electronics

AUGUST · 1956

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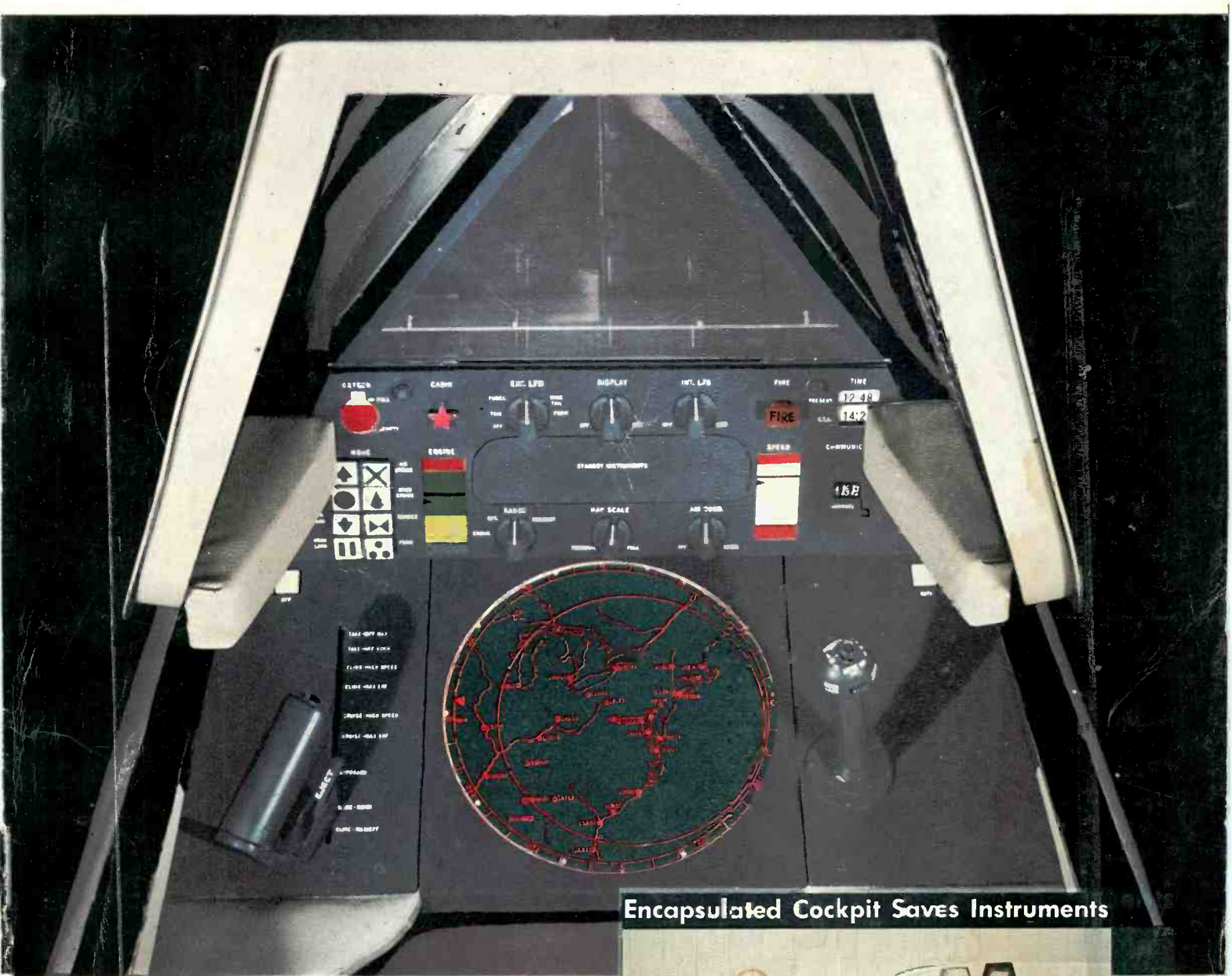


Encapsulated Cockpit Saves Instruments

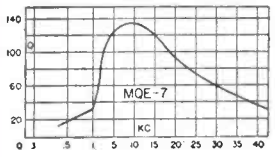
LARGEST PRODUCERS IN THIS FIELD FOR TWO DECADES...

HIGH Q INDUCTORS
FOR EVERY APPLICATION

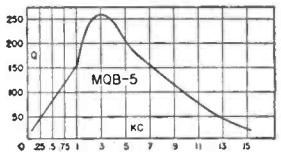
FROM STOCK... ITEMS BELOW AND 650 OTHERS IN OUR CATALOGUE B.

MQ Series
Compact Hermetic
Toroid Inductors

The MQ permalloy dust toroids combine the highest Q in their class with minimum size. Stability is excellent under varying voltage, temperature, frequency and vibration conditions. High permeability case plus uniform winding affords shielding of approximately 80 db.

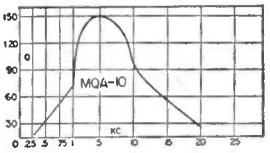


MQE
15 stock values
from 7 Mhy.
to 2.8 Hy.



MQB
12 stock values
from 10 Mhy.
to 25 Hy.

MQA
19 stock values
from 7 Mhy.
to 22 Hy.

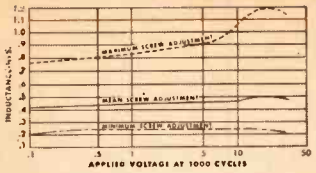


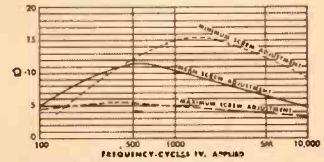
MQ drawn case structure.

	Length	Width	Height
MQE	1/2	1-1/16	1-7/32
MQA	11/16	1-9/32	1-23/32
MQB	1-5/16	2-9/16	2-13/16

VIC case structure

Length	Width	Height
1-1/4	1-11/32	1-7/16





Type	Mean Hys.	Type	Mean Hys.
VIC-1	.0085	VIC-12	1.3
VIC-2	.013	VIC-13	2.2
VIC-3	.021	VIC-14	3.4
VIC-4	.034	VIC-15	5.4
VIC-5	.053	VIC-16	8.5
VIC-6	.084	VIC-17	13.
VIC-7	.13	VIC-18	21.
VIC-8	.21	VIC-19	33.
VIC-9	.34	VIC-20	52.
VIC-10	.54	VIC-21	83.
VIC-11	.85	VIC-22	130.

VIC Variable Inductors

The VIC Inductors have represented an ideal solution to the problem of tuned audio circuits. A set screw in the side of the case permits adjustment of the inductance from +85% to −45% of the mean value. Setting is positive.

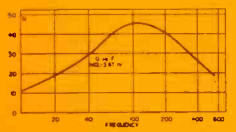
Curves shown indicate effective Q and L with varying frequency and applied AC voltage.

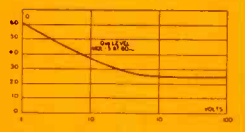
MQL Low Frequency High Q Coils

The MQL series of high Q coils employ special laminated Hipermalloy cores to provide very high Q at low frequencies with exceptional stability for changes of voltage, frequency, and temperature. Two identical windings permit series, parallel, or transformer type connections.

MQL-1	2.5/10 Hys.
MQL-2	5/20 Hys.
MQL-3	50/200 Hys.
MQL-4	100/400 Hys.

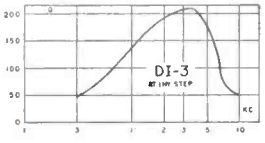
MQL case
1-13/16 dia. X 2-1/2" H.





DI Inductance Decades

These decades set new standards of Q, stability, frequency range and convenience. Inductance values laboratory adjusted to better than 1%. Units housed in a compact die cast case with sloping panel ideal for laboratory use.



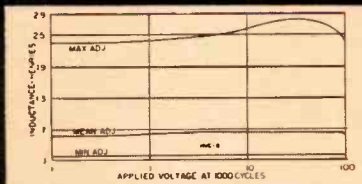
DI-1	Ten 10 Mhy. steps.
DI-2	Ten 100 Mhy. steps.
DI-3	Ten 1 Hy. steps.
DI-4	Ten 10 Hy. steps.

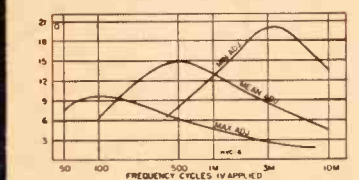
DI DECADE

Length	4½"
Width	4⅜"
Height	2⅜"

HVC Hermetic
Variable Inductors

A step forward from our long established VIC series. Hermetically sealed to MIL-T-27 . . . extremely compact . . . wider inductance range . . . higher Q . . . lower and higher frequencies . . . superior voltage and temperature stability.





Type No.	Min. Hys.	Mean Hys.	Max. Hys.
HVC-1	.002	.006	.02
HVC-2	.005	.015	.05
HVC-3	.011	.040	.11
HVC-4	.03	.1	.3
HVC-5	.07	.25	.7
HVC-6	.2	.6	2
HVC-7	.5	1.5	5
HVC-8	1.1	4.0	11
HVC-9	3.0	10	30
HVC-10	7.0	25	70
HVC-11	20	60	200
HVC-12	50	150	500

HVC case structure.

Width	Length	Height
25/32	1-1/8	1-7/32

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150 Varick Street, New York 13, N. Y. EXPORT DIVISION: 13 E. 40th St., New York 16, N. Y. CABLES: "ARLAB"

electronics

AUGUST • 1956

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ENCAPSULATED COCKPIT SAVES INSTRUMENTS—Ejectable unit fabricated by Douglass Aircraft is designed to fit any aircraft and save men and expensive equipment in case of ditching (see page 192) ..... COVER

CONTINUED ON NEXT PAGE

contents

continued

SHOP

▶ **MISSILE MEMORIES** . . . Comment on radio communications barrier that may exist around objects moving faster than Mach 10 (*Crosstalk*, June '56) induced further speculation from readers.

Missiles reentering the earth's atmosphere from outer space could compact ionized gas around them sufficiently to blank out telemetering signals for perhaps 30 seconds. One way to avoid loss of information would be to record flight data within the missile on magnetic tape during this period, feeding this information into the transmitter immediately thereafter and before the missile lands.

▶ **WE GET SURVEYED** . . . One of the editorial functions of a magazine is to make surveys of the various facets of the industry it serves and to analyze and present the findings.

Many of the articles in the *Industry Report of* ELECTRONICS result from such surveys and from time to time feature articles are published that are based on larger surveys.

Usually we are the surveyor, but sometimes we become the surveyee. We received a questionnaire the other day that apparently is being sent out to all kinds and sizes of magazines. Under the question Editorial Background?, two lines of space were provided. It seemed that 20 or 30 sheets of paper would be needed.

A phone call to the surveyor saved us a lot of work. The two lines were

electronics

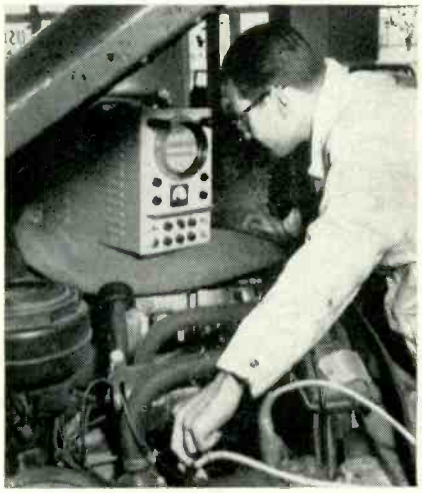
AUGUST, 1956 Vol. 29, No. 8

Member ABC and ABP

TALK

filled in by some simple arithmetic. Ten editors times years on staff, 77.5, gave an average time with ELECTRONICS alone of 7.75 years.

Our own company quietly surveyed us and other McGraw-Hill magazines recently and came up with the statistic that "no less than 19 basic texts and reference books in the field of electronics have been written by the members of the staff of the magazine ELECTRONICS."



▶ **THEORY, PLUS PRACTICE** — Extent to which ELECTRONICS editors dig into a subject is illustrated by these photographs of two members of the staff out in the field. At left, John Markus examines a jig while collecting material for Production Techniques department. At right, Haig Manoogian wears a borrowed mechanics jumper while he gets first-hand information on the operation of a dynamic engine analyzer as it diagnoses an automobile's neuroses

▶ **DEMPA GIZITSU** . . . Words were added to our vocabulary when we received the material for the article on Japanese transistor techniques that appeared in the July issue. Some of the data was enclosed in an envelope on which were printed Japanese symbols, but the words "dempa gizitsu" appeared in Arabic letters.

Checking with the New York representative of a Japanese company, we find that these words can be translated as "literature" or "manuscript", in our editorial language.

Speaking of manuscripts, we are always pleased when an author tells us he will go ahead on preparation of a new one for the magazine. We were more than pleased when one engineer wrote in as follows:

"While the demand for technical articles on the new ..... would easily exhaust the ability of every engineer we have to write even if we were to put them to work at nothing else, for months to come, we consider ELECTRONICS of such importance to the entire electronic engineering profession that we feel an obligation to provide you with an article which is satisfactory to you and to your readership.

"I will, therefore, undertake to prepare the article for you."

▶ **EDUCATIONAL** . . . During a recent visit to Eastman's model laboratory in Rochester, N. Y. to investigate electronic applications in photofinishing, one of our editors met an overseas reader, L. D. Rehfeldt. He is connected with Kodak Hawaii, Ltd., and has been reading ELECTRONICS for years.

He and his friends feel that our magazine helps make up for the lack of graduate-level engineering schools in that part of the world. He considers us "must" reading to keep up with the latest developments in the field, both in this country and abroad.

Which reminds us that New York City newspapers have carried help-wanted ads in recent months that specify a degree in electrical engineering or physics but say that this requirement will be waived if the applicant has taken some math and engineering courses and is a regular reader of ELECTRONICS and one of the society journals.

Published monthly with an additional issue in June by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. **Executive, Editorial and Advertising Offices: McGraw-Hill Building, 330 W. 42 St., New York 36, N. Y.** Longacre 4-3000. Publication Office, 99-129 North Broadway, Albany 1, N. Y. Donald C. McGraw, President; Paul Montgomery, Executive Vice-President; Joseph A. Gerardi, Vice-President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice-President, Publications Division; Ralph B. Smith, Vice-President and Editorial Director; Joseph H. Allen, Vice-President and Director of Advertising Sales; J. E. Blackburn, Jr., Vice-President and Circulation Director.

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Single copies 75¢ for United States and possessions, and Canada; $1.50 for Latin America; $2.00 for all other foreign countries. Buyers' Guide $3.00. Subscription rates—United States and possessions, $6.00 a year; $9.00 for two years. Canada, $10.00 a year; $16.00 for two years. Other western hemisphere countries and the Philippines, $15.00 a year; $25 for two years. All other countries $20.00 a year; $30.00 for two years. Three-year rates, accepted on renewals only, are double the one-year rate. Entered as second-class matter August 29, 1936, at the Post Office at Albany, N. Y., under act of Mar. 3, 1879. Printed in U.S.A.

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Different outside . . . and *inside!* The latest design in magnetic amplifier regulation. A silicon diode is used as reference element and a transistor amplifier provides the control current for the magnetic amplifier. Wide range, continuously adjustable voltage at high current. Regulation ±0.5% against line or load, ripple 1% RMS. Versatile, dependable, rugged, economical.

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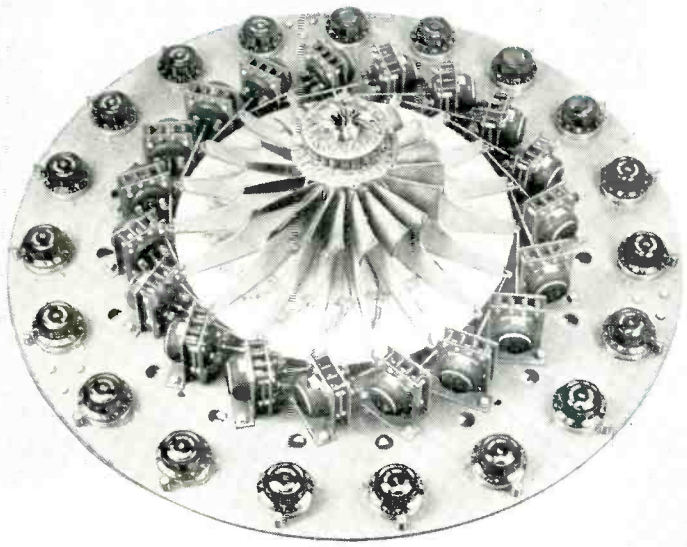

FOR THE

ENGINEER

SCIENTIST

RESEARCH WORKER

TECHNICIAN

The July issue of Technique, Volume 10. No. 3., includes the following articles:—

"Rig for Vibrating Centrifugal Impellers" by D. A. Drew, B.Sc., A.M.I.Mech.E., Head of Vibration Department, Rolls Royce Limited.

"Instructional Applications of the D-669-A Frequency Analyser" by A. W. Keen, M.I.R.E., A.M.I.E.E., Senior Lecturer in Electronics, Coventry Technical College, England.

Write and have your name placed on our mailing list to receive Technique quarterly, without charge.

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new

POWER TRANSISTOR—

provides 2½ watts
Class A output with
*5% total harmonic distortion

FEATURES—

- 10 watts maximum collector dissipation
- 2 amps max. collector current
- 40 volts max. collector voltage
- New heliarc-weld hermetic seal
- 30 db minimum power gain (typically 35 db)
- 85° C storage temperature
- 100° C operating temperature
- derating—3° C per watt (typically 2° C per watt)

new

DETECTOR-DRIVER

Type 12J8—delivers 20 mw signal
power output with
*5% total harmonic distortion

CHARACTERISTICS—

- zero signal plate current —14 ma
- zero signal screen current—3 ma
- plate resistance —2000 ohms
- transconductance —540 μmhos
- plate voltage —12.6 volts
- heater voltage —12.6 volts

low distortion* pack for HYBRID AUTO RADIO

combined engineering forces produce new power transistor and detector-driver tube—full line of 12-volt tube types completes auto radio complement.

SYLVANIA, in close co-operation with leading auto radio manufacturers, has just completed a full-time joint engineering project to develop a transistor-tube "power pack" for new hybrid auto radio designs.

Result of this combined engineering program is a new power transistor and the type 12J8 detector-driver tube especially designed to produce high current at low plate voltage for optimum power coupling to the output transistor.

Other important power transistor features include a heliarc-weld hermetic seal for ruggedness and a storage temperature of 85° C to eliminate heat problems under inoperative conditions.

Sylvania also offers a full line of 12-volt tubes to complete auto radio complements.

Designers of transistorized equipment will find Sylvania's new transistor highly useful in all power applications calling for a maximum collector dissipation of 10 watts.

Engineering Sample Offer

Sylvania will honor all bona-fide requests for engineering samples of the new hybrid "power pack" including the new power transistor and driver tube 12J8, plus samples or information on 12-volt types to complete your auto radio complement.

For samples of the power transistor for use in other applications, write on your company letterhead indicating your intended use.

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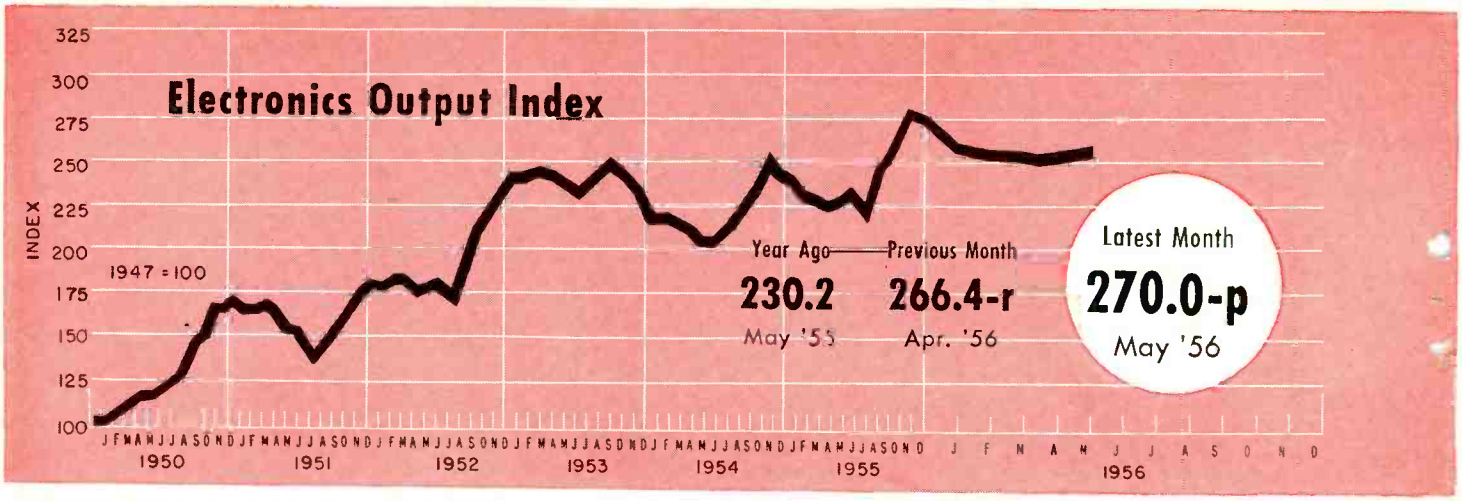


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month	Previous Month	Year Ago
	May '56	Apr. '56	May '55
Television sets, total	467,913	549,632	467,394
With UHF	58,116	74,102	61,784
Color sets	nr	nr	nr
Radio sets, total	1,060,165	992,982	1,114,035
With F-M	nr	nr	8,726
Auto sets	282,611	299,253	563,369

RECEIVER SALES

(Source: RETMA)	May '56	Apr. '56	May '55
Television sets, units	393,080	347,630	416,908
Radio sets (except auto)	566,357	471,193	398,449

RECEIVING TUBE SALES

(Source: RETMA)	May '56	Apr. '56	May '55
Receiv. tubes, total units	33,015,000	35,184,000	32,920,310
Receiv. tubes, value	$27,145,000	$28,616,000	$25,914,821
Picture tubes, total units	906,732	830,902	779,324
Picture tubes, value	$16,123,625	$15,141,461	$14,572,518

INDUSTRIAL TUBE SALES

(Source: NEMA)	Quarterly Figures: Latest Quarter	Previous Quarter	Year Ago
	4th '55	3rd '55	4th '54
Vacuum (non-receiving)	$9,967,411	$9,027,845	$9,338,181
Gas or vapor	$3,251,621	$3,438,835	$3,498,123
Magnetrons and velocity modulation tubes	$13,726,323	$10,998,967	$15,249,651
Gaps and T/R boxes	$1,578,767	$1,421,138	$1,788,780

MILITARY PROCUREMENT

(Source: Defense Dept.)	1st '56	4th '55	1st '55
Army	$40,490,000	$48,477,000	$2,833,000
Navy	$28,700,000	$20,378,000	$43,147,000
Air Force	$124,828,000	$131,938,000	$133,503,000
Total—Electronics	$194,018,000	$200,793,000	$179,483,000

BROADCAST STATIONS

(Source: FCC)	Latest Month	Previous Month	Year Ago
	June '56	May '56	June '55
TV stations on air	496	495	458
TV stations CPs—not on air	113	112	124
TV stations—new requests	43	41	16
A-M stations on air	2,896	2,890	2,732
A-M stations CPs—not on air	124	118	108
A-M stations—new requests	274	273	222
F-M stations on air	530	532	540
F-M stations CPs—not on air	16	15	12
F-M stations—new requests	10	4	6

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	May '56	Apr. '56	May '55
Aeronautical	47,660	46,739	42,396
Marine	56,038	55,580	50,187
Police, fire, etc.	20,422	20,339	18,149
Industrial	30,287	28,946	24,347
Land transportation	9,073	9,001	7,579
Amateur	150,222	148,648	137,199
Citizens radio	17,835	17,046	11,816
Disaster	327	327	315
Experimental	698	690	619
Common carrier	2,283	2,219	1,934

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Apr. '56	Mar. '56	Apr. '55
Prod. workers, comm. equip.	384,500-p	383,500-r	350,500
Av. wkly. earnings, comm.	$75.70 -p	$74.96 -r	$70.98
Av. wkly. earnings, radio	$72.18 -p	$71.82 -r	$68.68
Av. wkly. hours, comm.	40.7 -p	40.3 -r	40.1
Av. wkly. hours, radio	40.1 -p	39.9 -r	39.7

SEMICONDUCTOR SALES ESTIMATES

	Apr. '56	Mar. '56	Feb. '56*
Transistors, Units	832,676	707,817	616,818

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	June '56	May '56	June '55
Radio-tv & electronics	405.1	424.0	508.4
Radio broadcasters	476.3	492.1	586.2

p—provisional r—revised nr—not reported
*1955 not available

FIGURES OF THE YEAR

FIGURES FOR FIRST FIVE MONTHS	1956	1955	Percent Change	1955 Total
Television set production	2,862,177	3,238,820	—11.6	7,756,521
Radio set production	5,585,390	5,853,954	— 4.5	14,894,695
Television set sales	2,428,888	2,772,648	—12.4	7,421,084
Radio set sales (except auto)	2,551,272	2,007,631	+27.0	6,921,384
Receiving tube sales	188,619,000	185,681,000	+ 1.6	479,802,000
Cathode-ray tube sales	4,376,137	4,207,069	+ 4.0	10,874,234

INDUSTRY REPORT

electronics—August • 1956

GROWING Los Angeles, host city for this year's WESCON, will get a new influx of visitors as . . .

1956 Western Electronic Show Expects 30,000

Exhibits and technical sessions are readied as the industry gets set for a mid-year look at itself

ENGINEERS and executives who attend WESCON, August 21-24, are expected to number 30,000. The event is jointly sponsored by WCEMA and IRE.

The Pan Pacific Auditorium in Los Angeles will house some 706 exhibitor units representing the products of more than 750 electronics manufacturers. Headquarters for the technical convention, held concurrently with the electronics exhibition, will be the Ambassador Hotel and the I.A.S. Bldg.

Technical papers scheduled for presentation during the convention are published in this issue of ELECTRONICS beginning on page 388. For each session, there will be accommodations for a minimum of 500 persons.

▶ **Registration**—Early arrivals can register at the Ambassador on Monday, August 20 from 7 to 9 pm. Otherwise, at the Pan Pacific Auditorium and Ambassador from August 21-24.

▶ **Local Industry** — Engineers and executives attending WESCON can also get a first-hand look at the growing electronics industry in Los Angeles. There are now 460 firms in the metropolitan area with an annual factory billing during 1955 of $916.6 million, according to the city's Chamber of Commerce.

These companies employ 72,167 people who earn an annual estimated payroll of $293.6 million. They manufacture a total of 172 products in 531 separate plant locations. Sales in 1956 are expected to hit $1 billion.

Government Appraises 1956 Business

Sees overall 1956 factory volume exceeding 1955 sales by $500 million

MID-YEAR survey by the Department Of Commerce of the electronics industry indicates the same

favorable outlook for the last half of this year that it reported in its December forecast for 1956. The report, prepared by the electronics division of the Business and Defense Services Administration, notes a continually high output, with some very slight variations in earlier estimated figures.

► **Volume**—Total factory output is expected to reach $6.8 billion for the year, as compared with $6.3 billion for 1955. Included in this estimate are radio and television receivers, broadcasting and radio communication equipment, industrial electronics and television equipment, tubes and electronic components, and a wide variety of military electronics equipment such as radar, navigation, communication, and missile guidance systems.

► **TV**—In the television receiver market, factory sales are expected to exceed $1 billion for the year. Color tv retail sales had been estimated at $250 million for this year, but dollar volume may be somewhat less because reduction in the prices of color sets is coming faster than anticipated, according to BDSA.

► **Components**—Repair parts sales for television, radios and phonographs in 1955 reached an estimated $200 million and are expected to increase to $290 million in 1957 and $480 million in 1958.

Commercial repair parts sales are expected to increase about 10 percent a year through 1958, from a 1955 level of $36 million. Defense maintenance parts sales are seen rising at about the same rate from a 1955 level of $105 million.

Color TV Gathers Momentum

Manufacturers see increasing volume as new lower priced sets are introduced

TV SET industry is moving ahead faster on color. Recent estimates by Sylvania show that during the first six months of this year 70,000 color sets were sold compared to 35,000 during all of 1955. About 30,000 sets were sold in the first quarter of 1956 and 40,000 in the second.

The firm estimates that there are now 110,000 color sets in use and that 7.6 million monochrome tv sets and 275,000 color sets will be produced by the entire industry this year. In 1957 color production is expected to reach 900,000 with sales to the public totaling 750,000.

► **Sets** — During the first six months of this year, 12 set manufacturers out of 29 surveyed had color sets available. At least three more firms introduced color models during July. Before the year is out, nearly every major set manufacturer is expected to have color sets available.

Admiral has a consolette model to sell for $499.95, Olympic has introduced a $495 color receiver. Packard-Bell has shown a color table model tentatively priced at $495 and RCA introduced a color tv table model at $495.

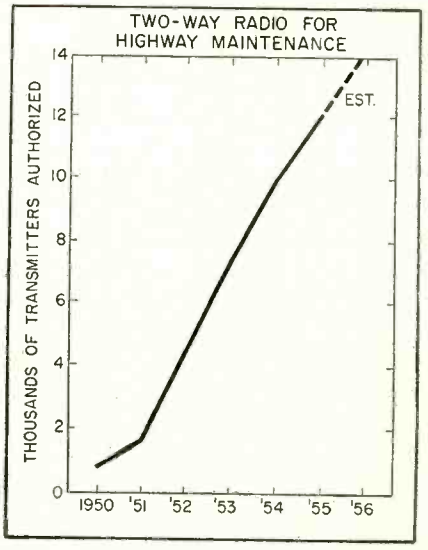
Electronics Advances In Industrial Control

USE of electronics in industrial control equipment has nearly doubled in the past eight years and may reach $20 million this year if the past trend holds its course. According to the Department of Commerce, $14.5 million in industrial electronic controls were shipped in 1954, a rise of nearly $7 million from the 1947 total of $7.6 mlilion.

► **Share**—Shipments of industrial electrical control equipment have been on the downward trend since 1952, dropping by some $35 million through 1954. During the same period, the electronic controls portion of the total climbed steadily. Now the electronic portion of the total control business is about five percent.

Two-Way Radio Girds For Highway Expansion

Government roadbuilding plan may expand market for highway communications



THE market for two-way radio in the highway building and maintenance field is already a substantial one. But it will be in for marked expansion in the near future as President Eisenhower's $25-billion road building program, passed by Congress, gets underway.

► **Maintenance**—At the end of fiscal 1956, over 14,000 transmitters were authorized by FCC to operate in the highway maintenance service representing an increase of some 2,000 during the year. All are licensed to government agencies since station authorizations are only available to states, counties, cities, towns and other governmental subdivisions. The equipment is used for public safety, protection of life and property as well as maintenance supervision and operation of public highways.

► **Why**—According to the FCC, the growth in authorizations reflects increased use of the highway maintenance service by city and county governments.

The equipment has enabled highway agencies to reduce costs through more efficient use of men

(Continued on page 12)

choose from this complete line of

MINIATURE PULSE TRANSFORMERS

Type 10Z
tubular pulse transformer

Type 15Z
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Type 20Z
drawn-shell bathtub pulse transformer

Type 41Z
plug-in pulse transformer

NOW YOU CAN CHOOSE from eighteen standard pulse transformers in four major construction styles, all in quantity production at Sprague. The standard transformers covered in the table below offer a complete range of characteristics for computer circuits, blocking oscillator circuits, memory array driving circuits, etc.

These hermetically sealed units will meet such stringent military specifications as MIL-T-27, and operate at temperatures up to 85°C. Special designs are available for high acceleration and high ambient temperature operation. In addition, the electrical counterparts of each transformer can be obtained in lower cost housings designed for typical commercial environment requirements.

Complete information on this high-reliability pulse transformer line is provided in Engineering Bulletin 502A, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

ELECTRICAL CHARACTERISTICS OF SPRAGUE PULSE TRANSFORMERS

Type No.	Turns Ratio	Pulse Width μ seconds	Rise Time μ seconds	Primary Inductance	Leakage Inductance	Repetition Rate	Load and Output	Typical Applications
10Z1	5:1	0.1	0.04	200 μH	5 μH	1 to 2 MC	15 volts 100 ohms	Used in digital computer circuitry for impedance matching and interstage coupling. Pulses are of sine wave type.
10Z2	4:1	0.07	0.03	200 μH	20 μH	1 to 2 MC	20 volts 100 ohms	
10Z3	1:1	0.07	0.03	125 μH	12 μH	1 to 2 MC	20 volts 200 ohms	
10Z4	3:1	0.07	0.03	160 μH	15 μH	1 to 2 MC	20 volts 100 ohms	
10Z6	4:1	0.1	0.04	200 μH	6 μH	1 to 2 MC	17 volts 100 ohms	
10Z12	1:1	0.25	0.02	200 μH	2 μH	12KC	100 volts	Blocking Oscillator
10Z13	1:1	0.33	0.07	240 μH	2 μH	2KC	50 volts	Blocking Oscillator
10Z14	7:1:1	0.50	0.05	1.2 mH	20 μH	1MC	25 volts	Impedance Matching
15Z1	3:1	5.0	0.04	7.5 mH	22 μH	10 KC	10 volts 100 ohms	Impedance Matching and Pulse Inversion
15Z2	2:1	0.5	0.07	6 mH	15 μH		40 volts	Blocking Oscillator
15Z3	5 1	10.0	0.04	12 mH	70 μH	10 KC	10 volts	Impedance Matching
15Z4	1 1.4	6.0	0.1	16 mH	15 μH	0.4 KC	15 volts	Blocking Oscillator
20Z1	5 5:1 Push-Pull	1.5	0.25	4.0 mH	0.3 MH		5 volts 10 ohms	Memory Core Current Driver
20Z3	6:1	1 to 4	0.22	18 mH	0.8 MH	250 KC (max.)	21 volts 200 ohms	Current Driver
20Z4	6:1:1	1 to 7	0.25	55 mH	0.3 MH	50 KC (max.)	22 volts 400 ohms	Current Driver and Pulse Inversion
20Z5	3.3:3.3:1 Push-Pull	2.4	0.2	2.8 mH	0.2 MH		2.5 volts 6 ohms	Memory Core Current Driver
20Z6	11:1	6.0	0.2	90 mH	0.2 MH	50 KC (max.)	10 volts 75 ohms	Current Transformer
41Z1	7:1:1	0.50	0.05	1.2 mH	20 μH	1 MC	25 volts	Impedance Matching

Sprague, on request, will provide you with complete application engineering service for optimum results in the use of pulse transformers.

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and heavy expensive roadbuilding equipment. Many highway maintenance agencies have been able to recover the cost of a radio installation in one or two years through resulting economies.

▶**Truck**—Market for two-way radio in the highway truck service may also be in for a big boost as the federal plan is started. About 15,000 transmitters are authorized to operate in this service, an increase of 3,000 during 1955.

New FCC Commissioner Takes Office

George C. McConnaughey, left, chairman of the Federal Communications Commission, congratulates T. A. M. Craven as he hands him his commission as an FCC Commissioner. Craven has received two interval appointments. He previously served on the FCC from 1937 to 1944

FCC Actions

▶**Adopted** plans to improve tv service by: (1) inviting comments on shifting all tv operation to uhf; (2) proposing immediate R&D programs to increase uhf range; (3) increasing maximum uhf power to 5,000 kw; (4) outlining considerations on vhf assignment and rules for channel changes.

▶**Granted** channel 8 to WIRL, Peoria, and channel 2 to WMAY, Springfield, with proviso neither can build until final decision is made on channel assignment rules (see above).

▶**Approved** Conelrad air-attack plan for all Hawaiian radio stations, making this first territory so covered.

▶**Published** list of tv broadcast transmitters and monitors that are type accepted or type approved. This supplements other approved equipment lists available at Commission field offices.

▶**Invited** telephone and telegraph companies to help effect a national priority system for resumption of intercity communications that might be interrupted by a national emergency.

▶**Extended** licenses of industrial radiolocation service stations operating below 1.8 mc to make expiration date fall on July 1.

▶**Waived** rules to permit operation of radiolocation station outside specified bands aboard *Horizon*, Scripps Institution of Oceanography.

▶**Proposed** provision of longer distance public radiotelephone service for ships off Gulf ports using frequencies between 5 and 25 mc.

▶**Granted** KGVO-TV, Missoula, Mont. permit for private intercity tv relay. This involves off-air pickup of KXLY-TV, Spokane, Wash. and 160-mile relay in 6,875-7,050 mc band.

Transistors Replace Tubes In More Radio Sets

Nearly every major radio manufacturer now has a transistorized set on the market

DURING the first half of 1956, 16 radio manufacturers in the U. S. and abroad out of some 42 manufacturers surveyed had transistorized radio sets on the market. With July introductions of new models, nearly every major radio manufacturer has a transistorized receiver available. The first transistorized home radio was marketed less than two years ago.

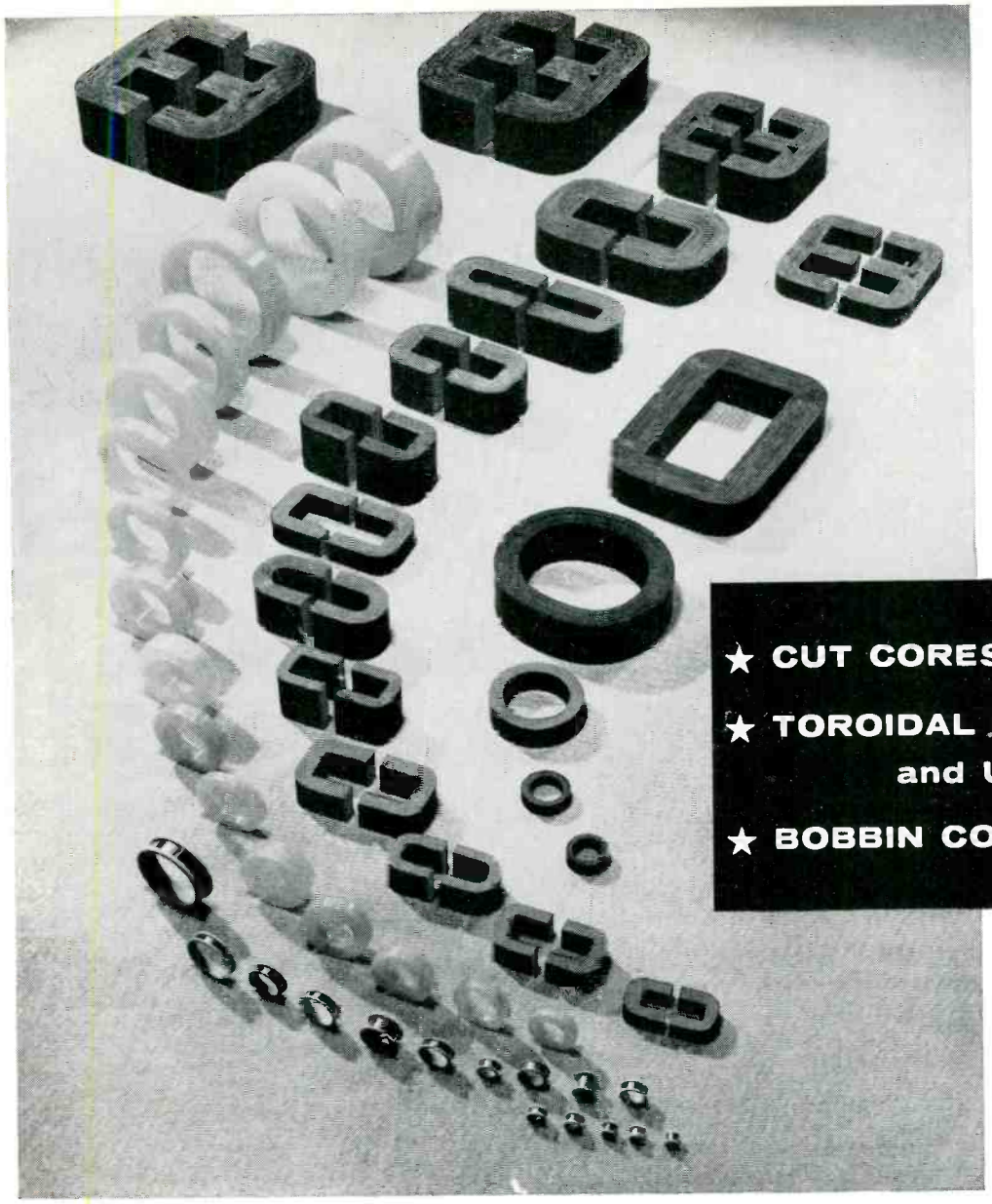
▶**Kinds**—Most of the transistorized sets are portables although a few manufacturers have table models. Individual firms offer from one to four basic models. Prices range from $28 without batteries to $100. Number of transistors range from three in hybrid sets up to seven.

▶**Car Radios**—The big three car manufacturers have had transistorized sets available since the beginning of 1956. Now transistors have moved into British car radios.

Pye recently introduced a transistorized car radio that contains three tubes, a germanium crystal diode as a detector and power transistors in the output stage. Output is 4 watts with one loud speaker or 6 watts with two. The set operates on 12-volt systems only.

▶**Prices**—General Electric recently announced price reductions ranging up to 27 percent on ten new entertainment transistors. The firm believes reduced transistor prices may bring about price reductions of up to 20 percent on 1957

(Continued on page 14)



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MATERIALS: Deltamax, 4-79 Mo-Permalloy, Supermalloy, Mumetal, 4750, Monimax, Silectron, Permendur: all are available for cores depending upon the specific properties required.

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transistorized portable radios. The company forecasts further transistor price cuts later this year or early in 1957. GE sees practically all portable radios and a large percentage of table model radios transistorized.

▶**Silicon** — Recent reductions in the price of silicon may help reduce transistor prices although the silicon used in a single transistor is only worth from five to ten cents. Silicon transistors are used where high ambient temperatures are encountered such as in military equipment.

Du Pont, one of the main suppliers of the material, had dropped the price of semiconductor-grade silicon $30, to $350 a pound. The $380 price had been in effect since November 1954. Before that the material sold for $430 a pound.

Further price reductions and greater supply of silicon is foreseen in the recent purchase by Du Pont of a 10,500-acre tract near Brevard, N. C. as a possible site for future expansion of its silicon business. A plant initially employing about 200 persons is planned.

Four silicon solar cells on top of this portable radio, demonstrated by Hoffman Electronics, convert sun energy into electricity to operate the set.

▶**Solar**—Du Pont also announced a special grade of silicon suitable for solar converters such as those shown in the portable radio. The material will sell for $180 a pound since the extreme purity of transistor-grade silicon is not required.

Magnetic tape magazine assembly and recorder, made by North American Aviation, is readied for flight as . . .

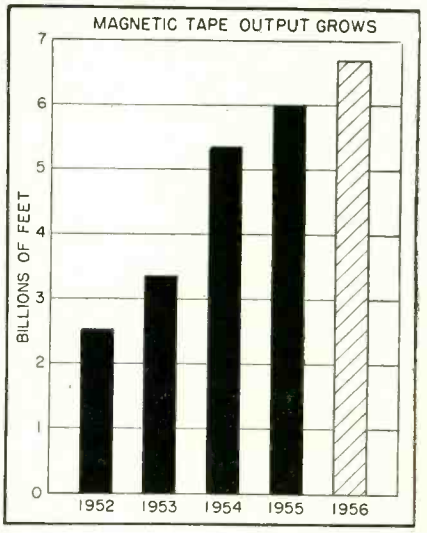
Magnetic Tape Market Expands

Home, industrial and lab uses boost tape consumption to king-size business

MAGNETIC recording industry is looking ahead to a banner year. Sales of recorders are continuing to climb and will boost tape consumption. Last year's growth of 50 percent additional volume in recorders may be topped by the end of 1956, according to the Magnetic Recording Industry Association, which represents 36 companies in the field. One manufacturer sees retail sales of recorders surpassing $100 million this year and believes the market is less than five percent saturated. This additional recorder volume is expected to boost tape volume to a new high.

▶**Growth**—This year, if the past trend holds its course, about 7-billion feet of magnetic tape will be produced, nearly double the amount used just three years ago. This will mean a sales volume for tape makers of about $9 million, compared to approximately $8 million in 1955.

▶**Future**—According to one tape manufacturer, sales of magnetic recording tape will double again in three or four years. The rise is based on present uses of tape and does not include applications such as tape recording for tv programs. The tv application alone is expected to boost tape production to even greater volume. For an hour's program on the Ampex device, about



5,000 feet of 2-inch tape is used.

Ampex expects to manufacture 100 tv tape recorders during 1957 bringing total quantity scheduled for production to over $5 million worth of Videotape machines. The company is increasing its video engineering staff. Factory facilities will be expanded by 50,000 sq ft.

▶**Uses**—Growing use of magnetic recorders and tape in instrumentation is highlighted by a $1.2-million contract let by the Air Research and Development Command to Consolidated Electrodynamic Corp. to provide magnetic-tape instrumentation along the 5,000-mile missile test range at Patrick AFB, Florida for testing intercontinental ballistic missiles.

