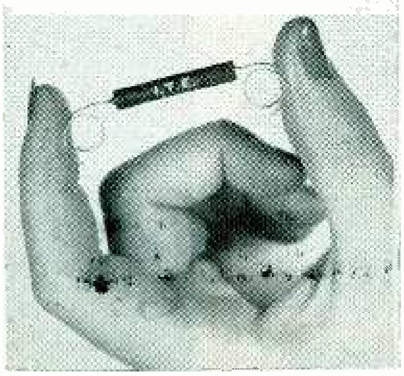
Examples of two uses for roller-jaw pliers. At left, pliers serve for tightening locknut in outlet box. At right, they are being used to remove burrs from metal tubing after sawing

NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

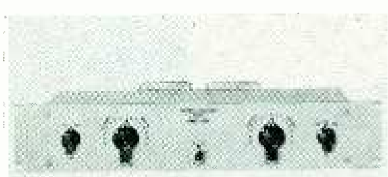
Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered . . . Thirty-Seven Trade Bulletins Reviewed

OTHER DEPARTMENTS
featured in this issue:



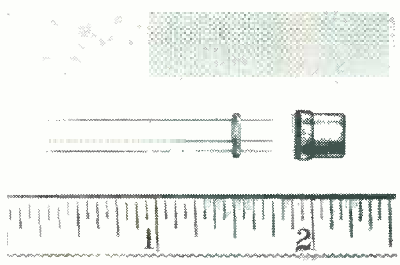
TINY RESISTOR
rated at 0.10 watt

I-T-E CIRCUIT BREAKER CO., Resistor Division, 1924 Hamilton St., Philadelphia 30, Pa. A tiny, new resistor type A3606CG, has been developed. Hermetically sealed, this subminiature resistor measures only $\frac{3}{16}$ in. in diameter × 1$\frac{1}{8}$ in. long. Resistors are built to customers' specifications, rated at 0.10 w. Maximum resistance, using Evenohm wire or its equivalent, is 500,000 ohms. Tolerances down to 0.1 percent are standard. Axial lead wires are of 22-gage tinned copper, 1$\frac{1}{2}$ in. long.



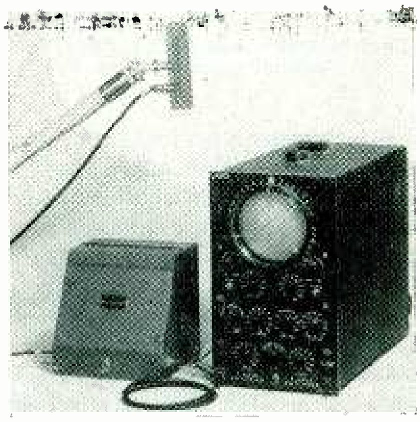
PROGRAM EQUALIZER
uses only 3½-in. rack space

HYCOR CO., INC., 11423 Vanowen St., North Hollywood, Calif. Type 4201 program equalizer meets present-day requirements for compactness, using only 3$\frac{1}{2}$ in. of rack space. It features low hum pickup through the use of toroid coils, inaudible switch-contact even at microphone levels and the ability to return to positions of known operating conditions. Transmission deficiencies, when known, may be preset. Low-frequency equalization is peaked at 40 cycles and 100 cycles in 2-db steps up to 12 db; high-frequency equalization is peaked at 3 kc, 5 kc and 10 kc in 2-db steps up to 12 db. Low-frequency attenuation is in 2-db steps at 100 cycles, maximum attenuation of 16 db. High-frequency attenuation is in 2-db steps at 10 kc, maximum attenuation of 16 db. An illustration, chief features, general specification and charts are given in bulletin E.



TRANSISTOR CLOSURES
are easily sealed

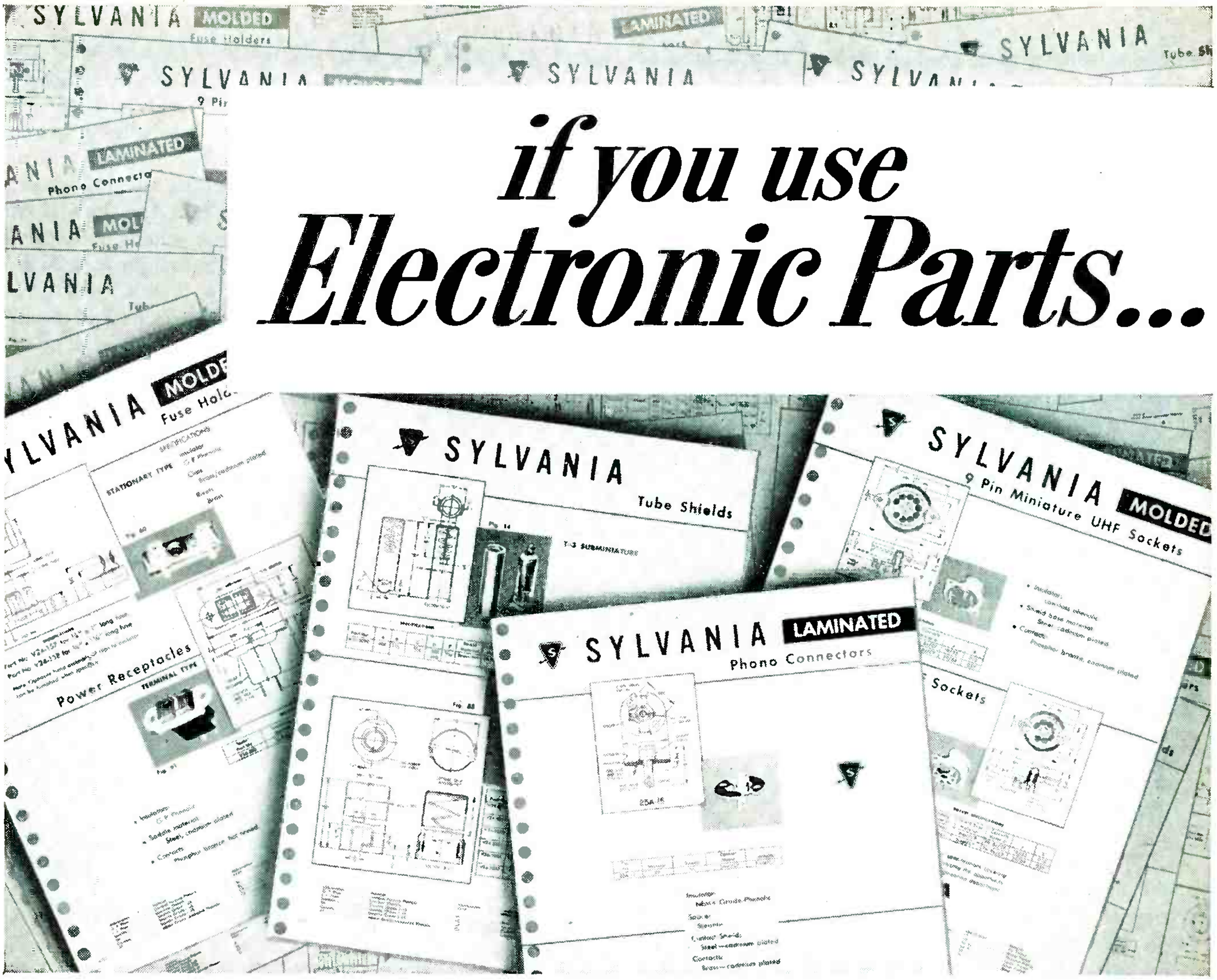
ELECTRICAL INDUSTRIES, INC., 44 Summer Ave., Newark 4, N. J., announces full production of a new standard-type transistor closure. The closures offer reduced size and feature a soldering dimple and hole to permit easy sealing. The closures available from stock are as follows: TC-IC can with soldering dimple and hole, TB-1A base with plug-in leads and TB-1B base with long leads. Write for samples and quotations.



CORONA DETECTOR
for high-voltage equipment

GENERAL ELECTRIC CO., Schenectady 5, N. Y., has announced a new device for detecting surface corona discharges which often indicate trouble or cause damage to insulation in h-v rotating equipment. The corona detector consists of a probe mounted at the end of a 10-ft insulating pole, a control box and necessary connecting cables. In operation the control box is connected to a standard oscilloscope (not part of the equipment) which gives a visual indication of the corona. The probe is a small capacitor covered with a plastic compound. When it is placed near a corona source, the variations in charge result in corresponding variations in the voltage on the probe electrodes. These variations are applied to a resonant circuit and cause it to oscillate momentarily. The pulse-type oscillations are then amplified and appear on the oscil-

if you use Electronic Parts...



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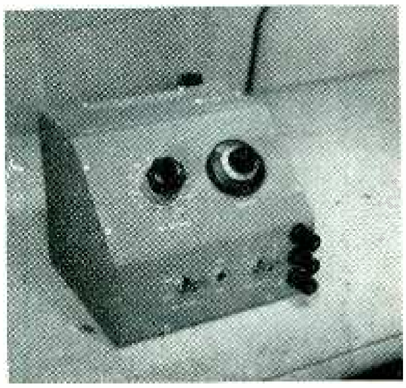
loscope screen as a corona indication.

AMPLIFIER TUBE
features high gain

SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y., has announced a new tube type, 6BQ7A, ideally suited to grounded-grid balanced amplifier service for frequencies up to 300 mc. It is another of the vhf cascode amplifier tube series with higher gain than its prototype, the 6BQ7. The 6BQ7A has a gm of 6,400 μmhos and an amplification factor of 38 with 150 v applied to the plate. It can be used as a replacement for the 6BQ7 with slight realignment of the tuned circuits.

TV CONVERTER
has excellent noise figure

DAVID BOGEN CO., 29 Ninth Ave., New York 14, N. Y. Model UCT-1 uhf-tv converter features an extremely high effective gain. Noise figure has been reduced to only 13 db. The unit is easily installed by connection to the antenna input of a standard vhf receiver. The equipment provides reception on all 70 uhf channels from 14 to 83 and operates through either channel 5 or 6 on the vhf receiver. Changeover from uhf to vhf is accomplished by a simple switch. In normal vhf use the converter is bypassed so that it has no effect on reception.

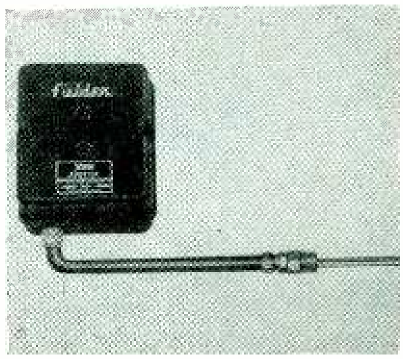


MILLIVOLT SOURCE
for calibrating instruments

ALLEGANY INSTRUMENT CO., 1,000 Oldtown Rd., Cumberland, Md. Model MV-60 millivolt source was designed for calibrating indicating recording instruments. Its low internal resistance results in minimum loading errors. Range is 0 to 60 mv; resolution, 10 μv. Uses include calibration of instruments for strain, temperature and d-c millivolt potentials, such as those produced in biological work. The unit is completely self-contained.

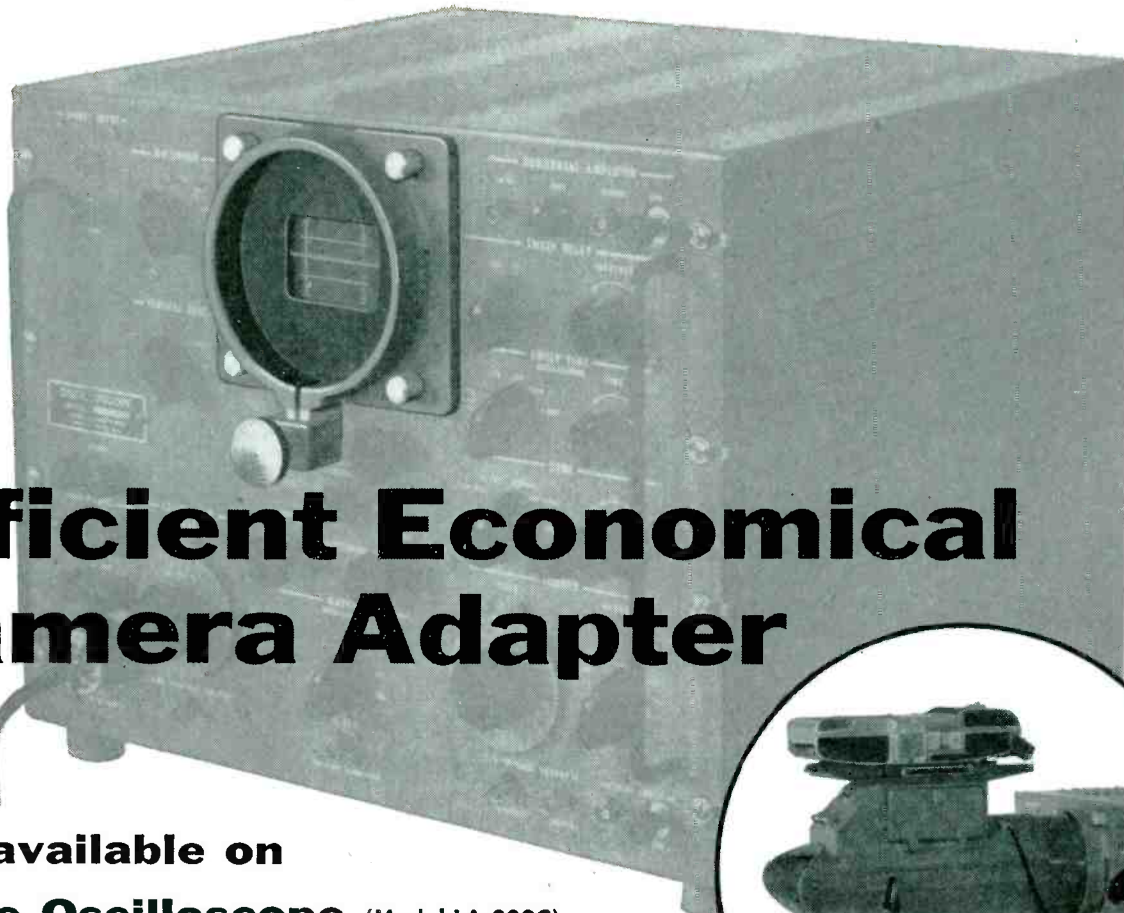
H-V RECTIFIER TUBE
features long life

BENDIX AVIATION CORP., Red Bank Division, Eatontown, N. J., has available the JAN-6106 full-wave high-vacuum rectifier tube. Incorporating features that promote long life the tube will assure long, dependable service and uniform operating characteristics under severe operating conditions. It is run-in tested and aged in the laboratory for 45 hours to indicate that it will withstand extreme shock and vibration. These tubes employ a cathode-type structure with extruded ceramic heater insulator and a coil-type heater instead of a filament structure. An arc-resistance, compound-filled melamine base with inter-pin barriers permits operation at altitudes up to 80,000 ft. The tube requires an 8-pin octal socket and can be mounted in any position.

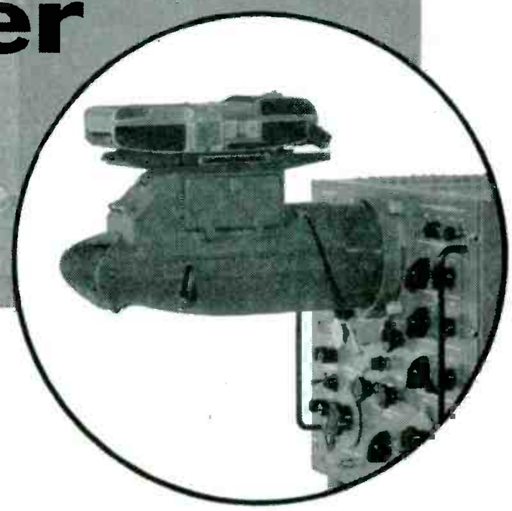


LEVEL CONTROL
has no moving parts

FIELDEN INSTRUMENT DIV., Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Philadelphia 33, Pa. The new Tektor level control is an improved capacitance unit with no moving parts. The simplified electronic circuit operates by a change in the electrical capacitance of the electrode caused by the approach of any material that flows. This instrument provides control as close as 1/8 in. of liquid, divided solid, interface, conducting or nonconducting, wet or dry materials. Electrodes are rigid rods or disks that may be completely sheathed in corrosion-resistant material. Electrodes are available for use with pressures up to 2,000 psi; temperatures up to 1,500 F. Model 101 and 102 Tektors are fail-safe, low-level respectively. New features include trimmer adjustment, accessible without removing cover for simpler installation and setup. Only a single radio tube is employed. The in-



Efficient Economical Camera Adapter



Now available on

Lavoie Oscilloscope (Model LA-239C)

The popular Lavoie Oscilloscope LA-239C has had a new plus feature added: The ability to mount the Lavoie Camera Adapter quickly and without modification. The Camera Adapter may be readily installed by removing the bezel, and securing the Adapter with four knurled nuts supplied on the panel. Already widely used in the development of radar and guided missiles, this new feature makes the LA-239C Oscilloscope a more valuable tool than ever.

NOTE: When ordering the LA-239C Oscilloscope primarily for photographic use, a P-11 Screen CRT is recommended. Specify type of phosphor desired.

- **Long persistence trace (P-2 phosphor)**
- **medium persistence trace (P-1 phosphor)**
- **blue photographic trace (P-11 phosphor) available.**

CAMERA ADAPTER DATA: Calibrated illuminated scale—1/50, 1/25, 1/2, 1, 5 secs. at f2.8
32 pictures per roll @ 5 cents each—a saving of 50 cents per roll.

OSCILLOSCOPE DATA

Wider Bandwidth: Complex waves from 5 cycles to 15 megacycles. Sine waves from 3 cycles to 20 megacycles.

Extended Sweep Frequencies: Linear from 10 cycles to 20 megacycles internally synchronized. Triggered sweep, from a single impulse to irregular pulse-intervals up to as high as 6 megacycles.

Square Wave Response: Rise time 0.022 microseconds, only 5% droop on flat-topped pulses as long as 30,000 microseconds duration.

Greater Stability: Electronically regulated power supplies throughout to maintain accuracy and constant operation under varying line conditions or line surges. Surges on the line from which Model LA-239C is being powered can be displayed without distortion.

Higher Signal Sensitivity: Maximum sensitivity without Probe: 10.4 millivolts. With Probe: 100 millivolts. (Maximum signals, 125 V. Peak and 450 V. Peak respectively.)

Timing Markers: Interval: Markers of 0.2, 1, 5, 20, 100, 500 or 2,000 microseconds may be superimposed on the trace for the accurate measurement of the time base.

Voltage Calibration: Signal amplitude is referenced to a 1,000 cycle square wave (generated internally) the amplitude of which is controlled by a step-and-slide attenuator calibrated in peak volts. (A jack is provided to deliver 30 V. Peak for use in calibrating other instruments.)

Sweep Delay: Any portion of the sweep longer than a 5 microsecond section may be expanded by 10:1 for detailed study of that portion of the signal.

Power Source: 110 to 130 V. AC from 50 to 1,000 cycles. 295 Watts. (Fused at 4 amperes.)

Dimensions: In Bench Cabinets: 19½ in. wide, 15¼ in. high, 16¾ in. deep. In Rack Mounting (with cabinet removed to fit standard relay rack): 19½ in. wide, 14 in. high.

Lavoie Laboratories, Inc.

MORGANVILLE, NEW JERSEY

Designers and Manufacturers of Electronic Equipment

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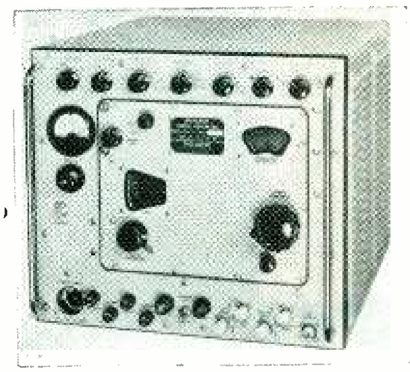
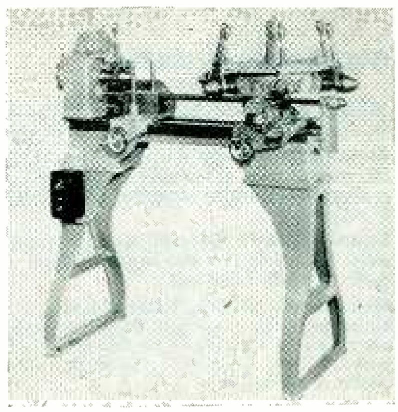
strument operates on 115-v 60-cycle power supply.



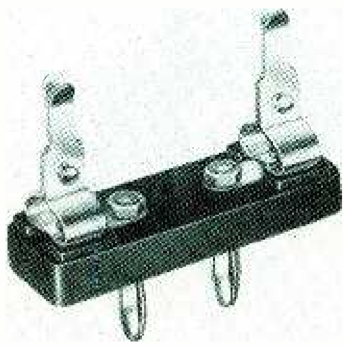
SIGNAL GENERATOR has single dial control

POLARAD ELECTRONICS CORP., 100 Metropolitan Ave., Brooklyn 11, N. Y. Model MSG-4 microwave signal generator features accuracy, simplicity and reliability. It covers the frequency range from 7,000 to 10,750 mc. In addition to the single tuning control and 1-percent accuracy, other advantages include temperature compensation, long-life cavity design, wide range of modulation frequency, pulse, f-m, internal and external modulation. It is constructed to military standards of sturdiness and can be used with complete efficiency under the most adverse conditions in the field or in the laboratory.



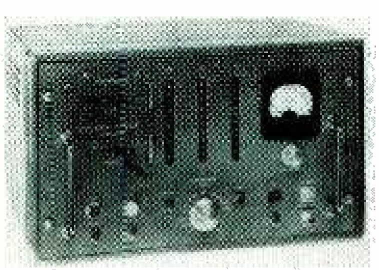
GLASS TURRET LATHE for tube manufacturing

KAHLE ENGINEERING CO., North Bergen, N. J. A glass turret lathe, model 2326, is designed for laboratory and short-run production work in the field of electronic tube manufacturing. Its advantages are that successive steps in glass work, the addition of successive pieces, or any combination of pieces and operations, may be made continuously without permitting the work to cool between steps, and without the necessity of re-chucking. The latter feature insures absolute concentricity about the same axis. Annealing becomes a part of the operation without loss of time. The entire turret is readily moved back and forth like the tool post of a machine lathe.



TEST BOARD
gives perfect contact

GRAYHILL, 561 Hillgrove Ave., LaGrange, Ill. The new No. 2-2 test board is designed to simplify the testing of resistors, capacitors, germanium diodes, and the use of general test leads. It is available with banana plugs on ¾-in. centers. The body is molded of a general-purpose phenolic. Plugs and clips are plated. The same sturdy, highly tensioned spring clips are used as are found in the company's test clips. A perfect contact is available at all times.



DECIMAL SCALER
for laboratory use

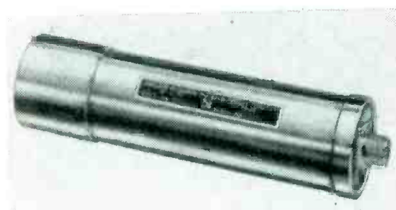
BERKELEY SCIENTIFIC, Div. of Beckman Instruments, Inc., 2200 Wright

Want more information? Use post card on last page.

Ave., Richmond, Calif. Model 2001 decimal scaler is a versatile instrument for accurate laboratory radioactivity measurement. An electronic scale of 1,000 is employed and special circuits provide for a large number of preset counts and scaling factors for operating external registers or other devices. A drum-type clock is located on the front panel directly beneath the mechanical register to simplify reading and recording information. The h-v supply provides excellent regulation for operation with scintillation counters as well as Geiger tubes.

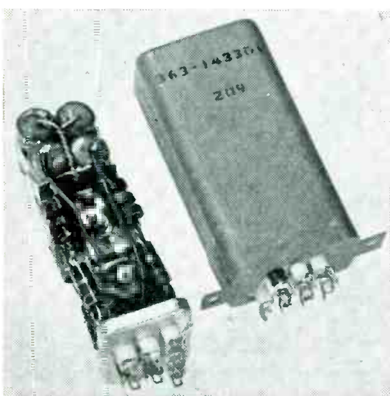
UHF CONVERTER peaked for single channel

CREST LABORATORIES, Rockaway Beach, N. Y., has introduced a multichannel converter designed for single-channel use. It is easily tunable to receive any channel within a 20-channel range, without instruments. Silver-plated high-Q tuned circuits provide high gain and sensitivity. Fundamental oscillator provides superior oscillator stability and reduces susceptibility to interference. The unit is designed for use with 300-ohm uhf antenna.



TINY BASIC UNIT for portable equipment

NUCLEAR RESEARCH AND DEVELOPMENT, INC., 6425 Etzel Ave., St. Louis 14, Mo., presents the SC-33 miniature basic unit. This counter, which is 2 in. in diameter × 6½ in. long, is light weight for portable equipment. The smaller diameter offers greater ease and economy in providing lead shielding, plus a more convenient size for hand-held probes. It also features a threaded end for rapid attachment of accessories, and construction of strong, lightweight aluminum alloy. The phosphors are used in conjunction with a RCA 6199 phototube, which is pressed firmly, with several pounds pressure, against the plexiglass crystal mounting, with a small amount of DC-200 silicone inserted between. A firm, excellent optical contact is achieved which is fully equivalent to a cemented joint. Alpha, beta and gamma phosphors up to 1½ in. in diameter are obtainable as attachments.

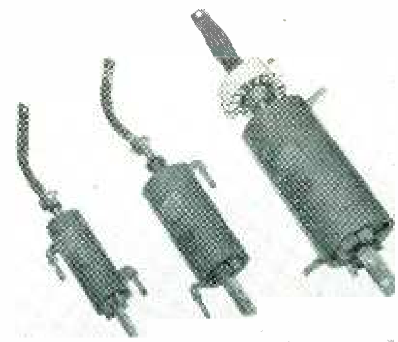


REGISTER
is magnetic-shift type

RAYTHEON MFG. CO., 148 California St., Newton 58, Mass. The magnetic-shift register illustrated, currently being used in a Raytheon computer, is one in a series of such packages being offered. It features a single magnetic core and single diode for each binary digit of information, increased circuit stability, better one-to-zero ratio and prewired multiple-stage connections.

SUBFRACTIONAL MOTOR
for 50-800 cycle range

AIR MARINE MOTORS INC., 3939 Merrick Rd., Seaford, L. I., N. Y. Type A15BF-15 subfractional h-p motor, manufactured for operation over the 50-to-800 cycle frequency range, is designed to operate on a 115-v variable-frequency supply. Input is 20 w at 50 cycles, 30 w at 400 cycles and 60 w at 800 cycles. Rated speeds are 3,000 rpm at 50 and 400 cycles, 2,800 at 800 cycles. It is designed for single-phase operation and is also available for 2 and 3-phase operation. It is protected against humidity and fungus growth, can be mounted in any position, and meets all AN specifications. It uses a single winding and is provided with four leads. The motor is reversible and can be supplied with or without fan or blower.

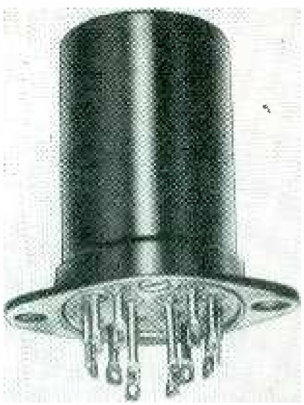


IGNITRONS
for industrial use

AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, Long Island, N. Y., has added five ignitrons to its line of industrial tubes. Types AX-5551, AX-5552, AX-5553, AX-5554 and AX-5555 are electrically and mechanically identical and are interchangeable with standard types of the same designation. Features include an improved, long-life ignitor and a heavy, detachable braided copper anode lead. Types AX-5551, AX-5552 and AX-5555 are illustrated.

COAX ASSEMBLY KIT
for prototype construction

MICRODOT DIVISION, Felts Corp., 1826 Fremont Ave., South Pasadena, Calif., has introduced a kit for microminiature connectors and cables. The kit is fully equipped for prototype construction with a self-assembly hand tool especially designed for makeup of typical coax assemblies employing the company's connectors, cable and adapters. It is expected to bring economies in time and money for laboratories, research and design engineers. The kit is a self-contained unit with a blow-up illustrated manual, the special hand tool, 30 connectors including male plugs, female panel receptacles, panel feed-throughs, blind-hole receptacles, couplings, adapters to BNC fittings, and 50 ft of 50-ohm coax cable.

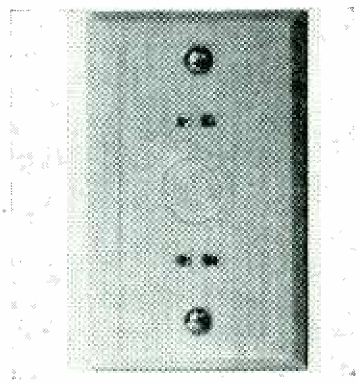


MINIATURE RELAYS
with rotary design

S. H. COUCH CO., INC., North Quincy 71, Mass., has introduced a new line of miniature and subminiature hermetically sealed relays featuring dynamically and statically balanced rotary design for high vibration, up to 2,000 cycles, and high shock up to 125 g. They are available in two sizes and various mountings. General specifications include a coil resistance from 6 to 30,000 ohms; d-c coil voltage from 6 to 400 v; temperature range from —65 C to 200 C; and contact ratings up to 5 amperes. Overall sizes are $1\frac{5}{8}$ in. and $1\frac{15}{16}$ in. high, $1\frac{1}{8}$ in. diameter.

RECTIFIER TUBE
features quick starting

TAYLOR TUBES, INC., 2312 W. Wabansia Ave., Chicago 47, Ill. Type 6288 Xenon-filled rectifier tube was designed for replacement of mercury rectifier tubes where quick starting and dependable rectification is required under unusual temperature and electrical conditions. Rugged construction makes the tube applicable for high-shock installations as it withstands impact to 100 g. Arc-resisting high-emission cathode is directly heated. Filament voltage is 2.5 v (a-c/d-c) and filament current is 2.0 + 0.2 ampere (a-c/d-c). Peak inverse voltage is 10,000 v. Average anode current is 125 ma with a peak current of 2.5 amperes. Average arc drop is 10 v or less and warmup time is 5 seconds. The tube is compensated for an ambient temperature range of —55 C to +75 C. Maximum height is 4.70 in. and maximum diameter, 1.57 in.

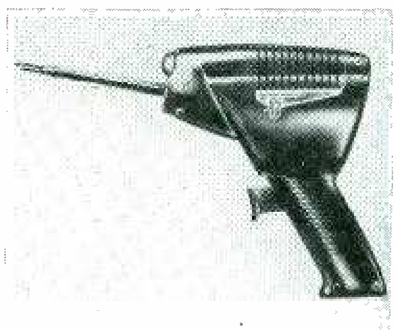


TWIN TV COUPLER
is a printed-circuit unit

JAVEX, P. O. Box 646, Redlands, Calif., has announced a printed circuit tv coupler for two-set installation. The new circuit feeds two tv receivers on the signal received from one antenna, and has been designed to eliminate attenuation and provide a maximum service distance up to 65 mi. Materials of construction are polystyrene and T675 Insurok. This new plate is capable of flush mounting anywhere without breaking a wall and without the use of a wall box, and can be used with all Javex plugs.

TWIN POWER TRIODE
for voltage regulation

CHATHAM ELECTRONICS CORP., Livingston, N. J., has announced the type 6336 high perveance, high plate dissipation twin power triode for voltage regulation. Used as a series tube, it will pass a minimum of 150 ma per section at 40 v d-c plate voltage, and the same current at 200 v using a grid bias of —60 v. The tube features a hard-glass envelope and a 8-pin butt stem. Height is 4.75 in. maximum and bulb diameter is 2.07 in. maximum. Filament voltage is 6.3 v, 5 amperes maximum. Maximum bulb temperature is 250 C. Forced ventilation is not necessary at ambient room temperature. Mu is 2.7; transconductance, 11,000 μmhos; and plate resistance, 250 ohms. Life is 1,000 hours minimum.

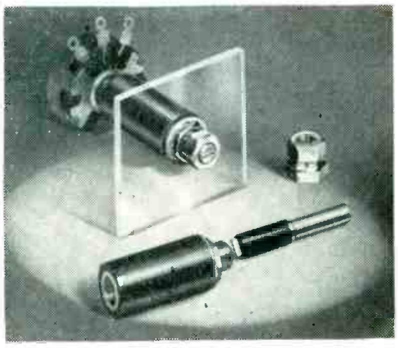


SOLDERING GUN
is instant-heating type

PHILLIPS MFG. CO., INC., 2816 Aldrich Ave. South, Minneapolis 8, Minn. Design of the new model 250 Versa-Tool instant heat soldering gun prevents tips from freezing in the barrel. Other features include a reinforced plastic housing of great impact strength; a one-piece phenolic molded trigger pivot arm assembly; a barrel assembly that can be removed without disassembling the housing; a fast-heating, long-life carbon element and favorable fuse-cap location. The unit is rated at 250 w, 115 v a-c (also available for 200-v a-c operation) and will reach soldering temperatures in less than 4 seconds.

UNIVERSAL CLAMP
for microphone positioning

ATLAS SOUND CORP., 1451 39th St., Brooklyn 18, N. Y., has released its model SK-1 Sky Hook universal clamp designed to solve many difficult problems of microphone positioning. The SK-1 securely fastens to almost every type of surface ledge, round pipe or irregularly shaped stanchion. A microphone can be attached directly to the $\frac{3}{8}$ in. tube supplied with the clamp-offering a versatile means of positioning an additional microphone on a floor stand. The chrome tube is 3 in. long.



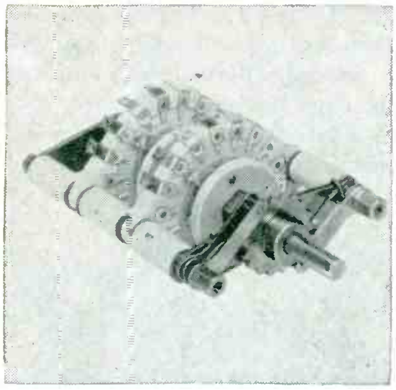
INTEGRATED UNIT molds pot shaft & coupling

JAMES MILLEN MFG. CO., INC., 150 Exchange St., Malden, Mass., has combined two of its designed-for-application products into a new single integrated unit—the combination insulated potentiometer extension mounting plus shaft lock. This combination design eliminates the necessity for special shaft lengths for different panel thicknesses as in the past as the new unit automatically provides for the proper shaft length independent of variations in panel thickness. The extension shaft and insulated couplings are molded as a single unit to provide accuracy of alignment and ease of installation.

SHF TEST OSCILLATOR weighs less than 12 lb

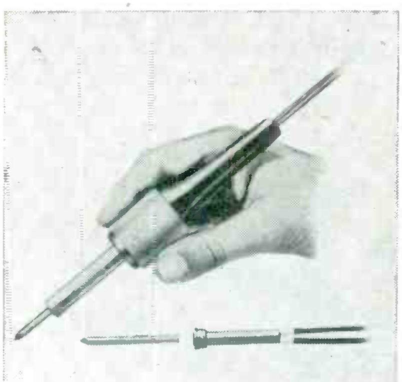
SEABOARD ELECTRIC CO., 417 Canal St., New York 13, N. Y. Model 1180 test oscillator combines broadband frequency range with portability and compactness, and delivers a minimum of 200 μv into 50 ohms over the frequency range of 3 to 11 kilomegacycles, pulsed at 800 pps. The cavity is excited by a spark generator that is energized by self-contained batteries. A waveguide-beyond-cutoff attenuator provides

100 db of attenuation. A broadband antenna and cable are provided for complete radar and microwave relay system checks. Total weight is less than 12 lb.



SELECTOR SWITCHES
available in 1 to 6 gangs

R-F ELECTRONICS, INC., 291 N. E. 61st St., Miami, Fla., is producing a line of precision, low-loss, 18-position Brown-Hill ceramic wafer-type selector switches for use where constant stability in conductivity is so necessary and where resistance, inductance and capacitance must be kept to a minimum. They have a voltage breakdown of 4,000 v a-c (peak at 60 cycles); and a current-carrying capacity of 30 amperes at 60 cycles, noninductive load. Available in 1 to 6 gangs, the switch features a new 20-deg positive detent mechanism with adjustable stops.



SOLDERING IRON
is improved pencil type

HEXACON ELECTRIC CO., 130 W. Clay Ave., Roselle Park, N. J., announces a new soldering iron combining all

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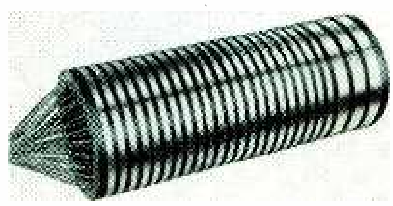
the advantages of a pencil iron and an industrial type. Tip and element are separate parts and both are replaceable independently. The cool handle of the 2-oz iron is held like a pencil only 3 in. from the solder joint. It is available in 25 w with a ⅛-in. tip or 30 w with a $\frac{3}{16}$-in. tip. Element, tip and housing are made of special alloys which increase soldering efficiency. The irons operate identically on d-c or a-c any cycle.

VARIABLE ATTENUATOR
has revolutionary design

HYCOR CO., INC., 11423 Vanowen St., North Hollywood, Calif., has announced the development and production of a completely new and revolutionary variable attenuator. The resistive elements are accurate, noninductive, wirewound and hermetically sealed in a special tough plastic compound, proof against shock, moisture and temperature. It withstands ambient temperatures of from −40 C to +100 C, and 95-percent humidity. It also features greater power dissipation. Stock types are available with ladder, T, H, L and potentiometer configurations up to 32 steps. Bulletin A-2 is available on request.

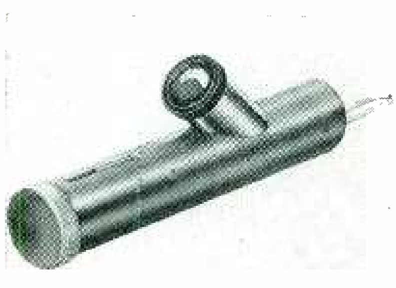


SLIP RING ASSEMBLY
for gyro test application

ELECTRO TEC CORP., South Hackensack, N. J. The 25-circuit slip-ring assembly illustrated was built for gyroscope test equipment. The assembly combines a dimensionally stable plastic body and two end pieces with high impact strength to facilitate assembly on to a shaft. The unit, in combination with properly designed brushes, provides an essentially noise-free circuit. Power circuits can also be carried by the same assembly. This is done by increasing ring width to allow for larger brushes to carry motor drive and heater currents that may be required, as evidenced by the three wide end rings. Shielding is provided between circuits. One-piece construction provides excellent concentricity, brush alignment and assembly features.

TINY DELAY RELAYS
are hermetically sealed

AMPERITE CO., INC., 561 Broadway, New York 12, N. Y., has available delay relays in the T6-½ bulb-base 9-pin miniature type. These tubes can be supplied for all standard heater voltages, such as 6.3, 26 and 115 v. Delays are available from 2 to 90 seconds. The heater consumes approximately 2 w. Contact rating is 115 v, 2 amperes a-c noninductive. Ambient compensated temperatures are from —50 to +70 C. Hermetically sealed, the relays are not affected by climatic conditions, and their rugged construction enables them to withstand vibration.



UHF WAVEMETER
covers 400 to 1,000 mc

LINEAR EQUIPMENT LABORATORIES INC., Brightwater Place, Massapequa, N. Y. Model U-3 uhf wavemeter is a new type specifically

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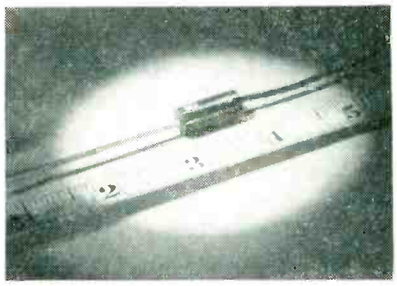
designed for the uhf-tv band. Covering a range from 400 to 1,000 mc, it provides a considerable overlap in frequency spectrum from the nominal 470 to 890-mc band allocated for this service. Coupling to the wavemeter tuning element is facilitated by the use of an external coupling loop so designed as to permit easy access to the portion of the circuit under examination. The absorption circuit used consists of a high-Q resonant cavity that is tuned by means of a slug-type split stator capacitor, providing a sharp indication of resonance. Sliding contacts are avoided, resulting in a unit which remains unaffected by moisture, oxidation or wear.

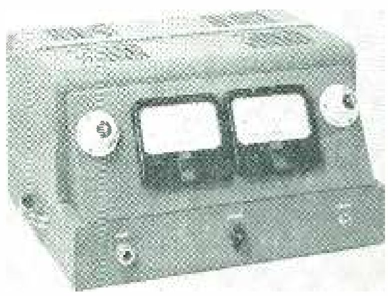


TINY RECTIFIERS
for military applications

ELECTRONIC DEVICES, INC., 429 12th St., Brooklyn 15, N. Y., has developed the Minisel line of subminiature selenium rectifiers. It consists of tiny selenium rectifiers in ratings up to 20 ma d-c output and 25,000 v a-c input per single stack and features a variety of constructions for military and commercial applications. Special constructions allow for hermetic sealing and fungus proofing. The rectifiers are constructed of matched ¼-in. diameter round selenium rectifier cells encased in Bakelite, glass or metal housing. There is very little variance in characteristics within the individual unit and from unit to unit. This uniform distribution of internal losses makes for extremely long life.

PREAMPLIFIER
has high output range

RADIATION COUNTER LABORATORIES, INC., 5122 W. Grove St., Skokie, Ill., has available the Oak Ridge A1C preamplifier (ORNL Specs. Q-1302 and Q-1326), the latest modification of the Bell-Jordan A1A preamplifier. The unit has increased output signal range and input circuitry arranged for multiplier phototubes using a negative power supply. The h-v coupling capacitor is retained for other possible modifications. Two signal connectors are provided: an Amphenol 82-805 of the type HN series, and an IPC 27,000 (UG 931/U), a high-voltage BNC type. Detailed technical specifications and price information are available.



H-V POWER SUPPLIES
in ranges up to 25,000 v

PRECISE MEASUREMENTS CO., 942 Kings Highway, Brooklyn 23, N. Y., has announced a new line of h-v power supplies. Standard instruments come in ranges up to 25,000 v, and feature well-filtered d-c output, as well as a choice of built-in direct-reading kilovoltmeters on any unit. The power supplies are also available with direct-reading current meters for leakage measurements. Special cutout circuits protect the meters on accidental shorts. They are perfect for breakdown and leakage tests as well as general power-supply uses. Both regulated and unregulated types are now available.

TINY AMPLIFIER
with etched-circuit wiring

ENDEVCO CORP., 689 South Fair Oaks Ave., Pasadena 2, Calif. Model 2607 amplifier is a rugged unit using subminiaturized components and etched-circuit wiring. It provides an input impedance of over 150 megohms for piezoelectric, ca-

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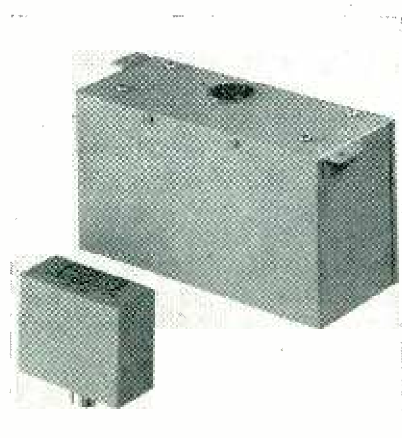
pacitive and other types of measuring instruments. Combined with the series 2200 accelerometers, it lends itself to installations in missiles, aircraft or ground tests where ambient conditions of temperature and vibration are severe. The selectable gain ratios of 10, 30 or 100 allow for a full 5 v output from an accelerometer generating 10 mv per g when measuring 5 g of acceleration or vibration.

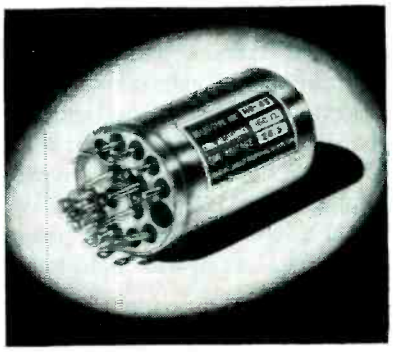
PLAYBACK HEAD
for motion picture projection

TRI-DI SOUND CORP., 4913 W. Jefferson Blvd., Los Angeles 16, Calif., has announced a 3-channel magnetic playback head for use on motion picture projection equipment producing stereophonic sound. New manufacturing techniques permit excellent gap alignment, which results in higher fidelity sound reproduction. The unit, 3 heads in one shielded case, is machined to extremely high tolerances and subject to rigid quality-control standards. It has been tested at high degrees of shock, vibration and humidity over a long period of time without changing characteristics.



BANDPASS FILTERS
occupy little space

BURNELL & CO., 45 Warburton Ave., Yonkers, N. Y., is now producing a series of telemetering bandpass filters completely miniaturized without sacrifice in attenuation characteristics. One complete set of 20 telemetering channels occupies a space of 300 cu in. as compared with the volume of 1,500 cu in. of the standard size filters. This new series is equipped with octal plug mounting and is hermetically sealed in accordance with government specifications. Literature is available upon request.



HIGH SHOCK RELAYS are hermetically sealed

HI-G INC., Bradley Field, Windsor Locks, Conn., has developed types HG-2 (2 pdt) and HG-4 (4 pdt) miniature high-shock relays for aircraft, guided missiles, railroad switching devices, computers, navigational and communications equipments and motor starting devices. Temperature ranges are from −65 to +500 F; coil voltages, from 6 v to 300 v; coil resistance, 8 ohms to 20,000 ohms; contact resistance —0.010 to 0.030 ohm available depending upon application; and breakdown voltage, 1,000 v, 60 cycles. Shock resistance is 100 g plus. Maximum size is $1\frac{5}{32}$-in. diameter × $1\frac{15}{16}$ in. long. Two and three-hole mounting flanges are available.

TRANSMITTER TESTER for tv sideband response

RADIO CORPORATION OF AMERICA, Camden 2, N. J., has announced a new tv sideband response analyzer designed for use with a cro. Type

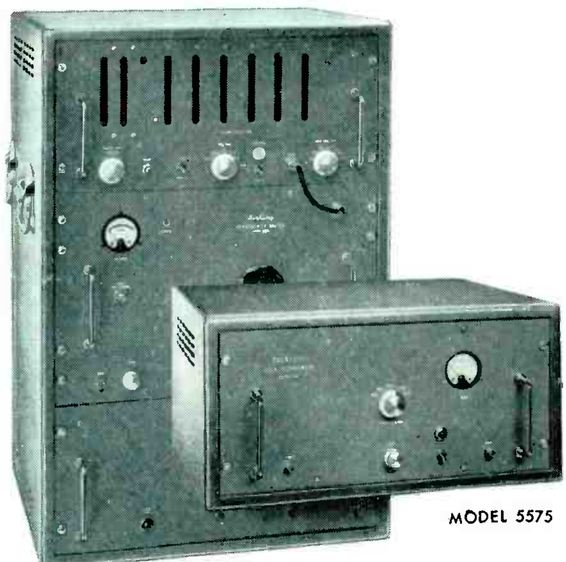
FOR RAPID, PRECISE DIRECT-READING FREQUENCY MEASUREMENTS to 150 Megacycles

THE BERKELEY F-2 Frequency Meter

DESCRIPTION: The BERKELEY Series F-2 Frequency Meter is a precise direct-reading instrument for the measurement of frequencies from 0 cps to 150 mc. Basic sections are (1) the Model 5575 VHF Converter,* (2) the Model 5570, which contains a HF Heterodyne unit and (3) a high speed 8-digit Events-Per-Unit-Time meter. Frequencies up to 42 mc. are read directly on the 8-digit EPUT panel. Frequencies between 42 and 150 mc. are applied through the VHF Converter; reading is the sum of a rotary selector switch marking and the EPUT indication. External adjustment of crystal control to WWV is provided to obtain an accuracy of 1 part in 10^7, ± 1 cycle.

**NOTE: Model 5575 Converter is available separately for owners of BERKELEY Model 5570 42 mc. Frequency Meters, to extend range to 150 mc.*

APPLICATIONS: Rapid, accurate transmitter monitoring, crystal checking, general laboratory and production line frequency determination. Addition of a BERKELEY Digital Recorder will provide an automatic printed record of the last 6 digits; ideal for plotting frequency drift or indicating stability.