The magnetic tape equipment

(Continued on page 16)

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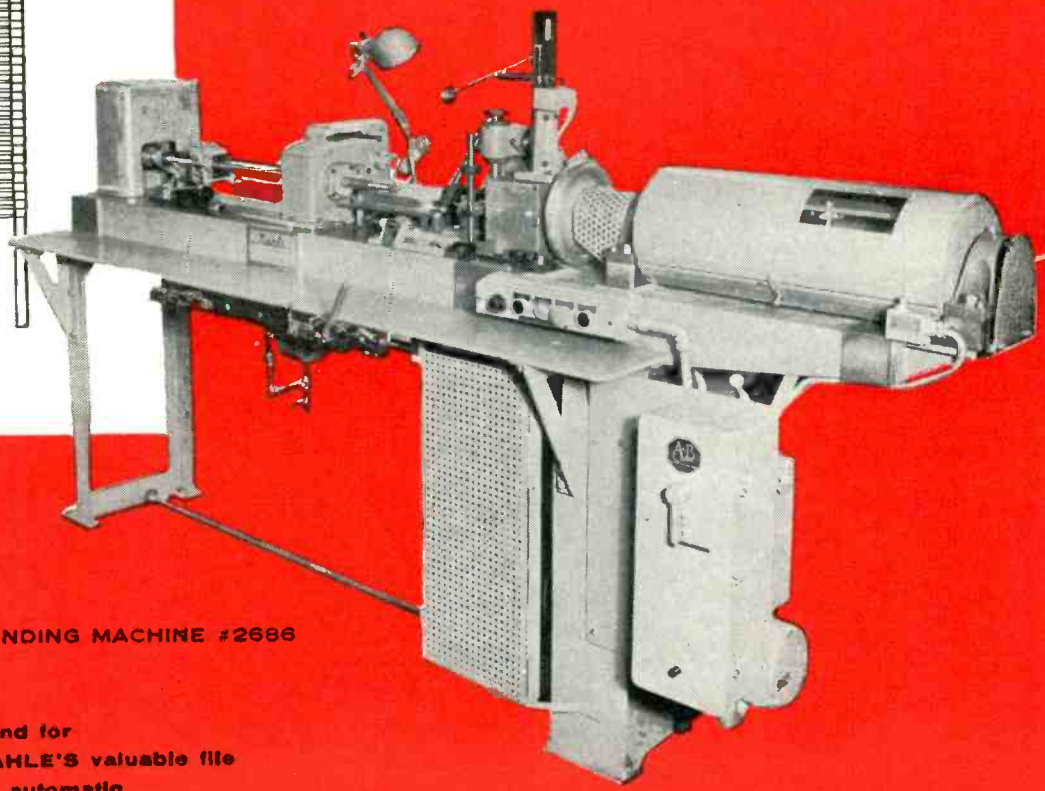

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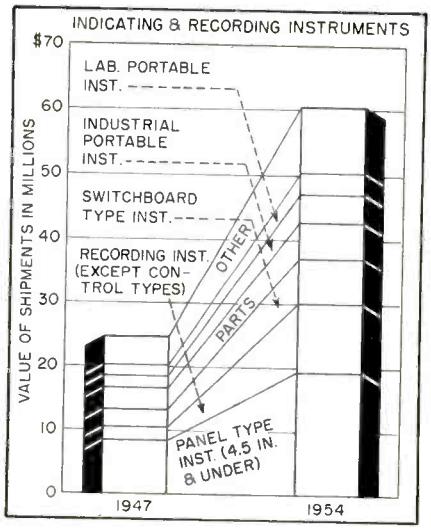
placed at over 100 stategic points on the ground and aboard ships along the range will record telemetered data, such as temperature, pressure and thrust, from the missiles and play it back for analysis and interpretation.

Use of recorders in manned aircraft is also increasing. The airborne taperecorder shown, records the operation of a fire control system during attack. It is being installed in four Air Defense Command interceptors. The North American Aviation recorders, translate information from the airplane radar equipment into signals that can be played back on a reproducer for the benefit of aircrews. More than 850 of the devices have been installed in Sabre Jets and the Air Force has taken delivery of more than 3,000 recorders and 150 reproducing machines.

Measuring Instrument Sales Gain

Indicating and recording instruments have doubled in sales since the war

INSTRUMENT business has more than doubled in sales volume in the past nine years. Value of shipments has climbed from $24 million in 1947 to $60 million in 1954. This year total volume may exceed $70 million.



▶ **Leaders** — Accounting for the largest volume of shipments in 1954 were panel-type instruments under 4.5 inches in size. There were over 2 million of these shipped in 1954 with a total value of $19.0 million. In 1947, such instruments also led in volume with a total of slightly more than one-million units valued at $8.3 million.

Second largest in shipment dollar value were graphic recording instruments with a total volume of $10.1 million compared to $1.9 million in 1947 .

Some 130,000 switchboard type instruments were shipped in 1954 valued at $7.1 million. In 1947, 115,000 units were shipped at a total value of $3.1 million.

The parts volume for both recording and indicating instruments rose during the seven year period from $3.4 million in 1947 to $5.9 million in 1954.

▶ **Portables** — Portable industrial ammeter and voltmeter shipments totaled 108,000 units valued at $4.2 million in 1954. In 1947 only 68,000 of the items, valued at $1.6 million, were shipped.

Portable laboratory instruments also accounted for a sizable volume of business in 1954. Some 33,000 of the items were shipped that year for a value of $3.4 million. In 1947 44,000 were shipped for a dollar value of $2.3 million.

▶ **Airborne**—Although the volume of aircraft instruments is relatively low in quantity and value, the devices showed the greatest percentage growth of any of indicating and recording instruments surveyed. There were 55,000 panel-type instruments valued at $2.8 million shipped in 1954 for use on aircraft in measuring electrical quantities. They include ammeters, voltmeters, volt-ammeters, frequency meters and phase-sequence indicators. In 1947, 43,000 of the devices, valued at $408,000, were shipped.

Current growth of this market is indicated by recent military contracts for the equipment. One electronics manufacturer has received over $5.8 million in orders in the past year for aircraft instruments and spare parts.

Nationwide Hookups Feed Computers

Industry and defense benefit as computing centers handle data from diverse points

ELECTRONIC brains have solved the problem of being in more than one place at the same time.

▶ **Industry** — Several companies, whose overall operations are complex enough to make a large computer economically feasible, have held off buying one because their plants individually are small and widely separated.

Sylvania faced this problem since it has 71 plants, laboratories, offices and warehouses in 61 cities in 20 states. The solution was a nationwide 18,000-mile Western Union private teleprinter network channeling data to Sylvania's data processing center at Camillus, New York.

▶ **Computer** — A Univac computer is installed in the company's new 50,000-sq ft center. Three switching centers: Williamsport, Pa., Salem, Mass. and Camillus route data from the 71 stations to the computer facility.

First chore for the Univac will be preparing payroll for Sylvania's 27,000 employees. Other jobs may include maintaining personnel records, inventory accounting, production planning and market research. The computer is expected to realize savings of $125,000 within two years and provide better management information than is now available.

▶ **Military** — Special-purpose digital control computers designated AN/FSQ-7 will form the nerve centers of the air defense of the North American continent. The so-called SAGE system will link far-flung radar stations to the computers. The computers, in turn, will evaluate the radar information and other data and calculate the most effective defense measures to employ against attacking aircraft. The computer will issue orders to intercepting aircraft and guided missiles

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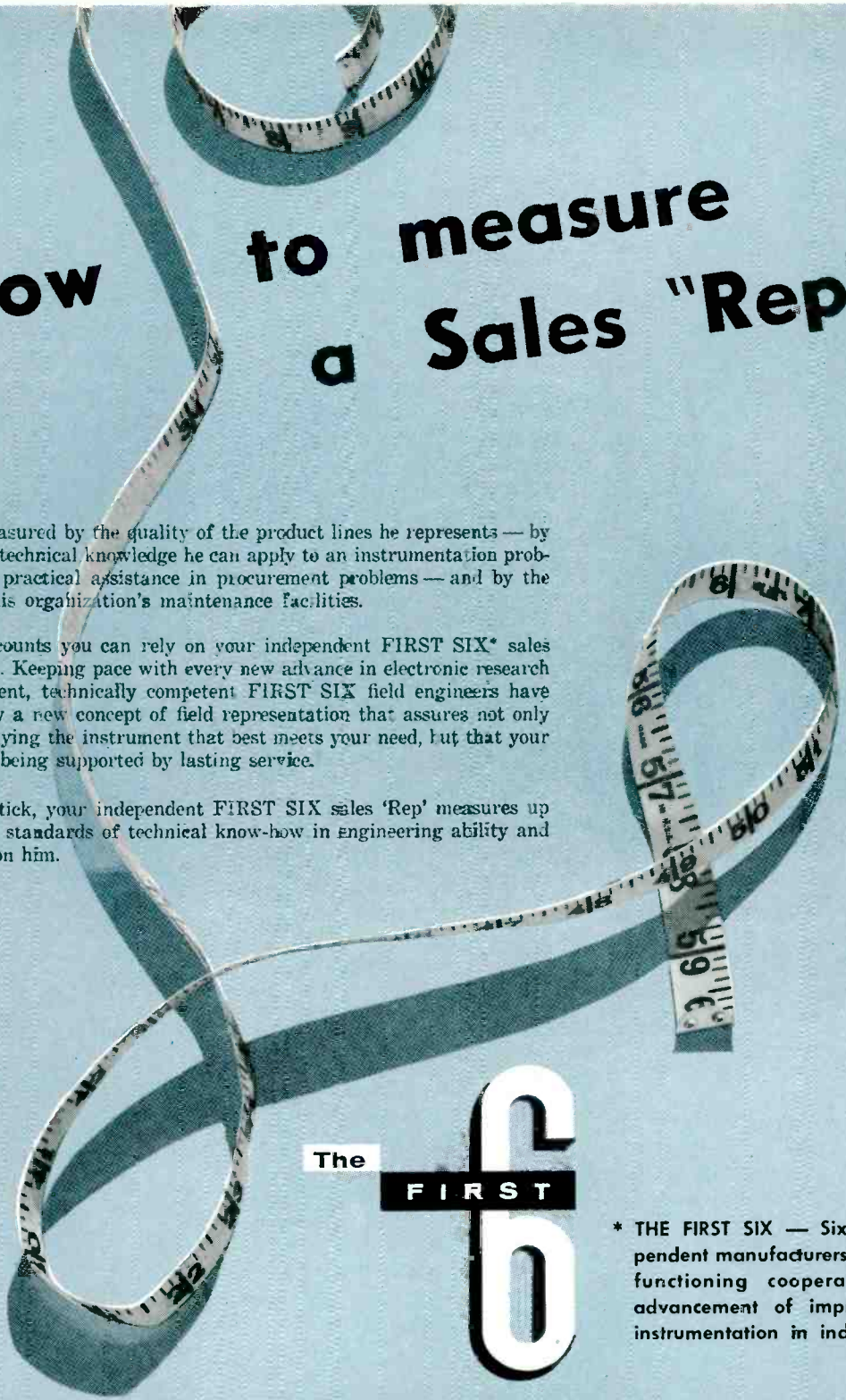

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over special radio links.

The computers are being manufactured by IBM. They cost the government about $14 million a piece.

The first one is ready for installation at McGuire Air Force Base in New Jersey. Two more are abuilding at IBM's new Kingston, N. Y. plant.

How Engineers Evaluate Jobs

Survey shows opportunity for individual growth is rated most important by job seekers

RESULTS of a recent nation-wide survey conducted by Melpar, Inc. of Falls Church, Va., reveal the factors considered most important by an engineer in evaluating a present or prospective position.

▶ **Breakdown** — Sixty-four percent of the 1,200 electrical and electronic engineers returning the survey questionaire listed opportunity for individual growth as first in importance Compensation and colleagues were considered most important by 29 and 28 percent, while environment was cited by 18 percent.

Other factors, listed in the order of their importance, were recognition of professional accomplishments, facilities, security, assignments in diverse fields and specialization.

▶ **Analysis**—A comparison of the preferences of engineers by different age levels and geographical location did not show any significant variations. Little difference was found in the preferences of nonsupervisory and supervisory personnel except that the factor of colleagues was considered most important by 30 percent of the former and only 20 percent of the latter.

Comparing the interests of the engineers on the basis of the type of work they were engaged in revealed a stronger interest in facilities on the part of research engineers.

Record Business Keeps Changing

Census figures show that volume has dropped since 1947 and that 78-rpm disks are still big sellers

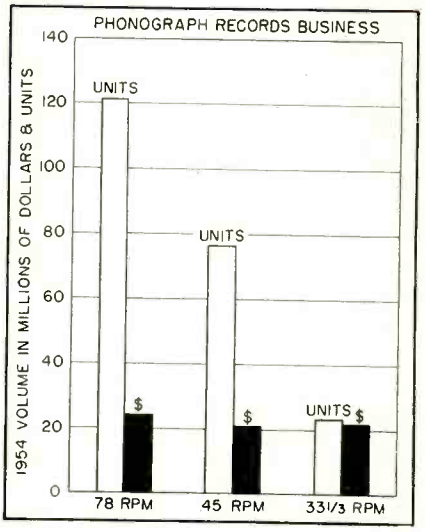
LATEST government survey of the phonograph record business shows that the industry is still changing as far as record speeds and volume of business is concerned. During 1954, manufacturers in the phonograph record field shipped products valued at $85 million, a decrease of 23 percent from the 1947 total of $110.2 million. The $85 million consisted of $83 million in manufactured products and almost $2 million in miscellaneous receipts for contract work, repair work, sales of scrap etc. The $83 million product shipments were accounted for by $79 million of phonograph records and record blanks, and $4 million of other products.

▶ **Speeds** — In 1954, the standard 78-rpm record still held top spot in the record field. Some 121 million 78-rpm platters worth $24 million were shipped compared to 76 million 45-rpm disks worth $21 million and 24 million 33.3-rpm disks valued at about $22 million.

▶ **Ratios Change**—In 1949 the percentage of total sales accounted for by each speed was: 78 rpm, 88 percent; 33.3 rpm, 8 percent; 45 rpm, 4 percent. In 1951 the percentages were 78 rpm, 66 percent; 33.3 rpm, 16 percent; 45 rpm, 18 percent. In 1954, the percentages based on value of shipments were: 78 rpm, 36 percent; 33.3 rpm, 33 percent and 45 rpm, 31 percent.

▶ **Companies** — According to the census there were 142 phonograph record manufacturers in the U. S. in 1954 employing 6,200 people. Of these, 4,700 were production workers. In 1947 there were 111 record companies with 10,000 employees, 8,200 of whom were production workers.

The Middle Atlantic states represent the main headquarters for the record industry. A total of 77 of the 142 firms in the business are located in the area, followed by 45 in the South and West, 14 in North



Central states and 6 firms in New England. Although the South and Western states have second largest number of companies in the business, they are small concerns. The 45 employ a total of 980 people compared to 2,225 in the Middle Atlantic, 1,648 in the North Central and 1,295 in the New England area.

Educational TV Takes On New Life

Closed-circuit tv combines with educational tv stations to boost video instruction

USE of television by educational intitutions has been slow in starting but now is gathering increasing speed. An estimated 100 institutions now have closed-circuit tv installations. In addition, there are 25 educational tv stations on the air and 7 more are expected during 1956.

▶ **Wire**—Most installations in educational institutions have been small experimental hook-ups of two or three rooms. Starting in September, more than 6,000 pupils in two high schools and six elementary schools in Washington County, Md. will receive a part of their daily instruction by closed-circuit tv.

Present plans call for expansion of the system to the entire Wash-

(Continued on page 20)

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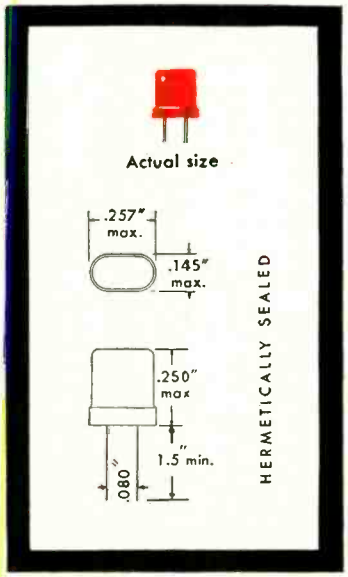

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1. **Temperature**
   4 hours at −55°C, then instant transfer to 4 hours at +150°C — twenty-five times
2. **Vibration**
   25G., 40 to 2000 cps, along each of the three mutually perpendicular axes. Five 3-minute sweeps through the range
3. **Shock**
   500G shocks of one millisecond duration through each of the three mutually perpendicular axes
4. **Noise**
   145DB random acoustical noise application, 200 cps to 20 kc
5. **Life**
   2000 hour tests, run as rectifier with *both* maximum reverse voltage and maximum rectified current

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Type	Peak Inv. Voltage 25°C	Forward Current at +1.0 V (min.) Current 25°C	Reverse Current at −10 V (max.) Current 25°C	Reverse Current (max.) in μA at specified voltage			Rectified Current (max.)		
				Volts	25°C	100°C	25°C	100°C	150°C
1N300	15 V	15 mA	.001 μA	10	0.001	0.1	65 μA	40 μA	18 μA
1N300A	15	30	.001	10	0.001	0.1	80	50	25
1N432	40	10	.005	10	0.005	0.1	55	30	15
1N432A	40	20	.005	10	0.005	0.1	70	48	22
1N301	70	5	.01	50	0 05	1.0	45	25	12
1N301A	70	18	.01	50	0.05	1.0	65	45	20
1N460	90	5	.01	75	0.1	1.0	45	25	12
1N460A	90	15	.01	75	0.1	1.0	60	40	18
1N303	125	3	.01	100	0.1	2.0	40	20	10
1N303A	125	12	.01	100	0.1	2.0	55	35	16
1N433	145	3	.01	125	0.1	3.0	40	20	10
1N433A	145	10	.01	125	0.1	3.0	50	30	16
1N434	180	2	.01	150	0.1	4.0	35	18	10
1N434A	180	7	.01	150	0.1	4.0	45	25	15
1N302	225	1	.01	200	0.2	5.0	30	14	8
1N302A	225	5	.01	200	0.2	5.0	40	22	13
CK863	300	1	.01	275	0.3	8.0	20	12	6
CK863A	300	3	.01	275	0.3	8.0	30	20	8

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ington County school system by September, 1958. A total of 47 schools will be supplied with equipment and approximately 20,000 pupils will receive tv instruction.

▶**Plan**—All necessary equipment for school installations during the life of the five-year project is to be contributed by electronics manufacturers through RETMA. The Ford Foundation through its Fund for the Advancement of Education is to provide funds for training personnel and supervising the program.

Total cost of the project is estimated at over $1 million. Educational tv proponents believe that successful results from this program will triple the use of closed-circuit tv as an educational medium.

▶**Stations**—Growth of educational tv stations has been relatively slow since channels were first allocated in 1952. One reason has been the uhf situation. According to the Joint Council on Educational Television, the five uhf educational tv stations now on the air have encountered many of the same problems that have confronted commercial uhf stations. Station coverage has been satisfactory but uhf receiver inconveniences and difficulties have caused considerable trouble. Two-thirds, 172, of the 258 channel assignments reserved for educational tv are in the uhf band.

FCC Proposes TV Shift To UHF

Invites industry comment on long-range plan while boosting uhf power ceiling

IN a far-reaching proposal, the FCC took the first step toward a possible complete changeover of tv broadcasting from vhf to uhf.

Final decision on deintermixture and channel assignments is still far in the future. However, the recent proposal maps out interim measures which may result in final adoption of the plan.

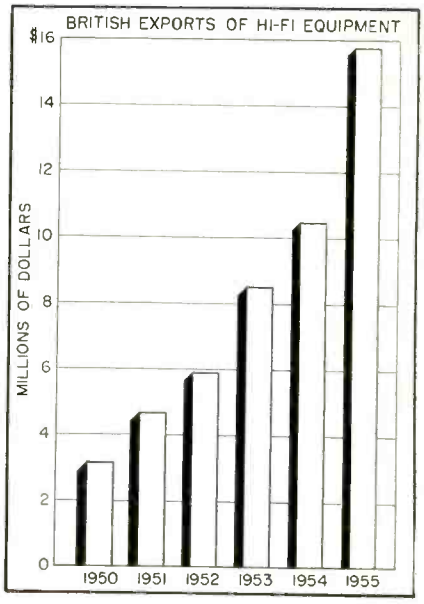
▶**Considerations**—The basic proposals outlined in the Commission's Report and Order are: an invitation to industry for comments by Oct. 1 on the possibility of shifting tv operation to the uhf band; proposal of an immediate R&D program concentrating on increasing uhf transmitter power and determining the feasibility of such techniques as uhf boosters and satellites, as well as increasing the sensitivity and reducing the noise factors of receivers along with improving their selectivity to permit channel reassignment with minimum restrictions on station separations; increasing the maximum power of uhf stations from 1,000 to 5,000 kw effective August 1.

▶**Other**—The Commission also: set forth interim measures for eliminating vhf assignments to create opportunities for uhf broadcasting as well as measures for assignment of additional vhf channels; set up rule making to consider 13 particular interim proposals for channel changes; relaxed present rules to permit new vhf assignments at shorter spacing from cities but still conforming to minimum spacing between transmitters of individual stations.

▶**Interim Action**—To establish a minimum criteria for decisions the following factors were suggested. In markets with one or more commercial vhf assignments consideration would be given to whether: significant numbers of people would lack service if the vhf channel were eliminated; one or more uhf stations are operating in the area; enough sets in use can receive uhf signals; terrain is reasonably favorable for uhf coverage; eliminating a vhf channel would create competition among more stations.

Assigning or adding a first vhf channel would depend on whether: the new transmitter can be located at minimum transmitter spacings; when shifting location there is a greater need at the new location; adding a new vhf channel would create competition among more stations.

Britain Moves Ahead In Hi-Fi Exports



World markets, including U. S., take increasing volume of British sound equipment

BRITISH electronics firms are breaking records in the export of hi-fi gear. In 1955, the total hit a new high, reaching a volume of nearly $16 million. Last year hi-fi exports increased by $5.7 million over the 1954 total. The rise alone was larger than the total of such exports in 1951. So far this year, British hi-fi exports are higher than last year by an estimated 17 percent.

▶**Breakdown**—Nearly $8 million worth of British phonographs were exported to world markets last year and the U. S. constituted one main market for the devices. Some $1.7 million in tape recorders and tapes and over $6.6 million in phonograph records were exported.

▶**Show**—Britain's National Radio Show, to be held in London from August 22 to September 1, will show some of the newest hi-fi equipment.

According to the Radio Industry Council, British high-fidelity sound reproduction equipment, including phonograph parts, is penetrating the U. S. market to an in-

(Continued on page 22)

BARRY ADDS NEW WEST COAST FACILITY

Occupies Plant in Burbank

With its purchase of all physical assets of the United States Sheet Metal Products Company in Burbank, California, Barry Controls Incorporated establishes a Western Division for improved service to the aircraft and missile industry. Operations of the Western Division will include an engineering design section, a shock and vibration test laboratory, a model shop, and production of special designs.

The metal-working facilities of this plant will be used to produce prototypes of vibration-isolating mounting bases and for short-run production of special mounting bases. Stocks of standard isolators will also be maintained here. Barry's present West Coast engineering office will become part of the engineering section of the Western Division.

With the availability of on-the-spot engineering consultation and local model-shop facilities, design and development of complex mounting systems for missiles and jet aircraft will be speeded and valuable lead-time gained for production of prototypes.

CHIVERS TO HEAD WESTERN DIVISION

A. S. Chivers, Sales Manager of Barry Controls Incorporated, has been appointed General Manager of the new Barry Western Division. A graduate of Massachusetts Institute of Technology, Chivers joined Barry in 1952 as administrative assistant with the sales department. He was made Assistant Sales Manager in 1953 and Sales Manager in 1955. As General Manager of the Western Division, he will be responsible for the direction of all its activities.

creasing degree. There will be 100 exhibitors at the show, including 35 manufacturers of radio and tv receivers. About 400 tv receivers will be on display and there will be some 30 demonstration rooms for tv and radio sets.

Industry Subsidizes Science Teachers

GROWING concern over future scientific manpower requirements is causing renewed interest on the part of industry in providing free summer fellowships for high-school teachers of science and mathematics.

The main objective in this subsidization is to help teachers gain more knowledge of their subjects so they can increase student interest in science and mathematics courses.

▶ **Cost**—A pioneer in this field, GE estimates the cost of its near sixty programs this summer at about $175,000. This amount will allow more than 250 teachers in 38 states to study. Just entering the field, Shell Oil estimates its programs will cost about $100,000 this summer.

Satellite Electronics Shape Up

Engineers describe telemetering and Minitrack systems to be used in the earth-satellite program

MORE complete picture of Project Vanguard, code name for the earth-satellite phase of the U. S. scientific program for the International Geophysical year, was presented by George Washington University at an IRE, AIEE symposium called Vanguard of Outer Space.

▶ **Telemetering**—One of the important tools in the launching of the earth satellite will be radio telemetering. As described by Donald G. Mazur, telemetering will be used in the test phases of the Vanguard program, to obtain complete performance data on the three rocket stages individually and in combination.

Telemetering equipment will be used in the actual launching. Emphasis will be on obtaining essential operation information, using one or two light-weight transmitters in the rockets.

Equipment reliability will be extremely important in this application. Another important qualification of the system will be its ability to transmit and receive signals over long ranges.

During certain phases of the launching, vehicle trajectory, the slant range between the rocket-borne transmitters and the ground receiving stations, will be over 300 miles. All telemetering systems under consideration have been proved out in actual rocket work. Twenty or more ground stations spread out over a thousand miles must be operated simultaneously and must provide overlapping coverage.

▶ **Tracking** — Radio will also be used for tracking the earth satellite and obtaining scientific data from it, according to John T. Mengal. Radio tracking will handle three jobs: to prove that the satellite is actually orbiting, determine its precise orbit, and measure what is happening within the satellite from the vantage point of a ground station.

These problems are solved by the Minitrack system of radio angle tracking developed by the Naval Research Laboratory. In the ground station layouts, seven antennas will be used. Six items of data will be obtained, sent to a general computing facility within 20 minutes of receipt, and used there for determining the orbit of the satellite.

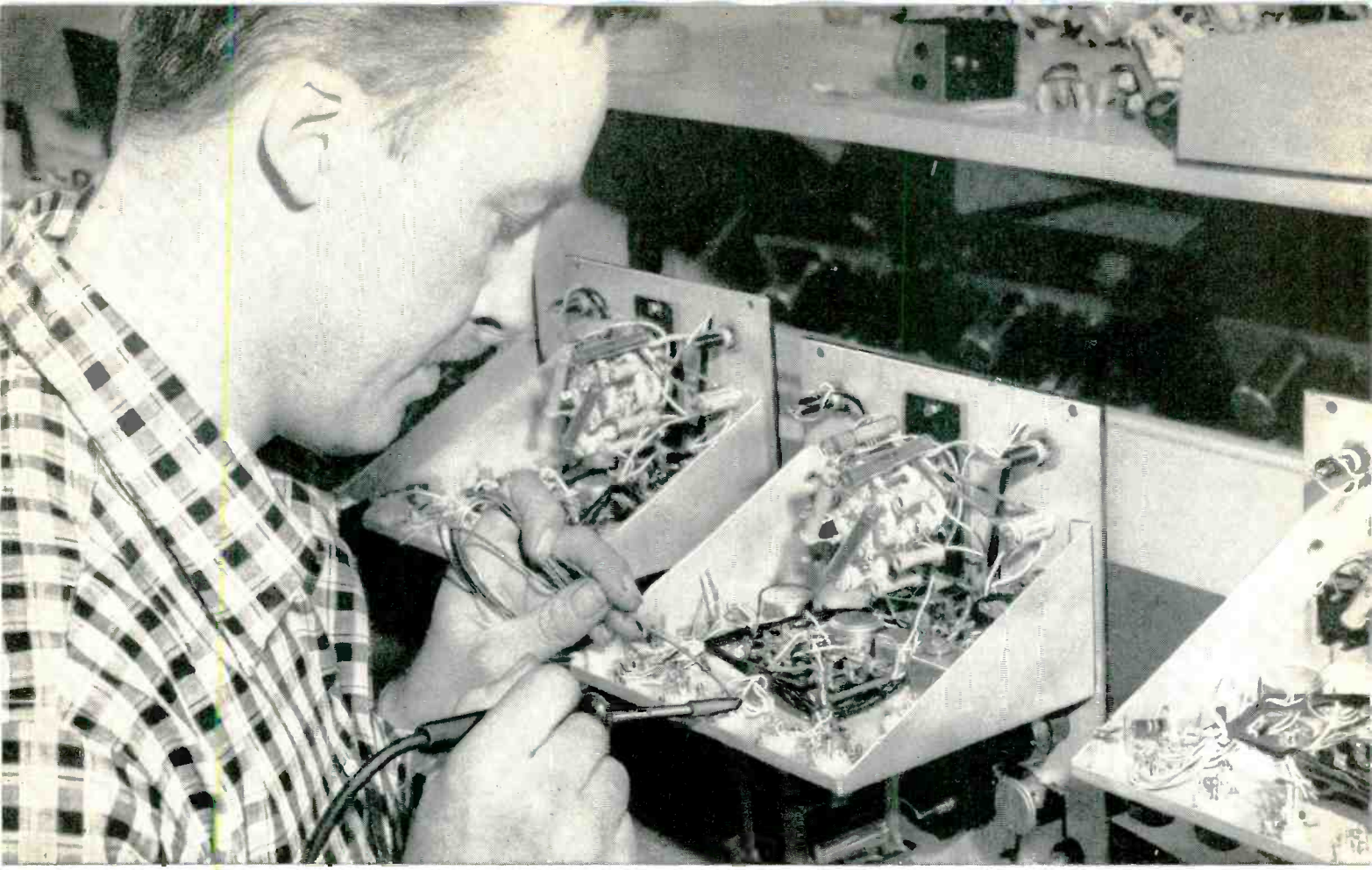
▶ **Technical**—The Minitrack transmitter will be a simple minimum weight (three pounds or less) oscillator with a power output of between 10 and 50 milliwatts at an operating frequency of 108 mc. Two developments are under consideration, one using subminiature low-filament-voltage electron tubes and the other using transistors. Reliability and general utility of the tube model is high, but it is considerably larger and heavier than the transistor unit. One of the common battery types will probably be used for a power supply. Solar batteries will be considered only if intensive tests ascertain their reliability.

Telemetering of data from the

(Continued on page 24)

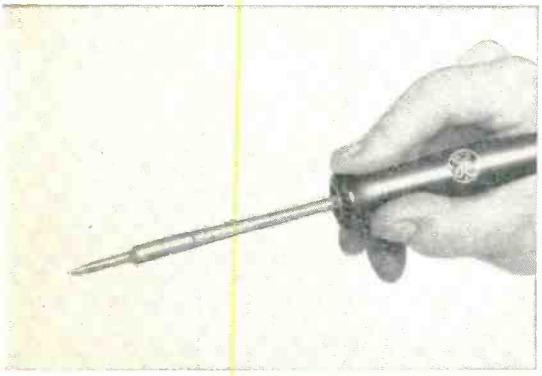
SAGE Device To Aid Air Safety

Commercial version of the Charactron shaped-beam tube (ELECTRONICS, p 174, Aug. 1952) which has been used for some time in the SAGE system of military aircraft surveillance, has been introduced by Stromberg-Carlson-San Diego, as an electronic display device to help solve air traffic control problems. Production has started on the new model, which has a 19-inch screen. In addition to providing the relative positions of aircraft and showing movement across a map-diagram, the system displays letters and numbers to represent such information as flight number, speed and altitude

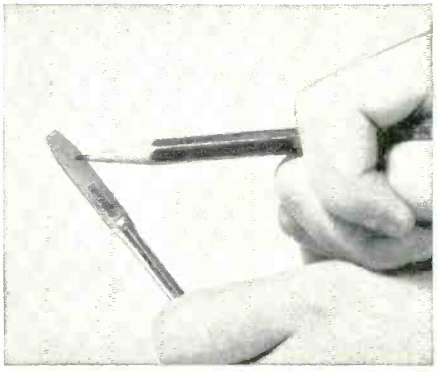


"BEST IRON WE'VE HAD in the plant," says William Fish, a production supervisor of General Radio, Cambridge, Mass. This company has switched to G-E Midget irons for soldering *both* delicate and heavy joints in their Type 1862-B Megohmmeters —jobs which formerly required *both* a heavy and a light iron. G-E Midget iron's light weight also helps reduce fatigue.

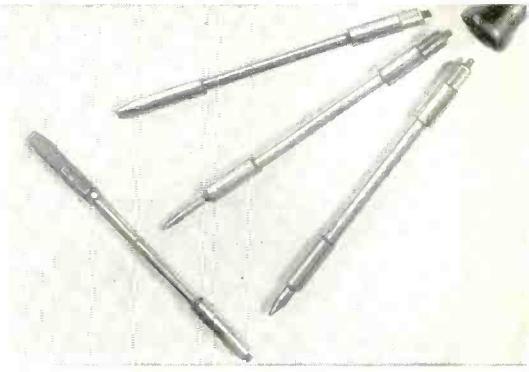
50 G-E Midget irons do work of 100 former irons at General Radio Co., boost production 25%



HANDLES LIKE A PENCIL—Weighing less than a package of cigarettes, the General Electric Midget soldering iron speeds production by reducing operator fatigue.



RAPID HEAT TRANSFER is achieved by locating the heater directly in the iron-clad-copper tip. Result—the G-E Midget iron's heat efficiency is 90%.



THREE-IN-ONE IRON with $\frac{1}{8}$", $\frac{1}{4}$", $\frac{3}{16}$" tip sizes gives you greater versatility to meet your soldering requirements. Tips can be changed in only 5 seconds.

SEE THE MIDGET AT THE WESCON SHOW, AUGUST 21–24.

For more information write for GED-2263, G-E Midget Soldering Iron, Section 724-3, General Electric Co., Schenectady 5, N. Y.

GENERAL ELECTRIC

satellite will also be accomplished through the Minitrack system. A method of ground command turn-on has been worked out so that the telemetering will transmit only when the satellite is directly over a ground recording station, to minimize battery requirements.

Electronics Attacks Heart Ills

New applications promise to aid medicine's fight against one of the nation's top killers

THREE new instruments that aid heart disease diagnosis are being added to the growing volume of electronic equipment used by the medical profession.

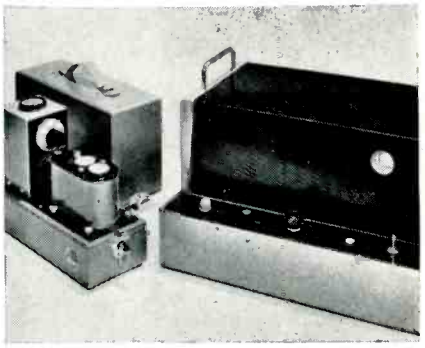
▶ **Instrument**—A tiny transducer, about 60 thousandths of an inch in diameter, placed on the tip of a heart catheter and introduced into the heart to locate defects, has been developed at the Philadelphia General Hospital by Dr. David H. Lewis and engineer James R. Brown, Jr.

The device consists of a barium titanate element, built into a specially designed cardiac catheter. It converts sound into electrical energy which is then tape recorded. By listening to sounds inside the heart, the exact spot of a defect can be located.

So far, the instrument has been introduced only into the right side of the heart. Dr. Lewis is working on further miniaturization of the device so that it will fit into the eye of a needle which can be introduced into the left side of the heart.

A similar instrument, employing a condenser microphone, was developed in Japan in 1954 but its pickup was limited, according to Dr. Lewis.

▶ **Meter** — An electronic device which facilitates diagnosis of blue baby conditions and other cardiac diseases, is being introduced by The Colson Corp. of Elyria, Pa. The instrument is a cuvette densitometer that gives continuous information on variations in the oxygen saturation of blood taken from specific regions of the heart through a catheter. By ascertaining the position of the catheter in the heart by x-ray, the physician can determine the positions in the heart at which the patients blood departs from the normal oxygen saturation.



Colson cuvette densitometer for monitoring oxygen saturation of blood

▶ **Scope**—DuMont Laboratories is coming up with a new oscilloscope designed for use by doctors during operations for the monitoring of the patients heart action. It will reveal possible heart failure in advance and prove a decided additional safety factor, according to Dr. A. B. Dumont.

Manufacturer Girds for Expansion

Sixteen electronic product businesses of GE have been reorganized into three major divisions as a result of the rapid expansion and future growth prospects of these fields which now have a sales volume greater than that of the entire company in 1940. Dr. W. R. G. Baker, right, GE vice-president recently elected president of RETMA, discusses future developments with the new general managers of the new divisions. They are, left to right, L. B. Davis, electronic components division; Dr. G. L. Haller, defense electronics division; and H. A. Strickland, Jr., industrial electronics division

Welding Uses More Electronics

Electronic and magnetic resistance welding controls double in volume

THIS year electronic and magnetic resistance welding controls shipments may reach a total value of over $9 million. Volume doubled between 1947 and 1954, going from $4.3 million to $8.2 million in the period.

▶ **Welders** — Manufacturers of welders shipped over 15,000 units during 1954, valued at $38.6 million. Electronic controls accounted for an estimated 20 percent of this total value.

Largest portion of resistance welders sold were spot welders. Over 13,000 of the units were shipped in 1954 valued at nearly $19 million. Seam welders were the second largest sellers. Some 221 were shipped valued at $3.5 million.

▶ **Market** — There are about 120 manufacturers of welding equipment in the U. S. These represent

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the primary market for some 15 manufacturers of electronic welding controls.

Over half, 63, of welding equipment manufacturers are located in the east north central states. In Michigan alone there are 31 manufacturers. Ohio has 11. In the middle Atlantic states there are 21 manufacturers, 17 in the south and west, 14 in the west north central states and 4 in New England.

Financial Roundup

Final profit reports of many firms in the field show up last year's business

ROUNDUP of companies in the field reporting annual net profits shows how the industry is doing on the financial front.

Company	Annual Net Profits 1955	1954
Admiral Corp.	$2,426,866	$6,547,974
Am. Cable & Radio	1,248,954	1,890,072
American Electronics	265,013	273,057
Amphenol	952,687	679,491
AT&T	546,200,000	480,277,306
Avco	758,311	3,639,436
Bendix Aviation	25,888,599	25,537,771
Burroughs	12,149,753	9,146,514
Canadian Marconi	1,007,065	1,083,590
Century Engineers	102,305	.....
Clary Corp.	286,000	125,000
Clevite Corp.	4,854,753	2,668,648
CBS	13,397,000	11,415,000
Consolidated Electrodynamics	803,696	842,863
Cornell-Dubilier	1,809,002	1,729,640
Curtiss-Wright	35,081,045	19,377,279
Daystrom Inst.	1,784,000	1,716,000
Dynamics Corp.	2,012,071	2,010,447
Eastern Industries	715,436	532,009
Electronic Assoc.	491,523	244,557
Electronics Corp. Of Am.	446,840	162,106
Eitel-McCullough	645,844	622,761
Emerson	2,463,063	1,884,976
Fairchild Camera & Inst.	792,000	1,607,000
Fischer & Porter	365,073	263,588
General Electric	200,923,835	198,913,221
Gray Manufacturing	357,110	130,407
Indiana Steel	766,945	587,854
IBM	55,872,633	46,536,625
IT&T	23,070,327	20,068,525
Jerrold Electronics	169,422	189,733
Magnavox	1,774,960	1,532,409
Minn. Honeywell	19,278,648	15,345,203
Minnesota Mining	34,323,370	24,241,885
National Cash Register	15,388,000	12,729,000
Packard-Bell	638,933	164,295
Philco	8,423,000	769,000
RCA	47,525,465	40,525,459
Rome Cable	2,023,000	931,000
Servo Corp.	269,800	150,500
Servomechanisms	441,367	503,926
Siegler Corp.	613,855	.....
Sperry Rand	46,348,878	44,580,821
Stewart-Warner	6,163,217	2,757,436
Sylvania	13,812,970	9,480,941
Tempco Aircraft	3,103,070	2,937,249
Tung-Sol	3,239,393	2,077,062
Van Norman Industries	633,398	.....
Westinghouse Air Brake	12,357,959	7,763,546
Westinghouse	42,803,000	79,922,000
Zenith	8,034,491	5,676,264

MEETINGS AHEAD

Aug. 20-21: National Telemetering Conference, IRE, AIEE, IAS, ISA, Biltmore Hotel, Los Angeles, Calif.

Aug. 21-24: 1956 Western Electronic Show and Convention, Pan-Pacific Auditorium, Los Angeles, Calif.

Aug. 22-Sept. 1: The 23rd Annual British National Radio Show, Earls Court, London.

Aug. 24-26: Seventeenth Annual Summer Seminar, IRE, Emporium, Pa.

Sept. 10-12: Information Theory Symposium, IRE, MIT, Cambridge, Mass.

Sept. 11-12: Second RETMA Conference on Reliable Electrical Connections, University of Pennsylvania, Phildelphia.

Sept. 14-15: Sixth Symposium, IRE, PGBTS, Mellon Institute, Pittsburgh.

Sept. 14-15: Conference On Communications, IRE, Roosevelt Hotel, Cedar Rapids, Ia.

Sept. 17-21: Eleventh Annual International Instrument-Automation Conference and Exhibit, ISA, New York Coliseum, New York, N. Y.

Sept. 24-25: Industrial Electronics Conference IRE, AIEE, Hotel Manger, Cleveland, Ohio.

Sept. 24-28: Trade Fair of the Atomic Industry, Atomic Industrial Forum, Navy Pier, Chicago, Ill.

Sept. 26-29: 1956 Convention of the Audio Engineering Society, New York Trade Show Bldg., New York, N. Y.

Sept. 27-30: New York High Fidelity Show, New York Trade Show Building, New York.

Oct. 1-3: IRE Canadian Convention, Automotive Bldg. Exhibition Park, Toronto.

Oct. 1-3: Twelfth Annual National Electronics Conference, Hotel Sherman, Chicago.

Oct. 1-4: Semiconductor Symposium Electrochemical Society, Statler Hotel, Cleveland, Ohio.

Oct. 7-12: SMPTE 80th Convention, Ambassador Hotel, Los Angeles, Calif.

Oct. 8-9: Second National Symposium on Aeronautical Communications, IRE, Hotel Utica, Utica, N. Y.

Oct. 9-10: Third Annual Computer Applications Symposium, Armour Research Foundation, Chicago, Ill.

Oct. 10-11: Engineering Convention of the Central Canada Broadcasters Association, Seaway Hotel, Toronto.

Oct. 11-12: URSI Fall Meeting, University of California, Berkeley, Calif.

Oct. 15-17: Radio Fall Meeting, IRE, RETMA, Hotel Syracuse, Syracuse, N. Y.

Oct. 16-18: Conference On Magnetism & Magnetic Materials, IRE, AIEE, APS, AIMME, Hotel Statler, Boston, Mass.

Oct. 25-26: Second Annual Technical Meeting of the IRE Professional Group on Electronic Devices, Shoreham Hotel, Washington, D. C.

Industry Shorts

▶ **Two-way** radio units will be leased by General Electric for installation in trucks owned by Ryder Rental Systems. The rental firm will then offer radio-controlled pickup and delivery service to its customers.

▶ **WCEMA** has given 18 western universities major scholarship grants for deserving engineering students. The donations will permit as many as 30 students to attend engineering schools during the 1956-57 term.

▶ **Sales** of varnished tubing and saturated sleeving totaled $4.2 million in 1955 compared to $3.3 million in 1954. Total of 184.9 million feet was sold in 1955 compared to 148.7 million feet in 1954. (ELECTRONICS, p 14, May, 1956) This brought total insulation sales, as compiled by NEMA, to $188.5 million in 1955 compared to $141.4 million in 1954.

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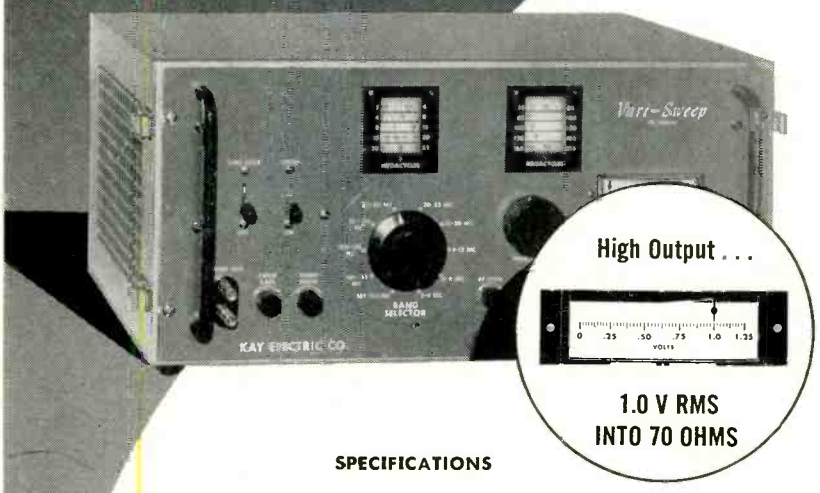

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- **Output Automatically Held Constant (AGC) Over Complete Range**
- **Variable Sweep Width (to 30 mc. PLUS) — Variable Center Frequency**
- **Direct Reading Frequency Dial Accurate To ±2.0%**
- **Sweep Repetition Rates Down to 10 cps**

Price: **$695.** FOB Plant

SPECIFICATIONS

Range: Fundamental frequency 2 to 220 mc., continuously variable in 10 switched overlapping bands. Direct reading frequency dial calibrated to ±2.0%.

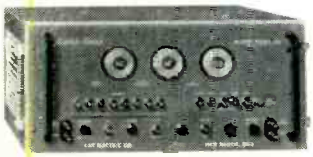
RF Output: 1.0 v. RMS into 70 ohms, metered. Flat within ±0.5 db over widest sweep and frequency band.

Sweep Width: Continuously variable to ± 30% of center frequency to maximum of at least 30mc.

Sweep Rate: Continuously variable 10 to 40 cps.; also locks at line frequency.

Attenuator: Switched 20, 20, 10, 6, and 3 db plus continuously variable 6 db.

Power Supply: Electronically regulated 105 to 125 v. A. C. 50 - 60 cycles



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- Variable Center Frequency, Variable Sweep Width • Includes Low End of Video Spectrum • Permits Observation of Complete Spectrum to 50 mc or Any 4 mc Part Over the Range • Markers at Set Frequencies or as Specified.

SPECIFICATIONS

FREQUENCY RANGE: Continuously variable, 50 kc to 50 mc.

SWEEP WIDTH: Linear, continuously variable, 4.0 mc to 50 mc.

SWEEP RATE: Variable around 60 cps; locks to line frequency.