MODEL 5575

MODEL 5570

SPECIFICATIONS

RANGE:	0 cycle to 150 megacycles.
ACCURACY:	± 1 count, ± crystal accuracy (short term: 1 part in 10^7).
POWER REQUIREMENTS:	117 volts, ± 10%, 60 cps, 360 watts.
INPUT REQUIREMENTS:	Approximately 0.1 volt rms. (100 ohm impedance standard, 100K on request).
DISPLAY TIME:	1 to 5 seconds continuously variable.
TIME BASE:	0.002, 0.02, 0.2 and 2 seconds.
DIMENSIONS:	Two cabinets; Model 5570, 32" high x 21" wide x 16" deep, Model 5575, 10½"x 21"x 16".
PRICE: (f.o.b. Richmond)	Series F-2 Frequency Meter complete $2,590.00
	Model 5575 VHF Converter only .... $ 600.00
	Model 5570 Frequency Meter (0-42 mc.) $1,990.00

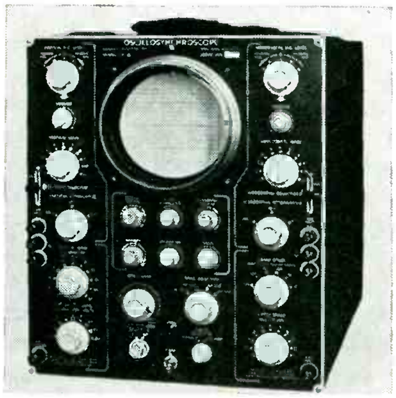
Prices and Specifications subject to change without notice.

Please request Bulletin G-12

Berkeley *division*

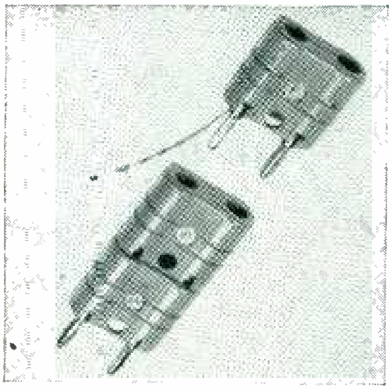
BECKMAN INSTRUMENTS INC.
2200 WRIGHT AVE., RICHMOND, CALIF.

BW-5A test equipment measures overall amplitude vs frequency of a vhf tv transmitter without using internal connections and with the transmitter operating at normal power output. The equipment includes a video sweep oscillator, and can be used in adjusting video amplifiers and modulators, and for tuning the overcoupled broadband r-f circuits and measuring their amplitude response characteristics. The unit is 10½ in. high, 19 in. wide, and 14½ in. deep. It has a power consumption of 200 w. It has an internal 260-v d-c regulated power supply. The complete equipment weighs 58 lb.



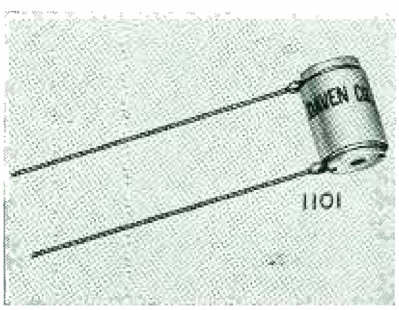
OSCILLOSYNCHROSCOPE for signal observation

BROWNING LABORATORIES, INC., 750 Main St., Winchester, Mass., announces the model OA-16 oscillosynchroscope, featuring a calibrated buck-out voltage which allows balancing out of d-c levels accurately to 10 percent, so that small superimposed a-c signals can be expanded for more minute inspection of both the signal and small changes in d-c level. This represents a possible 40-to-1 expansion of the signal over that observable using conventional d-c methods. Also featured are vertical and horizontal amplifier bandwidths from d-c to 5 mc and 1 mc, and sensitivities of 50 mv, peak-to-peak per in. and 120 mv, peak-to-peak per in., respectively. Triggered or recurrent sweeps from 0.4 μsec per cm to 10 seconds total sweep time are available. A video delay line permits observation of rising wavefronts of pulses. Amplitude measurement may be made through use of a 60-cycle square wave which adequately covers any deflection range with an accuracy of 5 percent.



BANANA PLUG
styled for easy gripping

NATIONAL Co., INC., 61 Sherman St., Malden, Mass., has announced production of a new type of banana plug. The FWT plug, molded of mica-filled bakelite in accordance with JAN specifications, is styled for easy gripping. Leads can be brought directly from the base of the prongs or through a hole at the bottom of the plug. The top of the plug has been designed to accept additional plugs. All contacts and screws are nickel-plated brass. Drawings, specifications and prices may be obtained by writing the company.

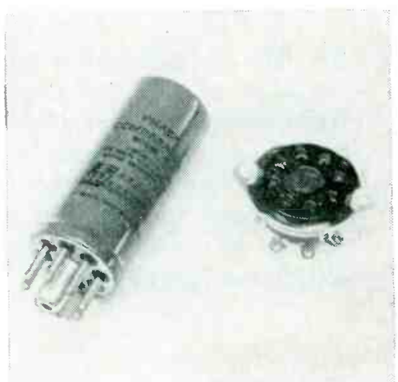


VERY SMALL RESISTOR
for military requirements

THE DAVEN Co., 191 Central Ave., Newark 4, N. J. Type 1101 subminiature resistor measures only ¼ in. in diameter and is only 11/32 in. long. Yet, it can be wound in all values up to 175,000 ohms. Resistance tolerances to ±0.1 percent are available with power rating of 0.10 w. The clearance hole is for a No. 0 screw. Special impregnation for resistance to humidity and extremes of temperature is provided for all military applications.

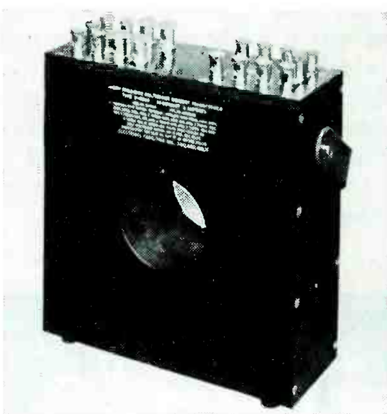
TAPE RECORDER
is a single-speed unit

TAPE RECORDER DIVISION, EICOR, INC., 1501 W. Congress St., Chicago 7, Ill. Model 400 single-speed recorder, designed for universal use, eliminates extra attachments and gadgets by its simplicity of design. It has a breakaway electrical cord for easier storage, a plug-in head and other features including easy playback through an external amplifier and a new automatic retractable rubber pressure roller. Frequency range is approximately 70 to 5,000 cycles at 3¾ in. Rewind speed is 6 to 1 with 2 hour, 7 in, reel tape capacity. Literature is available.



BRIDGE COMPARATOR
is a packaged unit

SANDERS ASSOCIATES, INC., Nashua, N. H., is producing a packaged bridge comparator, a well balanced, hermetically sealed unit for phase and amplitude comparison. It is a versatile, full-wave bridge comparator that can be used as a modulator, rectifier, switch or chopper. It consists of two complete bridges with appropriate switching resistors and has a frequency range of 0 to 5,000 cps. It has a conversion efficiency of 85 percent. Dynamic range is 46 db with fixed reference amplitude and 60 db with variable reference. Linearity over this range is 1 percent of full scale. Because there are no moving parts the comparator is mechanically secure against shock, acceleration and vibration. It is a plug-in unit with standard octal mounting and is mechanically interchangeable with mechanical choppers and electron-tube comparators. The unit is 3 in. long, 1 in. in diameter and weighs 2 oz. Operating temperature range is −55 C to +85 C. Maximum signal voltage is 60 v rms; maximum reference voltage, 120 v rms, with a d-c output of ± 50 v when used as a comparator.



TRANSFORMER
for lab, shop and field

ELECTRICAL FACILITIES INC., 4239 Holden St., Oakland 8, Calif. A new Knopp precision multirange current transformer, type P-5000, is offered for high and low-voltage work in the laboratory, shop and field for testing, measuring and calibrating. It has current ranges from 5 to 5,000 amperes. The unit is furnished for a specified secondary burden of 0 to 25 va. For example, with a secondary burden of 15 va, the ratio is well within 0.02 percent and the phase angle is well within 1 minute from 20 percent to 100 percent full-load current. A total of 30 primary ranges is provided. The transformer can

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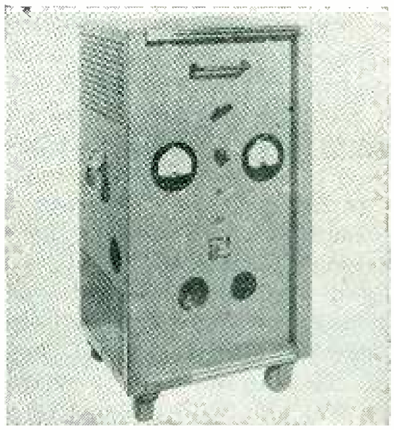
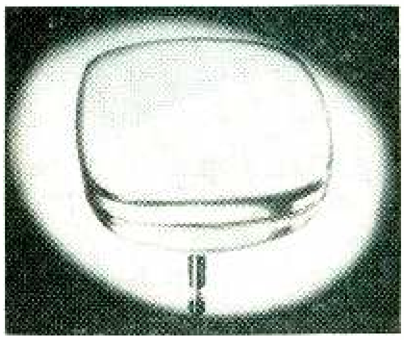
be calibrated in itself without a standard of comparison by means of the Knopp one-to-one method.



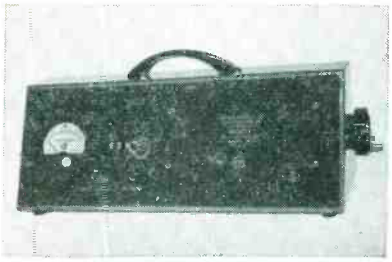
D-C SUPPLY
has many applications

Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn. Nobatron model MA6/15 is a tubeless, regulated d-c supply that uses magnetic-amplifier principles. Intended primarily as an automative test instrument, its high capacity makes it widely useful in a broad range of applications. It delivers 100 amperes at 6 v (adjustable to 7.7 v) or 75 amperes at 12 v (adjustable to 15.4 v). Regulation is ±1 percent against line and load combined.



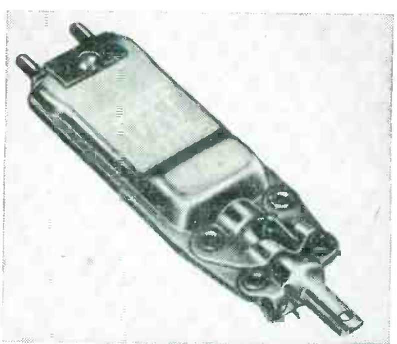
TV TUBES
have filter-glass faceplate

The Rauland Corp., 4245 N. Knox Ave., Chicago, Ill., has announced production of two new c-r tubes for tv application—types 24CP4 and 24CP4A, its aluminized counterpart. They are rectangular, glass, magnetic focus and magnetic deflection direct-view picture tubes. They feature an electron gun that is used with an external single-field ion-trap magnet and an external conductive coating that acts as a filter capacitor when grounded. Another feature of the two new types is a gray, filter-glass faceplate to improve contrast in the presence of ambient light.



SURVEY WAVEMETER has a wide range

THOMPSON PRODUCTS, INC., Electronics Division, 2196 Clarkwood Rd., Cleveland 3, Ohio, has available a compact survey-type wavemeter with the following features: very wide range that eliminates the need for several wavemeters; one setting only required; indication on any easy-reading dial counter; reading of wavelength directly in cm; indication to two decimal places; and provision of an auxiliary meter jack.

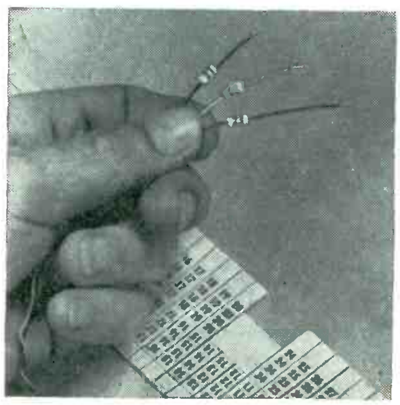


CRYSTAL CARTRIDGE for replacement use

WEBSTER ELECTRIC CO., 1900 Clark St., Racine, Wisc. Model FX is a 2-needle, dual-output crystal cartridge developed for replacement use. It is adaptable to either high or low-output applications by means of a shunting capacitor. Without the capacitor, this cartridge develops 4.4 v at 78 rpm and 2.6 v at 33⅓-45 rpm. With the capacitor, it develops 1.2 v at 78 rpm and 0.6 v at 33⅓-45 rpm. The lightweight unit has a tracking pressure of 8 grams and a cutoff frequency of 3,500 cps.

TEST EQUIPMENT
for microwave application

CUBIC CORP., 2841 Canon St., San Diego 6, Calif. Model 601 standing-wave amplifier, designed as an accurate companion to the slotted line for vswr indications, meets laboratory needs without waste space. It features 8.75 and 4.5-ma bolometer bias at a flick of a switch with vernier adjustment. Bolometer bias is monitored directly on the panel meter. A 0-60 db decade switch and continuous gain adjustment are combined in one concentric control. Sensitivity is 0.3 μv with less than 0.03 μv of noise. Dimensions are 9¼ in. long × 7 in. wide × 8 in. high and weight is 15 lb.

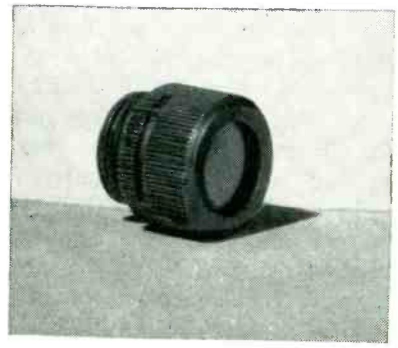


CODING MARKERS
for small gage wire

WESTERN LITHOGRAPH CO., 600 E. Second St., Los Angeles 54, Calif. Designed especially for coding small gage wires on electrical and electronic equipment, small component parts and test equipment, the small markers illustrated eliminate the older, time-consuming method of trimming large markers to size. Only $\frac{3}{4}$ in. long, the markers are center die cut and mounted on a handy pocket-size backing card (2 in. × 10 in.) with easy-to-use speed tabs for quick removal. The backing card contains 68 individual markers. Pressure-sensitive, the markers require only finger-tip pressure to apply, are positive sticking and require no moistening. Made of tough fabric coated with special adhesive material, they resist dirt, moisture and grime. Currently available in over 1,000 codes including ASA and NEMA specifications, the markers can also be made on special order to meet individual coding requirements.

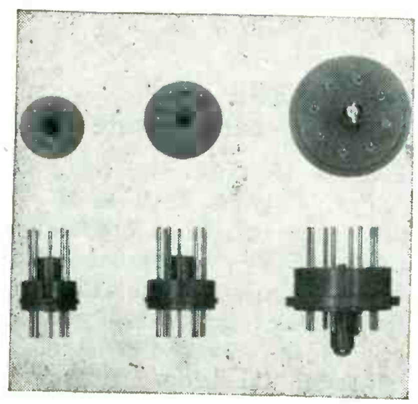
R-F BRIDGE
is ± 1 percent accurate

MARCONI INSTRUMENTS LTD., 23 Beaver St., New York 4, N. Y. Balance and unbalance complex impedances and the impedance between any pair of terminals in a 3-terminal network are easily measured on the Wayne-Kerr bridge, type B601. The bridge employs the tapped-transformer principle and reads directly, with an accuracy of ±1 percent, resistances from 10 ohms to 10 megohms, capacitances from 0.1 $\mu\mu$f to 20,000 $\mu\mu$f, and inductances from 0.5 μh to 0.05 henry, in the frequency range of 15 kc to 5 mc. There are no tubes or power requirements, the bridge being used with external signal generator and detector. Particularly useful in antenna measurements, this instrument has found new application in the transistor and the nonlinear ceramic fields.



PILOT LIGHT DIMMER
for use in control towers

TLG ELECTRIC CORP., 31 W. 27th St., New York 1, N. Y., has designed a polaroid light dimmer assembly specifically for the CAA for use in control towers. The model A-CA-03C utilizes the light polarization principle to give continuous and smooth dimming of the pilot light intensity from full-on to blackout. It mounts in a $\frac{9}{16}$-27 tapped hole as close as $\frac{15}{32}$ between centers; and may be mounted on thin material using a $\frac{9}{16}$-27 mounting nut. It accommodates lamps of the NE-51 and No. 47 size.

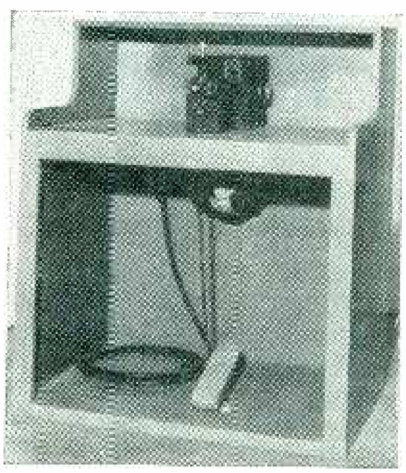


TUBE BASE PLUGS
available in three types

VECTOR ELECTRONIC CO., 3352 San Fernando Road, Los Angeles 65, Calif. Three new plugs are presented which fit the 7 and 9-pin miniature sockets and the 8-pin loctal socket, respectively. Bodies are mica-filled phenolic and may be mounted by means of a center screw or by a retainer ring. These plugs are ideal for small plug-in units, potted circuits or tube adaptation uses. Round cans to slip over the plugs are available.

TV CAMERA KITS
for amateur or professional

KM LABORATORIES, 550 Beverly Road, Teaneck, N. J., have developed a line of tv camera kits for experimental and commercial use. Illustrated is model 2AX, the low-priced type for the experimenter. Other models in the line include wired commercial units with or without electronic view finders. All models can be coupled to home-type receivers through 72-ohm coaxial cable to antenna terminals. Distance between camera and receiver may be up to 2,000 ft without line boosters.



PRECISION WELDER
has 2.5-kva power rating

VACUUM TUBE PRODUCTS, 506 South Cleveland St., Oceanside, Calif., has available a precision spot welder specifically designed to cover a wide range of spot welding requirements. It is intended for use in the assem-

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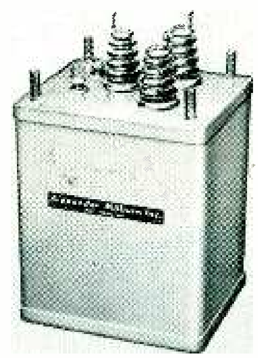
bly of all types of vacuum tubes, precision resistors and in the manufacture of transistors. Power rating is 2.5 kva. Voltage is 220 v (3 wire 110-0-110) and 110 v (low range only). Maximum current is 24 amperes. A catalog sheet is available giving maximum ratings and special features.

TEFLON FILM
in metallized form

DILECTRIX Co., 211-48 Jamaica Ave., Queens Village 28, N. Y., is now metalizing thin cast Teflon film. Using the high-vacuum technique, Teflon films in thicknesses of 0.00025 in., 0.0005 in., 0.001 in. and 0.002 in. have been coated with silver and copper. The material is available in experimental qualities for investigation. Film may be either fully coated or marginally coated. Probable uses include miniature capacitors, shielding and printed circuits.



POWER SUPPLY
with regulated output

ALEXANDER MILBURN, INC., 1241 Ridgely St., Baltimore 30, Md., has introduced a new high-voltage regulated power supply. The unit operates with an input of 100 to 130 v a-c at 50 or 60 cps and supplies an output of 3 kv or 6 kv, well filtered, at a maximum current of 2 ma. Output is regulated for 20-percent line-voltage changes. Any of the output terminals can be grounded, thus the available output combinations are ±3 kv or ±6 kv, centertapped. The unit is contained in a standard MIL-T-27 size MA case, equipped with self-contained stnds for easy mounting. It is designed to withstand military shock and vibration requirements.

D-C MOTOR
of the reversible type

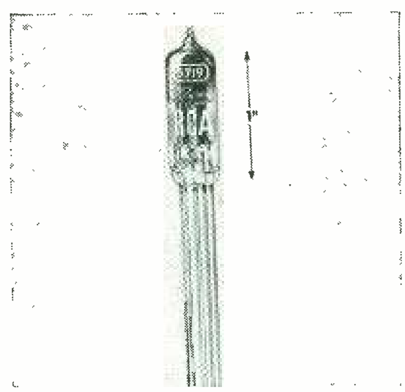
MOTORDYNE, INC., 2661 S. Myrtle Ave., Monrovia, Calif. While the model 1200 continuous-duty reversible d-c motor is being used on an actuator for aircraft, it may be built to meet other specific requirements. Features of this model include ambient temperature from —55 C to +105 C. Size is 1.25 in. in diameter and 2.18 in. long. It works off 18 to 30 v with or without brake, and weighs 5.3 oz without brake. Complete technical data are available on request.

STABILIZED CRYSTAL
for 500 to 1,500-kc range

JAMES KNIGHTS CO., Sandwich, Ill. The JK G-12 stabilized crystal is specially designed to handle applications in the difficult 500 kc to 1,500-kc range. It provides ultra-stable frequency control for applications such as frequency standards, timing and counting circuits, broadcast equipment and frequency monitors. Electrodes are deposited directly on the large, precision-made quartz plate, shock mounted in an evacuated glass envelope. The crystal may be designed for a minimum temperature coefficient from O C to 50 C or for temperature controlled operation at 60 C with a JKO7E 115-v oven. The unit is 2¾ in. in height above chassis, and maximum diameter of octal base is 1¾ in.

WALL HORN
has built-in corner

BROCINER ELECTRONICS LABORATORY, 344 E. 32nd St., New York 16, N. Y., has designed the model 4W wall horn. This loudspeaker has in effect a built-in corner without requiring corner placement. It is powered by a twin-cone driver unit designed especially for horn loading over the entire audible range. The middle range and treble frequencies are dispersed uniformly by a newly-designed reflector horn. For the bass range, the back of the driver unit is coupled to the air by means of two folded horns with openings at the sides of the cabinet.

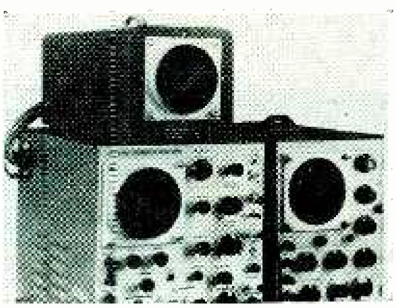


HIGH-MU TRIODE
features compact structure

RADIO CORP. OF AMERICA, Harrison, N. J. The 5719 is a premium high-mu triode of the subminiature type, with flexible leads, for use primarily as an audio amplifier in mobile and aircraft receivers where dependable performance under shock and vibration is important. In audio service as a resistance-coupled amplifier, it is capable of providing high voltage gain. Featured is a compact structure designed to resist shock and vibration and to reduce microphonic output. A pure-tungsten heater is used to give long life under conditions of frequent on-off switching.

RESISTORS
have one-piece molded case

ERIE RESISTOR CORP., Erie, Pa., is in production on $\frac{1}{2}$-w deposited-carbon precision resistors in values from 100 ohms to 0.5 megohm. Standard tolerances are 1 percent, 2 percent and 5 percent. A distinctive feature of the style 155 stable pyrolytic resistor is the one-piece molded case. The thermosetting molded insulation protects against humidity and also gives assurance against mechanical damage to the carbon film. Actual size of the resistor is $\frac{13}{32}$ in. long $\times$ $\frac{3}{16}$ in. diameter, and leads are axial No. 20 tinned copper wire. Sold under the trade name "Hi-Stab", the style 155 resistors meet test requirements of MIL-R-10509A.



CONVERSION UNIT
for wide-band operation

COMPUTER CONTROL CO., 106 Concord Ave., Belmont 78, Mass., has developed a wide-band dual-beam conversion unit. Model 3CT1 converter is usable with Tektronix models 511, 512 and 514 without any loss in oscilloscope operating features. The oscilloscopes can be used individually or with the converter as needed. Initial conversion is accomplished by replacing the deflection-plate terminal boards of the oscilloscope with new plug-type terminal boards. Rewiring consists of changing 14 solder connections. The converter can be used by simply plugging it in when needed. Unplugging returns the oscilloscopes to normal single-beam operation. For dual-beam opera-

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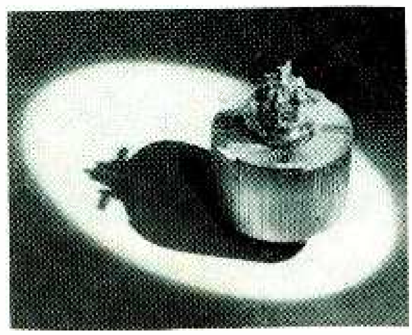
tion, jumpers between proper front terminal posts of the two oscilloscopes permit several modes of dual sweeping.

AIRCRAFT UNITS are glass-to-metal sealed

MARION ELECTRICAL INSTRUMENT Co., Manchester, N. H., has announced a series of improved multi-element aircraft instruments. The series consists of single seal glass-to-metal hermetically sealed aircraft types that incorporate the ruggedized D'Arsonval movements and a unique columnar construction that provides greater rigidity and more precise alignment of the elements. They are available as 2-element, 3-element and 4-element types. Applications include: ammeters, voltmeters, radio navigational types (such as omnirange and ILS), temperature indicators and others. The instruments meet AND 10401 dimensional requirements for 2⅝-in. dial instruments.



HEAVY-DUTY TRIODE is forced-air-cooled

MACHLETT LABORATORIES, INC., Springdale, Conn., announces the ML-5531, a forced-air-cooled, heavy-duty triode for industrial and broadcast use. Operating at frequencies up to 30 mc, it meets the need for a single-tube oscillator in 15-kw output electronic-heater service and a single-tube final-stage amplifier in 10-kw a-m broadcast service. Maximum ratings include 30-kw plate input, 10-kw plate dissipation. Filament operates at 6.3 v, 92 amperes. Incorporating a heavy-wall anode, stress-free, self-supporting thoriated tungsten filament, sturdy electrode mountings

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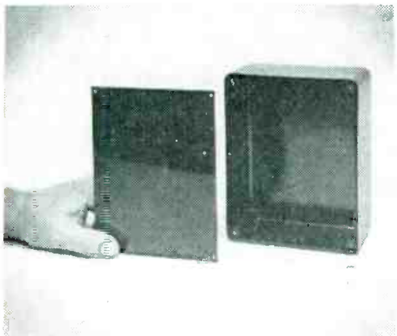
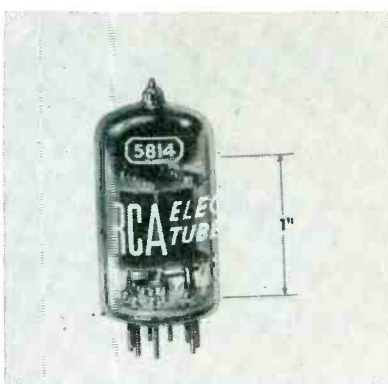
and kovar seals, it will provide long, low-cost operation under rigorous conditions.



BAKELITE CASES
for instrument protection

INSULINE CORP. OF AMERICA, 3602 35th Ave., Long Island City 1, N. Y., has available two new Bakelite cases designed for electronic instruments requiring high insulation protection. The No. 8201 measures 6¼ in. × 3¾ in. × 2 in. high, and the No. 8202 measures 6¾ in. × 5¼ in. × 2⅜ in. high. The cases are molded in one piece, have threaded brass corner inserts, and are provided with accurately fitted ⅛-in. blank Bakelite panels.



TWIN TRIODE
is 9-pin miniature type

RADIO CORP. OF AMERICA, Harrison, N. J. The 5814 is a premium medium-mu twin triode of the 9-pin miniature type for use in many different applications including mixers, oscillators, multivibrators, synchronizing amplifiers, and numerous industrial-control devices where dependable performance under shock and vibration is a major consideration. It has electrical characteristics similar to those of the 12AU7 but differs in having higher heater current and a lower heater-cathode voltage rating. It utilizes a compact structure designed to resist shock and vibration, a pure-tungsten heater to give long life under conditions of frequent on-off switching, a mid-tapped heater to permit operation from either a 6.3-v or a 12.6-v supply, and separate terminals for each cathode to provide flexibility of circuit arrangement.

Literature

Electric Test Equipment. Industrial Instruments Inc., 89 Commerce Rd., Cedar Grove, N. J. Catalog 19A is a 12-page booklet listing electrical test equipment to meet most test needs in both the laboratory and on the production line. Among the items described and illustrated are megohm meters, voltage testers, test fixtures, variable h-v a-c breakdown testers, capacitance and resistance limit bridges, resistance and capacitance decades, Wheatstone bridges and Kelvin bridges. Also included are ordering data and prices.

Ribbon Pickup. Ferranti Electric Inc., 30 Rockefeller Plaza, New York 20, N. Y. A recent 4-page bulletin covers the company's new ribbon pickup. Pickup head and arm are illustrated and described. The elliptical stylus is discussed and output characteristics are given. Chief design features and specifications are outlined.

Community Antenna System. Radio Corp. of America, Camden, N. J. A 4-page folder, form 2R8612, describes and illustrates the company's community Antenaplex system designed to help those living in fringe areas. It tells how a single antenna mast, high on a nearby mountain top in the case of rugged terrain, or a tower rising high above flat terrain, supports the antenna array, while especially developed antenna amplifier, converter, line amplifiers and cable permit multichannel program distribution. Here is the story of a few of the many progressive modern communities that have adopted the community Antenaplex to improve local tv reception.

Hydraulic-Magnetic Overload Relay. Heinemann Electric Co., 307 Plum St., Trenton 2, N. J. Complete engineering data, model specifications and information on application of Silic-O-Netic overload relays is provided in bulletin 5101A. The bulletin includes a complete description of the hydraulic-magnetic operating principle and shows the principle in graphic form along with outlined data on the hermetically sealed time element. Also shown is a time vs percent load curve giving definite response points for various size overloads. General dimensions and specifications of all models are given, and details of a typical application in protecting a three-phase air-conditioning compressor motor are provided to illustrate circuitry.

Capacitor Catalog. F. W. Sickles Division, General Instrument Corp., Chicopee, Mass. Catalog AT-53 is a 12-page compilation of specifications and data on air-dielectric trimmer capacitors. It announces a completely approved source for JAN-C-92 trimmer capacitors plus many other types with a variety of choices in mechanical assembly details.

Tantalum Capacitors. Fansteel Metallurgical Corp., N. Chicago, Ill. Bulletin 6.100-1 describes a new series of tantalum capacitors of the porous tantalum electrode type, intended for applications where premium capacitor performance is essential. The bulletin lists 3 physical sizes of capacitors in a variety of capacity and working voltage ratings, ranging from 325 μf at 6 v d-c to 25 μf at 125 v d-c. Curves illustrating typical temperature characteristics (capacity and equivalent series resistance vs temperature) are shown.

Analog Computing Devices. George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass. A new catalog covers the latest de-

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velopments, new components and prices of the complete GAP/R assemblage. Of special interest is the inclusion of the new operational manifold, model HK, which, utilizing the versatile K2-W, gives the user a true table-top computer.

Recording Potentiometer. Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J., offers a new booklet that fully illustrates and describes all features of its simplified recording potentiometer. The instrument described is of completely new design with all parts interchangeable, with a universal slide wire that never needs changing, and which permits chart speeds to be changed on-the-line by a simple screwdriver adjustment.

Electrical Control Components. Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill., has introduced a complete, comprehensive catalog illustrating telephone-type components for industrial use. It is a helpful guide to engineers and purchasers. Illustrated with scores of photographs and diagrams, it contains specifications and general data on key switches, impulsing devices, switchboard lamps, jacks and caps and other control devices. Specification tables are designed for easy ordering.

Permanent Magnets. Carboloy Dept. of General Electric Co., Detroit 32, Mich. Latest information on the uses, design, properties and manufacture of Alnico permanent magnets, cast grade 7, is available in the 4-page technical report PM-112. In addition to graphs and tables explaining magnetic and physical characteristics of the magnets, the report includes a detailed discussion of design considerations, test information and a general comparison of cast grade 7 with other magnetic materials.

Comparators. Apparecchi Elettronici Marposs, Via Artieri 2, Bologna, Italy. A 4-page folder illustrates and describes a line of electronic comparators for cylindrical grinding machines designed for measuring internal and external diameters and for measuring bearing races. General and con-

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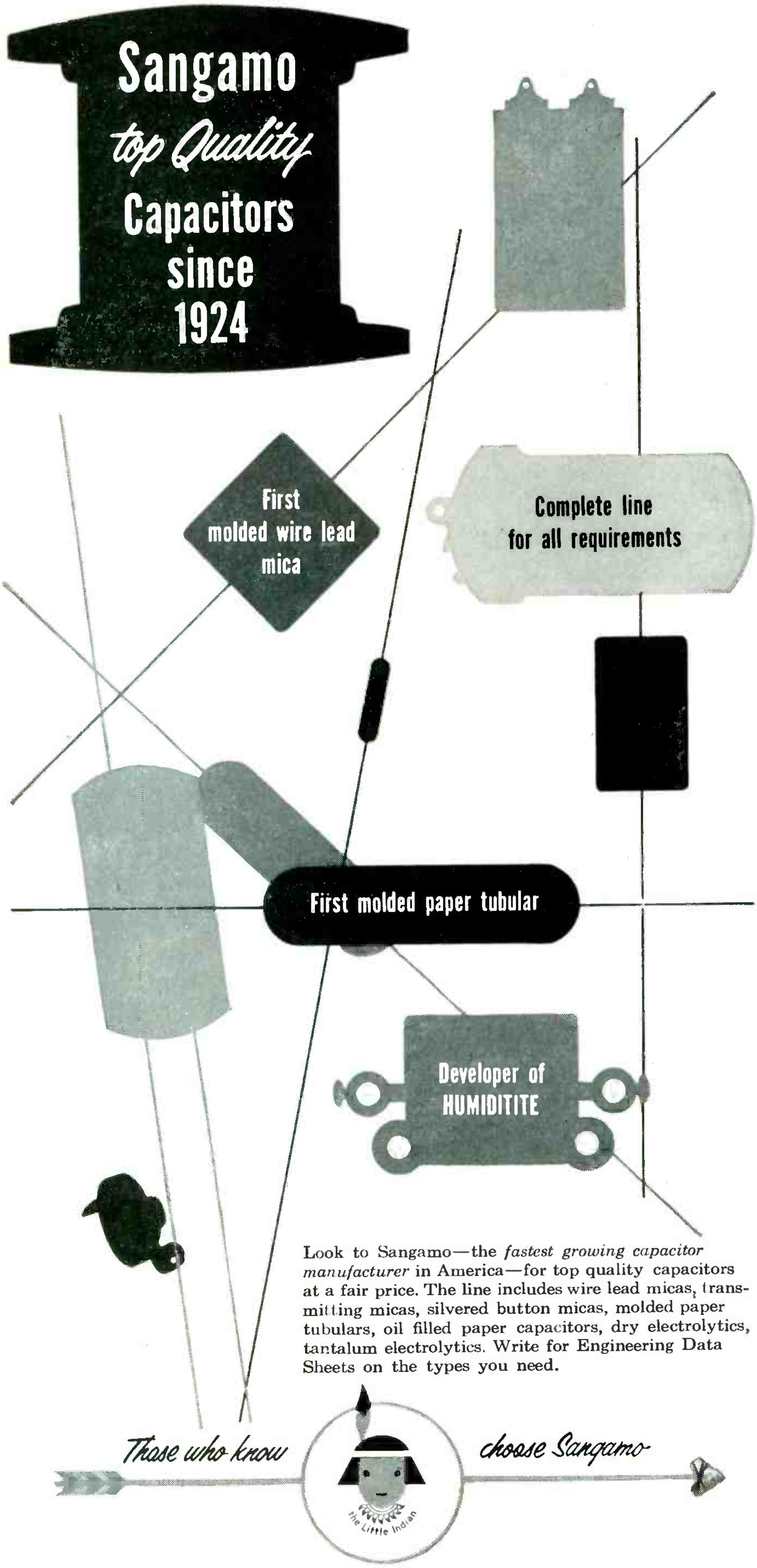

sructional characteristics are included. Also given is a list of advantages, such as reduction of tolerances, reduction of cost and elimination of rejects.

Plastic Components. Tri-Point Mfg. & Developing Co., 401 Grand St., Brooklyn 11, N. Y. A recent folder contains illustrated descriptions of a line of precision-machined plastic components. Among the line covered are Teflon, Kel-F, Nylon, laminated phenolics, Formica, Rexolite, polyethylene and polystyrene. The bulletin points out that the company is engaged in producing vast quantities of precision plastic parts for aircraft, instrument, radio, tv and various electronic manufacturers. Tolerances of 0.0005 are held on production runs. On experimental work any tolerance can be held that may be required.

Selenium Rectifier Stacks. General Electric Co., Schenectady 5, N. Y., has published a new bulletin on miniature selenium rectifier stacks for electronic circuit applications. The illustrated, 4-page publication, GEA-5935, contains data on the applications, construction features, and electrical characteristics of the small selenium rectifiers. Included are tables of ratings and dimensions, plus graphs on the effect of temperature and life expectancy of the various types of stacks.

Magnetic Recording. Minnesota Mining and Mfg. Co., 900 Fauquier St., St. Paul 6, Minn. Low-frequency problems in magnetic recording is the subject of "Sound Talk" bulletin No. 25. The technical bulletin discusses problems encountered in special recorders for instrumentation, geophysical work and medical uses, where low frequencies are involved, and points out how the problems can be overcome.

Audio Amplifier. Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa., has available bulletin DB85-950, describing the type FG5, or 10 kw, variable-frequency audio amplifier. Applications of the amplifier are suggested. The unit described will amplify 30 to 10,000-cycle signals as much as a for lacings that stay put!

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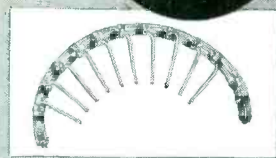

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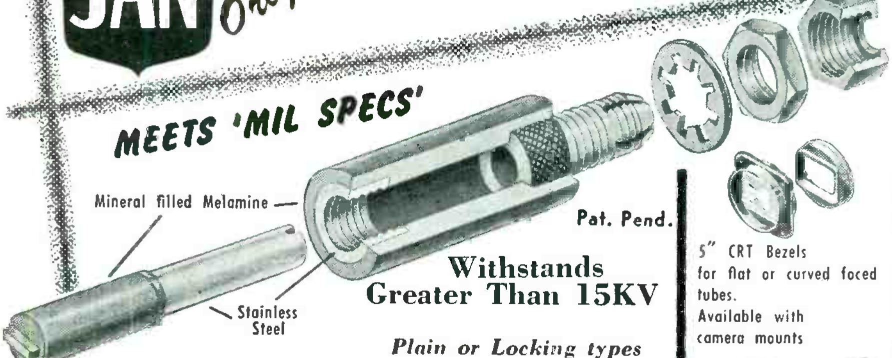

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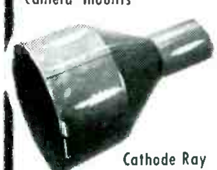
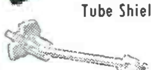


Cathode Ray Tube Shields



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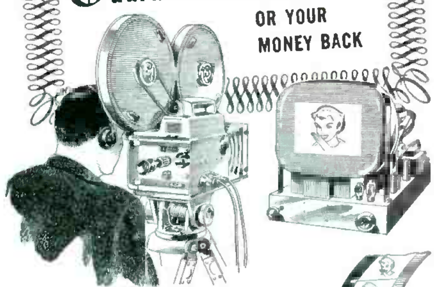

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million times. Design and construction features of the equipment are discussed, and operation is described. Complete electrical characteristics of the amplifier are included.

Electronic Components. Herman H. Smith, Inc., 2326 Nostrand Ave., Brooklyn 10, N. Y., has published a 20-page catalog giving a very comprehensive presentation of plugs, jacks and connectors. Also described is a full line of those small, inexpensive, yet hard-to-find though essential components and accessories. An index and prices are included.

Product Research. Arthur D. Little, Inc., 30 Memorial Drive, Cambridge 42, Mass., has available a new brochure "Product Research" (bulletin A) dealing with the development of a new product, improvement of an established product or the method of producing it, discovering new uses for it or a better raw material for it. Included are a few common product problems and a listing of some types of products improved or developed in part or entirely by the company.

Electronic Control Booklet. Photoswitch Inc., 77 Broadway, Cambridge 42, Mass., has published a completely revised edition of the handbook entitled "Cutting Production Costs with Electronic Controls." Purpose of the book is to help manufacturers find the many ways that their operations can profit by the use of electronic and photoelectric controls. It presents 46 case studies of industrial control problems and explains, in terms that can be understood by everyone, how they were solved through the use of electronics. An index lists applications both alphabetically and by industries. Line drawings illustrate nearly every application described.

Parts Catalog. Newark Electric Co., 223 W. Madison St., Chicago 6. Ill., has available a comprehensive parts catalog containing the newest in electronics. This 196-page book contains thousands of items for industry laboratories, high-fidelity, radio and television. Whole sections are devoted to test

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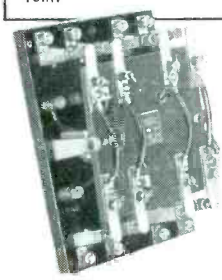

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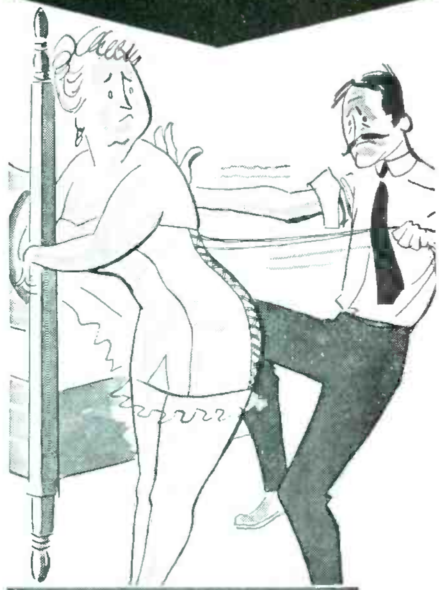

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Miniature Multitester. International Instruments, Inc., P. O. Box 2954, New Haven 15, Conn. A recent data sheet gives information on a miniature multitester combination volt-ohm meter for testing resistances and a-c or d-c voltages. The tester described is only $4\frac{1}{4}$ in. × 3 in. × $1\frac{1}{2}$ in. and weighs 12 oz. It has 4 d-c voltage ranges reading to 300 v, 4 a-c voltage ranges reading to 600 v and 4 resistance ranges reading to 2,000,000 ohms, all selected from the front with rotary switch. The unit is illustrated and a technical description and specifications are included.

Component Shock Machine. The Barry Corp., 807 Pleasant St., Watertown 72, Mass. Product bulletin 535 presents complete technical and performance data on the type 20VI component shock machine. The unit described is specifically designed for use in developing and qualification-testing equipment components that must withstand shock of the severity experienced in military service. Carrying loads up to 20 lb, it produces calibrated shock tests to a maximum peak acceleration of 210 g. The bulletin gives detailed dimensions, construction features, operation and installation instructions, and calibrated performance curves for use in testing work.

Microphones and Acoustic Devices. Shure Brothers, Inc., 225 West Huron St., Chicago 10, Ill. Catalog 44A covers microphones; microphone parts and accessories; phono cartridges and pickups; and wire and tape recording heads. It lists replacement information on phono cartridges, communications microphones and magnetic recording heads. Included is a listing of

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company representatives for the convenience of manufacturers and distributors.

Refrigeration Testing Units. Bowser Technical Refrigeration, Terryville, Conn. A recently issued 4-page bulletin illustrates and describes the company's line of research and testing units. Standard units described have test spaces ranging from 4 to 36 cu ft and an operating range of + 185 F to — 80 F. All models discussed are of the self-contained type, ready for plug-in operation, and are available with humidity feature.

Electronic Recorder Data. Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Philadelphia 33, Pa. An informative 8-page technical data bulletin covering the Tektolog electronic recorder has been prepared. Tektolog features of simplified design, accuracy to ± 1 percent of full scale, and self-starting operation from low-energy sources are fully described.

TV Accessories. United Technical Laboratories, Morristown, N. J., has published an informative, illustrated bulletin describing eight new television accessory products. Items described include a new tv interference filter, uhf-vhf crossover network, two-receiver tv coupler, a calibrated variable inductance kit and new Klipzons for panel mounting. Also included are alligator-clip adapters and banana-plug adapters.

Complex Plane Analyzer. Technology Instrument Corp., 531 Main St., Acton, Mass., has available a 6-page bulletin on its type 250-A complex plane analyzer, a computer for network analysis and control system design. A detailed description of the instrument's theory and operation is included in the bulletin, along with lists of specifications and features.

Side-Register Control Systems. General Electric Co., Schenectady 5, N. Y. Photoelectric side-register control systems, how they operate and what they do, are described in a 2-color, 8-page bulletin. Designated as GEA-5947, the publication explains the two-point and

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proportional register systems that are used on slitting, rewinding, side-trimming and printing operations. Operational drawings show the various uses and features of the two-point (for moderate speed runs) and proportional (for high-speed high-accuracy register control systems. Component parts and various installations are photographically presented.

High-Current Test Instrument. Multi-Amp Corp., Harrison, N. J., has available a 4-page catalog describing 6 different models of a portable high-current test instrument. Instruments shown include the standard models 1010 (1 kva) and 1005 (2.5 kva), as well as models with built-in ammeter and built-in electronically actuated electric stop timer. The illustrated catalog 953 gives specifications, application data and prices on a testing instrument that permits economical and safe checking and calibrating of current-actuated devices such as: motor starter overload relays, current transformers, circuit breakers, reclosers, sectionalizers, fuse links and meters.

Growth of Electronics Industry. Radio - Electronics - Television Manufacturers Association, 777 14th St., N. W., Washington 5, D. C. The exciting development of the electronics industry from Benjamin Franklin's kite flying days to the present age of electronically-controlled rockets is vividly portrayed in a new booklet, "The Kite and the Key." Designed primarily for school and classroom use, the booklet briefly traces the history of the industry and explains in nontechnical language the workings of radio and tv.

Electrical Measuring Instruments. Gray Instrument Co., 64 W. Johnson St., Philadelphia, Pa. Catalog E-16 is presented as a permanent file of information on instruments for measurement of electrical characteristics to the precision required in modern laboratories and industrial plants. In the first section are shown resistance standards and resistance measuring apparatus. Additional leaves describing the company's potentiometers and accessory apparatus will

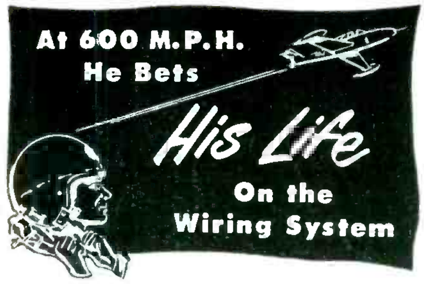
be issued in the near future and can be added to the catalog as received.

Automatic Bridge-Balance and Calibrating Unit. B & F Instruments, Inc., 4732 N. Broad St., Philadelphia 41, Pa., has available a single-sheet bulletin illustrating and describing an automatic bridge-balance and calibrating unit (model 21-200) that matches any strain gage or resistance pickup to any oscillograph galvanometer. The unit described provides the direct recording of strains, loads, accelerations, forces and pressures. A single-channel schematic drawing is included.

Modernizing Materials Handling. General Electric Co., Syracuse, N. Y., has published a 6-page illustrated booklet discussing the application of two-way radio in the materials-handling field. The booklet relates the proven manners by which two-way radio can cut costs, improve efficiency and increase production when applied in this field. The publication includes average costs of equipment installations and a resumé of FCC licensing regulations. Also included is a list of 28 GE offices throughout the country, from which communications advisory service is now available to provide answers to specific application problems.

Servo Systems and Components. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Instrumentation data sheet 10.20-3a describes Brown amplifiers, converters and motors, adaptable to a wide variety of servo loops and electromechanical systems. Applications, specifications and amplifier input vs motor speed tables are included; in addition to motor dimension data and table of typical servo component combinations.

Coil Bulletin. Aerocoil, Inc., 24 Cliff St., Jersey City, N. J. A recent 4-page bulletin discusses the design and manufacture of coils. Included are listings of cores on which coils are produced and a full line of products. Typical coils illustrated include r-f coils, r-f chokes, delay lines, toroids, coils,



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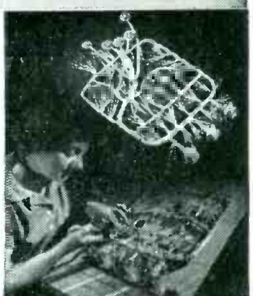

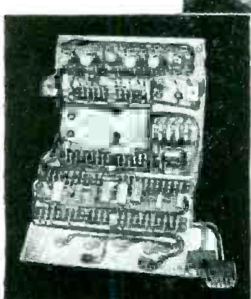

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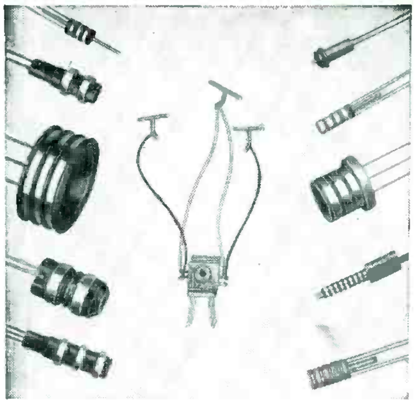

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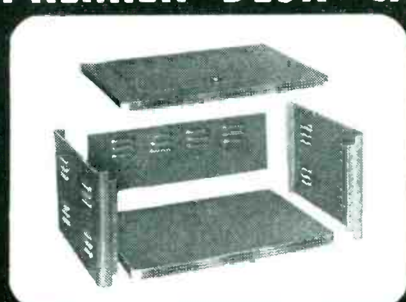

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★ They're available in Standard and Super Deluxe models.
★ When assembled, bolts are invisible and the racks cannot be distinguished from the welded models.
★ Available in 10 different sizes for each model.

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filters, custom coils, transformers and noise suppressors.

Instruments for Modern Measurements. Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio. A 34-page book illustrates and describes over 37 different instruments especially engineered and produced for: electrical measurements, physical measurements, resistance-welding measurements, textile measurements, ultrasonic energy applications and electro-acoustical measurements. Several new instruments are included as well as improved models. The book is of special interest to research engineers, methods and production engineers, factory superintendents and other production and research executives.

Keys and Switches. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. A new 12-page catalog gives complete information about keys and switches for use in industrial or laboratory applications. It describes how the keys and switches are being used to connect into low-voltage circuit thermocouples, Thermohm or Rayotube detectors, conductivity cells, batteries, galvanometers, or other two or three-lead elements. Included are photos and line drawings illustrating the design features of the keys and switches. To facilitate selection of switches, necessary dimensions and mounting directions are given. For each reference, all specifications are arranged in tables.

Snap-Action Plate-Circuit Relay. Thermo Instruments Co., 1310 Old County Rd., Belmont, Calif. A new relay having sharp single-impulse opening and closing, and thus primarily applicable to plate-circuit application, especially with thyratrons, is described in a new leaflet, Form C-1-753. The new unit, designated as the type C relay, is illustrated and described as a rugged-service device incorporating a snap-action switch with contacts suitable for highly-inductive loads. Data are included on overall dimensions, weight, frame type, armature, core, coil, power requirements, release value, contact rating, contact arrangement and mounting.

Want more information? Use post card on last page.

PLANTS AND PEOPLE

Edited by WILLIAM G. ARNOLD

OTHER DEPARTMENTS
featured for this issue:

Audio Society Honors Eight Engineers

THE Audio Engineering Society bestowed three awards for achievement, an honorary membership and four fellowships at its annual banquet held in conjunction with its Fifth Annual Convention.

The Society's John H. Potts Award for outstanding achievement in audio engineering was given to Edward W. Kellogg. Among Dr. Kellogg's major achievements is his role in the development of the Rice-Kellogg dynamic loudspeaker. He joined RCA in 1930 and on his retirement from active service in 1948 was in charge of advanced development engineering in the engineering products department of RCA Victor. Immediately upon retirement, he was appointed consulting engineer to the department, a post he held until recently.

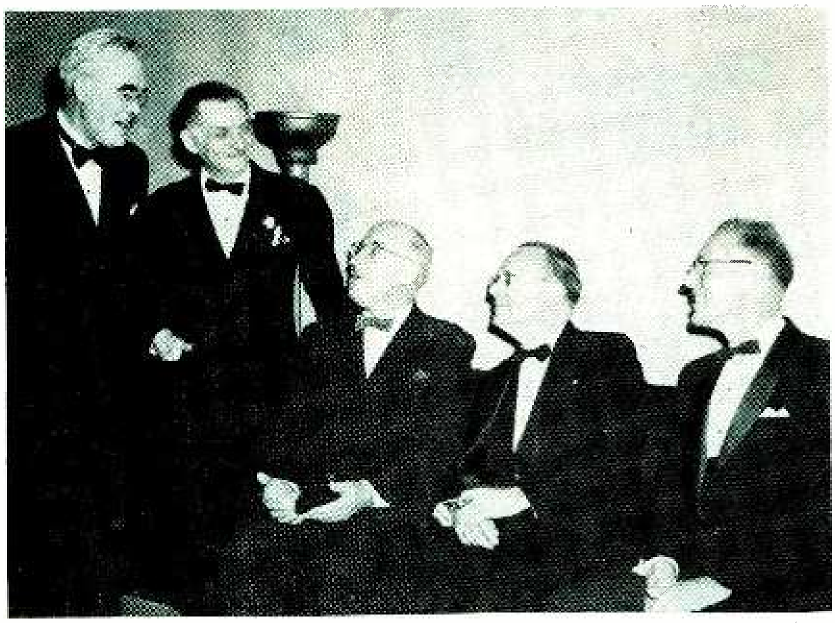
The Emile Berliner Award was given to Henry C. Harrison "in recognition of his outstanding inventions and developments in audio engineering; for his application of transmission line principles in loudspeakers and the lateral, rubber line recorder used in making the first and many subsequent electrically cut records for phonograph and talking move applications; and for his contributions to carbon-button microphones, the orthophonic victrola, wire-spring relays and a multi-reed elective signalling system used in mobile radio."

The Society gave an honorary membership to Edward C. Wente in recognition of his achievements in audio engineering. Dr. Wente has been engaged for nearly forty years in technical research and his inventions have related, for the most part, to acoustics and acoustical instruments, with special reference to their application to the transmission, recording and reproduction of speech and music. One of his early developments is the condenser microphone.

The Audio Engineering Society Award for service to the Society was bestowed this year upon C. G. McProud, editor and publisher of "Audio Engineering."

Four fellowships were awarded by the Society for outstanding work in the audio engineering field. The recipients were: Howard A. Chinn of CBS, C. J. LeBel of Audio Devices and Audio Instrument, Chester A. Rackey of NBC and H. E. Roys of RCA Victor.

Engineers Attend SMPTE Convention



Television and motion picture engineers in attendance at the 74th semiannual convention of the SMPTE in New York City included, left to right: Axel G. Jensen of Bell Labs, John B. McCullough of the Motion Picture Association of America, Raymond Guy of NBC, Loren L. Ryder of Paramount Pictures and Russell O. Drew of RCA Victor

Magnetic Recording Association Formed

OFFICIAL organization of the Magnetic Recording Industry Association was announced by its newly elected president, Joseph R. Hards, vice-president of A-V Tape Libraries of New York.

In addition to Hards, other officers elected by 19 members of the group are: Russell Tinkham of Ampex, vice-president; Herman Kornbrodt of Audio Devices, secretary and Victor Machin of Shure Brothers, treasurer. The board of directors will include the four officers and Paul Jansen of Minnesota Mining

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CONSIDER THESE STAR POINTS :—
The ' Magidisk,' a unique and exclusive feature of the Monarch, is something different in radiogram engineering. By its ability to select any record of any size inter-mixed in any order, the 'Magidisk' gives a long continuous record programme at 33⅓, 45 or 75 r.p.m.
Quick Change. No other changer can match the Monarch's speedy record change. So swiftly and so effortlessly is this accomplished, that there is no distracting interruption to mar enjoyment.
Tonal Purity is emphasized by the dual stylus cartridge which attains a new high fidelity performance.
Control is as central and simple as the reliability is permanent.
Census of Opinion shows that leading radiogram manufacturers automatically insist on the Monarch because it is the finest auto-changer manufactured.

MONARCH
BSR
BRITISH MADE
THREE SPEED RECORD CHANGER

BSR

WORLD'S MOST WANTED AUTOCHANGER

BIRMINGHAM SOUND REPRODUCERS LTD., OLD HILL, STAFFS, ENGLAND

and Everett Olson of Webster-Chicago.

"With magnetic recording now a $100,000,000 industry, there is a need for a representative and lasting group to exchange ideas and information among its members and with the public, and to promote good relations between the industry, government, the public and business concerned with magnetic recording," said president Hards, who is largely responsible for organizing the new group.

"In the next two or three years," he stated, "all indications point to consumer use of tape on a scale comparable to the current market for phonographs in the home. This fact further points up the need for the Magnetic Recording Industry Association."

Hards stated that within 30 days a total of 35 companies are expected to be official members of the group.

RETMA Committee Chairman Named

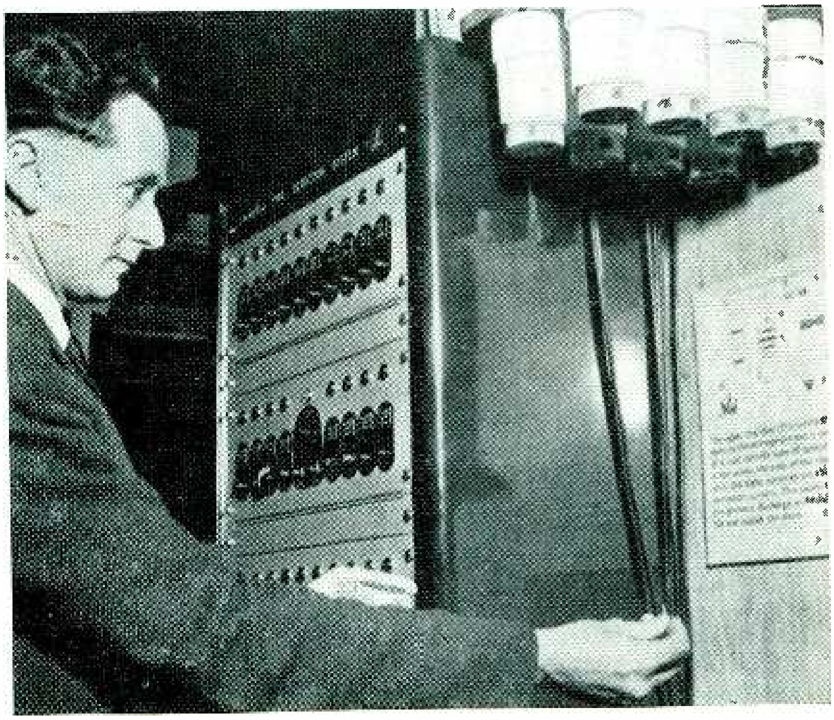
ROBERT C. SPRAGUE, chairman of the board of directors of RETMA, named RETMA directors H. J. Hoffman and J. J. Kahn as co-chairmen of the Association's membership promotion committee.

Chairman Robert S. Alexander of RETMA's set division reappointed J. B. Elliott as chairman of the Association's sports committee for the coming year. The group directs RETMA activities in the promotion of cooperation and goodwill between the sports and radio-tv industries.

Dan D. Halpin, general sales manager of DuMont's tv receiver sales division, was appointed chairman of RETMA's sales managers committee, succeeding William K. Dunn who resigned the chairmanship when he transferred to a company outside the set manufacturing industry.

In other actions, RETMA's engineering department moved its New York office to larger quarters at 500 Fifth Avenue. The move was made necessary, according to W. R. G. Baker, RETMA engineering director, by the ever-growing scope of the department's activities and its recently enlarged staff under the supervision of RETMA chief engineer, Ralph R. Batcher.

1,000-YEAR FIRE DETECTORS



British device now in use by the Admiralty detects fires by means of small cells containing radioactive material. Each cell will protect from 20 to 50 yards of floor space. Its guaranteed life is 1,000 years. The least trace of smoke triggers an electrical bridge circuit containing a special cold-cathode tube that pulls in a relay to ring the alarm

GE Electronics Division Forms Two Departments

ESTABLISHMENT of a commercial equipment department and a laboratories department in GE's electronics division was announced by W.R.G. Baker, vice-president and general manager.

The new commercial department will concentrate on monochrome and color tv station equipment, industrial radio and microwave communications and germanium products. According to Dr. Baker, recent and projected growth of GE's electronics business in the various commercial areas now requires concentration in these fields. With the new unit, the division now has five product departments, the others being the tube, radio and tv, government and components departments.

The new laboratories department will comprise the electronics laboratory at Syracuse, N. Y. and the advanced electronics center at Cornell University. Together they employ nearly 500 persons, including 300 engineers and scientists. The electronics lab is engaged in advanced development and investigation in civilian and military electronics including such projects as transistors, radar, color tv, computers, video tape recording and automatic assembly machines. The advanced center at Cornell is currently engaged in numerous studies of the application of complex electronics systems.

William J. Morlock has been named general manager of the new commercial equipment department. He joined GE in 1948 and served in several executive engineering positions until June, 1950, when he was appointed assistant manager of the commercial and government equipment department. He was named general manager for commercial equipment activities of the department in 1951. Prior to joining GE, Morlock was with the U. S. Navy and other government agencies. For several years before the war he was manager of distributive products for RCA.

Brig. Gen. Tom C. Rives (Ret.) has been appointed manager of the new laboratories department. He

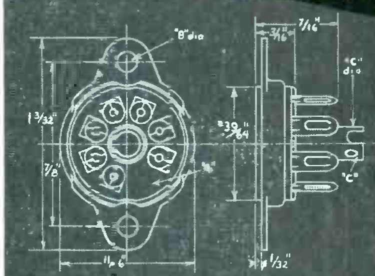
MINIATURE TUBE SOCKETS FOR *UHF Applications*

Methode design and tooling, completed well in advance of the thaw in commercial ultra-high frequency station allocations, makes available miniature sockets especially designed to minimize inductance and capacity in tuner and converter tube applications. Miniaturization of contacts and insulator permits 50% reduction in distance between lead terminations and tube seal.

Available with several types of standard mountings, superior performance in these precision products is assured by METHODE'S high production experience in their manufacture.

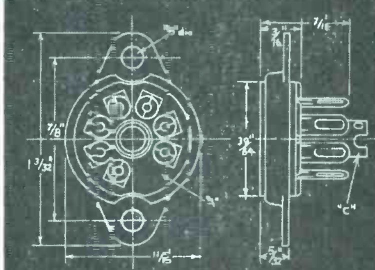
Sub-Panel Saddle

PART NO.	"A" INSULATOR MATERIAL	"B" MOUNTING HOLES	"C" CENTER SHIELD
SMU-153-093	Mica-Phenolic	3/32"	
SMU-153-125	Mica-Phenolic	1/8"	
SMU-154-093S	Mica-Phenolic	3/32"	1/8"D x 3/8"L
SMU-154-125S	Mica-Phenolic	1/8"	1/8"D x 3/8"L



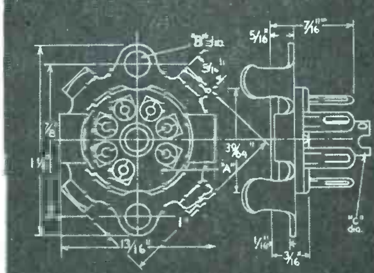
Top Panel Saddle

PART NO.	"A" INSULATOR MATERIAL	"B" MOUNTING HOLES	"C" CENTER SHIELD
SMU-155-093	Mica-Phenolic	3/32"	
SMU-155-125	Mica-Phenolic	1/8"	
SMU-156-093	Mica-Phenolic	3/32"	1/8"D x 3/8"L
SMU-156-125S	Mica-Phenolic	1/8"	1/8"D x 3/8"L



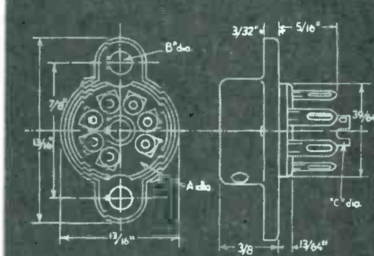
Top Panel Mount "Snap-In" Shield Base

PART NO.	"A" INSULATOR MATERIAL	"B" MOUNTING HOLES	"C" CENTER SHIELD
SMU-185-093	Mica-Phenolic	3/32"	
SMU-185-125	Mica-Phenolic	1/8"	
SMU-186-093S	Mica-Phenolic	3/32"	1/8"D x 3/8"L
SMU-186-125S	Mica-Phenolic	1/8"	1/8"D x 3/8"L



Top Panel Mount "Twist-On" Shield Base

PART NO.	"A" INSULATOR MATERIAL	"B" MOUNTING HOLES	"C" CENTER SHIELD
SMU-175-093	Mica-Phenolic	3/32"	
SMU-175-125	Mica-Phenolic	1/8"	
SMU-176-093S	Mica-Phenolic	3/32"	1/8"D x 3/8"L
SMU-176-125S	Mica-Phenolic	1/8"	1/8"D x 3/8"L



Material Specifications:

Insulators are mica-filled phenolic (type MFE). Contacts are low resistance copper base alloy with cadmium finish (silver if specified). Mounting saddles and bases are cadmium plated steel.

NOVAL SOCKETS SIMILAR TO THE ABOVE ARE ALSO AVAILABLE

METHODE Manufacturing Co.
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Production capacity on this new product is being rapidly increased to meet industry demand

William J. Morlock

joined GE in 1950 and has been manager of technical military liaison. He retired from military duty in 1949 after more than 31-years service. During World War II, he served as chief of several divisions in the office of the Chief Signal Officer and was a deputy air communications officer for the Air Force. He served from 1945 to 1949 as chief of the electronics subdivision in the Air Material Command at Wright-Patterson Air Force Base. Upon his retirement in 1949, he joined the University of Illinois as a special research associate professor.

The newly formed commercial equipment department has been organized into three functional units and Morlock has appointed general managers for the three product organizations.

Paul L. Chamberlain, who joined GE in 1942 and was manager of marketing for commercial products of the former commercial and government equipment department, was named general manager for broadcast equipment. This product line includes transmitters, antennas and studio gear for radio and tv stations.

H. Brainard Fancher, who joined GE in 1936 and was previously manager of engineering for commercial products of the former commercial products and government equipment department, was appointed general manager of germanium products. These include germanium diodes,

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Type No.	Capacitance μμF/ft.	Impedance ohms	O.D.
C.44	4.1	252	1.03"
C.4	4.6	229	1.03"
C.33	4.8	220	0.64"
C.3	5.4	197	0.64"
C.22	5.5	184	0.44"
C.2	6.3	171	0.44"
C.11	6.3	173	0.36"
C.1	7.3	150	0.36"

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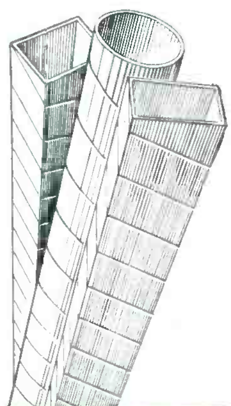

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Brig. Gen. Tom C. Rives

transistors and power rectifiers and quartz crystals.

Harrison VanAken, Jr., who has been associated with the company's electronics business since 1946 and has been manager of business planning controls for the radio and tv department at Syracuse since early this year, was named general manager for communication equipment. Included in this line are two-way radio, microwave equipment and carrier current equipment.

In the broadcast equipment unit, P. L. Chamberlain named Frank P. Barnes as manager of marketing, C. Graydon Lloyd as manager of engineering and Glenn R. Lord as manager of manufacturing.

In the new germanium products unit, H. Brainard Fancher appointed James H. Sweeney as manager of marketing, James E. Keister as manager of engineering and Theodore E. Jamro as manager of manufacturing.

In the communications equipment unit of the new department, Harrison VanAken, Jr. named Lacy W. Goostree, Jr. as manager of marketing, Charles Heiden as manager of engineering and Clair C. Lasher as manager of manufacturing.

Committee On Vacuum Techniques Is Formed

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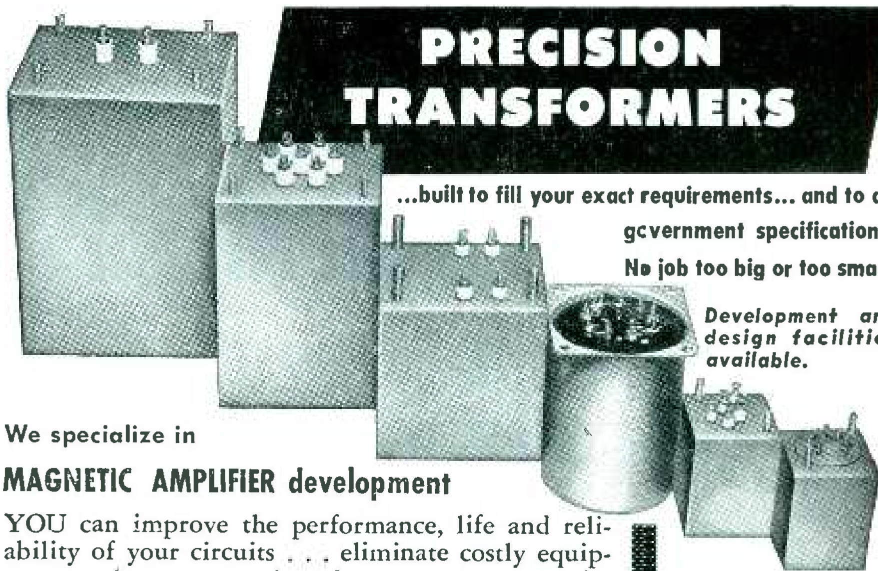

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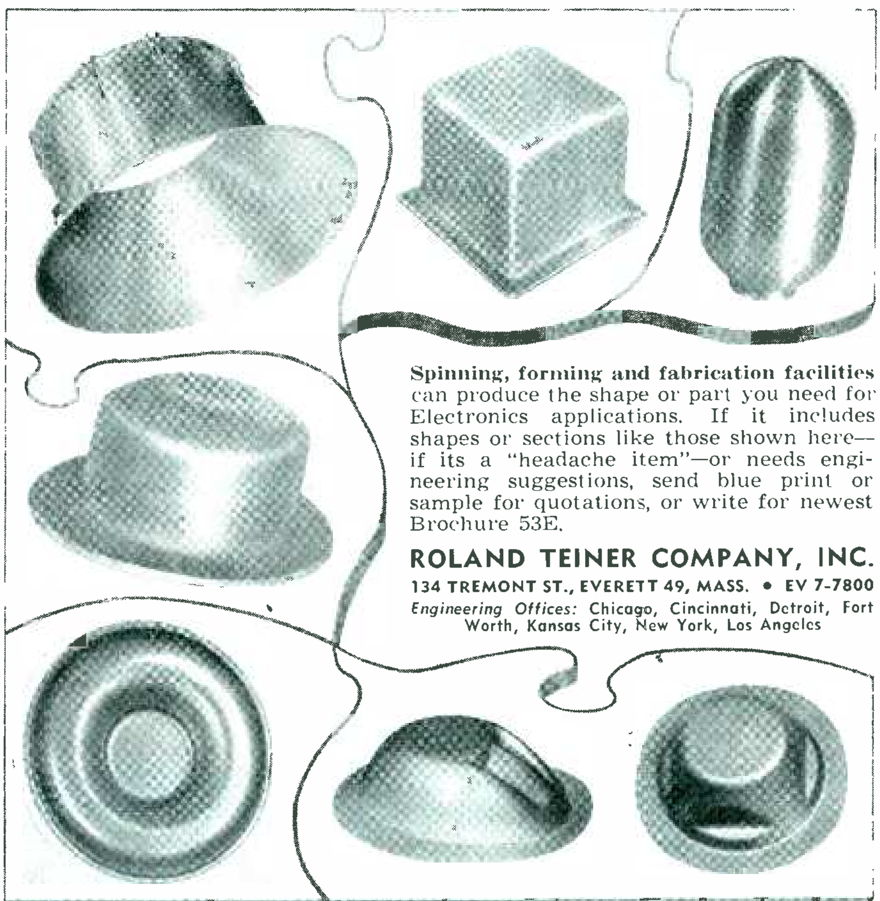

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Engineering Offices: Chicago, Cincinnati, Detroit, Fort Worth, Kansas City, New York, Los Angeles vacuum technology, stimulate exchange of ideas and encourage research on new processes and equipment.

Permanent standing committee chairmen have been elected: J. B. Merrill of High Vacuum Equipment Corp., permanent organization committee; Harry Bliven of Vacuum Electronic Equipment Corp., finance and budget committee; E. M. Brown of Consolidated Vacuum Corp., arrangements committee; R. A. Koehler of GE, program committee; John H. Durant of National Research Corp., publicity and publications committee; B. B. Dayton of Consolidated Vacuum Corp., standards committee; Frederick McNally of Jarrell-Ash Co., education committee.

The Committee on Vacuum Techniques plans to sponsor a High-Vacuum Symposium in June, 1954 at Asbury Park, N. J.

SMPTE Elects New Officers

New SMPTE officers

NEW OFFICERS elected by the Society of Motion Picture and Television Engineers are shown at the Society's 74th semiannual convention in New York City. Left to right are SMPTE's new financial vice-president Barton Kreuzer, manager of theatre and industrial equipment for RCA Victor; engineering vice-president Axel G. Jensen, director of tv research of Bell Labs; and treasurer George W. Colburn of the George W. Colburn Laboratory. They were elected to two-year terms beginning next January.

Arthur V. Loughren of the Hazel-

tine Corp. received the David Sarnoff Gold Medal Award "for his contributions to the development of compatible color tv, including his active work on the principle of constant luminance adopted as part of the signal specifications of the NTSC." Mr. Loughren was cited for his work as chairman of the color video standards panel of the NTSC and was described in the citation as "a guiding spirit and forceful exponent of compatible color tv."

Recipient of the Samuel L. Warner Memorial Award for outstanding technical contributions to the motion picture industry was W. W. Wetzel of Minnesota Mining and Manufacturing Company. At the Convention he revealed a new process for applying multiple magnetic sound tracks to 35-mm film and a new long-life playback head, soon to be available for magnetic sound reproduction in motion picture theaters. Both developments are expected to be of particular advantage to the use of stereophonic sound.

The society presented its annual Progress Medal Award to Fred Waller, chairman of the board of Cinerama, for his development of the Cinerama process.

Twelve other men were honored by the society for outstanding technical papers published in the Society's journal.

Guided Missile Plant Didn't Sell

When the Pima County treasurer put the Hughes Tool Co. guided missile plant near Tucson, Ariz., up for tax sale, just one bid was received, a five-dollar check by mail.

The treasurer returned it, probably recalling that when the government bought the same plant two years ago for $8 million it took $8,833 in revenue stamps just to transfer title from the Hughes Co. to the government.

The tax sale was caused by the government's failure to file its deed of ownership. Until the time of the tax sale Pima County listed the Hughes Co. as owner of the plant and assessed taxes accordingly. The government deed was subsequently filed, but wasn't on record the first

Want more information? Use post card on last page.

day of January, 1952.

Hughes Co. contends that since the government bought the land in 1951 there were no taxes to be levied.

Following the tax sale, lien on the property was turned over to the State of Arizona. During the next three years Hughes may legally redeem the property by paying up all back taxes and penalties. If it refuses, the state legally can assume title and sell to the highest bidder.

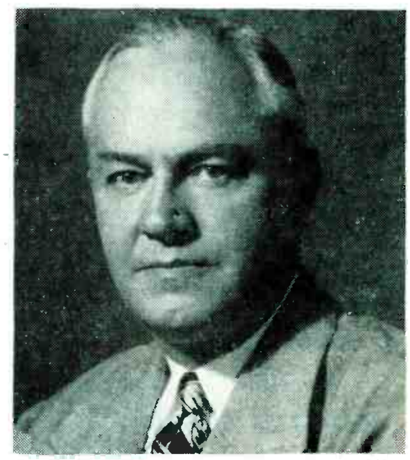
Executives Advance At IT&T

PROMOTIONS of four executives in divisions of International Telephone and Telegraph Corp. were announced by the company.

Henry C. Roemer, president of Federal Telephone and Radio, has been named vice-president in charge of the administration of the domestic divisions of IT&T. These include Federal Telephone and Radio, Federal Telecommunication Labs, Kellogg Switchboard, Coolerator Co. and Capehart-Farnsworth.

Joining IT&T in 1927, Roemer was made chief accountant in 1930. From 1933 to 1938 he was in charge of accounting and finance for IT&T associates in Great Britain, Europe and Cuba. He was elected a director of IT&T in 1943, a vice-president in 1944 and comptroller in 1946. In 1951, he became president of Federal.

Mr. Roemer's successor to the presidency of Federal is Raymond S. Perry, who has been vice-presi-



Raymond S. Perry

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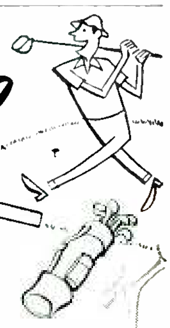

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dent and general sales manager. He joined the company in 1949 as general sales manager and since 1951 has, in addition, been vice-president and director in charge of all domestic and government sales activities. He was previously associated as an executive and member of the board of directors of Olin Industries. He also has served as vice-president in charge of engineering and sales for Ingersoll Milling Machine Company.

Mr. Perry announced the appointment of J. A. Frabutt as general sales manager of Federal. He has served as manager of sales to government agencies since 1946. He joined Federal in 1939 as a radio engineer, specialized in air navigation and communication systems and was closely identified with the technical development of instrument landing systems and other navigational aids by Federal. Before joining Federal he was associated with Westinghouse and Bendix Aviation.

J. A. Frabutt

In the Federal Telecommunications Labs division of IT&T, Brigadier General Peter C. Sandretto, formerly assistant technical director, was named technical director. He joined IT&T in 1946 and has since served in key executive positions in the company in the field of aeronautical radio engineering, including that of director of aviation of the labs division. He was appointed assistant technical director in 1948. He has been in the aeronautical radio engineering industry since 1930 when he became a member of the technical staff of Bell Labs. He joined the U. S. Air Force in 1942 and advanced to become

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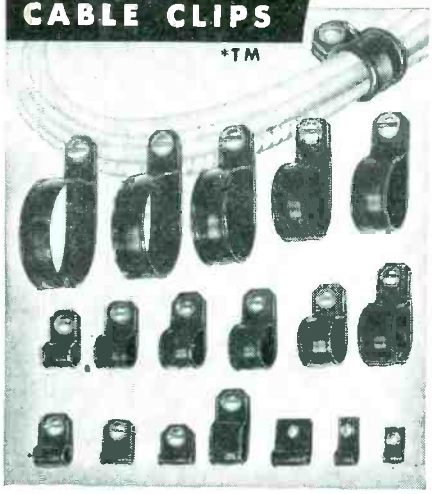

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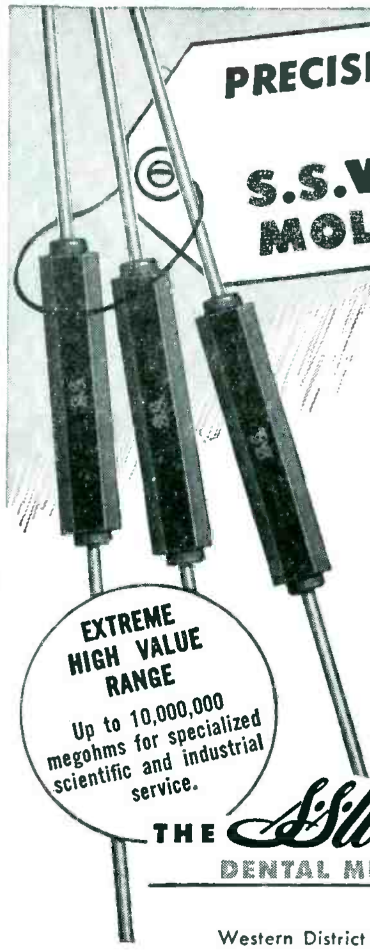

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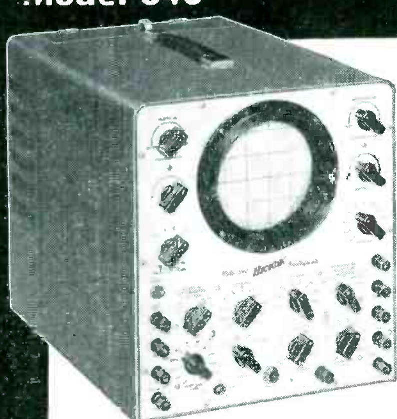

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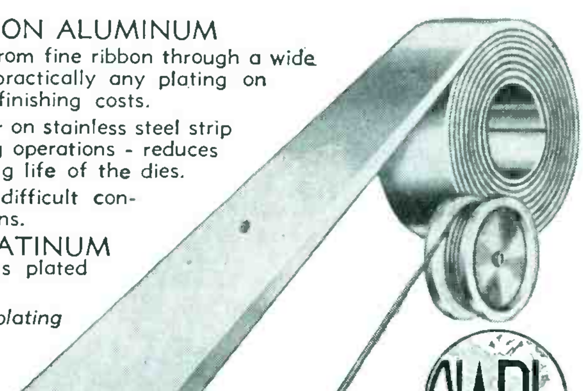

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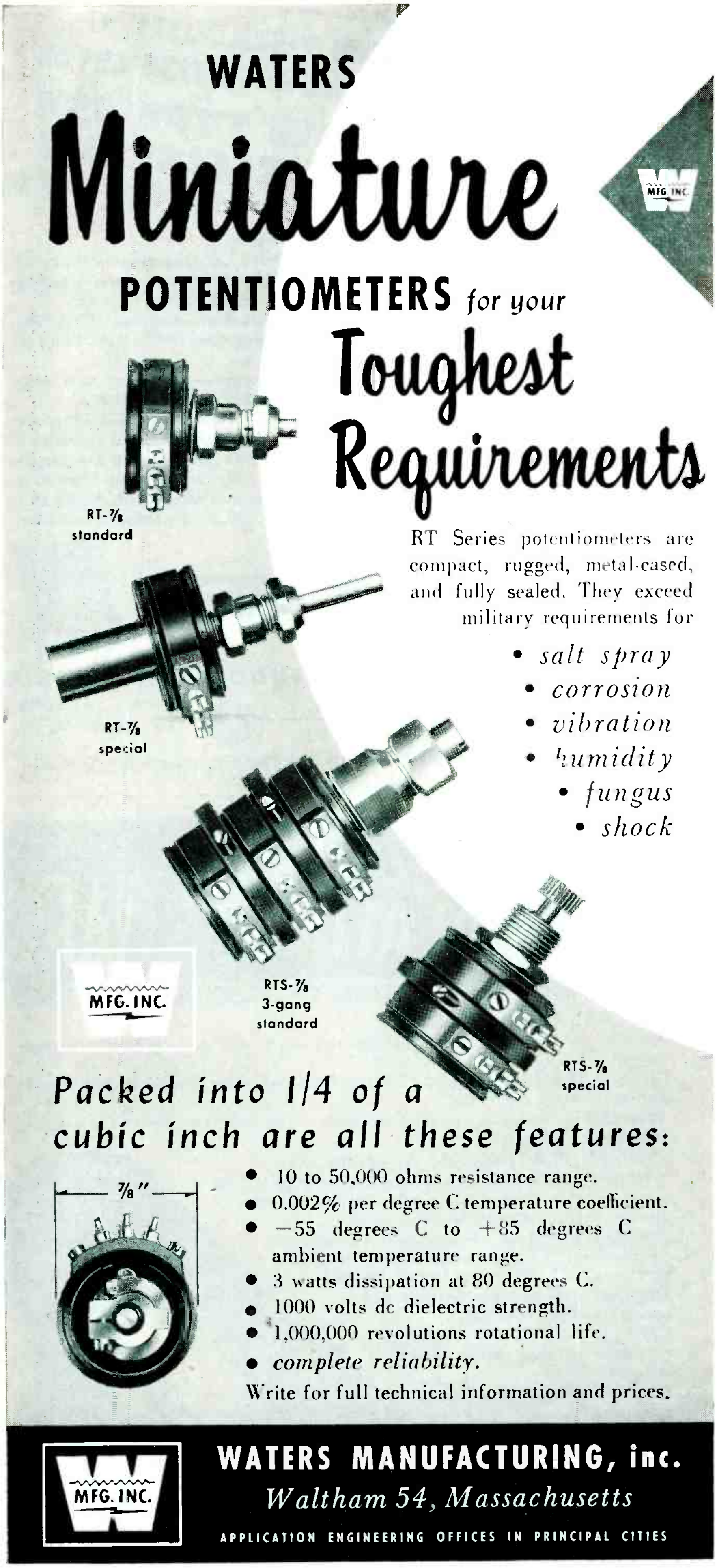


Brig. Gen. Peter C. Sandretto

chief of the electronics division of the U. S. Army Strategic Air Force.

Sprague To Head U. S. Bomb Defense Study

SENATOR Leverett Saltonstall, head of the Senate Armed Forces Sub-Committee, announced the appointment of Robert C. Sprague by the Committee to direct a full-scale study of hydrogen and atomic bomb defense.

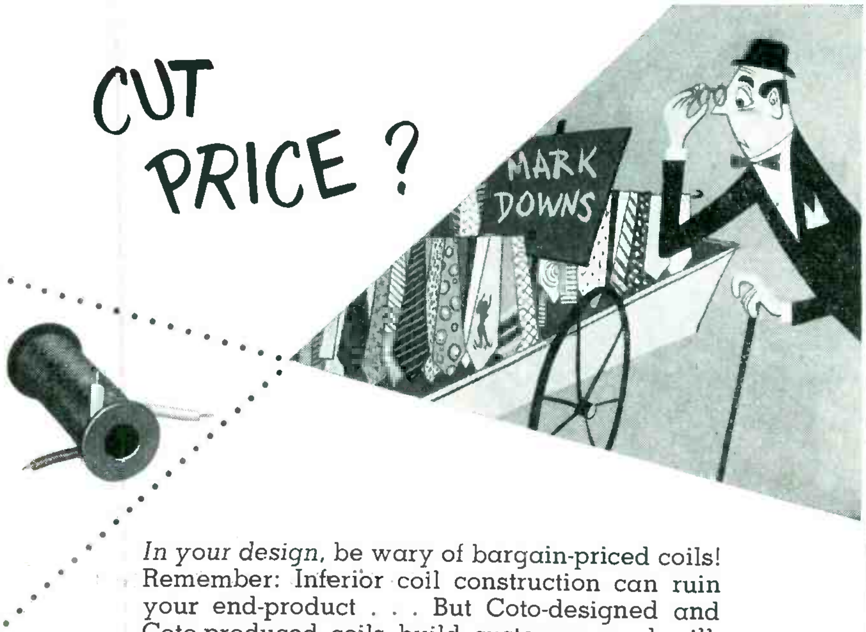
Mr. Sprague is chairman of the board of the Sprague Electric Co. and the RETMA.

In announcing the appointment, Senator Saltonstall said the Committee had decided that the highly technical problem of guarding against bomb attack must be reduced to lay terms in order that the members themselves could better understand the details which face the nation in preparing for its defenses.

The Preparedness Unit was fortunate, he continued, in obtaining the services of Mr. Sprague to head up this important study. Senator Saltonstall noted that Mr. Sprague was experienced in technical matters of this sort and thus "uniquely qualified to act as advisor to the Senate group."

Environmental Equipment Makers Organize

FORMATION of the Institute of Environmental Equipment Manufacturers was announced by George D. Wilkinson, general manager. Head-



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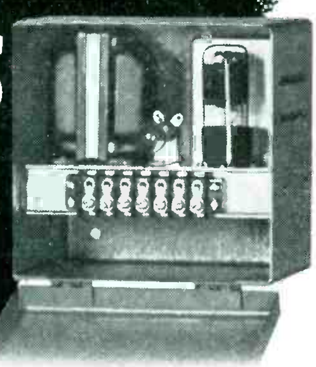

Devtronics engineers have developed three new outstanding basic relay circuits. The sensing elements use activating currents of .1, .01 and .001 microamperes with input resistances as high as 500 megohms. Can be furnished with open or hermetically sealed snap-action relays with varying load carrying capacities up to 30 amperes non-inductive. Circuit response time may be varied from .004 seconds to .125 seconds.

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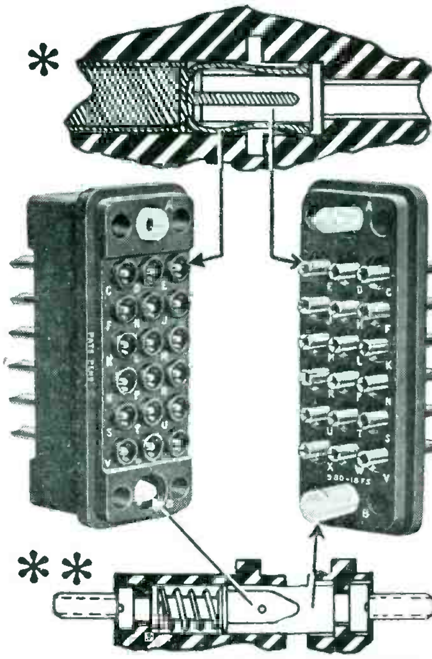
DOUBLE FEATURES Create demand for U.S.C. 980 Series- 12-18-24-34 CONNECTORS



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Environmental testing

quarters will be in New York City.

One of the Institute's most important functions will be to supply industry with technical data on environmental testing. Along this line, a library will be maintained, standards will be prepared in cooperation with the National Bureau of Standards and technical bulletins will be disseminated both to industry and to educational and research organizations.

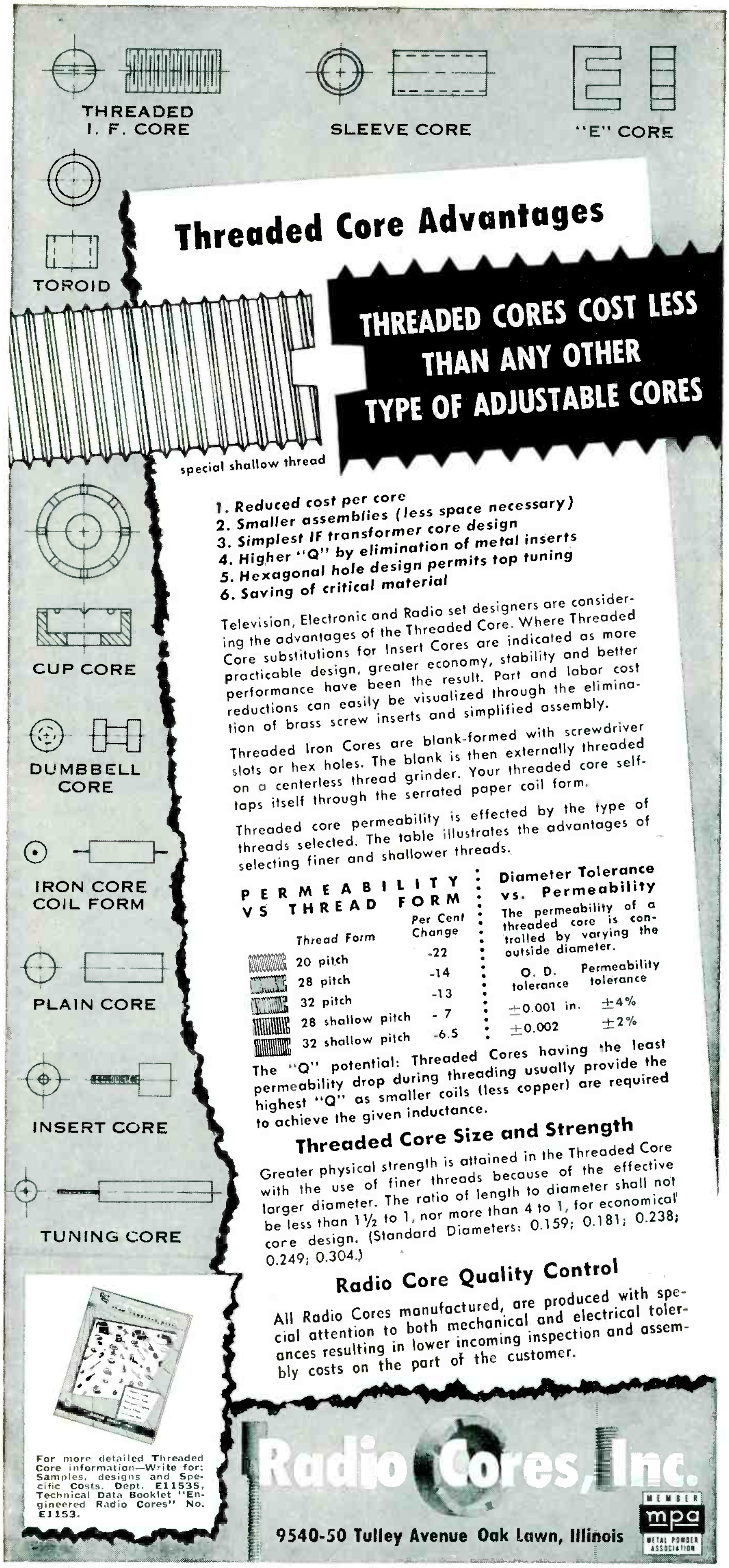
The Institute also will guide the industry in providing maximum service to equipment users by maintaining and improving quality and service standards in production and marketing, standardizing and simplifying designs, and adopting trade practices and methods designed to preserve and promote fair and ethical competition.

Westinghouse Names Witting Of DuMont

CHRIS J. WITTING, managing director of the DuMont Television Network, will be appointed president of Westinghouse Radio Stations on Jan. 1 succeeding E. V. Huggins, vice-president of the parent company. He will report to Huggins in the overall Westinghouse organization.

"Our selection of Mr. Witting for this important post reflects the increasing importance Westinghouse is placing on its broadcasting activities," Huggins said. "He brings with him an intimate experience with both network and station operations which should prove invaluable to us as we broaden the scope of our tv and radio activities."

With the DuMont organization



since 1947, Mr. Witting set up operating procedures for its telecasting division, then being formed. He became general manager of the network in 1949, and soon thereafter was named managing director. Previously he was an executive with Price, Waterhouse Co. and obtained wide experience in installing operating systems and in internal procedures throughout industry. He helped to organize U. S. O. Camp Shows, and later became controller and assistant treasurer of the organization.

Newton Receives Levy Medal

For his paper, "Compensation of Feedback-Control Systems," Dr. George C. Newton, Jr., associate director of the servomechanism lab of MIT, will be awarded the Louis E. Levy Medal by The Franklin Institute. Presentation will be made on the annual medal day ceremonies.

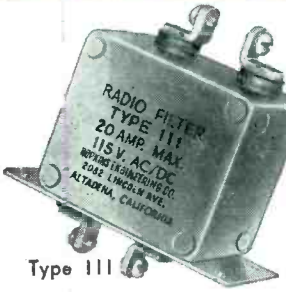
In addition to his teaching activities at MIT, Dr. Newton carries on a consulting practice in the field of automatic control. He also has served as an engineer of the York Safe and Lock Co. and as project engineer at Sperry Gyroscope Co. In 1944 he became a member of Franklin Institute.

Motorola Appoints Head Physicist

Virgil E. Bottom

Virgil E. Bottom has been appointed development physicist in charge of the solid state devices development group at Motorola Research Laboratories in Phoenix, DEPENDABLE *Miniature*

RADIO FILTERS



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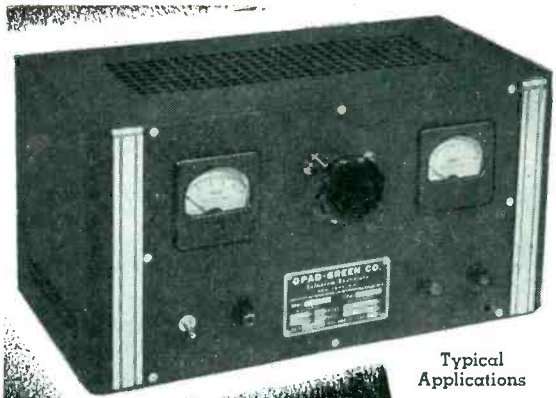

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	50.0	K47	K48
	100.0	K56	K57
0-12	12.5	K65	—
	25.0	K74	K75
	50.0	K83	K84
0-28	10.0	K92	—
	20.0	K101	K102
	40.0	K110	K111

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For additional information write for Bulletin No. 147

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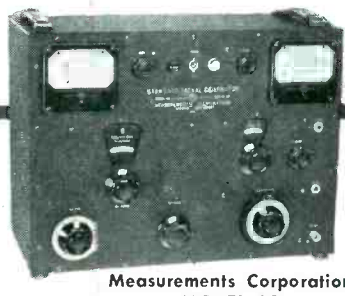

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STANDARD SIGNAL GENERATOR

20 Cycles to 50 Mc.

FREQUENCY RANGE: 20 cycles to 200 Kc. in four ranges. 80 Kc. to 50 Mc. in seven ranges.

OUTPUT VOLTAGE: 0 to 50 volts across 7500 ohms from 20 cycles to 200 Kc. 0.1 microvolt to 1 volt across 50 ohms over most of range from 80 Kc. to 50 Mc.

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Ariz., Daniel E. Noble, vice-president in charge of the communications and electronics division, announced.

Dr. Bottom heads a group of engineers and physicists developing transistors and other devices based on the flow of electrical currents in semiconducting materials.

Previous to his appointment, Dr. Bottom was associated with Colorado A&M College where he was professor of physics and director of research in piezoelectricity and frequency control. He is holder of several patents in the field of quartz crystals for frequency control and filter applications.

Thompson Products Buys Bell Sound

MARKING the entrance of Thompson Products into the commercial electronics field, J. D. Wright, president, announced the purchase of Bell Sound Systems by the company.