AMPLITUDE: 1.0 v, peak-to-peak, into nom. 70 ohms. Flat within ±0.5 db over widest sweep.

ATTENUATORS: Switched 20, 20, 10, 6 and 3 db, plus continuously variable 3 db.

MARKERS: Eight sharp, pulse-type, crystal-positioned, internal or external markers.

PRICE: $695.00 F.O.B. Factory. Substitute markers, $10.00. Additional markers, $20.00 each.

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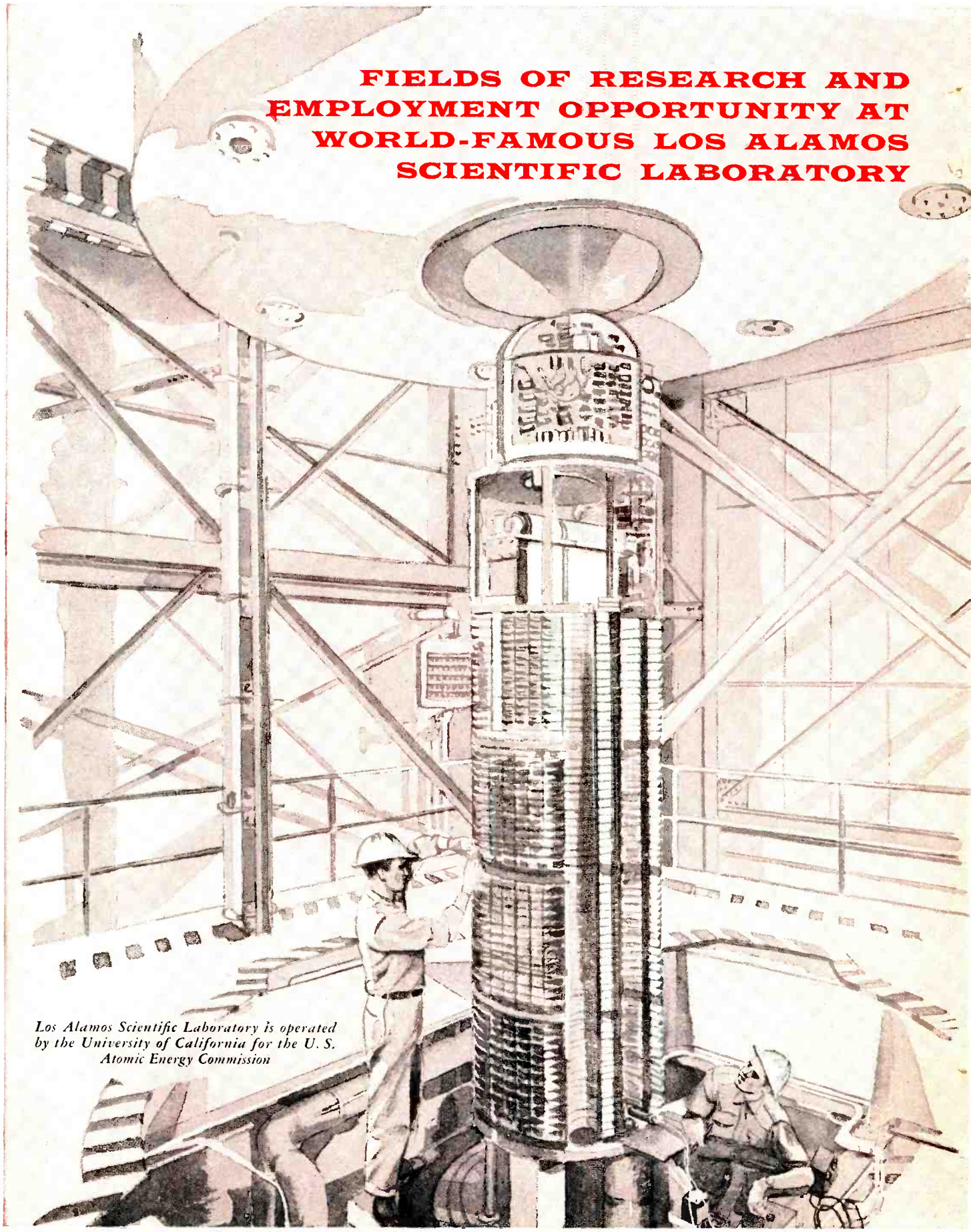

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Theoretical Physics and Mathematics

In the field of theoretical physics, the Laboratory carries on studies of nuclear theory, equations of state, mathematical analysis methods, hydrodynamics problems and various aspects of applied mathematics. The Theoretical Division is also concerned with the conceptual design of nuclear weapons, and supports many non-weapons activities such as the nuclear reactor and propulsion programs. The equipment used includes the Los Alamos-developed Maniac, the Maniac II, two IBM 704's and an IBM 701.

Experimental Nuclear Physics

Much of the work in experimental physics is concerned with nuclear properties of various materials. Fundamental studies are made of nuclear forces, neutron and charged-particle reactions and cross sections. Experimentation in controlled thermonuclear reactions is assuming increasing importance. Among the facilities available are three Van de Graaffs, two Cockcroft-Walton machines and a variable energy cyclotron.

Electronics and Instrumentation

The Laboratory is engaged in the design and development of nuclear physics research instruments, scintillation counters, fast pulse amplifiers, multi-channel analyzers, fast oscilloscopes, radiation detection instruments, electronic controls and control systems, and high-speed cameras which operate at 15 million frames per second. Electronics specialists also assist in the design of digital computers and of instruments for studying nuclear and thermonuclear detonations.

Nuclear Reactor Research

In connection with the peacetime applications of nuclear energy, the Laboratory is currently developing several advanced power reactors of unusual design. In addition, two research reactors are available for experimental studies. The remotely controlled critical assembly machines, known as Topsy, Godiva and Jezebel, constitute neutron research tools of a unique character.

Nuclear Propulsion

The Laboratory is actively engaged in the application of nuclear energy to the new and challenging field of self-propelled mobile reactors. There are studies in progress relative to engine design, heat transfer, controls and instrumentation.

Chemistry

Research in chemistry is devoted largely to inorganic and physical studies, especially of materials such as uranium, plutonium, deuterium and tritium used in nuclear energy systems. Radiochemical methods are applied in various investigations. Much work is being done on reaction kinetics, the effects of radiation on chemical reactions, complex ion formation and the determination of heats of combustion and solution. Extensive analytical studies include the use of a great variety of instruments, as well as the techniques of microanalysis.

Metallurgy and Metallurgical Engineering

Research activity and development in this field includes investigation of the metallurgical properties of materials used in nuclear energy systems; studies of extremely refractory substances, ceramics, cermets and plastics; the behavior of materials under extremely high temperatures and high pressures; studies of the properties of plutonium and its alloys, with increasing reference to their use in reactors, and of uranium and its alloys; development of fabrication techniques for various metals and alloys; and the high temperature properties of refractory metals tungsten, molybdenum, columbium, etc.

Weapons Physics, Design and Testing

Still the nation's principal institution for nuclear and thermonuclear weapons research, the Laboratory takes nuclear weapons from the concept stage to proved performance as determined by field tests. Activities in weapons research and development include the mechanics and dynamics of initiating a nuclear energy release; the behavior of supercritical systems; the testing of nuclear devices and weapons assemblies in Nevada and in the Pacific; engineering design of tests and prototypes of nuclear systems; and the design and development of nuclear weapons components and the techniques for their manufacture.

Explosives Research and Development

Work in this field includes study of fabrication, storage and stability problems of explosives; making and evaluating novel organic chemical compounds of possible use as explosives; mechanics and dynamics of explosive phenomena; and physical and chemical properties of explosive material using mass spectrometer, infra-red spectrometer, X-ray equipment and other analytical techniques. High explosives are employed in research on equations of state and shock wave phenomena.

Mechanical Engineering

Design and development work is carried on in connection with weapons design, field test facilities, the power reactor and propulsion programs, servo-mechanisms and remote control systems. High explosives systems are designed and manufactured. Other types of work are estimating, cost analysis and liaison between architectural engineers and contractors.

Chemical Engineering

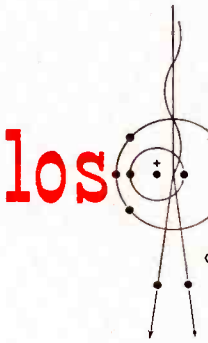
Chemical engineering work includes studies of heat transfer, fluid flow, solvent extraction, evaporation, distillation and systems at extreme temperatures and pressures. Problems supporting inorganic and physical chemistry research projects are also undertaken. Other activities are the remote control handling of radioactive materials and corrosion and erosion studies.

Electrical Engineering

Much effort is devoted to the design of induction heating systems for study of alloys at extremely high temperatures; of DC power supplies at currents up to 100,000 amperes; of servo-mechanism controls for nuclear reactors; and of high magnetic field systems. Work is done in planning, building and installing power distribution systems and their controls.

The Laboratory now has staff openings for technically qualified people interested in these fields of research and development. For additional information address your inquiry to

Director of Personnel
Division 1103

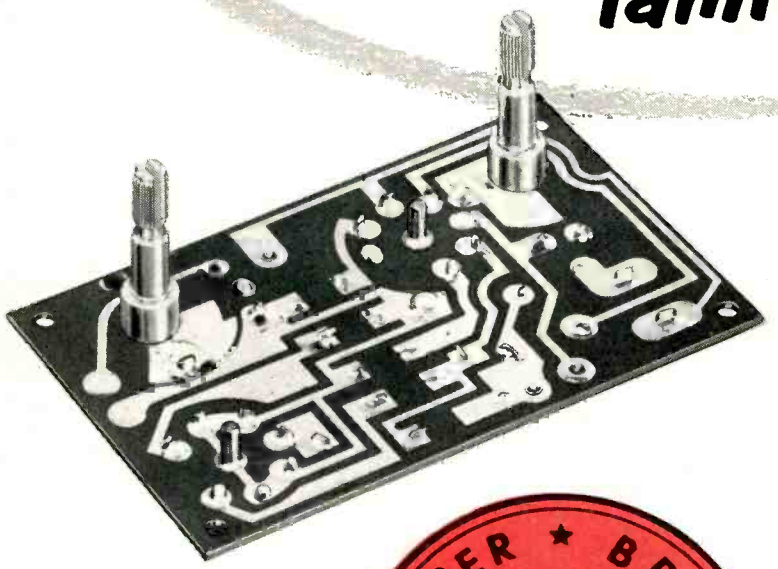


los alamos
scientific laboratory
OF THE UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO

Taylor Fibre Co.

says...

"Using Revere Rolled Copper we are able to produce superior copper-clad laminates!"



At the top of the page opposite is a section of an etched printed circuit enlarged 10 times. These particular lines are of .008 thickness, spaced .012 apart. They show the kind of printed circuits obtainable by combining Revere Rolled Printed Circuit Copper and Taylor laminates. Note the fine line etching, the close spacing and the sharp definition of the edges . . . the smoother surface (freer from pits, pinholes and imperfections) . . . the more uniform thickness with no sacrifice of conductivity. Results—consistently satisfactory etching at better production rates.

Laminators and users alike also have found that Revere Rolled Copper produces no peaks or valleys, that its smooth, hard surface of uniform density permits resist to clean off easily for there are no pores to hold resist and cause trouble when soldering.

They have noted, too, that Revere Rolled Copper is free from oxidation as it comes from the mill and is without lead inclusions. And because of its clean surface, fluxes wet readily, while in the automatic soldering operation it makes possible a uniform solder coat every time free of skips or bald spots.

Those are the very reasons why you should insist that Revere Rolled Copper be used when ordering blanks from your laminator. It is available in unlimited quantities in standard coils of 350 lbs. in widths up to 38" and in .0015 and .0027 gauges, weighing approximately 1 oz. and 2 oz. per square foot. Revere Rolled Copper exceeds requirements of standard specifications and meets ASTM B5 specification for purity with 99.9% minimum.

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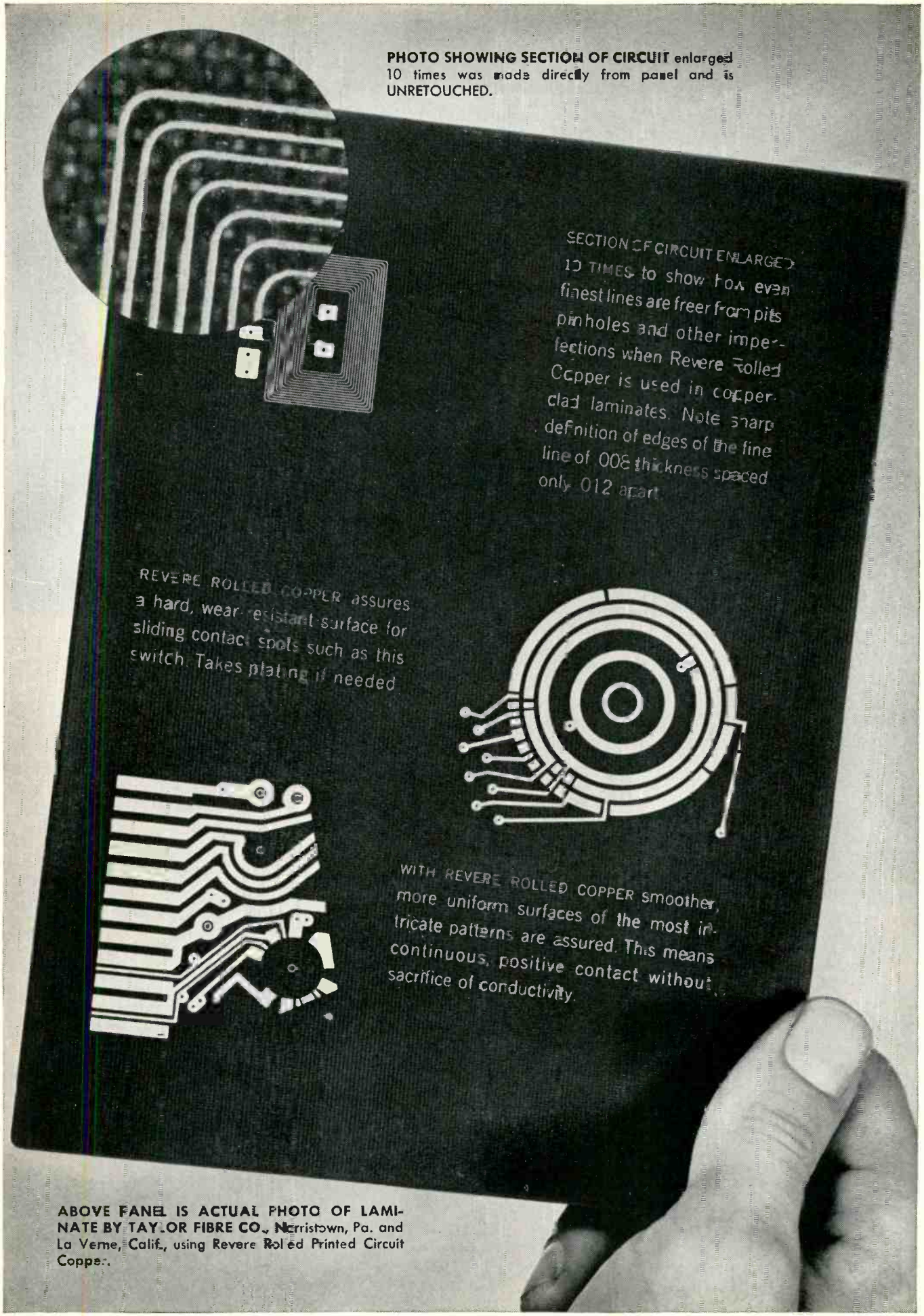
230 Park Avenue, New York 17, N.Y.

Mills: Baltimore, Md.; Brooklyn, N. Y.; Chicago, Clinton and Joliet, Ill., Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Newport, Ark.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.

COPPER ★ BRASS ★ 18 01 ★ REVERE ★ ALUMINUM



TEFLON GLASS FIBER LACING

Ben-Har Braided TAPES

New Ben-Har Braided lacing and winding tapes combine two superior insulation materials . . . duPont Teflon and glass fibers. Teflon, with its high heat resistance of 500°F. has been coated directly on the glass fibers before braiding so as to preserve a rough texture for knottability while eliminating the abrasive action of the glass.

Developed particularly for harnessing, lacing and winding applications where heat is a determining factor, Ben-Har offers these additional features:

- non-shrinking — will not cut through insulated wires.
- pliable through −100°F. to 500°F.
- wax-free — fungus proof.
- inert to most known chemicals and oils.
- non-absorbent.
- knots hold tight, won't slip.

Ben-Har Braided Tapes are available in .048, .062, .090 and .22 inch widths; in natural color (offwhite); in 250 and 500 yard spools and a Universal wound ¼ pound tube. Brown, white, yellow, orange, red, green, blue, violet and black can be had on special order. Write for prices and samples.

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1308 Barclay St.
CONSHOHOCKEN, PA. • TELEPHONE: TAYLOR 8-0634

BENTLEY, HARRIS *Fiberglas* ***INSULATIONS**

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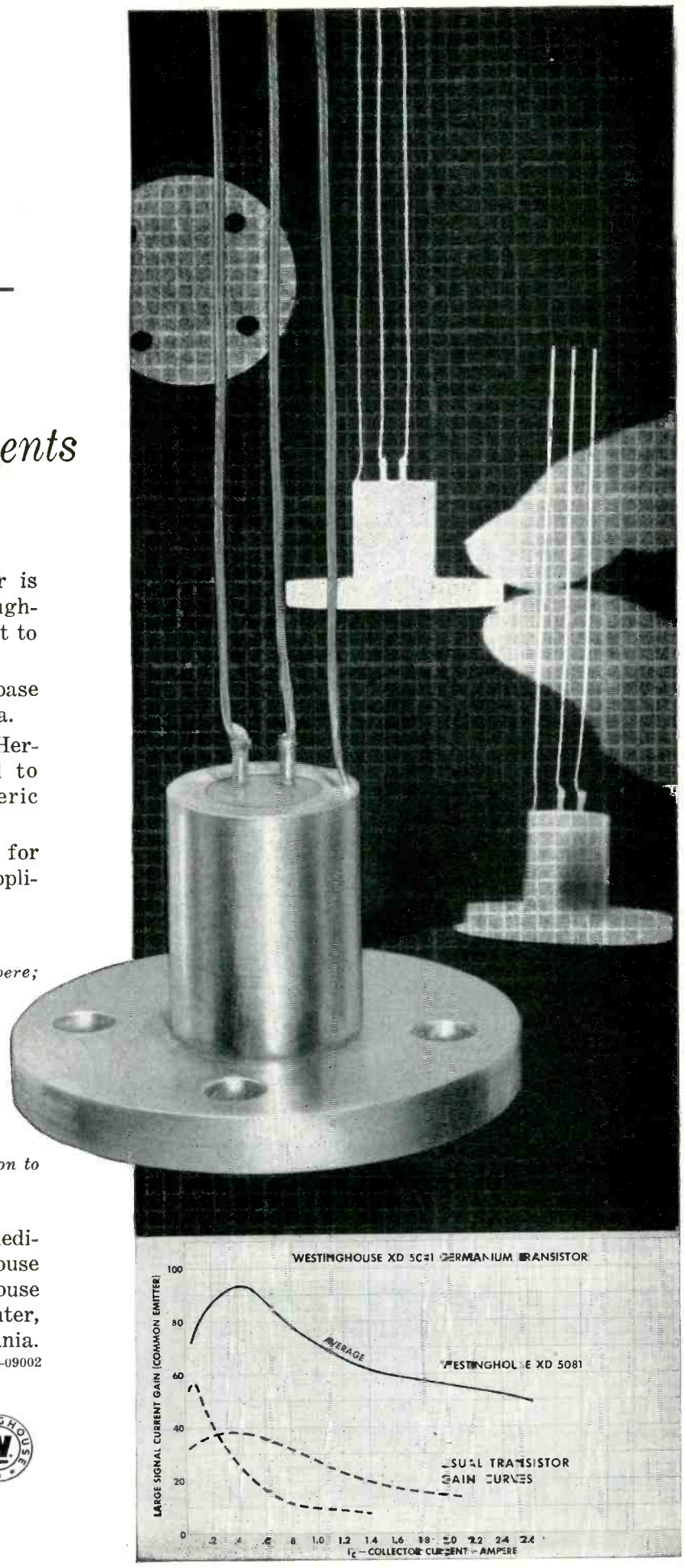
WESTINGHOUSE
2-AMP GERMANIUM
POWER TRANSISTORS

High Current Gain— Maintained at Large Collector Currents



New Westinghouse XD-5081 transistor is characterized by high current gain throughout its operating range. Distortion is cut to a minimum.

THERMAL DISSIPATION. Large copper base provides an ample heat dissipating area.

LONG LIFE — RELIABLE OPERATION. Hermetically sealed in glass and metal to exclude moisture, prevent atmospheric contamination.

TYPICAL APPLICATION. Ideally suited for audio output stages and switching applications.

Performance data on the XD-5081:

Large signal current gain . . . 70 at Ic = 1 ampere; 55 at Ic = 2 amperes

Large signal frequency cutoff (common emitter) . . . > 10 kc

Maximum voltage (Vce) . . . 35 volts

Maximum current (Ic) . . . 2 amperes

Saturation characteristic (Vce) . . . < 1 volt at Ic = 1 ampere

Thermal drop . . . 3.5°C per watt from junction to case

Maximum junction temperature . . . 100°C

Sample quantities are available immediately. Contact your nearest Westinghouse district sales office or write, Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-09002

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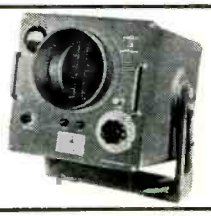
Superior

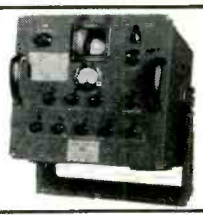
MARINE ELECTRONIC EQUIPMENT

by EDO

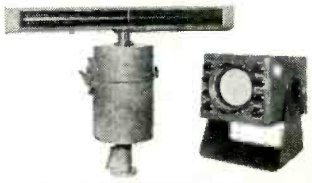
EDO DEEP DEPTH SOUNDER Sonar unit in wide Navy use, now available commercially. Gives clear indication of depth on CRT in two scales: 0-100 feet; 0-100 fathoms. Records continuously in three scales: 0-600 feet; 0-600 fathoms; 0-6,000 fathoms.



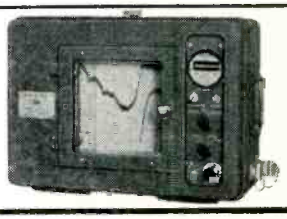
EDO FISHSCOPE Most advanced fish finding device on the market, available in three versions for deep and shallow fishing. Spots fish on CRT at depths to 400 fathoms, then magnifies any 10-fathom sector 20 to 40 times for clearer view. Compact design, single transtransducer.



EDO LORAN Compact, direct-reading aid to long-range navigation. No special training required to operate. Fix obtained from single, 28-tube unit in matter of seconds, regardless of weather or sea conditions. Absolutely accurate though relatively low in cost.



EDO RADAR For long and short-range navigation in any weather. CRT display gives clear picture on 1, 2, 5, 10 and 20-mile range. Patented slotted waveguide antenna, mounted on transmitter, assures superior definition. Ideal where space and generator capacity are limited.



EDO SURVEY DEPTH RECORDER
Extremely accurate equipment for measuring depth of water for survey purposes. Legible, permanent record of depth, 0 to 250 fathoms, is made within eight overlapping range scales. For permanent or temporary installation.

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Edo

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1 MINIATURE — Actual size shown. Diameter, 1¼". Overall length, 2".
Ideal for pulsed beacon applications.

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Reliable characteristics up to 10 g.'s from 20 to 1000 c.p.s.

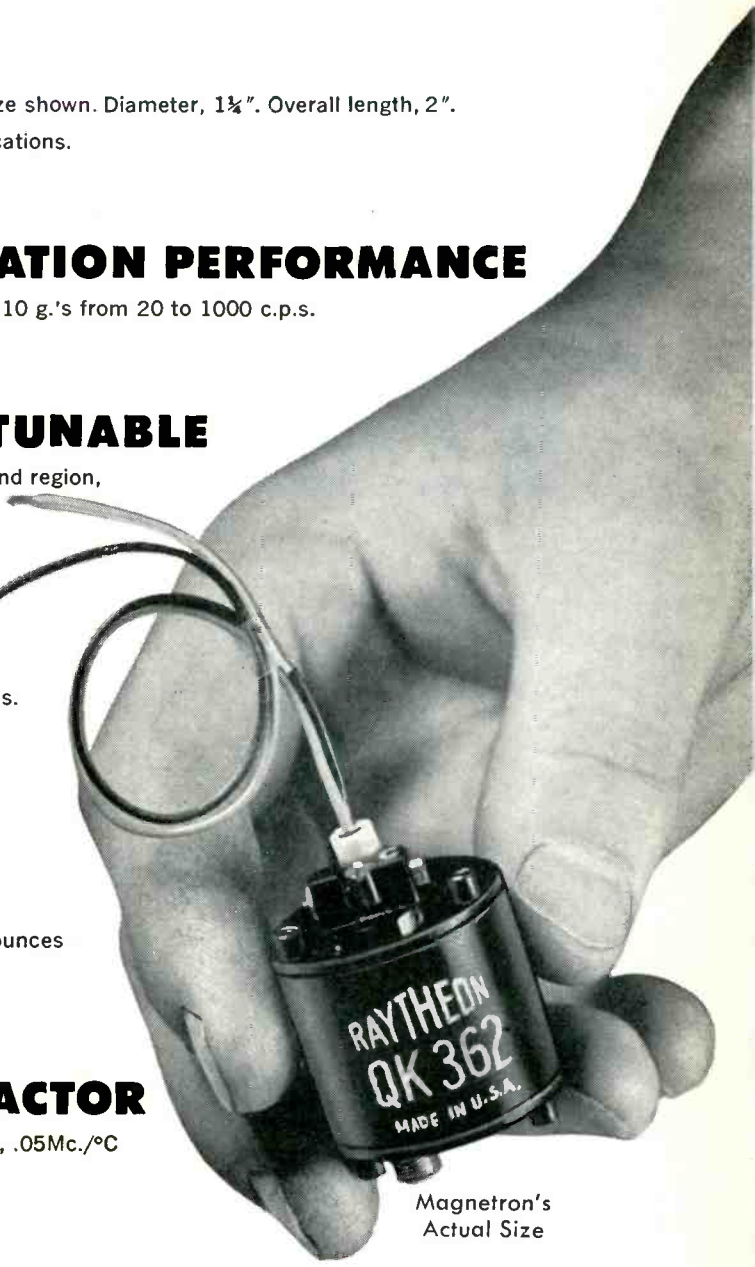
3 MECHANICALLY TUNABLE
Tunes mechanically over X-band region, 9300-9500 Mc min.

4 RUGGED
Withstands 1,000 g. shock along cathode axis. 500 g. in two other perpendicular planes.

5 PULSE POWER
50 watts peak

6 LIGHTWEIGHT — 6 ounces

7 LOW THERMAL FACTOR
Exceptional frequency stability, .05Mc./°C



Magnetron's Actual Size

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FOR YOUR NEW EQUIPMENT DESIGNS

For specifications on the extraordinary QK 362 magnetron write today. Similar tubes at other frequencies and power levels are available. Ask for copies of latest bulletins listing most of our unclassified Magnetrons and Klystrons and special tubes. Call on us for help in your microwave problems. There is no cost or obligation, of course.

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RAYTHEON MANUFACTURING COMPANY

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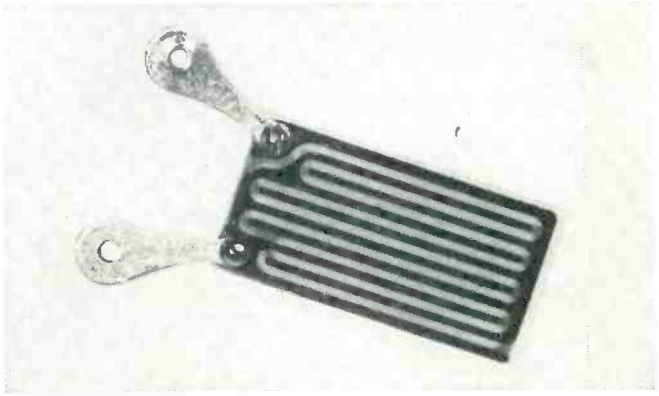
NOW...A GREAT, NEW ADVANCE IN MEASUREMENT AND CONTROL OF RELATIVE HUMIDITY

SIMPLE • FAST • ACCURATE • DEPENDABLE

EL-TRONICS

HUMIDITY SENSING ELEMENT

An entirely new principle . . . completely stable over long periods . . . mass produced at low cost.



Composed of a specially treated plastic material, the El-Tronics Humidity Sensing Element (patented) is only $\frac{5}{8}''$ wide, $1\frac{1}{2}''$ long, and $\frac{1}{32}''$ thick.

The resistance of the element varies as the logarithm of the relative humidity. The signal produced by the resistance change may be amplified and used to operate indicators, recorders, and controls.

RAPID RESPONSE

Reaction to humidity change is rapid, 67% of the change registers within 30 seconds on standard production elements. This reaction time can be reduced to 1 second for special applications.

ACCURATE OVER WIDE TEMPERATURE RANGE

For use over a wider range than heretofore possible, from -5° to 80° C (23° to 176° F), the standard element has a repeat accuracy within 3% R.H. Long-term stability and maintenance of calibration under adverse conditions are additional features of the El-Tronics Humidity Sensing Element.

MANY APPLICATIONS

The El-Tronics Humidity Sensing Element is applicable to the entire field where relative humidity is measured or controlled. This includes humidifiers, dehumidifiers, dehydrators, dryers, home and industrial air conditioning, packaging process control, industrial, educational, and government laboratories.

PROVED PERFORMANCE

The El-Tronics Humidity Sensing Element is the result of five years of research and intensive tests under a wide range of operating conditions.

SPECIFICATIONS

Standard Ranges, R.H.: 10-100%, 20-100%, 40-100%
10-50%, 20-50%, 10-25%
Ambient Temperature Range: +23° to 176° F
Repeat Accuracy: Within 3%
Reaction time, standard models: 67% of change registers within 30 seconds
special models: 67% of change registers within 1 second
Dimensions: $\frac{5}{8}''$ wide, $1\frac{1}{2}''$ long, $\frac{1}{32}''$ deep

FOR COMPLETE INFORMATION ON QUOTATIONS . . . PHONE . . . WIRE . . . OR WRITE:

EL-TRONICS INSTRUMENTS FOR THE MEASUREMENT AND CONTROL OF RELATIVE HUMIDITY

EL-TRONICS *Laboratory* HYGROMETER

Complete range of 10 to 100% R.H. Measures to 1% R.H.

MODEL 101

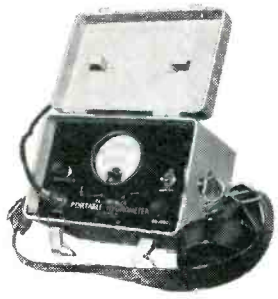
This is a precision 3-scale measuring instrument and can be used as a secondary standard. It is accurate within ±1% R.H. This hygrometer is plugged into a 110 volt a-c outlet to operate and is compensated for line voltage variations.

SPECIFICATIONS

Ranges: 40-100% (2% Graduations)
20-50% (1% Graduations)
10-25% (1% Graduations)
Calibration Accuracy: 1% R.H.
Power: 105-125 volts, 50-60 cycles
Size: 8″ x 10½″ x 10½″
Finish: Hammertone Gray

EL-TRONICS *Portable* HYGROMETER

Lightweight . . . Accurate . . . Battery Operated



Designed especially for humidity measurement work where a-c voltage may not be available. Under intermittent use, batteries are good for over 200 operating hours.

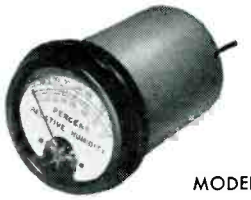
Range of 10-100% R.H. permits measurements of 10-50% R.H. in 1% graduations and of 20-100% in 2% graduations.

SPECIFICATIONS

Range: 10-100% R.H. (2 scales)
20-100% (2% Graduations)
10-50% (1% Graduations)
Calibration Accuracy: 2% R.H.
Power: Batteries
Battery Life: 200 hours (Intermittent)
Size: 5″ x 6″ x 7″
Weight: 6 pounds
Finish: Hammertone Gray

EL-TRONICS *Panel* HYGROMETER

Inexpensive . . . Versatile



MODEL 102

For panel mounting in industrial applications. Through external switches, any number of sensing elements, remotely located, may be connected to the meter singly.

SPECIFICATIONS

Range: 20-100% (2% Graduations)
10-50% (1% Graduations)
Calibration Accuracy: 4% R.H.
Power: 117 volts, 60 cycles
Size: 3½″ x 3½″ (Cylindrical)

EL-TRONICS *Industrial Humidity Control*

Manual or automatic . . . controls over full range 10-100% R.H.

MODEL 201 and MODEL 202

This is an electronic relay which is available in two types depending upon differential. Model 201 has a differential of ± 5% R.H. and Model 202 has a differential of ± 1% R.H. A standard thyratron tube "triggers" the relay. Contact rating is ample for electrical equipment rated up to ⅓ h.p.

SPECIFICATIONS

Range: 10-100% R.H.
Differential: Model 201—±5% R.H.
Model 202—±1% R.H.
Contacts: Double Pole, Double Throw
Current: 10 amperes
Power: 117 volts, 50-60 cycles
Size: 4″ x 4″ x 5½″
Finish: Hammertone Gray

EL-TRONICS, INC.
Mayfield, Pennsylvania

Please send me complete information on
Laboratory Hygrometer . . . . . _____
Portable Hygrometer . . . . . _____
Panel Hygrometer . . . . . _____
Industrial Humidity Control . . . . . _____
Please have representative call . . . . . _____

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

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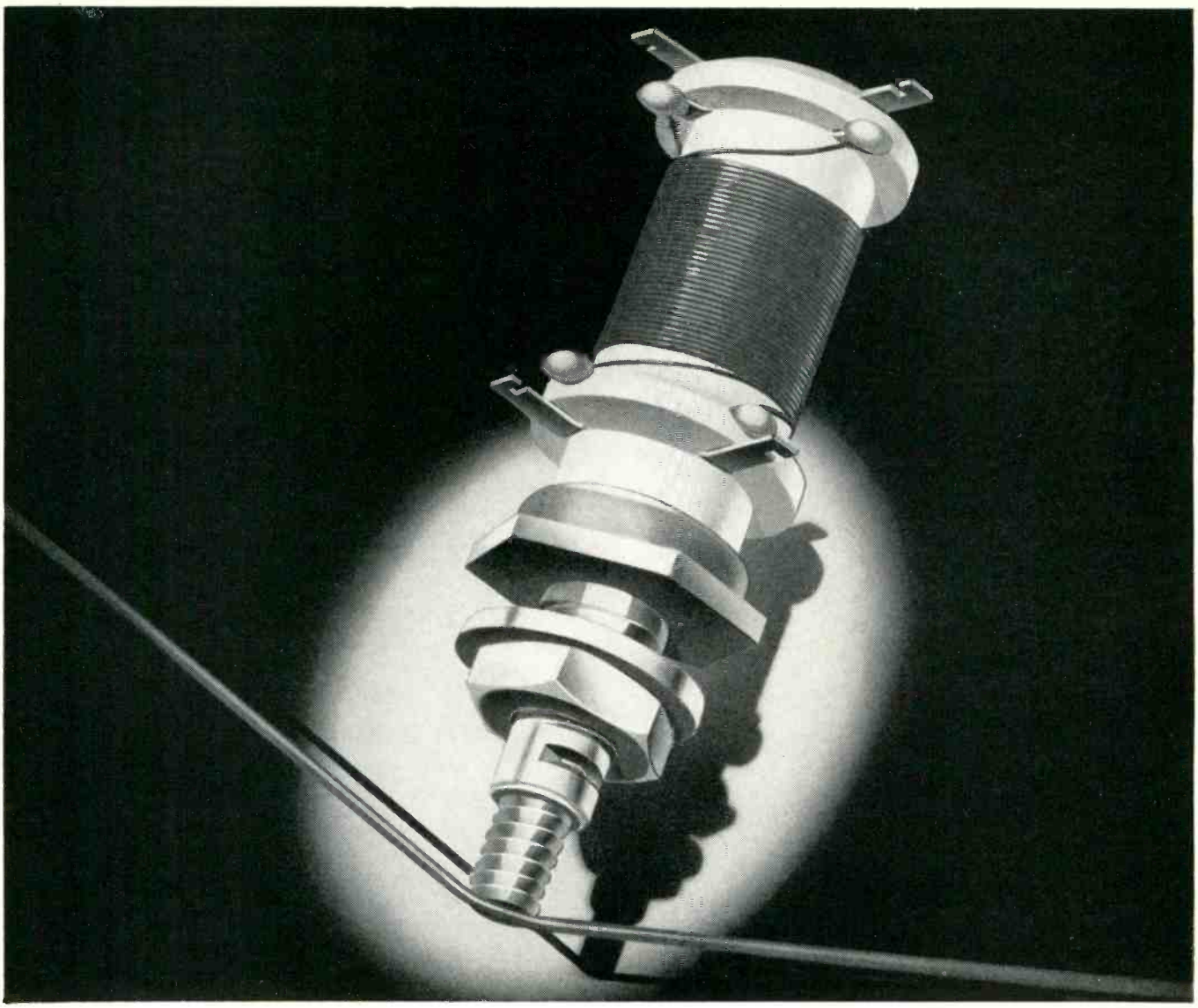
Want more information? Use post card on last page.



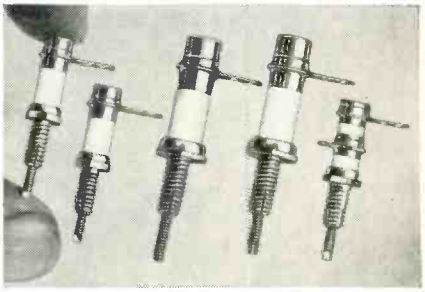
CTC Slug Tuned Coils are made in single layer or pie type windings to your specifications. Forms are of grade L-5 silicone impregnated ceramic. Mounting studs are cadmium plated brass; silicone fibreglas collars facilitate termination of simple or multiple windings.

Death-defying performance

You can depend upon CTC Coils to give a steady, star performance whether you use ten or ten thousand! They won't go dead even under severe temperature, climate or vibration conditions. Here's why:

All CTC coils are precision-made to meet individual specifications — and to meet, or better, government specifications. Continuous quality control is maintained. As a result, you get a *guaranteed* electronic component — custom or standard.

Precision-made CTC components that benefit from CTC high quality standards include terminals, terminal boards, capacitors, swagers, hardware, insulated terminals and coil forms. For all specifications and prices, write Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. A West Coast stock is maintained by E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 and 988 Market St., San Francisco, Calif.



CTC Capacitor family: Metallized ceramic forms. From left to right — CST-50, in range 1.5 to 12.5 MMFD's. CST-6, in range 0.5 to 4.5 MMFD's. CS6-6, in range 1 to 8 MMFD's. CS6-50, in range 3 to 25 MMFD's. CST-50-D, a differential capacitor with the top half in range 1.5 to 10 MMFD's and lower half in range 5 to 10 MMFD's.

CTC

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MILLIONS OF VARIABLE RESISTORS
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- 315,000 sq. ft. of plant area devoted to variable resistors.
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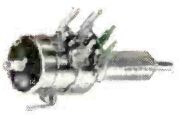
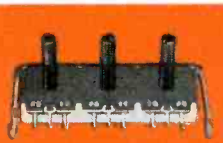
- Write for complete 62 page catalog today.

Typical Bushing Mounted Controls	Typical Ear-Mounted Controls	Typical Printed Circuit Controls	Typical Military Controls
 Miniaturized 3/4" diameter composition	 Molded shaft twist ear mounted 5/16" diameter composition	 Solder or clinch ear mounted 15/16" diameter composition with flush shaft	 Miniaturized 3/4" diameter 1/2 watt composition
 15/16" diameter composition	 Hollow shaft twist ear mounted 5/16" diameter composition for screwdriver adjustment	 Bushing mounted 15/16" diameter concentric tandem composition with SPST switch	 15/16" diameter 1 watt composition
 15/16" diameter composition with SPST switch	 Twist ear mounted 15/16" diameter composition with flatted shaft for push-on knobs	 Self-supporting snap-in mounted 15/16" diameter composition	 15/16" diameter composition with water-seal between shaft and bushing and bushing and panel
 1-1/8" diameter concentric tandem tone switch and composition variable resistor with SPST on-off switch	 Twist ear mounted 15/16" diameter composition with SPST switch	 Self-supporting snap-in bracket mounted 15/16" diameter composition with SPST switch	 1-1/8" diameter composition
 1-1/8" diameter composition with SPST switch	 Twist ear mounted 15/16" diameter preset tandem	 Self-supporting snap-in mounted compact 3-section multiple composition	 1-1/8" diameter 2 watt composition
 1-17/64" diameter 2 watt wirewound	 Miniaturized clinch ear mounted composition	 Miniaturized bushing mounted 3/4" diameter composition	 1-17/64" diameter 2 watt wirewound with locking type bushing
 1-17/32" diameter 4 watt wirewound	 Miniaturized clinch ear mounted composition with SPST switch	Terminals For Wire Wrapping  Bushing mounted 15/16" diameter composition with SPST switch.	 1-17/32" diameter 4 watt wirewound

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American has space for your shipment where and when it's needed most. A combined daily lift potential of over a half million pounds gives American the greatest cargo capacity of any airline.

ELECTRONIC EXECUTIVES ALL THESE BENEFITS

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Shipments get faster forwarding...spend less time in terminals with American's greater frequency of schedules. Over 1000 departures daily offer more service to more cities than any other air carrier.

DEPENDABILITY

First with scheduled airfreight, American today has the largest, most experienced personnel force . . . most modern handling facilities. Is better able to solve shipping problems . . . provide dependable on-time deliveries.

AMERICAN AIRLINES AIRFREIGHT

—carries more cargo than any other airline in the world

ACCURATE FREQUENCIES

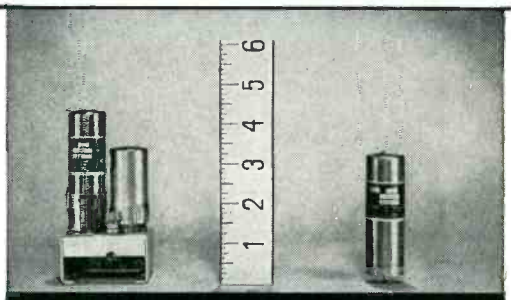
LOW WEIGHT
SMALL SIZE
ECONOMICAL

HIGH RELIABILITY
HIGH PRECISION
HIGH QUALITY

FREQUENCY STANDARD
240 to 800 Cycles

Type 50 C
± .02% at — 65° to 85°C

Type R 50 C
± .002% at 15° to 35°C



PRECISION FORK UNIT
240 to 800 Cycles

Type 50
± .02% at — 65° to 85°C

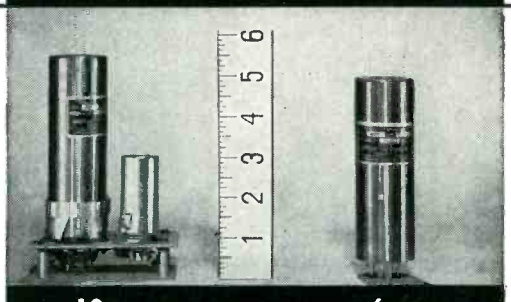
Type R 50
± .002% at 15° to 35°C

FREQUENCY STANDARD
200 to 4000 Cycles

Type 2003 C
± .02% at — 65° to 85°C

Type R 2003 C
± .002% at 15° to 35°C

Type W 2003 C
± .005% at — 65° to 85°C



PRECISION FORK UNIT
200 to 4000 Cycles

Type 2003
± .02% at — 65° to 85°C

Type R 2003
± .002% at 15° to 35°C

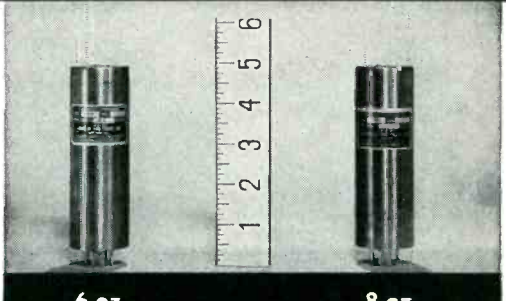
Type W 2003
± .005% at — 65° to 85°C

FREQUENCY STANDARD
200 to 2000 Cycles
Sub-miniature Tube

Type 2007
± .02% at — 65° to 85°C

Type R 2007
± .002% at 15° to 35°C

Type W 2007
± .005% at — 65° to 85°C



FREQUENCY STANDARD
240 to 1000 Cycles
Transistorized

Type 2007 T
± .02% at — 65° to 85°C

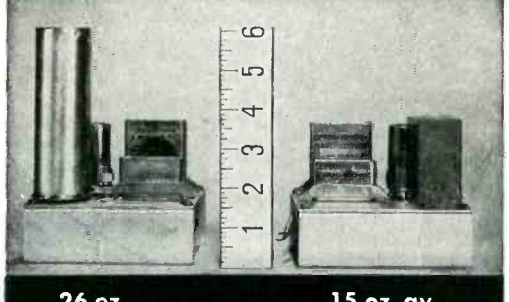
Type R 2007 T
± .002% at 15° to 35°C

Type W 2007 T
± .005% at — 65° to 85°C

FREQUENCY STANDARD
200 to 3000 Cycles

Type 2001-2
± .001% at 20° to 30°C

WHEN REQUESTING
INFORMATION
PLEASE SPECIFY
TYPE NUMBER



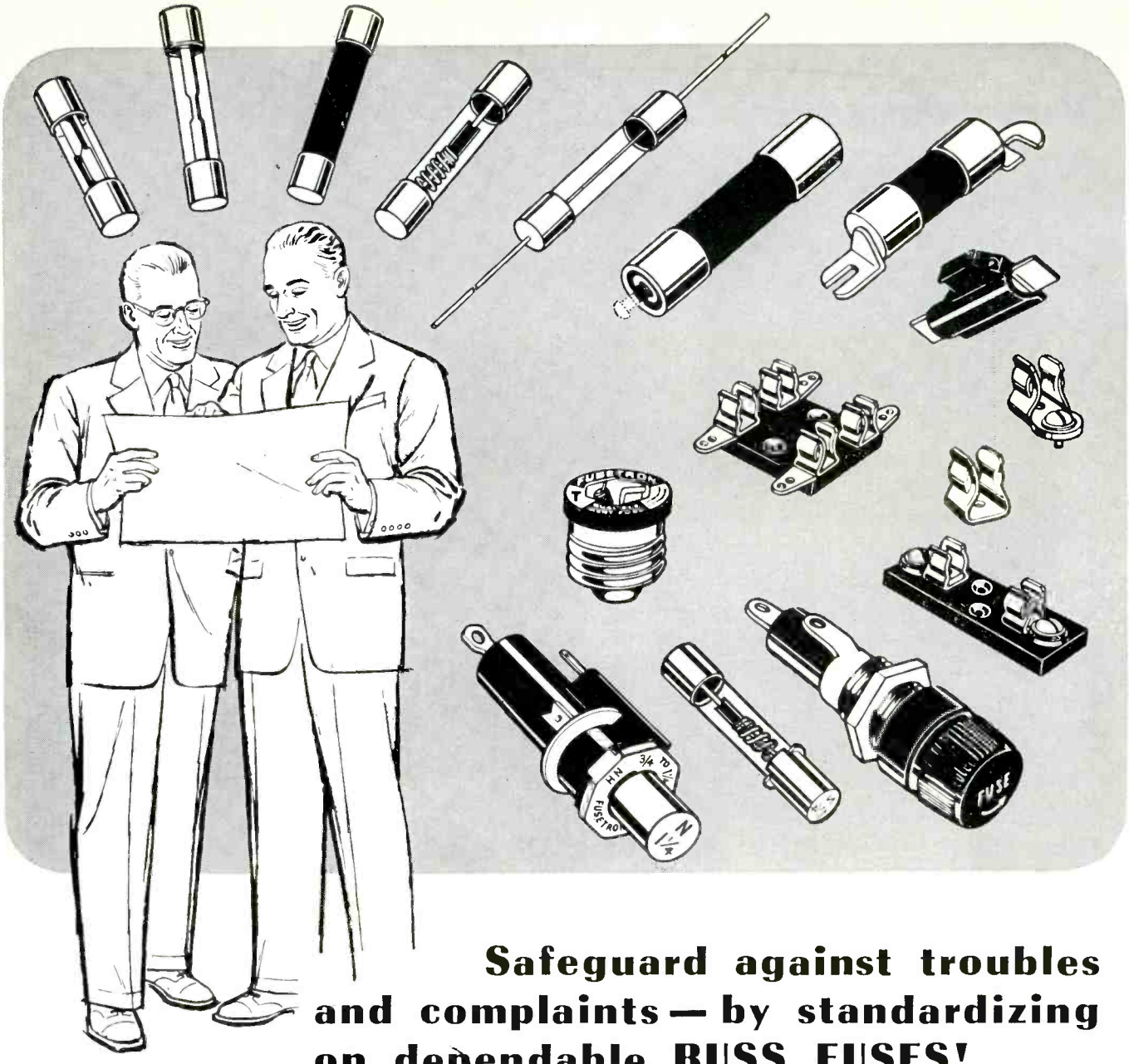
ACCESSORY UNITS
for Type 2001-2

L—for low frequencies, multi-vibrator type, 40-200 cy.
D—for low frequencies, counter type, 40-200 cy.
H—for high freqs., up to 20 KC
M—Power Amplifier, 2W output
P—Power Supply.