"We are happy to enter this field with a line of reputable products and in association with Floyd Bell, who is so well known in the industry," Wright said. "Mr. Bell will remain with the company and will work with us in the promotion of the enterprise. Bell Sound Systems will retain its present identity, continuing to operate in Columbus as a wholly-owned subsidiary of Thompson Products."

Mr. Wright said that the subsidiary would be operated under the direction of William M. Jones, manager of Thompson's electronics division in Cleveland, and that a resident manager at Columbus would be named. He said Thompson would provide capital for the expansion of Bell's present lines, and expects to introduce new products through Bell's present jobber organization.

Thompson executives will serve on Bell's board of directors. Judson S. Sayre, former president and principal owner of Bendix Home Appliance, Inc., who recently joined the Thompson organization as a merchandizing consultant, will also serve on Bell's board and as an advisor on its sales problems.

Bell's annual sales are currently in the $1.5 million range. Total sales of Thompson Products in 1953 are expected to exceed $300 million.

Bell's commercial operations do not conflict with existing activities of Thompson Products in the electronics field. The company entered the field in 1950 with a line of high-frequency electronic components designed primarily for military use.

Recently, Thompson agreed to aid in the financing of the Ramo-Wooldridge Corp. which will be devoted to research, development and manufacturing in the general field of advanced electronics and guided missiles. Thompson Products now hopes to expand in both the commercial and military electronics field.

Carl F. Schunemann

The company also announced the appointment of Carl F. Schunemann as chief engineer of the electronics division. He will be in charge of research and development of microwave components and accessories and specialized test equipment.

Jerome L. White has been appointed senior project engineer of the firm's Columbus, Ohio antenna research laboratory.

Sylvania Electric Starts New Plant

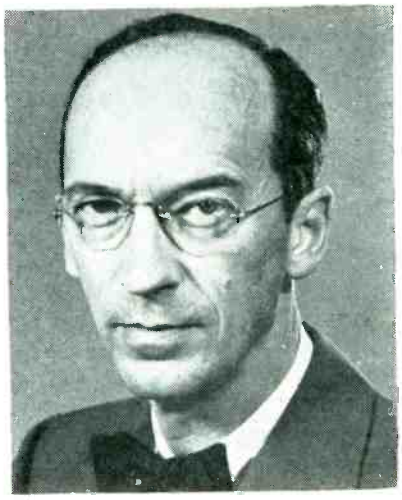
GROUND has been broken for a new Sylvania tv picture tube plant at Fullerton, Calif. The plant is being built on a 20-acre orange grove site and will have 51,000 sq ft of usable space. The building is expected to be ready for occupancy about April 1, 1954.

W. H. Lamb, general manager of the tube division, said that the new

New Sylvania plant

plant is being built to meet the requirements of West Coast tv set manufacturers as well as the tv replacement tube market.

Raytheon Appoints Assistant V-P



William W. Garstang

THE APPOINTMENT of William W. Garstang as assistant vice-president in charge of manufacturing at the television and radio division of Raytheon was announced by Henry F. Argento, vice-president and general manager.

He has been associated with the company since 1947 as midwestern sales manager, manager of the special products division and for the past year and a half as works manager. He had previously been a manufacturer of special electronic, infrared and ultraviolet products.

Service Convention Plans Ahead

THE National Alliance of Television & Electronic Service Associations convention in Chicago brought delegates from 38 states and Canada to view the 32 manufacturer's displays

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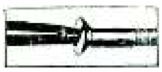

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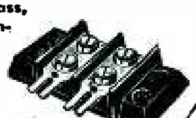

No. 2-142-¾ W

No. 2-142-Y

Shown: Screw Terminals—Screw and Solder Terminals—Screw Terminal above, Panel with Solder Terminal below. For every need.

Six series meet every requirement: No. 140, 5-40 screws; No. 141, 6-32 screws; No. 142, 8-32 screws; No. 150, 10-32 screws; No. 151, 12-32 screws; No. 152, ¼-28 screws.

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and to attend the seminars, color-tv symposium and discussion groups.

All present officers of NATESA were re-elected for the 1954 term and one additional office was filled. Four new affiliate groups joined the organization. Officers re-elected include F. J. Moch, president; John Hemak, treasurer; J. B. McDowell, secretary-general; Bertram Lewis, eastern vice-president; Fred Colton, vice-president; Harold Rhodes, eastern secretary; Francis Fingado, western vice-president and W. A. Rosenberg, west central secretary.

C. N. Burns was elected east central secretary.

A three-point program was outlined by NATESA for the coming year. It includes an integrated public relations and customer relations program in cooperation with regional and local affiliates which will include promotional and advertising material, an expansion program and a manufacturer relations program which was described by president Moch as presaging closer liaison between suppliers and service groups, and a training program. This will include a speakers bureau, lectures, films and training sessions in cooperation with manufacturers.

Sylvania Appoints Planning Head

O. G. Haywood, Jr.

O. G. HAYWOOD, JR. has been appointed manager of engineering planning for Sylvania, according to Robert M. Bowie, director of engineering. In his new position, Dr.

Haywood will coordinate, in cooperation with executives of the operating divisions and research laboratories, Sylvania's engineering planning in the fields of lighting, radio, electronics and tv, with particular emphasis on the long-range future of company engineering.

Haywood was formerly a colonel in the U. S. Air Force. Two years ago he organized the Office of Scientific Research of the Air Research and Development Command in Baltimore and headed the office until his resignation in September.

Previously he had served on the research staff of the Los Alamos Scientific Laboratory and the Atomic Energy Commission in Washington. He served in the Corps of Engineers, U. S. Army, from 1936 to 1947 when he transferred to the Air Force.

Litton Engineering Buys A Hospital

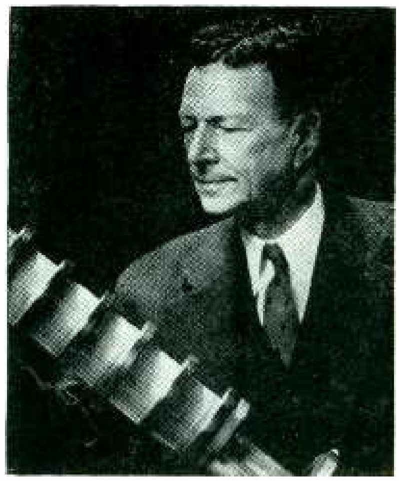
LITTON ENGINEERING LABORATORIES of San Carlos, Calif., manufacturers of measuring instruments and equipment for making vacuum tubes and handling glass, purchased the partially finished Memorial Hospital in Grass Valley, Calif., and will complete it for the firm's new home. The three-story structure and 156 acres of land were sold for $135,000. The company plans to spend another $250,000 to complete the building and install equipment.

Litton plans to begin its move to the new building in two years, when 75 percent of the staff and equipment will be transferred. The firm's operations will be carried on in both San Carlos and Grass Valley, until the entire move is completed.

The hospital was started in 1939. Construction was halted in 1942, after an expenditure of $360,000, because of wartime priority problems and was never resumed.

GE Scientists Win Honors

W. D. COOLIDGE, director emeritus of the General Electric Research Laboratory, is shown studying the multi-section 2-million-volt x-ray tube, one of the major developments with which he has been associated during his long and fruitful career



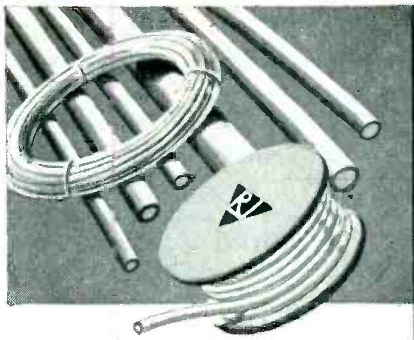
W. D. Coolidge

with GE. Dr. Coolidge was honored in Cleveland upon the occasion of his 80th birthday. Tribute was paid to him as one of the founders of four major American industries—electronics, lamps, man-made cutting tools and x-ray.

In addition, Dr. Coolidge received the Henry Spendadel Award of the Eastern Dental Society "in recognition of his contributions to the welfare of humanity in the field of dentistry." In accepting the award the GE scientist said that the time lag between the acquisition of new scientific knowledge and its application to useful ends is becoming less and less. "It is now so short that the rate of our technological progress is largely determined by the amount of our fundamental research effort," he said.

At the thirteenth annual convention of the Non-destructive Testing Society Dr. Coolidge presented, in behalf of the society and the GE x-ray department, the first annual William D. Coolidge award to the author of the year's outstanding paper on x-ray. Winner of the award is D. T. O'Connor, chief of the Radiology Section of the U. S. Naval Ordnance Laboratory in White Oak, Md. The laboratory contains what is believed to be the most complete array of industrial x-ray apparatus in the world.

Another GE engineer also won honors recently. Wilbur W. Brown, engineer in the electronics division, was presented the Exceptional Service Award by the Military Transport Service at Andrews Air



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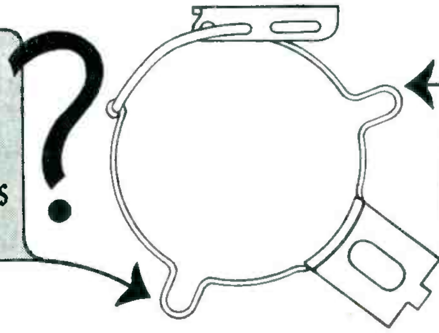

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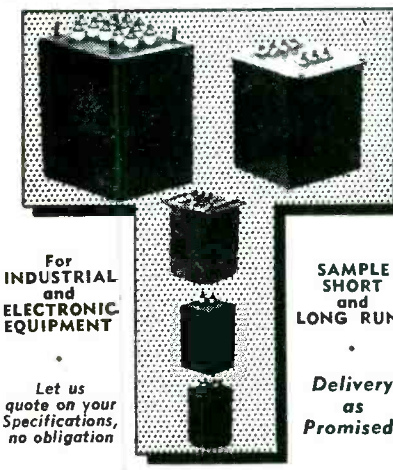

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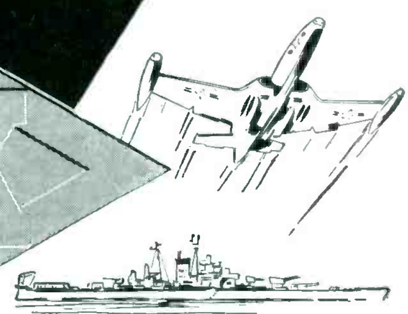

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Force Base in Maryland. The award is one of the highest given to civilians in peacetime. According to the citation, Brown "rendered outstanding service by assisting in the establishment of vital radio circuits in the installation of radio facilities with the material at hand. In many instances this saved long periods of delay which would have occurred had it been necessary to wait for the arrival of the ordered final equipment."

Packard-Bell Opens New TV Plant

Packard-Bell plants

PACKARD-BELL formally opened the two new buildings housing its cabinet milling and finishing division, giving the company a completely integrated tv plant. Valued at more than $3 million, the company property spreads over 12 acres of ground at the West Los Angeles site.

The entire operations of chassis assembly and cabinet construction are performed under one roof. The plant employs more than 1,500 people. Complete production control allows plant engineers to discontinue models or place new ones into production in less than 24 hours. Manufacture of the cabinets within the plant also does away with the additional cost and extra handling necessary when cabinets are shipped from distant wood-working mills, as is the custom throughout the industry.

In the north wing of the plant the cabinets travel over nearly a mile of continuous conveyor tracks while the chassis are assembled on production lines in the west wing of the building. They meet at a junction where they are assembled and processed as one unit.

In another move, Charles A.

Edward L. Michaels

Nichols, director of engineering for the company, announced the appointment of Edward L. Michaels as supervisor of the company's advanced development group which is engaged in research and development of color tv and the possible applications of transistors and printed circuitry to radio and tv receivers.

Dr. Michaels comes to Packard-Bell from the Pomona division of Convair where he was supervisor of the control system design group, engaged in research on the application of transistors. Prior to that he was a member of the research staffs of the Rauland Corp. and Cook Research Laboratories. While with Rauland he engaged principally in development of color tv picture tubes and with Cook as senior project engineer in charge of Aerobee rocket instrumentation.

NYU Appoints H. W. Serig

COL. HOWARD W. SERIG, a specialist in administration of electronics research and development, has been appointed to the research division staff of New York University's College of Engineering, according to an announcement by Harold K. Work, director of the division. He will serve as director of a research group which furnishes staff support to the Panel on Electron Tubes of the Department of Defense.

Before retirement from the Air Force earlier this year, after 30 years service, Col. Serig was vice-commander of the Air Force Cambridge Research Center. He previously served as director of the Coles

Want more information? Use post card on last page and Evans Signal Labs and as assistant chief of the electronics subdivision of the Air Technical Service Command.

From 1948 to 1952, Col. Serig was Air Force Secretary of the Committee on Electronics of the Research and Development Board.

Sperry Products Sets Up In Europe

SPERRY PRODUCTS of Danbury, Conn. has appointed the Resources and Facilities Corp. of New York to develop suitable license and sales arrangements of its patented products in Europe and the Far East.

According to J. B. Farwell, president of Sperry, it is contemplated that Resources and Facilities Corp. will set up prominent companies abroad as licensees under Sperry patents. Such licensees will be closely supported by Sperry's technical and service organization. REFAC will also survey foreign market conditions generally for the company.

Dunn Elected President Of Magnecord

William L. Dunn

WILLIAM L. DUNN, former vice-president of the tv and radio division of Raytheon, has been elected president of Magnecord, according to an announcement by Glenn D. Roberts, retiring president of the Chicago tape recorder manufacturing company.

Dunn resigned from Raytheon and has assumed his duties as the

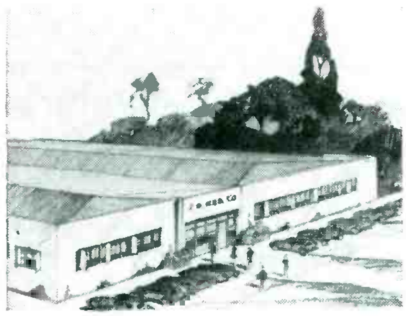
operating head of the company.

In announcing the election, Roberts said, "The election of Mr. Dunn as president implements a long-range program of general expansion designed to entrench Magnecord's position of leadership in the tape recording industry."

"With sufficient capital, increased facilities and experienced leadership we are looking forward to a period of expansion not only in existing fields of magnetic recording, but other fields in which we have already had considerable success in research but have not exploited commercially."

Dunn had been associated with Raytheon for 21 years. He joined the company in 1933 as chief engineer and was named general manager of the special products division in 1940. He was elected vice-president in 1945 when Belmont became a subsidiary of Raytheon.

Rea Moves To New Plant



New Rea plant

THE J. B. REA Co., designers and manufacturers of automatic control systems, will move into a new plant in Santa Monica, Calif. that contains 22,000 sq ft of floor space. The building will house offices, engineering department, laboratories, model shop and equipment for manufacturing. An analog and digital computing center will also be incorporated in the new building.

The company, which started in 1951 with 3 employees, now employs approximately 100 scientists, engineers and technicians. The company has concentrated on design and development of automatic controls for the military. However, with new facilities, more emphasis will be placed on manufacture. Its chief product at present is the Reacon, a high speed analog to digital converter which can store 20 sets of data from 400 separate inputs or a total of 8,000 pieces of information at a rate of one set every two seconds.

Kelly Joints DuMont As Marketing V-P

APPOINTMENT of William H. Kelly to the newly-created office of vice-president in charge of marketing of DuMont Laboratories has been announced by A. B. DuMont, president.

Kelly, whose resignation as vice-president of Motorola, Inc. has been announced, will assume his new duties on Jan. 1, 1954. At that time, the receiver sales division and receiver advertising and merchandising departments will report to the new vice-president.

Dan D. Halpin, who has been general sales manager of the receiver division will continue in that position and work with Kelly in development of plans for the intensified operation.

In the DuMont tv transmitter division, Charles E. Spicer has been named sales operations manager. He will supervise sales engineering, new-products planning, finished stock, customer service and spare parts.

Radio Condenser Opens Plant

A PART of Radio Condenser Company's new 90,000-sq-ft manufacturing plant at Camden, N. J. has been placed in operation, according to R. E. Cramer, president. The new one-story plant, with equipment, represents in total an expenditure of approximately $1.5 million. It will house the company's special apparatus division, tv tuner production expansion and when finally completed, its principal offices.

In addition to the new building partially placed in operation, Radio Condenser recently completed expansion of an existing building at Camden, which gave the firm an additional 34,000 sq ft of manufacturing space. A new, single-unit heat and power plant which replaced four others also will go into service at Camden.

When the new facilities are completed, the company will have 300,000 sq ft of office and manufacturing space at its Camden headquarters. The new plant and others will enable Radio Condenser to nearly double the output of its commercial division over the next 18 months, according to president Cramer.

Gabriel Appoints Research Head

John E. Martin

John E. Martin, senior staff member of Gabriel Laboratories, has been named director of research for the Gabriel Co. He joined the company in 1952 when he first came to the U.S. He was previously employed in England as a senior engineer for the BBC, specializing in antenna design. During World War II he was engaged in naval radar research for the British Admiralty. In his new position he will supervise electronic research and development of various Gabriel products.

Raytheon Makes New Moves

Henry F. Argento, vice-president and general manager of Raytheon's television and radio division announced that, with the resignation of William L. Dunn, vice-president of Raytheon, to become president of Magnecord, the sales, advertising

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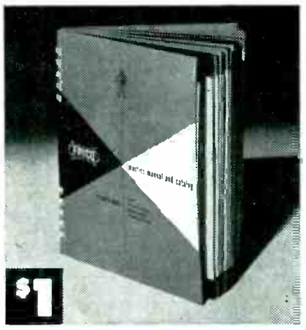

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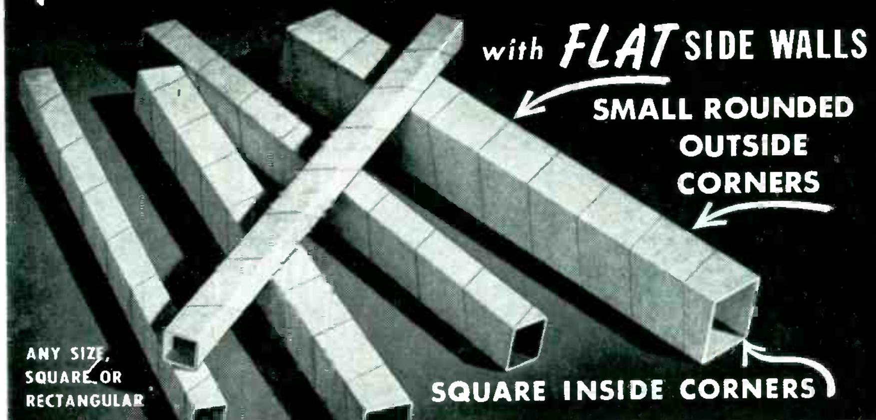

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Qualified to instruct in the operation and supervise installation, maintenance and repair of Radar, Sonar and allied electronic equipments in the Field.

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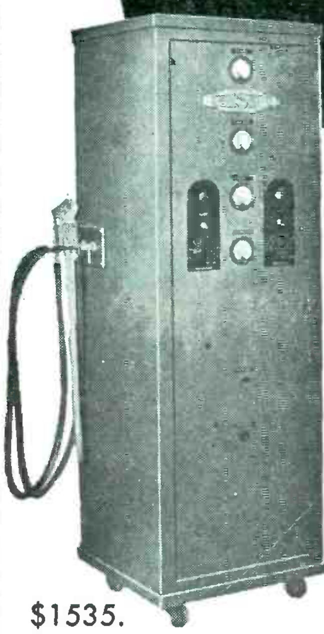

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and engineering heads of the division would come under his immediate direction. William J. Helt, general sales manager, George M. Hakim, director of advertising and Lou Schreiner, chief engineer, will work closely with him in formulation of policies and programs for the firm's tv lines.

Two new assistant vice-presidents were also appointed by Raytheon. Ashley A. Farrar, manager of government contracts for the equipment division, and Gordon S. Humphrey, executive assistant to the general manager of the equipment division, were named assistant vice-presidents.

Farrar joined Raytheon in 1942 in the company's field engineering group. As manager of government contracts he is responsible for sales, contract administration and field engineering relating to all purchases by the government of the division's products.

Humphrey, who has been with Raytheon for 10 years, joined the firm in the early years of World War II to handle its government contract negotiations and to organize and develop a government contract department, an assignment resulting from his work with the U. S. Navy's Bureau of Ships as director of contract field engineering services.

Raytheon also announced the appointment of Edward J. Davenport as commercial engineer of the tv picture tube section at Quincy, Mass. Prior to joining the company, he was associated with National Union Radio Corp. for eight years, three as design engineer on tube test equipment and five as commercial engineer on tv picture tubes. He was previously employed in the radio set manufacturing field in various engineering capacities and has a total of 17 years experience in the electronics field.

Ampex Enters Motion Picture Sound Field

AMPEX CORP. is manufacturing and offering complete theater sound systems for use in picture processes using stereophonic sound techniques. All components, from magnetic soundheads to loudspeakers, are built by the company itself. Systems range in basic cost from $4,500 to $10,300. The company has negotiated a contract with Altec Service to handle installation. Speakers used with the Ampex system are the new Jim Lansing design built by Ampex under license from the James B. Lansing Sound Corp.

Harper Executive Named To NPA

Victor A. Spoehr

VICTOR A. SPOEHR, vice-president and general manager of the H. M. Harper Co., has been appointed director of the general components division of the National Production Authority.

Spoehr has been associated with Harper since 1936. He is on leave from the company under a rotation system by which the services of outstanding businessmen are made available to the government.

GE Increases Plant Facilities

A 44,000-SQ-FT plant addition has been completed at GE's receiving tube plant at Tell City, Ind., it was announced by J. Milton Lang, general manager of the GE Tube Department.

All component parts and mounts for receiving tubes will be produced in the new addition, for processing into completed tubes in the plant.

The Tell City addition is the third plant construction or modification project of the year for the GE Tube Department. During the summer, GE undertook a multi-million dollar retooling and building project at its Syracuse and Buffalo, N. Y. picture

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tube plants, and the company is now converting a former GE dishwasher plant at Scranton, Pa. for production of hydrogen thyratron tubes for radar.

Besides the plant projects, the Tube Department also expanded its warehousing facilities by 171,000 sq ft this year. In June, it formally opened a new 100,000-sq-ft warehouse in Chicago and it will open a new 25,000-sq-ft warehouse in Los Angeles and a new 46,000-sq-ft addition to its Clifton, N. J. warehouse.

The Carboloy Department of GE is also expanding facilities and will open its new magnet plant in Edmore, Mich. It will employ about 450 persons. Pushbutton-controlled operations are spread over nearly 2 acres of floor space and use about 1½ miles of conveying systems to produce approximately 2,200 types of magnets.

Engineers Advance At Consolidated

Two Promotions in the engineering and transducer divisions of Consolidated Engineering were announced by James R. Bradburn, vice-president in charge-of-engineering.

Walter B. Claus, who has served as chief mechanical engineer of the Pasadena firm since 1949, has been named director of manufacturing of the transducer division. He will also act as assistant head of the transducer division, where galvanometers and transducers for Consolidated's dynamic measuring and recording systems are produced.

Succeeding Claus as the company's new chief mechanical engineer is Gerald S. Perkins, who has been associated with the company as assistant chief mechanical engineer since January, 1953. He was formerly both a project and research engineer at Paramount Pictures.

MIT Appoints Reintjes

John F. Reintjes, associate professor of electrical engineering at MIT, has been named director of the Servomechanisms Lab of the department of electrical engineering, succeeding William M. Pease who

resigned to begin a career in industry.

Following a two-year term on the staff of the MIT Radar School, he served as an engineer with GE. In 1947 he was named assistant professor of electrical engineering at MIT, where he has had charge of the educational subjects in the field of radar and contributed to research in the Research Laboratory of Electronics and Project Lincoln.

Gates Names Colvin Engineering Director

Jack Colvin

JACK COLVIN has been appointed director of engineering of the Gates Radio Co., according to an announcement by P. S. Gates, president. Prior to joining Gates, Colvin was chief engineer and plant manager of the Commercial Radio Co. of New York, chief audio engineer for the American Broadcasting Co. and systems engineer for RCA.

Tel-O-Tube Names Chief Engineer

KENNETH R. HESSE has been appointed chief engineer of the Tel-O-Tube Corp. of America. He has been with the company since 1949. Previously he was employed as a metallurgist-spectroscopist at DuMont.

Onondaga Pottery Expands Electronics

AN ELECTRONICS division for commercial production of ceramic capacitors and printed resistor-capacitor circuits has been formed by the Onondaga Pottery Co. of Syracuse, N. Y. Operations are being conducted in a separate building of 50,000 sq ft with installed facilities valued in excess of $200,000. When in full operation, the division will employ several hundred persons.

Executives in the division are: James S. Pass, director; Paul L. Christensen, sales; Charles A. Shaw, engineering and development; Flemmon P. Hall, research and Gordon B. Smith, production.

Ohmite Moves To New Plant

OHMITE MANUFACTURING CO. of Chicago, Ill. has moved its offices to a new plant in Skokie, Ill. The new facility, completely air conditioned, has a floor area of 128,000 sq ft, permitting increased production of the firm's resistance products. Some products will continue to be manufactured at the Chicago plant.

Standard Coil Forms Research Division

STANDARD COIL PRODUCTS has separated its research and development facilities from production operations and set them up in a new division to be known as the Thias Research Division of Standard Coil. Glen E. Swanson, president of the firm, stated that construction will begin shortly on a new building which will house the plant's research staff of 250 engineers, physicists, draftsmen and other technical personnel. Construction of the new plant, which will be located near the firm's Los Angeles plant, is scheduled for completion early this December.

Edwin Thias, vice-president in charge of engineering, will head up the division which will be concerned exclusively with research in uhf, sound, color tv and other phases of advanced communications and electronics.

Minault Appointed Chief Engineer

S. SYDNEY MINAULT has been named chief engineer of National Research Corp., according to an announcement by H. C. Weingartner, vice-president and general manager of the equipment division.

Minault has previously served as production manager and later vice-president and general manager of Tracerlab; chief product engineer, camera plant manager and later chief engineer of Ansco; methods supervisor and later manufacturing engineering superintendent of Sperry Gyroscope Co.

Pyramid Electric Expands Plant

A NEW plant in Gastonia, North Carolina, is being readied for occupancy by the Pyramid Electric Co. of North Bergen, N. J. It is currently being fitted with equipment, and manufacturing operations are expected to begin in its 160,000 sq ft of floor space around Jan. 1. Ultimately, nearly 1,000 persons will be employed at the Gastonia plant.

Paper capacitors as well as motor-starting and ceramic capacitors will be manufactured at the plant.

Morrison Heads Sprague Research Section

WILBUR A. LAZIER, vice-president and technical director of Sprague Electric, announced the appointment of Adair Morrison as head of the research section of the company's research and engineering department. In his new position, Dr. Morrison will be in charge of investigations of fundamental sciences related to the electrical component technology.

He comes to the company from the Arthur D. Little organization and is a research physicist and former laboratory director. He was long associated with the National Research Council of Canada, representing the physics section at the International Radiology Conference in 1950.

Stromberg Acquires Southern Electric

STROMBERG-CARLSON has acquired by exchange of stock, all assets, patents, license rights and goodwill of Southern Electric & Transmission Co. of Dallas, Texas. The company, which becomes a division of Stromberg, manufactures wire carrier electronic equipment for the in-

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dependent telephone industry and for gas and oil pipe line systems. For the present, Southern will continue to operate in Dallas.

Graham Named V-P Of IEC

VIRGIL M. GRAHAM has been elected a vice-president and member of the executive committee of the U. S. National Committee of the International Electrotechnical Commission (IEC) according to the American Standards Association, the American parent body. The IEC is the

Graham is director of technical relations of Sylvania Electric and has been active in standardization work in the radio and electronics field for nearly 30 years. He is presently chairman of the communications and electronics section on electrical standards of the JETEC and associate director of the RETMA engineering department.

Burroughs Names Hilary Moss

HILARY MOSS has joined the staff of the research center of Burroughs Corp. as manager of the tubes and circuits department. Dr. Moss was formerly chief engineer of Electronic Tubes of England.

Waldom Starts New Plant

New Waldom plant

CONSTRUCTION has begun on a new plant for Waldom Electronics of Chicago, according to Jay Greengard, executive vice-president and general manager of the firm. Centered on a 34,000-sq-ft plot with railroad siding facilities and parking accommodations, the new facility will double Waldom's production capacity, Greengard said. Cost of the new plant and equipment is estimated at $250,000. The firm's complete line of products now numbers more than 2,000 items of electronic components and products.

Monroe Research Plans Move

THE MONROBOT CORP., wholly-owned research and development subsidiary of the Monroe Calculating Machine Co., of Orange, N. J. will occupy 6,000 sq ft of the parent company's new 100,000-sq-ft plant in Morris Plains, N. J. The space, to be known as Monrobot Laboratories, will be devoted to development of electronic calculating machines.

Kaye-Halbert Acquires Pacific Instrument

KAYE-HALBERT has completed plans to absorb all facilities of Pacific Instrument and Control Co., maker of servo-instruments and other precision devices, according to Harry Kaye, president. The merger will represent combined assets of some $2 million dollars in equipment, plant, patents and material. Orders on file for the next year total 12 million for the combined operations.

National Union Names Tube Chief

KENNETH C. MEINKEN, vice-president of sales of National Union Radio Corp., announced the appointment of Edward J. Davenport as chief of the cathode-ray tube commercial engineering division of the company. He will have full responsibility for commercial engineering, quality, measurements, sales engineering and liaison.

Syntronic Enlarges Plant Area

A NEW addition which doubles existing plant area has been completed by Syntronic Instruments of Addison, Ill. The added space is being used for manufacturing tv yokes and for expanding production facilities on the firm's line of components for laboratory, military and special-purpose cathode-ray tube applications.

NEW BOOKS

Einführung in Die Theorie Der Hochfrequenz-Bandfilter

BY VON RICHARD FELDTKELLER, DR. RER. NAT., *Professor und Direktor des Instituts für Nachrichtentechnik an der Technischer Hochschule Stuttgart; 4th Edition of "Der Rundfunk-Siebschaltungen" with* 110 *figures, and* 198 *pages; Stuttgart, S. Hirzel Verlag,* 1953.

THIS BOOK, which was originally published in 1939, now appears with a new title in an improved and more usable form. The subject of the book, which the title does not make obvious to American readers, is, actually, interstage networks. The frequency interval to which the discussion is particularly directed might be considered to lie between 10 kc and 10 mc, although its boundaries are not definite.

The building-block, about which the analysis is constructed, is the parallel coil and capacitor circuit, which as the author points out offers in its capacitance a means of absorbing the inevitable strays between grid and ground, or plate and ground. The general plan of the book is logical and simple so that the leisurely and carefully developed subject is readily understood and appreciated. An important characteristic of the treatment is the specific numerical example which follows each division of the text and exhibits for the reader both numerical magnitudes and computational procedures.

If the reader has good competence in German, the book, which has been prepared on quite a simple foundation, should offer little difficulty. There is only needed a good knowledge of algebra, the ability to express complex numbers in rectangular and polar form and make Argand diagrams, a little familiarity with trigonometry and an understanding of basic alternating-current circuit theory.

Seven introductory pages preface the book's nine chapters. The first chapter in itself is also introductory, since it discusses dissipation in circuit elements. This is quite a satisfactory beginning because in the circuits of the text dis-

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4165	5760	6340	6975	7825	1525	3215	6200	7173	8173
4190	5773	6350	7450	7840	1915	3237	6440	7175	8175
4255	5775	6373	7473	7850	1930	3245	6450	7200	8200
4280	5800	6375	7475	7873	1940	3250	6473	7206	8340
4300	5806	6400	7500	7875	1950	3460	6475	7225	8350
4397	5825	6406	7506	7900	2065	3500	6500	7240	8375
4450	5840	6425	7525	7906	2105	3540	6506	7273	8380
4490	5850	6673	7540	7925	2118	3590	6525	7275	8400
4495	5852	6675	7550	7940	2125	3640	6540	7300	8425
4780	5873	6700	7573	7950	2140	3680	6550	7306	8430
4845	5875	6706	7575	7973	2145	3720	6573	7325	8450
4930	5880	6725	7600	7975	2305	3735	6575	7340	8460
5030	5900	6740	7606	8206	2320	3760	6600	7350	8475
5205	5906	6750	7610	8225	2390	3800	6606	7375	8483
5235	5925	6773	7625	8240	2415	3840	6625	7400	8500
5250	5940	6775	7640	8250	2430	3885	6640	7425	8525
5300	5950	6800	7641	8273	2442	3995	6650	7440	8550
5305	5973	6806	7650	8275	2460	6000	7000	8000	8575
5333	5975	6825	7673	8300	2532	6025	7006	8006	8583
5385	6225	6840	7675	8306	2545	6050	7025	8025	8600
5485	6240	6850	7700	8325	2557	6073	7040	8040	8625
5500	6250	6873	7706	8630	2605	6075	7050	8050	8650
5675	6255	6875	7720	8683	2738	6100	7073	8073	8700
5677	6273	6900	7725	8690	2785	6106	7075	8075	8733
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374	395	416	438	502	523	441	462	6450	2052	2320	3215
375	396	418	481	503	525	442	463	6470	2065	2360	3232
376	397	419	483	504	526	444	464	6497	2082	2390	3237
377	398	420	484	505	527	445	465	6522	2105	2415	3250
379	401	422	485	506	529	446	466	6547	2125	2435	3322
380	402	423	486	507	530	447	468	6610	2131	2442	3510
381	403	424	487	508	531	448	469	7350	2145	2532	3520
383	404	425	488	509	533	450	470	7380	2155	2545	3550
384	405	426	490	511	534	451	472	7390	2220	2557	3570
385	406	427	491	512	536	452	473	7480	2258	2660	3580
386	407	429	492	513	537	453	474	7580	2260	2940	2945
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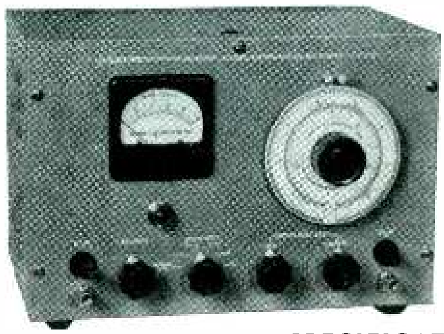

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ACCURACY: ± 0.1 degree (6 minutes) in phase reading, or ± 1% of the time delay indicated on the dial of the continuously variable delay line.

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TIME DELAY: Two continuously variable delay lines are supplied with the unit, 0 to 0.25 microsecond and 0 to 0.05 microsecond. Continuously variable delay lines with different time delay can be obtained on request.

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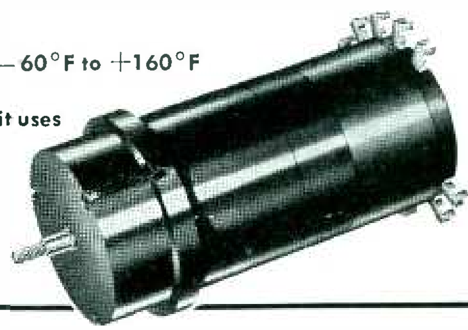

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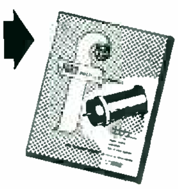

8

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DIVISION OF THE SPERRY CORPORATION
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sipation is crucial to transmission characteristics, a fact which amateur designers often tend to neglect.

The second chapter introduces the single stage amplifier, where the output voltage of the plate circuit is developed across an antiresonant circuit. This is well done, and the first of the generalized definitions, which are to be used in later analysis, are introduced here. Chapter III expands this treatment to two cascaded amplifier stages, each with an antiresonant circuit between plate and ground. Further definitions for stagger tuning, band ripple, cutoff frequencies and other transmission properties are stated.

Chapter IV covers what might be described as four-terminal interstages. That is, the plate of one stage is coupled to the grid of the next stage by means of a π. The shunt elements of this π are antiresonant circuits. The series element may be a coil, or capacitor, or even the inductive coupling between the two shunt coils. The generalization and discussion of the circuit properties for these various cases integrate the performance pattern of this type of circuit.

The fifth chapter is perhaps the most important in the book, for within its fifty-seven pages the relation between the input and output voltages of an amplifier are developed in polynomial form as functions of a generalized complex frequency. The design problem consists in determining the values of complex frequency which characterize the zeros and poles of these polynomials. These polynomials as the author uses them are expressed in Tschebycheff functions, which are coming into more general use in many network problems. This treatment appears to be simple enough for ready understanding, and at the same time full enough for application to interstage design, or even other circuit problems. The development is carried right up to the specification of a Tschebycheff amplifier.

The remaining four chapters, which occupy together some thirty-eight pages, utilize the Tschebycheff polynomials for the analysis of interstage couplings of both the four-terminal and two-terminal type. The final topic is variable bandwidth at a fixed frequency.

There are three pages of bibliography with sixty references to periodical literature and five references to books. Fifteen of the periodical and two of the book citations are English or American. However, there is no mention of the important work of H. W. Bode ("Network Analysis and Feedback Amplifier Design," Van Nostrand, 1945) and H. A. Wheeler (*Proc. I.R.E.*, July, 1939). The book does not have an index, but the table of contents is quite complete.—B. A. KINGSBURY, *Bell Telephone Laboratories, Incorporated.*

Circuit Theory of Electron Devices

BY E. MILTON BOONE, *Ohio State University. John Wiley & Sons, Inc., New York, N. Y.*, 1953, 483 *pages*, $8.50.

DESIGNED to provide material for a first course in electronic circuits for college and university students enrolled in electrical engineering and engineering physics curricula, the book is based on course material used at Ohio State University for the past ten years. The subject matter is comprehensive and well presented.

The material is divided into 12 sections with the chapter on a-f voltage amplifiers receiving by far the heaviest weight. Of particular interest is the final chapter on transistor circuit theory. The principles of semiconductor devices are discussed in a simple and understandable fashion with a minimum of physics. Circuit applications of both the point-contact and junction types are described in some detail.

The first chapter, on diodes, triodes and their equivalent circuits, contains an interesting discussion of four-pole theory as applied to vacuum-tube equivalent circuits.

Other chapters describe tetrodes and pentodes, a-f power amplifiers, gas tubes, single-phase and polyphase rectifiers, r-f amplifiers, oscillators and modulation and demodulation.

Although primary emphasis is on communications applications of electron devices, material is included on subjects such as motor-control circuits, d-c amplifiers, and the free-running multivibrators. The book might, however, have been made even more valuable had its scope been broadened to include counting circuits and other pulse-type circuitry currently finding widespread use in modern electronic equipment.

The author cites mathematics through differential and integral calculus, sophomore physics and one year of a-c circuit theory as prerequisite to a course using this book. The material covered seems indeed to be within the capabilities of a student possessing these prerequisites. The number and type of problems given likewise seem adequate for a two-semester course. The book is well-indexed for a textbook.—J. C.

Introduction to Electron Microscopy

BY CECIL E. HALL. *McGraw-Hill Book Company, Inc.*, 1953, 451 *pages*, $9.00.

DR. HALL'S BOOK on electron microscopy is an excellent addition to a rapidly growing library on the subject. In content it is rather conventional, working through fundamental physical principles to basic electron optics, electrostatic and magnetic lenses, lens aberrations, electron microscopes, the composition and interpretation of the image, the principles and methods of specimen preparations and concluding with some examples of the application of the electron microscope in research. However, it differs considerably from many of its predecessors in that it rarely leads the reader astray. It is refreshing to find a book in which senseless ritual is recognized for what it is, particularly with regard to the manipulation of the instrument and the preparation of specimens. It is just the well balanced and very useful practical exposition that one would expect of a worker who has been an acknowledged leader in his field for many years. Certainly few electron microscopists in this country or elsewhere are qualified to ignore this book.

The above praise does not mean that the book is entirely without faults. In contrast to the lucid and logical exposition of the principles

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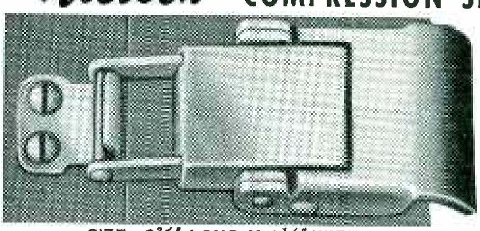

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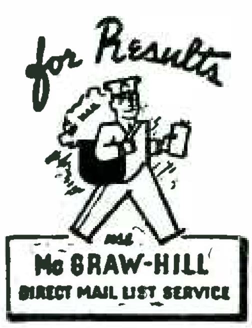

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of electron microscopy, the first chapter on elementary physics is very fuzzy and quite often wrong. It is regrettable that the author did not have this part checked by one of the several masters of elementary exposition of the quantum theory.

This reviewer is in complete agreement with the author's decision to give only a few examples of the application of the electron microscope. However, he does feel that choosing a more representative set of examples, particularly in the field of biology, would have improved the book and aroused the interest of a much broader group of readers. For instance, examples from the fields of bacteriology, from the study of animal viruses and from the study of fine scale anatomy could have replaced the last three examples, which, while excellent in themselves, are really only slightly different aspects of the same problem and do not illustrate any particularly different uses of the electron microscope.

All of the electron micrographs presented in the book are technically excellent. The quality of the half-tone reproductions is satisfactory but somewhat variable and certainly not as good as in some other publications.

These defects detract very little from the value of the book as a manual on electron microscopy. It is the opinion of the reviewer that Dr. Hall has made a major contribution to the cause of the intelligent use of electron microscopy and that the book should be heartily recommended to all who have a serious interest in the subject.—JAMES HILLIER, *Falls Church, Va.*

Data and Circuits of Radio Receiver and Amplifier Valves (Second Supplement)

Book IIIa of Electronic Valve Series Published by Philips Technical Library (1952). *Distributed in USA by Elsevier Press, Inc.*, 482 *Lovett Blvd., Houston* 6, *Texas*, 487 *pages*, $6.25.

THE Philips Company is to be complimented on the thoroughness with which it supplied detailed and read-able information on its electron tubes and their application.

In this volume, Philips has assembled in convenient form a great deal of information on thirty-six types of receiving tubes introduced in the period from 1945 to 1950. Each type is pictured and discussed, and considerable technical data and many characteristic curves are given.

In addition to the data on the individual tube types, the book includes circuit information for the construction of seventeen radio receivers using the various types. Each receiver is treated at length, and a description of the functioning of the various stages, lists of component parts, tabulated values of measured voltages and currents, and performance curves on the completed sets are given.

The types covered in this book are principally tubes of the Rimlock series, which are button-stem glass tubes about the same size as the American nine-pin noval miniature (22 mm in diameter), but having a metal rim cemented on the stem end that locks into the socket. Several seven-pin miniature and noval types are also included. The types shown do not have exact American counterparts, but in general the characteristics do not differ much from American types. An interesting exception is the EQ80 enneode, a seven-grid noval type for use as a limiter-discriminator for high-quality f-m set performance.

The book is well printed and the characteristic curves are easy to read. The technical nomenclature is British rather than American, but should present no difficulty for the experienced engineer.—T. J. HENRY, *Tube Department, Radio Corporation of America, Harrison, New Jersey.*

THUMBNAIL REVIEWS

Timing Engineering By Myrten G. Saake, Ribble Engineering Co., 74–80 Montgomery St., Jersey City 2, N. J., 243 pages, 1953, $5.00. Very largely a description of synchronous-motor-driven timers of all kinds with circuits, descriptions and illustrations. Virtually nothing about electronic timers except "they have been used for spot

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welder controls . . . photographic timing, mechanical stop alarm . . . Traffic signals." Useful for the control engineer.

Be Your Own Television Repairman. By William Prior, Jr. Greenberg, 201 East 57 St., New York 22, N. Y., 1953, $1.00. Pages unnumbered. Tells how to detect and fix the two major causes of TV troubles—bad tubes and antenna ailments. Eight pages of text, two of typical patterns and many pages of tube-layout diagrams of typical TV receivers.

Opportunities in Electrical Engineering. By S. Paul Shackelton. Vocational Guidance Manuals, Inc., 45 West 45 St., New York 36, N. Y., 128 pages, 1953, $1.00. Fair and useful summary, dealing not only with the opportunities but with the requirements and responsibilities. Recommended reading for any young man contemplating a career in electronics or other phase of electrical engineering.

Dielectric Constant and Dissipation Factor, Glasses, 1—300 kc. By G. F. Stockdale. University of Illinois, Urbana, 27 pages, 1953, 30¢. Study of glasses of various soda-potassia-silica content.

Linear Scale Non-logarithmic Slide Rules. By Morris L. Groder. G & G Corp., 2003 East 12 St., Brooklyn 29, N. Y., 64 pages, 1952, $2.98. Interesting and instructive book on how to construct and use linear-scale rules for all conventional manipulations ordinarily carried out on log rules. For all engineers.

Handbook of Noise Measurement. By A.P.G. Peterson and Leo L. Beranek. General Radio Co., Cambridge 39, Mass., 102 pages plus catalog and tables, 1953, $1.00. A manual on measuring industrial noise based on the GR sound-measuring system but having much material of broad interest on the subject. Chapters on applications for the system, methods of measurement, mechanism of hearing, noise source characteristics and noise control, etc.

Wheeler Monographs Vol. 1. By Harold Wheeler and Associates. Wheeler Laboratories, Great Neck, N. Y., 1953, $5.00. A large and basic book containing eleven monographs on various subjects such as transmission line theory and use, slide rule operation for radio problems, powdered iron at radio frequencies, superregenerative receivers, efficiency of linear networks and frequency changers, etc. Rather mathematical, but highly practical.

Tube Picture Book. Commercial Engineering, RCA Tube Department, Harrison, N. J., 16 pages, $0.25. For schools, an educational booklet of photos, cutaway drawings and exploded views showing structural details of triodes, thyratrons, camera tubes, etc.

Selenium Rectifier Replacement Guide. Sarkes Tarzian, Inc., Bloomington, Ind., 12 pages, 1953, $0.25. Rectifiers for radios and TV sets by manufacturer and model. For servicemen.

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BACKTALK

Antennas

DEAR SIRS:

I WAS particularly intrigued by John D. Kraus' review of the H. Lottrup Knudsen book, "Antenna Systems With Complete Or Partial Rotational Symmetry" (Oct. 1953, p 444);—and alas, not reading Danish, nor possessed of Kraus's authority on antenna matters, my inquisitiveness shall not increase further, even helical-wise.

However, it does bring to mind a rather spectacular experiment which I encountered in Europe during the war. While chief engineer of Radio Luxembourg (147 kw on 232 kc), for the OWI-PWD/-SHAEF group, I found that the normal antenna system of this long-wave station had been modified in an attempt to provide a rotational directional parameter, covering 360 degrees.

The normal antenna system employed consisted of, essentially, a vertical radiator, with a top hat. Three towers 590 ft. high supported a spider web array as the top loading, and the vertical elements consisted of three down leads, suitably coupled to an open-wire transmission line. Adjacent to this, two auxiliary towers, also of 590-ft. height and similarly guyed, supported an array of dipoles (whose nature defied my then-current knowledge of antennas), fed by an equally-complex system of down-leads. The whole was fed from the normal by switchable open-wire transmission line and an elaborate phasing network of truly gigantic proportions (considering the power and frequency), located in the attic of the Radio Luxembourg transmitter building.

M. Ferd Scholtes, then the Luxembourg chief for the station, told me that neither the designer, nor the German group who operated the station while it was in their hands, could make the thing perform as its theoretical restrictions indicated.

However, it was a nice idea; and it would seem that Prof. Knudsen might have been the one to make it work! I was instrumental in removing the offending thing during the war, since it absorbed considerable power and restricted our radiation toward Northern Germany.

DON V. R. DRENNER,
Engineer, KGGF
Coffeyville, Kansas

SARAH Lost Weight

DEAR SIRS:

WE WERE most interested to read your story on SARAH in the *Industry Report* section of your August issue. We appreciate your interest in this project.

However, our engineering staff has had hot and cold flashes ever since they read the equipment weighs "31 pounds". The downed fliers would indeed be in a sad situation if they were carrying anything of that weight. Obviously, it appears that what you intended as 3¼ pounds was translated by the gremlins on the linotype as 31 pounds.

I would appreciate it very much if you could arrange to print a clarification of this fact, since of course, as you can see, weight is a vital factor in this project.

RUSSELL NEWCOMB
Simmonds Aerocessories Inc.
Tarrytown, New York

Citizenship

DEAR SIRS:

IN THE COURSE of studying and enjoying your wonderful journal (July 1953) I have once more come across the remarkable statistics concerning supply and demand of electronics engineers in the United States.

For an engineer who watches the amazing scene of technical progress and initiative in the States, it is indeed tantalizing to see so many fascinating jobs going begging for want of occupants.

Naively I have written to a couple of firms advertising for engineers—only to obtain replies that they are very pleased to hear from me, but that unfortunately they work on Service contracts and

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are therefore not in a position to employ noncitizens.

I am a Bachelor of Electrical Engineering—a four-year course at the University of Melbourne, which I understand is higher than a first degree from U. S. universities. I also have an Arts degree, mostly in mathematics. I have five years experience in research and development work in telecommunications and a year of administrative experience. I am not a brilliant engineer—but I have a good deal of common sense.

I want nothing more at the moment than to see and work in the American electronics industry. Do you think there are any companies that do not work on classified work?

H. BARBER,
Department of Defence Production
Melbourne, Australia.

(Editor's Note: Many letters similar to the one printed above are received at this office. We would be interested in hearing from employers who have been successful in importing foreign engineers to help meet current needs.)

Tech Writer's Lament

PERHAPS you can use the enclosed outpouring of self pity. Actually it's not a bad business.

DEAR SIRS:

Tech Writers are a sorry breed
They worketh in a morass twixt the Arts and Sciences and brother to neither
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They labor long to pen a logical discourse from a mass of hazy data, preliminary drawings and development models never quite complete
They weave from such nebulous facts a script that an Engineer gleefully tears to shred with the barbs of second guesses
They must rewrite and revise and correct until there cometh the glorious day of final approval
They spendeth more endless hours of marking photos, checking drawing, correcting proofs and planning layout
They struggle on until out of all this travail a book is brought forth
They enjoyeth not the fruit of their labor for the good is forgotten and the bad lingers on to taunt them
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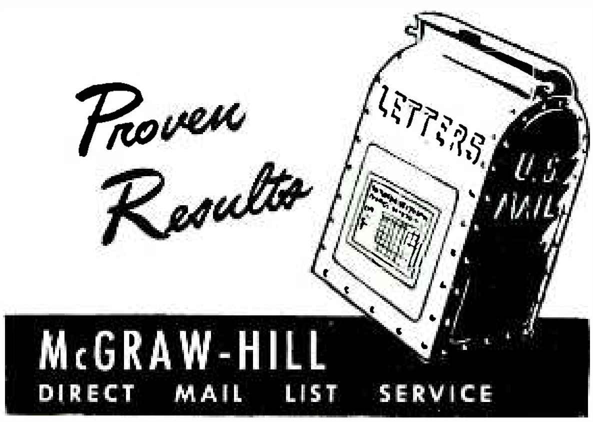

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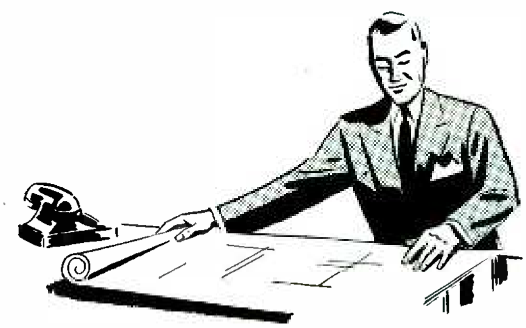

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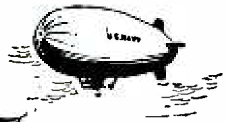

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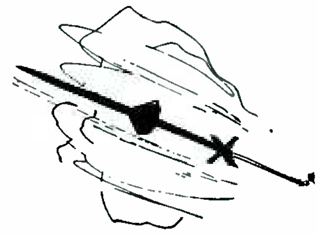

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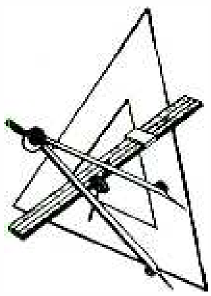

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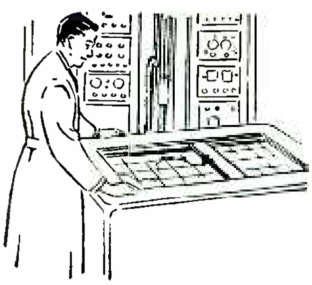

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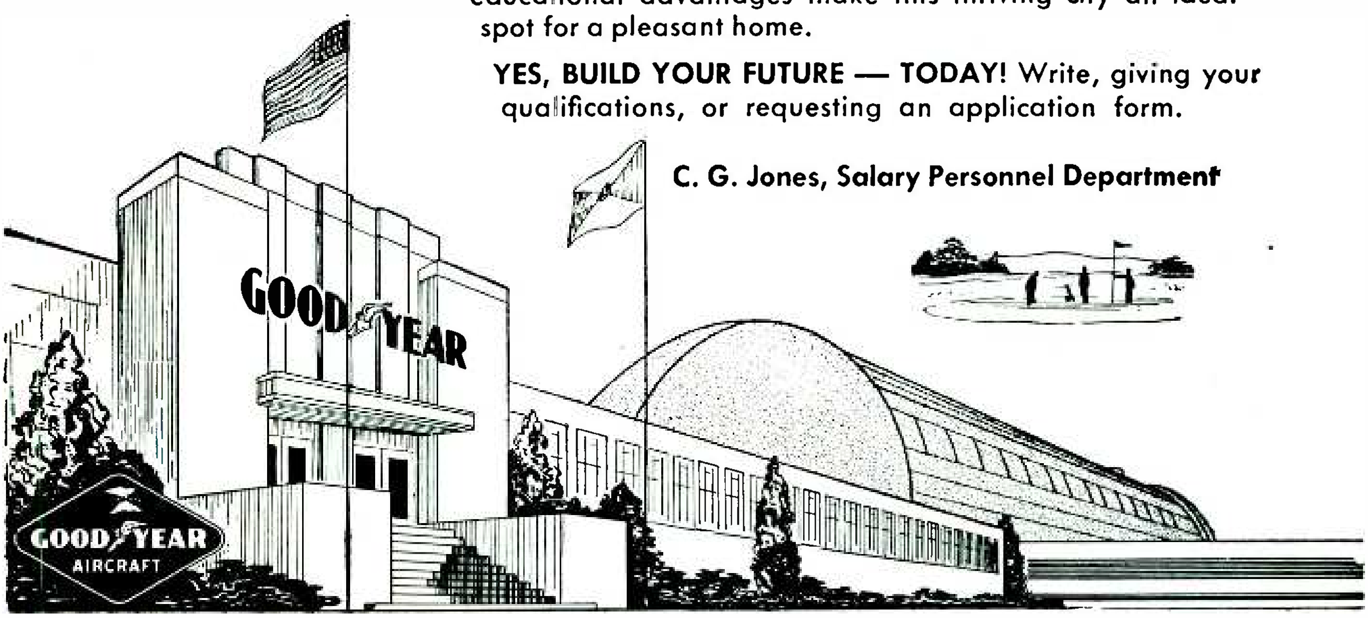

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Reply to Department A.

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Boonton Radio Corporation, Boonton, N.J.

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Pacific Division, Bendix Aviation Corporation, needs electronic field engineers to form a new Field Engineering Group offering excellent opportunities for growth. The job requires supervision of installation and maintenance, and instruction in the operation of Bendix airborne radar at aircraft plants and Air Force Bases within U. S. limits.

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Weston HIGH QUALITY TEST EQUIPMENT

WL-117 WAVEMETER

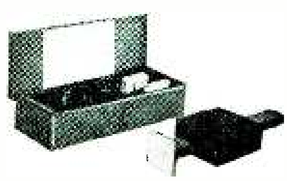
A precision wavemeter having a range from 2400 mc to 3400 mc with an accuracy of better than 0.1% over the entire range. The resonant cavity has a Q of not less than 1000 and normally from 1000 to 2000. The unit, supplied with a pickup dipole interconnecting cable and adapters, may also be used for relative field strength measurements.

PRICE: $390.00

WL-62 ECHO BOX

A portable ringing cavity for microwave research; the unit has a frequency range from 9320 to 9420 mc, with a Q of 50,000 to 80,000. The echo box is used for relative power measurements, spectrum analysis, frequency checks, tests for unstable operation and a host of other applications in the laboratory.

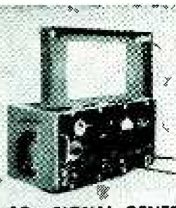
PRICE: $550.00



WL-108 TERMINATION

This 1" x ½" waveguide hi-power load is capable of dissipating a peak power of 200 kilowatts and an average power of 150 watts. The VSWR is less than 1.10 over the entire frequency range of 9300 to 9450 mc. All accessories including carrying case and coupling adapters are supplied with the unit.

PRICE: $90.00



WL-13 SIGNAL GENERATOR

A versatile x-band signal generator providing a source of pulsed or CW power and having provisions for square-wave and saw-tooth modulation. Accurate monitoring of the RF output is accomplished with a thermistor bridge and a calibrated attenuator. The power supply is electronically regulated to insure stable operation of the 723A/B Klystron oscillator.

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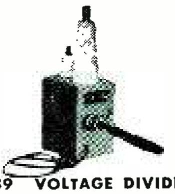

WL-89 VOLTAGE DIVIDER

An indispensable aid in high power radar and transmitter measurements this unit has provisions for 100:1 and 10:1 voltage division. It can be used with an oscilloscope to measure video pulses between 200 and 20,000 volts in high-impedance circuits. The ratio accuracy is within +15% and transmission is within 2 db from 150 cycles to 5 megacycles.

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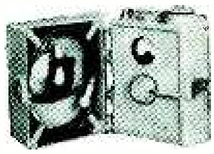
Equivalent to the TS-102/AP Range Calibrator, this crystal controlled pulse generator produces a square-topped, 50 volt synchronizing pulse of .8 microseconds at a prf of 400, 800, 1600 or 2000 cps. and a triangular marker pulse of 0.4 microseconds duration at a prf corresponding to a pulse-echo distance of 1500 ft. The phase between the marker and sync. pulses is continuously variable from —180 to +180 degrees.

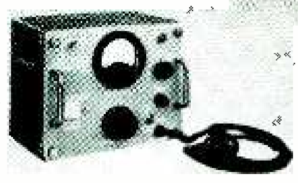
PRICE: $550.00



WL-125 POWER METER

This instrument is a compact, battery operated thermistor bridge designed to measure power in the range of 2400 to 3335 mc., and having a full-scale sensitivity of 2 milliwatts. Among other applications, it can be used to measure antenna patterns, check standing wave ratio and determine average or peak powers. A complete set of accessories, including a 10 db and 16 db attenuator pad for measuring higher power levels, are supplied with the unit.

PRICE: $390.00



SG-8/U NOISE GENERATOR

This popular model, employing a 5722 temperature limited diode as the R.F. noise source, can be used as an absolute means of receiver noise measurements as well as for fundamental studies. The normal input impedance is 270 ohms but a 50 ohm adaptor is supplied with the unit as a standard accessory.

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Provides a 50 ohm termination in the form of a 50 to 1 ratio voltage divider for making over-all performance tests on radar units such as the AN/APQ-7, 13, 13A, 23 and a host of other equipments in this frequency and power range. The 49 and 1 ohm resistor elements are carbon coated ceramic rods in helium filled glass tubes and are capable of dissipating up to 500 watts at a peak voltage of 5000 volts.

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PRICE:

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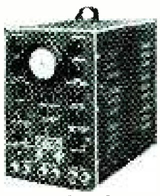
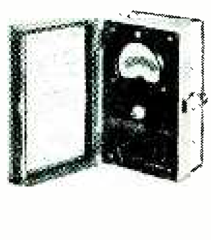
With Modulation	165.00
115v Power Supply	35.00



TS-100 OSCILLOSCOPE

This instrument can be used with a linear sweep as a general purpose test oscilloscope or it can be used with a circular sweep as a precision range calibrator. It has a PRF rate of 300 to 1500 per second. Trigger input — 15 volts at 100 volts per microsecond rise. Trigger output — 120 volts (+ 20 volts). It can be used for detecting "jitter" in trigger divider circuits and modulator trigger pulse, and also for determining and adjusting division rate.

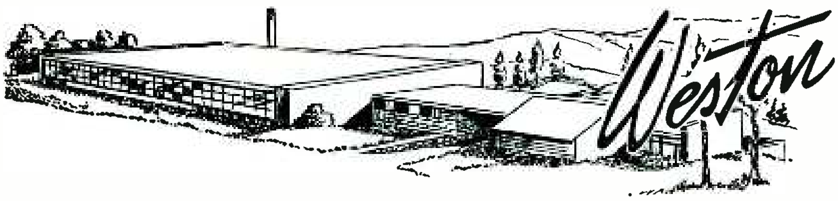
PRICE: $550.00



WL-268B/U CRYSTAL RECTIFIER TEST SET

A combination ohmmeter-ammeter designed to measure the electrical characteristics of microwave crystal rectifiers such as the 1N21 and 1N23 series. The instrument is completely self contained and requires only a single 1½ or 2-volts cell for operating power.

PRICE: $53.75



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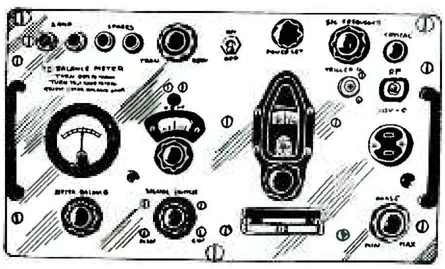
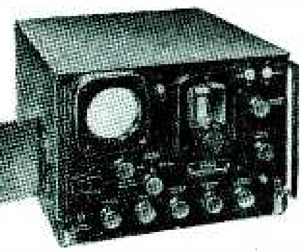
OB2	1.35	2J31	29.95	4C27	25.00	FG17	6.95	394A	5.00	803	7.95	958A	.69
OC3	1.25	2J32	69.95	4C28	35.00	KY21A	8.75	MX408U	.75	805	5.95	991	.65
OD3	1.25	2J33	69.95	4E27	17.50	FG33	12.95	417A	17.95	807	1.69	F1148	.35
C1B	3.95	2J34	69.95	4J25	199.00	35T	3.50	434A	19.95	808	3.50	1280	1.25
1B21A	2.75	2J36	105.00	4J26	199.00	45 Special	.35	446A	1.95	810	11.00	1611	1.95
1B22	3.95	2J38	17.95	4J27	199.00	RK39	2.95	446B	5.40	811A	3.95	1613	1.38
1B23	9.95	2J39	12.50	4J28	199.00	HF50	1.75	450TL	45.00	813	9.95	1616	2.95
1B24	15.00	2J40	35.00	4J29	199.00	VT52	.25	464A	9.95	814	3.95	1619	.89
1B26	2.95	2J42	150.00	4J30	199.00	RK72	1.10	471A	2.75	815	3.50	1622	1.75
1B27	13.50	2J49	109.00	4J31	199.00	RK-73	1.95	527	25.00	816	1.45	1624	2.00
1B32	4.10	2J50	95.00	4J32	199.00	100TH	9.95	WL530	3.50	829	12.95	1625	.45
1B42	19.95	2J61	45.00	4J33	199.00	FG95	24.95	WL531	22.50	829A	13.95	1851	1.85
1B50	25.00	2J62	45.00	4J34	199.00	FG105	24.00	WL533	17.50	829B	15.95	2050	1.85
1B51	9.95	2K25	29.50	4J35	199.00	203A	8.95	700A/D	25.00	830B	2.50	2051	1.80
1B56	49.95	2K28	37.50	4J36	199.00	211	.95	701A	7.50	832	7.95	8012	4.25
1B60	69.95	2K29	37.50	4J37	199.00	217C	18.00	703A	5.00	832A	9.95	8013	2.95
1N21	1.35	2K39	150.00	4J38	189.00	242C	10.00	705A	3.95	833A	49.95	8013A	5.95
1N21A	1.75	2K41	150.00	4J39	199.00	244A	12.95	706AY/FY	45.00	834	7.95	8014A	89.00
1N21B	4.25	2K45	149.50	4J40	199.00	249C	4.95	707A	17.95	836	4.95	8019	1.75
1N21C	23.00	2K48	170.00	4J41	199.00	250TH	22.50	707B	17.95	837	2.95	8020	3.50
1N22	1.75	2K50	350.00	4J42	250.00	250TL	19.95	714AY	17.95	838	6.95	8025	6.95
1N23	2.00	2K54	200.00	4J51	350.00	274A	3.00	715A	7.95	845	5.59	PD8365	99.00
1N23A	2.75	2K55	200.00	4J53	350.00	274B	3.00	715B	12.00	849	52.50	9001	1.75
1N23B	4.25	2K56	180.00	C5B	3.95	304TH	10.00	715C	25.00	860	4.95	9002	.95
1N34A	.96	2V3G	2.10	5BP1	6.95	304TL	12.00	717A	1.95	861	29.50	9003	1.75
1N43	2.50	3BP1	7.50	5BP4	6.95	307A	4.95	718AY/EY	48.05	866A	1.79	9004	1.75
2B4	1.50	3B24	5.50	5CP1	6.95	310A	5.95	719A	29.50	869B	69.00	9005	2.90
2B22	1.95	3B24W	7.50	5D21	21.00	310B	6.75	721A	3.95	869BX	50.00	9006	.35
2B26	3.75	EL3C	5.95	5JP1	27.50	311A	6.95	722A	3.95	872A	3.95		
2C34	.35	3C22	120.00	5JP2	19.50	312A	3.95	723A/B	24.95	878	1.95		
2C40	10.00	3C24	1.95	5JP4	27.50	323A	15.00	724A	4.95	880	300.00		
2C43	16.00	3C31	3.95	WE6AK5	2.50	327A	3.95	724B	6.95	884	1.95		
2C44	.90	3DP1A	10.95	C6A	12.50	328A	6.95	725A	9.95	885	1.75		
2C46	12.00	3DP1-52	12.00	C6J	10.95	350A	10.00	726A	24.00	889R	199.50		
2D21	1.75	3EP1	7.50	7BP7	7.95	350B	5.95	726B	56.00	914	75.00		
2E22	2.25	3E29	15.50	7DP4	10.00	352A	3.00	726C	69.00	931A	5.00		
2E30	2.75	3FP7	7.50	12AP4	55.00	357A	15.00	728AY/GY	27.00	954	.35		
2J21A	17.95	3HP7	7.50	12DP7	25.00	368AS	5.00	730A	24.00	955	.55		
2J22	17.95	4A21	2.75	15E	1.95	371B	1.95						

Thousands of other tubes



TS-147 C/UP TEST SET
Hard-to-get X-Band SIGNAL GENERATOR Now Available

Test Set TS 147 C/UP is a portable Microwave Signal Generator designed for testing and adjusting beacon equipment and radar systems which operate within the frequency range of 8500 MC to 9600 MC.



MICROWAVE TEST EQUIPMENT TS148/UP SPECTRUM ANALYZER

Field type X Band Spectrum Analyzer, Band 8430-9580 Megacycles.

Will check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q or resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, in carrying case.

Other test equipment, used checked out, surplus.

TSK1/SE K Band Spectrum Analyzer
TS3A/AP Frequency and power meter S Band
RF4A/AP Phantom Target S Band
TS12/AP VSWR Test Set for X Band
TS13/AP X Band Signal Generator
TS14/AP Signal Generator
TS33/AP X Band Power and Frequency Meter
TS34/AP Western El Synchroscope
T35/AP X Band Signal Generator
TS36/AP X Band Power Meter
1-96A Signal Generator
TS45 X Band Signal Generator
TS47/APR 40-400 MC Signal Generator
TS69/AP Frequency Meter 400-1000 MC
TS100 Scope
TS102A/AP Range Calibrator
TS108 Power Load
TS110/AP S Band Echo Box
TS125/AP S Band Power Meter
TS126/AP Synchroscope
TS147 X Band Signal Generator
TS270 S Band Echo Box
TS174/AP Signal Generator
TS175/AP Signal Generator
TS226 Power Meter
TS239A Synchroscope
TS239C Synshroscope

SURPLUS EQUIPMENT

APA10 Oscilloscope and panoramic receiver
APA38 Panoramic Receiver
APS 3 and APS 4 Radar
APR4 Receiver
APR5A Microwave Receiver
APT2 Radar Jamming Transmitter
APT5 Radar Jamming Transmitter

MINIMUM ORDER 25 Dollars

YOU CAN REACH US ON TWX NY1-3235

Cables: TELSERSUP

SPECIAL

Wide Band S Band Signal Generator 2700/3400MC using 2K41 or PD 8365 Klystron, Internal Cavity Attenuator, Precision individually calibrated Frequency measuring Cavity. CW or Pulse Modulated, externally or internally.

Large quantities of quartz crystals mounted and unmounted.
Crystal Holders: FT243, FT171B others.
Quartz Crystal Comparators.
North American Philips Fluoroscopes Type 80.
Large quantity of Polystyrene beaded coaxial Cable.

LIBERTY ELECTRONICS, INC.
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PHONE WORTH 4-8262

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Reliance Specials

SOUND POWERED HANDSET

Brand New

TS-10 Type—includes 5 ft. cord. USES NO BATTERIES OR EXTERNAL POWER SOURCE PAIR—$18.95

SOUND POWERED HEAD & CHEST SET

Navy Type M Head and Chest Set. Brand New For Work Requiring Free Use of Hands. Heavy Duty—Consists of Headset with 2 Phones and Chest Mike. Includes 20 Ft. Rubber Cord ....EACH $14.88

TELEPHONE FIELD WIRE

W-110-B

½ MILE COIL..... $7.95

1 MILE REEL.....$14.95

HAYDON TIMING MOTOR

1 R.P.M. 115 V., 60 Cycle...$1.95

TIMING MOTOR

8 RPM 115 V. 60 cyc

E. Ingraham Co.

$1.79

Timer—Industrial Timer Corp. 15 min. on 15 min. off continuous 115 V. A.C. Fully cased Plugs into octal socket $5.50

TIME DELAY RELAY

Raytheon CPX 24166

1 Min. Delay. 115 V., 60 Cycle

2½ second recycling time spring return • Microswitch contact, 10A • Holds ON as long as power is supplied • Fully Cased • ONLY $6.50

JONES BARRIER STRIPS

2-140Y	$0.17	2-141	$0.17	7-141¾W	$0.56
3-140	.18	3-141	.20	8-141	.44
3-140¾W	.21	3-141¾W	.27	8-141¾W	.64
4-140	.20	3-141W	.27	9-141Y	.71
6-140	.28	4-141	.24	9-141	.52
10-140W	.59	5-141	.29	2-150	.43
10-140¾W	.59	5-141¾W	.41	3-150	.60

PULSE TRANSFORMERS

UTAH 9262 3 windings-peak 200 VDC Current 10 MA. Turns Ratio 1-1-1 Impedance Variable 0-5000 ohm $12.50 ea.

MANY OTHER PULSE TRANSFORMERS IN STOCK DATA UPON REQUEST

3 AG FUSES

Amp.	Per 100	Amp.	Per 100	Amp.	Per 100
⅛	$4.00	¾	$4.00	8	$3.00
⅜	4.00	1	3.00	10	3.00
½	4.00	4	3.00	15	3.00
		5	3.00		

3 AG FUSE HOLDERS (Finger) 25¢

RESISTORS

Type EB ½W 10%..........6¢ ea. $4.00 per C
" EB ½W 5%..........12¢ ea. 8.00 per C
Type GB 1W 10%..........9¢ ea. 7.00 per C
GB 1W 5%..........18¢ ea. 14.00 per C
Type HB 2W 10%..........12¢ ea. 9.00 per C
HB 2W 5%..........24¢ ea. 18.00 per C

AVAILABLE IN ALL STANDARD RMA VALUES

POSTAGE STAMP MICAS

AVAILABLE IN ALL STANDARD RMA VALUES

PRICE SCHEDULE

5 mmf to 910 mmf..........5¢
.001 to .0013 mfd..........8¢
.0015 to .0056 mfd..........15¢
.0062 to .0091 mfd..........20¢
.01 mfd..........28¢

SILVER MICA—POSTAGE STAMP

AVAILABLE IN ALL STANDARD RMA VALUES

PRICE SCHEDULE

10 mmf to 910 mmf..........10¢
.001 mfd to .002 mfd..........20¢
.0022 mfd to .0091 mfd..........50¢
.01 mfd..........95¢

ASSORTMENTS

GEARS—100 SMALL GEARS, BUSHINGS & SHAFTS. $6.50

RESISTORS—200 ½ WATT ALL INSULATED AMERICAN MADE $2.50

HARDWARE—5 lbs. BOLTS—NUTS—LUGS—WASHERS ETC $2.00

PHOTO FLASH COMPONENTS

32 mfd 2500 V. DC Oil Filled Condenser......$15.80 ea.
30 mfd 2500 V. DC Oil Filled Condenser......$14.75 ea.
Transformer PRI 115 V 60 cy SEC. 900 V 10 MA. plus two 2.5 F windings for voltage doubling with 2X2 Tubes $3.95 ea.
CK 5517/CK1013 ....$2.25
2X2 Tubes..........Special..........2 for $1.00

AN CONNECTORS

See Our Ad February, 1953 Electronics

PHONE! WIRE! WRITE! YOUR NEEDS

TERMS — Cash with Order or 25% Deposit — Balance C.O.D. Net 10 Days to Rated Accounts. All Prices are Net F.O.B. Our Warehouse.

UNIVERSAL JOINTS ALUMINUM

¼" hole, ½" O.D. 1-⅛" long with two 6/32 tapped set-screw holes EACH 85¢

3/16" hole, ⅜" O.D. 1-⅛" long with two 6/32 tapped set-screw holes EACH ....80¢

OIL FILLED CONDENSERS

MFD	V.D.C.	Price	MFD	V.D.C.	Price
5.2	50	$0.89	0.5	3,000	$2.40
6	400	.85	2	3,000	4.50
3 x 3	400	1.00	2	4,000	7.95
4	500	.85	0.01	5,000	.95
1	600	.55	1	5,000	4.88
0.5-0.5	600	.40	0.03-0.03	6,000	1.50
2	600	.75	1	6,000	9.95
4	600	1.75	0.02-0.02	7,000	1.55
8	600	1.95	0.1	7,000	1.79
10	600	3.25	0.1-0.1	7,000	5.95
4 x 3	600	2.50	0.1	7,500	2.25
8-8	600	1.95	0.075-0.075	8,000	6.50
1	800	.60	0.15-0.15	8,000	6.95
1	1,000	.69	0.25	20,000	19.95
2	1,000	.95			
3	1,000	1.70			
1	1,500	1.45			
0.02	2,000	.65			
0.1-0.1	2,000	1.30			
0.1-0.5	2,000	.95			
0.5	2,000	1.65			
3	2,000	3.75			
8	2,000	7.95			
0.25	3,000	2.25			

1 mfd 6,000 V.D.C. G.E.

$9.95

OIL FILLED AC CONDENSERS

MFD	V.A.C.	Price	MFD	V.A.C.	Price
7.5	220	$2.00	15	440	$6.25
20	220	4.95	1	660	2.95
1	236	.49	2.9	660	4.35
4	236	1.60	3	660	4.45
8	236	1.95	4	660	4.95
3	330	1.45	5	660	5.45
4	330	2.25	6	660	5.95
20	330	6.75	8	660	7.50
25	330	7.50	0.2	750	.69
4.4	375	2.15			

COAXIAL CABLE CONNECTORS

A full line of jan approved connectors in stock

83-1AC	$0.42	PL-274	$1.10	UG-88/U	$0.90
83-1AP	.30	PL-275	2.10	UG-89/U	1.10
83-1BC	.35	SO-239	.40	UG-102/U	.80
83-1F	1.10	UG-13/U	1.70	UG-103/U	.68
83-1H	.12	UG-18B/U	1.05	UG-104/U	1.40
83-1HP	.22	UG-20B/U	1.60	UG-105/U	1.50
83-1J	.73	UG-21/U	.85	UG-106/U	.15
83-1R	.40	UG-21B/U	1.00	UG-107B/U	2.75
83-1RTY	.65	UG-21C/U	1.05	UG-146/U	2.00
83-1SP	.45	UG-21D/U	1.45	UG-167/U	3.75
83-1SPN	.50	UG-22/U	1.30	UG-175/U	.12
83-1T	1.30	UG-22A/U	1.60	UG-176/U	.12
83-2AP	1.95	UG-22B/U	1.20	UG-185/U	.95
83-2J	2.10	UG-23/U	1.20	UG-196/U	1.65
83-2R	1.65	UG-23B/U	1.50	UG-203/U	.65
83-22AP	1.40	UG-23C/U	1.10	UG-224/U	1.15
83-22F	2.10	UG-24/U	1.30	UG-255/U	1.95
83-22J	1.40	UG-27/U	1.25	UG-260/U	.85
83-22B	.68	UG-27A/U	2.25	UG-261/U	1.10
83-22SP	.80	UG-27B/U	2.95	UG-262/U	1.10
83-22T	1.95	UG-28A/U	2.95	UG-273/U	1.45
83-168	.12	UG-29B/U	1.75	UG-274/U	2.30
83-185	.12	UG-30/U	2.30	UG-290/U	.90
CW-123A/U	.45	UG-57B/U	1.85	UG-291/U	.95
M-358	1.30	UG-58/U	.70	UG-306/U	2.65
M-359	.30	UG-58A/U	.90	UG-414/U	1.95
M-359A	.65	UG-59A/U	1.90	UG-499/U	1.25
PL-258	.75	UG-88/U	1.75	UG-625/U	1.35
PL-259	.45	UG-85/U	1.65		
PL-259A	.50	UG-87/U	1.40		

NEW COAXIAL CABLES Jan approved

	Price per 1000 ft.		Price per 1000 ft.
RG5/U*	$140.00	RG22/U*	$150.00
RG6/U	180.00	RG22A/U	285.00
RG7/U*	85.00	RG24/U	675.00
RG8/U*	100.00	RG26/U	475.00
RG9/U*	250.00	RG29/U*	50.00
RG9A/U	275.00	RG34/U*	300.00
RG10/U	240.00	RG35/U	900.00
RG11/U*	100.00	RG41/U*	295.00
RG11A/U*	150.00	RG54A/U	97.00
RG12/U	240.00	RG55/U*	110.00
RG13/U*	216.00	RG57/U*	325.00
RG17/U	650.00	RG58/U*	60.00
RG18/U	900.00	RG58A/U*	70.00
RG19/U	1250.00	RG59/U*	60.00
RG20/U	1450.00	RG62/U*	75.00
RG21/U*	220.00	RG77/U*	100.00

Add 25% for orders less than 500 feet.

* No minimum order—other 250 minimum.

NEW RG-8/U Unmarked 100 Ft. Coil..Special $5.95

SELSYN MOTORS

Army Ordnance Type C-78248 115V, 60 Cy. Transmitter. Approx. 3-⅝" dia. x 5-⅜" L. Like new..EACH $27.50

SELSYN MOTORS

50 V. 50 Cy. High Torque. Connect in Series For Use On 110 V. 60 Cy. Approx. 3-⅝" dia. x 5-⅜" L. Like New ....ONLY $12.95 PAIR

DIFFERENTIAL Used $4.95

115 V., 60 Cycle #C78249 New $9.95

3⅝" dia. x 5⅜" long

Used between two C78248's as a dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted)..........$5.50

Mounting Brackets—Bakelite for selsyns, and differentials shown above..........35¢ pair

PRECISION RESISTORS (WIRE WOUND SPOOL TYPE)

½ watt one percent tolerance WW3 or Equal 35¢ ea.

.250	7.4	19.37	105.8	400	5000	20K
.334	9.1	20	123.8	414.3	5900	25K
.502	10.48	25	125	705	6500	30K
.557	10.84	30	130	723	7000	32.89K
.627	11.1	46	147.5	750	7500	33.3K
.760	11.25	50	180	855	8000	35.89K
1	11.74	52	210	2193	8500	36K
1.01	12.32	55.1	220.4	2200	8800	37K
1.53	13	62.54	235	2250	10K	40K
2	13.02	75	260	2500	12K-2%	47K
2.04	13.15	79.81	270	2850	14.82K	50K
2.53	13.52	87	298.3	3427	15K	59K
3.54	13.89	97.8	301.8	4000	15.75K	59.15K
5.26	14.98	100	366.6	4300	16.7K	79.01K
				4451	17K	125K

1 watt one percent tolerance WW4 or Equal 45¢ ea.

.861	3.39	20	270	2000	7000	50K
1.01	5.1	28	425	2200	8000	55K
2.55	5.21	38	1250	3300	9000	80K
2.58	12	50	1750	6000	20K	

1 watt one percent tolerance WW4 or Equal 60¢ ea.

100K	128K	150K	240K	320K	500K	600K
120K	130K		250K			

1 watt WW5 or Equal 65¢ ea.

84K-2% 522K-1% 645K-1% 700K-1% 1 meg-5%

1 MEGOHM 1 WATT 1% $1.50

TYPE "J" POTENTIOMETERS

Ohms	Shaft	Ohms	Shaft	Ohms	Shaft
100	SS*	2.5K	SS	100K	7/16
150	SS	3.0K	3/8	200K	SS
150	SS*	4.0K	3/8	250K	5/8
500	1/4	15K	3/8	250K	SS
1.0K	9/16	25K	SS	1.0 Meg.	1/4
1.5K	5/16	75K	SS		
2.0K	1/4	100K	3/8		

SS: Screw-driver slot.
*: Split locking bushing.

$1.25 EACH

TYPE "JJ" POTENTIOMETERS

Ohms	Shaft	Ohms	Shaft	Ohms	Shaft
10K-10K	5/16	30K-10K	⅜†	90K-3K	¼
15K-15K	SS	† With switch.			

PRICE—$2.50 EACH

High Current Filament Transformer

Amertran type W Pri. 105-125 V. 60 cy. 1 Phase—Sec. 5V. 190 amps.—.97 KVA 35 KV. RMS Insul. Test 7x10x12; Wt. 80 lbs. Ideal For Use As Arc Welder. SPECIAL $29.50 ea.

Kenyon S-14940 S.C. #2Z9943-1073 Pri. 105-125 V. 60 Cy. Sec. 5V. 115 Amps..........$19.50 ea.

FILTER CONDENSER SPECIAL

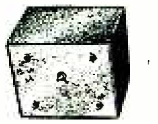
4 MFD 1000VDC oil filled 2¾x2⅜x4½"..........$1.59 ea.

RAYTHEON PLATE TRANSFORMER

TYPE U8355A

PRI. 110V/220V/440V/60 cy.
SEC #1 300V @ 4 AMPS. SEC. #2 300V @ 4 AMPS. 1780 RMS TEST, 9¾"x9½"x8½" HIGH. $19.95

Choke 10 hy
400 MA
90 OHMS
HERMETICALLY SEALED



$4.88

STORAGE BATTERIES

BB-54 Willard 2 volt 20 amp. hrs. built in charge indicator 4 x 3 x 5½ high—BRAND NEW $1.95 ea. 100 lots ....$1.75 ea. 1000 lots ....$1.50 ea.

BB-212/U 2 volt 40 amp. hrs. 6⅞ x 2⅜ x 4½ high BRAND NEW ....$2.35 ea.

400 CYCLE INVERTERS

Leland Electric Co.

#10800 in: 20-28 V.D.C., 92 A. 8000 R.P.M. Out: 115V. 400 Cyc. 1 phase, 1500 V.A. 90 PF..........$29.50

Minimum Orders $3..........Get on our Mailing List

RELIANCE MERCHANDIZING CO.

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GUARANTEED BRAND NEW

"LECTRONIC" RESEARCH TUBE SPECIALS

STANDARD BRANDS ONLY

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Receiving Tubes

Type No.	Price
OOA	$1.50
O1A	.67
OZ4	.59
OZ4A	.63
1A3	.71
1A5GT	.72
1A7GT	.79
1AB5	1.30
1B3GT	.99
1B4P	.79
1B5	.74
1C5GT	.85
1C6	.69
1C7G	.69
1D5GP	.69
1D8GT	.99
1E5GP	.71
1F4	.69
1F5G	.69
1F6	.71
1G4GT	.69
1G5G	.69
1G6GT	.69
1H4G	.89
1H5GT	.69
1H6G	.75
1H6GT	.79
1J5G	.74
1J6G	.69
1L4	.69
1LA4	.87
1LA6	.99
1LB4	1.01
1LC5	.81
1LC6	.93
1LD5	.93
1LE3	.93
1LH4	.82
1LN5	.74
1N5GT	.83
1N6G	.75
1P5GT	.69
1Q5GT	.99
1Q6	.99
1R4	.69
1R5	.79
1S4	.71
1S5	.69
1T4	.71
1T5GT	.71
1U4	.73
1U5	.77
1V	.65
1X2A	.93
2A3	1.28
2A5	.79
2B7	.79
2E5	.94
2X2	.50
2X2A	1.85
3A4	.65
3A5	.95
3A8GT	1.50
3B7	.57
3C6	1.15
3D6	.57
3Q4	.77
3Q5GT	.83
3S4	.77
3V4	.79
5AZ4	.54
5R4GY	1.59
5T4	1.91
5U4G	.59
5V4G	.98
5W4	.82
5X4G	.79
5Y3GT	.47
5Y4G	.71
5Z3	.87
5Z4	1.40
6A3	1.28
6A6	.82
6A7	1.05
6A8	.95
6AB4	.83
6AB7	.98
6AC5GT	1.19
6AC7	.85
6AC7W	3.25
6AD6G	.98
6AD7G	1.29
6AE6G	.89
6AF6G	.89
6AG5	.79
6AG7	1.45
6AH6	1.29
6AJ5	1.95
6AK5	.84
WE-6AK5	1.85
6AK5W	2.95
6AK6	.99
6AL5	.59
6AL5W	2.65
6AQ5	.72
6AQ6	.79
6AQ7GT	1.26
6AR5	.79
6AS5	.99
6AS6	2.25
6AS7G	4.25
6AT6	.63
6AU5GT	1.21
6AU6	.65
6AV6	.55
6B4G	1.25
6B5	1.20
6B7	.95
6B8	.75
6B8G	.75
6BA6	.65
6BA7	1.20
6BC5	.88
6BC7	1.10
6BD5GT	1.60
6BD6	.85
6BE6	.65
6BF5	1.10
6BF6	.83
6BG6G	1.89
6BH6	.95
6BJ6	.95
6BK7	1.60
6BL7GT	1.45
6BN6	1.59
6BQ6GT	1.26
6C4	.55
6C5	.70
6CB6	.79
6C6	.73
6C8G	.96
6CD6G	2.21
6CL6	1.50
6D6	.88
6D8G	.83
6E5	1.10
6F5GT	.83
6F6	.99
6F6G	.87
6F7	1.05
6F8G	.91
6G6G	.99
6H6	.66
6H6GT	.66
6J5	.59
6J5G	.61
6J5GT	.55
6J6	.95
6J6W	1.75
6J7	.99
6J7GT	.79
6J8G	1.28
6K5GT	.99
6K6GT	.65
6K7	.79
6K7G	.86
6L5G	1.06
6L6	1.87
6L6G	1.49
6L6GA	1.39
6L7	.99
6L7G	.85
6N7	.99
6N7GT	.89
6P5GT	.96
6Q7	.89
6R7	.79
6S4	.72
6S7	1.06
6S7G	.99
6SA7	.71
6SA7GT	.67
6SB7Y	1.04
6SC7	.93
6SD7GT	.94
6SF5	.83
6SF5GT	.80
6SF7	.75
6SG7	.75
6SH7	.75
6SH7GT	.75
6SJ7	.71
6SJ7GT	.69
6SJ7Y	.85
6SK7	.72
6SK7GT	.72
6SL7GT	.81
6SN7GT	.73
6SN7-WGT	2.10
6SQ7	.65
6SQ7GT	.65
6SR7	.63
6SS7	.99
6ST7	1.05
6T7G	1.23
6T8	.98
6U5	.98
6U7G	.65
6V6	1.49
6V6G	.89
6V6GT	.67
6W4GT	.64
6W6GT	.88
6X4	.59
6X5GT	.59
6Y6G	.89
6ZY5G	.89
7A4	.76
7A5	.79
7A6	.75
7A7	.76
7A8	.78
7AD7	1.44
7AH7	1.08
7B4	.79
7B5	.79
7B6	.79
7B7	.79
7B8	.78
7C4	.45
7C5	.79
7C6	.79
7C7	.79
7E5	.79
7E6	.58
7E7	.83
7F7	.99
7F8	1.35
7G7	.89
7H7	.79
7J7	1.10
7K7	1.10
7L7	.97
7N7	.97
7Q7	.79
7R7	.94
7S7	1.11
7V7	1.11
7W7	1.11
7Y4	.73
7Z4	.79
10	.39
12A	.65
12A6	.64
12A6GT	.64
12A7	1.16
12A8GT	.77
12AH7GT	1.32
12AL5	.79
12AT6	.55
12AT7	.99
12AU6	.71
12AU7	.86
12AV6	.54
12AV7	.99
12AW6	1.20
12AX7	.99
12BA6	.69
12BA7	.95
12BD6	.99
12BE6	.66
12C8	.65
12F5GT	.79
12H6	.69
12J5GT	.55
12K8	.70
12Q7GT	.67
12SA7	.69
12SA7GT	.69
12SC7	.90
12SF5	.79
12SF5GT	.79
12SF7	.85
12SG7	.85
12SH7	.73
12SJ7	.71
12SJ7GT	.65
12SK7	.69
12SL7GT	.93
12SN7GT	.89
12SQ7	.69
12SQ7GT	.68
12SR7	.79
12SR7GT	.79
12X3	.89
12Z3	.89
14A4	.97
14A7	.74
14B6	.74
14B8	.89
14C5	1.10
14C7	.93
14E6	.99
14E7	1.09
14F7	.89
14H7	.89
14J7	.89
14N7	.89
14R7	.89
14S7	.89
14W7	.89
14X7	.89
19	.89
19T8	.99
22	1.16
24A	.89
25A6	1.16
25L6GT	.69
25Z5	.79
26	.79
27	.69
28D7	1.95
30	.70
30 Spec.	.45
31	.54
32	.69
32L7GT	.87
33	.69
34	.69
35/51	.59
35A5	.72
35B5	.75
35L6GT	.67
35W4	.55
35Y4	.72
35Z4GT	.69
35Z5GT	.55
36	.64
37	.69
38	.69
39/44	.59
41	.71
42	.79
43	.79
45	.79
45Z5GT	.89
46	.81
47	.99
50	1.09
50A5	.89
50B5	.69
50C5	.69
50L6GT	.63
50Y6GT	.92
55	.99
L55B	.32
56	.69
57	.69
58	.69
59	1.24
70L7GT	1.29
71A	.79
75	.85
76	.69
77	.69
78	.79
79	.89
80	.59
81	1.41
82	1.19
83	1.11
83V	1.25
84/6Z4	.75
85	.79
89Y	.55
117N7GT	1.89
117P7GT	1.89
117Z3	.65
117Z6GT	.97
FM-1000	1.59

Transmitting and special Purpose Tubes

Type No.	Price
OA2	$ .95
OA3	1.15
OA4G	1.25
OB2	1.10
OB3	1.19
OC3	1.10
OD3	.95
1B21A	2.65
1B22	2.50
1B23	9.60
1B24 West	12.95
1B24 Sylv.	18.95
1B24A	39.50
1B26	3.73
1B27	14.95
1B29	2.75
1B32	3.75
1B35	11.00
1B36	12.50
1B37	14.70
1B38	32.50
1B40	4.95
1B41	51.94
1B42	9.80
1B49	50.33
1H20	.88
1P21	35.00
1P23	4.10
1P24	1.27
1P29	2.89
1P30	2.85
1Q23	122.50
1S21	9.50
1Z2	3.75
2A4G	1.22
2AP1	8.95
2AP5	8.95
2B4	2.10
2B22	2.20
2C21	.65
2C22	.45
2C26	.39
2C26A	.49
2C33A	4.95
2C34	.49
2C39	22.00
2C39A	29.00
2C40	12.00
2C42	23.75
2C43	17.75
2C44	1.20
2C46	21.50
2C51	5.75
2C53	11.75
2D21	1.55
2E22	1.85
2E24	4.10
2E26	3.79
2J21	8.75
2J22	8.95
2J26	24.75
2J27	22.95
2J31	27.00
2J32	36.50
2J33	39.50
2J34	27.00
2J37	13.70
2J38	17.50
2J39	36.50
2J40	34.50
2J48	49.50
2J49	65.00
2J50	39.50
2J54	67.50
2J56	148.50
2J61	45.25
2J66	165.00
2K23	37.50
2K25	28.50
2K26	78.50
2K28	29.50
2K29	27.50
2K33	265.00
2K33A	280.00
2K39	135.00
2K45	129.50
2K55	135.00
3AP1	8.95
3AP4	10.25
3B22/EL-1C	2.60
3B24	5.20
3B24W	7.50
3B25	4.50
3B26	3.75
3B27	4.20
3B28	7.75
3BP1	5.75
3C22	89.50
3C23	9.65
3C24	1.85
3C27	6.95
3C31/EL-C1B	3.95
3C37	32.50
3C45	12.95
3CP1	2.25
3D21	2.98
3DP1	4.85
3DP1A	6.75
3E29	13.75
3EP1	4.75
3FP7	2.90
3FP7A	6.95
3GP1	3.95
3HP7	3.95
3J31	145.00
4-125A	29.50
4-250A/5D22	35.00
4A1	1.18
4AP10	4.40
4B22/EL-5B	8.95
4B24	5.75
4B25/EL-6CF	8.95
4B32	10.50
4C27	17.50
4C35	27.00
4E27	21.50
4J36	150.00
4J38	120.00
4J52	275.00
4X150A	36.00
4X500A	118.50
4X1000A	129.36
5AP1	5.95
5AP4	4.75
EL-C5B	3.95
5BP1	5.50
5BP4	5.50
5C22	47.75
5CP1	4.95
5CP7	9.50
5D21	19.50
5D22/4-250A	35.00
5FP7	1.95
5HP1	5.50
5HP4	5.75
5J26	325.00
5J29	18.50
5JP1	26.50
5JP2	26.50
5JP4	26.50
5LP1	21.75
5LP5	19.75
5MP1	10.50
6-8B	.85
C6A	6.75
6AN5	3.30
6AR6	3.25
6C21	27.50
6C24	52.50
6F4	5.95
C6J	9.95
6J4	6.85
7-7-11	1.19
7BP1	8.65
7BP7	6.50
7BP12	14.95
7BP14	14.95
7CP1	14.95
9GP7	11.75
9LP7	4.50
10FP4	22.50
10T1	.88
10Y	.39
12DP7	14.50
12GP7	18.50
12HP7	14.75
13-4	.80
13T4	.85
15E	1.95
15R	.65
FG-17/5557	4.95
RK-19	1.85
21-2	.65
RK-21	1.65
REL-21	1.95
23D4	1.15
24G	1.85
RK-25	3.82
FG-27A	8.25
FG32/5558	6.75
FG33	22.54
RK34	.49
35T	4.95
35T ION gauge	5.95
35TG	4.95
REL 36	.45
T-40	3.75
FG-41	122.50
RK-47	4.92
CE-48	1.90
EF-50	.79
VT-52	.45
53A	5.60
RK59	2.44
QK-60	65.00
SK-60	6.62
QK-61	65.00
QK-62	65.00
VT-62 Br	1.15
RK-63	22.50
FG-67	14.80
VT-67	.48
RK-69	2.25
72	1.32
73	1.32
RK-75	4.25
75T	5.80
VR-75	1.15
VR-78	.64
FG-81A	3.95
VR-90	1.19
91	14.80
FG-95/5560	25.00
VT-98/Br	19.50
C100A	2.30
C100E	2.30
100R	2.90
100TH	9.95
WE-101F	3.62
WE-102F	2.85
FG-104/5561	24.60
FG-105	19.50
VR-105	1.10
VU-111S	1.60
WE-113A	1.32
HY-114B	.75
WE-117A	.95
F-123A	7.75
WE-124A	3.80
F-127A	22.50
VT-127A	3.60
AB-150	12.50
VR-150	.95
FG-166	48.50
FG-172	29.50
FG-178	14.50
FG-190	12.15
HF200	16.50
L-200B	65.00
203A	7.40
203B	6.33
204A	47.50
CE-206	3.15
211	.95
WE-211D	12.50
WE-211E	12.50
212E	42.50
WE-215A	.24
217C	8.95
WE-220B	155.00
221A	1.95
227A/5C27	4.60
WE-231D	2.25
232CH	240.00
RX-233A	4.95
FG-235A/5552	94.50
WE-245A	2.35
WE-249B	4.50
WE-249C	4.50
250R	17.50
250TH	22.50
250TL	22.50
WE-254A	5.90
WE-257A	3.77
FG-271/5551	62.50
WE-274A	5.50
274B	2.85
WE-275A	6.95
WE-283A	4.25
WE-285A	5.57
WE-294A	5.75
304TH	8.75
304TL	8.75
307A	4.25
WE-310A	6.25
312A	3.95
WE-313C	4.15
316A	.89
TR-317	18.50
327A	4.25
WE-331A	9.75
WE-343A	185.00
WE-346A	2.75
WE-350A	6.95
350B	4.95
WE-356B	5.45
368A	6.95
371A	.95
371B	.95
388A	2.95
393A	8.60
394A	4.50
WE-399A	4.70
410R	185.00
414	118.60
GL-415/5550	39.50
417A	16.95
434A	24.50
446	1.75
446A	1.95
446B	2.95
450TH	42.50
450TL	42.50
451	5.75
471A	2.65
473	140.25
481A	4.31
502A	1.67
503AX	1.25
506AX	1.25
507AX	1.47
527	17.50
530	22.00
531	7.50
532A	3.75
WL-533	19.50
559	2.20
561	3.50
575A	20.58
579B	14.70
KU610	21.56
HY615	.49
616	213.75
KU-623	39.50
624	47.00
KU-627	19.80
KU-628	22.50
KU-629	11.70
631P1	5.00
WL-632B	26.10
KX642	11.34
WL-652/5551	62.50
WL-654/659	82.00
WL-670A	8.70
WL-672	22.00
672A	34.30
KU-676	52.25
677	52.25
678	46.06
WL-681/5550	49.00
700A	24.50
700B	24.50
700C	24.50
700D	24.50
701A	6.95
703A	5.95
704A	.95
705A	2.25
706AY	45.00
706BY	45.00
706CY	45.00
706FY	45.00
706GY	45.00
707A	7.95
707B	14.90
708A	4.75
709A	3.85
710A	1.70
713A	1.45
714AY	10.75
715A	6.25
715B	8.95
715C	19.50
717A	1.47
718AY	45.00
718BY	45.00
720DY	95.00
721A	3.95
722A	2.25
723A	9.95
723A/B	18.50
724A	3.22
724B	3.22
725A	8.95
726A	14.50
726B	45.00
726C	65.00
730A	25.00
788Y	1.40
800	1.75
801A	.45
802	3.30
803	4.95
805	4.50
806	33.50
807	1.65
808	2.65
809	3.60
810	10.95
811	3.60
811A	4.25
812A	3.50
813	10.50
814	3.95
815	5.25
816	1.45
826	1.25
828	9.60
829	9.95
829A	11.95
829B	12.95
830B	2.95
832	7.95
832A	9.95
833A	39.50
836	4.10
837	1.45
838	3.75
841	.49
843	.59
845W	6.75
849	29.50
851	67.00
852	19.50
857B	204.78
858	498.00
860	4.95
861	22.50
864	.35
865	1.28
866A	1.48
866A Jr./2B26	1.25
868	1.74
869B	125.40
872A	3.95
874	1.35
876	1.60
878	1.85
880	460.00
884	1.75
885	1.75
886	2.60
889A	179.00
889RA	289.10
891	218.54
892	218.54
892R	355.76
893A	617.40
893AR	1127.00
895	931.00
895R	1274.00
902P1	9.95
905	3.50
913	11.25
917	3.43
919	1.95
920	3.74
923	1.35
924	2.97
925	2.16
926	2.61
927	1.85
928	2.57
931A	5.00
954	.39
955	.55
956	.49
957	.49
958A	.69
959	2.25
991	.45
1003	.63
CK-1005	.69
CK-1006	3.30
CK-1013/5517	2.25
1201	.79
1203	.45
1291	.57
1294	.69
1299	.57
1602	2.25
1613	.89
1614	2.00
1616	1.07
1619	.39
1620	6.25
1622	2.25
1623	3.99
1624	1.90
1625	.39
1626	.30
1629	.30
1630	.95
1631	1.38
1632	.75
1633	1.00
1636	3.10
1642	.65
1644	.95
1655	1.90
1656	6.50
1665	1.80
1904	14.80
1960	.70
2002	4.85
2050	1.70
2051	1.10
5516	7.70
5517/CK-1013	2.25
5518	514.59
5549	362.00
5550	49.00
5551	62.50
5552	94.50
5553	251.70
5554	180.55
5555	314.00
5557	4.90
5558	6.75
5559	19.15
5560	25.01
5561	24.60
5581	2.00
5582	2.63
5583	2.90
5584	3.89
5588	117.68
5592	1204.40
5593	85.72
5604	529.20
5610	2.10
5611	115.09
5619	382.20
5621	13.20
5622	12.23
5623	13.25
5624	13.23
5626	22.03
5627	26.45
5628	25.46
5629	20.48
5651	2.78
5654	2.95
5663	1.86
5664	9.24
5665	55.64
5670	4.10
5671	1225.00
5674	85.75
5675	16.95
5683	9.24
5685	31.27
5686	3.68
5687	4.80
5691	8.55
5692	8.55
5693	6.95
5696	1.87
5713	173.48
5718	9.33
5719	8.33
5720	22.54
5725	4.16
5726	1.72
5727	3.43
5734	17.63
5736	156.80
5740	73.50
5741	83.30
5742	14.21
5743	13.72
5749	1.96
5750	2.45
5751	3.43
5763	1.72
5770	975.10
5771	532.14
5779	78.40
5786	76.44
5794	16.43
5796	13.47
5814	3.43
5822	140.14
5826	1274.00
5830	196.00
5840	10.54
5846	126.40
5855	75.46
5876	18.38
5879	1.72
5890	25.48
5893	19.20
5896	7.10
5899	10.53
5902	10.78
5915	1.18
5934	14.70
5936	1078.00
5939WA	47.04
5974	215.60
6005	3.68
6012	4.41
6026	2.89
6072	5.39
6082	5.19
6095	1.45
6096	1.65
6099	3.95
6101	2.95
6135	2.69
6136	3.19
6137	2.45
6159	4.80
6201	5.39
UX6653	.65
7193	.45
8000	10.15
8003	13.72
8011	.87
8012	2.60
8013	2.75
8013A	4.90
8014A	55.00
8016	1.05
8020	1.25
8025	6.95
8025A	4.75
9001	1.50
9002	.95
9003	1.50
9004	.45
9005	1.95
9006	.35
189048	3.79
189049	3.79
199698	2.69