American Time Products, Inc.

580 Fifth Avenue New York 36, N. Y.

OPERATING UNDER PATENTS OF WESTERN ELECTRIC COMPANY



Safeguard against troubles and complaints — by standardizing on dependable BUSS FUSES!

BUSS fuses give you double protection against loss of customer goodwill because . . . BUSS fuses blow only to protect — never needlessly. To make sure of proper operation, BUSS fuses are tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

By specifying BUSS fuses, you are safeguarding users of your equipment against irritating useless shutdowns due to faulty fuses blowing needlessly. And you are providing them with maximum protection against damage caused by electrical faults.

Most important, the reputation of your product for service and quality is not harmed by the faulty operation of poor quality fuses.

To meet your needs, a complete line of BUSS fuses is available, plus a companion line of fuse clips, blocks and holders.

If your protection problem is unusual, BUSS places at your service the world's largest fuse research laboratory and its staff of engineers to help you select the fuse or fuseholder best suited to your application.

For more information available on BUSS and Fusetron small dimension fuses and fuseholders . . . Write for bulletin SFB.

Makers of a complete line of fuses for home, farm, commercial, electronic, automotive and industrial use.

BUSSMANN MFG. CO. *(Div. of McGraw Electric Co.)*
University at Jefferson, St. Louis 7, Mo.

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

ELRC
856

WHITE ALICE

The largest forward propagation tropospheric scatter system yet conceived is nearing completion by REL. Telephone service for the major portion of Alaska, in much of which no such service now exists, will be provided by the huge "White Alice" system.

Its 132 channels will furnish ample facilities both for civilian telephones and for military communications in an area larger than Texas, California, New York, Illinois, Delaware, and Tennessee combined. REL is manufacturing all the tropospheric radio equipment for White Alice, including 10 and 1 kw klystron amplifiers, driver exciters, dual diversity receivers, and radio test equipment.

Your specialized radio problems deserve the experience of REL.

Eleventh in a series describing REL versatility

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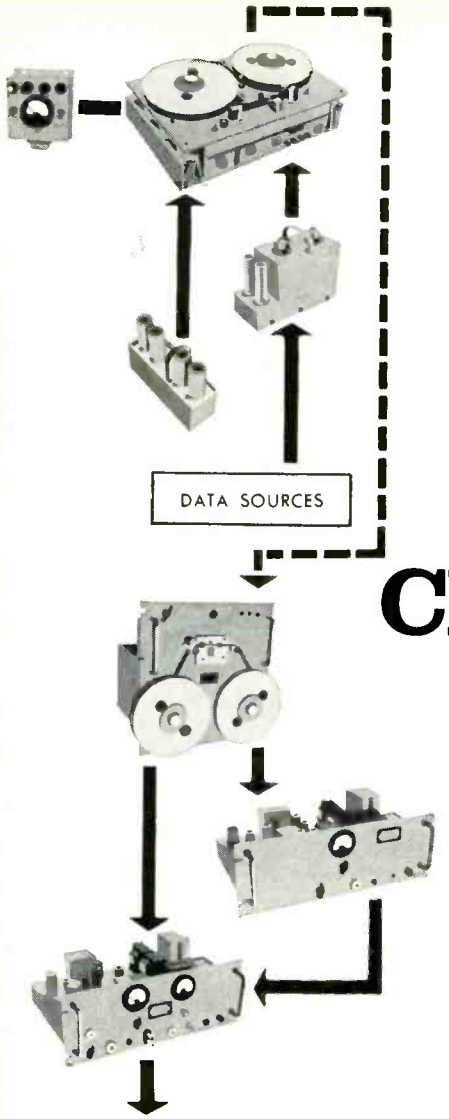
Creative careers at REL await a few exceptional engineers. Address resumes to James W. Kelly, Personnel Director.



In choosing data recording equipment, it is now feasible to tailor the equipment to present and future data handling needs. It is no longer necessary to tailor your entire program to equipment limitations.

Choosing A System

for magnetic tape DATA recording

When magnetic recording was in the audio phase of its development, there was just one recording method —direct recording. But today, several methods are available. And while direct recording is still common in audio work, it has taken a back seat to modulated carrier techniques in the more critical field of *data* recording.

To take advantage of the broad range of equipment and techniques now available, start with a thoroughgoing analysis of your own present *and future* data handling . . . data processing needs. Then, match the techniques and individual components *to those needs.*

Choose the recording method first: Direct recording is limited in data work by its poor amplitude reproduction and poor low frequency response on playback. Pulse width modulation (PWM) recording is excellent for recording a large number of channels with limited frequency response. Digital recording offers extremely high data accuracy, but relatively low information capacity.

FM recording, electronically compensated for wow and flutter, offers a combination of high overall system performance, frequency response, and information capacity, suiting it for most analog recording applications. Any or all of these methods can be supplied in the same recording system by inserting the proper plug-in circuitry.

Consider physical requirements next: Where you plan to use a system is an extremely important factor. To record data in a missile or jet, you will obviously need different equipment than would be used in a laboratory. But reel size, tape width, tape speeds, must also be selected. And heads, available for recording from 2 to 24 data tracks or even more, should be specified early. Keep in mind also the planned final disposition of the data, whether to a computer, direct writing recorder, or other equipment.

Finally, select system components and accessories: In FM carrier recording alone, you can choose from at least three recording oscillators, two reference generators, and several signal and compensation discriminators. Speed control servos, power supplies, and remote controls also require attention.

Needless to say, much of this process of selection requires special experience, and should be placed in the hands of the competent data recording systems manufacturer. But the important thing to remember is that data recording on tape is a field in itself, with special techniques and special equipment that can be matched to virtually any recording need. The day when the problem had to be tailored to the equipment is long past.

More detailed information on recording systems and equipment, and how to select them, is provided in "The Role of Magnetic Tape In Data Recording," available on request to Davies Laboratories, Inc.

Davies

LABORATORIES, INCORPORATED

4705 QUEENSBURY ROAD • RIVERDALE, MARYLAND

VOICE under the SEA

Relies on ALSIMAG®

For dependable service on the ocean floor AlSiMag precision insulators are used in the new Transatlantic Voice Cable

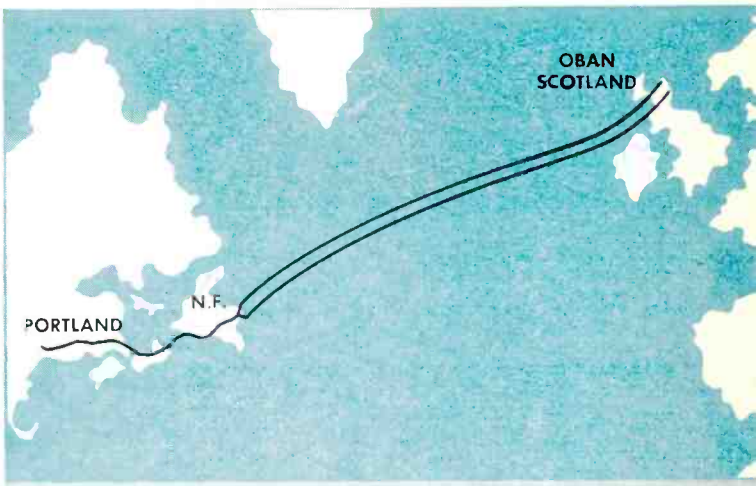
For 25 years communications engineers have studied the problems of laying a voice cable under the Atlantic Ocean to link the Americas with Europe. Today, the "voice" is nearing reality. The new link, a twin cable system, will be completed this year.

The almost incredibly exacting standards involved in making parts of the transatlantic cable have produced some truly remarkable engineering—engineering that accepts results no less than perfect. A select group of suppliers share in the achievement and AlSiMag is proud to be among them.

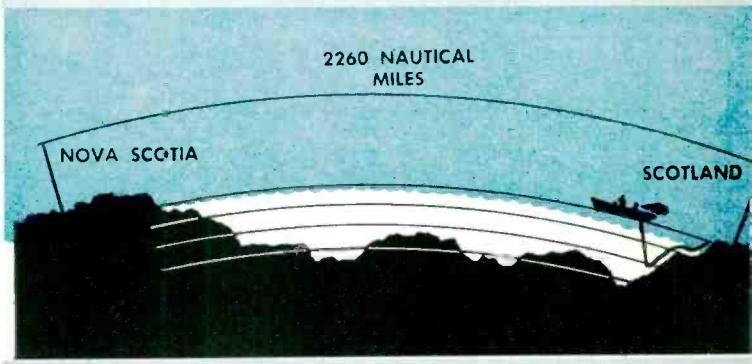
Men who perform "impossible" tasks stake their success on their creative ability plus the quality of their products. When technical ceramics are required on such critical applications, almost without exception the choice is AlSiMag. There are many reasons for this: One is the wider choice of materials available in AlSiMag. The exact composition for the required performance may be chosen from the many available . . . **right in physical characteristics, right in electrical characteristics, right in every way!**

AlSiMag performs at higher temperatures . . . withstands greater thermal shock . . . is stronger, more durable . . . permanently rigid . . . chemically inert . . . thoroughly dependable! AlSiMag can be fabricated in intricate designs to tolerances that compare favorably with precision metal work. AlSiMag will not rust, corrode or deteriorate with time. AlSiMag is the product of fifty-five years of specialized experience plus the finest production equipment . . . high speed presses, high temperature, continuous-fire kilns . . . every possible facility for the finest possible ceramics. In a wide range of shapes and sizes. Volume production or small quantity lots.

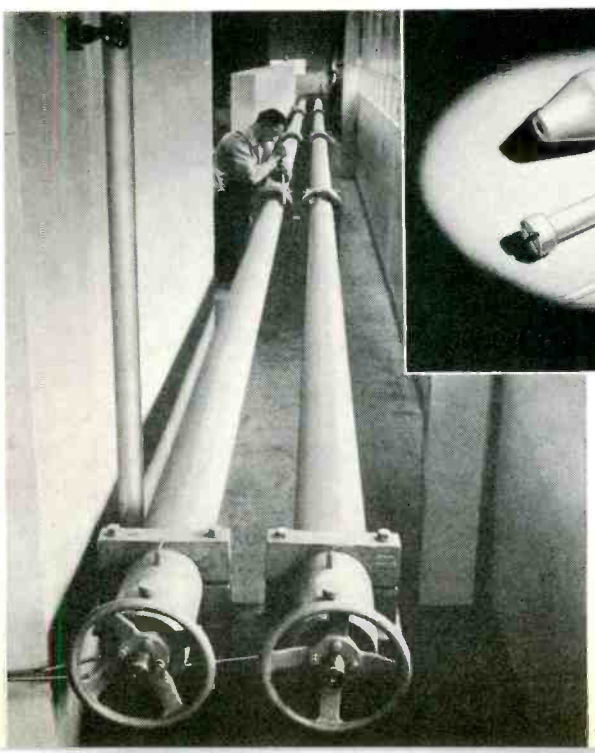
Highly technical applications, however, are not the end of the service story. AlSiMag is entirely practical . . . and vastly superior . . . for everyday industrial use. Economical, too! For any ceramic requirement, your best buy is AlSiMag. Send blueprint or sketch for full details.

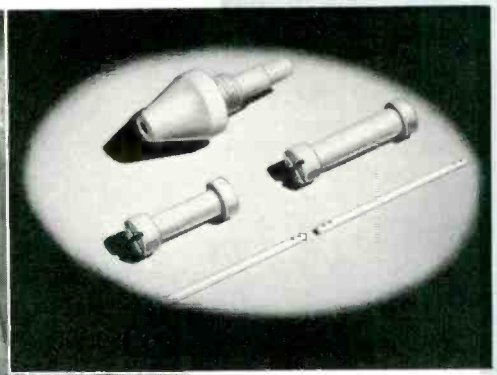


Route of transatlantic telephone cable system between Portland and Oban.



Profile of the ocean bottom on which the cable will rest.





Dependable service on the ocean floor . . . not for years but for decades . . . calls for the most careful selection of components. To be economically feasible, the repeater units must have an exceptionally long life, since to raise the cable for replacing just one repeater would be a very costly operation. In the new transatlantic cable, impulses will be relayed by a series of repeaters, built by Western Electric Co., spaced some 40 miles apart. These rugged, low-cost AlSiMag parts are components of these repeaters.

Finished repeaters, with cable leads at each end, are tested at up to 7,500 pounds a square inch in these long cylinders.

AMERICAN LAVA

CORPORATION
CHATTANOOGA 5, TENN.
55TH YEAR OF CERAMIC LEADERSHIP

A subsidiary of Minnesota Mining and Manufacturing Company

AMERICAN LAVA SALES OFFICES IN PRINCIPAL CITIES

Complete, Accurate Time-Domain Measurements with One Instrument!

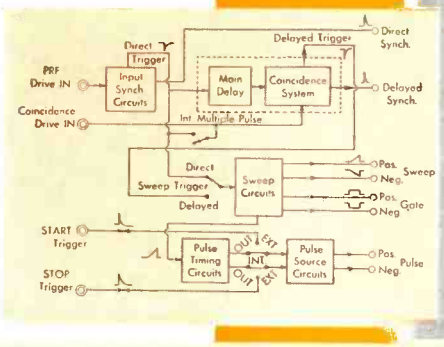
NEW GR

Pulse, Sweep and Time-Delay Generator

a High-Performance Instrument of Extreme Flexibility.

The Type 1391-A is both a measuring apparatus and generator, an instrument which is useful in many kinds of work of varying complexity. This new equipment generates pulses with a wider range of pulse durations over a greater range of repetition rates than has been previously available in a general-purpose tool of this kind. Rise and fall times average 25 milli-microseconds for all pulses, and gates and pulses available at the output are highly stable and exhibit small time jitter.

The Type 1391-A Pulse, Sweep and Time-Delay Generator takes sine wave, square wave, pulse, or other cyclic voltage — uses this signal to synchronize its delay, sweep, and pulse circuits — and makes available at the various binding posts, for your use:



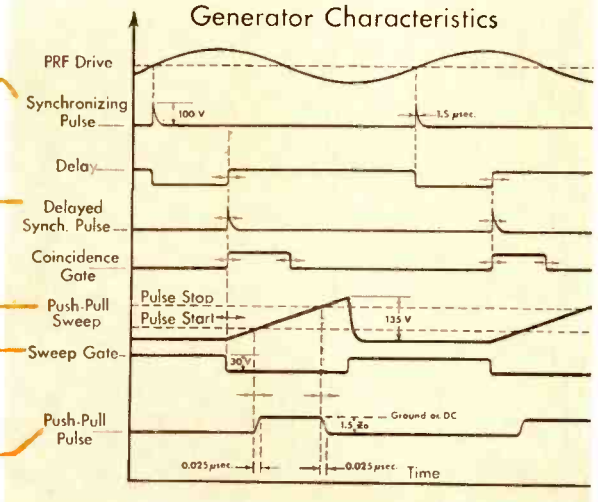
A direct-trigger pulse (or synchronizing pulse) timed by the input signal.

A delayed synchronizing pulse accurately adjustable in time by delay generator — to perform time selection, built-in coincidence circuitry permits timing of the delayed synchronizing pulse to be controlled by externally generated pulses fed into the instrument.

A push-pull sawtooth voltage of sufficient amplitude to be applied to the deflection plates of any oscilloscope for examining the generator's output pulses, or for use in driving auxiliary equipment.

A push-pull gating pulse having the same duration as the sweep.

Positive or negative pulses with excellent shape characteristics, continuously adjustable in duration, amplitude, and delay with respect to (a) the input trigger and (b) the sweep, at a variety of output impedances.



Pulse Timing

A switch and binding posts are included . . .

to make available to the user the accurately timed pulses (not shown on diagram) which start and stop the main pulse.

for starting and stopping the main pulse with externally generated timing pulses; under such operation the maximum pulse repetition rate can be extended to several Mc.

CONDENSED SPECIFICATIONS

Input System:
Accepts sine or square wave of 0.5v, p-to-p, or pulses of 10v, p-to-p, from external source to form a direct-trigger pulse.

Direct Synchronizing Pulse:
From cathode follower; positive, over 80 volts in amplitude, 1 μsec duration.

Main Delay Circuit:
Range — 1 μsec to 1.1 sec in six ranges.
Absolute Accuracy — 2%; Incremental Accuracy ±(1% + .05 μsec).
Resolution — 1 in 8800
Stable — against hum and line transients to better than one part in 10,000 at all time delays.
Duty Ratio Effects — Less than 2% error at 90% duty-ratio.
Delay Repetition Rate — 0 to 400 kc.

Coincidence Circuit
Coincidence Gate Duration — 3 to 1000 μsec.
Coincidence Amplifier — may be triggered by either pos. or neg. pulses in 5-100v range.

Delayed Synchronizing Pulse:
From cathode follower; positive, over 60 volts, 1 μsec duration.

Sweep Circuit:
Range — 3, 6, or 12 μsec to 30,000, 60,000, or 120,000 μsec in five decade ranges.
Accuracy — ±2%.
Linearity — Better than 1%.
Sweep Repetition Rate — 0 to 250 kc.
Sweep Duty-Ratio Effects — Sweep duty ratios up to 50% cause no more than 5% error in slope on shortest ranges, less effect on longer ranges.
Push-Pull Sweep Output — Cathode follower, 135v each phase.
Push-Pull Sweep Gate — Cathode follower, 40v each phase.

Push-Pull Pulse:
Pulse Duration Range — 0.05 to 2.5, 0.05 to 5.0, and 0.05 to 10 μsec, with the 3, 6, and 12 μsec sweeps respectively — five-decade sweep multiplier extends pulse duration to 100,000 μsec; interconnection with delay circuit extends max. pulse duration to 1.1 sec.
Pulse Duration Accuracy ±(1% + .05μ sec) when sweep is calibrated with "vernier" knob.
Pulse Repetition Rate — 0 to 250 kc; can be pulsed at 2 to 3 Mc with aid of suitable supplementary trigger generating equipment.
Pulse Shape — Rise and decay (0.025 ±0.01 μsec) — overshoot and ringing less than 5%.

Output Impedances:
50, 72, 94, 150, 600 ohms ±5% — intermediate values obtainable using external resistors.
Output Voltage:
150 ma current source into any output impedance from 0 to 600 ohms; voltage equals (0.150 x output impedance)
Power Supply Input:
105-125 (or 210-250) volts, 50 to 60 cycles, 385 watts.
Dimensions:
Generator, 19 x 14 x 12½ inches; Power Supply, 19 x 10½ x 12½ inches.
Net Weight:
Generator, 30 pounds; Power Supply, 40 pounds.

GR ® **GENERAL RADIO Company**

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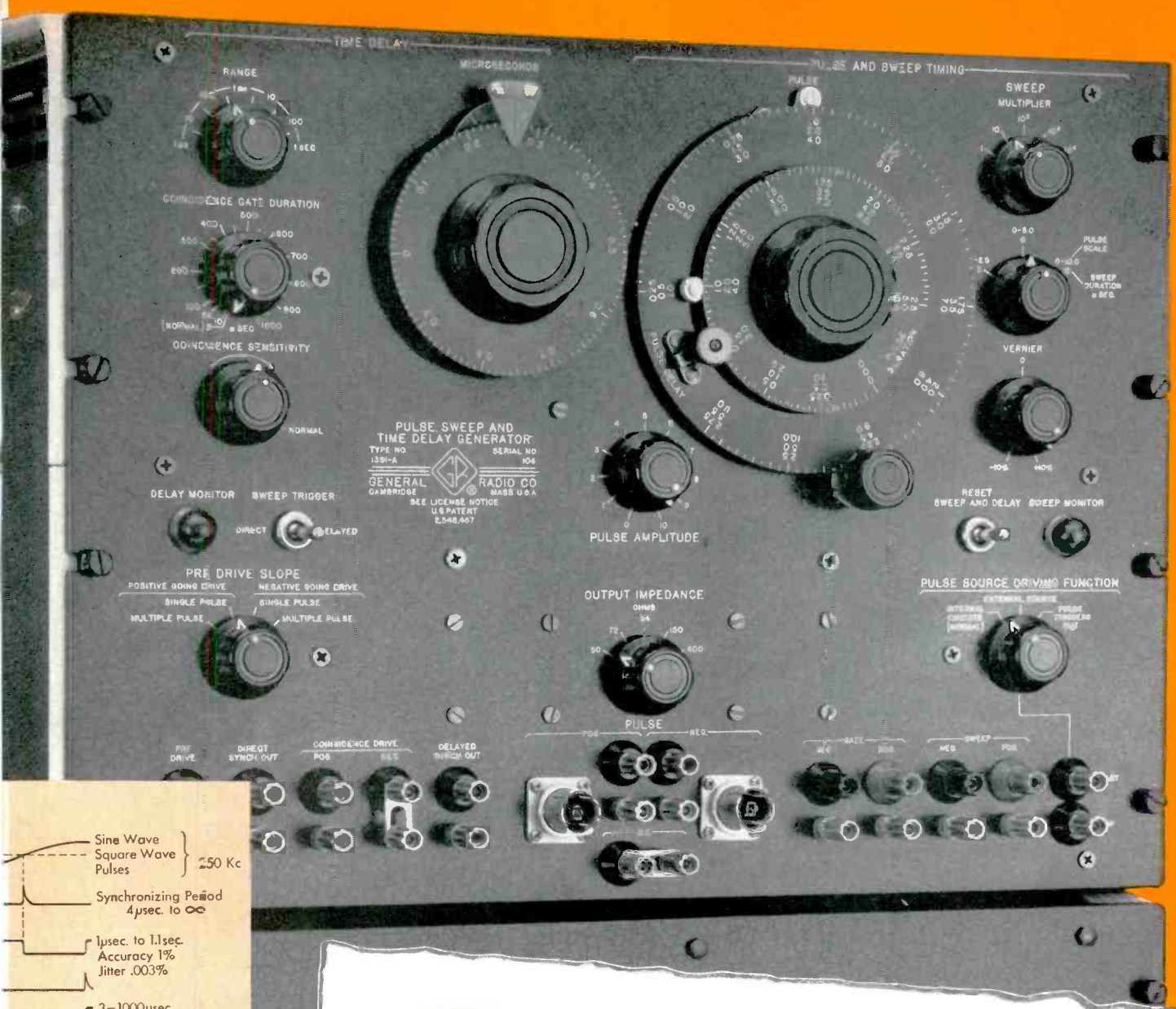


3 instruments in 1

Pulse Generator Time-Delay Generator Sweep Generator

The Most Complete Time-Domain Measuring Instrument Ever Offered.

Wide Ranges of

Pulse Duration: 0.05 μsec—1.1 sec
Pulse Repetition Rate: 0-250 kc
Time Delay: 1 μsec — 1.1 sec
Delay Repetition Rate: 0-400 kc
Output Impedance: 0-600 ohms

Superior Pulse Characteristics
Excellent Rise and Decay Times: 0.025 ±0.01 μsec. No Duty-Ratio or Frequency Restrictions on the Pulse

High Basic Timing Accuracy
Timing Scales are Linearly Calibrated and Accurate to 1%

Extreme Versatility
Panel controls for all important instrument characteristics. Binding posts provide ready access to triggers, gates, delayed signals, pulses and internal sweeps.

The New G-R Type 1391A Pulse, Sweep and Time-Delay Generator offers best performance obtainable with modern-day techniques and materials. A carefully thought-out design, developed over several years, provides the pulse specialist with the apparatus he has been seeking ever since the close of World War II.

Price, complete with Power Supply $1745

At long

150A High Frequency Oscilloscope

130A Low Frequency Oscilloscope

***-hp-* 130A Low Frequency Oscilloscope** is a versatile, accurate tool for laboratory and design work, yet its high gain, balanced input, simple operation and rugged construction make it a practical production instrument. The instrument also serves as a millivoltmeter or voltmeter.

Horizontal and vertical amplifiers are similar. Sensitivity is 1 mv/cm or 10 mv full scale deflection. Amplifiers have wide pass bands from dc to 300 KC. Input circuits are balanced on the five most sensitive ranges. Single ended input is also available, either ac or dc coupled. Both amplifiers are highly stable, and their gain may be standardized by an internal 1,000 cycle square wave source. These features, together with the instrument's precision input attenuator, permit use of the oscilloscope as a millivoltmeter or voltmeter accurate within 5%.

21 sweep times may be set and read directly. Horizontal sweeps are calibrated from 1 μsec/cm to 5 sec/cm. Accuracy is within 5%, and sweeps are highly linear.

In most cases, *-hp-* 130A will accept signals direct from a standard transducer without preamplification, presenting findings as a brilliant, high resolution trace visible under

BRIEF SPECIFICATIONS

-hp- 130A Low Frequency Oscilloscope

Sweep Range: 1 μsec/cm to 15 sec/cm.
Calibration: 21 sweeps: 1-2-5-10 sequence, 1 μsec/cm to 5 sec/cm. 5% accuracy.
Triggering: Internal, line voltage or external 2 v or more. Pos. or neg. slope, +30 to —30 v trigger range.
Preset Trigger: Optimum setting for automatic stable triggering.
Input Amplifiers: (Similar Vert. or Horiz. Amps). Sensitivity 1 mv/cm to 50 v/cm; 14 ranges plus continuous vernier. Pass band dc to 300 KC.
Amplitude Calibration: 1 KC square wave. 5% accuracy.
Price: $450.00.

-hp- 150A High Frequency Oscilloscope

Sweep Range: 0.02 μsec/cm to 15 sec/cm.
Calibration: 24 sweeps: 1-2-5-10 sequence, 0.1 μsec/cm to 5 sec/cm. 3% accuracy.
Triggering: Internal, line voltage or external 0.5 v or more. Pos. or neg. slope, +30 to —30 v trigger range.
Preset Trigger: Optimum setting for automatic stable triggering.
Horizontal Amplifier: Magnification 5, 10, 50, 100 times. Vernier

Now, more than ever, hp means "Complete

last!

Real Dependability day after day!

hp OSCILLOSCOPES

Revolutionary Convenience
Broadest Possible Usefulness

any light. A special feature of the instrument is the "universal" automatic triggering system — one preset condition which provides optimum triggering with almost any input signal.

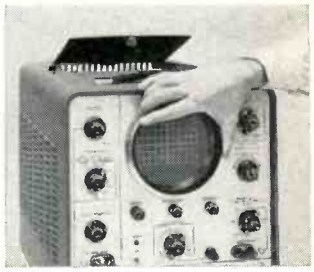
***-hp-* 150A High Frequency Oscilloscope** employs plug-in vertical preamplifiers. These include *-hp- 151A*, a high gain unit with 5 mv/cm sensitivity and frequency response from dc to 10 MC; and *-hp- 152A*, a dual amplifier permitting two phenomena to be presented on the CRT simultaneously.

Model 150A's vertical amplifier has good transient response and less than 0.035 μsec rise time, pass band dc to 10 MC. A 0.25 μsec delay line permits viewing the leading edge of the signal triggering the sweep.

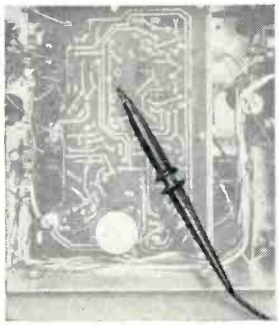
A direct reading panel control selects any of 24 calibrated sweeps. The instrument includes the "universal" triggering adjustment providing optimum triggering for almost all conditions. Model 150A also features a single-shot sweep circuit which, after "firing", remains locked out until rearmed.

The instrument's horizontal amplifier provides sweep magnification of 5, 10, 50 and 100 times. "Reminder" lamps indicate when the circuit is in use, or the combination of sweep time and magnification exceeds the maximum calibrated sweep time. The amplifier's sensitivity is 50 mv/cm to 25 v/cm, pass band dc to 500 KC.

Unitized construction. Basic circuit elements assembled as separate units. Translucent mounting boards, hinged sub-chassis for maximum accessibility.



15° turn removes bezel for filter replacement, or quick CRT interchange. Bezel provides solid camera base. Top access door permits direct CRT connections.



Voltage divider probe. New 10 μμf capacitance probe has exclusive clip-on nose; 10 megohm input impedance.

See this new -hp- equipment at WESCON Booths 1050-1051

Vertical Amplifier: Pass band dc to 10 MC. Optimum transient response and rise time less than 0.035 μsec. Signal delay of 0.25 μsec permits leading edge of triggering signal to be viewed.

Amplitude Calibration: 18 calib. voltages, 2-5-10 sequence, 0.2 mv to 100 v peak-to-peak. Accuracy 3%. Approx. 1 KC square wave, rise and decay approx. 1.0 μsec.

Prices: *-hp-* 150A High Frequency Oscilloscope, $1,000.00.
-hp- 151A High Gain Amplifier, $100.00.
-hp- 152A Dual Channel Amplifier, $200.00.
Data subject to change without notice. Prices f.o.b. factory.

hp hp hp

HEWLETT-PACKARD COMPANY
3636A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U. S. A.
Field engineers in all principal areas
Cable "HEWPACK" • DAVENPORT 5-4451

Coverage" in electronic test instruments!

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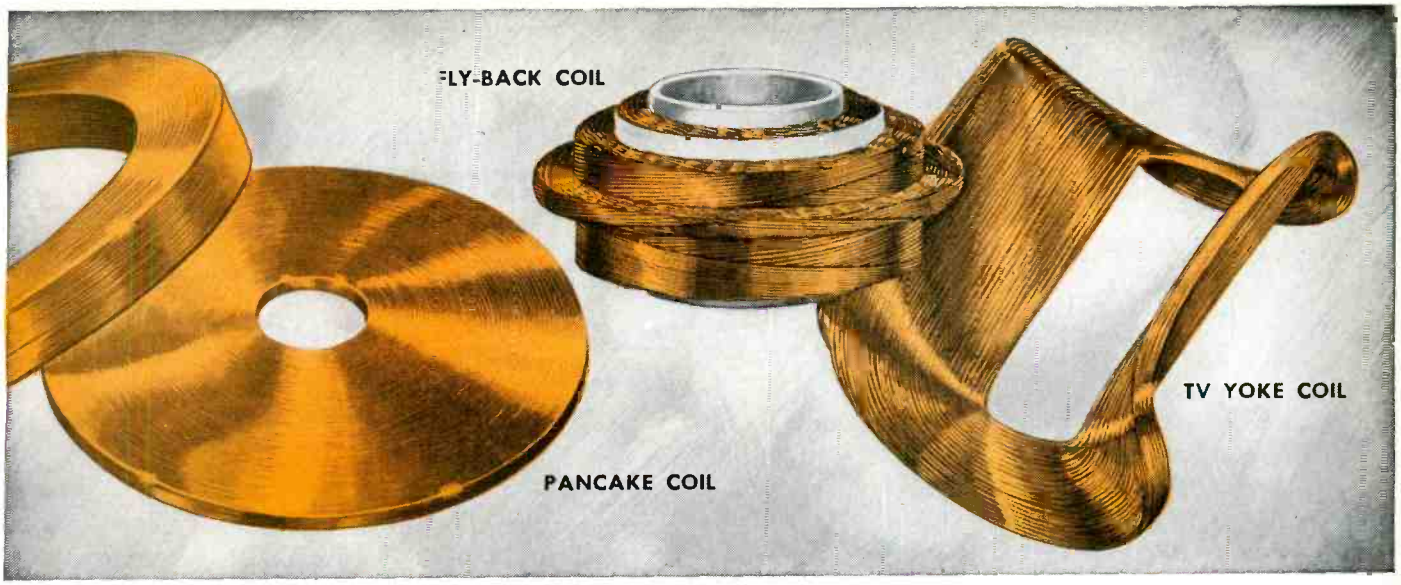


APPLICATIONS !

Redesigning? BONDEZE may provide one answer to your overall cost reduction program!

BONDEZE is Phelps Dodge magnet wire with a special thermo-plastic film applied over the insulation. It offers a quick, economical means of bonding wires together, turn to turn, through single application of heat or solvents.

BONDEZE offers unusual opportunities for redesign of windings and in many cases influences finished product design with overall savings to the user.

Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer.

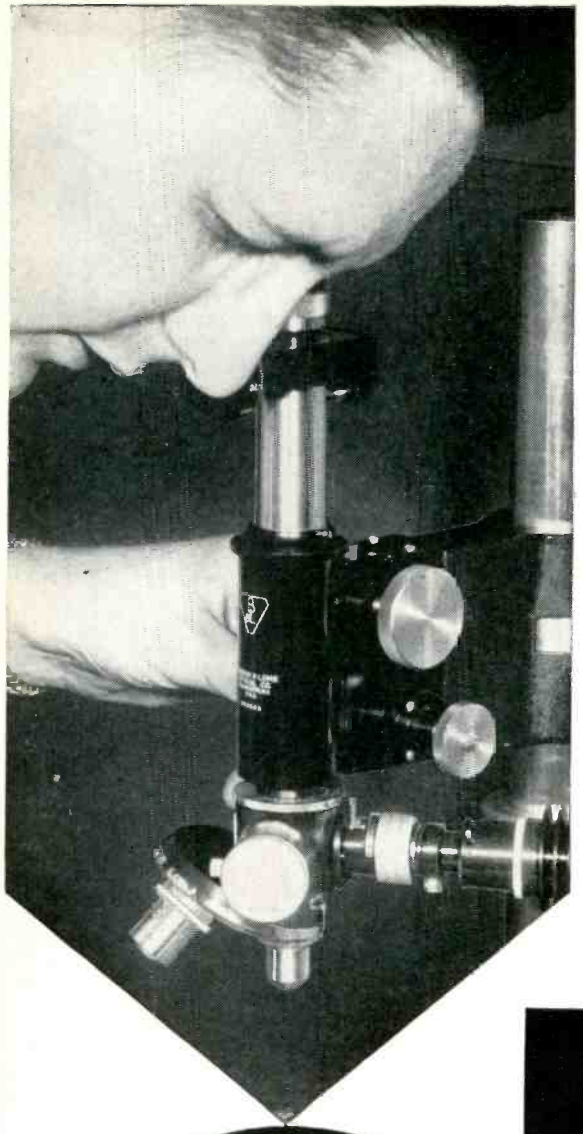
*BONDEZE is a Phelps Dodge Trademark

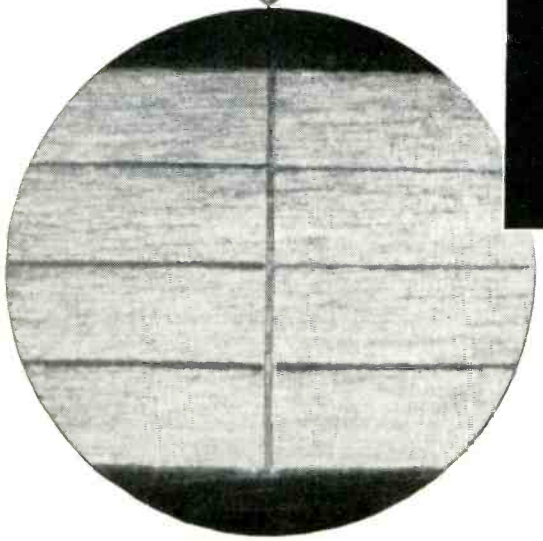
PHELPS DODGE COPPER PRODUCTS CORPORATION

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA

Want more information? Use post card on last page.





400X enlargement shows high precision gap and track construction.

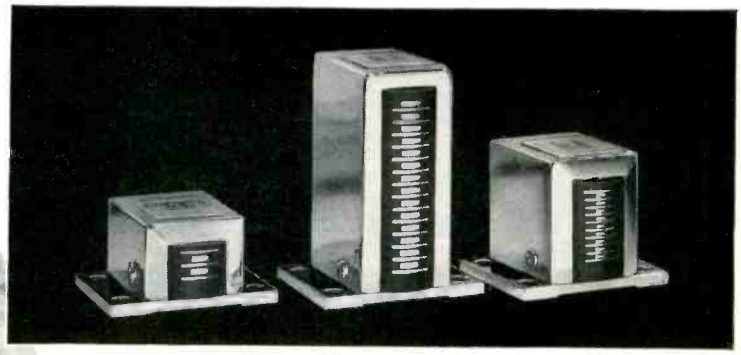
BRUSH *announces...*

NEW PRECISION MAGNETIC HEADS FOR CRITICAL RECORDING APPLICATIONS

Brush now offers a new design concept in multi-channel magnetic heads which provides extremely close tolerances to assure accuracy in recording and reproduction. These heads have already been proven in exacting airborne and missile applications.

ADVANTAGES

- **Uniform output assured by close mechanical tolerances on track width and channel spacing ... ± .002 in. maximum.**
- **Channel-to-channel timing accuracy provided by precise gap alignment... ± .0001 in. maximum.**
- **Crosstalk minimized by full shielding.**
- **Sustained accuracy under severe operating conditions assured by our new construction techniques.**



AVAILABILITY

Brush offers these heads in three designs: providing 7, 8, or 13 tracks per inch. Heads may be interlaced to provide up to 25 tracks per inch. Modifications or new designs using this construction technique may be made to your requirements. Consult Brush on your magnetic head needs—write Brush Electronics Company, Department K-8, 3405 Perkins Avenue, Cleveland 14, Ohio.

BRUSH ELECTRONICS COMPANY

3405 Perkins Avenue, Cleveland 14, Ohio

BRUSH 6 ELECTRONICS

DIVISION OF CLEVITE CORPORATION

WHERE RELIABILITY COUNTS

Automation takes many forms. In industry, electronic circuits control processes and machines to turn out products with a uniformity that results in low cost and high quality.

High speed operations that the human eye cannot follow are supervised by electronics. These applications of automatic control must be reliable to be useful.

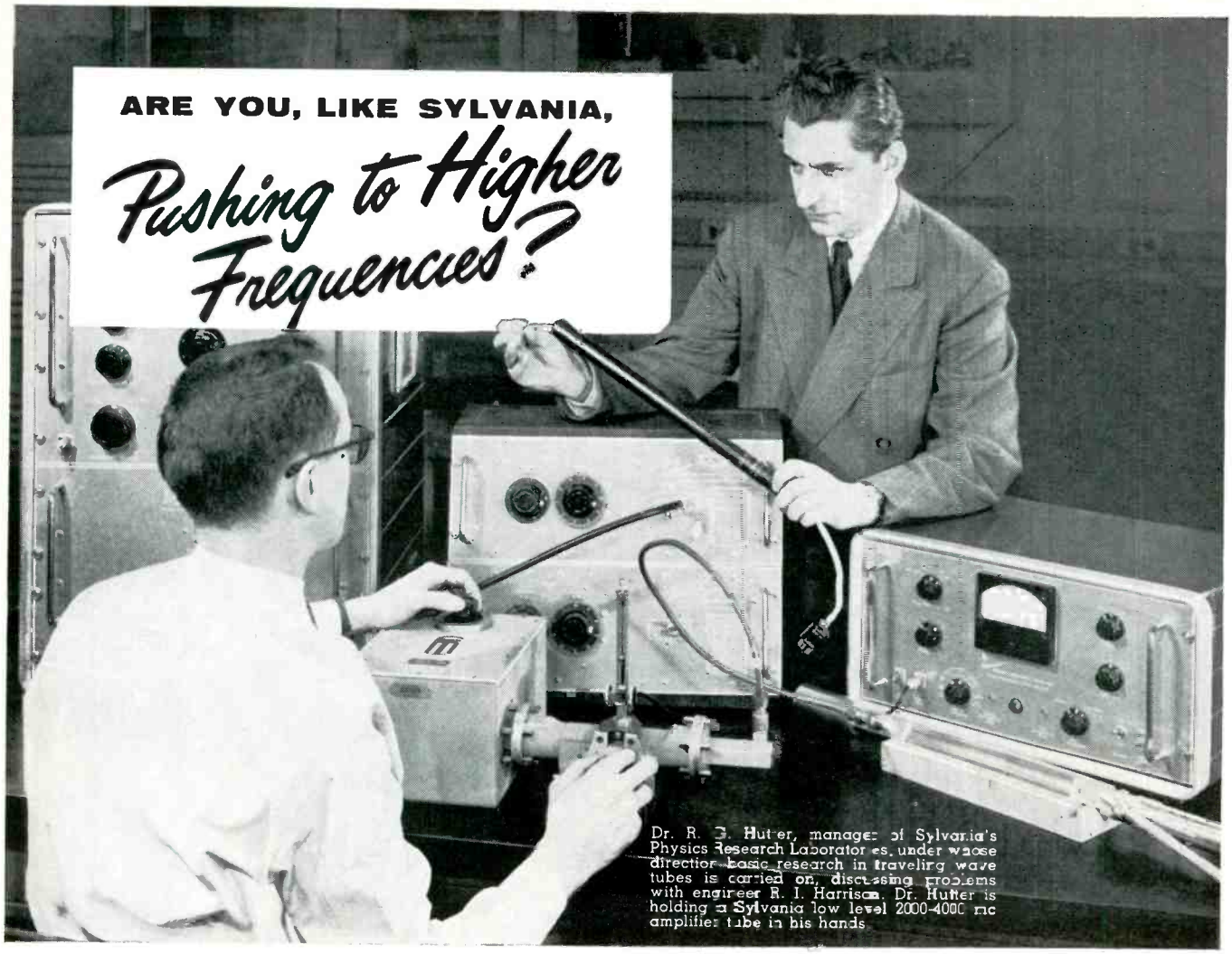
In our national defense, high reliability of electronic equipment and control devices is a necessity. The airborne fire control system computer shown here, is manufactured to standards of peak reliability for the Navy, by the Air Arm Division of Westinghouse Electric Corporation. In it Airpax choppers convert DC input signals into AC voltages for use with the computer's AC servo amplifiers. Airpax choppers are highly developed electromechanical switches that can be relied on for billions of operations.

Where you need a dependable means for changing low level signals from DC to AC, investigate Airpax choppers. For complete technical details just write to

AIRPAX

DESIGNERS ENGINEERS

MIDDLE RIVER BALTIMORE 20, MD.



When Sylvania started out on a traveling wave tube program, their research engineers specified PRD test equipment. High quality was an important factor in their choice. In addition, they wanted a line of test equipment covering a wide frequency range to take care of future developments in higher frequencies.

If you, like Sylvania, are pushing to higher frequencies, you will be interested in PRD's full coverage and especally in the –

PRD MILLIMETER WAVEGUIDE TEST EQUIPMENT

Why? Because:
1. Precision really counts with millimeter equipment
2. PRD has pioneering experience in this field
3. The equipment is available *now*.

Write for Complete Catalog A

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BROOKLYN 1, N. Y.
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Midwest Sales Office:
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ELECTRONIC DIVISION

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the brawn

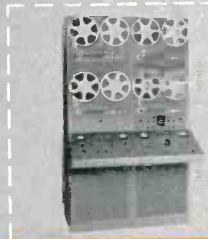
THE VISION

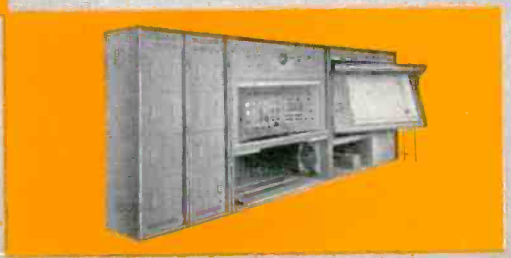
the skills

THE EXPERIENCE

the tools

INTEGRATED *for defense electronics*





OTIS . . . a proven source for research, development, manufacture and maintenance of large-scale equipment and systems in the fields of:

- missile guidance and control
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- radar and counter measures
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- communication
- special electronic devices
- computers
- ultrasonics
- servomechanisms
- magnetic amplifiers
- testing instrumentation
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For engineering achievements, rely on engineering-minded management—rely on Otis.
Write on your letterhead for 32-page history and facilities report.

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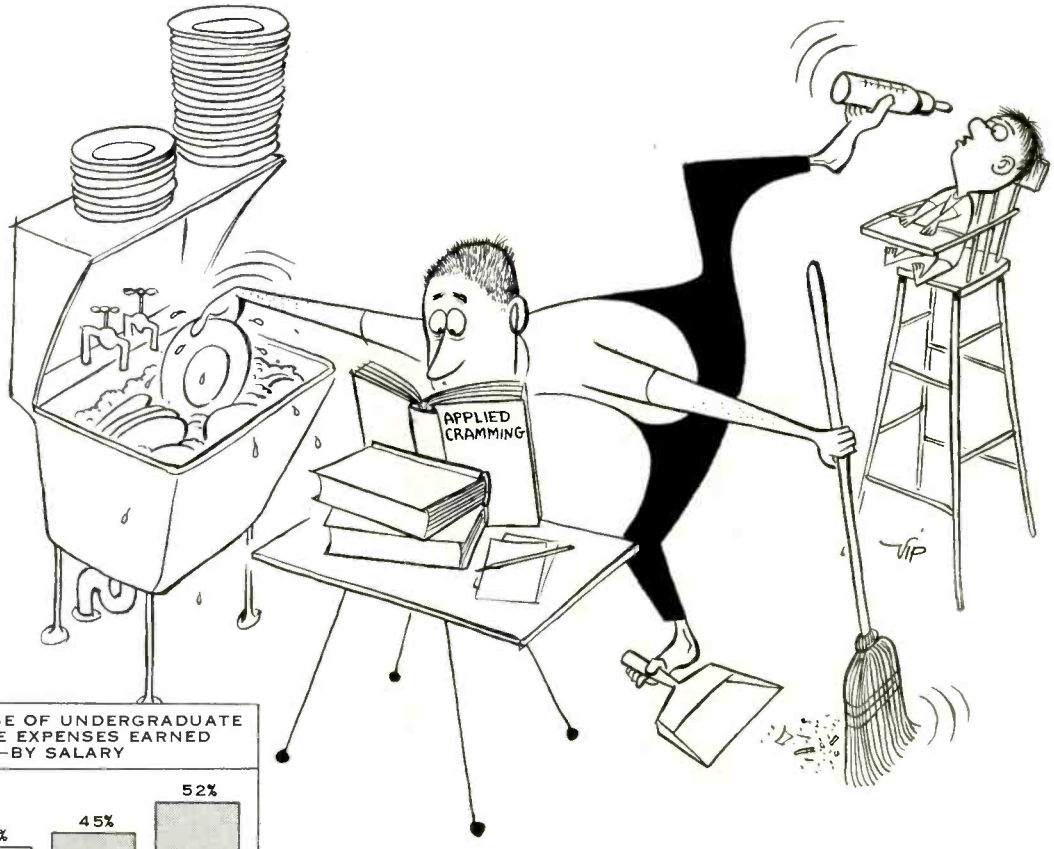
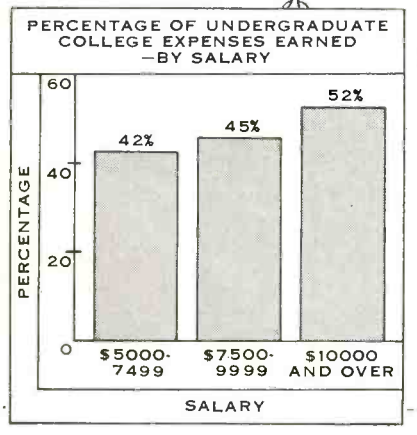
ELECTRONIC DIVISION

SIDELIGHTS ON THE SCIENTISTS *number* **5** *of a series*





Data obtained from a 20% random sample of the 2400 professional engineers and scientists on the staff of Hughes Research and Development Laboratories.

College Expenses Earned . . . and Present Salaries

The chart shown here represents the percentage of undergraduate college expenses earned—by present salaries at Hughes. The net result of this comparison is, that the higher the present salary of the individual—the more he earned while an undergraduate. College jobs included baby-sitting, "hashing", collecting laundry, lawn-mowing, car-washing, etc., etc. One scientist included in his list of college jobs—"Walking the Dean's rheumatic bulldog."

How to make $10,000 *(and up)*

Here at Hughes we have been analyzing the files of personal data regarding our scientists and engineers. Together with some additional facts cheerfully contributed by individuals, the findings reveal some interesting—and sometimes surprising—group characteristics and relationships. In this series we shall chart and attempt to interpret the results for you.

In the Hughes laboratories more than half of the engineers and scientists have had one or more years of graduate work; one in four has his Master's; one in 15 his Doctorate. Our research program is of wide variety and scope, affording exceptional freedom as well as superior facilities for these people. From every standpoint, it would be difficult to find a more exciting and rewarding climate for a career in science. Too, we are continually stepping up projects which will insure success in commercial as well as military work.

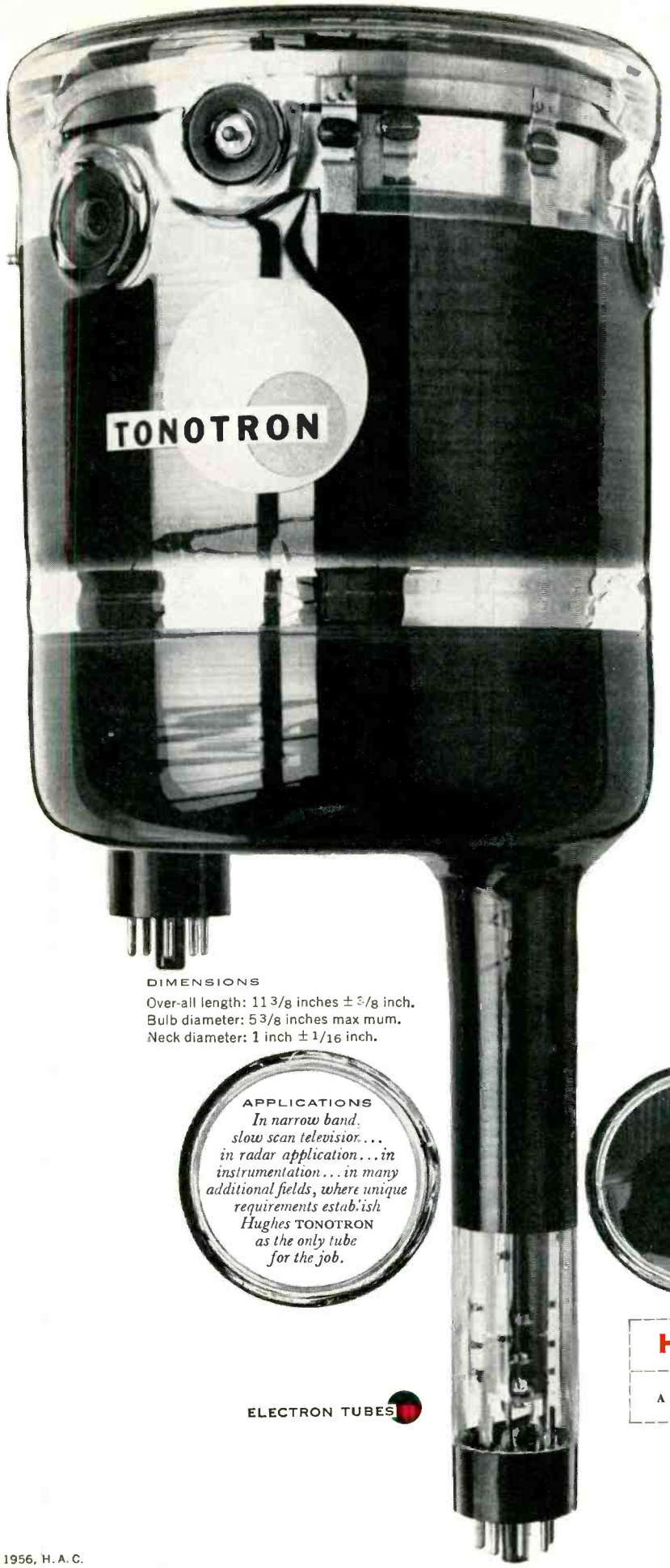
Hughes is pre-eminent as developer and manufacturer of the electronic armament control system now standard equipment on all Air Force all-weather interceptors. Our program also embraces ground systems radar, the Hughes Falcon and other guided missiles, automatic control, synthetic intelligence. Projects of broader commercial and scientific interest include research in and manufacture of semiconductors; electron tubes; digital and analog computation; data handling; navigation; production automation.

Scientific Staff Relations

HUGHES

The Laboratories now have positions open for all phases of work on ground and airborne digital computers—from logical design to production engineering. Why not write us?

RESEARCH AND DEVELOPMENT LABORATORIES
HUGHES AIRCRAFT COMPANY
Culver City, Los Angeles County, California



Hughes Products proudly announces

TONOTRON

Full circle persistence • New brilliance

Defies sunlight

Hughes Products introduces the TONOTRON, *another in its series of new, direct-display cathode ray tubes designed for commercial, industrial, and military applications.*

FEATURES

With TONOTRON, high-fidelity picture reproduction is possible for the first time. This new tube displays black, white, and *all* intermediate shades—with persistence which can be adjusted to maintain nearly maximum brilliance throughout the major portion of a 360-degree sweep. Both persistence and rate of decay can be controlled to suit a variety of specific applications. And TONOTRON's extreme brilliance makes observation possible in the brightest sunlight without a hood.

DIMENSIONS

Over-all length: 11 3/8 inches ± 3/8 inch.
Bulb diameter: 5 3/8 inches max mum.
Neck diameter: 1 inch ± 1/16 inch.

APPLICATIONS

In narrow band, slow scan television... in radar application... in instrumentation... in many additional fields, where unique requirements establish Hughes TONOTRON *as the only tube for the job.*

ELECTRON TUBES

HUGHES PRODUCTS

A DIVISION OF THE HUGHES AIRCRAFT COMPANY

For additional information, please write:
HUGHES PRODUCTS
ELECTRON TUBES
International Airport Station, Los Angeles 45, California

For Connecting Wires

In Terminal Strips

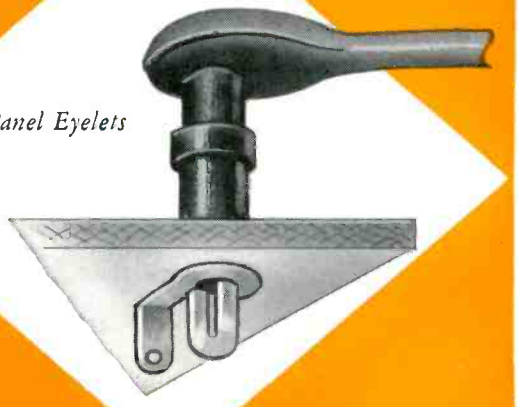
HUBBELL *Interlock*

TRADE-MARK

AUTOMATIC LOCKING — QUICK DISCONNECT

PLUGS and CONNECTORS

For Printed Circuits (Type "C")



In Panel Eyelets

Insulated

Non-Insulated

Insulated

Non-Insulated

TYPE "B" MINIATURE PLUGS AND CONNECTORS

Current Capacity: 5 Amperes
Wire Sizes: #18 to #22

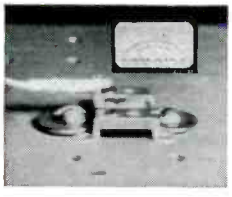
TYPE "C" SUB-MINIATURE JACKS AND CONNECTORS

Current Capacity: 1 Ampere
Wire Sizes: #20 to #22

TYPE "A" PLUGS AND CONNECTORS

Current Capacity: 10 Amperes
Wire Sizes: #14 to #18

VIBRATION PROOF!



Left: With an Interlock Plug and Jack securely mounted, test begins with platen vibrating at 10 cycles per second. Right: at 50 cycles per second, camera stops motion to show plug still locked in its jack! Tested for 18 hours at an amplitude of .06 inch and at a varying frequency from 10 to 50 to 10 cycles per second, conductive quality remained steady with no current interruption during vibration.

For Further Information, Write Dept. C:

HARVEY HUBBELL, INC.

Interlock Electronic Connector Dept., Bridgeport 2, Conn.

HUBBELL REG. U.S. PAT. OFF.

SELF-LOCKING HUBBELL CONNECTORS Pats. & Pdg. Pats.

RUGGED, LONG LIFE EIMAC 4X5000A CERAMIC TETRODE DELIVERS 10kw FOR SINGLE SIDEBAND

4X5000A RADIAL-BEAM POWER TETRODE
TYPICAL OPERATION
FREQUENCIES BELOW 30 mc.

	Class C CW	Class AB* R-F Linear Amplifier
D.C Plate Voltage	7500 v	7500 v
D-C Screen Voltage	500 v	1250 v
D-C Grid Voltage	−350 v	−300 v
D-C Plate Current	2.8 amps	1.9 amps
Driving Power	150 w	0 w
Plate Dissipation	5 kw	4.2 kw
Plate Power Output	16 kw	10 kw

*Class AB figures shown are under Peak Envelope or Modulation Crest Conditions.

Top Single Sideband performance plus the advantages of great immunity to damage by thermal or physical shock are combined in the metal and ceramic Eimac 4X5000A radial-beam power tetrode.

Developed especially for Single Sideband communication systems the 4X5000A delivers 10kw power output and has a maximum plate dissipation rating of 6000 watts. High output is easily developed without going into the positive grid region.

A unique integral-finned anode permits the 4X5000A to be cooled with low air pressures. Simple coaxial construction provides low inductance multiple terminals.

Now available for optimum socketing and cooling of the 4X5000A is the Eimac SK300 air-system socket.

For further information about the 4X5000A and its companion socket write our Application Engineering Department.

Eimac

EITEL-McCULLOUGH, INC.
SAN BRUNO CALIFORNIA
The World's Largest Manufacturer of Transmitting Tubes

William H. Roberts, Supervisor of Tantalytic Capacitor Engineering, and active member of the I.R.E., holds actual size Tantalytic capacitor against its greatly enlarged cut-away counterpart.

Since 1949, Roberts has worked continuously on foil-type, tantalum electrolytic capacitors, which he helped develop to their present stage of dependable performance.

BILL ROBERTS TELLS YOU WHY...

Tantalytic* capacitors outperform ordinary tantalum capacitors

*General Electric's registered trade mark for its tantalum electrolytic capacitors

"We're not going to tell people *how* we build Tantalytic capacitors," says Engineer W. H. "Bill" Roberts. "We've spent ten years in getting the answers. But we can tell them that those ten years have taught us a lot about tantalum, enough to enable us to build the best tantalum capacitor on the market.

"When Lee Foster and I along with chemists Al Jenny and Ralph Ruscetta attacked the tantalum problem, we knew that tantalum was rare (54th in occurrence in the earth's crust), that it was a valve-forming metal (its oxide forms a good dielectric), and that it was hard to isolate (its melting point is 2950C, just below tungsten).

"Basic research and hard work—we built hundreds of capacitors by hand in our pilot shop—led us to the development of 1. Fine gauge tantalum foil; 2. A hard, porous oxide; 3. The roll-crimp case; 4. The first successful etching process for tantalum. These four developments alone have made the Tantalytic capacitor the smallest, highest rated, most rugged, and most versatile in performance of its type."

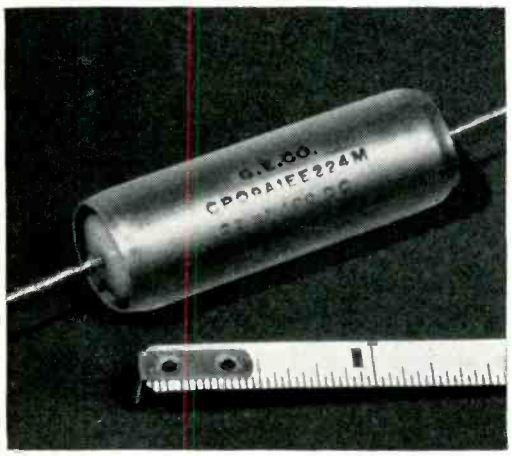
In other types of capacitors, the same kind of engineering teamwork has been applied and has now resulted in General Electric's new subminiature metal-clad tubular capacitor (pictured below) with mineral oil impregnant. This latest addition to General Electric's subminiature line is designed to meet MIL-C-25A specifications.

The new mineral oil unit is designed for "workhorse" applications in military electronic circuits. The superior Kovar glass-to-metal sealing process is highly resistant to oil leakage and moisture penetration.

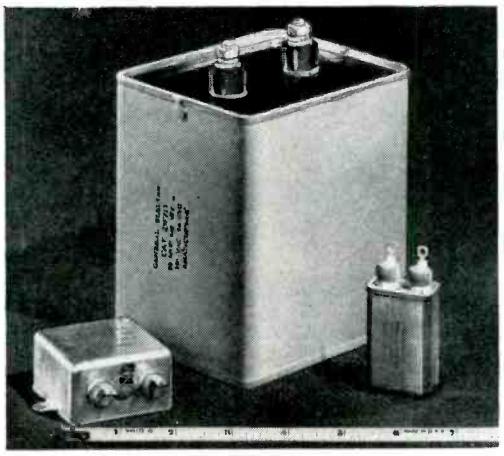
Your General Electric Apparatus Sales Engineer has complete up-to-date buying information on mineral oil tubular capacitors. For assistance with your specific capacitor applications, just contact him or write to the General Electric Company, Section 442-37, Schenectady 5, New York.

Progress Is Our Most Important Product

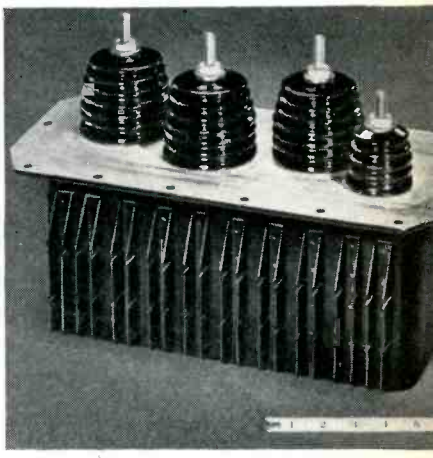
GENERAL ELECTRIC



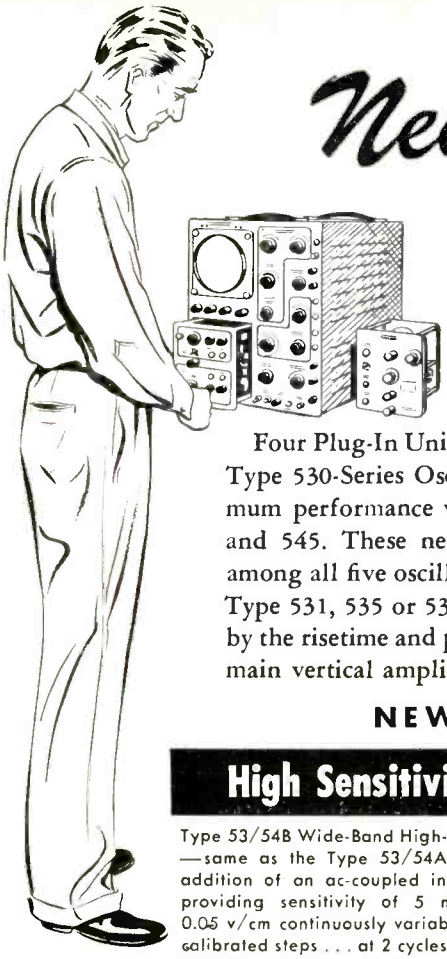
METAL-CLAD TUBULAR CAPACITORS——85C, mineral oil impregnated. Built to MIL-C-25A. Ratings: .001 to 1.0 uf, 100–600 v. d-c. Tol: ±5%, ±10%, or ±20%. Write for GEC-1390.



MIL-C-25A CAPACITORS—for filter, by-pass, and blocking in military equipment. Ratings: .05 to 15 uf at 100 to 12,500 v. d-c in case styles CP50, CP60, CP70 series. Temp. range: −55C to +85C, and −55C to +125C. Write for GEC-810.



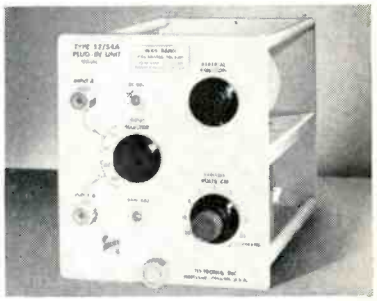
CAPACITOR PULSE FORMING NETWORKS—for missiles and radar equipment. Capacitance tolerance: ±7% (at +25C). Temperature range: −55C to +125C. Write for GEA-4996.



New TEKTRONIX® OSCILLOSCOPE PLUG-IN UNITS

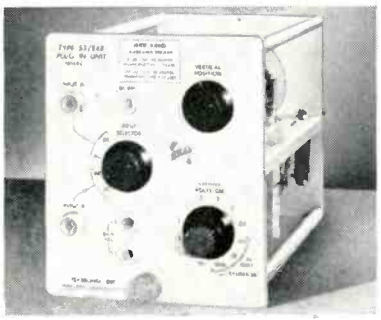
Plug-In Preamplifiers for Tektronix Types 541, 545, 531, 532, 535

Four Plug-In Units with excellent performance records in the Type 530-Series Oscilloscopes have been redesigned for maximum performance with the fast-rise Oscilloscopes, Types 541 and 545. These new Type 53/54 Units are interchangeable among all five oscilloscopes in both series. When used with the Type 531, 535 or 532, however, overall performance is limited by the risetime and passband characteristics of the oscilloscope's main vertical amplifier.



NEW PLUG-IN UNITS

High Sensitivity



Type 53/54B Wide-Band High-Gain Unit—same as the Type 53/54A with the addition of an ac-coupled input stage providing sensitivity of 5 mv/cm to 0.05 v/cm continuously variable, with 3 calibrated steps . . . at 2 cycles to 12 mc, 0.03-μsec risetime with Types 541 and 545 . . . 2 cycles to 9 mc, 0.04-μsec risetime with Types 531 and 535 . . . 2 cycles to 5 mc, 0.07-μsec risetime with Type 532. Price $125.

Wide Passband

Type 53/54A Wide-Band DC-Coupled Unit—dc to 20 mc, 0.018-μsec risetime with Types 541 and 545 . . . dc to 10 mc, 0.035-μsec risetime with Types 531 and 535 . . . dc to 5 mc, 0.07-μsec risetime with Type 532. Sensitivity 0.05 to 50 v/cm; ac or dc, continuously variable, with 9 calibrated steps from 0.05 to 20 v/cm. 60-db isolation between two input connectors. Price $85.

OTHER PLUG-IN UNITS

Three other Plug-In Preamplifiers are also interchangeable among all five oscilloscopes.

Fast Rise

Type 53/54K—risetime 12 millimicroseconds, passband dc to approximately 30 mc with Types 541 and 545 . . . 0.031-μsec, dc to 11 mc with Types 531 and 535. Calibrated sensitivity from 0.05 v/cm to 20 v/cm. Input capacitance 20 μμf direct, 8 μμf with 10x (P410) probe. Price **$125**

Millivolt Sensitivity

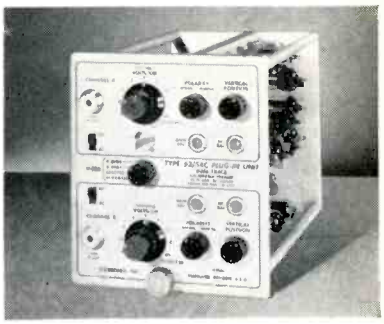
Type 53/54D—passband dc to 350 kc at 1 mv/cm sensitivity, increasing to dc to 2 mc at 50 mv/cm sensitivity. Calibrated range, 1 mv/cm to 50 v/cm. Differential input, high rejection ratio. Price . . **$145**

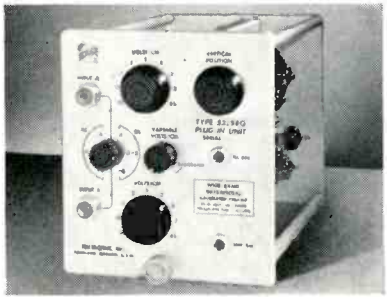
Microvolt Sensitivity

Type 53/54E—sensitivity 50 microvolts/cm to 10 millivolts/cm in 8 calibrated steps. Frequency response 0.06 cycles to 30 kc at full gain, increasing to 0.06 cycles to 60 kc at 0.5 mv/cm. Differential input, high rejection ratio. Price **$165**

Two Channels

Type 53/54C Dual-Trace DC Unit—two identical amplifier channels, each with passband and risetime of . . . dc to 24 mc, 0.015-μsec with Types 541 and 545 . . . dc to 10 mc, 0.035-μsec with Types 531 and 535 . . . dc to 5 mc, 0.07-μsec with Type 532. Sensitivity 0.05 to 50 v/cm continuously variable, with 9 calibrated steps from 0.05 to 20 v/cm. Electronic switching triggered by sweep, or tree-running at about 100 kc. Input capacitance 20 μμf direct, 8 μμf with 10x (P410) probe. Price $275.





Differential Input

Type 53/54G Wide-Band Differential DC Unit—dc to 20 mc, 0.018-μsec risetime with Types 541 and 545 . . . dc to 10 mc, 0.035-μsec risetime with Types 531 and 535 . . . dc to 5 mc, 0.07-μsec risetime with Type 532. Sensitivity 0.05 to 50 v/cm continuously variable, with 9 calibrated steps from 0.05 v to 20 v/cm. Rejection better than 100 to 1 at full gain for entire passband, 300 to 1 at 60 cycles. Price $175.

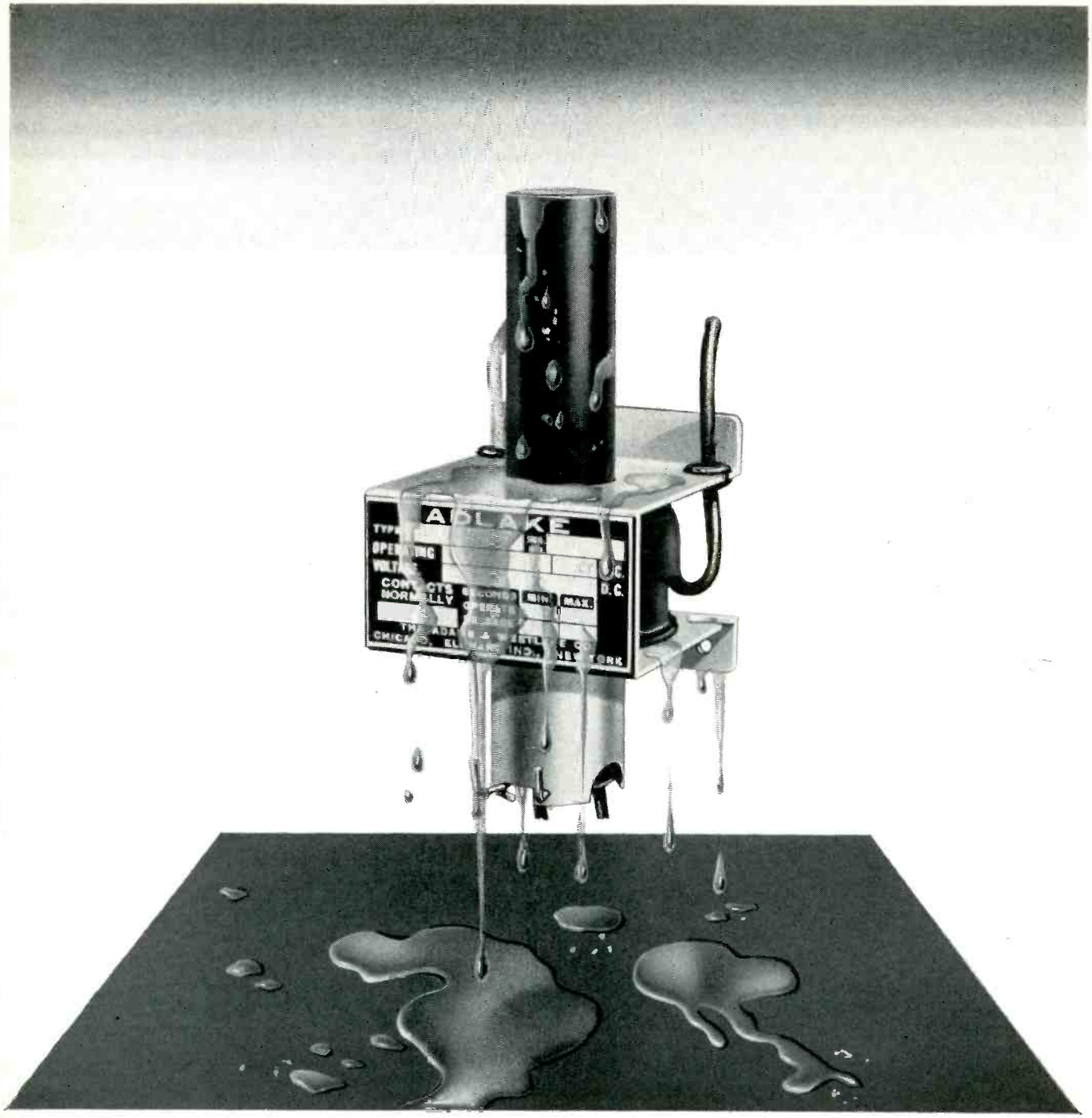
See these new **Plug-In Units** with Type 530-Series and Type 540-Series Oscilloscopes at **WESCON** August 21-24.

Tektronix, Inc.

P. O. BOX 831 • PORTLAND 7, OREGON

Phone CYpress 2-2611 • TWX-PD 265 • Cable: TEKTRONIX

ENGINEERS—interested in furthering the advancement of the oscilloscope? We have openings for men with creative design ability. Please write to Richard Ropiequet, Vice President, Engineering.



If moisture troubles your controls... it'll pay you to use

Adlake mercury relays

Adlake relays require no maintenance whatever...are quiet and chatterless...free from explosion hazard. Dust, dirt, moisture and temperature changes can't affect their operation. Mercury-to-mercury contact gives ideal snap action, with no burning, pitting or sticking. Time delay characteristics are fixed and non-adjustable.

For more information about Adlake Relays, write The Adams & Westlake Company, 1171 N. Michigan, Elkhart, Indiana

SEE
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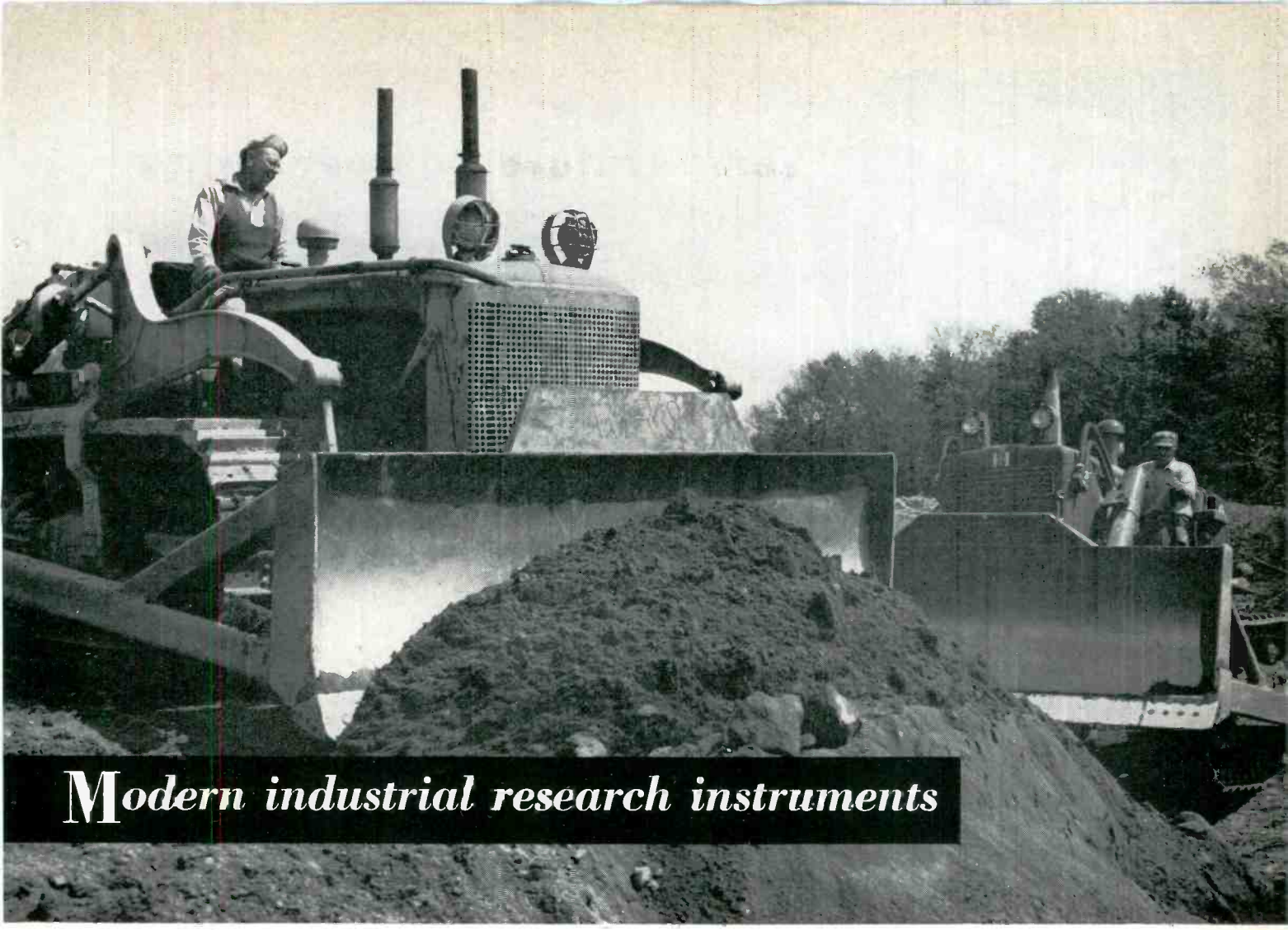
AT BOOTH 305
Eleventh Annual Instrument Automation Conference & Exhibit
Coliseum, New York City
Sept. 17 to 21, 1956

The Adams & Westlake Company

Established 1857 • ELKHART, INDIANA • New York • Chicago
the *original* and largest manufacturers of mercury plunger-type relays

Adlake
99th year
of serving the transportation building and control industries



Modern industrial research instruments

THESE seven-ton bulldozers are truly research tools, for they are taking part in an exhaustive program for the study and revision of accepted methods of oscillographic recording system design and manufacture.

Yes, Sanborn Company is on the move! The instruments above are levelling off small mountains of earth and rock in preparation for a new and modern Sanborn plant near Boston, Mass.

Completion of the structure late this year will mean vastly improved facilities for research, manufacturing and other operations. This will directly and immediately benefit not only the work Sanborn does, but also the people who use Sanborn systems, amplifiers, recorders and other components. It will make possible more rapid development and production of new instruments, and increased opportunity for a larger number of people to apply their skills to the problems of modern instrument design and manufacture.

This represents not "just a new plant", but a reflection of Sanborn's growing role in providing better answers to industry's oscillographic recording needs.

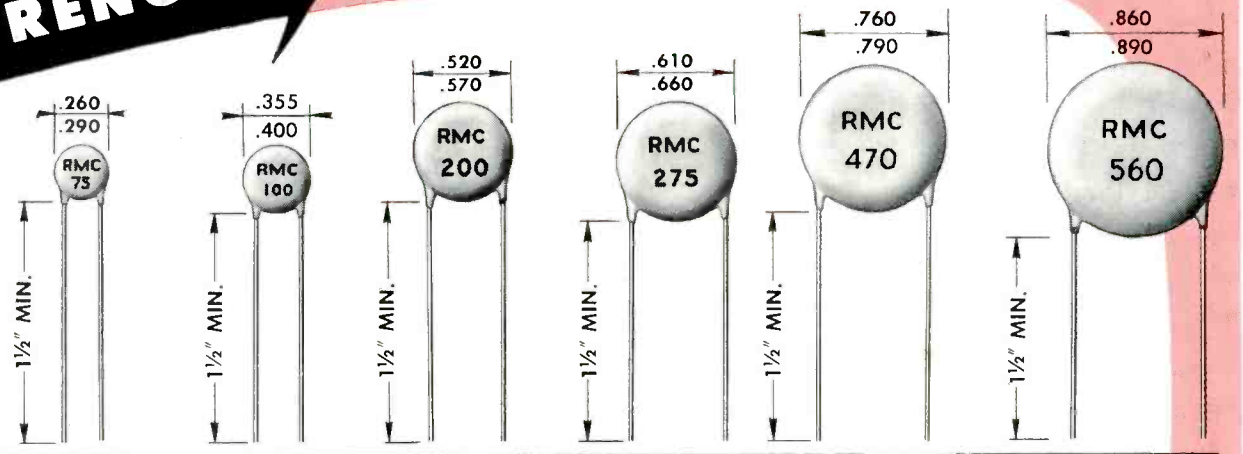
Sanborn Company, Industrial Division, Cambridge 39, Massachusetts

Scale model of new Sanborn plant just off Route 128 in Waltham, Mass.

Greater STABILITY
Smaller SIZE
Greater STRENGTH

Temperature Compensating

RMC DISCAPS



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- 20 MMF	—	—	—
NPO	2- 13	14- 29	30- 69	70- 85 MMF	86-115 MMF	116-150 MMF
N- 33	2- 13	14- 29	30- 56	57- 62	63-100	101-150
N- 75	2- 14	15- 27	28- 56	57- 68	69-110	111-150
N- 150	2- 15	16- 30	31- 68	69- 75	76-140	141-150
N- 220	3- 15	16- 30	31- 75	76- 90	91-130	131-190
N- 330	3- 15	16- 30	31- 75	76-100	101-150	151-190
N- 470	3- 20	21- 40	41- 80	81-120	121-200	201-240
N- 750	5- 29	30- 68	69-150	151-180	181-300	301-350
N-1500	15- 50	51-120	121-200	201-250	251-330	331-560
N-2200	47- 75	76-150	151-200	201-275	276-470	471-560

Temperature coefficients up to N-5200 available on special order.

SPECIFICATIONS

POWER FACTOR: Over 10 MMF less than .1% at 1 megacycle. Under 10 MMF less than 2% at 1 megacycle.

WORKING VOLTAGE: 1000 V.D.C.

TEST VOLTAGE (FLASH): 1750 V.D.C.

CODING: Capacity, tolerance and TC stamped on disc

INSULATION: Durez phenolic-vacuum waxed

INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms

AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms

LEADS: No. 22 tinned copper (.026 dia.)

TOLERANCES: ±5% ±10% ±20%

These capacitors conform to the RTMA specification for Class 1 ceramic condensers.

The capacity of these condensers will not change under voltage.

RMC Type C temperature compensating DISCAPS are universally recognized as the ideal money-saving replacement for tubular ceramic and mica capacitors. Rated capacities will not change under voltage. Smaller size permits compact circuit designs. Greater mechanical strength assures rugged assemblies and lower costs in production line operations. Rated at 1000 working volts, Type C DISCAPS are available for a wide range of applications and cost no more than ordinary 600 volt capacitors.

Whatever your ceramic capacitor problem, standard or specialized, RMC engineers are prepared to solve it for you. Take advantage of a wealth of experience by writing today

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS CORPORATION

GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.

Two RMC Plants Devoted Exclusively to Ceramic Capacitors

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

THE SHORTAGE OF SCIENTISTS AND ENGINEERS:

A Threat to Economic Progress

THERE are two paramount reasons for concern over the serious shortage of scientists and engineers that now confronts the United States:

- The first reason, with which this editorial deals, is that continued expansion of our economy and further increases in our living standards are threatened unless we train more scientists and engineers and use them more effectively.
- The second reason for concern is that we run the risk of falling behind the Soviet Union in the technology so essential to national security. The consequences of losing this race to the Russians are not comforting. (The possibility that this might happen over the next few years was discussed in an earlier editorial in this series.)

The crucial contribution of scientists and engineers to the well-being of the American people has been to find ways of making better use of limited resources, to make equipment more productive, to develop new and better products that enrich our lives, to enable us to live longer and be healthier. They have made this contribution with greater success in the last 15 years than ever before, but it has required progressively more resources and more trained people.

During this 15-year period our annual production of goods and services, in dollars of constant purchasing power, has almost doubled. Since our total population has increased only 25 percent, this has meant a tremendous rise in the economic well-being of the American people as a whole. But in accomplishing this, the number of scientists and engineers has been more than doubled.

Tasks for Research

If the American economy is to continue to grow and if our living standards are to show further improvement, the work of scientists and engineers must be stepped up even more in the years ahead. Unless answers to several pressing problems are found through intensified research efforts, economic progress will become increasingly more difficult.

Productivity per hour of labor must be increased at a faster rate. Improved medical care has greatly increased the number of people who attain retirement age, and sharply higher birth rates since the war will mean larger numbers of children in school and college. Meantime, because of low birth rates during the depression, the number of people reaching working age is not rising nearly so fast. The result is that over the next 20 years our population will increase by about one-third, while the total manhours worked are not expected to increase more than 15 percent. So, simply to maintain the same living standards for a rising population — with no provision for additional improvements — ways must be found to enable each worker to produce for more dependents.

It is primarily to the scientists and engineers that we must look for help in making human labor more productive. This will require enormous increases in our power

resources. We will need to make more effective use of our existing fuel supplies — coal, oil and natural gas. And we will have to devise economically practical means of tapping other energy sources, particularly nuclear power and new rocket fuels.

Also, better ways must be found to use scarce and low-grade raw materials. Thanks to great strides in metallurgy and mining techniques, we are now utilizing sources of copper and iron ore that, for all practical purposes, were not available to us only ten years ago. Similar strides are needed in the mining and processing of bauxite if low-grade domestic ores are to help satisfy a fast-growing market for aluminum. And stubborn technical obstacles in the area of "high temperature" metals—such as nickel, cobalt, columbium, tantalum and titanium — are impeding progress in jet and turbine engines.

These are only a few of the challenging tasks that demand intensified research and engineering activity in the years immediately ahead if the United States is to continue to raise living standards. We need more houses, schools and highways for a rising population, more medical research to reduce further the ravages of illness, more research in chemistry and other sciences to sustain the flow of new and improved products that are so essential an ingredient of our economic progress.

Ceiling on Growth

American industry has indicated that it is ready to meet the challenge and undertake vastly expanded research programs. A recent survey conducted by the McGraw-Hill Department of Economics revealed that total research and development expenditures of American industry were almost $5 billion last year, 29% higher than in 1953. By 1959 business plans to be spending well over $6 billion on research and development. And the total could well prove to be much higher, based on the trend of recent years.

But industry's programs for research and development cannot be carried out unless enough qualified research workers and engineers are available. Ernest R. Breech, chairman of the Ford Motor Company, recently described the supply of engineers as the "ceiling on our future growth." He gave force to his point by announcing: "If 900 qualified engineers were to approach us next week looking for jobs, we would hire every one." The U. S. Bureau of Labor Statistics found in interviews with some 200 large companies at the end of 1954 — a recession year — that at least half were unable to hire enough research scientists and engineers to meet their needs. A third of the companies reported substantial shortages of technical personnel.

The shortage of technically trained people, furthermore, is becoming more acute. The number of engineers and scientists now being graduated is only about enough to cover replacement requirements, while the needs of industry, government and education are mounting every year. According to the best information available — as indicated in the first editorial in this series — these needs are now about twice as great as our current engineering graduating classes and annual production of scientists with Ph. D. degrees.

To perform the research needed to remove roadblocks to our economic progress — and at the same time hold our own in the technology essential to our security as a free nation — we must have an adequate supply of men and women with engineering and scientific training. Instead, we are faced with an acute shortage, now and for several years to come. Reasons for the shortage and proposals for working our way out of the shortage will be discussed in the remaining two editorials in this series.