Crystal Diodes

Type No.	Price
1N21	$1.19
1N21A	1.69
1N21B	3.00
1N22	1.25
1N23	1.95
1N23A	2.75
1N23B	3.45
1N27	1.79
1N31	7.90
1N34	.66
1N34A	.90
1N38	1.50
1N38A	2.55
1N39	6.10
1N41	9.85
1N42	18.00
1N43	1.65
1N45	.94
1N52	1.05
1N55	3.05
1N60	.55

GENERATORS AND INVERTERS

Pioneer 716-3A GENERATOR (NAVY NEA-3A)—Out—AC 115V 10.4A 800 to 1400 cy. 1 ph.—DC 30V 60 A. Brand New $38.50

Pioneer 1235-3A GENERATOR—Out—30VDC 15A. Brand New—original packing $15.50

Pioneer 12133-1A INVERTER—28VDC to 115 VAC 400 cy. 3 ph. 250VA 0.8 PF—Volt & Freq. Regulated $225.00

Pioneer 12137-1A INVERTER—24VDC to 115VAC 400 cy. 3 ph. 250VA Volt & Freq. Regulated $225.00

PE-109D INVERTER—13.5VDC to 115 VAC 400 cy. 175VA 1 ph. Brand New $79.50

PE-218 INVERTER—28VDC to 115VAC 400 cy. 1500VA. New $49.50

Pioneer 800-1B INVERTER—28VDC to 120VAC 800 cy. 7A. Used $22.65

G.E. INVERTER—28VDC to 120VAC 800 cy. 750VA 1 ph. $39.50

ATR INVERTER—6VDC to 110VAC 60 cy. 75 W $22.95

Pioneer 12121-1A INVERTER—24VDC 18A. input—AC output 115V 400 cy. 3 ph. 250 VA 0.7A. Volt & Freq. Regulated—New $225.00

Pioneer 12116 INVERTER—28VDC to 115VAC 400 cy. 1 ph. 50VA $79.50

Pioneer 12117 INVERTER—28VDC to 26VAC 400 cy. 1 ph. 6VA $33.50

Leland 10563 INVERTER—28VDC to 115VAC 400 cy. 3 ph. 115VA $75.00

REVERSIBLE GEAR HEAD MOTORS

G.E. 5BA10AJ65—27.5 VDC .66A 2.35 RPM 8 oz-ft Torque $27.50

G.E. 5BA10FJ18—24 VDC .51A 9.5 RPM 10 oz-in Torque $22.50

G.E. 5BA10FJ19—24 VDC .51A 56 RPM 12 oz-in Torque $22.50

G.E. 5BA10AJ41—PM 24 VDC .55A 140 RPM 10 oz-in Torque $22.50

G.E. 5BA10AJ52—27 VDC .7A 145 RPM 14 oz-in Torque $19.50

Delco 5069230—PM 27VDC 145 RPM $19.50

Delco 5068750—27 VDC 160 RPM $22.50

G.E. 5BA10AJ51—27 VDC 160 RPM .65A 8 oz-in Torque $19.50

Delco 5069600—PM 27 VDC 250 RPM $22.50

G.E. 5BA10AJ8—27 VDC 250 RPM .72A 8 oz-in Torque $19.50

Delco 5067127—PM 27.5 VDC 250 RPM $22.50

Delco 5068820—PM 27 VDC 250 RPM $22.50

G.E. 5BA10AJ37B—27 VDC 250 RPM 8A 8 oz-in Torque $19.50

TACHOMETER GENERATOR

Elnico type PM-1M. DC Tachometer Generator-New **$27.50**

OIL FILLED CONDENSERS

MFD	VDC	Price	MFD	VDC	Price
2	400	$ .55	.5	3000	2.40
5-5	400	1.65	1	3000	$3.40
1	600	.55	2	3000	5.85
2	600	.69	3 x .2	4000	2.95
2-2	600 R'd	1.65	2	4000	7.95
3	600	.95	1	5000	5.75
4	600	1.65	2	5000	12.50
4	600 R'd	1.65	5	5000	29.50
5	600	1.75	.01-.03	6KV	1.65
6	600	1.85	1	6000	9.95
8	600 R'd	1.85	.1	7000 R'd	1.79
4-4-4	600	2.50	.1-1	7000	5.95
4 x 3	600	2.50	.1	7500	2.85
10	600	3.25	.5	7500	7.95
50	600	7.95	1-1	7500	26.50
1	1000	.65	.075-.075	8 KV	6.50
2	1000	.90	1	10KV	29.50
2	1000 R'd	.95	.1	12KV	8.95
3.5-.5	1000	1.85	1	15KV	47.50
4	1000	1.95	.25	20KV	19.95
6	1000	2.50	1	20KV	54.00
8	1000	3.25	1	25KV	85.00
1	1200	.85	.001	50KV	24.50
1-1-1	1200	1.85	.005	50KV	34.50
.1	1500	.69	.025	50KV	37.50
3	1500	2.50	.2	50KV	67.50
4	1500	2.95	.25	50KV	70.00
.1-.5	2000	.95	7.5	220VAC	1.95
.25	2000	1.50	20	236VAC	3.95
.3	2000	1.30	1-3	330VAC	1.95
1	2000	1.95	12.75	330VAC	4.10
12	2000	8.95	15	330VAC	4.50
1	2500	2.75	5	440VAC	3.10
1-1	2500	3.85	2.9	660VAC	3.50
30	2500	14.75	7	660VAC	4.25
32	2500	15.90	8	660VAC	4.50

OILMITES

MFD	V.	TYPE	Price
.02	600	OM-6002	$ .45
.05	600	OM-6005	.48
.1	600	OM-610	.51
.25	600	OM-625	.55
.5	600	OM-650	.60
1.0	600	OM-601	.85

2 ϕ LOW INERTIA SERVO MOTORS

Diehl FPE-25-11—75V 60 cy. .11 Amp 4 Watts. Each $34.50

KOLLSMAN—45 Volt 60 cycle 4 watts 1500 RPM—new $22.50

PIONEER—10047-2-A 26 volt 400 cycle with 40:1 reduction gear $14.50

Minn. Honeywell type—115V 60 cy. 13.5W—Brown Instr. 76750-1 162 RPM; 76750-2 54 RPM; 76750-3 27 RPM. Any Type .... $19.50 ea.

COAXIAL CONNECTORS

83-1AC	$ .42	83-1RTY	$ .65	83-22J	$1.40
83-1AP	.30	83-1SP	.45	83-22R	.68
83-1F	1.10	83-1SPN	.50	83-22SP	.80
83-1H	.12	83-1T	1.30	83-22T	1.95
83-1HP	.22	83-2AP	1.95	83-168	.12
83-1J	.73	83-22AP	1.40	83-185	.12
83-1R	.40	83-22F	2.10	86-765	.24
				83-776	.65

UG-7/AP	$6.30	UG-58/U	$ .70	UG-185/U	$ .95
UG-12/U	.95	UG-58A/U	.90	UG-191/AP	.80
UG-15/U	1.25	UG-59A/U	2.15	MX-195/U	.75
UG-18/U	1.25	UG-60A/U	1.75	UG-197/U	2.80
UG-18A/U	1.05	UG-61A/U	2.10	UG-201/U	1.95
UG-19/U	1.60	UG-83/U	1.75	UG-203/U	.85
UG-20B/U	1.60	UG-85/U	1.60	UG-206/U	1.80
UG-21/U	.85	UG-86/U	2.25	UG-224/U	1.15
UG-21A/U	1.50	UG-87/U	1.40	UG-236/U	3.85
UG-21B/U	1.00	UG-88/U	.90	UG-245/U	2.25
UG-21C/U	1.05	UG-89/U	1.10	UG-246/U	2.35
UG-22/U	1.30	UG-90/U	1.15	UG-254/U	2.75
UG-22B/U	1.20	UG-98/U	1.85	UG-255/U	1.95
UG-22C/U	1.20	UG-102/U	.80	UG-260/U	.85
UG-23/U	1.20	UG-103/U	.68	UG-261/U	1.10
UG-23B/U	1.50	UG-104/U	1.40	UG-262/U	1.10
UG-23C/U	1.10	UG-106/U	.12	UG-273/U	1.45
UG-24/U	1.30	UG-107B/U	2.75	UG-274/U	2.30
UG-25/U	1.35	UG-108/U	2.60	UG-275/U	5.50
UG-27/U	1.25	UG-109/U	2.60	UG-276/U	2.75
UG-27A/U	2.25	CW-123A/U	.45	UG-290/U	.90
UG-28A/U	2.95	UG-146/U	1.95	UG-291/U	.95
UG-29/U	.95	CW-159/U	.60	UG-306/U	2.65
UG-29A/U	1.85	UG-166/U	32.50	UG-349/U	2.65
UG-29B/U	1.75	UG-167/U	3.75	MX-367/U	.85
UG-30/U	2.30	UG-171/U	2.25	UG-414/U	1.95
UG-34/U	9.75	UG-173/U	.35	UG-498/U	1.89
UG-36/U	12.50	UG-175/U	.12	UG-536/U	1.65
UG-37/U	17.50	UG-176/U	.12	UG-625/U	1.35
UG-57B/U	1.85	UG-177/U	.24		

Full line of JAN Approved coaxial connectors in stock UHF-N-BN-BNC-pulse—Prices on request.

COAXIAL CABLE

Type	Price Per M Ft.	Type	Price Per M Ft.
RG-5/U	$140.00	RG-22/U	$150.00
RG-6/U	180.00	RG-22A/U	285.00
RG-7/U	85.00	RG-24/U	675.00
RG-8/U	100.00	RG-26/U	475.00
RG-9/U	250.00	RG-29/U	50.00
RG-9A/U	275.00	RG-34/U	300.00
RG-10/U	240.00	RG-35/U	900.00
RG-11/U	100.00	RG-54A/U	97.00
RG-12/U	240.00	RG-55/U	110.00
RG-13/U	216.00	RG-57/U	325.00
RG-17/U	650.00	RG-58/U	60.00
RG-18/U	900.00	RG-58A/U	70.00
RG-19/U	1250.00	RG-59/U	60.00
RG-20/U	1450.00	RG-62/U	75.00
RG-21/U	220.00	RG-77/U	100.00

ADD 25% TO PRICES SHOWN FOR QUANTITIES UNDER 500 FT.

Terms 25% cash with order, bal. COD unless rated. All prices net F. O. B. warehouse, Phila., Penna., subject to change without notice.

CABLE ADDRESS "LECTRONIC PHILADELPHIA"

LECTRONIC RESEARCH LABORATORIES

715-19 ARCH ST. PHILA. 6, PA.

Telephones - MARKET 7-6771-2-3

Want more information? Use post card on last page.

SWEEP GENERATOR CAPACITOR
Magnavox Part #XC-260048-G1

Rotating split stator capacitor. Cylindrical silver plated rotor concentric to silver plated stator on inside of Bakelite housing. Housing diameter 1⅝". Square end bells 1⅝" sq Shaft extension ½" x 0.1875 dia. High speed ball bearings. Capacity 5 to 10 mmf. Ideal for motor driven high frequency sweep generator. BRAND NEW $2.50

G. E. GENERATORS

General Electric Type 5-ASB-31JJ3; 400 cycles out at 115 volts; 7.2 amps; 8,000 rpm.; size 6" long x 6" dia. $89.50 ea.

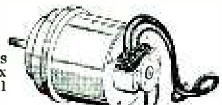
SINE-COSINE GENERATORS
(Resolvers)

Diehl Type FJE43-9 (Single Phase Rotor). Two stator windings 90° apart, provides two outputs equal to the sine and cosine of the angular rotor displacement. Input voltage 115 volts, 400 cycle...........$30.00 ea.
Diehl Type FPE-43-1 same as FJE-43-9 except it supplies maximum stator voltage of 220 volts with 115 volts applied to rotor....................$25.00 ea.

VOLTAGE GENERATORS (RATE)

ALNICO MIDGET D.C. VOLTAGE GENERATOR Type B-35-D $17.50
ALNICO MIDGET D.C. VOLTAGE GENERATOR Type B-44-D $17.50
A.C. GENERATOR: 67 V., 20 Cyc., 2-Phase. .015 Amps. Type PM-1, 1200 R.P.M..............$15.00

SYNCHRONOUS SELSYNS



110 volt, 60 cycle, brass cased, approx. 4" dia. x 6" long. Mfg. by Diehl and Bendix.
Quantities Available.
REPEATERS ....$20.00 ea.
TRANSMITTERS ....$20.00 ea.

AUTOSYN MOTOR TYPE 1

115 VAC; 60 cycle; 1-phase; DR. # CB 4279 Foot Mounted; Mfg. Bendix Aviation Corp.....$15.00 ea.

SELSYN GENERATOR

General Electric MOD. 2J15M1; 115-57.5 Volts 400 Cycle ....$22.50 ea.

SYNCHROS

AUTOSYN MTR. KOLLSMAN Type #403; 32 VAC; 60 cycle; single phase.......................$22.50
AUTOSYN MTR. BENDIX Type #851; 32 VAC; 60 cycle; single phase..........................$22.50
SYNCHRO TRANSMITTER, KEARFOTT Type R-212-1A-A Rotor; 26 Volts; single phase; Stator 11.8 Volts; 3-phase; 400 cycle..................$25.00
MICROSYN UNIT, Type 1C-006-A..........$35.00
IF Special Repeater (115V-400 Cy.).......$15.00 ea.
2JIF 3 Generator (115-400 cyc.)...........$10.00 ea.
5CT Control Transformer: 90-50 Volt; 60 Cy..$45.00
5F Motor (115/90 Volt—60 cyc.).............$45.00
5/DG Differential Generator (90-94 volts—400
TRANSMITTER, BENDIX C-78248: 115 Volt, 60 Cycle ....$25.00 ea.
cyc.) ....$30.00 ea.
Differential—C-78249; 115 V., 60 Cy..........$5.00
5N MOTOR (115 Volts/60 Cycle)..............$22.50
REPEATER, BENDIX C-78410; 115 Volt, 60 Cycle ....$37.50 ea.
REPEATER, AC synchronous 115 V., 60 cycle, C-78863 ....$15.00 ea.
REPEATER, DIEHL MFG. No. FJE 22-2; 115 Volt; 400 Cy.; Secondary 90 V.......................$27.50
5G GENERATOR (115/90) 60 cycles............$45.00
7G Synchro Generator (115/90 volt; 60 cycle)..$75.00
6G Synchro Generator (115/90 volt; 60 cycle)..$60.00
6DG Synchro Differential Generator (90/90 volt; 60 cycle) $50.00
2-JF5-J Selsyn Control Transformer: 105-55 Volts: 60 Cycle $50.00
5JD5HAI Selsyn Generator: 115-105 Volts; 60 cycle $50.00
2JIFI GENERATOR: 115—57.5 Volt; 400 cycle. $12.50 ea.
2JIHI DIFFERENTIAL GENERATOR: 57.5—57.5 Volt; 400 cycle.........................$12.50 ea.
2JIGI CONTROL TRANSFORMER: 57.5—57.5 Volt; 400 cycle ....$7.50 ea.

PIONEER TORQUE UNITS

TYPE 12606-1-A: Contain CK5 Motor coupled to output shaft through 125.1 gear reduction train. Output shaft coupled to autosyn, follow-up (AY43). Ratio of output shaft to follow-up Autosyn is 15.1. $70.00 ea.
TYPE 12604-3-A: Same as 12606-1-A except it has a 30:1 ratio between output shaft and follow-up Autosyn ....$70.00 ea.
TYPE 12602-1-A: Same as 12606-1-A except it has base mounting type cover for motor and gear train $70.00 ea.

Immediate Delivery
ALL EQUIPMENT FULLY GUARANTEED
All prices net FOB Pasadena, Calif.

INVERTERS

10563 LELAND ELECTRIC

Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 PF. Input: 28.5 VDC; 12 amp......$59.50

PIONEER 12117

OUTPUT: 26 volts; 400 cycles; 6 volt amperes, 1-Phase. INPUT: 24 VDC; 1 amp..........$25.00 ea.

ALTERNATOR, CARTER

Mfg. Carter Motor Co.; OUTPUT: 7 VAC; 8.7 amp.; 650 cycles, and 295 VDC. 200 amps. INPUT: 26.5 VDC; 10.5 amps; 6500 rpm.............$49.50 ea.

PE 218 LELAND ELECTRIC

Output: 115 VAC; Single Phase; PF 90; 380/500 cycle 1500 VA. INPUT: 25-28 VDC; 92 amps; 8000 RPM; Exc. Volts 27.5.
BRAND NEW ....$39.95 ea.

PE 109 LELAND ELECTRIC

Output: 115 VAC, 400 cyc; single phase; 1.53 amp.; 8000 RPM; Input: 13.5 VDC; 29 amp.........$65.00

MG 153 HOLTZER-CABOT

Input: 24 V. DC, 52 amps; Output: 115 volts—400 cycles, 3-phase, 750 VA. and 26 Volt—400 cycle, 250 VA. Voltage and frequency regulated.......$95.00 ea.

PIONEER 12130-3-B

Output: 125.5 VAC; 1.15 amps. 400 cycle single phase, 141 VA. Input: 20-30 VDC, 18-12 amps. Voltage and frequency regulated $75.00

12116-2-A PIONEER

Output: 115 VAC; 400 cyc.; single phase; 45 amp. Input: 24 VDC 5 amp.......................$65.00

10285 LELAND ELECTRIC

Output: 115 Volts AC, 750 V.A., 3 phase, 400 cycle, .90 PF, and 26 volts, 50 amps, single phase, 400 cycle, .40 PF. Input: 27.5 VDC, 60 amps, cont. duty, 6000 RPM. Voltage and Frequency regulated.......$95.00

10486 LELAND ELECTRIC

Output: 115 VAC; 400 Cycle; 3-phase; 175 VA; .80 PF. Input: 27.5 DC; 12.5 amp; Cont. Duty. $90.00 ea.

PIONEER 10042-1-A

DC INPUT 14 Volts; OUTPUT: 110 Volts; 400 Cycle 1-Phase; 50 Watt............................$75.00

94-32270-A LELAND ELECTRIC

Output: 115 Volts; 190 VA; Single Phase; 400 Cycle; .90 PF. and 26 Volts; 60 VA; 400 Cycle; .40 PF. Input: 27.5 Volts DC 18 amps cont. duty, voltage and freq. regulated $95.00

PIONEER 12147-1-B

OUTPUT: 115 VAC 400 cycle; Single phase. INPUT: 24-30 VDC; 8 amps $79.50

MG 149F HOLTZER-CABOT

OUTPUT: 26 VAC @ 250 VA; 115V @ 500VA; Single Phase; 400 cycle. INPUT: 24 VDC @ 36 amps. $75.00

EICOR CLASS "A" NO. 1-3012/08-7

OUTPUT: 125 VAC; 400 cycle; single phase; 100 VA. INPUT: 24-30 VDC; 11 amps; Duty int. Voltage and Frequency Regulator $99.50

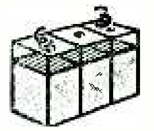
POWER RHEOSTATS

Standard Brands; 5 Ohms; 100 Watt; 4.48 amps 100 Ohms; 100 Watt; 1.0 amp.
Boxed, Brand New with Knob $2.50 each—or—$25.00 per Doz.

PIONEER AUTOSYNS

AY-1...........26 Volt—400 Cycle...........$6.95
AY-5...........26 Volt—400 Cycle...........$7.95
AY27D $12.50
AY6—26 Volt—400 cyc....................$4.95 ea.
AY30D—26 Volt—400 cyc.................$25.00 ea.
AY14D $10.00
AY34 ....$20.00
AY20—26 Volt—400 cyc..................$12.50 ea.

MIDGET TYPE NT-6 WILLARD 6V. STORAGE BATTERIES
Dry Charged



3 Amp-Hour rating. Transparent plastic case. SIZE: 3⅝" x 1-13/16" x 2⅜". Weight approx. 1¼ lbs. Uses standard electrolyte. Regularly lists at $12.00 each. NOW........New, unused......$2.49 ea.; Four for $8.50; Quantities: 36 or more $1.85 each.

ALNICO FIELD MOTORS

(Approx. size overall . . . 3¾" x 1¼" diameter)
DELCO TYPE #5069600: 27.5 volts DC; 250 RPM.......$19.95
PM Motors Delco Type #5069371: 27.5 volts; DC Alnico Field; 10,000 r.p.m.; dimensions 1" x 1" x 2" long; shaft extension ½" diameter 0.125".....$15.00

PIONEER GYRO FLUX GATE AMPLIFIER

Type 12076-1-A, complete with tubes..........$22.50

AC CONTROL MOTOR

A. C. SYNCHRONOUS MOTOR Type RBC 2505; Volts 115; Cycles 60; RPM 2; Mfg. HOLTZER CABOT ELECT. Approx. size: 2⅝" x 2⅝" x 2⅝"..$15.00 ea.

400 CYCLE MOTORS

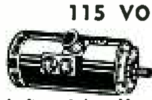
PIONEER: TYPE CK5 2 Phase; 400 cycles $25.00 ea.
EASTERN AIR DEVICES TYPE J49A: 115 V; 0.1A; 7000 r.p.m. Single phase 400 cycle........$17.50 ea.
AIRESEARCH: 115V; 400 CPS; Single phase 6500 RPM; 1.4 amp; Torque 4.6 in. oz.; HP .03. $10.00 ea.
EASTERN AIR DEVICES TYPE JM6B: 200 VAC; 1 amp; 3 phase; 400 cycles, 6000 RPM....$12.50 ea.
EASTERN AIR DEVICES, TYPE J31B: 115 V. 400-1200 Cycle. Single Phase................$12.50 ea.
AIRESEARCH: AC induction, 200 V; 3 Phase, 400 Cycle, 2 H.P.; 11,000 RPM; 8 amps......$79.50 ea.
AIRESEARCH: AC Induction, 200 V; 3 Phase, 400 Cycle, 12 H.P. 6500 RPM; 1.5 amps..........$25.00
Electric Motor: PNT—1400—A1—1A Serial No. 207, 208 V., 400 Cycles, 3 Phase Kearfott Co., Inc. $17.50 ea.

SERVO MOTOR 10047-2-A; 2 Phase; 400 Cycle, with 40-1 Reduction Gear $17.50

SMALL DC MOTORS

DELCO #5072000: 27.5 VDC; 11.75 rpm......$15.00
DELCO #5068750: constant speed: 27 VDC; 160 RPM; built-in reduction gears and governor. $12.50 ea.
J. OSTER: series reversible motor: 1/50th H.P.; 10,000 RPM; 27½ VDC; 2 amps; SPERRY #806069: approx. size 1⅝" x 3½"..................$7.50 ea. (Approx. size......4" long x 1½" dial.)
General Electric Type 5AB10AJ37: 27 volts, DC; 5 amps. 8 oz. inches torque; 250 RPM. shunt wound; 4 leads; reversible ....$15.00 ea.
General Electric. Mod. 5BA10FJ33: 12 oz. inches torque, 12 DC. 50 RPM, 1.02 amp........$15.00 ea.
General Electric Type 5BA10AJ52C: 27 volts DC; 5 amps. 8 oz. inches torque; 145 RPM; shunt wound; 4 leads; reversible ....$15.00 ea.
GENERAL ELECTRIC DC MOTOR Mod. 5BA10AJ64. 160 r.p.m.; 65 amp; 12 oz.-in. torque; 27V DC. $19.95 ea.
2¼ H.P. MOTOR—Mfg. LEECE-NEVILLE Co; Type 1454-MO; 24VDC; 4000 RPM; 100 amp.......$35.00

115 VOLT GENERATORS



Brand new Eclipse generators; 115 VAC; 9.4 amp; 1000 watts; single phase; 800 cycles. 2400-4200 rpm. DC output is 30 volts at 25 amp. Unit has spline drive shaft and is self-excited....................$29.95

MICROPOSITIONER

Barber Colman AYLZ 2133-1 Polarized D.C. Relay: Double Coil Differential sensitive, Alnico P. M. Polarized field, 24V contacts; .5 amps; 28 V. Used for remote positioning, synchronizing, control, etc.$12.50 ea.

BLOWER

Eastern Air Devices, Type J31B; 115 volt: 400-1200 Cycle; single phase; variable frequency; continuous duty; L. & R. #2 blower; approx. 22 cu. ft./min. $15.00

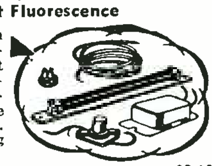
BLOWER ASSEMBLY

115 Volt, 400 Cycle, Westinghouse Type FL, 17CFM, complete with capacitor. New.............$12.50 ea.

SENSITIVE ALTIMETERS

Pioneer Sensitive altimeters, 0-35,000 ft. range . . . calibrated in 100's of feet. Barometric setting adjustment. No hook-up required. $12.95 ea.

BLACK LIGHT KITS
Ultra-Violet Fluorescence

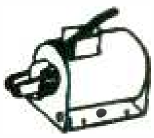


Now . . . build your own black light lamp equipment at a new low cost with these easy-to-assemble components. Kit contains: Ultra-Violet tube brackets, ballast, starter, wire, plug and wiring diagram.
4-Watt Kit—(5½" tube).......................$3.00
8-Watt Kit—(12" tube).......................$4.00

C and H Sales Company
BOX 356-X EAST PASADENA STATION • PASADENA 8, CALIFORNIA

RELAYS RELAYS RELAYS

A.C. SOLENOIDS

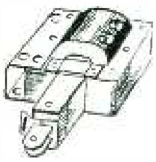


GUARDIAN No. 1: 24 VAC, 6 ohms ⅛ to ½" stroke, 6 oz.-in. #R 804 **1.95**

GUARDIAN No. 4: 115 VAC, 133 ohms ⅛ to 1⅛" stroke, 14 oz.-in. #R 805 **3.95**

GUARDIAN No. 4: 115 VAC, Intermittent Duty, 49 ohms ⅛" to 1⅛" Stroke, 2 lb.-in. 3.95

WARD LEONARD N83 CONTACTOR; 110 VAC Heavy Duty. 8 lb.-in. stroke; #R233 **10.95**



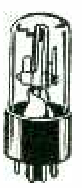
UNIVERSAL 110V AC, 6-lb. pull, 2x2x2½", 1" thrust. #R176 ..... $2.75

D. W. DAVIS MINIATURE 110V AC, Intermittent duty, 1⅝x1⅝x1½", ¾" stroke, 12 oz-in pull, #R178 .... $1.95

D. W. DAVIS MINIATURE 24V AC, 1⅝x1⅝x1½", ¾" stroke, 12 oz-in pull, #R179 .... $1.79

LEACH 980, 110V AC Intermittent duty, 1⅝x3⅛x2¼" Hinged type, #R180 .... $2.25

AMPERITE THERMOSTATIC DELAY RELAY



Amperite Thermostatic Delay Relays are actuated by a heater . . . can therefore be used on AC, DC, or pulsating current. Being hermetically sealed, Amperite Relays are not affected by altitude, moisture, or other atmospheric conditions. At the present time only SPST is available — normally open or normally closed.

NET 2.40 each

Available in voltage ratings of 2.5, 5, 6.3, 12, 26 and 115 volts. Delays in seconds are available as follows: 2, 3, 5, 10, 15, 20, 30, 45, 60, 75, 90 and 120 seconds. Most types from stock. When ordering specify: Voltage—Delay in Seconds—Open or Closed.

HAYDON 5901-2: 220V 60 cyc. Adjustable Reset Timing Relay; SPDT (10 amp); #R466. .... $7.95

AIRCRAFT SOLENOID CONTACTORS

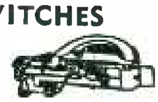
All types B2; B2A; B4; B4A; B5; B5A; B5B; B6A; B6B; B7A; B7B; B8; B9; B11; 1204-1; 1204-3, etc. available from stock in quantities in popular makes at low prices. SEND US YOUR REQUIREMENTS.

IMPULSE DIAL

To open a normally closed circuit. Ten holes — capacity: 1-10 impulses. Has 3 shunt springs, arranged to make when dial is moved off normal. #D101 .... $4.95

STEPPING SWITCHES

AUTOMATIC ELECTRIC TYPE 13



25 Position: Self Interrupter Springs; Norm. Oper Volts: 24 VDC; Max 30 VDC; 0.6 Amps; 30 Ohm. Three Levels Auto. Elec. RA92; #R600 .... $17.75

ULTRA SENSITIVE RELAY

KURMAN BK35—Nominal Operating Characteristics, 11,000 Ohms, 0.4 Ma. 4V DC SPDT. Adjustable contacts and armature. #R277. 10 for $55.00 100 for $475.00

5.95 each

JOBBERS—EXPERIMENTERS—LABORATORIES

WRITE OR PHONE WALKER 5-9642 FOR YOUR RELAY REQUIREMENTS

Ask for Mr. Greenberg or Mr. Herzog

We have a large variety of standard types of relays and solenoids for a multiplicity of uses which for various reasons are not listed in our advertising. When inquiring concerning your needs give as much information as possible. Catalog numbers are not sufficient. Give coil voltage; specify AC or DC; give current or resistance; contact current and arrangement.

ALL MERCHANDISE IS GUARANTEED AND MAY BE RETURNED FOR FULL CREDIT

WE'RE SELLING YOU RELAYS—WHAT ARE YOUR OTHER NEEDS?

Our Normal Inventory Includes Over 80,000 Different Items in the Electronic, Radar and Radio Fields

RELAYS—Approximately 300,000 in over 1100 types
CAPACITORS—Approximately 450,000
OIL • TUBULAR • MICA • FIXED and ADJUSTABLE CERAMIC FEED-THRU • STAND-OFF • APC TRIMMERS • VARIABLES • SILVER MICA
RESISTORS—Over a million
CARBON • WIRE WOUND • FERRULE • POTENTIOMETERS & RHEOSTATS
DYNAMOTOR BRUSHES—Approximately 400,000
FUSES—Approximately 800,000 in stock
WIRE and CABLE—Millions of feet.
SWITCHES—Approximately 200,000
CHOKES and TRANSFORMERS—Approximately 120,000
COILS—RF and AF CHOKES—Approximately 350,000
TIMERS and DELAY RELAYS—Both clock and thermal types
BATTERY CLIPS—Approximately 50,000
BUSHINGS and SPACERS—Thousands of pounds. **CHASSIS**—Dozens of sizes.
COAXIAL CABLE—Many sizes in stock
SPRINGS—Over 5000 pounds—Hundreds of types
JONES CONNECTORS—Many types in stock
INVERTERS—
From 110DC to 60 cycle AC
From 20 to 500 Watt
Also some 400 cycle units
RECTIFIERS—Made to your specifications
NU-METAL LAMINATIONS—Thousands of pounds in a dozen sizes
KOVAR GLASS SEALS—Approximately 400,000 in stock in several dozens of types
CERAMIC and HI-FREQUENCY STAND-OFFS—Approximately 300,000 in stock
TAPE—Cellulose, Textile, Masking and Electrical—All sizes
GUY WIRE—Both Light and Heavy. **INTERCOM SYSTEMS**—Best Buys
SOLENOIDS—Approximately 75,000 in stock
TELEPHONE RELAYS, RETARDATION COILS and CAPACITORS
GROMMETS—Approximately 20,000 pounds
TUBES—Most receiving types and many special types in stock
IRON CORE SLUGS—Over a million in stock

We Also Have a Limited Assortment of the Following Items in Stock:

DIAL LIGHT Assemblies
DIAL PULLEYS
DIAL PLATES
PILOT LAMPS
EYELETS AND RIVETS
BOLTS, NUTS, SCREWS and WASHERS
SPEAKERS
SOCKETS
HEADPHONES
TELEGRAPH KEYS
VARNISHED and VINYL TUBING
ALNICO MAGNETS
JACKSON PLUGS
SOLDER
LINE CORDS
LUGS—Terminal, Soldering, Stakon
POWER RHEOSTATS
ROTARY SWITCHES

Send Us Your Specific Requirements for Our Quotes

ALLIED TYPE BO & BOY RELAYS

Contacts are silver and have a non-inductive rating of 15 amperes, or 30 amperes for double break (d.b.) at 24V DC and 110V AC. Operate time to make 18.5 milliseconds; release time 8.0 milliseconds.

Contacts*	1.5-3.2VDC, 4 Ohm		6 9VDC, 37 Ohm		12VDC, 70 Ohm		24VDC, 230 Ohm	
	Cat.#	Price	Cat.#	Price	Cat.#	Price	Cat.#	Price
SPST (1A)	R506	2.00	R467	2.00	R476	2.00	R484	2.00
SPST (1A)d.b.	R507	2.25	R468	2.25	R06	2.25	R485	2.25
SPST (1B)	R508	2.00	R469	2.00	R477	2.00	R486	2.00
SPST (1B)d.b.	R509	2.25	R470	2.25	R478	2.25	R487	2.25
1A, 1B	R510	2.50	R492	2.50	R493	2.50	R494	2.50
DPST, 2A	R511	2.75	R499	2.75	R500	2.75	R501	2.75
DPST, 2B	R517	2.75	R518	2.75	R519	2.75	R520	2.75
SPDT (1C)	R512	2.50	R471	2.50	R479	2.50	R488	2.50
SPDT (1C)d.b.	R513	3.00	R472	3.00	R480	3.00	R238	3.00
1C, 1A	R514	3.25	R473	3.25	R481	3.25	R489	3.25
1C, 1B	R515	3.25	R474	3.25	R482	3.25	R490	3.25
DPDT (2C)	R516	3.50	R475	3.50	R483	3.50	R491	3.50

BO9D2 8; 5.9VDC; 3PDT (3C); 14.2 Ohm; #R225. .... 3.95 ea.
BO9D3 5; 26VDC; 3PDT (3C); 240 Ohm; #R522. .... 3.95 ea.
* A = SPST normally open; B = SPST normally closed; C = SPDT

BOY TYPE DC RELAYS

CONTACTS*	1.0 VDC	1.5 Ohm
	Cat.#	Price
SPST (1A)	R495	2.00
SPST (1A) d.b.	R496	2.35
DPST (2A)	R497	2.50

OTHER ALLIED TYPES

AR; 12VDC; SPST (1A); 75 Ohm #R429....... 1.00 ea.
FID; 3000 Ohm; 8 ma; SPST (1A); #R504..... 1.50 ea.
AN 13D33; 24VDC; SPST (1A) d.b.; 175 Ohm; 75 amp. continuous duty (Electrical and Mechanical equivalent to CN13D33) #R436..... 2.95 ea.

ALLIED BJ TYPE RELAYS

Contacts are silver and are rated at 5 amperes, at 24 VDC and 115 VAC.

BJ6D36; 24VDC; DPDT; 255 Ohm; #R420..... 1.75 ea.

BJX42; 12 or 24VDC; SPST (1B) d.b.; 240 Ohm C.T.; #R226............................ 1.50 ea.

BJU (Electrical Latching); 6VDC; 4PDT (4c); 16 Ohm each coil; Dust Cover; 11 pin RMA plug base; #R435........................ 6.95 ea.

BJ5A115; 115VAC; 1C, 1A; #R503............ 2.50 ea

TERMS:—All prices F.O.B. Our Plant. Rated Firms Net 10 Days: All Others Remittance with Order.

Merchandise returnable within 10 days for full credit.

Orders Under $10 Remittance With Order. Plus Approximate shipping charges (overage will be returned.)

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Universal general corp.

Want more information? Use post card on last page.

COMMUNICATIONS EQUIPMENT CO.

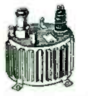
PULSE NETWORKS

15A—1.400-50: 15 KV, "A" CKT, 1 microsec. 400 PPS, 50 ohms imp. $37.50
G.E. #3E (3-84-810) (8-2.24-405) 50P4T: 3KV "E" CKT Dual Unit; Unit 1, 3 sections, 0.84 Microsec. 810 PPS, 50 ohms imp.; Unit 2, 8 Sections, 2.24 microsec. 405 PPS 50 ohms imp. $6.50
7-5E3-1-200-67P. 7.5 KV "E" Circuit, 1 microsec. 200 PPS, 67 ohms impedance 3 sections $7.50
7-5E4-16-60. 67P. 7.5 KV "E" Circuit, 4 sections 16 microsec. 60 PPS. 67 ohms impedance $15.00
7-5E3-3-200-67P. 7.5 KV. "E" Circuit, 3 microsec. 200 PPS. ohms imp. 3 sections $12.50
KS8865 CHARGING CHOKE: 115-150 H @ .02A. 32-40H @ .08A. 30,700V Corona Test, 21KV Test $37.50
G.E. 25E5-1-350-50 P2T. "E" SKT. 1 Microsec. Pulse @ 350 PPS. 50 OHMS Impedance $69.50
KS9623 CHARGING CHOKE: 16H @ 75 MA, 380 Ohms DCR, 9000 Vac test $14.95
G.E. 6E3-5-2000 50 P2T: 6 KV., "E" Circuit 0.5 usec/2000 PPS/50 ohms/2 sections $7.50

PULSE EQUIPMENT

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp). Duty Ratio: .001 max. Pulse duration: 5. 1.0. 2.0 microsec. Input voltage: 115 v. 400 to 2400 cps. Uses: 1-71B. 4-89-B. 3-'72's, 1-'73. New .... Less Cover—$135
APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk pwr. out 35 KW Energy 0.018 Joules $49.00
TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KW (1200 KW pk): pulse rate 200 PPS. 1.5 microsec. pulse line impedance 50 ohms. Circuit series charging version of DC Resonance type. Uses two 705-A's as rectifiers, 115 v. 400 cycle input. New with all tubes $49.50
SPRAGUE H-615 "E" Circuit 10KV, 0.85 microsec pulse at 750 PPS—50 ohms $27.50
SPRAGUE H-616. "E" Circuit, 10KV 2.2 microsec pulse at 3.75 PPS—50 ohms $27.50

PULSE TRANSFORMERS



GE #K-2449A
Primary: 9.33 KV. 50 ohms Imp.
Secondary: 28 KV, 450 ohms.
Pulse length: 1.0/5 usec @ 635/120 PPS. Pk. Power Out: 1.740 KW
Bifilar: 1.5 amps (as shown) $62.50
GE #K-2748-A. 0.5 usec @ 2000 Pps. Pk. Pwr. out is 32 KW impedance 40:100 ohm output. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Bifilar rated at 1.3 Amp. Fitted with magnetron well $39.50
K-2745. Primary: 3.1/2.8 KV, 50 ohms Z. Secondary: 14/12.6 KV 1025 ohms Z. Pulse Length: 0.25/1.0 usec @ 600/600 PPS. Pk. Power 200/150 KW. Bifilar: 1.3 Amp. Has "built-in" magnetron well $42.50
K-2461-A. Primary: 3.1/2.6 KV—50 ohms (line). Secondary 14/11.5 KV—1000 ohms Z. Pulse Length: 1 usec @ 600 PPS. Pk. Power Out: 200/130 KW. Bifilar: 1.3 Amp. Fitted with magnetron well $39.75
UTAH X-151T-1: Dual Transformer, 2 Wdgs. per section 1:1 Ratio per sec 13 MH inductance 30 ohms DCR $7.50
UTAH X-150T-1: Two sections, 3 Wdgs. per section, 1:1:1 Ratio, 3 MH. 6 ohms DCR per Wdg $7.50
68G711: Ratio: 4:1 Pri: 200V. Sec. 53V. 1.0 usec Pulse @ 2000 PPS. 0.016 KVA $4.50
TR1049: Ratio: 2:1 Pri. 220 MH, 50 Ohms, sec. 0.75 H. DCR 100 Ohms $6.75
K-901695-501: Ratio 1:1. Pri. Imp. 40 Ohm, Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.05 usec rise $8.95
Ray UX 7896—Pulse Output Pri. 5v. sec. 41v $7.50
Ray UX 8442—Pulse inversion—40v + 40v $7.50
PHILCO 352-7250. 352-7251. 352-7287
RAYTHEON: UX8693. UX5986 .... $5 ea.
W.E.: D-166310. D-166638. KS 9800. KS9948.
UTAH #9262. with Cracked Beads, but will operate at full rated capacity $5.00
UX 8693 (SCS #2Z9627-54): 3 Wdgs. 32 turns #18 wire. DCR is: .362/.372/.4 ohms. Total voltage 2500 vdc. $5.00
D-166173: Input: 50 ohms Z. Output: 900 ohms 3 Wdgs. Freq. range 10 kc-2mc. P/O AN/APQ*-13 .... $12.50

10 CM R.F. HEAD

Complete R.F. Head and Modulator delivers 50 KW Peak R.F. at 3000 MC. Pulser delivers 12KV pulse at 12 Amp. to magnetron of .5, 1, or 2 microsec. duration at duty cycle of .001. Unit requires 115V. 400-2400 Cycles, 1 phase @ 3.5A. Also 24-28 VDC @ 2A. External sync. Pulse of 120V Req'd. Brand New. Complete with schematic and all tubes $375.00

THERMISTORS

D-164699	Bead Type DCR: 1525-2550 Ohms @ 75 Deg. F, Coefficient: 2% Per Deg. Fahr. Max. Current 25 MA AC/DC	$2.50
D-167332	Bead Type, DCR is 1525-2550 Ohms. Rated 25 MA at .825-1.175 VDC	1.50
D-167613	Disk Type DCR: 355 Ohms @ 75 Deg. F. P. M. 2.5%, 1 Watt	1.50
D-166228	Disk Type 7120 Ohms @ 60°F. 4220 Ohms @ 80°F 2590 Ohms @ 100°F, 1640 Ohms @ 120°F	1.50

MICROWAVE COMPONENTS

"S Band," RG48/U Waveguide

POWER SPLITTER for use with type 726 or any 10 CM Shepherd Klystron. Energy is fed from Klystron antenna through dual pick-up system to 2 type "N" connectors .. $22.50 EACH
DIRECTIONAL COUPLER. Broadband type "N" Coupling, 20 db. with std. flanges, Navy #CABV47AAN-2 (as shown) $37.50
LHTR. LIGHTHOUSE ASSEMBLY. Part of RT39 APG 5 & APG 15. Receiver and Trans. Cavities w/assoc Tr. Cavity and Type N CPLG. To Recvr. Uses 2C40, 2C43, 1B27. Tunable APX 2400-2700 MCS. Silver Plated $49.50
BEACON LIGHTHOUSE cavity p/o UPN-2 Beacon 10 cm. Mfg. Bernard Rice, each $47.50
MAGNETRON TO WAVEGUIDE Coupler with 721-A Duplexer Cavity, gold plated $45.00
RT-30 APG-5 10 cm. lighthouse RF head c/o Xmtr.-Recvr-TR. cavity compl. recvr. & 30 MC IF strip using 60K5 (2C40, 2C43. 1B27 lineup) w/Tubes.
721A TR BOX complete with tube and tuning plungers $12.50
McNALLY KLYSTRON CAVITIES for 707B or 2K28 .... $4.00
WAVEGUIDE TO ⅞" RIGID COAX "DOORKNOB" ADAPTER CHOKE FLANGE. SILVER PLATED BROAD BAND $32.50
AS14A AP-10 CM Pick up Dipole with "N" Cables $4.50
OAJ ECHO BOX. 10 CM TUNABLE $22.50
HOLMDELL-TO-TYPE "N" Male Adapters. W.E. #D167284 .... $2.75
I.F. AMP. STRIP: 30 MC, 30 d.b. gain, 4 MC Bandwidth. uses 6AC7's—with video detector. A.F.C. less tubes $24.50
POLYROD ANTENNA, AS31/APN-7 in Lucite Ball. Type "N" feed $22.50
ANTENNA. AT49A/APR: Broadband Conical. 300-3300 MC Type "N" Feed $12.50
"E" or "H" PLANE BENDS. 90 deg. less flanges $7.50

X Band— RG 52/U WAVEGUIDE

VSWR Measuring Section. Consisting of 6" straight section, with 2 pick-up, Type "N" Output Jacks. Mounted ½ Wave apart $8.50
1" x ½" waveguide in 5' lengths. UG 39 flanges to UG40 cover .... per length $7.50
Rotating-joints supplied either with or without deck mounting. With UG40 flanges .... each, $17.50
Bulkhead Feed-thru Assembly $15.00
Pressure Gauge Section 15 lb. gauge and press nipple $10.00
Pressure Gauge. 15 lbs. $2.50
Directional Coupler. UG-40/U Take off 20db. .. $17.50
TR-ATR Duplexer section for above $8.50
Waveguide Section 12" long choke to cover 45 deg. twist & 2¼" radius. 90 deg. bend $4.50
Waveguide Section 2½ ft. long silver plated with choke flange $5.75
Rotary joint choke to choke with deck mounting $17.50
90 degree elbows. "E" or "H" plane 2¼" radius $12.50
45 degree twist $8.00
Microwave Receiver. 3 CM. Sensitivity: 10-13μ Watts. Complete with L.O. and AFC Mixer and Waveguide Input Circuits. 6 I.F. Stages give approximately 120 DV gain at a bandwidth of 1.7 MC. Video Bandwidth: 2 MC. Uses latest type AFC circuit. Complete with all tubes, including 723A/B Local Oscillator $175.00
ADAPTER. waveguide to type "N", UG 81/U, p/o TS 12. TS-13. Etc. $27.50
ADAPTER. UG-163/U round cover to special btl. Flange for TS-45, etc. .... $2.50 ea.