Transitron

SILICON DIODES

HIGH CONDUCTANCE

RATINGS AT 150° C

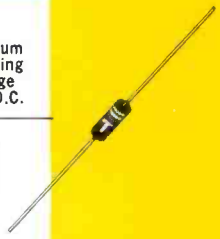
Type	Maximum Average Forward Current ma	Continuous Inverse Operating Voltage Volts D.C.	Minimum Saturation Voltage Volts
IN484B	50	130	150
IN486A	50	225	250
IN488A	50	380	420
IN457	25	60	70
IN458	25	120	135
IN459	25	180	180

HIGH FREQUENCY

SPECIFICATIONS AT 125° C

Type	Forward Current At + 1 V ma	Inverse Current At Specified Voltage ua at Volts	Maximum Operating Voltage Volts D.C.
IN252	10	10 @ - 5	20
JN251	5	10 @ - 10	30
S9G	2	10 @ - 20	40

Typical Shunt Capacitance: 0.8 uufd
Typical Pulse Recovery time: 0.15 usec
Operating Frequency Range: 0-1000 mc



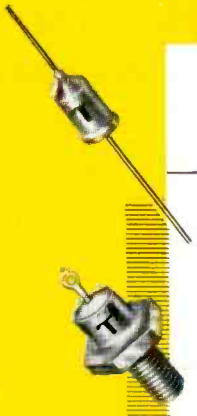
Write for Bulletin TE-1350

THE PROVEN PERFORMANCE of Transitron's silicon rectifiers and diodes has led to their widespread use in critical high temperature applications. The large number of types available allows optimum design for any given circuit.

For low level power supply or magnetic amplifier service, the subminiature diodes or miniature rectifiers are recommended. For higher power requirements, the stud-mounted rectifiers provide up to 30 KW.

SILICON RECTIFIERS

UP TO 35 AMPS AT 150°C



RATINGS AT 150° C

	Maximum Average Forward Current Amps	Peak Recurrent Inverse Voltage Volts	RMS Inverse Voltage Volts
Miniature (Pig Tail Leads)			
TJ10A	0.2	100	70
TJ20A	0.2	200	140
TJ40A	0.2	400	280
Military Types			
IN253*	1.0	100	70
IN254*	0.4	200	140
IN255*	0.4	400	280
IN256*	0.2	600	420
Medium Power Types			
IN249A	20	100	70
IN250A	20	200	140
TR352	20	350	250
High Power Types			
IN412A	35	100	70
IN413A	35	200	140
TT352	35	350	250

* JAN types Rated at 135° C

Write for Bulletin TE-1351

WESCON SHOW
BOOTH 903

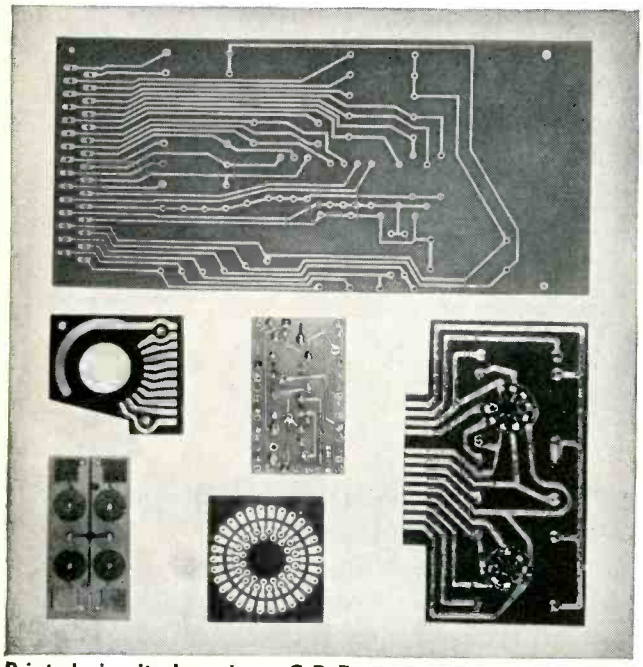
Transitron

electronic corporation · **melrose 76, massachusetts**

Germanium Diodes · Transistors · Silicon Diodes · Silicon Rectifiers

T®

For the most dependable printed circuits, you need the high bond strength, workability, heat-resistance of C-D-F DILECTO® METAL-CLAD LAMINATES



Printed circuits based on C-D-F materials are being used with great success in military electronic equipment, commercial television and radio sets, telephone switchboards—even sub-miniature radiosonde equipment and hearing aids.
Photos courtesy of Photocircuits, Inc., Glen Cove, N. Y.

HIGH BOND STRENGTH—C-D-F's special adhesive for metal-clad Dilecto bonds the copper foil to the plastic without affecting the laminate's superior electrical properties. Heat-resistance, dissipation factor, dielectric constant, dielectric strength, and insulation resistance of the Dilecto base remain unaffected. The closely-bonded foil can be etched cleanly and dipped in hot solder to 450°F. for ten seconds with a guarantee of no blistering or separating. Metal-Clad Dilecto can be punched or machined either before or after etching.

EXCELLENT WORKABILITY—On all four Dilecto metal-clad grades, you can solder, punch, saw, and assemble components either by hand or automatically. Thanks to the inherently superior workability of the plastics laminate over that of ceramic-type materials, Dilecto can be dropped, jammed into tight chassis, and otherwise treated roughly on the assembly line and in service.

HIGH HEAT-RESISTANCE—Metal-Clad Dilecto Laminates are made of phenolic, epoxy, or Teflon* resin for various conditions of service and assembly, and have either cellulosic paper or woven glass-fabric base. All are ideally suited to printed-circuit applications in which heat-dissipation is a major problem. Continuous exposure to high ambient operating temperatures in enclosed electronic equipment has no significant effects on Dilecto's electrical and physical properties.

UNLOAD YOUR HEADACHE HERE! C-D-F, a big, reliable source of supply, can help you get the most for your printed-circuit money by reducing rejects, lowering fabrication costs, assuring dependable quality every time. Send us your print or problem, and we'll gladly supply appropriate test samples free. See our catalog in the Product Design File (Sweet's) or send for the new 20-page Dilecto catalog. Let your nearby C-D-F sales engineer (listed in Sweet's) help you right from the design stage!

TYPICAL PROPERTY VALUES

	Copper-Clad PHENOLIC (Grade XXXP-26)	Copper-Clad PHENOLIC (Grade XXXP-28)	Copper-Clad EPOXY (Grade GB-181E)	Copper-Clad TEFLON* (Grade GB-112T)
BOND STRENGTH—0.0014" foil (Lbs. reqd. to separate 1" width of foil from laminate)	7 to 11	5 to 9	8 to 12	4 to 8
MAXIMUM CONTINUOUS OPERATING TEMP. (Deg. C.)	120	120	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil.)	800	800	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35° C. & 90% RH	50,000	25,000	20,000	Over 10^6 megohms
DIELECTRIC CONSTANT 10^6 Cycles	4.20	4.20	4.54	2.85
DISSIPATION FACTOR 10^6 Cycles	0.026	0.052	0.018	0.0006
ARC-RESISTANCE (Seconds)	10	5	120	180
TENSILE STRENGTH (psi.)	16,000 x 13,000	12,000 x 10,000	48,000 x 44,000	23,000 x 21,000
FLEXURAL STRENGTH (psi.)	21,000 x 18,000	18,000 x 16,000	65,000 x 55,000	13,000 x 11,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.40 x 0.35	0.40 x 0.35	13.5 x 11.5	6.0 x 5.0
COMPRESSIVE STRENGTH flatwise (psi.)	28,000	22,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Cotton rag paper	Cotton rag paper	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural greenish	Natural Brown	Natural	Natural

All these standard grades are available with 0.0014", 0.0028", 0.0042", or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

*duPont Trademark

CDF **CONTINENTAL DIAMOND FIBRE**

CONTINENTAL-DIAMOND FIBRE DIVISION OF THE BUDD COMPANY, INC.

NEWARK 16, DELAWARE

Keeping pace with the rapid growth of the electronics industry in the West, Neely Enterprises has opened a new office — THEIR SEVENTH — in Las Cruces, New Mex co.

The mark of Neely Enterprises is known and respected throughout the West. For over 20 years, this brand has stood for the finest — most complete — service in electronic instrumentat on.

The primary aim of the Neely Engineer who calls on you is to save your t me — increase the efficiency of your operation — with the application of the latest electronic equipment.

Time spent with a Neely Engineer pays you dividends.

LAS CRUCES OFFICE
126 South Water St.
JAckson 6-2486

LOS ANGELES OFFICE
3939 Lankershim Blvd.
Phone: STanley 7-0721

SAN FRANCISCO OFFICE
2830 Geary Boulevard
Phone: WA 1-2361

SACRAMENTO OFFICE
1317 Fifteenth Street
Phone: GI 2-8901

SAN DIEGO OFFICE
1029 Rosecrans Street
Phone: AC 3-8106

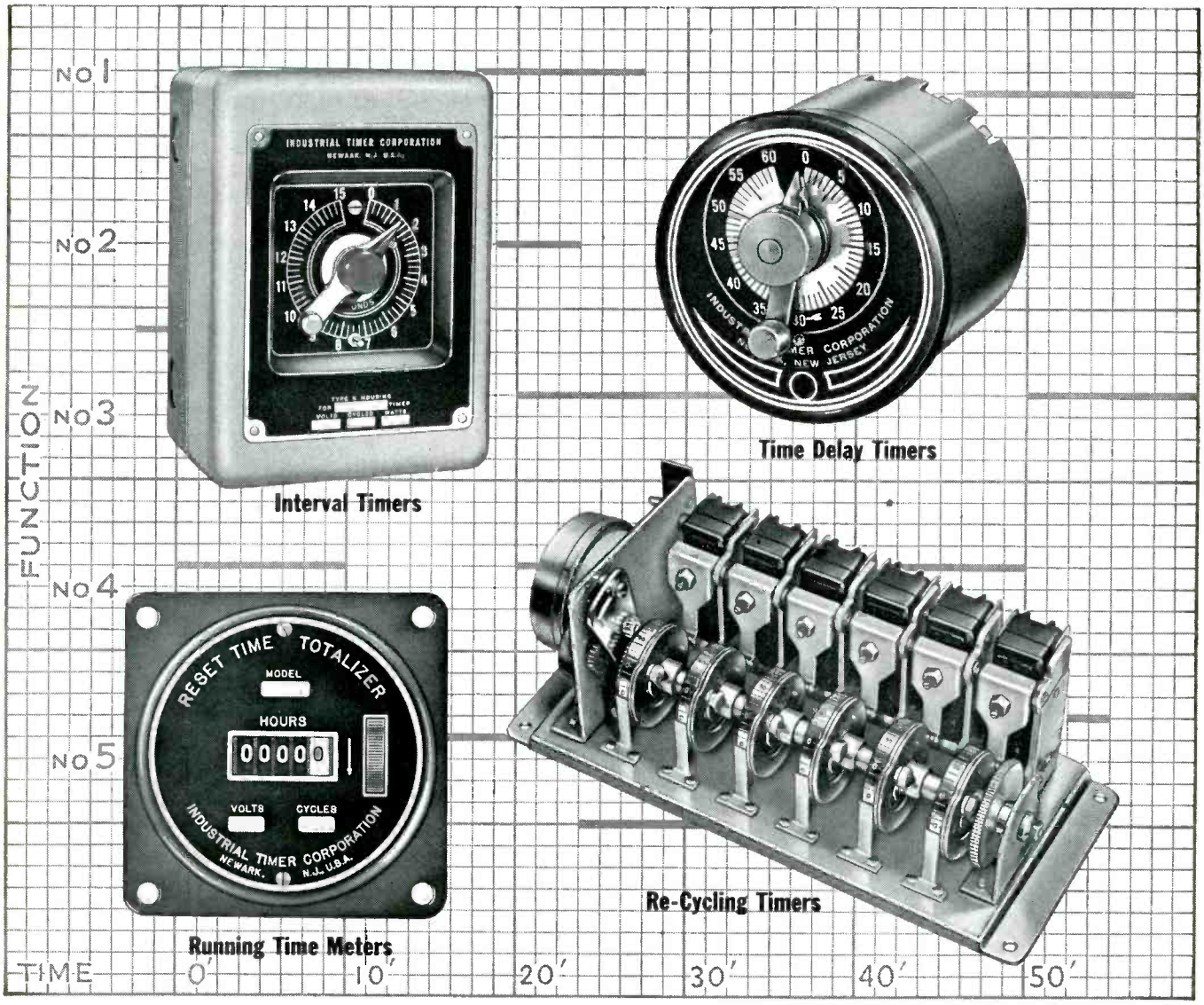
ALBUQUERQUE OFFICE
107 Washington Street, S.E.
Phone: 5-5586

PHOENIX OFFICE
641 E. Missour Avenue
Phone: CR 4-5431

NEELY ENTERPRISES

electronic manufacturer's representatives

YOUR "SPECIAL" TIMER
may be one of our
721 STANDARD UNITS!



We have 20 years of experience in developing new timers to meet our customers' widely varying requirements. Our Engineering Department not only originates new designs, but also develops modifications for that purpose. That's why most requests for special timers can be filled without delay—by one of the 721 combinations we've developed so far from our 17 basic types of timers. But if we don't have what you want on hand, we'll welcome the chance to design and make it for you! And quickly too!

We manufacture a complete line of timers in these 4 broad classifications:

INTERVAL TIMERS • TIME DELAY TIMERS
RE-CYCLING TIMERS • RUNNING TIME METERS

Our large stock assures you of rapid deliveries—even when we have to create a brand new timer for your special needs. Ask us first—you may save yourself much lost motion . . . and your inquiry will receive prompt attention.

Timers that Control the Pulse Beat of Industry

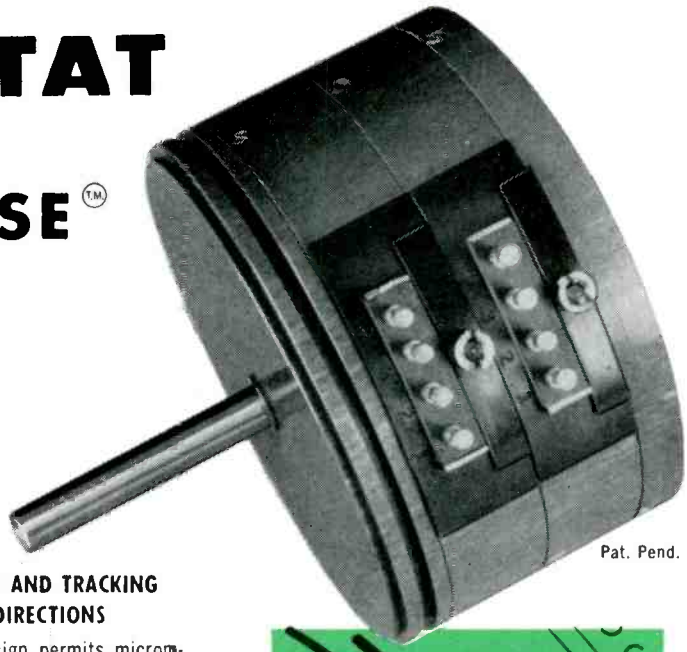
INDUSTRIAL TIMER CORPORATION

INDUSTRIAL TIMER CORPORATION
1409 McCARTER HIGHWAY, NEWARK 4, N. J.

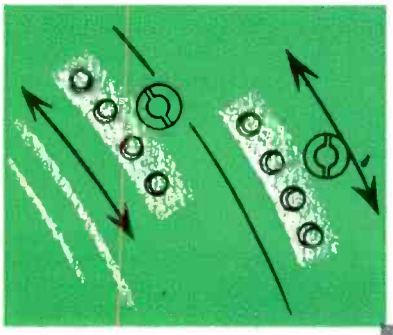
A new and better variable-phase, single-turn precision potentiometer

CLAROSTAT

VARI-PHASE®



Pat. Pend.

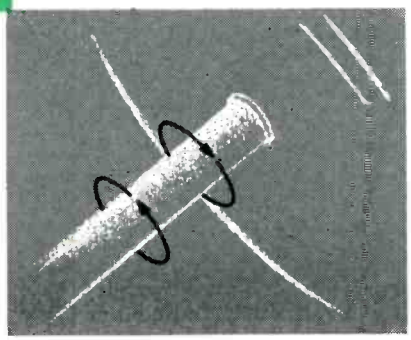


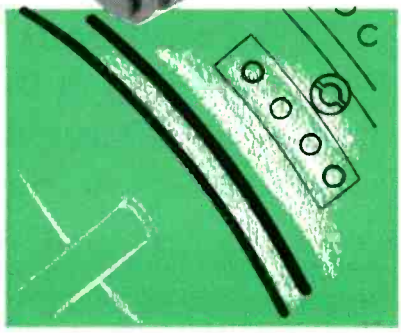
EQUAL TORQUE AND TRACKING IN BOTH DIRECTIONS

Unique contact design permits micrometer tension adjustment at factory and assures equal torque and tracking in either direction at all times.

NO CLAMPING RINGS

Simplified phasing—External independent phasing of each cup without affecting the relationship of the others.—To phase, loosen clamping nut, move terminal board in desired direction, tighten clamping nut and it's done. Speedy phasing saves time and money. Reduced overall diameter by elimination of clamping rings.





STANDARD A.I.A. MOUNTING

Mounting per A.I.A.* standards—others available. Meets or exceeds electrical and mechanical A.I.A. requirements.

Materials selected for lightest weight possible. Design assures highest performance.
Five sizes available—7/8", 1-1/16", 1-5/8", 2" and 3" diameters.

Another CLAROSTAT first. A product of advanced imagineering.

WRITE FOR COMPLETE ELECTRICAL AND MECHANICAL SPECIFICATIONS.

CLAROSTAT®

CLAROSTAT MFG. CO., INC.
DOVER, NEW HAMPSHIRE

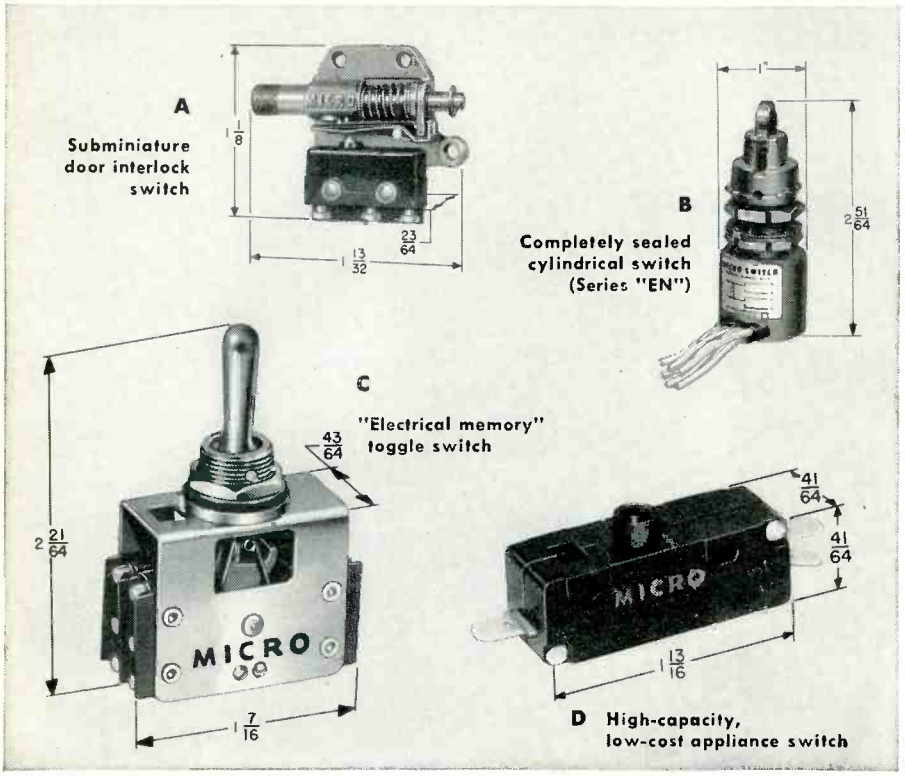
In Canada: Candian Marconi Co., Ltd., Toronto 17, Ont.
Manufactured under license in Great Britain by A. B. Metal Products Ltd., 17 Stratton St., London W.1, Concessionaires for British Commonwealth except Canada.

*Aircraft Industries Associated.

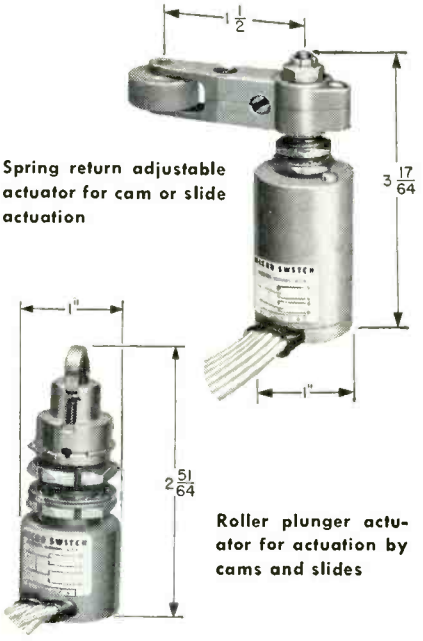
MICRO precision switches

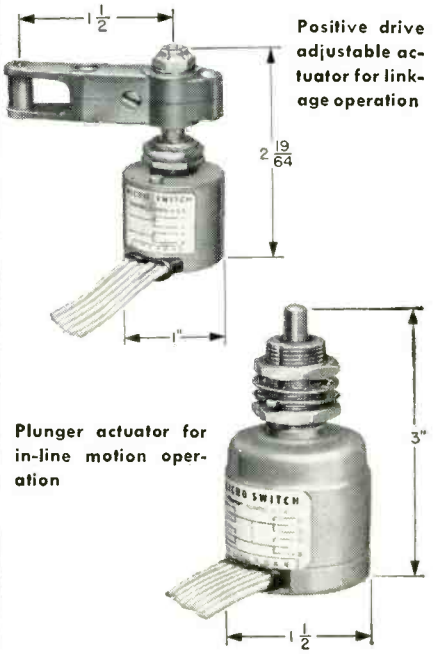
...THEIR USE IS A PRINCIPLE OF GOOD DESIGN

HONEYWELL



See the unusual design flexibility of the new MICRO Series "EN" switches





A continuous flow of Precision Switch Developments anticipates Your design needs

MICRO precision switches are developed and built to meet specific requirements. Some designs call for the utmost precision, plus reliability. Other designs put long life and extreme reliability at the top of the list. Some must have all of these and more. Whatever YOUR requirement may be, MICRO SWITCH has a switch readily available or can work with you in its development.

Here are a few recent MICRO SWITCH *developments to meet specific needs:*

A The subminiature door interlock switch is for use where an extremely small assembly is desired to provide automatic cut-off of the power circuit when a cabinet door is opened. This switch assembly has been found extremely valuable on radio, radar, x-ray and other hazardous equipment where it is desirable to provide automatic protection to operating personnel. (*Ask for Data Sheet P108*).

B The MICRO SWITCH "EN" Series switches are capable of reliable, long-life performance under extreme environmental and mechanical conditions. They are completely sealed, cylindrical in shape and can be mounted wherever a through hole can be provided. Variations of the "EN" are capable of actuation by almost any means (see right hand column). (*Send for Data Sheet 105*).

C This is the first of a new series of "electrical memory" toggle switches being introduced by MICRO SWITCH. They offer a completely new concept in switching remotely controlled circuits. They promise to simplify basic circuit designs of radar units, computers, aircraft control panels and similar devices. The switch indicates through a pilot light or buzzer which circuit was last actuated. (*Send for Data Sheet 109*).

D MICRO SWITCH now offers a new series of low cost plastic encased switches especially designed for use on domestic appliances. In addition to their small size and high electrical capacity, these switches are ruggedly constructed for hard service. They are readily adaptable for use with auxiliary actuators. (*Send for Data Sheet 106*).

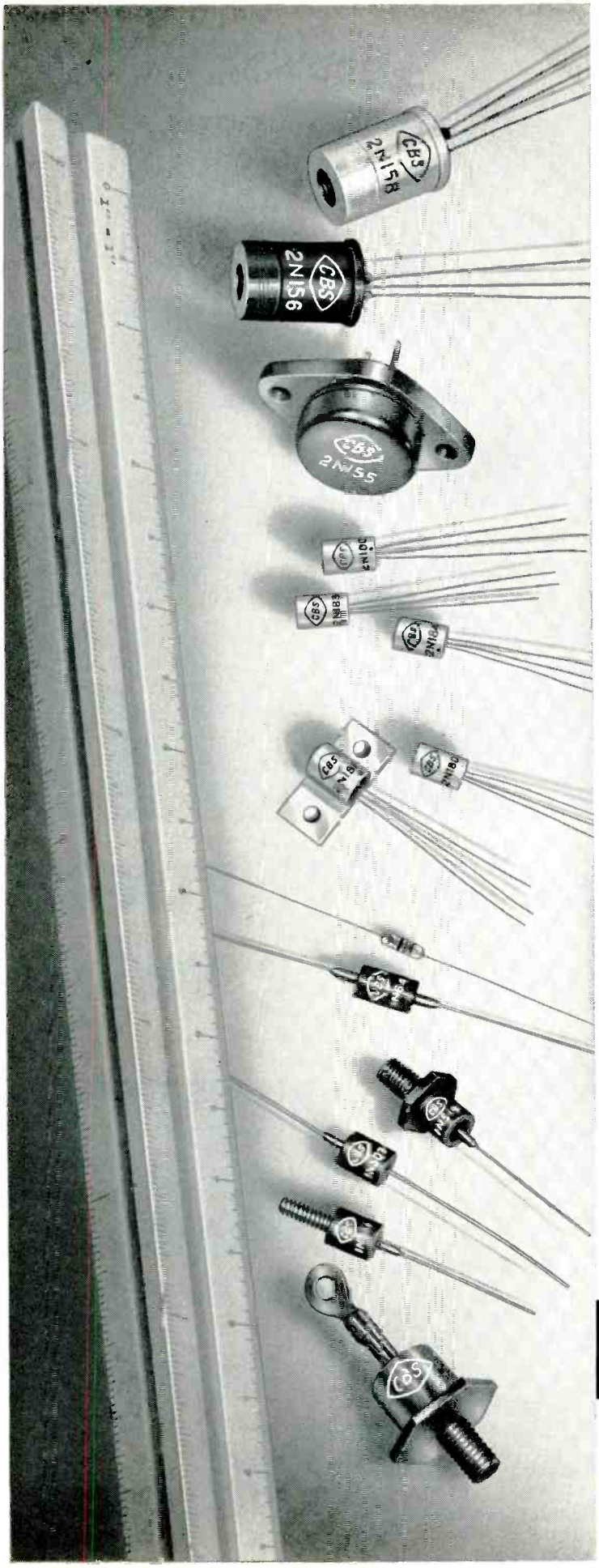
MICRO SWITCH *Engineering service is available at nearby branch offices. A call can save you time and money.*

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leoside, Toronto 17, Ontario • FREEPORT, ILLINOIS

HONEYWELL



growing line of

CBS

semiconductors

features uniformity and reliability

Users rate the rapidly expanding line of CBS semiconductors as "exceptionally uniform and reliable." They have also discovered that CBS' mass production insures dependable delivery and competitive prices. You, too, will prefer advance-engineered CBS semiconductors. Write for data and quotation on the types you need.

Power Transistors Popular auto-radio type 2N155. General-purpose 2N156 (12-volt) and 2N158 (28-volt). And *new higher-power and higher-voltage versions* for larger audio output systems and power supplies.

High-Frequency Transistors Uniform and reliable performance up to 20 mc. CBS 2N182, 2N183, 2N184 are NPN symmetrical, permitting unusual applications.

General-Purpose Transistors CBS 2N180 and 2N181 are noted for outstanding dependability. Integral C-clamp mounting of 2N181 permits dissipation up to 250 mw.

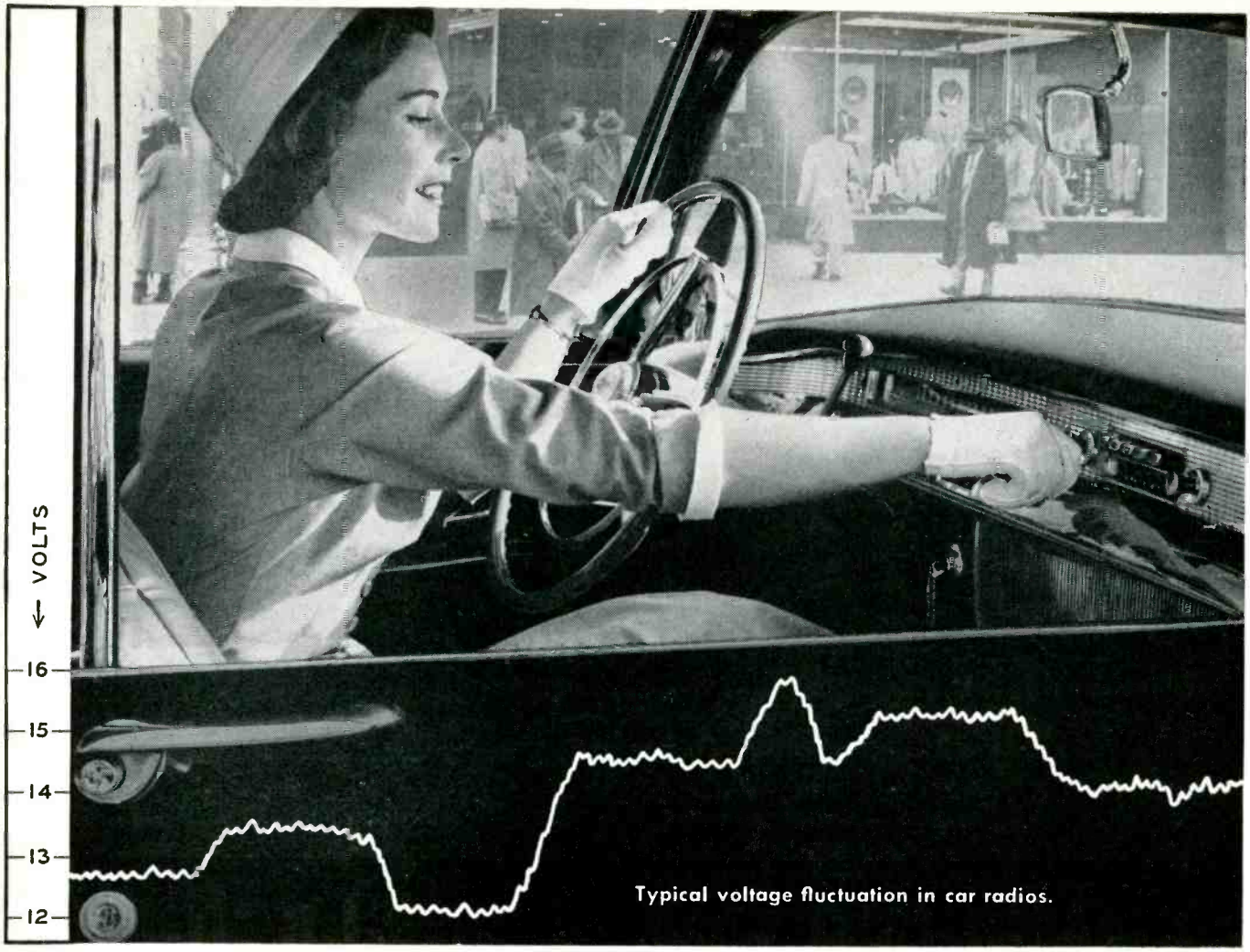
Diodes A complete line from one source: Glass . . . plastic . . . point-contact . . . bonded-junction . . . entertainment . . . general-purpose . . . and computer.

Silicon Power Rectifiers Series 1N503-1N508 rated at ⅛ amp . . . 1N511-1N516 at 1 amp . . . 1N519-1N524 at 1¼ amp. Also *a new much higher-current series* for heavy-duty power supplies.

Reliable products
through Advanced-Engineering

CBS semiconductors

CBS-HYTRON
Semiconductor Products, Lowell, Mass.
A DIVISION OF COLUMBIA BROADCASTING SYSTEM, INC.



Typical voltage fluctuation in car radios.

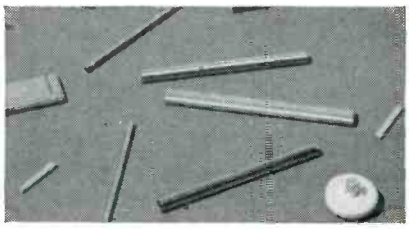
FOUND: a Cathode alloy that prolongs tube life under fluctuating voltage

CATHALOY* A-31 IDEAL FOR CAR RADIO TUBES. This discovery was made in actual car radio installations. Heater supply voltages were found to vary up to 25% above specification. And the tubes using Superior's new Cathaloy A-31† consistently outlasted others.

These findings prompted car radio manufacturers to insist on longer-life tubes in car radio service. Specifications stipulate several hundred hours at approximately 25% overvoltage. No cathode alloy can match Superior's Cathaloy A-31 in meeting these requirements.

OTHER ADVANTAGES. Cathaloy A-31, with its 4% tungsten, is probably the strongest cathode material at high temperatures that is commercially available today. Hence it qualifies especially for use in ruggedized tubes. In addition, its special composition reduces the twin problems of sublimation and interface impedance.

SEND FOR FREE CATALOG. Contains complete technical information on Cathaloy A-31 and other cathode alloys and on electronic tubular parts. Write Superior Tube Co., 2500 Germantown Ave., Norristown, Pa.



Cathodes made from A-31 are available in Weldrawn, Lockseam † and disc cathodes.*

• • •

*T.M. Reg. U.S. Pat. Off., Superior Tube Co.
†Manufactured under U.S. patents.

Superior Tube

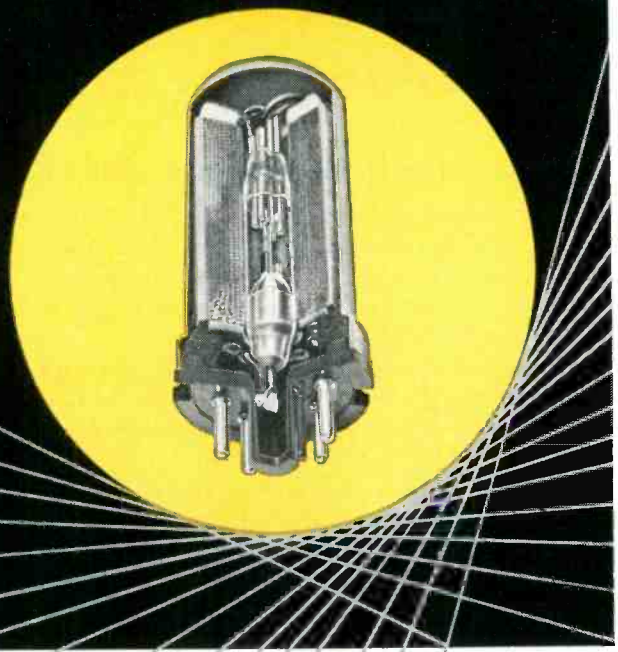
The big name in small tubing

NORRISTOWN, PA.

It can cost you much more to settle for less than this Clare relay

This ad was all but written by a Clare customer. Here is the story as he told it:

"I shopped around for relays for continuous-duty, high-speed switching service. Clare engineers recommended Type HG Mercury-Wetted Contact Relays. They said they were ideal for this application. I thought so, too; but they do cost a little more than some other relays, and I thought I couldn't afford to use them. I thought the extra cost, multiplied by the large number of relays in my machine, would run my price too high. So I built a model with cheaper relays. In just a few weeks the relays wore out. I knew that Clare Type HG relays would last for years under the same conditions, and it didn't take me long then to decide that *I couldn't afford not to use them.*"



Ask yourself whether you, too, don't have jobs for which no other relay is good enough. Consider that the life of a Clare Mercury-Wetted Contact Relay is measured in billions of maintenance-free operations. Compare the cost per flawless operation with that of other relays: this is the crux of the matter—a vital, basic point.

The price is very reasonable, and delivery is quick—one to seven weeks, depending on the particular assembly desired and the size of the order.

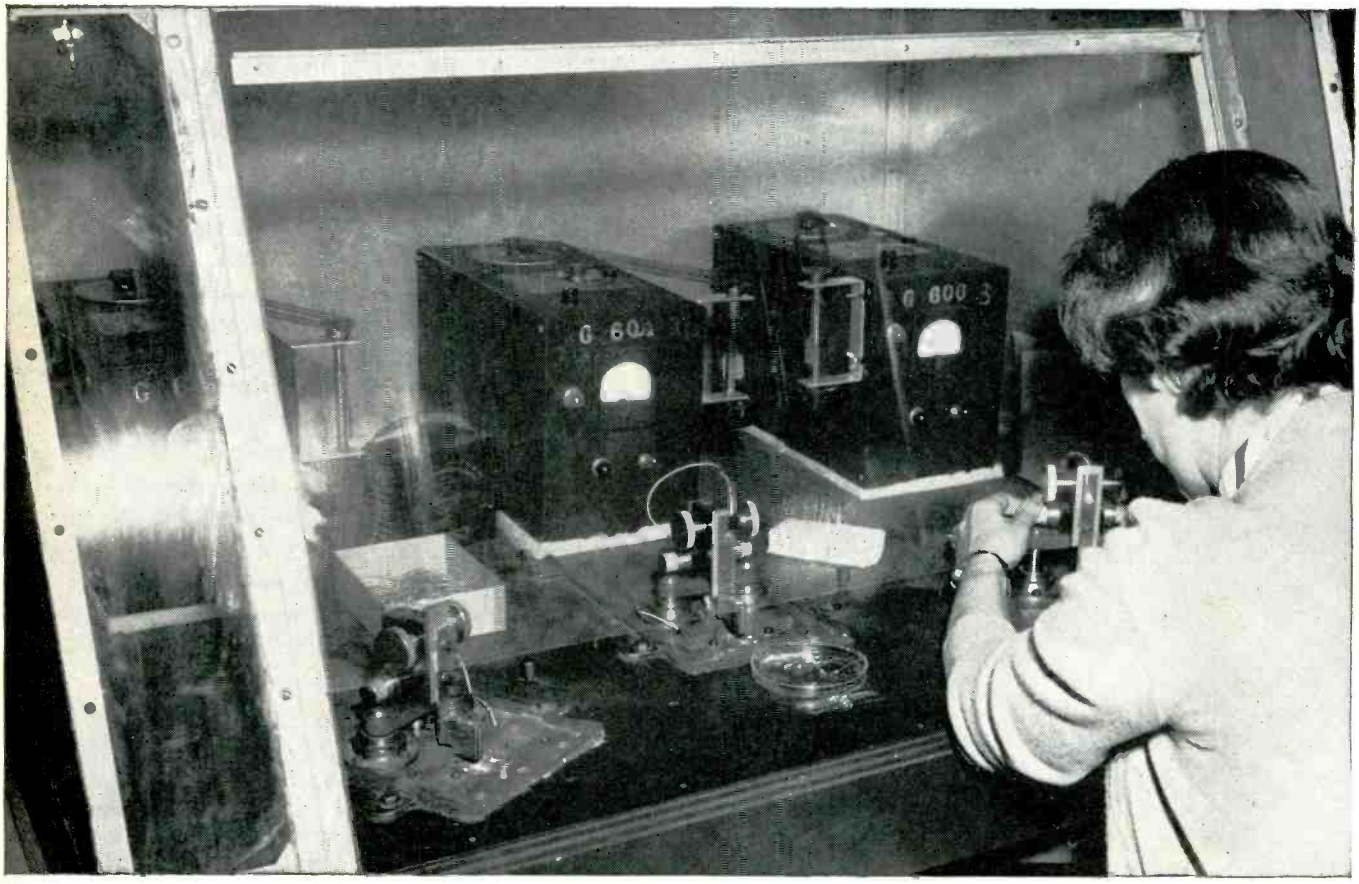
FOR COMPLETE INFORMATION on CLARE Mercury-Wetted Contact Relays for single or multiple circuits contact your nearest CLARE representative or address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare & Co., 659 Bayview Avenue, Toronto 17. Cable address: CLARELAY.

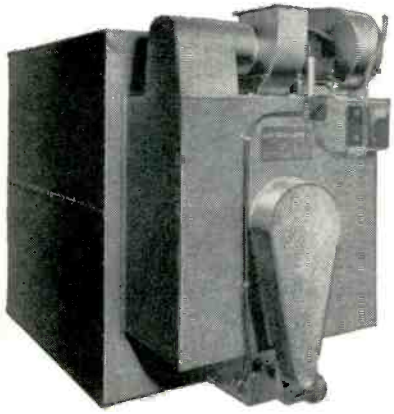
Send for CLARE Sales Engineering Bulletins Nos. 120 and 122

CLARE RELAYS

FIRST in the industrial field

Radio Receptor's diodes are assembled under glass in a DRY atmosphere





Type CH Air-Drying Lectrodryer

A Lectrodryer maintains the extreme DRYness required

Moisture is locked out of this chamber in which germanium gold-bonded diodes are being assembled at Radio Receptor's Brooklyn, New York, plant. A constant supply of DRY air from Lectrodryer keeps the flow of air outward. This makes certain there's no moisture present to impair the high quality of these precision products.

More and more manufacturers are learning how vital DRYness is in the production and operation of electronic equipment. Moisture is a hazard which cannot be tolerated, if quality is to be maintained and procedures standardized.

You may be dealing with small volumes of air, as here at Radio Receptor Company, or with entire workrooms. There are Lectrodryers to handle any volume and any degree of DRYness. Tell your DRYing problem to Pittsburgh Lectrodryer Company, 359 32nd Street, Pittsburgh 30, Pa. (a McGraw Electric Company Division).

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

* REGISTERED TRADEMARK U. S. PAT. OFF.

ANOTHER VARIAN

first

A MINIATURE *backward wave oscillator*

This Varian Model VA-161 is the *only* rugged, system-tailored, voltage-tuned Backward Wave Oscillator now available for radars, signal generators, search receivers and related microwave equipment. Here are some of its important advantages:

- Instantaneously tuned by changing voltage.
- Low voltage requirements... operates over a frequency range of 8.2 to 12.4 kMc on less than 600 volts.
- *Existing* radar system power supplies can be used... operates over the normal 8.5 to 9.6 kMc radar band on 300 volts or less.
- Designed for modern miniaturized equipment... small, compact... body measures approximately 4" x ¾".
- Withstands shock and vibration... rugged metal and ceramic construction.
- Permanent magnet weighs less than 5 pounds... eliminates need for electromagnet *and* its power supply.
- Power output is smooth across entire tuning range... fluctuations are small.
- Low thermal drift.

Additional tubes covering other frequencies are being developed to help solve your microwave system problems.

SYSTEM DESIGNERS . . . Why not get the full story on this important new Backward Wave Oscillator? For complete technical data, write Applications Engineering Dept. H-1

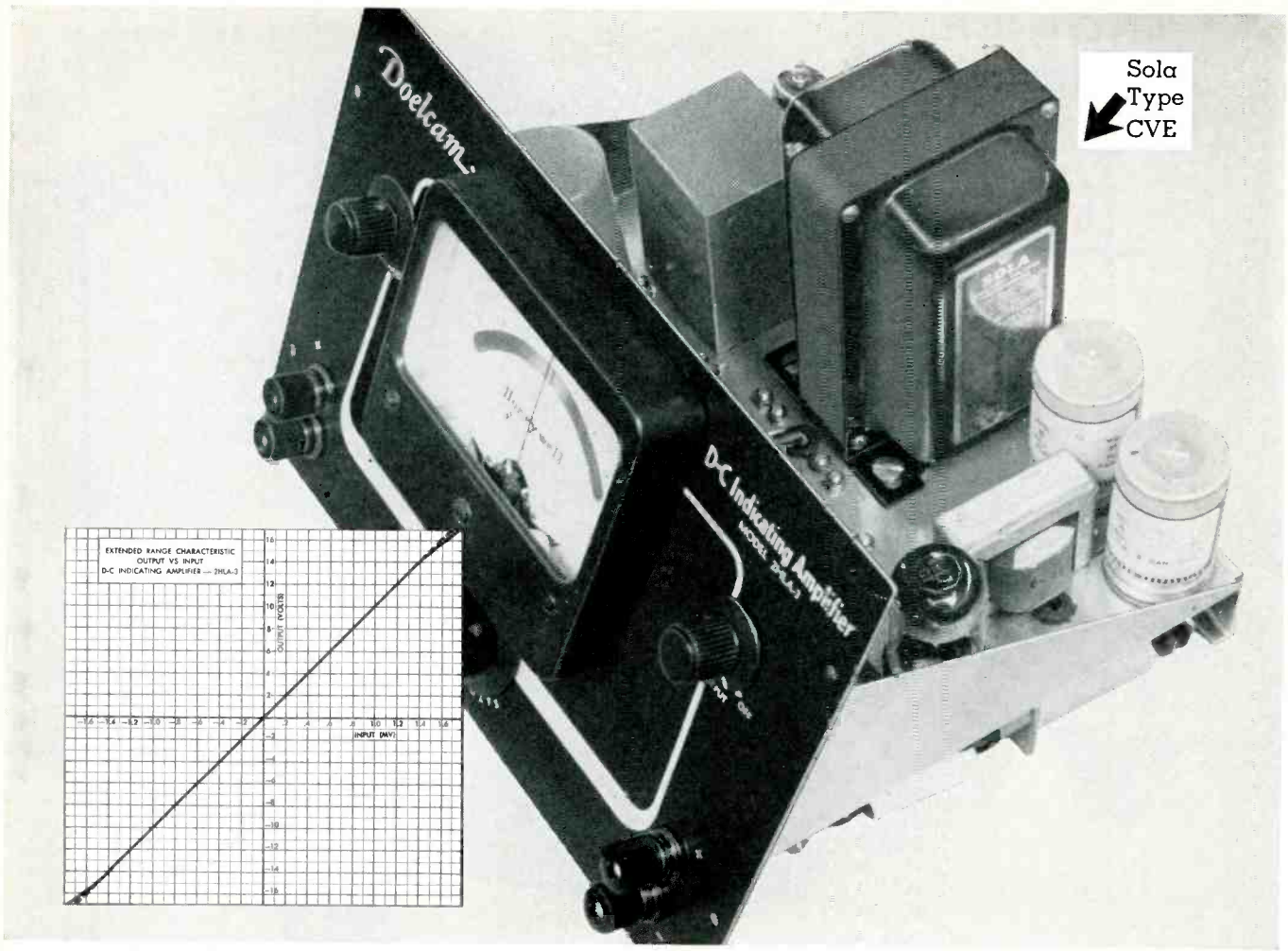
THE MARK OF LEADERSHIP

VARIAN associates

PALO ALTO, CALIFORNIA

Representatives in all principal cities

KLYSTRONS, TRAVELING WAVE TUBES, BACKWARD WAVE OSCILLATORS, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, R. F. SPECTROMETERS, MAGNETS, MAGNETOMETERS, STALOS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES



Above is the 2HLA-3 Indicating Amplifier, a product of the Doelcam Division of Minneapolis-Honeywell. Housing is removed to show chassis-mounted Sola Type CVE Regulated Power Supply Transformer. Inset is an extended-range characteristic showing linear amplifier output.

Sola-Regulated DC Amplifier Provides Reliable Measurement of 2×10^{-15} W Signals

The Doelcam 2HLA-3 DC Indicating Amplifier has introduced a standard of performance heretofore unattainable in the field of amplification and measurement of low level dc signals. This precision instrument measures signals as small as 2×10^{-15} watt. High gain, excellent linearity, and negligible drift of the 2HLA-3 are *unaffected by variations in line voltage* or tube characteristics.

Contributing to this reliable and stable performance of the Doelcam amplifier is its chassis-mounted Sola Type CVE Regulated Power Supply Transformer. The Sola CVE static-magnetic stabilizer provides a single, compact source of plate and filament supply voltages regulated within ±3%, with input voltage variations of 100-130 volts. All windings are on the same core, providing a moderately-priced unit to replace both voltage-regulating circuit, or component, as well as conventional power transformer.

These Sola transformers are available in three standard models (±3% regulation); or in special designs with regulation of one winding as close as ±1%. They have no moving parts or tubes, and are completely automatic, instantaneous, and continuous in operation. In addition, they provide self-protection against short circuit, and require no maintenance.

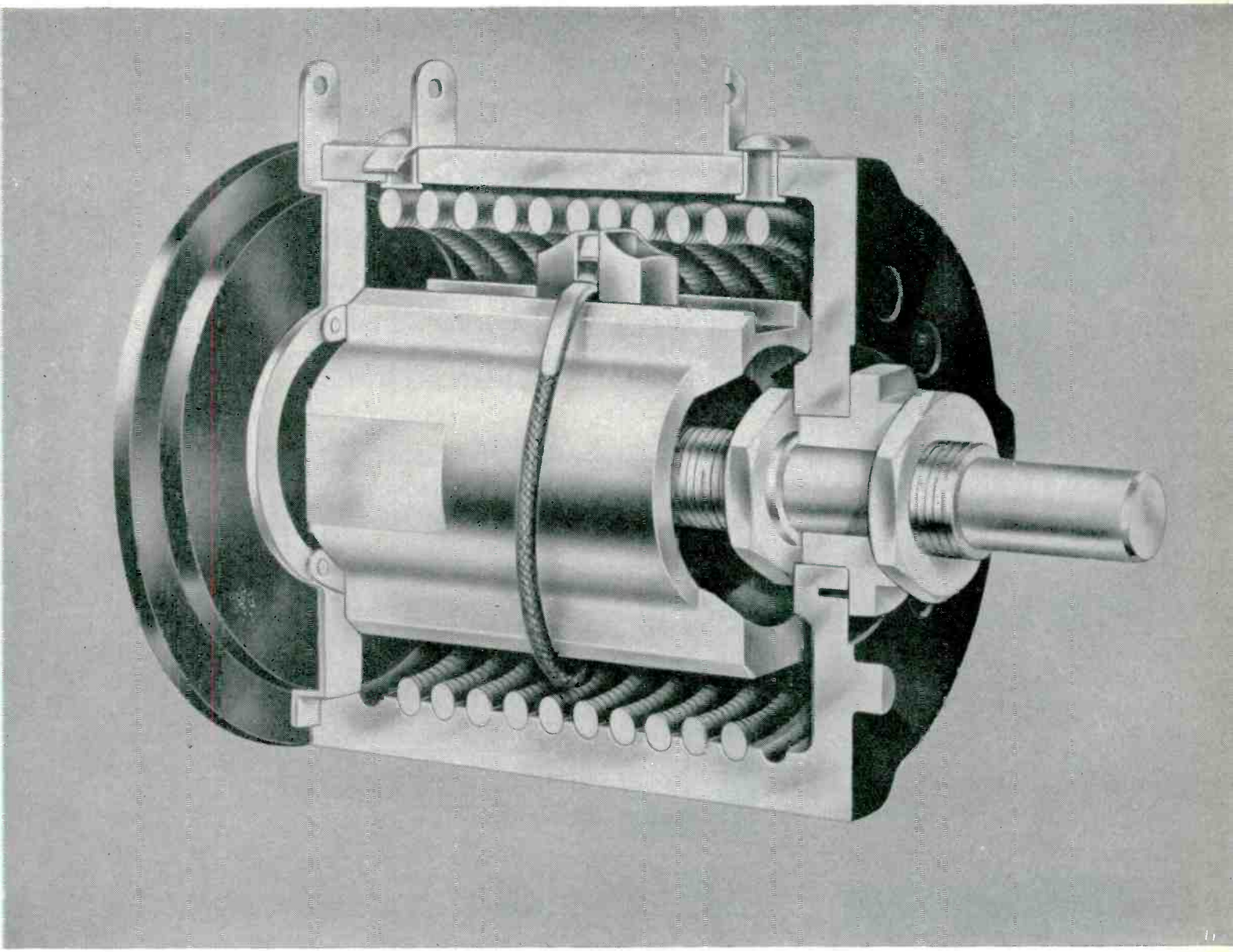
Your area representative will be happy to provide you with information on the specific benefits of a Sola Type CVE Regulated Power Supply Transformer as a component in your product.

SOLA *Constant Voltage* **TRANSFORMERS**

Write for Bulletin 7H-CV-170D
SOLA ELECTRIC CO.
4633 W. 16th St.
Chicago 50, Ill.

CONSTANT VOLTAGE TRANSFORMERS for Regulation of Electronic and Electrical Equipment • **LIGHTING TRANSFORMERS** for All Types of Fluorescent and Mercury Vapor Lamps. • **SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414** • *NEW YORK 35: 103 E. 125th St., TRafalgar 6-6464 • PHILADELPHIA: Commercial Trust Bldg., RIttenhouse 6-4988 • BOSTON: 272 Centre Street, Newton 58, Mass., BIgelow 4-3354 • CLEVELAND 15: 1836 Euclid Ave., PRospect 1-6400 • KANSAS CITY 2, MO.: 406 W. 34th St., Jefferson 4382 • LOS ANGELES 23: 3138 E. Olympic Blvd., ANgelus 9-9431 • TORONTO 17, ONTARIO: 102 Laird Drive, Mayfair 4554 • Representatives in Other Principal Cities*

"heart" of the most accurate tank gauge ever made!



It's housed in Monsanto **RESINOX* 3700**

. . . only material tested that met every exacting requirement

HEART OF THE remote transmission in the new Gilbarco Electronic Gauge—which accurately measures the liquid levels of storage tanks—is the Helipot® precision potentiometer. To house this all-important component, engineers needed a material with:

- **low moisture absorption**
- **superior dimensional stability**
- **high electrical resistance**

Of all materials tested, only Resinox 3700 measured up to all these exacting requirements. And, since specifying Resinox 3700, Gilbarco electronic tank gauges have been able to transmit remotely storage tank liquid levels accurate to 1/16th of an inch!

Resinox 3700 can solve your critical electric parts problem just as it did for Gilbarco. In addition to the characteristics outlined above, Resinox 3700 also has:

- **outstanding arc resistance**
- **dielectric strength**
- **good impact resistance**
- **excellent moldability**

For complete information, write: Monsanto Chemical Company, Plasties Division, Room 408, Springfield 2, Mass.

The Electronic Tank Gauge is manufactured by Gilbarco (Gilbert & Barker Mfg. Co.), West Springfield, Mass. Precision potentiometers are made by Helipot Corporation, South Pasadena, Calif.

MONSANTO

*Resinox: Reg. U. S. Pat. Off.

PANELS · TIMERS · TACHOMETERS
by Standard Electric

flexlab PANELS
Distribution Switchboards
Control Panels, Test Benches and Units

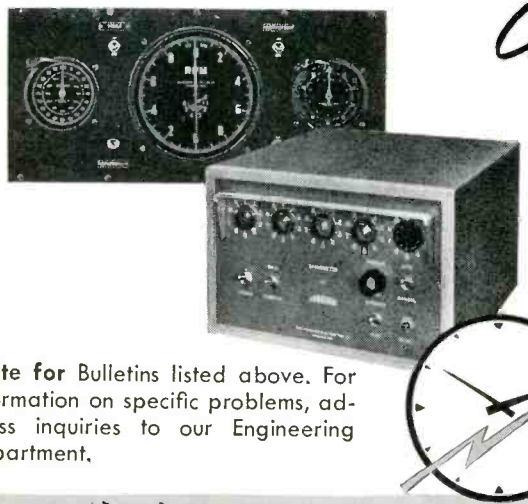
Custom Designed and Custom Built for a long and impressive list of users in Industry, Research, Government, and in Vocational and Technical Schools and Universities. **Send for Bulletin 187.**

flexlab RECEPTACLES AND PLUGS and binding posts, for quick, frequent, flexible, plug-in connections for power distribution and circuitry on test or production equipment. **Send for Bulletin 238.**

Precision TIMERS

For extreme accuracy and continuous performance. Rugged, for heavy duty service; flexible in application; to measure and indicate elapsed time intervals. Synchronous motor drive. Electric clutch controlled by manual switch, automatic switch or output of electronic tubes. Manual or electric zero reset. **Send for Bulletin 198.**

Model	Scale Divisions	Totalizes	Accuracy
S-100	1/5 sec.	6000 sec.	±.1 sec.
S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min.
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	.360 sec.	±.001 sec.
MST-500	1/1000 sec.	30 sec.	±.002 sec.



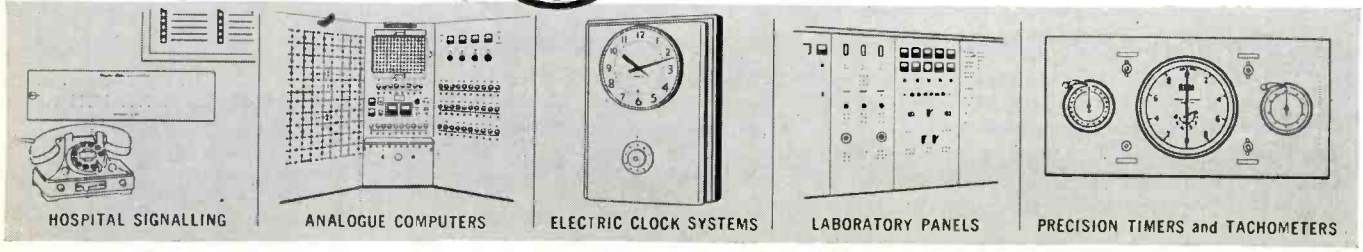
Chrono and Electronic TACHOMETERS

These NEW and IMPROVED TACHOMETERS are designed to give you these outstanding benefits: Extreme Precision — Reliability — Readability — Self-Checking — Package-type, plug-in construction to simplify servicing. **Write for Bulletins 218 and 240.**

Write for Bulletins listed above. For information on specific problems, address inquiries to our Engineering Department.

THE **Standard** ELECTRIC TIME COMPANY

97 Logan Street • Springfield 2, Massachusetts



PHILCO

SBT*2N240

HIGH SPEED SWITCHING TRANSISTOR

with response time in millimicrosecond range

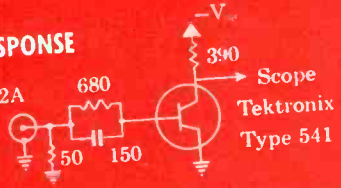
GUARANTEED CHARACTERISTICS

CHARACTERISTIC	CONDITION	VALUE
"ON"	$I_b = -.3$ ma, $I_c = -2$ ma. $I_b = -2.5$ ma, $I_c = -8$ ma.	$V_{ce} = -0.07$ V MAX. $V_{ce} = -0.10$ V MAX.
"OFF"	$V_{be} = -0.10$V., $V_{ce} = -4.5$V.	$I_c = -150\,\mu$a MAX.
h_{fe} (COMMON EMITTER CURRENT GAIN)	$V_c = -3$V., $I_c = -.5$ ma.	16 MIN.
C_{ob} (COMMON BASE OUTPUT CAPACITY)	$V_c = -3$V , $I_c = -.5$ ma.	6 $\mu\mu$f. MAX.
I_{cb} (COLLECTOR CUTOFF CURRENT)	$V_{cb} = -5$ V	3 μa MAX.
I_{eb} (EMITTER CUTOFF CURRENT)	$V_{eb} = -5$ V	3 μa MAX.

MAXIMUM RATINGS

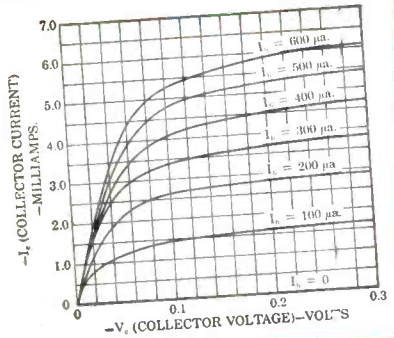
$V_{ce} = -6$ V. $I_c = -15$ ma. $P_c = 10$ mw @ 40°C.

PULSE RESPONSE

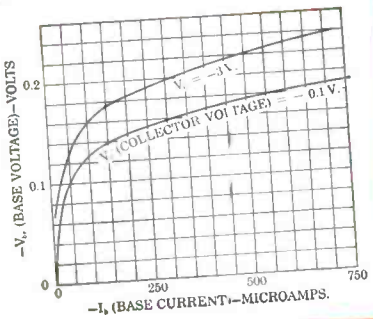


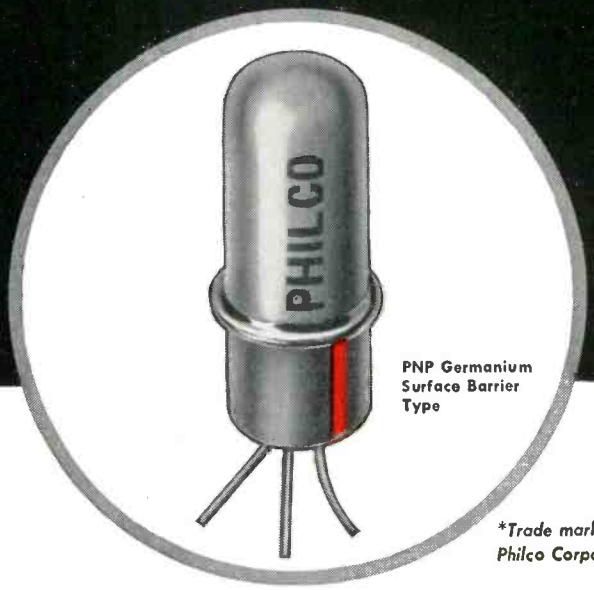
Test Conditions: V_{cc} is set to −6 V and pulse input is adjusted until transistor is just in saturation V_{cc} is then lowered to −1.5 V for saturated pulse curve. t_s = hole storage time.

COLLECTOR CHARACTERISTIC IN SATURATION REGION



INPUT CHARACTERISTIC





PNP Germanium Surface Barrier Type

*Trade mark of Philco Corporation

FEATURES

- Low saturation resistance
- Low saturation voltage
- Ideal electrical characteristics for direct coupled circuitry
- Extremely fast rise and fall time
- Absolute hermetic seal
- Available *now* in production quantities

Proven performance of the Philco Surface Barrier Transistor has made it the basis for design of both military and commercial computers where speed and reliability are the major considerations. And now this transistor goes even farther . . by giving reliable performance in 20 megacycle switching circuits!

Make Philco your prime source of information for high speed computer transistor applications.

Write to Dept. E, Lansdale Tube Company Division, Lansdale, Pa.

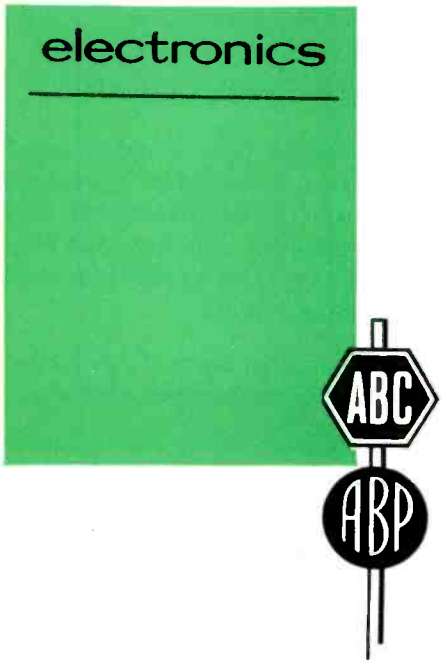
PHILCO CORPORATION

LANSDALE TUBE COMPANY DIVISION

LANSDALE, PENNSYLVANIA

HOW TO SELL A GIANT

electronics' market-pattern does it



Now you can build your business *parallel to its potential!*

Your yardstick for measuring potential . . . territory by territory . . . is the penetration of **electronics.**

The pattern of **electronics** circulation shows you where business exists . . . tells you how each territory compares with all the others . . . enables you to spot your salesmen and set their quotas.

Also . . .

We have proved that the number of copies of **electronics** going into any one company is proportional to the use of electronics by the company itself.

Send for **electronics'** market-pattern maps . . . check your distribution against your potential.

electronics

. . . of course!

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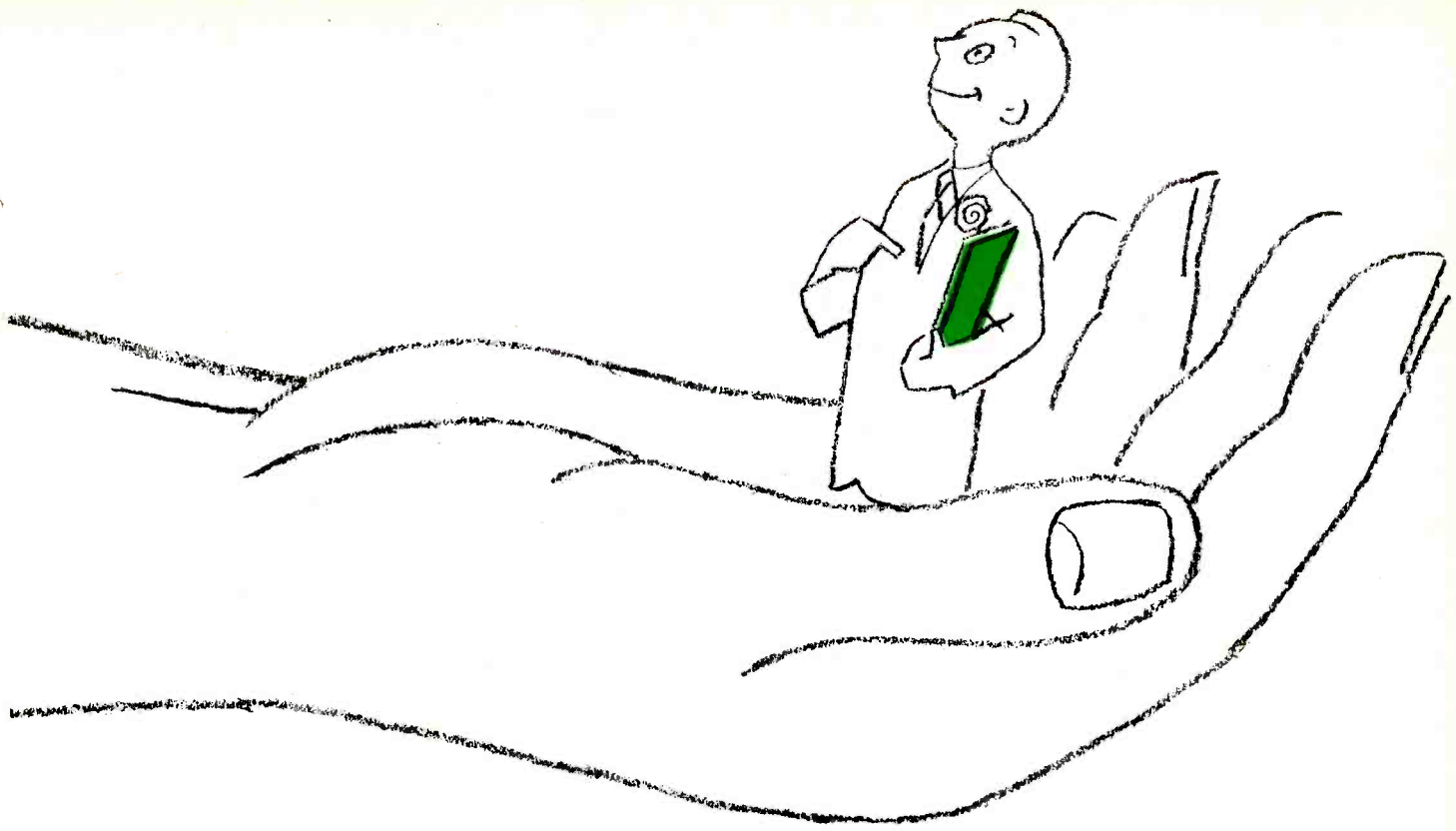
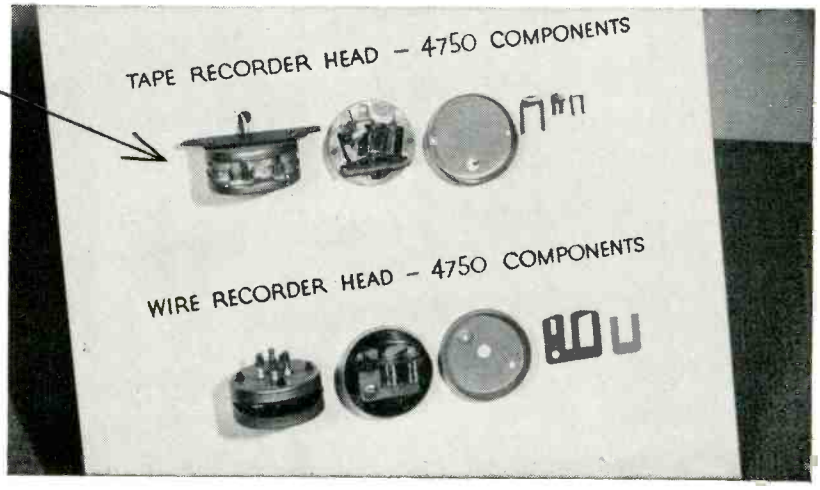


for
HEARING
AIDS



or
RECORDING
HEADS

or *ANY* MAGNETIC MATERIALS JOB . . .

Write for your Copy
"MAGNETIC MATERIALS"

This 32-page book contains valuable data on all Allegheny Ludlum magnetic materials, silicon steels and special electrical alloys. Illustrated in full color, includes essential information on properties, characteristics, applications, etc. Your copy gladly sent free.
ADDRESS DEPT. E-80

You can *rely* on core materials like the Allegheny 4750 components illustrated above, in your receivers, recording heads or microphone assemblies.

In fact, whether your equipment is small or large, the extra-broad line of A-L magnetic materials will solve your magnetic core problems. It includes all grades of silicon steel sheets or coil strip, as well as Allegheny Silectron (grain-oriented silicon steel), and a wide selection of high-permeability alloys such as 4750, Mumetal, Permendur, etc.

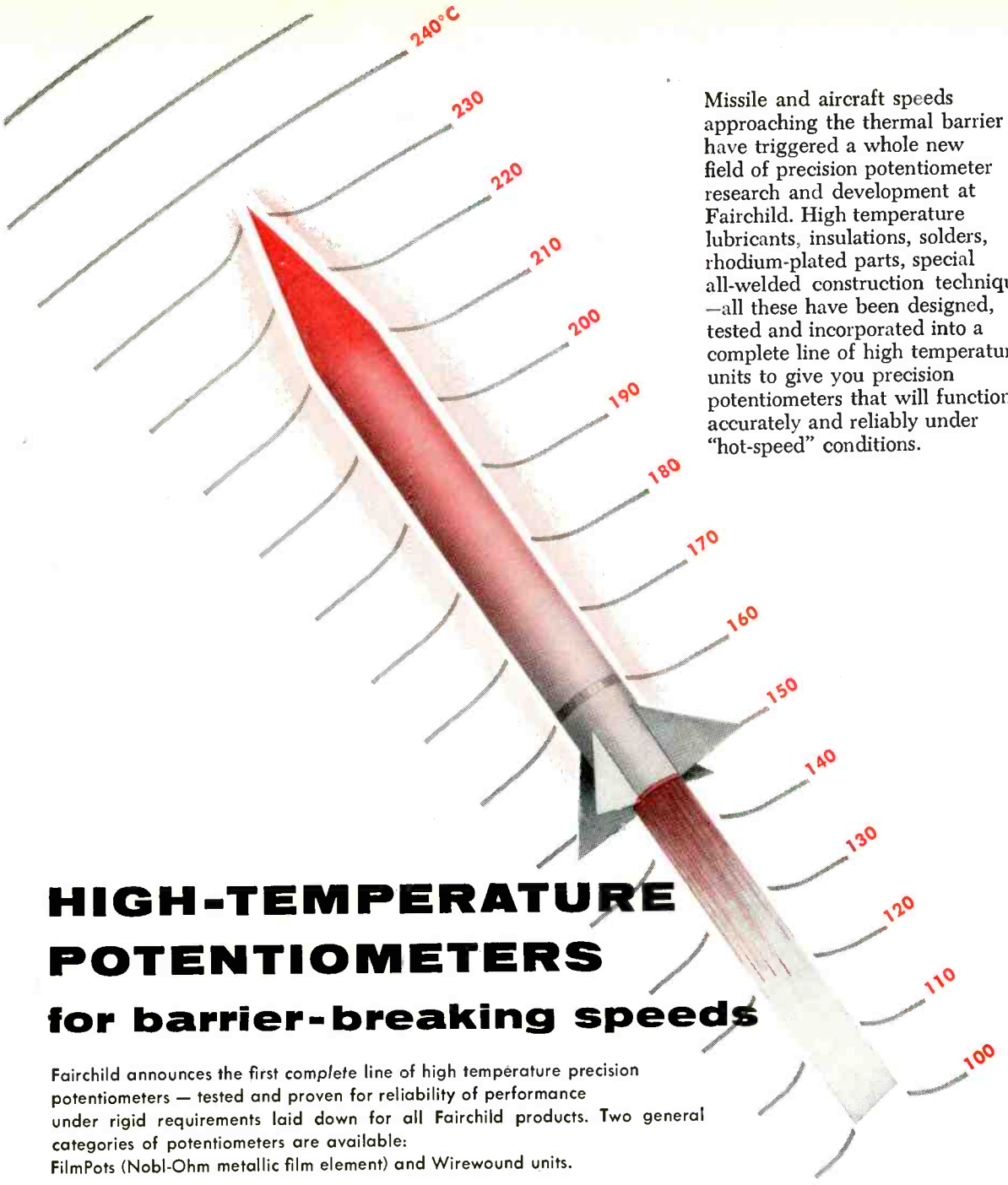
Our service on these materials also includes complete facilities for the fabrication and heat treatment of laminations. (For users of electrical sheets and strip, our lamination know-how is a real bonus value!) Either way, we'll welcome the chance to serve you. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

STEELMAKERS to the Electrical Industry

Allegheny Ludlum

WAD 8335

AL® STEELS FOR THE ELECTRONIC AGE



Missile and aircraft speeds approaching the thermal barrier have triggered a whole new field of precision potentiometer research and development at Fairchild. High temperature lubricants, insulations, solders, rhodium-plated parts, special all-welded construction techniques —all these have been designed, tested and incorporated into a complete line of high temperature units to give you precision potentiometers that will function accurately and reliably under "hot-speed" conditions.

HIGH-TEMPERATURE POTENTIOMETERS

for barrier-breaking speeds

Fairchild announces the first *complete* line of high temperature precision potentiometers — tested and proven for reliability of performance under rigid requirements laid down for all Fairchild products. Two general categories of potentiometers are available:
FilmPots (Nobl-Ohm metallic film element) and Wirewound units.

FILMPOTS — Operate at 150°C, 175°C and 225°C.

WIREWOUND — To 150°C, single turn and multi-turn types.

A new line of Pressure Transducers which meets all military requirements for humidity, shock, and other environmental conditions, is also available.

Fairchild components research, implemented by critical production techniques and severe testing programs, is continuing to develop units for even higher temperatures and can offer constructive cooperation in guided missile and aircraft control programs. For data sheets, or for assistance on specific problems, write to Fairchild Controls Corporation, Components Division, Dept. 140-72A.

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225 Park Avenue
Hicksville, L. I., N. Y.

WEST COAST
6111 E. Washington Blvd.
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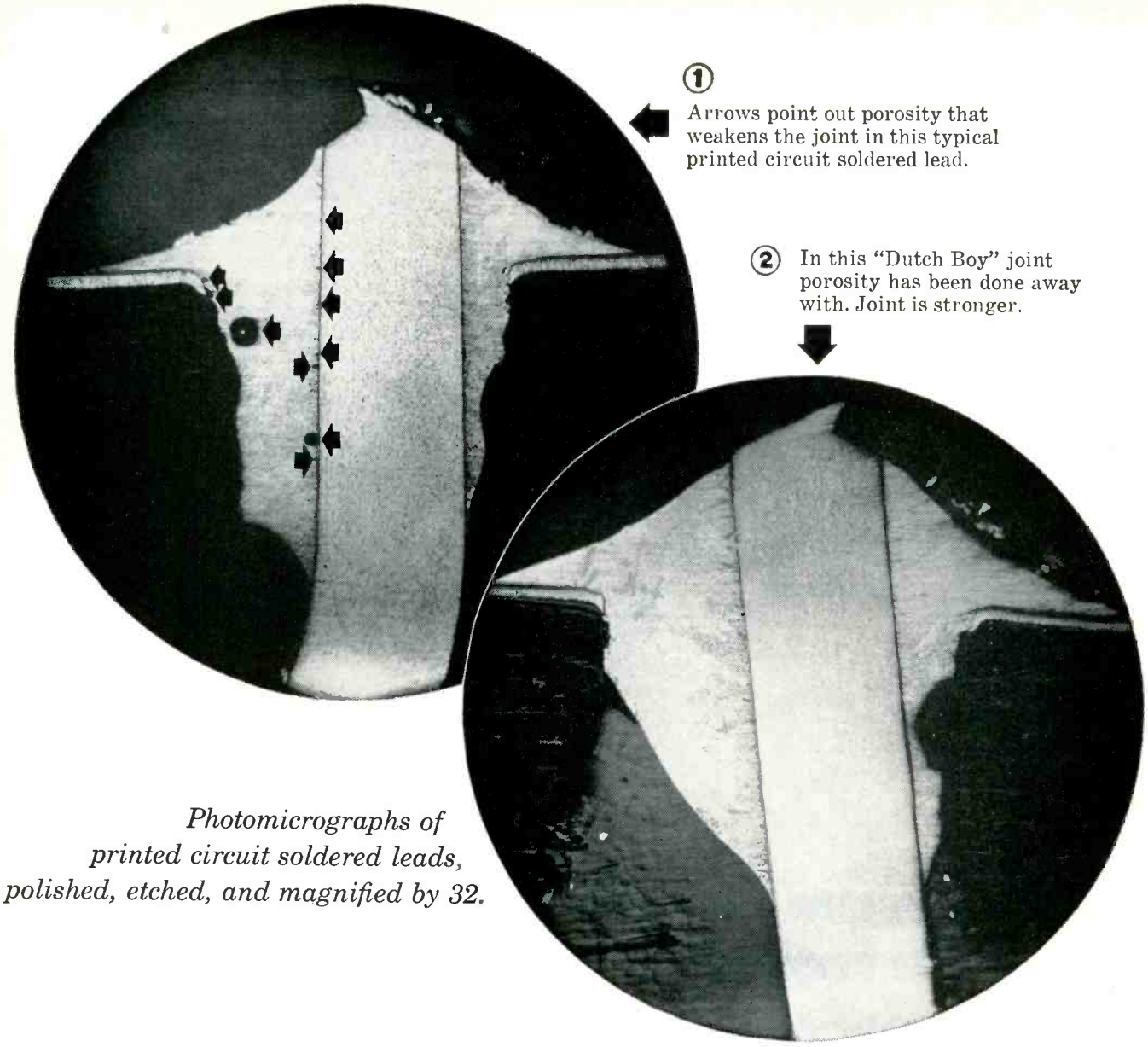
Visit us at Booths 1206-1207 at the Wescon Show.

FAIRCHILD
PRECISION POTENTIOMETERS and COMPONENTS

Want more information? Use post card on last page.



① Arrows point out porosity that weakens the joint in this typical printed circuit soldered lead.

② In this "Dutch Boy" joint porosity has been done away with. Joint is stronger.

Photomicrographs of printed circuit soldered leads, polished, etched, and magnified by 32.

"Dutch Boy" gets inside story on printed circuit soldering

...develops solders and fluxes that give stronger joints, coat more uniformly, show higher conductivity

"Dutch Boy" researchers keep a close eye on printed circuit soldering.

For example, they cross-section soldered leads, polish, and examine the polished sections under the microscope.

Most such joints prove too weak

The photomicrograph above left shows why. Notice this typical joint is honeycombed with porosity. Arrows point to holes.

Now look at the photomicrograph on the right. This joint is strong. Non-porous.

How was joint on the right made stronger?

No great trick. A "Dutch Boy" Solder Specialist simply worked out slight improvements in flux and solder formulae and operating conditions.

Maybe this would help improve *your* printed circuits.

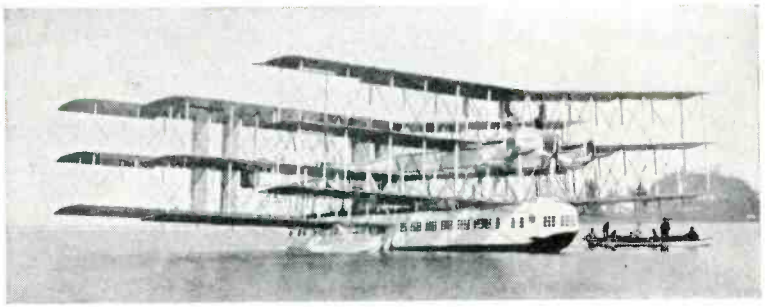
"Dutch Boy" solders develop maximum surface tension. They don't form "tear drops" when coated boards are lifted from the bath...they improve coating uniformity. The residual flux is both non-corrosive and non-conductive, and can be left on the soldered board.

So, if you feel there is room for improvement in your printed circuit soldering, look first to "Dutch Boy". Write, giving details if possible, to National Lead Company, 111 Broadway, New York 6, N. Y.

Dutch Boy®
SOLDER AND FLUXES

too modern?

Built by Count Gianni Caproni, in 1922, this 100 passenger flying boat, with three banks of triplanes and eight engines, was thought by some to be too modern for its time. Today's newest, fastest jet leaps the sonic barrier on abbreviated wings . . . only 7-1/2 feet from fuselage to tip.

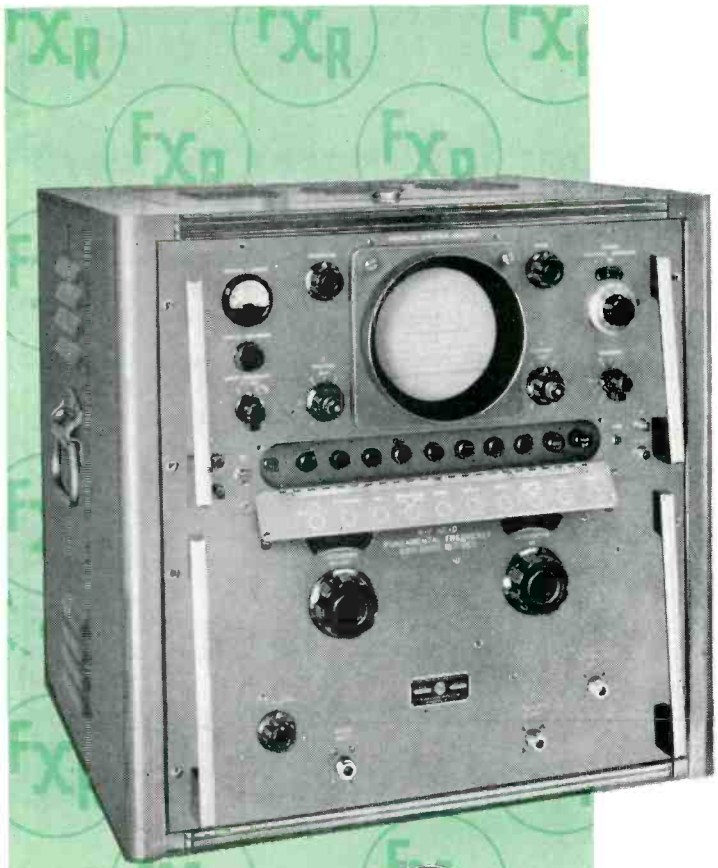


Courtesy "Pegasus"—Fairchild Engine & Airplane Corp.

Simplicity Spells Progress . . .

in the FXR BROADBAND SPECTRUM ANALYZER

. . . with broadband r-f heads and superior specifications



Once complexity was a constant companion to progress. Today, new trends in technology achieve tremendous advances through simplicity of design.

FXR's Spectrum Analyzer too has achieved tremendous advances in every major specification. The r-f heads are broadbrand in design permitting operation with one head in the range from 950 to 16000 Mc. Then too, there is more sweep width and the sweep range is greater, the display is better and all of the controls are more convenient. A versatile microwave receiver, this unit reflects the careful craftsmanship and quality components for which FXR is famous.

SPECIFICATIONS

Frequency Range:	L701A: 950 to 2000 Mc Fund. Freq. S701A: 1900 to 4000 Mc Fund. Freq. Harmonic operation to 16,000 Mc
Accuracy of Frequency:	Direct Reading Dial: ±1%*
Sensitivity:	– 90 dbm at 7 Kc Bandwidth – 80 dbm at 50 Kc Bandwidth Low Dispersion Fund. Freq.
Note: Sensitivity decreases approx. 7 db per harmonic.	
Sweep Width:	50 Mc maximum
Resolution:	7 Kc and 50 Kc (Front Panel Switch)
Input Attenuator:	Direct Reading to 100 db Accuracy: ±1 db over entire range
Sweep Rate:	1 to 35 sweeps per second (2 ranges)
Display Tube:	5ADP7

N410A

*When greater accuracy is required, the FXR Type No. N410A Direct Reading Coaxial Frequency Meter will provide ±0.1% accuracy from 1000 to 4000 Mc.

FXR · ELECTRONICS & X-RAY DIVISION · F-R MACHINE WORKS, INC. ·

FIRST BY FAR

Electronics & X-Ray Division

F-R MACHINE WORKS, Inc.

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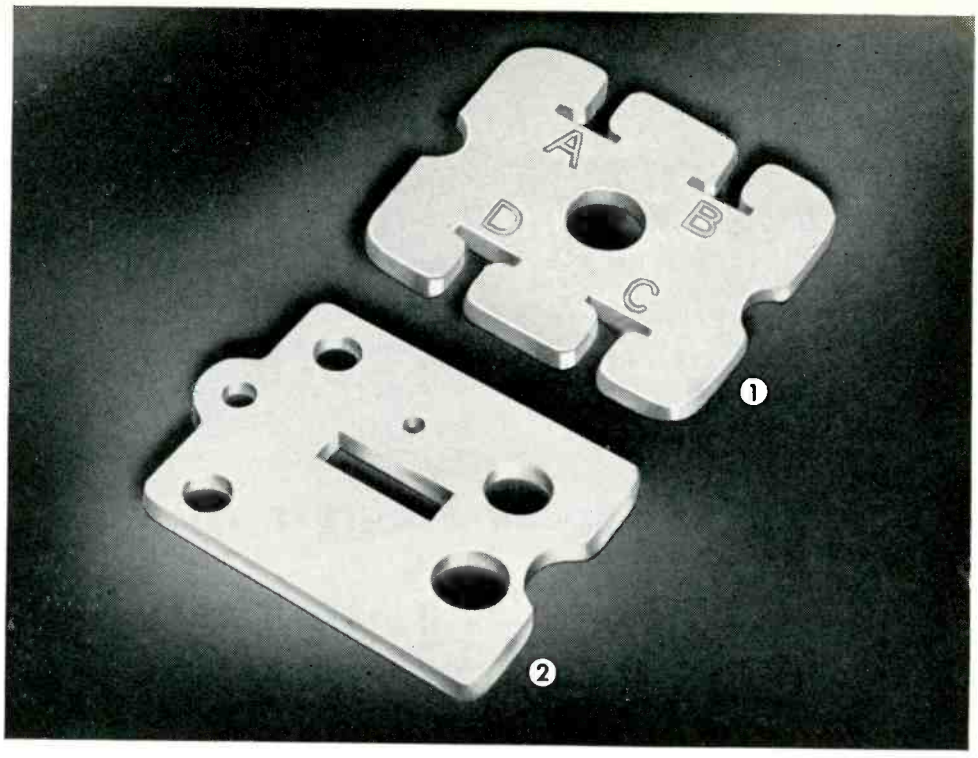
Now Available: New 1956-57 Catalogue of the complete line of FXR PRECISION MICROWAVE TEST EQUIPMENT.

At the WESCON, see Van Groos—Booth No. 1138

Want more information? Use post card on last page.



1. Grade XP-240 for warm punching. *2. Grade XXP-241 for hot punching.*

Put these two new Taylor phenol laminates to work

HERE are two major additions to the extensive Taylor line of laminated plastics. There's a good chance that a product you're now designing can be improved through the use of these new materials . . . or that products now in your production line can be more economically made with them. Check the features of these outstanding paper base, phenolic laminates. They may be exactly what you're looking for.

Grade XP-240 is a warm punching grade that requires some heat when punching more complicated shapes, though much less heat than comparable NEMA grades . . . and can be cold punched in thicknesses to 1/16". With this material, there's no lifting around punched holes, and check-in is negligible. It has excellent staking characteristics, and good dielectric strength. XP-240 has much to recommend it for such applications as insulating washers, terminal boards, plug and socket bases, switch bases, panels for sub-assemblies, and terminal strips.

Grade XXP-241 is a hot punching grade with excellent physical and electrical characteristics, plus good moisture-resisting properties. It's dimensionally stable, punches without lifting around holes, and machines with clean-cut edges. XXP-241 can be used to advantage in such applications as condenser stator brackets, wave switch rotors and stators, plug and socket bases, terminal boards and sub panels, insulating washers. Both laminates are available in sheets approximately 49" x 49".

If you're interested in fitting these tough, versatile materials into your plans, Taylor engineers will help you work out design and production details. Call or write for the facts.

TAYLOR FIBRE CO. • Plants in Norristown, Pa. and La Verne, Calif.

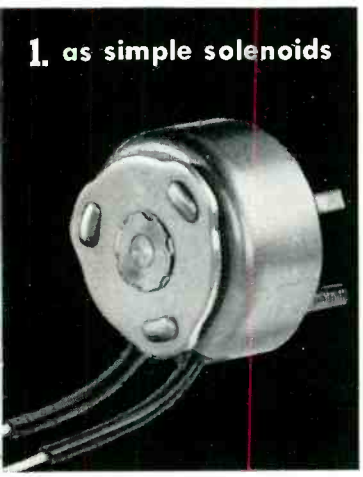
Taylor Fabricating Facilities

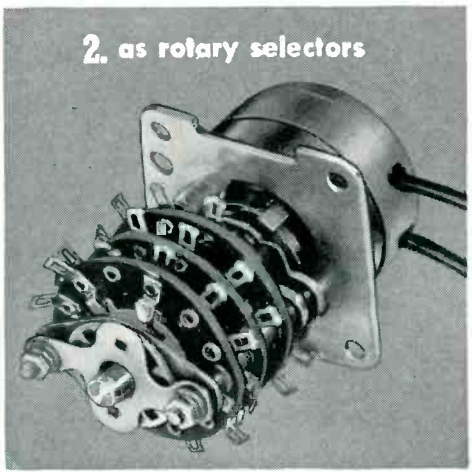
Your production can be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and over-all costs reduced by having Taylor fabricate finished parts to your specifications. Efficient, modern facilities are ready to serve you. Get in touch with Taylor about your specific requirements.