1¼" x ⅝" WAVEGUIDE

CG 98B/APQ 13 12" Flex. Sect. 1¼" x ⅝" OD $10.00
X Band Wave GD 1¼" x ⅝" O.D. 1/16" wall aluminum .... per ft. 75¢
Slug Tuner Attenuator W.E. guide, old plated .. $6.50
BI-Directional Coupler. Type "N" Takeoff 25 db. coupling $27.95
BI-Directional Coupler. UG-52. Takeoff 25 db. coupling $24.95
Waveguide-to-Type "N" Adapter. Broadband .. $22.50

WAVEGUIDE FLANGES

UG 39/U	$1.10	UG 51/U	$1.65
UG 40/U	$1.25	UG 52/U	$3.40
UG 40A/U	$1.65	UG 52A/U	$3.40

MICROWAVE MIXER

CV-12/APR-6: Waveguide/mixer unit. 4000-6000 mc. Designed for use with microwave receiver. Has pick up loop for coupling to lighthouse cavity local oscillator. RF input is to 1" x 2" waveguide (contact flange). Output (thru 1n21 xtl.) is from standard 50-ohm coax connector. Brand new, complete with crystal. As shown $35.00

MAGNETRONS

Type	Freq. Range(MC)	Peak Power Out (KW)	Duty Ratio	Price
2J21A	9345-9405	50		$8.75
2J22	3267-3333	265		7.50
2J27	2965-2992	275	.002	19.95
2J31	2820-2860	285	.002	24.50
2J32	2780-2820	285	.002	28.50
2J38*	3249-3263	5		16.50
2J39*	3267-3333	8.7		24.50
2J48	9310-9320	50	.001	24.50
2J49	9000-9160	50	.001	59.50
2J56*	9215-9275	50	.001	132.50
2J61†	3000-3100	35	.002	34.50
2J62†	2914-3010	35	.002	34.50
700B	690-700	40	.002	22.50
700D	710-720	40	.002	39.75
706EY	3038-3069	200	.001	32.50
706CY	2976-3007	200	.001	32.50
725-A	9345-9405	50	.001	Write
730-A	9345-9405	50	.001	24.50
4J38	3550-3600	750	.001	169.45

*—Packaged with magnet.
†—Tunable over indicated range.

QK 60, 61, 62—$85 ea.

KLYSTRONS

723A	$12.50	2K25/723A/B	$27.50
723A/B	19.50	417-A (Sperry)	17.50

MICROWAVE ANTENNA EQUIPMENT

AT49/APR—Broadband Conical. 300-3300 MC. Type N Feed (as shown) $12.50
AS-31/APN-7: 10 cm Polyrod in Lucite Ball. Type N Fitting Coax Feed $22.50
Relay System Parabolic reflectors approx. range 2000 to 6000 Mc. Dimensions 4½" x 3'. New $100.00
Dipole for above $12.00
TDY "JAM" Radar rotating antenna, 10 cm. 30 deg. beam. 115 V AC drive. New $150.00
Parabolic Peel. Radiation pattern approx. 25 deg. in horizontal 33 deg. in vertical planes $35.00
Cone Antenna. AS 125 APR. 1000-3200 mc. Stub supported with type "N" connector $14.50
AS14A/AP, 10 CM pick up dipole assy. complete w/length of coax and "N" connectors $3.50
AS46A/APG-4 Yagi Antenna, 5 element array. $22.50
30" Parabolic Reflector Spun Aluminum dish .. $4.85
APS-34 Pillbox Antenna, waveguide input: 24,000-27000 MC $22.50
6 Ft. Parabolic Dishes, Perforated. Metal Construction $45.00

RADAR ANTENNAS

AS-12/APS-3	AS-125/APR
AS-17/APS-2	AS-217/APG-15
AS-13/APG-2	AT49/APR
AS69/APT	AS14/AP

RADAR SETS

SO-1 10 cm. with a range of 4, 20, and 80 miles. PPI presentation on a 5 inch screen. 360 deg rotation of antenna with a pattern 8 deg in horiz. and 18 deg in vert. plane. Operates from 115 vdc. Set consists of following: antenna, m/g—modulator. xmtr—rcvr, PPI unit, accessory control, and rectifier power unit.

MK 10 GUN RADAR. Extremely accurate, rugged and compact. Designed for ship board use to direct naval gun turrets. Antenna utilizes conical scanning for accurate pointing. Max. range is 20,000 yards with an error of pm 15 yds pm .1% of range. Pointing accuracy is pm .25 deg. Pulse dur. 0.5 usec. at prr of 3600 cps. Pk. power output is 25 Kw. Primary power consumption is 1300 watts. Operates from 115V, 60 CPS Source. BRAND NEW, COMPLETE WITH SPARES AND INSTRUCTION MANUAL .... POR*

SQ Portable radar with type PPI, "A", or "B" Scope. Frequency is Approx. 3000 Mcs. 3 ranges: 3. 15. and 45 miles. Operates from 115v, 60 cycles $850

SE 10 cm radar for use on small surface craft for Sea-Search use. Max. range 80,000 yards, with an accuracy of 100 yards ± 1% of range. Bearing accuracy 2 degrees. Operates from 115 VDC. Complete Equipment, Brand new, in original matched sets @ $850.00

SN Portable, lightweight, 10 cm set with ranges of 4 and 20 Mi. Presentation is on 5" "A" Scope. Operates from 115V, 50-60 Cy. Ideal for labs, Classrooms, and small boats $850.00

IFF SETS RC 148 RC 184 Navy BM RC 145 RC 188
PRICE ON REQUEST

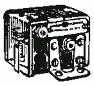
MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. SEND M.O. OR CHECK. ONLY SHIPPING SENT C.O.D. RATED CONCERNS SEND P. O. ALL MDSE SUBJECT TO PRIOR SALE AND PRICES SUBJECT TO CHANGE WITHOUT NOTICE. PARCELS IN EXCESS OF 20 POUNDS WILL BE SHIPPED VIA CHEAPEST TRUCK OR RAILEX.

131 Liberty St., New York 7, N. Y. Dept E-12 Chas. Rosen Phone: Digby 9-4124

COMMUNICATIONS EQUIPMENT CO.

D.C. RELAYS

CR2792B116A3



SPST—50 Amp Contracts. Operates from 22-30 VDC. Coil Res. 200 Ohms. Completely enclosed in transparent plastic case, which may be removed for adjustments $1.59

GE #CR2791B116W3

Same as above, except additional terminal brought out from contact arm........................ $1.74

GE #CR2791-F100D3

Differential: DPST. Norm. open. Dual coil. 1500 ohms per coil—25 Ma. Operating Current. Contacts: 20 Amp............................. $2.25

GE #CR2791F100G3

Same as above, except has extra 1A contact. Rated 5 Amp. $2.35

GE #CR2791D101F3

All Ceramic Insulation, DPDT, Coil—12VDC. 100 Ohms DCR. Contacts designed for fast operation. Rated at 5 Amps.......................... $1.25

GE #CR2791B106J3

3PDT, 5 Amp. contacts. Coil rated 22-30VDC. 150 Ohms DCR. Contacts are designed for fast operation, and enclosed by clear plastic cover...... $1.35

GE #CR2791B106C3

SPDT. Dual Contacts will handle 20 Amps. Coil: 18-28VDC 125 Ohms DCR.................. $1.25

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	PRICE
DM 416	14	6.2	330	.170	$6.75
DM 33A	28	7	540	.250	3.95
BD AR 93	28	3.25	375	.150	7.50
23350	27	1.75	285	.075	3.95
B-19 Pack	12	9.4	275	.110	8.95
			500	.050	
DA-3A*	28	10	300	.260	6.95
			150	.010	
			14.5	5.	
5053	28	14	250	.060	3.95
PE 73 CM	28	19	1000	.350	22.50
BD 69‡	14	2.8	220	.08	12.95
D-402†	13.5	12.2	300	8.8VAC	12.50
SP 175	18	3.2	450	.06	4.49
DM 25†	12	2.3	250	.05	6.95

‡ Less Filter * Replacement for PE 94.
† Used, Excellent

INVERTERS

PE-218-H: Input: 25/28 vdc, 92 amp. Output: 115v. 350/500 cy 1500 volt-amperes. NEW.......... $37.50

PE-206: Input: 28 vdc, 36 amps. Output: 80 v 800 cy, 500 volt-amps. Dim: 13"x5½"x10½". New $22.50

NAVY COR-211095: Input 22-30 VDC/75-60A. OUTPUT: 115V/400 CY. 1 KVA/8.7A. RPM: 4800. With coupling provision for motor. Brand New. Original packing $150.00

SELENIUM RECTIFIERS*

Current (Continuous)	18/14 Volts	36/28 Volts	54/42 Volts	130/100 Volts
1 Amp.	$1.35	$2.15	$3.70	$8.50
2 Amps.	2.20	3.60	5.40	10.50
2½ Amps.	....	....	6.00	13.00
4 Amps.	4.25	7.95	12.95	25.25
6 Amps.	4.75	9.00	13.50	33.00
10 Amps.	6.75	12.75	20.00	44.95
12 Amps.	8.50	16.25	20.50	49.00
20 Amps.	13.25	25.50	38.00	79.50
24 Amps.	16.25	32.50	45.00	90.00
30 Amps.	20.00	38.50	....	....
36 Amps.	25.00	* 48.50		

* F. W. Bridge

EE-89 REPEATER

Extends range of EE-8 field phone up to 20 miles of dry or wet wire operation. Extremely rugged, portable and lightweight. Uses hybrid coils and V.T. Amplifier, with extreme long-life characteristics. Brand new, complete with tube and tech. Manual, only.......

$12.75 EACH

HELMHOLTZ PHASE-SHIFTER

Stator consists of 4 loops oriented at 90 degrees to each other. Total stator inductance is 40MH. Rotor: 10MH. Total phase shift 0-360 deg. Designed for range unit of SCR-268 .... **3.95 EACH**

POWER TRANSFORMERS

Comb. Transformers—115V/50-60 cps Input

CT-766	300-0-300V/120MA, 2 x 5V/3A, 2.5V/5A	$3.95
CT-129	550-0-550V @ 150 MA, 6.3V/4A, 2.5VCT/5A	5.79
CT-013	450-0-450V @ 200 MA, 10V/1.5A, 2.5V/3.5A 5V/3A	6.95
CT-15A	550VCT .085A 6.3V/.6A, 6.3V/1.8A	2.85
CT-341	1050 10MA,—625V @ 5 MA, 26V @ 4.5A 2x2.5V/3A, 6.3V @ 3A	9.95
CR 825	360VCT .340A 6.3VCT/3.6, 6.3VCT/3A	3.95
CT-626	1500V .160A 2.5/12, 30/.100	9.95
CT-071	110V .200A 33/.200, 5V/10, 2.5/10	4.95
CT-367	580VCT .050A 5VCT/3A	2.25
CT-403	350VCT .026 A 5V/3A	2.75
CT-931	585VCT .086 A 5V/3A, 6.3V/6A	4.25
CT-456	390VCT 80 MA 6.3V/1.3A, 5V/3A	3.45
CT-931	585VCT 86 MA 5V/3A, 6. V/6A	4.95
CT-442	525VCT 75 MA 5V/2A, 1 CT/2A, 50V/200 MA	3.85
CT-43A	600-0-600V/.08A, 2.5VCT/6A, 6.3VCT/1A	6.49
CT-501	650VCT/200MA, 6.3V/8A, 6.3V/5A	6.49
CT-444	230-0-230V/.085A, 5V/3A, 6V/2.5A	3.49

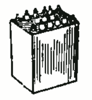
Filament Transformers—115V50-60 cps Input

Item	Rating	Each
FT-140	5VCT @ 10A 25KV Test	$22.50
FT-157	4V/16A, 2.5V/2.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25A/21A, 2x7.75V/6.5A	14.95
FT-824	2x26V/2.5A, 16V/1A, 7.2V/7A, 6.4V/10A, 6.4V/2A	8.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-38A	6.3/2.5A, 2x2.5V/7A	2.79

Plate Transformers, 115V 60Cy Input

PT 175	550-0-550VAC, (400VDC) @ 150MA	$6.30
PT 157	660-0-660 VAC, (500VDC) or 550-0-550 VAC (400VDC) at 250 MADC	8.70
PT 158	1080-0-1080V (1000VDC) at 125MA Plus 500-0-500 VAC (400VDC) at 150MADC Simult. Ratings	10.80
PT 159	900-0-900 VAC (750VDC) or 800-0-800 VAC (500VDC) at 225 MADC	10.35
PT 167	1400-0-1400 VAC (300MADC) or 1175-0-1175 VAC (1000VDC) at 300MADC	25.80
PT 168	2100-0-2100 VAC (1750VDC) or 1800-0-1800 VAC (1500VDC) at 300MADC	33.00
PT 062	2900-0-2900 VAC (2500VDC) or 2385-0-2385 VAC (2000VDC) at 300MA	48.00

Transformer Special



#766: Primary: 115 V, 60 cy. 1φ. Secondary: 300-0-300 V @ 120 MA. D.C., 2-5V WDGS @ 3 A ea. Also 2.5 VCT @ 5 A. Ruggedized. Herm. Sealed. Size: 4¾" H x 3⅜" x 4½". 11 Solder Tmls. M.F.D. W.E. **$3.95**

400 CYCLE TRANSFORMERS

(All Primaries 115V. 400 Cycles)

Stock	Ratings	Price
352-7102	6.3V/2.5A	1.45
M-7472426	1450V/1.0MA, 2.5V/.75A, 6.4V/3.9A, 5V/2A, 6.5V/.3A, P/O ID-39/APG-13	4.95
352-7039	640VCT @ 380MA, 6.3V/.9A, 6.3V6A 5V/6A	5.49
702724	9800/8600 @ 32MA	8.95
K59584	5000V/290MA, 5V/10A	22.50
KS9607	734VCT/.177A, 1710VCT/.177A	6.79
352-7273	700VCT/350MA, 6.3V0.9A, 6.3V 25.A 6.3V/.08A, 5V/CA	6.95
352-7070	2x2.5V/2.5A (2KV TEST) 6.3V/2.25A, 1200/100/750V. @ .005A	7.45
352-7196	1140/1.25MA, 2.5V/1.75A, 2.5V/1.75A —5KV Test	3.95
352-7176	320VCT/50MA, 4.5V/3A, 6.3VCT/20A, 2x6.3VCT/6A	4.75
RA6400-1	2.5/1.75A, 6.3V/2A—5KV Test	2.39
901692	13V 9A	2.49
901699-501	2.77V @ 4.25A	3.45
901698-501	900V75MA, 100V/.04A	4.29
Ux8855C	900VCT/.067A, 5V/3A	3.79
RA6405-1	800VCT/65MA, 5VCT/3A	3.69
T-48852	700VCT/806MA5V/3A, 6V/1.75A	4.25
352-7098	2500V/MA, 300, VCT, 135MA	5.95
KS 9336	1100V/50MA TAPPED 625V 2.5V/5A	3.95
M-7474319	6.3V/2.7A, 63.V/.66A, 6.3VCT/21A	4.25
KS8984	27V/4.3A, 6.3/2.9A, 1.25V/.02A	2.95
52C080	650VCT/50MA, 6.3VCT/2A, 5VCT/2A	3.75
32332	400VCT/35MA, 6.4V/2.5A, 6.4V/.15A	3.85
68G631	1150-0-1150V	2.75
80G198	6VCT/.00006 KVA	1.75
302433A	6.3V/9.1A, 6.3VCT/6.5A, 2.5V/3.5A, 2.5V/3.5A	4.85
KS 9445	592VCT/118MA, 6.3V/8.1A, 5V/2A	5.39
KS 9685	6.4/7.5A, 6.4V/3.8A, 6.4/2.5A ALL CT	4.79
70G30G1	600VCT/36MA	2.65
M-7474318	2100V/.027A	4.95
352-7069	2-2.5V Wdgs. at 2.5A, Each Lo-Cap., 22Kv Test	5.95
352-7096	2.5V/1.75A, 5V/3A. 6.5V/6A, 6.5V/1.2A, P/O BC800	
352-7099	360VCT/20MA, 1500V/1MA, 2.5V/1.75A, 6.3V/2.5A, 6.3V/.6A, P/O BC-929	6.45
D163253	5200V/.002A, 2.5V/5A	5.35
M-7471957	2.5V/20A, 12KV Test	4.85
352-7179	250V/100MA, 6.5V/12ACT 5V/2A	3.45

SPECIALS

DC RELAYS
ALLIED TYPE "AS", SPST. N.O. COIL 3 VDC, 77 OHMS MIDGET .... .85¢
LEACH 1257, DPDT. 10 AMP CONTACTS COIL: 60 VDC, 2400 OHMS, 25 MA......... $2.85
COL. RAD #55251, FOR ARC-3............ $1.35
COL. RAD #55528, FOR ARC-3............ $1.35
PHILCO 452-1127, SPST, N.O. COIL, 28 VDC, 300 OHMS .... .85¢

SWITCHETTES
CR1070C122A3 .... .32¢
CR1070C130D3 .... .32¢

TEST SET I-104 For testing 274-N, ARC-4, ETC $47.50

TEST SET, IE-36, FOR TESTING SCR-522, Less Meter $47.50

SPARE ARMATURES FOR GENERATORS: GN-35, GN-45, GN-37, BD 86............... $4.95

EE-89A Telephone repeater, New............. $12.50

PHOTOTUBE 932: Infra-red, but may be used with incandescent light.. Complete with data.......... .75¢

ID-24/ARN-9 Cross Point. Indicator. Contains 2—0-200 U AMP MOVEMENTS $6.95

MP-22 Mast Bases, original packing............. $4.95

COILS, C-387-D, For BC 610 transmitter......... $3.95

COILS, C-390-A For BC 610 transmitter......... $2.79

DYNAMIC MIKE and HEADSET COMBO, as used in B-19 TANK TRANSMITTERS................... $3.75

OSCILLOGRAPH Photo Recording paper, HIGHLY SENSITIVE, 35 mm x 250 Ft. Rolls $1.00

BRUSH CAPS For BD77 Dynamotor SCS #3H1777/8 ea. .12¢

POWER SUPPLY For Super-Pro Receiver, #RA-74, NEW $69.50

- Driver Transformer, for ART-13, T-202........ $1.29
- Side-Tone Transformer, for ART-13, T-203.... $1.19
- Modulation Transformer, ES-691025 for BC 456 $1.19
- AN-104A Antennas for SCR-522............... .95¢
- BC 929 Indicators, p/o APN-2.................. $32.50
- BC 451 Trans. Control Box, p/o SCR 274N.... $1.85
- C-30/ARC-5 Control Box..................... $1.65
- FT-225-A Mounting Racks.................... $1.65
- FT-227-A Shock Mount Racks.................. $1.65

MD7/ARC-5 Modulators, all Tubes............. $5.95

MC 211 Right Angle Drives..................... .21¢

BC 43G Compass Rcvrs., Used, Excellent........ $32.50

ART-13 Barometric Limit Switches.............. $8.75

BC 306 Antenna Loading Unit for BC 375........ $3.00

RL-7 Interphone Amplifiers, Used, Excellent, Less Tubes $3.75

SA-4A/APA-1 Motor Driven (28 VDC) Yagi Antenna Switch $24.50

MT-36-C Ant. Loading Unit for TA-2J XMTR... $35.00

A-62 Phantom Antennas. for use with Mobile XMTRS, 20-38.9 MC 40 Watts................. $3.95

RT-19/ARC-4 Trans-receivers, 24 VDC, covers Amateur 2—Meter Band. Completo with Tubes and Crystals $39.50

Radar Trainer, Type 15-C. Consists of 4 separate XMTRS. Operating 380-500 MC., 1—Pulse Gen. 1—Power Supply, all Cables, 2 Inst. Books..$215.00

Rubber Inserts, M-300 for HS-30 Headsets....$3.25/M

Crystal Diode: W.E. Type IN45—79¢. Timing Motor, Telechron, 115V AC, 60 Cy 1 RPM or 3 RPM, either type $1.95

Selsyns. 115VAC, 60 Cy. & Rans—C-78248 and differential. C-78249 .... Per Set $24.50

PE-94 Power Supply for SCR 522. Brand New..$12.75

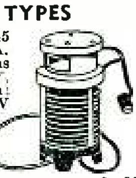
ARC-5 PLUGS

#5842	.35¢	#7027	.45¢
#5577	.35¢	#7025	.45¢
#PL 154	.70¢	#PL 152	.65¢
#PL 154A	.70¢	#6418	.35¢

C-114 Loading Coils .... .85¢

VOLTAGE REGULATORS

CARBON—PILE TYPES



LELAND TYPE "A": Coil: 245 ohms. Current 108-110 MA. Reg. Resistance: 1.5-2.5 ohms with 1.2-3.3 Amps. For 80 V.

LELAND TYPE "B": Volts In: 21-30 V. Volt Out: 18-25 V DC. at 5 A.

LELAND TYPE "C": Spec. VR 9000—2 C. Input: 22-30 VDC. Coil: 300 MA. Output: 19 V @ 5.7 A.

WEBSTER: 35x025: Philco 451-1035 Input: 21-30 V. D.C. Output: 18 VDC/4.75 A.

Price, Any Model...... $2.25 ea.

GN 35 HAND GENERATORS

BRAND NEW. IN ORIGINAL CARTONS. WILL DELIVER 8 V @ 2.5A AND 325-365 V @ 100 MA OR 10 V 1.25A AND 380-420 V @ 70 MA. LESS HAND CRANKS. A GREAT VALUE...... $17.50

CIRCUIT BREAKERS

HEINEMANN: .01A, 2340 V — Insulated for 5000 V. Separate Tmls. for coil and contact $1.95
#1510 M-7: 7 A, 24 VDC SCS #3H900-7-3.... $1.65
#AM 1614-100: 100 Amps. 24 VDC.......... $1.65
#AM 1614-80: 80 Amps. 24 VDC............ $1.45
#AM 1610-.5: 500 MA. 1000 VDC. Curve 3. SCS #3H900A-50 .... $2.25
SCS #3H900-10-3: 40 VDC. 10 Amps......... $1.65

MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. SEND M.O. OR CHECK. ONLY SHIPPING SENT C.O.D. RATED CONCERNS SEND P. O. ALL MDSE SUBJECT TO PRIOR SALE AND PRICES SUBJECT TO CHANGE WITHOUT NOTICE. PARCELS IN EXCESS OF 20 POUNDS WILL BE SHIPPED VIA CHEAPEST TRUCK OR RAILEX.

131 Liberty St., New York 7, N. Y. Dept E-12 Chas. Rosen Phone: Digby 9-4124

SELENIUM RECTIFIERS

Full-Wave Bridge Types

Current (Continuous)	18/14 Volts	36/28 Volts	54/42 Volts	130/100 Volts
1 Amp	$1.35	$2.15	$3.70	$8.50
2 Amps.	2.20	3.60	5.40	10.50
2½ Amps.	3.10	4.20	6.00	13.00
4 Amps.	4.25	7.95	12.95	25.25
6 Amps.	4.75	9.00	13.50	33.00
10 Amps.	6.75	12.75	20.00	44.95
12 Amps.	8.50	16.25	20.50	49.00
20 Amps.	13.25	25.50	38.00	87.50
24 Amps.	16.25	32.50	45.00	95.00
30 Amps.	20.00	38.50	.....	.....
36 Amps.	25.00	48.50	.....	.....

We can supply other selenium rectifiers, transformers, chokes, and filter capacitors.

NEW SELENIUM RECTIFIER TRANSFORMERS
PRI: 115 V., 60 cycles in.
SEC: 9, 12, 18, 24, and 36 volts
Continuous Ratings

- 4 Amps. $8.75
- 12 Amps. 16.75
- 24 Amps. 35.75
- 30 Amps. 45.00
- 50 Amps. 59.75

NEW SELENIUM RECTIFIER CHOKES

- 2 Amps.—.06 Hy.—4 ohms $3.95
- 4 Amps.—.07 Hy.—.6 ohm $7.95
- 12 Amps.—.01 Hy.—.1 ohm $14.95
- 24 Amps.—.004 Hy.—.025 ohm $29.95

FILTER CAPACITORS

Capacity	W. Voltage	Ea.
500 MFD.	50 V.	.85
1000 MFD.	15 V.	.35

- W. E. HERM. SEALED POWER TRANSFORMER Type KS9799. Primary 115 AC, 60 Cy. Secondary: 930 VCT @ 520 MA and 5.2 V @ 4 Amps (20 KV Insul) Brand New $7.50
- W. E. HERM. SEALED POWER TRANSFORMER Type D175847. Primary 115 AC, 60 Cy. Secondary 1000 VCT @ 500 MA. 5 V @ 5 Amps. (20 KV Insul) 5¼" x 5¼" x 6½". Brand new $8.50

- New Erco 4 Channel Ship-to-Shore Marine Transmitter — Receiver — F.C.C. Approved. Brand New, Complete, less xtals @ .... $179.50 Write for Full Details

WESTERN ELECTRIC CHOKES
NEW—HERMETICALLY SEALED
SMOOTHING 8 Henries @ 300 MA. 75 Ohms 4¾" x 5¼" x 5". W.E. # KS 9476 .... $4.75
SWINGING from 4 to 7 Henries. 200 to 700 MA. 42 Ohms. 5" x 5½" x 5". W.E. KS13063. $4.75

- VIBRAPACKS—12 Volt Input—Mallory 300 VDC @ 125 MA. Output. New $9.95
- TRIMM "FEATHERWEIGHT" thin HEADSETS complete with band. Brand new. Very sensitive. Only $4.35
- Bliley-Type SMC100—Crystal Standards. New—100 KC and 1,000 KC BAR $8.50
- JENNINGS VACUUM CAPACITORS 50 MMF—20 KV $8.50

FULLY GUARANTEED — **TUBE SPECIALS** — STANDARD BRANDS ONLY

Type	Price
OA2	$ .87
OA3/VR75	1.03
OB2	.85
OB3/VR90	.90
OC3/VR105	.91
OD3/VR150	.89
OZ4	.49
1AE4	.85
1A3	.70
1A7GT	.66
1AX2	1.05
1B3GT	.90
1B22	1.20
1B23	5.75
1B24	7.15
1B26	2.20
1B27	11.50
1B32	1.45
1B35	8.00
1B42	8.25
1B46	1.85
1B63	39.50
1C6	.45
1G6GT	.60
1H4G	.60
1J6G	.55
1L4	.45
1L6	1.10
1LN5	.73
1N21-B	1.90
1N23A	1.95
1N23B	2.20
1N31	7.25
1N34A	.78
1N38	1.20
1N38A	.95
1N44/400B	1.50
1N45/400C	.90
1N48	.50
1N54	.85
1N54A	.98
1N64	.68
1N69	.65
1P23	2.50
1P28	9.00
1P40	1.55
1P42	5.00
1Q6	.75
1R4	.67
1R5	.59
1S4	.70
1S5	.60
1T4	.60
1U4	.50
1U5	.55
1V	.65
1V2	.69
1X2A	.90
1Z2	3.20
2AP1	5.70
2B22	2.25
2C21	1.05
2C22	.40
2C39	12.25
2C39A	14.25
2C40	6.00
2C43	14.95
2C44	.98
2C51	3.85
2C52	3.75
2D21	1.17
2E24	3.30
2E26	3.40
2E30	2.25
2J21/2J21A	7.75
2J22	5.00
2J26	13.00
2J27	9.70
2J31	20.00
2J32	22.00

Type	Price
2J34	18.50
2J37	12.00
2J39	6.95
2J40	32.00
2J48	24.50
2J50	18.35
2J54	62.95
2J54B	95.00
2J55	49.50
2J61	29.50
2J62	33.95
2K22	19.50
2K23	11.40
2K25	20.20
2K28	25.00
2K29	23.00
2K30/410R	320.00
2K33	175.00
2K33A	195.00
2K34	139.50
2X2	.33
2X2A	1.39
3A4	.59
3A5	.85
3AP1	5.00
3B7/1291	.39
3B22	2.45
3B24	3.95
3B25	3.50
3B26	2.75
3B28	4.95
3B29	10.50
3BP1	3.65
3BP11	7.75
3C23	6.75
3C24/24G	.90
3C27	3.50
3C31/C1B	2.50
3C33	8.75
3C45	11.75
3D6	.40
3DP1	2.75
3DP1A	6.50
3DP1-S2	3.75
3E29	11.50
3FP7	1.75
3GP1	2.70
3J30	95.00
3J31	75.00
3L4	.90
3Q4	.60
3Q5GT	.84
3QSGT	.84
3RP1	7.50
3S4	.65
3V4	.68
3X2500A3	135.00
4A1	1.15
4B22	7.50
4B25/EL6CF	7.95
4B28/CE225	3.95
4C27	12.75
4C35	19.25
WL4D21/4-125A	30.25
4D22	18.50
4E27	14.00
4E27A	29.90
4J32	220.00
4J36	140.00
4J37	195.00
4J63	195.00
4X150A	29.95
5AW4	1.40
5A6	2.75
5BP1	3.35

Type	Price
5BP4	3.35
5CP1	4.25
5C22	37.50
5D21	11.98
WL5D22/4-250A	41.25
5FP7	1.25
5GP1	3.35
5J29	11.50
5J30	29.50
5JP2	19.75
5JP7	22.75
5LP5	17.00
5R4GY	1.20
5R4WGY	1.60
5TP4(RCA)	35.00
5T4	1.40
5U4G	.55
5V4G	.95
5W4	.80
5X4G	.75
5Y3GT	.44
5Y4G	.56
5Z3	.60
5Z4	1.05
EL6CF	7.95
C6J	10.75
6C21	24.95
6-4/6-4B	.39
6AB4	.57
6AB7	.90
6AC7	.95
6AF4	1.20
6AG5	.67
6AG7	1.10
6AH4GT	.75
6AH6	1.18
6AJ5	1.30
6AJ6	1.95
6AK5	.76
6AK5W	1.50
6AK5(WE)	1.10
6AK6	.90
6AL5	.48
6AN4	1.55
6AQ5	.49
6AQ6	.65
6AR5	.75
6AR6	2.70
6AS5	.72
6AS6	2.15
6AS7G	3.45
6AT6	.54
6AU5GT	1.00
6AU6	.56
6AV6	.49
6AX4GT	.73
6AX5	.72
6B4G	1.15
6B8	.75
6BA6	.60
6BC5	.70
6BE6	.60
6BG6G	1.89
6BG7	1.65
6BH6	.73
6BJ6	.70
6BK7	1.12
6BL7GT	1.01
6BN6	.85
6BQ6GT	1.13
6BQ7A	1.15
6BX7GT	1.50
6BY5G	2.50
6BZ7	1.18
6C4	.52
6C5	.59
6C6	.65
6CB6	.56
6CD6G	1.75

Type	Price
6CL6	1.10
6CS6/5915	1.10
6CU6	2.10
6F4	3.50
6F5	.68
6F6M	.65
6F8G	.90
6G12	.90
6H6	.50
6J4	4.95
6J5M	.55
6J5GT	.52
6J6	.75
6J7M	.70
6K4/6K4A	2.25
6K6GT	.60
6K7	.60
6L5G	.90
6L6G	1.05
6L6GA	1.05
6L6M	1.39
6L7M	.85
6N7	.75
6P7G	.85
6S4	.65
6S7M	.95
6SD7GT	.80
6SA7GT	.63
6SA7M	.63
6SC7	.79
6SG7	.60
6SH7	.65
6SJ7	.58
6SK7M	.62
6SK7GT	.62
6SL7GT	.64
6SN7WGT	1.70
6SN7GT	.70
6SO7	.55
6SR7	.59
6SS7	.83
6T8	.95
6U5/6G5	.75
6U8	.85
6V3	1.20
6V6-GT	.60
6V6M	1.35
6W4GT	.55
6W6GT	.75
6X4	.50
6X5GT	.55
6X8	.95
6Y6-G	.88
7A4	.70
7A7	.74
7A8	.67
7B7	.76
7BP7	4.25
7B8	.75
7C4	.29
7C5	.69
7C6	.69
7C23	65.00
7C30	85.00
7E5	.39
7E6	.55
7F7	.80
7GP4	4.25
7H7	.70
9LP7	3.50

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10T1	.75
12A/112	.75
12A5	1.25
12A6	.75
12AL5	.70
12AT6	.50
12AT7	.80
12AU7	.65
12AV6	.50
12AV7	.85
12AW6	.88
12AX4GT	.90
12AX7	.73
12AY7	1.75
12AZ7	.90
12B4	.82
12BA6	.60
12BE6	.60
12BH7	.88
12BY7	.98
12BZ7	1.10
12GP7	15.25
12SA7	.66
12SC7	.85
12SG7	.78
12SH7	.63
12SJ7	.56
12SK7	.63
12SNJ	.75
12SQ7	.55
15E	.80
15-R	.25
19AP4A	43.00
19BG6G	1.88
19T8	.90
22	.99
23D4	.85
24-A	.55
25AV5	1.20
25A6	1.15
25BQ6GT	1.18
25L6GT	.62
25-T	2.50
25Z6GT	.57
26	.55
27	.55
28D7	1.55
35A5	.60
35B5	.60
35C5	.60
35L6GT	.62
35W4	.42
35Y4	.55
35Z5GT	.50
41	.75
42	.70
45 (Special)	.40
47	.80
50A5	.75
50B5	.63
50C5	.65
50L6GT	.65
50Y6	.73
50T	3.95
53A	4.95
RK59	1.20
WL-SK60	5.15
QK-60	60.00
QK-61	60.00
VR-65	1.50
70L7GT	1.00

Type	Price
QK-72	250.00
RKR-72	.90
RKK-73	.90
75	.65
76	.50
77	.70
78	.75
80	.64
81	.95
82	.85
83	1.11
83-V	1.00
84/6Z4	.61
98R	5.50
HF-100	6.25
C-100E	2.50
100-TH	5.95
101-F (WE)	2.25
101L (WE)	2.10
102-F (WE)	2.25
104-D (WE)	3.10
FG-105 (GE)	17.50
VU-111	.88
HY-114B	.50
117L7GT	1.65
117Z3	.55
117Z4GT	1.55
C-120	9.90
121-A	8.00
WL-172	51.00
CV-172	25.00
183 (TS)	2.50
211/VT4C	.85
RX215	7.75
227/227A	3.75
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RX232	3.20
RX233A	3.35
245A	2.25
250-TH	17.75
HK-257B	14.00
271-A	6.30
FG-271/5551	55.00
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275-A (WE)	5.95
HF-300	17.50
304-TH	7.75
304-TL	8.75
306-A	3.95
307-A	4.25
310-A (WE)	3.95
311-A (WE)	3.25
316-A	.85
328-A	4.05
332-A	25.50
350-A	4.90
350-B	3.75
359-A (WE)	4.00
371-B	.68
373-A (WE)	3.75
374-A (WE)	3.30
387-A (WE)	2.75
388-A	1.25
393-A (WE)	7.75
394-A	2.50
403-B (WE)	5.00
404-A (WE)	12.95
404-B	12.95
407-A (WE)	4.95
408-A (WE)	3.00
416-A	12.95
417-A (Klystron)	12.95
417-A (WE)	7.50
418-A	12.00
421-A	5.95
422-A	5.95
GL-434-A	14.75
GL-446-A	1.19

Type	Price
WL-450-TH	73.00
450-TL	40.00
GL-451	3.00
464-A	9.50
GL-471A	2.20
WL-481A	4.30
CK-501LX	1.25
WL-502A	1.65
527	10.95
WL-530	13.00
WL-531	5.00
WL-532	3.75
GL-559	1.15
GL-562	75.00
575-A	13.95
WL-579B	14.70
WL-KU610	21.50
WL-KU627	19.80
WL-629	11.70
WL-632B	26.00
635	11.00
651	65.00
ZP-653	195.00
WL-672-A	34.25
WL-KU676	52.25
WL-677	52.25
WL-678	46.00
700-A	14.00
700-B	15.00
700-D	14.00
703-A	4.50
704-A	.85
705-A	.98
706-B	2 .50
706EY	27.50
707-A	4.00
707-B	9.25
708-A	3.50
709-A	2.65
CK-710	.95
713A	.90
714-AY	9.95
715A	3.00
715B	4.00
717-A	.80
719-A	16.00
721-A	1.95
723	7.00
723A/B	13.40
724-A	1.70
724-B	1.90
725-A	4.75
726-A	8.75
726-C	59.50
728-EY	185.00
730-A	19.50
801-A	.35
802	3.25
803	3.25
805	3.20
807	1.53
808	1.50
WL-810	15.95
810	10.75
811	2.95
811-A	2.90
812	2.65
812-A	3.50
WL-813	17.75
813	10.25
814	3.50
815	5.00

Type	Price
816	1.40
822	19.50
826	.95
827-R	53.00
828	9.50
829	6.75
829-A	6.75
829-B	8.95
832	6.50
832-A	7.50
WL-833-A	49.00
834	8.00
836	3.00
837	.95
838	2.90
841	.40
845	6.75
WL-845	13.50
849	29.00
860	2.25
861	15.00
865	.95
866-A (JAN)	1.25
866-A (CBS)	1.75
869-B (AMP.)	65.00
872-A	2.75
872-A (Box)	3.25
874	.95
884	1.50
885	1.65
WL-889-RA	289.10
WL-891	218.54
892-R	195.00
902	5.00
902P1	9.00
918	2.20
921	1.85
922	1.60
924	2.60
927	1.65
954	.35
955	.45
956	.45
957	.45
958	.68
959	1.75
968	1.50
991/NE-16	.50
FM1000	.40
CK1005	.65
CK1006	1.50
CK1027	2.75
1201/1201A	.65
1203A	.45
1299A	.55
1608	4.95
1612	2.00
1613	.80
1616	.85
1619	.35
1622 (6L6M)	1.95
1624	1.50
1625	.30
1626	.20
1629	.25
1630	.90
1632	.45
1636	2.75
1638A	.50
1655	1.75

Type	Price
1665	1.75
1960	.60
2050	1.40
2051	1.00
5514	4.75
5516	7.65
WL-5550/681	49.00
WL-5552/651	120.00
WL-5553/665	251.50
WL-5554/679	180.55
WL-5557/17	8.40
WL-5558/32	14.40
WL-5559/57	21.90
5636	5.75
5637	3.00
5643	8.00
5645	7.75
5646	7.75
5654	1.75
5670	3.25
5676	1.15
WL-5683	9.24
WL-5685	31.27
5687	2.75
5693	6.20
5694	2.50
5702	2.85
5702-WA	4.50
5703	1.20
5703-WA	3.50
5718	6.00
5719	5.50
5725	4.10
5726	1.50
5732	3.95
WL-5736	156.80
5744	2.25
5749	1.90
5751	2.95
5763	1.30
5787	4.25
5800	6.50
5814	2.00
5829	2.75
5837/SD1104	110.00
5838	3.00
5840/SN1039A	7.75
5844	2.00
WL-5846	126.40
5881	2.50
5886	3.00
5964	1.45
5991	3.95
5910	.75
WL-5934	14.70
WL-5996	25.00
5995	6.00
6090	2.00
6095	Write
6096	Write
6097	Write
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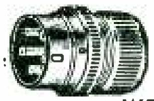

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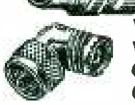

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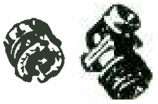

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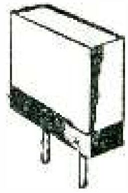

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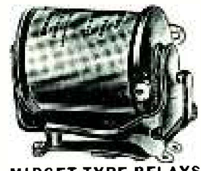
Thoardson Tru-Fidelity Plate Transformer. Primary 208-210-220-230-240 Volts 60 Cycle. Secondary 3310 V.C.T. @ .86 Amps. 10,000 Volt insulation. Brand new—limited quantity.
Stock 6399A — Price Each **$60.00**

SENSITIVE RELAYS



MIDGET TYPE RELAYS
Automatic Electric Type R-45, 6500 ohm Coils.
Normally open contacts except as noted.

Stock No.	Contents	M.A.	Price Each
102152	5.P.S.T.	2.0	$1.25
102249	2.P.S.T.*	4.5	1.50
102264	3.P.S.T.	6.0	2.00

* 1 Norm. open-1 Norm. closed.

Same type and style as above, but has 24 V.A.C. coil. Intermittent duty. Will operate on 6 V.D.C. Continuous duty. Contacts: S.P.S.T.-N.O. and S.P.D.T.
Stock No. 102248A — Price Each **$1.25**

HI-Z HEADSETS

Signal Corps Type P-20 Headsets. 24000 Ohm Impedance. Complete With 6 Foot Moulded Rubber Cord and PL-55 Plug. Type R-2A Units.
Stock No. 6468A — Price Each **$2.95**

Famous Signal Corps HS-18 Headset Units. Consists of 2 Type R-14 Units With Interconnecting Short Cord and PL-54 Plug. Less Headband. 8000 Ohm Impedance.
Stock No. 6469A — Price Each **$1.00**

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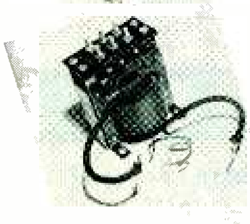
3 OUTSTANDING TRANSFORMER VALUES!



.... Acme Induction Heating or Transmitter Plate Supply

3100 Volts Each Side of Center at 500 M.A. Primary tapped for 98, 104, 110, 116, 123 Volts, 60 cycle A.C. Conservatively rated. 15 KV. impregnated mica insulation. Balanced secondary windings. Special high silicon low loss core. Size: 9" L. x 8" H. x 7 1/2" W. Shipping wt: 60 lbs. Priced extremely low at **$34.50.**

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2.5 Volts (C.T.) at 10 amps. 10 KV. insulation. Primary tapped as above. Excellent design and construction for continuous operation. Limited quantity. Only **$2.75 each.**

.... Acme Filament Transformer

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2C39A	12.00	3GP1	2.50	RK-72	1.00	355A	10.00	726A	7.50	849	18.50
2C40	6.25	3KP1	9.75	RK-73	1.00	F-375A	12.50	726B	40.00	851	45.00
2C43	10.50	4E27	13.75	F-128A	75.00	393A	8.00	726C	45.00	860	2.00
2C44	1.00	4J34	75.25	F-129B	150.00	394A	2.50	728CY	35.00	861	13.50
2D21	1.00	4J35	125.25	VT-158	30.00	417A	6.50	728DY	35.00	866A	1.00
2E22	1.75	5BP1	3.50	FG-190	6.00	GL-434A	12.00	728EY	35.00	869B	55.00
2J26	13.50	5BP4	3.50	C-202	12.50	446A	1.00	728FY	35.00	872A	2.50
2J27	9.75	5C30/C5B	3.00	204A	25.25	446B	3.00	728GY	35.00	878	1.25
2J31	20.25	5CP1	4.00	F-207	100.00	450TL	37.50	802	3.00	884	1.00
2J32	22.50	5D21	12.00	WL-218	25.25	464A	7.00	803	2.50	885	1.25
2J33	20.25	5FP7	1.00	250R	5.00	527	9.75	805	3.00	892R	262.00
2J34	18.75	5FP14	10.25	250TH	12.50	631-P1	4.75	807	1.25	902-P1	5.00
2J36	75.00	5JP1	13.25	250TL	10.00	700A	14.50	808	1.50	918	1.25
2J38	12.50	5JP4	13.25	267B	7.00	700D	14.50	809	2.50	923	1.00
2J50	25.25	5JP11	35.50	271A	12.25	701A	4.50	810	9.75	927	1.00
2J55	50.00	5J23	30.00	274B	2.00	702A	2.00	811	2.50	931A	4.25
2J56	75.50	5J30	23.50	276A	12.25	705A	1.00	812	2.50	959	1.50
2J61	30.00	5J32	60.00	282A	7.50	706AY	25.00	813	8.75	CK-1006	1.50
2J62	25.00	5LP1	13.00	283A	3.75	706FY	35.00	814	2.50	1614	1.50
2K25	20.50	5R4GY	1.00	304TH	6.75	706GY	35.00	815	4.50	1624	1.00
2K41	93.75	C6A	7.50	304TL	6.75	707A	6.00	816	1.00	2050	1.25
3AP1	5.00	6BL6	52.50	307A	3.00	707B	8.75	826	1.00	ZB-3200	125.00
3BP1	3.75	6BM6	62.50	310A	3.00	709A	2.50	828	9.50	8002R	85.00
3B24	4.25	6C21	15.00	311A	3.25	715A	3.00	829A	6.50	8005	4.25
3B24W	6.75	6J4	4.75	313C	3.00	715B	4.00	829B	8.00	8012	1.75
3B25	3.50	7BP7	3.00	323B	9.75	715C	14.75	830B	2.00	8013	2.00
3B26	2.75	9LP7	3.50	328A	4.00	719A	16.50	832	6.50	8020	1.00
3B28	4.00	12DP7	12.50	329A	6.00	721A	2.00	832A	7.50	8025	3.50
3C23	6.75	12GP7	15.50	348A	6.00	722A	1.50	833A	28.50	PD8365	50.00

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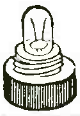

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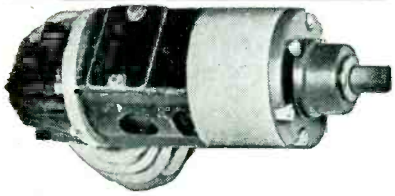
#322	3 V.	.19 amp.
#328	6 V.	.2 amp.

100 for $25.00 10 for $3.00



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Clamps to hold motor: $1.50 ea.

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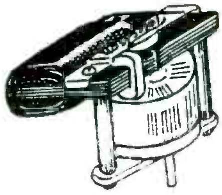

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1800 RPM SYNCHRONOUS Motor; 115 volts AC, 18 watts 1 1/4 lbs.; 2"x3"x2"...... **$4.50**

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A 10 amp. timing device. Pointer moves back to zero after time elapses. Ideal for shutting off radios and TV sets when you go to bed. Limited supply at this special PRICE **$4.90**

Also available in 15 min., 30 min., 1 hr. at $5.90

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A hand wound electric TIMING SWITCH. Pointer moves back to ZERO and shuts off RADIO—TV—Electric Mixer—Photographic Devices—Time Delay etc. Furnished with Calibration Chart and Pointer Knob. Biggest bargain we ever had...... **$1.25**

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ZENITH Motorized Remote control made for T.V. but ideal for opening doors—windows—Turntables—Gadgets—Tuning Radios. Complete with Transformer 16 ft. cable and reversing button. A few more left...................... **$8.95**

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55¢ EACH
(To Quantity Buyers)
75¢ in Smaller Quantities
10¢ Extra for Locking Bushing

Ohms	Shaft	Bushing	Ohms	Shaft	Bushing
50	1/8 S	1/2 L	20K	5/16 F	1/4
60	3/8 F	1/4	20K	1/2 R	1/4
60	1/4 R	3/8	20K	1/8 S	1/2 L
70	1/2 R	3/8	25K	2 3/4 F	1/4
100	1/8 S	1/2 L	25K	1/8 S	3/8
100	2 1/8 F	3/8	25K	1/2 R	1/4
200	1/8 S	1/2 L	25K	2 1/8 F	3/8
400	1/8 S	1/2 L	30K	5/16 F	1/4
500	1/8 S	3/8	50K	1/8 S	3/8
500	5/16 R	3/8	50K	1/4 S	1/4
500	3/8 S	3/8	50K	1/2 F	1/4
1000	1/8 S	3/8	50K	1/2 R	1/2 L
1000	1/8 S	1/2 L	50K	1/8 S	1/2 L
1300	1/4 S	1/4	50K	3/8 R	3/8
1500	1/8 S	3/8	50K	3/8 F	3/8
1500	1/8 S	1/2 L	50K	1/2 S	3/8 SW
1500	1/2 F	1/2	60K	1/4 S	1/4
2000	1/4 F	1/4	60K	1/8 S	1/2 L
2000	1/8 S	3/8	70K	1/8 S	3/8
2000	1/8 S	1/2 L	100K	1/4 R	1/4
2500	1/8 S	3/8	100K	1/2 F	1/4
2500	1/8 F	1/4	100K	1/2 R	1/2
3500	1S	3/8	100K	1/8 S	1/2 L
5000	1/4 F	1/4	100K	2 1/8 R	3/8
5000	1/4 S	3/8	150K	1/8 S	1/2 L
5000	1/8 S	1/2 L	150K	1S	3/8
5000	3/8 R	3/8	150K	3/8 R	3/8
6500	1/8 S	1/4	200K	1/4 F	1/2 L
7500	1S	3/8	200K	1/4 R	3/8
10K	5/16 R	1/4	200K	3/8 R	3/8
10K	1/4 S	3/8	200K	1/8 S	3/8
10K	7/8 R	1/2	200K	1/8 S	1/2 L
10K	5/16 R	3/8	250K	1/8 S	1/4
10K	1/8 S	1/2 L	250K	3/8 S	3/8
10K	5/8 R	3/8	250K	1/8 S	1/2 L
10K	1/4 S	1/4	250K	2 1/8 F	3/8
10K	3/8 F	3/8	300K	1/8 S	1/4
10K	1/4 F	1/4	500K	1/2 S	3/8
10K	1/2 R	3/8	500K	2 1/8 F	3/8
10K	2 1/8 R	3/8	500K	2 1/8 R	3/8
10K	2 1/8 F	3/8	1 Meg	1/8 S	1/4
15K	1/8 S	1/4	1 Meg	1/8 S	3/8
15K	1/2 S	3/8	1 Meg	1/8 S	1/2 L
20K	1 1/8 R	3/8	1 Meg	2 1/8 R	3/8
20K	3/4 S	1/4	1 Meg	1/2 S	3/8
20K	3/8 R	3/8	4 Meg	3/8 R	3/8
20K	1/2 R	3/8	5 Meg	2 1/8 F	3/8

TYPE "JJ"—$1.25 EA.

($1.50 in Small Quantities)

Ohms	Shaft	Bush	Ohms	Shaft	Bush
250–250	2 1/8 R	3/8	25K–25K	2 3/4 F	1/4
500–500	1/8 S	1/2 L	25K–10K	2 3/4 F	1/4
600–600	1/4 R	1/4	35K–35K	1/4 S	1/2 L
1K–1K	2 1/8 R	3/8	50K–50K	1/8 S	3/8
2K–30K	3/8 F	3/8	100K–100K	2 1/8 R	3/8
3K–3K	1/2 S	1/4	150K–150K	1/8 S	1/2 L
5K–500	3/8 F	1/4	175K–225K	1/4 R	3/8
5K–500	1/8 S	1/2 L	250K–250K	3/8 S	1/4
10K–10K	2 1/8 R	3/8	250K–250K	1/4 R	3/8
15K–15K	1/8 S	1/2 L	250K–250K	2 1/8 R	3/8
20K–350K	5/16 F	1/4	300K–300K	1/8 S	1/2 L
20K–800K	1/2 R	1/4	500K–500K	2 1/8 R	3/8

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10¢ EACH
(To Quantity Buyers)

MFD	Volt.	Style Terminals	MFD	Volt.	Style Terminals
10/10/30			50	25	Side*
/30	25	Side	50	25	Side
12/12	50	Side	50	25	Top*
16/16/16	250	Side	50	40	Side
20	50	Side	50	50	Side
20	350	Side	100	25	Side
25	50	Side*	100	50	Top
25	50	Top*	200/200	9	Side
25	250	Bottom	* can common		

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10 MFD—220 VAC
85¢ EACH

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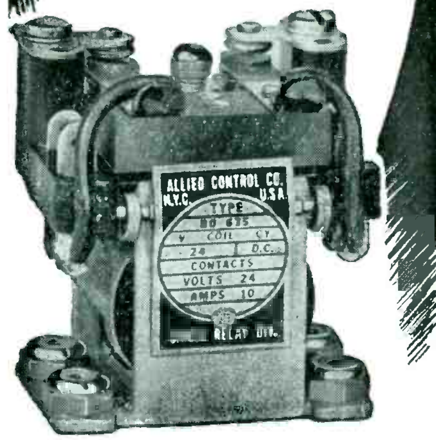

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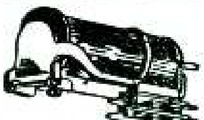
TELEPHONE RELAYS



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CLARE TYPE C STANDARD SIZE SENSITIVE TELEPHONE RELAYS

	Coil	Contacts	Will Close at	Price
1)	6500 ohms	1A	4 MA	$2.25 ea.
2)	6500 ohms	1C	2 MA	3.00 ea.
3)	6500 ohms	1B-1C	3.5 MA	2.75 ea.
4)	6500 ohms	2A	4 MA	3.00 ea.
5)	6500 ohms	4A	4 MA	3.00 ea.
6)	6500 ohms	3A-1B	4 MA	3.00 ea.
7)	6500 ohms	5A	5 MA	3.25 ea.

CLARE TYPE G HALF SIZE SENSITIVE TELEPHONE RELAYS

	Coil	Contacts	Will Close at	Price
1)	6500 ohms	2A	5 MA	$2.50 ea.
2)	5800 ohms	3A	4 MA	2.50 ea.
3)	5800 ohms	2B-1C	5 MA	2.50 ea.
4)	3600 ohms	1C	6 MA	2.00 ea.
5)	4850 ohms	1A	5 MA	2.00 ea.
6)	3300 ohms	(None)	ACTUATOR	1.50 ea.

All above Relays may be used for continuous duty operation on 110V. D.C.

OTHER TYPE G TELEPHONE RELAYS

1)	1300 ohms	1A-1C	24 or 48V	$2.50 ea.
2)	500 ohms	Actuator	24 V.	1.25 ea.
3)	400 ohms	Actuator	24 V.	1.25 ea.
4)	30 ohms	Actuator	3 or 6 V.	1.00 ea.

CONTACT SYMBOLS
A=Norm. Open B=Norm. Closed C=S.P.D.T.

G.E. Relays #CR2791-B109P36 Coil—10,000 ohms Contacts 1A, 1B Operates on 8 MA....Price $1.65
Signal Wheelock Relays #KS9665 Coil—2,000 ohms Contacts-1A, 1B, 1C Oper. at 9 Ma Price—$2.75 ea.
Leach Relays Type 1025-SN-BF. Coil—24V. 425 ohms Contacts—D.P.S.T. Norm. closed. Rated at 10 Amps ....Price—$1.50 ea.
FIVE Prong CR-2791 G.E. Plug In Relays.
1) C-103C25 2200 ohms SPDT 4.5 MA....$4.00 ea.
2) C-104B28 700 ohms SPDT 6 MA.......$3.00 ea.

CLARE TYPE A Tel. Relay. Coil—55 Volts AC 60 cy. Contacts—3PDT (3 form C) Price—$3.50 ea.

Clare SK-5032 (Hermetically Sealed) Plug-In Relays. Coil—30 ohms 6 volts Contacts—DPDT. Price—$4.00 ea.

SIGMA TYPE 5F SENSITIVE RELAYS. Has two 70 ohm coils. Contacts—SPDT....Price—$3.00 ea.

TYPE H TRANSMITTING MICA CONDENSERS

1)	.003 MFD	2500v.	DCW	$.45 ea.
2)	.01 MFD	1200v.	DCW	.45 ea.
3)	.001 MFD	1200v.	DCW	.35 ea.

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AN/ARN-7 COMPLETE	ARC-3
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AN/ARC-1 VHF EQUIPMENT	APN-1

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CU-25 ANT. LOAD	DY-11 & 12 Dynam't'r
MT-283 MOUNT	0-16 LFO
MT-284 MOUNT	ATC DYNAM'T'R
SA-22 ANT. LOAD	C-87 CONTROL BOX

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SCR-729 New	APS-2, 3, & 15 Components
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RTA-1B	AN/ARC-5 VHF
BC-1016	SCR-274 & ARC-5, Command Equipm't
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APA-11 INDICATOR	R-4/ARR-2 Receivers
APA-17 RADAR	BC-640 VHF XMTR
HS-33 HEAD SETS, NEW	SCR-510
	SCR-522
MG-149F & H	MG-153

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AN/ARN-7	AN/ARC-1
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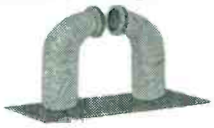

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RA-37 RA-49 RA-50 RA-62 RA-63 RA-67 Extensive stock of rectifiers and power supplies.

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5639	12.00
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5643	8.00
5644	12.00
5645	7.75
5646	7.75
5647	5.50
5651	2.30
5654	1.65
5656	10.00
5658	.80
5670	3.25
5676	1.15
5686	3.00
5687	2.75
5691	9.50
5692	9.75
5693	7.75
5702	2.95
5702WA	4.50
5703	1.20
5703WA	3.50
5704	2.80
5718	6.00
5719	5.50
5720	23.00
5725	3.25
5726	1.50
5744	2.25
5749	2.15
5750	2.50
5751	2.95
5763	1.50
5783	6.00
5787	4.25
5814	2.25

5825	12.75
5829	2.75
5837	110.00
5840	6.00
5844	2.00
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5902	11.00
5910	.75
5915	1.20
5932	8.50
5937	24.00
5963	1.30
5964	1.45
5995	6.00
6005	3.75
6072	5.50
6080	5.95
6082	5.25
6095	write
6096	write
6097	write
6099	write
6101	write
6111	11.50
6112	11.50
6135	2.75
6146	4.85
6163	3.25
6187	2.50
8001	5.50
8013A	3.95
8020	2.00
8025	5.25
1N21	1.28
1N23A	2.00
1N21B	2.00
1N23B	2.25
1N34A	.70
1N44	1.20
1N45	1.30
1N48	.50
1N54	.75
1N54A	1.00
1N63	4.50
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.0001	6KV	.00065	10KV	.015	7KV
.00015	6KV	.001	10KV	.25	1.6KV
.0002	6KV	.002	10KV	**G-4 TYPE**	
.0004	6KV	.03	2KV	.00025	30KV
.0008	6KV	.045	2KV	.0006	35KV
.001	6KV	**G-3 TYPE**		.0025	25KV
.01	4KV	.0001	20KV	.0039	20KV
.032	2KV	.00015	20KV	.0075	15KV
.04	1KV	.00025	20KV	.01	15KV
.051	1.5KV	.0004	20KV	.01083	12KV
.08	1.5KV	.00045	15KV	.03	8KV
.09	1.5KV	.00047	20KV	.056	5KV
G-2 TYPE		.0005	20KV	**OTHERS**	
.0001	10KV	.00095	5KV	.000155	30KV
.00015	10KV	.001	20KV	.0004	30KV
.0002	10KV	.0012	20KV	.000533	30KV
.0003	10KV	.00124	15KV	.001	30KV
.000375	10KV	.0015	20KV	.007	15KV
.004	5KV	.0051	10KV	(Many Others)	

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1	600	.54	3	600	.59
1	240 AC	.49	3	240 AC	.54
1	1000	.67	3	4000	8.95
1	1500	1.35	4	600	1.59
1	2000	1.95	4	400	.89
1	2500	2.75	4	700	1.61
1	3000	3.40	4	1000	1.90
1	5000	5.75	4	2500	4.85
1	6000	9.91	5	50	.85
2	250 AC	.67	5	600	1.49
2	330 AC	.73	6	400	1.59
2	200	.49	6	600	1.69
2	400	.59	8	600	1.79
2	500	.64	8	440 AC	2.95
2	600	.68	10	600	3.19
2	1000	.89	10	1000	3.95
2	1500	1.79	10	2500	7.25
2	2000	2.80	15	600	4.95
2	2500	3.95	15	1000	7.49

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ohms	W	Ea.	ohms	W	Ea.	ohms	W	Ea.
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.5	25	1.98	50	50	2.10	500	100	3.6
.5	50	2.34	60	25	1.86	500	150	4.63
.5	150	4.89	75	25	1.86	500	300	6.93
1	50	2.34	75	50	2.10	750	25	1.86
2	50	2.34	75	75	3.25	750	150	4.90
2	100	3.86	80	50	2.10	1000	25	2.10
2	300	6.93	100	25	1.86	1000	50	2.22
3	100	3.86	100	50	2.10	1200	225	6.41
3	225	6.41	100	100	3.60	1200	300	6.93
5	25	1.86	125	25	1.86	1250	50	2.22
5	50	2.10	150	50	2.10	1250	150	4.90
5	100	3.86	175	25	1.86	1500	25	2.10
5	150	4.63	185	25	1.86	1500	50	2.22
6	25	1.86	200	25	1.86	1600	50	2.22
6	50	2.10	200	100	3.60	1800	150	5.15
6	75	3.25	200	150	4.63	2000	25	2.10
7	25	1.86	225	50	2.10	2000	50	2.22
7.5	75	3.25	250	25	1.86	2250	150	5.15
7.5	225	6.41	250	50	2.10	2500	50	2.22
8	50	2.10	300	50	2.10	2500	100	3.71
10	25	1.86	300	75	3.25	2500	150	5.15
10	50	2.10	300	100	3.60	3000	25	2.22
10	100	3.60	350	25	1.86	3000	100	3.71
12	25	1.86	350	100	3.60	5000	25	2.22
12	50	2.10	350	150	4.63	5000	50	2.34
15	25	1.86	370	25	1.86	7500	50	2.34
15	75	3.25	378	150	4.63	7500	100	4.40
15	100	3.60	400	25	1.86	10000	50	2.50
20	50	2.10	400	75	3.25	10000	100	4.75
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INDEX

SEARCHLIGHT

DECEMBER, 1953

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ADVERTISERS INDEX

TO THE ADVERTISERS

DECEMBER, 1953

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(Classified Advertising)
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100MA @ 130V	2.05	.79	8.68
150MA @ 130V	2.25	.99	10.78
200MA @ 130V	3.15	1.39	14.98
300MA @ 130V	3.30	1.49	15.98
400MA @ 130V	4.25	1.89	20.38
500MA @ 130V	4.40	1.98	21.28
230MA @ 18V	1.40	.59	5.98
230MA @ 36V	2.25	.89	8.38
250MA @ 300V	6.95	1.39	14.98

SOCKET ASSEMBLIES

½" Jewel Bayonet Socket Light Dimmer (Shutter) Regular 3/c ... 33¢ EA.
Less Than (3) ... 39c Lots of 5
Dialco 31101 Pilot Light 1" Jewel 115V. High Polish Finish. Reg. $1.03 "TAB" price ...85 ... @ 10 for $7
Neon Panel Lite Dialco 95408 Clear With Lamp. Reg. $1.09; SPECIAL...79
Pilot Lamps #40-41-44-46-47 ... 10 for .65

OIL CONDENSERS WAREHOUSE CLEARANCE SALE RECTANGULAR CASE

.5MFD 1500VDC ... 95c; 2 for $1.50
5MFD 600VDC ... 1.50; 3 for 4.00
3MFD 330VAC 1000VDC ... 49c; 3 for 1.20
2x2MFD 600VDC ... 89c; 2 for 1.59

BATHTUB SIDE TERMINALS

1MFD 600VDC ... 39c; 3 for 1.00
4MFD 50VDC ... 50c; 5 for 2.00
.1MFD 2000VDC ... 1.05; 5 for 4.50
2x.1MFD 400VDC ... 49c; 5 for 2.00

OIL CONDENSER SPECIAL

10 MFD 600 VDC $1.75 ea LOTS OF 3
Case Dimensions, Not including Insulators, 4¾H—3¾W—1¾"D
Quantities Less Than 3, Ea. ... $1.98

FREQUENCY METER AND WAVE METER

BC1162 Control Unit. Part of RC150 & SCR270 Radar Equipment 19 Tube Line Up, Operates 150-210 Megacycles, 115V 60 cy. Includes Heavy Duty Power Supply. Excellent Condition Less tubes ... $19.95
Two for ... $36

CONDENSER SPECIALS

2 MFD 1000 VDC 330 VAC "CD" MFGR 25¢ LOTS OF 10
Smaller Quantities Each ... 49c; 3 for $1.25
2MFD 600VDC Porcelain Insulators With Adjustable Mounting Clamp ... 3 for $1.50

CRYSTAL DIODES

1N23B Sylvania $1.89
New, Boxed & Jacketed Lots of 10 Smaller Quantity, Unit Price $2.25
1N21 ... 85c; 6 for $4.00
1N21A ... $1.55; 5 for $7.00
1N21B ... $2.95; 4 for $10.00
1N27 ... $1.55; 5 for $7.00
1N46 ... 69c; 5 for $3.25

METER BUYS

0-30 VDC "AN" $1.98; 2 for $3.25
0-60 ADC "AN" Type Mtg Less Shunt ... 2.95; 2 for 5.00
0-15 VAC GE 3½ Rnd 800cy 1.29
0-150 VAC/Westghs/3½ Rnd 3.49
0-150 VAC/25-135cy/3½ Square RA35/Westgh ... 4.49
0-1/MADC Westghs 3¼" Sq RA35 LN ... 4.49
0-500 MADC/2¼"; Rnd Triplett 221T ... 4.98
VU-20 + 3 Weston 301 3" Sq. Lt. Pt. $41 ... 14.98
0-120 MA RF 3½" Rnd Weston 301 ... 12.98

LAB OR HI-FI POWER SUPPLY

Sola constant voltage power transformer mounted on chassis with 2 octal rectifier sockets.
New Mfgrd By Dumont
Furnishes 400VDC/250MA to filter system & 5V/6A Regulated, 12.6VCT/6 Amp or 2x6.3V/6 Amp (Common Tap)
With filter condensers, choke and rectifier tubes. $59 Value ... SPECIAL $18.98

FILAMENT TRANS.

6.3V/2A ea 99c; 6 for $5.49; 12 for ... $10.
2.5V/2A @ 79c, 3 for $1.49, 10 for ... 6.49
2.5VCT/10A 5KVINS ... 3.59
7.5VCT/12A CSD KENYON 15 KVINS ... 10.95
24V/1.25A CSD @ $1.98 Two for ... 3.49
2X12V/2A or 24V/2A @ $3.89 Two for ... 6.98

"TAB" THAT'S A BUY

RHEOSTAT SPECIALS

20 ohm 50W Model J ... 1.98; 2 for 3.50
60 ohm 50W w/knob ... 2.25; 2 for 3.98
100 ohm 50W Model K ... 1.98; 2 for 3.50
200 ohm 25 Model D ... 1.49; 2 for 2.49
250 ohm 25W ... 1.19; 3 for 2.98
300 ohm 225W Model P ... 2.98; 2 for 5.00
350, 500, 5000 ohm Slotted shaft, 25 watt ... 79c; 3 for 2.00
Write for Others and Quantity Prices.

ADJUST-A-VOLT STANDARD ELECTRIC VARIABLE VOLTAGE TRANSFORMERS

Type 20 0-135V/3 Amp/N ... $11.98
Type 116U/0-135V/7.5A/N ... 16.98
Type 116 Specs 116U & Cased/N ... 21.98
Type 1126/0-135V/15 Amp/Cased/N ... 43.98
Type 1226/0-270V/9 Amp/Cased/N ... 43.98
Type Staco/3000B/0-135V/30 Amp/Cad/N $55.00
GR 50A Variac/0-135V/45 Amp/LN ... 112.00
GR 50B Variac/0-270V/31 Amp/LN ... 112.00
Staco LRL-5/Mtrd/140V/5A/0.5KW/LN ... 29.50
Staco PAL-7/Metered/135V/7.5A/1KW/N 40.50
Industrials; Order 6 Deduct 5%; 12-10%
Simpson Model 260 VOM Prepaid ... 36.98
Hickok 600A MU Tube CHKR Prepaid ... 153.98
GE ST4A Sweep Generator (N) ... 295.00
GE ST5A Marker Generator (N) ... 325.00
GE ST2A Oscilloscope (N) ... 275.00
HF-1 Oscilloscope (N) Special ... 179.95
(N) NEW & (LN) LIKE NEW

DC POWER-SUPPLY

0 to 12VDC/2 AMP Variable DC supply—Input 115v/60 cy. Usable LAB supply, filament D.C. plating, battery charging, model railroad includes voltage or speed control and center off reversing sw. Ideal for two "HO" loco's. "TAB" Special to Your Door, Prepaid U.S.A. ... $10.95; 2 for $20

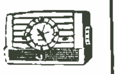
STORAGE BATTERIES

36 Volt WILLARD Mini-BRAND NEW 5 oz Designed Portable Equip. Models ... 98c; 4 for $3
Four 36V BATTERIES w/acid* ... 3.35
2V 20AH Willard PLUS 2V. Vibrator ... 2.98
2V 20AH Batt. W/Vib. & Acid* ... 3.59
4V/16AH Gould ... 1.98
6V/6AH Willard NT6/BB214U ... 2.98
6V/6AH Batt. W/Acid* ... 3.25
6V/40AH Willard ... 6.98
6V/40AH Batt. W/Acid* ... 9.25
* Acid is shipped in Bottles. R'Exp only.

ELECTROLYTIC CONDENSER KIT

POPULAR VALUES 25¢ EA LOTS OF 15
15 ASSORTED CNDSRS, ONLY $3.75

CLOCK RADIO

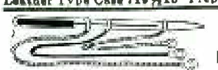


WAKE UP TO MUSIC
Just set the dial, & radio automatically turns on. Beautiful plastic cabinet. MAROON OR IVORY
"TAB" Special to Your Door, Prepaid, U.S.A. ... $20.98
Above Radio Less Clock, Prepaid U.S.A. ... 16.98
With Appliance Outlet & Switch. P.P. USA 22.98

"TAB" XMAS SPECIALS

To Your Door Prepaid; Gtd Table Radio Sets. Exceptional Tone & Reception
#1040 Superhet 5 Tubes, Clock Dial, Ivory or Walnut Cabinet 10x6½"x5" Prepaid U.S.A. $15.98
#1028 Super Xtra Hi-Gain Superhet RF Stage, 5 Dual Tubes 12x8½x8" Prepaid U.S.A. ... $18.98
#1029 2 Bands Bdcst & 6 to 18 Mcs Same as Super-X a1028 Size & Specifications. Prepaid U.S.A. $23.98
#1030 3 Bands Bdcst & 2 to 6 & 6 to 18 Mcs Same as Super-X a1028 Spec's Prepaid U.S.A. ... $26.98
#1040 Personal Portable 3 Way, AC/DC & Batt Leather Type Case 7x9½x5" Prepaid U.S.A. $19.98

MERCURY THERMO REGULATOR

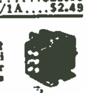


DUAL CKT, 105° F & 32° F. Extremely sensitive & accurate for most exacting requirements—Research, Fire Prev., Freeze, Pt Control, or Max-Min Temp Control. Brand New, w/data & ckt. Ea. 98c; 12 for $10.00

TRANSFORMER BARGAINS

2.5VCT/10A 12.5KVINS Kenyon $6.98; 3 for $19.
778VCT/200MA, 5V/3A, 6.3VCT/5A Thordarson ... $6.98; 3 for $15.
800VCT/150MA Stancor ... $5.98; 3 for $15.
850VCT/148MA 5V/3A, 6.3V/5A, 6.3V/3A ... $6.49
2500VDC/200MA w/CT. Transformers Power & Bridge Filaments & 4/866's Special ... $23.00
600VCT/50MA, 6V/3A, 6V/1.5A, 5V/1A ... $2.49

TRANFORMERS



All 115 V 60 Cyc Input TV & CR Pwr Xmfr up to 20" tubes. HI VOLTS up to 20 KV (w/quadrupler ckt.) ALL Tubes. PL & Fil wndgs
300 VDC/275Ma Full-Wave; 6.4V, 10.3A, 5.4V/3A, 2.5V/3A Hypersil Core, Oil Impreg. $8.49; ... Two for $11.98
1000VCT/85MA, 795VCT/80MA, 360VCT/55MA 3X5V/3A, 6.3VCT/1A, 6.3VCT/.3A CSD HVINS CAN BE USED 2X RATING RAYTHEON, HYPERSIL CORE ... $4.98
950VCT/100MA, 5V/2.5A, 5V/3A. 45V/1A, 10V/1.5A WESTERN ELECT ... $5.49
900V/35MA, 2X2.5V/2A, XCLENT 1800V DBLER TWO 2X2 FIL WNDGS ... $2.25
780VCT/250MA, 5V/6A, 12.6V/5.5A ... $7.95
770VCT/200MA, 5V/6A, 12.6V/5.5A ... $6.95
770V/2.5MA, 2.5V/3A, HVINS HMSLD includes FILTER PARTS 4/scope ... $3.69
720V/85MA, 5V/3.5A, 6.3V/3.5A ... $2.98
700VCT/120MA, 2X6.3V/3A, 6.3V/1A Price ... $3.98; Two for ... $7.25
680VCT/200MA, 5V/3.5A, 6.3V/4A, 78V/1A ... $4.39; 3 for $12.
420VCT/90MA, 6.3V/1.9A, W/INPUTS 6, 12, 24, 115VDC & 115 & 230 VAC @ ... $1.49

FILTER CHOKES

12Hy/80ma/3KVins ... 2.25
10Hy/75ma ... 1.25
10Hy/125ma/UTC/Csd/H'sld/1 KVins ... 1.49
50Hy/125ma/Csd/H'Sld ... 2.89
12Hy/300ma/5KVins ... 4.95
20Hy/300ma or 15Hy/400ma/12KVins Kenyon ... 8.95
13.5Hy/1Amp/17KVins/Raytheon ... 39.95
6 Hy 175ma 250 Ohm ... $1.49; 2 for 2.49

ELECTRIC DRILLS with Jacobs Geared Chuck and Key Model 200J ¼" Workhorse

HI-torque (Powerful) UL appvd. 2400 Rpm 115V AC/DC motor, self-aligning oilless ball thrust bearings. Special "TAB" to your door. Prepaid U.S.A. ... $14.95
Model 793 ⅜" Drill 600 Rpm & 9 Drill-Bits $20.98
Model 400J ½" Drill 425 Rpm & 9 Drill-Bits $29.98

CHROME VANADIUM SPEED DRILLS

29 Drills Chrome Vanadium (C.V.) Speed Steel. Top Quality for Machinists or All Purpose Use. 1/16 to ½ by 64ths. "TAB" SPECIAL ... $7.98
DRILLS, 60 Pcs 1 to 60 C.V. W/Index ... 6.49
DRILLS, 13 Pcs 1/16" to ¼", C.V. W/Index 1.98
DRILLS, 12 Pcs 1/16" to ½" C.V. ... 3.49

SPEED DRILL KIT

Model 200JK, Includes ¼" Jacobs Geared Chuck & Key Drill, Asst'd Drill Bits & Accessories for Grinding, Sanding, Polishing, Buffing, Paint Stirrer & Many Other Uses. 55 Pieces in All. Special, Only ... $19.25

KITS AND COMPONENTS

Oil Condensers Assorted ... 5 for $1.25
Electrolytics Assorted ... 5 for 1.25
Silver & Mica Cndsrs ... 15 for 1.25
Controls, Popular Values ... 5 for 1.25
Resistors, ½ & 1W ... 100 for 1.25
Vitreous W W Resistors ... 8 for 1.25
Sockets, Asstd. 8, 7, 5, 4P ... 12 for 1.25
Iron Core Slug & Screw ... 50 for 1.25
Knobs, Asstd. w/Insert ... 10 for 1.25
"TAB" Special YOU PICK 'EM $1.00 Lots of 5

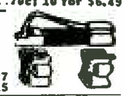
"AN" CONNECTORS REDUCED UP TO 90% OFF LIST

Send "Tab" Your Connector Queries

PRECISION RESISTORS

2 MILLION IN STOCK
Guaranteed 1% Tolerance
ORDER ANY VALUE YOU NEED
.42 to 970K OHM ... 35c; 10 for $3.29
1 MEG & UP ... 70c; 10 for $6.49

CIRCUIT BREAKER FUSES



PUSH TO RESET
Amps 3-5-7-10-15-20 Ea. .27
4 for $1.; 25 for $5.; 100 for $15
Circuit Breaker Fuse W/2 Mounting Clips 39c; 3 for ... $1.00; 20 for ... $5.98; 100 Asst ... $20.00
Fuse is 3AG Size. Operates up to 24 Volts. Please State Amps (current) desired.

CIRCUIT BREAKERS

Heinemann Magn Bkrs. Amps: 3, 7, 9, 12, 15, 20, 30, 35, 40, 80, 150 Ea. $1.69; 10 for $15.98
Sq. D & CH Toggle Sw Brkrs. Amps: 5, 10, 15, 20, 25 98c ... 10 for $8.98
Klixon Therma Push Button Brkrs Amps: 5, 10, 15, 20, 25, 30 89c ... 10 for $7.98

MICA CONDENSERS

Fig.	MFD	WVDC	PRICE
A	.038	600	69c; 5 for $2.50
A	.03	600	69c; 5 for 2.39
A	.02	600	69c; 5 for 2.25
A	.015	2500	1.75; 2 for 3.00
B	.01	600	56c; 3 for 1.20
B	.01	1000	49c; 3 for 1.25
B	.01	1200	69c; 3 for 1.49
A	.005	2500	1.19; 3 for 2.95
B	.004	600	49c; 3 for 1.10
B	.002	1200	58c; 3 for 1.25
A	.002	2500	98c; 3 for 2.25
A	.001	1200	55c; 3 for 1.20
C	.0007	3000	89c; 3 for 2.39
A	.0004	2500	39c; 6 for 1.95
A	.0001	600	25c; 5 for 1.00
C	.0001	3000	89c; 3 for 2.00
C	.0001	5000	1.49; 4 for 5.00
C	.00005	3000	39c; 4 for 1.00

Write for Condenser Listing

FL-5 FILTER

Range or voice. Filters 1020 cycle audio, excellent for CW Work ... 59c; 2 for $1.00

BANDPASS FILTER

Sharp Cutoff HIQ, Cased & Shielded 60, 90, 150 cycles ... Each $1.75; 2 for $3.00
UTC 854, 1024, 1250 Cyc Ea. $1.50; 2 for $2.50

INFRARED SNOOPERSCOPE

SEE IN DARK TUBE

Image-Converter Tube HiSensitivity simplified design 2" dia. Willemite screen—Resolution up to 350 lin/in. Complete data & tube ... ea. $7.98; 2 for $13.98
Snooperscope Pwr Supply 1800VDC/35MA, Using Doubler Crkt. Transformer, Rectifiers, Sockets, Resistors, Capacitors and Diagram 115V/60cy Oper ... $6.98

SELSYNS

2J1H1 GE Selsyns ... Each $8.98
2J1F3 GE Brand New 115V/400 cy. ea ... 9.75
C78248 Sync. Trans. 115/60 cy ... $25; 2 for $45
C78249 Sync. Diff. 115V 60 cy ... $9.00; 2 for $15
Sync. Repeater 115/60 cy Type 11-4 ... 2 for 99.00
Bendix Autosyns AY1 & AY5 ... 2 for 6.95
Bendix AY20 New Orig Crtns ... 12.98
OTHER TYPES IN STOCK

DYNAMOTORS

INPT 6VDC, Output 200V/100ma, or 12/24V Output 500V/50ma 'P' Magnt. As Illustrated ... 6.95
INPT 28VDC/1.4A Output 250V/60ma ... 3.69
DA3A 28V/10.5A out 300VDC/260ma 150VDC/10ma. 14.5vdc/5amp ... 6.75
PE94 Plate Supp., Uses DA3A (SCR522) ... 2.98
PE97 Plate Supp., Less Tubes ... 8.98
PE103 SCR284 or BC654 ... 29.95

TACHOMETER GENERATOR

GENERAL ELECTRIC
PART #2CM5-AAK-20
MARK V STUD MTG
NEW ... $4.98; 2 for $8.00

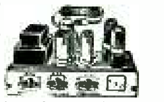
RELAY SPECIAL

SPST Mini Size 115VAC 3A CTS ... 98c; 3 for $2.75
SPDT Mini Size 115VAC 3A CTS ... $1.39; 3 for $3.75
DPDT 6VDC/8A CTS
ALLIED ... $1.49; 2 for $2.49
SPNO 115VAC/15A CTS S'Dunn ... $1.98; 2 for $3.50
DPDT & SPNO 12 VDC/10A CTS ... $2.25; 2 for $3.75
DPDT Clare SK5010, Octal Base, 18-28V 2A Contacts, Nitrogen Sld. New Stock ... $2.98

AUDIO COMPONENTS

GE RPX041 Phono Cart ... $4.49
GE RPX050 Triple Play Cart ... 4.98
Electrovoice Triple Play ... 3.98
Pickup Arm & Xtal Hi-Output 2.39
PM 12" GE 81201A Speaker ... $18.69
Stentorian 10" Hi-Fi Woofer & Horn Tweeter. 10 Watt 40-20Kc ... 29.98
PM 5" Speaker Gud Tone ... 1.98
GE RPJ010 Dual .001" & .003" Sapphire ... 1.98
GE RPJ005 Single .001" Sapphire ... 1.35
GE RPJ001 Single .003" Sapphire ... 1.35
GE RPJ004 Single .001" Diamond ... 11.98
GE RPJ013 Dual Diamond & Sapphire ... 12.98

AUDIO AMPLIFIERS READY TO GO

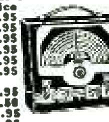


Model AMP5 Hi-Fi 5 Watt AC amplifier, plus built-in Pre Amp GE V.R. pickup, 60 to 18000 cps/1DB/down 2DB 40 cys. Hum level -55DB. Mike & Phono Volume, Continuous Bass Treble Controls. 6SJ7, 6SC7, 6V6, 6X5 "TAB" Hi-Fi specia to your door. Prepaid USA ... $21.39
Same unit ess GE Pre Amp. Prepaid USA 15.98
Model 302PA 3 Tube Phono Amp. Idea for Custom Building your Phonograph w/tubes $4.98
Model 200MO Mike OSC. Broadcasts Through Your Radio with No Direct Connection. W/Tubes. "TAB" SPECIAL ... $6.98
Model 100PO Phono OSC. Phonograph Broadcasts Through Your Radio. No Direct Hookup W/Tube "TAB" SPECIAL ... $4.98

GROMMES SPECIAL HI-FI AMPS

LJ2 Pre & Pwr Amp 8 Watt 20 to 20Kc ... $35.77
503GP Pre & Pwr Amp 10 Watt 20 to 20Kc 53.90
215BA Williamson Pre & Pwr Amp 15 Watt/10-100Kc ... 97.51
205PA Pre Amp 0.5DB 20 to 20Kc ... 53.90
5PA Pre Amp for Reluctance G.E. Cart ... 11.37
5C1 Record Compensator ... 9.50
Columbia 360 Hemispheric Prepaid USA .136.70
Garrard RC80 & G.E. RPX050 3 Play With Any Amplifier Above ... SPECIAL 47.00

EICO TEST EQUIPMENT



Stock #	Type	Kit Price	Bult Price
145K	Sig Tracer	$19.95	$28.95
566K	Volt Meter	14.90	18.95
221K	VTVM	25.95	49.95
315K	Sig Gen	39.95	59.95
322K	Sig Gen	23.95	34.95
360K	Sweep Gen	34.95	49.95
377K	Aud & Sq Gen	31.95	49.95
470K	7" Scope	79.95	129.50
625K	Tube Tester	34.95	49.95
1171	Resistance Decade	24.95	

Industrials & Schools Write Qty Price

866A KIT AND XFORMER

2 Tubes, Sckts, xfmr 115v 60cyc Inp, outpt. 2.5vct. 10A/Hv insul. SPECIAL ... $4.98

DIODE PROBE TUBE

Unexcelled for No-Loss VHF testing. Ultra sensitive subminiature-envelope. New. w/data VR92 ... 25c; 5 for $1

THROAT MIKE

T-30V Double Button Flat 200-5000 cps ± 3DB Sig Corps 98¢ BRAND NEW
P20 Headset High Imp. New ... $4.98
Crystal Mike & Cable ... 2.98
Navy Sound Powered Mike ... 6.98

ODDS & ENDS CLEARANCE SALE

Helipot 50K ohm 10 Turn 0.5% 50KAJZ..$8.98
Attenuator 7470 & 1063 ohm 12 step ... 3.49
Daven Attenuator T323G dual 600 ohm. 20 step 1½ DB per/step ... 10.98
Lacing cord #6 Waxed ... $1.29; 6 for 4.98
Lacing cord #12 Waxed ... $1.49; 6 for 6.98
K. Miller stripper #100 & cutter ... .89
Carbide drills for TV/Ant ¼, ⅜, ½" .. 3 for 3.89
Hytron adapter SH27, 28, 29 Asst ... 3 for 5.00
Line filter F/5 AR for AN/ARC5 installation, used, as-is ... 1.98

YOU PICK THEM 39¢ Lots of 10 WHILE THEY LAST

ELECTROLYTIC CONDENSERS

20MF/25VDC	2X15MF/350VDC
20MF/450VDC	2X20MF/25V, 30MF/450V
25MF/300VDC	40MF/250V, 20MF/25V
50MF/350VDC	3X100MF/35VDC
100MF/25VDC	30/15/100MF/250VDC
ALL SIZ E	TYPES NEW STOCK

UHF ANTENNAS

Microwave Antenna AS125/APR 1000 to 3400 MC W/UG58U Terminal. Inbuilt Hi Pass filter Flange mtg Special ... $5.98
Mobile Whip Ant 6 ft., Spring Steel. Broad response, with antenna, matching Base ... $2.89
UHF Antenna 12" 30CM ATS/ARRI, usable Citizen & Ham band, incul coax Terminal, Mobil mounting—39c; 4 for $1.05
PL-259 plug for above antenna ... 60c

AUDIO COMPONENTS

Western Electric Push-Pull Pentode Output Transformer 197A. Rated 10 Watts for 6V6's or 6AQ5s Excellent Freq. Response Flat 30 to 15000 Cycles. Secondary 600 Ohm. "TAB" Special ... $2.98; 2 for $4.98
UTC Varimatch line to voice coil or line. 30 Watt New $1.98; Six for $10.
XFMR HMT-SLD UTC Super Electric 3 Wdg. 600 Ohm Ct & 4000 Tapped 250 & 150 Ohm. Can be Used Mi Grid. Line to Line & Line to Grid. Special 49c ... 10 for $4.49; 100 for $25.00

Money Back Guarantee (Cost of Mdse. Only) $5 Min. Order FOB N Y C. Add Shpg. Charges or 25% Dep. Tubes Gtd. via R-Exp. only. Prices Subject to Change Without Notice.

THAT'S A BUY "TAB" THAT'S A BUY

Dept. 12E 111 Liberty Street, New York 6, N. Y., U. S. A.
PH. RECTOR 2-6245 CABLE: "TABPARTS"

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Volume XXVI

January to December Issue Inclusive 1953

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Items for which the page reference is marked "D" are editorial material published monthly in Electrons at Work and Production Techniques.

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Title Electronic Engineer
Company Kings' Company, Inc.
Co. Address 161 Avon St., Stratford, N.J. E-8

HOW TO ORDER

Please read these instructions carefully. They provide a simple method which, if followed, will bring you the information you desire.

1. There are two business reply postcards on the right. Each one divided in four parts, thus providing space for eight individual requests.

2. Each request must be made separately and the required information must be completely given for each one. This is important, for these cards are cut apart and sent to manufacturers. Therefore, each one must have ALL the necessary mailing and addressing information.

3. This service applies only to the advertisements that appear in this issue. It does not apply to any part of the editorial content.

4. Please print as neatly as possible.

5. Use ink, as pencil is apt to smudge with handling.

6. Tear out complete postcard, even if all four portions are not used. Drop in the mail—no postage required.

PLEASE NOTE:

In the event this copy of ELECTRONICS is passed along to other members of your company, please leave this sheet in for their convenience. This assures everyone in your plant the opportunity to fill in their requests. When the round is completed, cards can then be detached.

GIVE ALL REQUIRED INFORMATION FOR EACH REQUEST YOU MAKE

THESE CARDS VOID AFTER DECEMBER 30

Request for "Ad" Information, Page No. ....
Advertiser ....
Your Name ....
Title ....
Company ....
....
Co. Address ....
.... E-12

Request for "Ad" Information, Page No. ....
Advertiser ....
Your Name ....
Title ....
Company ....
....
Co. Address ....
.... E-12

Request for "Ad" Information, Page No. ....
Advertiser ....
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.... E-12

An electronics service designed

FOR THE CONVENIENCE

of

READERS and MANUFACTURERS

FOR THE READER . . .

ELECTRONICS fundamental policy has always been to supply its readers with all the pertinent and timely industry news. The ELECTRONICS Reader Service supplements this policy by offering the reader an easy and effective means of obtaining complete, up-to-the minute data on equipment, components, materials, instrumentation and allied products and, of maintaining at his fingertips comprehensive, practicable information on products and services in the industry.

In every issue of ELECTRONICS there's complete coverage of the month by month development of manufacturers products. Some of these items will be of particular interest to specific design and plant engineers, buyers, executives and others of our readers. They will want to make further inquiry concerning the products advertised. ELECTRONICS Reader Service makes it easy for them to obtain in readily accessible and usable form the information they desire.

FOR THE MANUFACTURER

This Reader Service has also been designed as an aid to manufacturers who advertise in ELECTRONICS. Many of those manufacturers are desirous of placing the complete news of their product as well as their technical bulletins and catalogs in the hands of those members of the electronic industry . . . including design, electrical, and production engineers, researchers, physicists, executives and purchasing agents—who have a particular interest in, or represent a potential buying power for, their products. The Reader Service assures advertisers in ELECTRONICS the most effective method of achieving that purpose.

THESE CARDS VOID AFTER DECEMBER 30

FIRST CLASS
PERMIT No. 64
(Sec. 34.9, P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

— POSTAGE WILL BE PAID BY —

ELECTRONICS
330 West 42nd Street
New York 36, N. Y.

READER SERVICE DEPT.

FIRST CLASS
PERMIT No. 64
(Sec. 34.9, P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

— POSTAGE WILL BE PAID BY —

ELECTRONICS
330 West 42nd Street
New York 36, N. Y.

READER SERVICE DEPT.

DAVEN's exclusive, patented, "KNEE-ACTION" Rotor embodies the most advanced principles in switch engineering.

Developed by DAVEN's own staff of switch specialists, it makes possible the fabrication of units with a greater number of switch positions and poles in smaller space than previously possible.

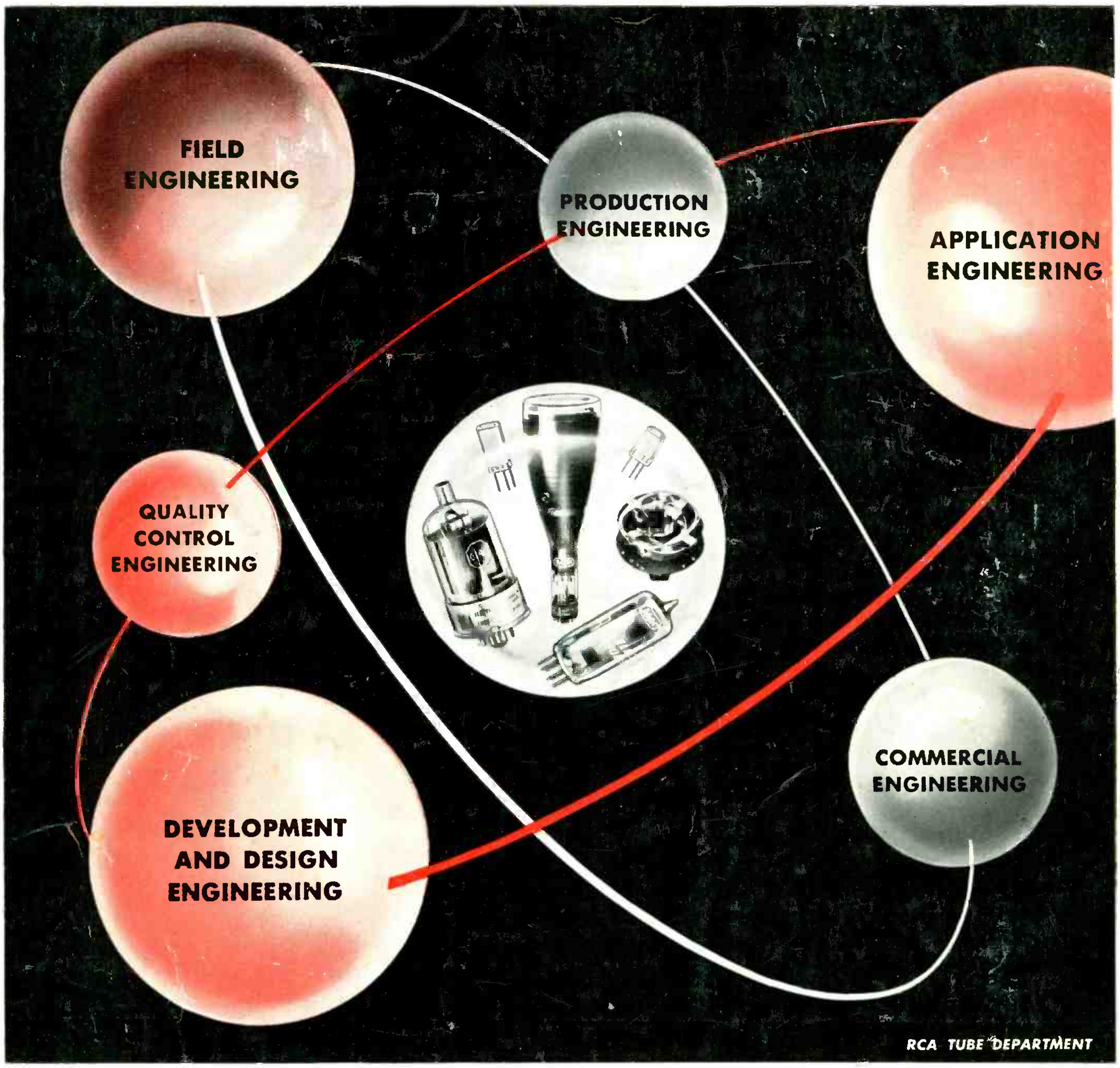
"KNEE-ACTION" insures low contact resistance and uniform contact pressure over the life of DAVEN Switches. Silver alloy contacts, slip rings, and rotor arms are used on all units.

Because a greater number of poles per deck is available, more compactness is possible . . . a feature which is in line with the present trend toward smaller size components which will render maximum performance in minimum space.

DAVEN also offers you every facility for solving your particular switch problems. It stocks a large assortment of standard parts . . . will develop special switches from these standard components . . . or will engineer special switches to meet unusual requirements. DAVEN's Development Engineering Department is at your service to help you. Call on DAVEN today!

Write for your Free copy of DAVEN's new, 28-page brochure on SWITCHES.

THE DAVEN CO. 191 CENTRAL AVENUE, NEWARK 4, NEW JERSEY



How these "spheres" of RCA Engineering —work for YOU

RCA Development and Design Engineering—anticipates the need for new electron devices, and translates your requirements into practical designs.

RCA Quality Control Engineering—assures consistent quality, from the raw materials to the finished product.

RCA Production Engineering—develops production techniques and maintains product reliability.

RCA Commercial Engineering—edits and publishes the industry's most useful and comprehensive technical publications, for your convenience in using RCA Tube Department Products.

RCA Application Engineering—solves your special problems in tube and component applications.

RCA Field Engineering—provides "on-the-spot" technical consultation service—co-ordinates your requirements with other RCA Tube Department Engineering Services.

For expert help from your RCA Field Engineer, write RCA Commercial Engineering, Section 42LR, Harrison, N. J. Or contact your nearest RCA Field Office:

(EAST) Humboldt 5-3900
415 S. 5th St., Harrison, N. J.

(MIDWEST) Whitehall 4-2900
589 E. Illinois St., Chicago, Ill.

(WEST) Madison 9-3671
420 S. San Pedro St., Los Angeles, Cal.

RADIO CORPORATION of AMERICA
ELECTRON TUBES AND COMPONENTS **HARRISON, N. J.**