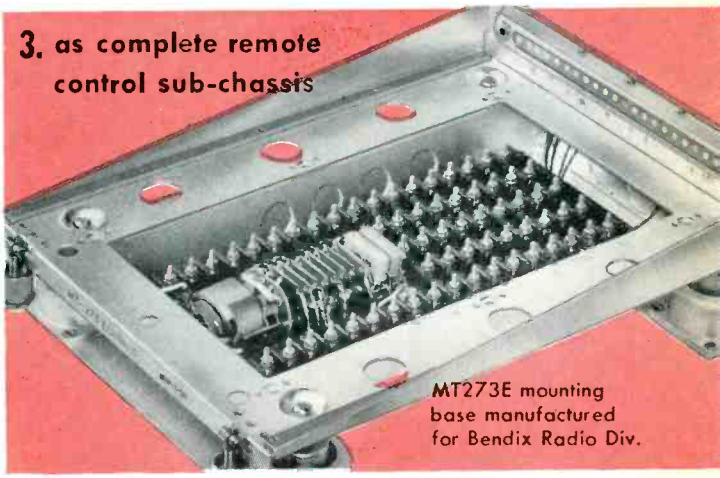
TAYLOR
Laminated Plastics
Vulcanized Fibre

remote control circuits packaged to your specifications with OAK rotary solenoids*

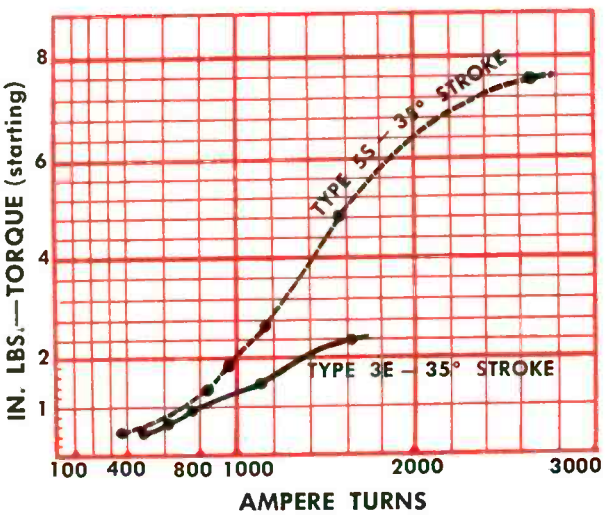
application-engineered and produced to meet your requirements







rugged, compact units that meet the most stringent MIL specs



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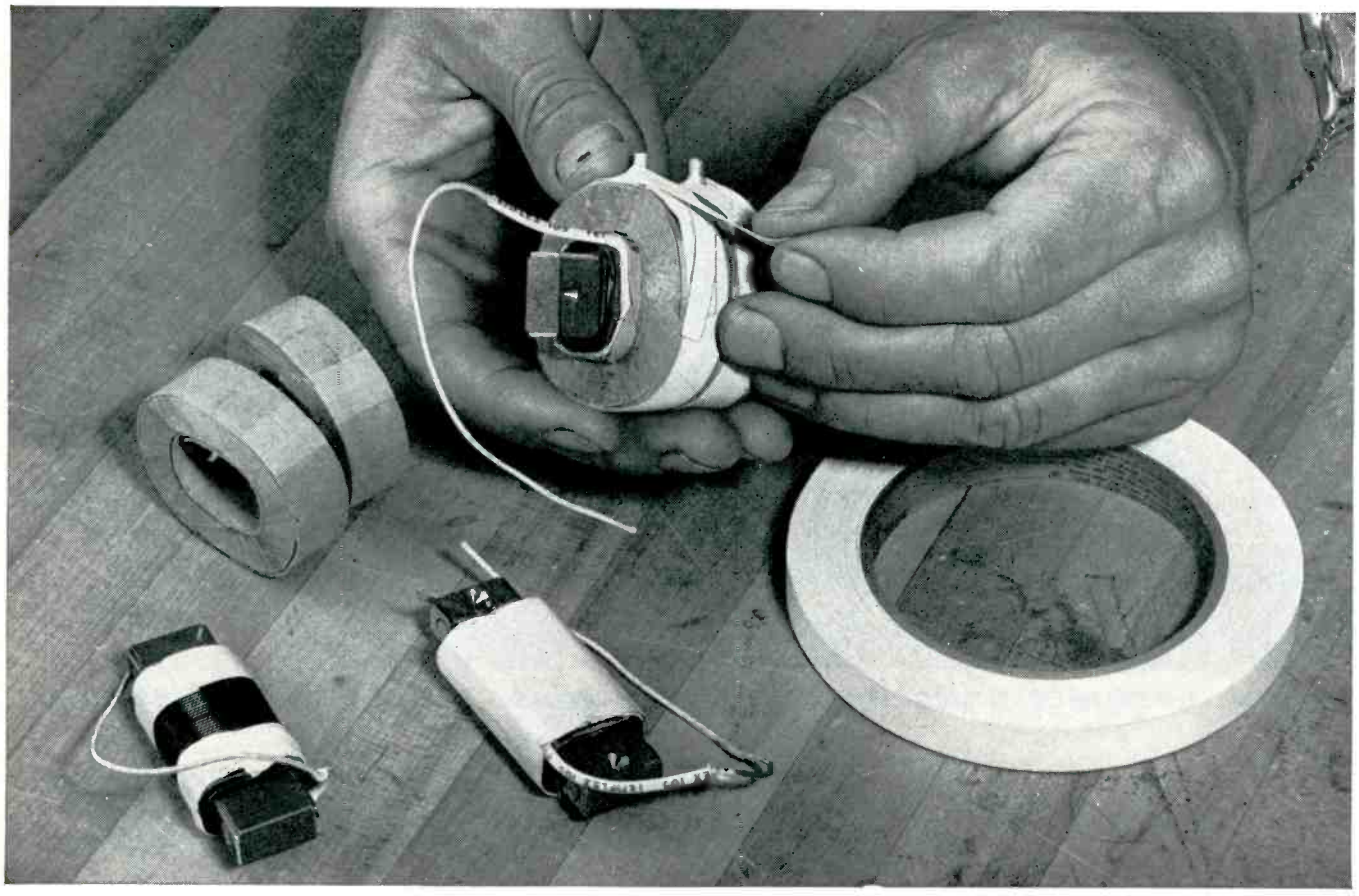
"SCOTCH" 28 prevents solvent action in Fairbanks-Morse coils

White acetate-cloth tape has true thermosetting adhesive



Insulating tape *must* hold on top-quality resin-encapsulated coils such as those turned out by Fairbanks-Morse. *True thermosetting* adhesive tapes are unaffected by solvent action of synthetic casting resins, especially those containing monomeric components. Result: A completely cured coil with no soft or wet spots. That's why "SCOTCH" Brand Thermosetting Tape No. 28 anchors primary leads and holds terminal posts on the secondary in Fairbanks-Morse coils.

"SCOTCH" Brand Thermosetting Tapes have a pressure-sensitive adhesive that sticks at a touch. After the curing process, these tapes become highly resistant to the solvent action of waxes, varnishes and resins, preventing softening or throw-out. Adhesive holding power actually *increases*, positively anchoring all components under high-heat conditions.

Next time you have a heat or solvent-resistant job for tape, think of the pressure-sensitive tapes with the *true thermosetting* adhesive — "SCOTCH" Brand! For more information, write 3M, Dept. CA-86, St. Paul 6, Minnesota.

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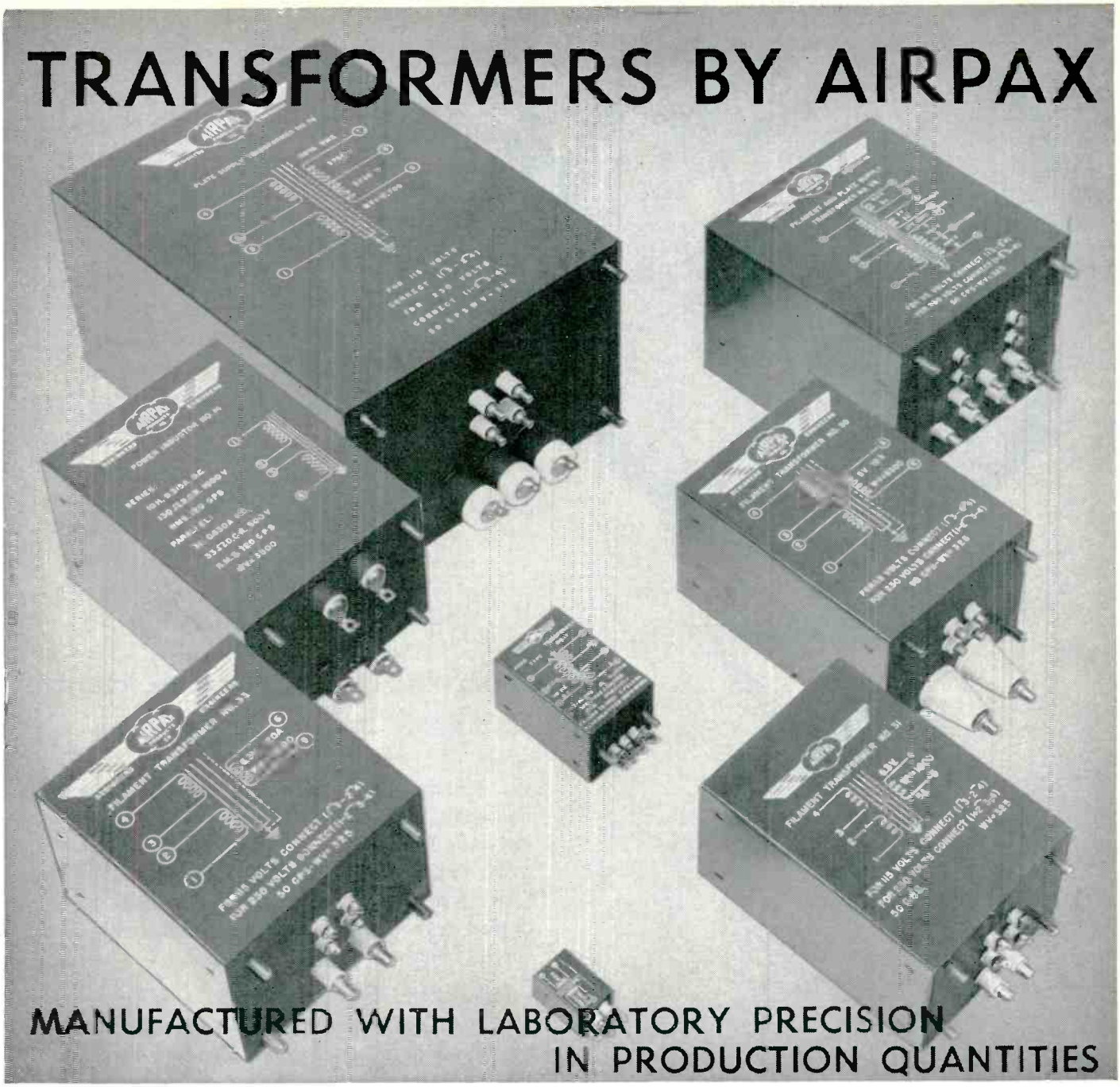
TRANSFORMERS BY AIRPAX



MANUFACTURED WITH LABORATORY PRECISION IN PRODUCTION QUANTITIES

Airpax manufacturers transformers with laboratory precision in production quantities. Engineers who need expertly designed transformers regularly send their specifications to Airpax.

The eight transformers shown here are typical of the hundreds of designs that Airpax regularly produces to customer requirements. These particular units meet MIL-T-27A. We will gladly send you copies of the drawings for them, which give complete mechanical and electrical ratings. Other Airpax transformers are going into industrial controls and test equipment.

Airpax superiority is the result of two ingredients: thorough design with attention to every detail, and careful production under close supervision. Transformers containing these ingredients cost little more and take only a trifle longer to design and build but give greatly improved performance, which after all, is what interests you most. Companies that value their reputation for quality equipment buy transformers from Airpax.

When your equipment depends on an especially reliable transformer designed and manufactured to the highest standards, turn to

AIRPAX

DESIGNERS ENGINEERS

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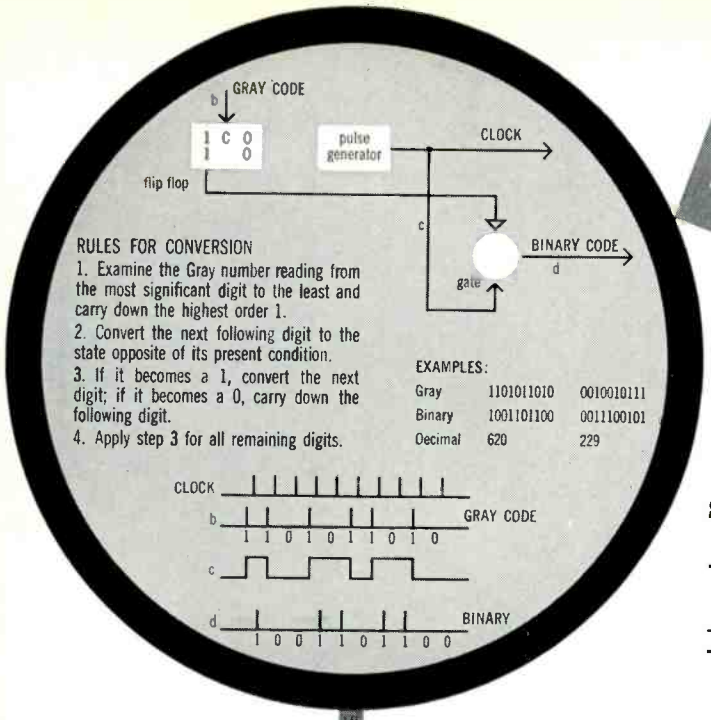

solving logical problems with Burroughs pulse control systems

TOOLS FOR ENGINEERS

converting Gray code to binary equivalents

Here is a simple method for converting Gray code to true binary equivalents. It was put into operation in minutes just by interconnecting Burroughs Pulse Control Units in accordance with the engineer's block diagram, without detailed specifications or complicated circuit designs. With pulse control equipment at his disposal, the engineer was able to turn immediately to other important problems awaiting his attention.

The majority of engineers solving logical problems are badly in need of such tools. Most are bogged down by equipment of limited use that must be redesigned and rebuilt for every new project . . . that clutters the path to a working solution instead of clearing and shortening it.

The smallest discrete units with which such a man can work are logical concepts . . . the basic logical operations. The ideal tools for him are these same operations, packaged for convenient and immediate use by simple interconnections—like the blocks in his block diagram. Such tools are Burroughs Pulse Control Units, which bring block diagrams to life in a matter of hours rather than weeks. Wherever logical problems are being solved with pulses they have earned the title "Tools For Engineers" by eliminating intermediate steps to a proof, obsoleting the frustrations and complexities of breadboarding.

Why not lift the burden of proof from your shoulders by passing pulse problems on to us? We'll gladly show you how Burroughs Pulse Control Units can bring your logical problems closer to a neat working solution . . . at no cost. Or, write for Bulletin 236.

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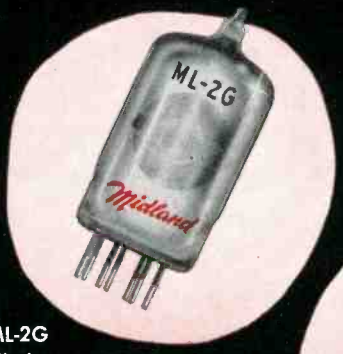

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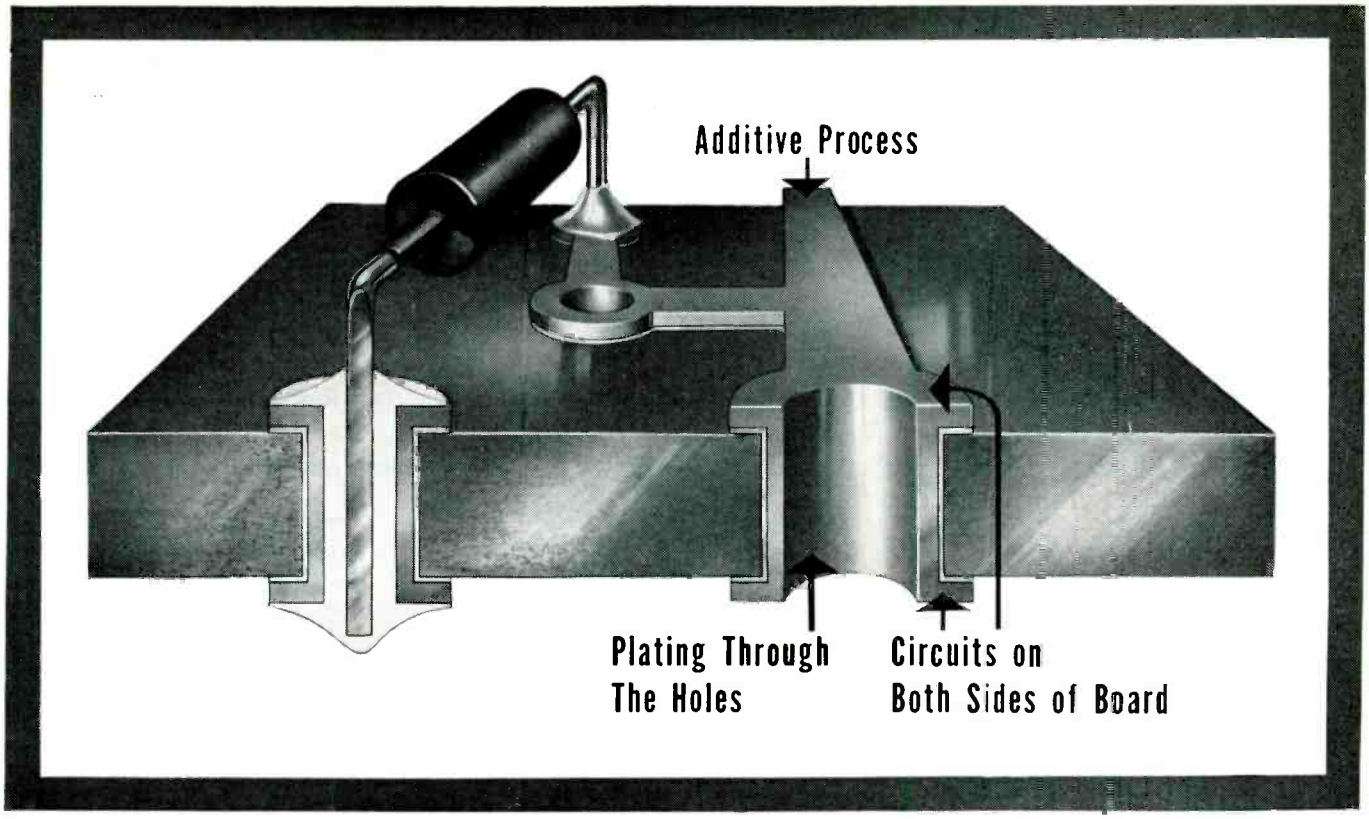


Order General Electric "Thru-Con" Boards for positive connections through the holes—see them at Booth 1213 at the Wescon Show, August 21-24

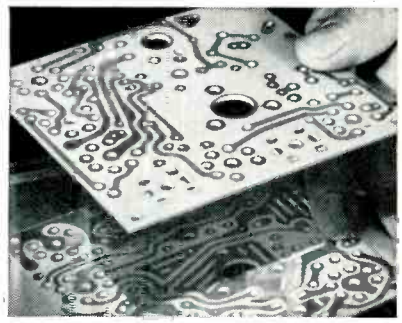
"Thru-Con" insures accurate solder filleting top and bottom for extreme strength and easier assembly.

Original Design Features. Original General Electric additive-method production techniques provide continuous copper plating through the holes. Positive connections do away with separate staking pins, assure perfect circuits. Costly rejects due to difficult soldering problems are eliminated. If desired, G-E "Thru-Con" boards may provide patterns on both sides, further reducing size and weight.

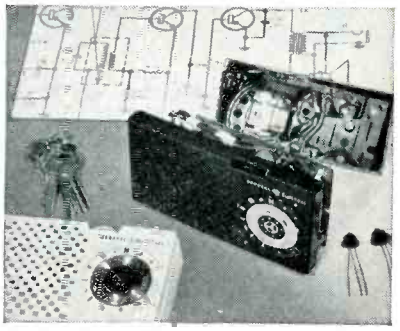
"Thru-Con" Boards Serving Many Industries. Important economies afforded by dependable G-E "Thru-Con" boards are helping manufacturers cut costs and improve profit pictures. Producers of lamps, radios, fans, street lighting and traffic control units, television receivers, appliances, and control equipment are using "Thru-Con" now.

Full Production Facilities. The G-E "Thru-Con" plant is devoted to full-time production of printed circuit boards. New, specially-designed equipment is capable of producing thousands of boards each day. The combination of custom wiring patterns, sizes, and shapes is virtually limitless.

Investigate G-E "Thru-Con" Boards, Today. It will pay you to look into the savings "Thru-Con" boards make possible in manufacturing techniques. For a full discussion of your printed circuit program, and a sample "Thru-Con" board, call or write: *General Electric Co., Specialty Electronic Components Dept., Section 486, Auburn, New York.*



G-E "Thru-Con" Printed Circuit Boards offer *positive connection through the holes*, without staking pins, patterns on both sides if needed. Printed circuitry cuts assembly time; eliminates product bulk, weight; reduces inspection time, parts inventory.



Positive Proof. This new transistorized portable radio features a full printed circuit using a G-E "Thru-Con" Board. Combining other advances in electronics with a "Thru-Con" circuit makes possible sweeping changes in size, weight, and styling.

ADVANCED COMPONENTS FOR THE ELECTRONICS INDUSTRY

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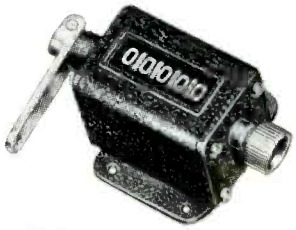
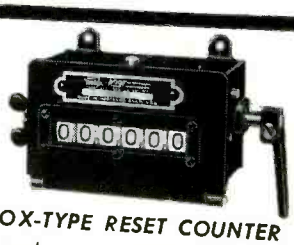


SMALL RESET COUNTER

A compact, rugged reset counter for moderate duty in parts inspection, quality control, conveyors, machine tools, light presses, etc.

Dimensions: 1¾" long, 1 19/64" high, 1 7/16" wide

Speed: Up to 1000 counts per minute.



BOX-TYPE RESET COUNTER

For punch press installations, conveyors, metal-working equipment, die casting, plastic-molding, rivet, spring and wire machining, or any installation requiring a heavy duty counter.

Dimensions: 4¼" long, 2 5/32" high, 3⅜" wide.

Speed: 500 counts per minute.

RESET MAGNETIC COUNTER

For remote indication of machine operation from plant to office.

Dimensions: 3 5/16" long, 2½" high, 1⅝" wide.

Speed: Up to 1000 counts per minute.

Coils: 110V-AC are standard. Other voltages are available. Panel mounting feature also available.

HAND TALLY

For quick spot-checks of production or performance.

Dimensions: 1 17/64" long (to end of reset knob), 1¾" deep, 2" high.

Counts one for each depression of the thumb lever, and resets to zero by a turn of the knob.

CLUTCH SPEED COUNTER

For checking to make sure that the machine is operating at the required R.P.M.

Dimensions: 3¼" long, ⅞" max. diameter. Non-Reset.

Internal clutch operates counter only when rubber tip is pressed against the shaft.

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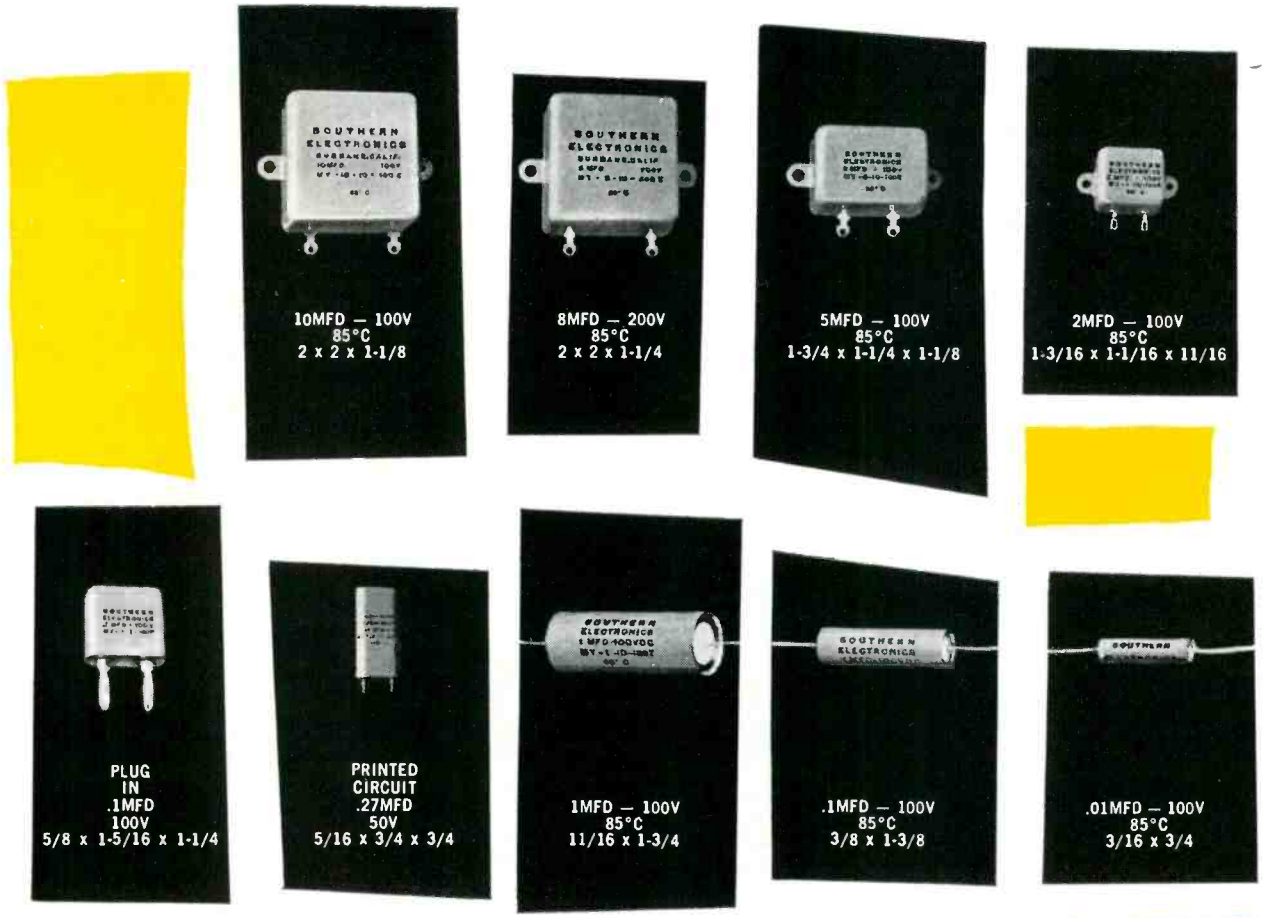

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300 volts — 33⅓%
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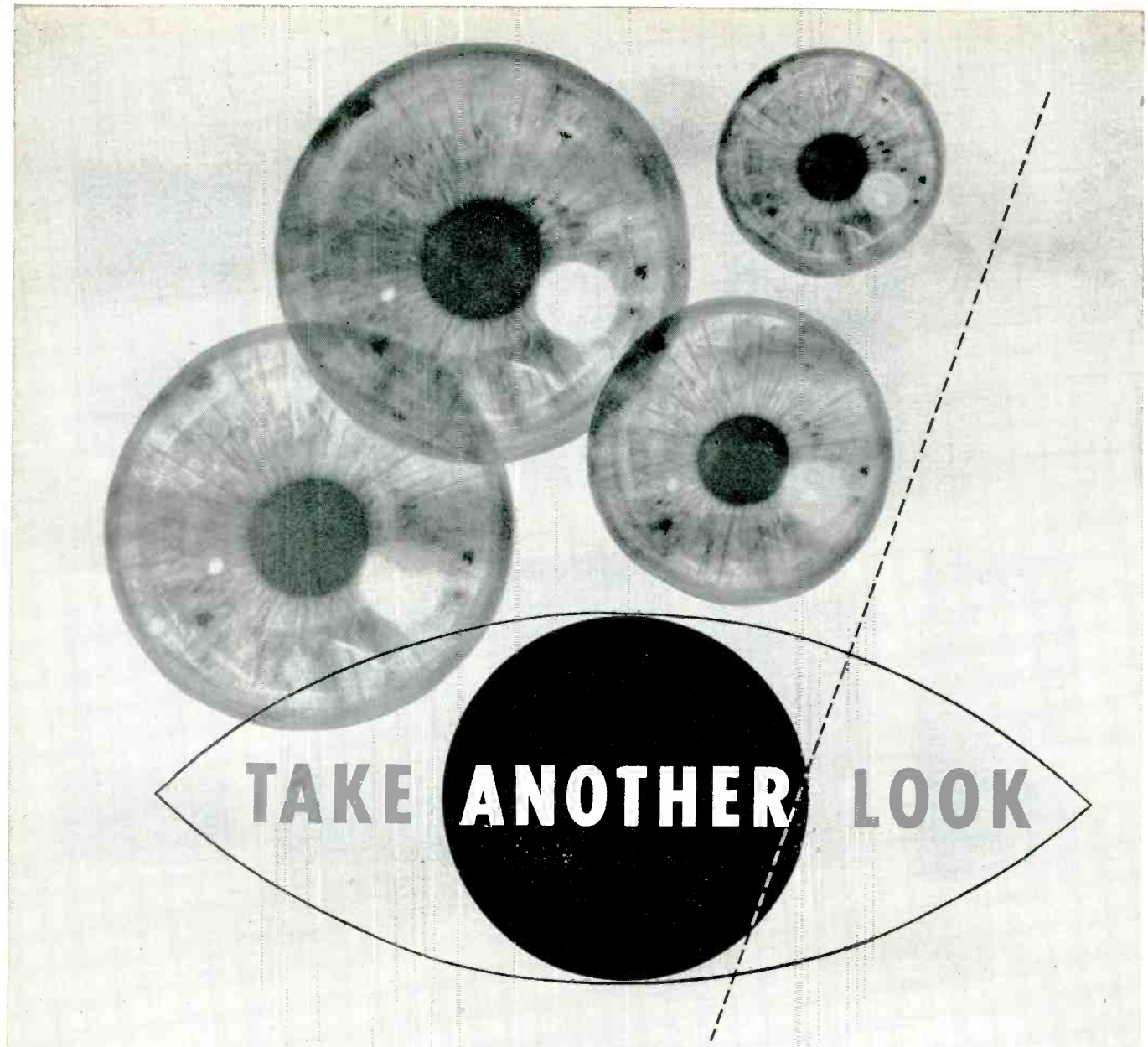

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Now . . . For The First Time . . . Precision Features in a Low Priced VHF Signal Generator . . . Ideal For Production Use!

This attractively priced RCA Signal Generator has laboratory precision features that make it highly desirable for production use. Excellent frequency accuracy and stability. Individually calibrated. Negligible RF leakage. Wave-guide below cut-off type attenuator normally found in more expensive instruments.

Valuable in designing and evaluating receivers, amplifiers, and other apparatus that operate at frequencies between 5 and 230 mc. Particularly useful in measuring sensitivity and gain and for driving impedance bridges. Other signal generators available to meet your equipment and price requirements.

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Here's a closely regulated D-C Power Supply accurate enough for the most exacting laboratory use, yet sufficiently rugged to use out in the plant for production testing and quality-control work. Back of this unusual combination is the Leach MAGNIVOLT's construction . . . it uses only static components, contains no vacuum tubes or other fragile parts. Heart of the unit is a design based on magnetic amplifiers and selenium rectifiers, assurance of stability today and long, maintenance-free dependability for years to come.

Use the MAGNIVOLT, either portable or easily rack mounted, as a dependable D-C voltage source in such demanding applications as these . . .

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A-C Input.....120 volts, 60-cycle, single phase

D-C Output.....3-32 volts (continuously adjustable) at 0 to full-rated amperage

Ratings Available.....5 to 30 amperes (max.)

Voltage Regulation...±½% from 24 to 32 volts for load change of no-load to full-load and for suppy-voltage change from 105 to 125 volts

Ripple.....less than 1% r.m.s.

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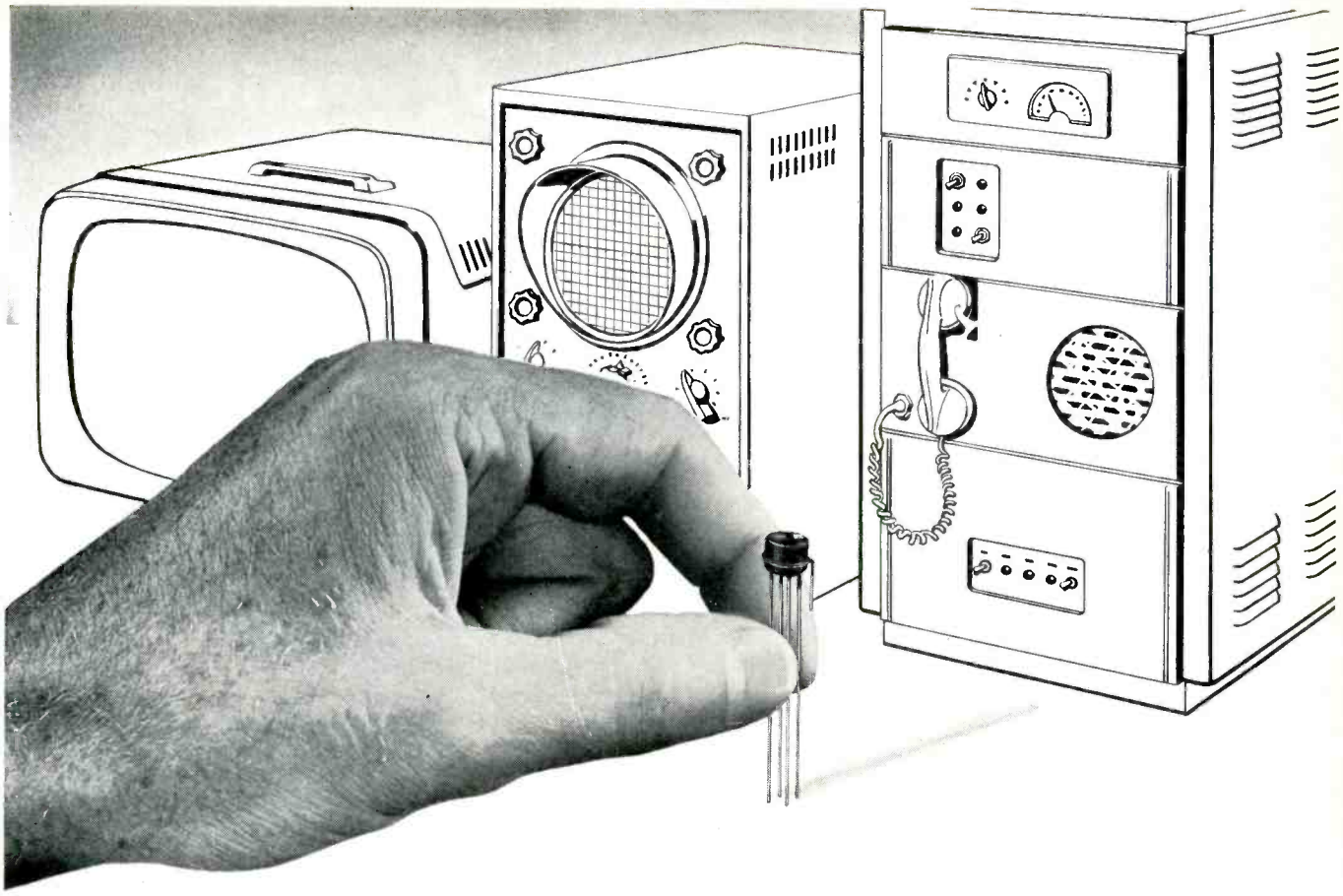

New General Electric Tetrode Transistor Amplifies at 120 mc

The new General Electric Germanium NPN Tetrode has been designed for amplification, switching, controlled oscillation, AGC, and other higher frequency operations

Meltback process, new package design. Higher frequency operation is made possible by recent G-E developments of the meltback process. Exceptional results obtained from devices produced through this process have led to the design of this new transistor. A new standard package design provides easy adaptation to printed circuit applications, an extra lead for grounding when used at higher frequencies, good heat dissipation, and a more convenient smaller size.

In Television Circuits: This transistor used in a six-stage TV IF amplifier operates at a center frequency of 45 mc. Maximum bandwidth in each tank circuit can be obtained with a variable inductance which resonates with the transistor and circuit capacitance. This tetrode amplifier delivers up to 57 db gain with a 4 mc bandwidth. A video amplifier of two stages, each containing a tetrode—produces a power gain of 33 db ±.4 db from 30 cps to 10 mc which is equivalent to vacuum tube performance.

In Radar Circuits: The new tetrode has been used in a standard radar IF amplifier. Operation showed a 70 db power gain at 30 mc with a 3 mc bandwidth.

In Oscillator Circuits: An oscillator operating at 110 mc produced a 10 mw output power.

In Pulse Circuits: A typical circuit with a pulse repetition rate of 1 mc has a peak pulse power gain of 10 db. The output pulse has a rise and fall time of 0.025 microseconds and a pulse width of 0.07 microseconds.

Four Typical Tetrode Specifications Are:

Collector Voltage	—	7 volts
Power Gain	—	10 db min. at 120 megacycles
Bandwidth	—	2 megacycles
Power Dissipation	—	50 milliwatts at room temperature

Ask your General Electric Semiconductor Specialist for the full details and technical specifications. Or, write today to: *General Electric Company, Section X486, Semiconductor Products Department, Electronics Park, Syracuse, N. Y.*

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the Heiland dynamic recording system gives you more...

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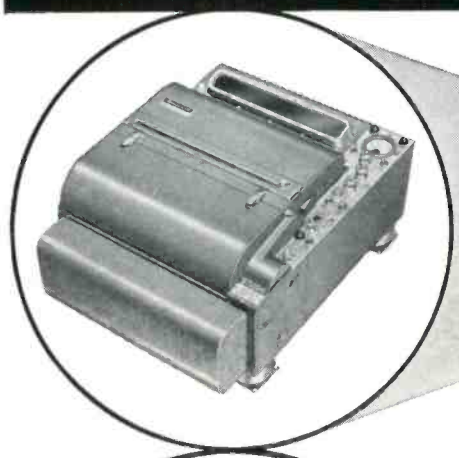
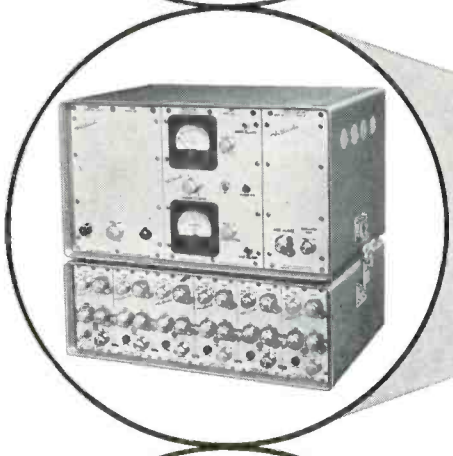
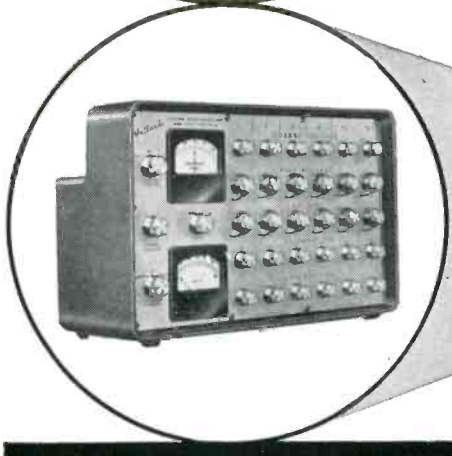


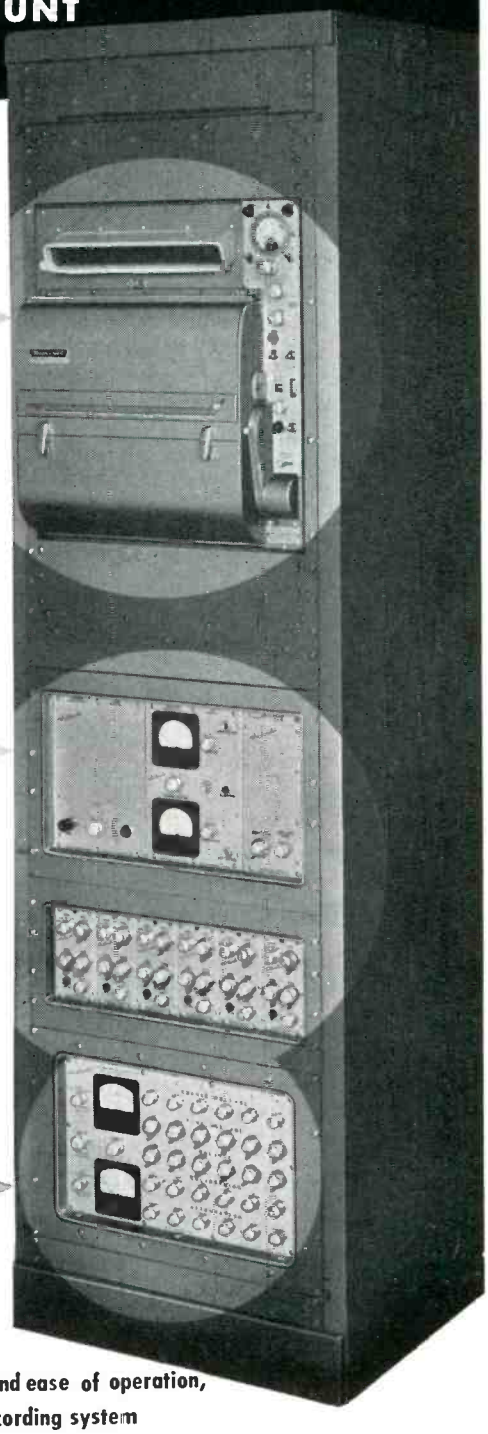
The Series 700 oscillographs feature 8" paper width with 1-36 channels, or 12" paper width with 1-60 channels. Available for 28 v.d.c. or 115 v.a.c. operation, the 700 Series has paper speeds adjustable from .030 to 144"/sec., and writing speeds in excess of 20,000"/sec. Separate supply and take-up drums are light-weight—and light tight for easy daylight loading.



The Heiland 119 Amplifier System offers up to 6 channels, in any combination, of either linear-integrate amplifiers or carrier amplifiers. Carrier amplifier channels provide linear frequency response from 0 to 1000 CPS, for resistive, linear differential transformer, or variable reluctance type transducer inputs. Linear-integrate amplifier channels provide linear frequency response from 5 to 3000 CPS for self-generating transducers. Provides high-amplitude recording up to 8" peak to peak deflection.



The Heiland 82-6 Bridge Balance and Strain Indicator Unit provides a simple and accurate means of balancing, calibrating and measuring static and dynamic phenomena from resistive-type transducers where you don't need amplification. When used as a strain-indicating device without an oscillograph, an input of 25 microamperes produces full scale on the indicating meter.



For versatility, performance, and ease of operation, choose the Heiland dynamic recording system

For details and specifications, write for Bulletin 701-RK

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Typical Temperatures	−60°C. to +150°C.
Typical Line Frequencies	60cps to 6000cps

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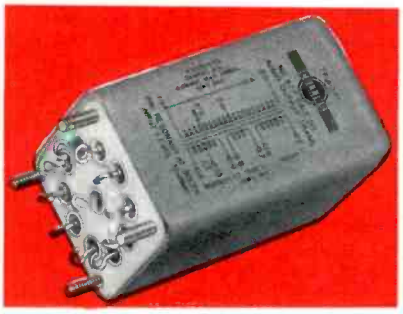
Recommended for supply frequencies above 400 cps and where size performance and reliability are factors. Thin nickel alloy toroidal cores reduce core losses. Toroid structure cures stray field problems.

SEALED MISSILE POWER SUPPLIES combining toroidal power transformers, toroidal filter chokes, hi temp capacitors and silicon rectifiers. These units offer multiple outputs and low ripple. Low stray field of toroidal elements obviate usual internal shielding. Mag regulation where required.



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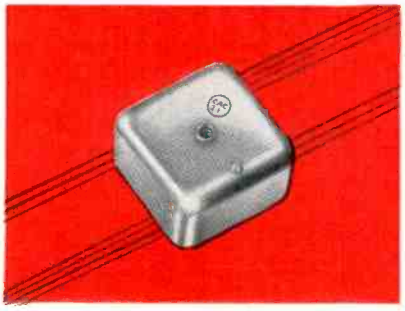
A complete line of laminated constructed units are now available through CAC. Our highly qualified engineering staff, a well complimented laboratory, humidity controlled production facility with modern manufacturing equipment guarantees conformance with any specifications. Both power and audio transformers employing advanced techniques can be supplied either hermetically sealed or encapsulated to 150° C. ambients. Catalogues, supplied upon request, cover a wide range of standardized designs including omnirange and ILS Filters.



PRECISION RATIO COMPUTER TRANSFORMERS

Toroidal form of construction is ideal for designing precision ratio transformers since the turns of wire are applied to and adjusted *on* the core. Normal production procedure of zero turn accuracy, high permeability cores, low phase shift, and near unity coupling will yield laboratory quality on any production run. Advanced design and newest packaging methods provide optimum performance with minimum size and rugged construction.

Catalogs on Individual Components are Available on Request.

New Grant 3400 *thinslide*

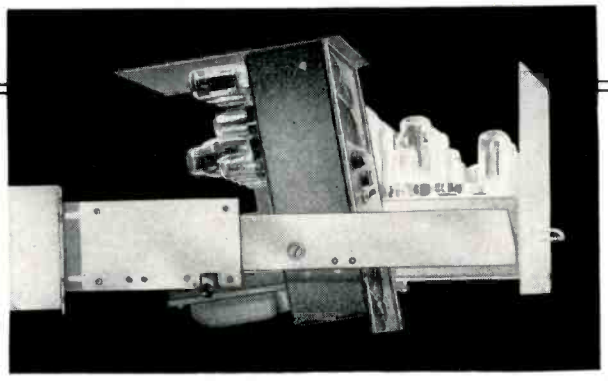
mounts standard 17" chassis in standard 18" rack or cabinets

REQUIRES ONLY 19/64" SPACE PER SIDE—

YET HAS

FULL ROLLER ACTION

(fits RETMA *rack hole spacing)*



The Grant 3400 Thinslide requires only 19/64" space per side—installs readily in standard racks and cabinets. Allows instant access to chassis measuring from 10" to 16" deep. Tilts through 100° for under-chassis servicing. Positive lock in "out" position. Lock has finger-tip release for instant return or removal of chassis. Eight hardened steel rollers carry the rated load of 100 lbs. smoothly and easily—durability insures frictionless rolling for thousands of cycles of use.

Slide mounting not only provides for quick access—it usually eliminates need for rear access doors and rear aisles—a very important saving of space.

The Grant 3400 is a versatile slide, suited for use in your *product*, in *plant equipment, prototype* and *breadboard* work, and in *production line or field test equipment.* Very moderate cost allows a wide range of applications in original equipment.

Write today for Grant 3400 Thinslide Technical Bulletin—contains full data and specifications.

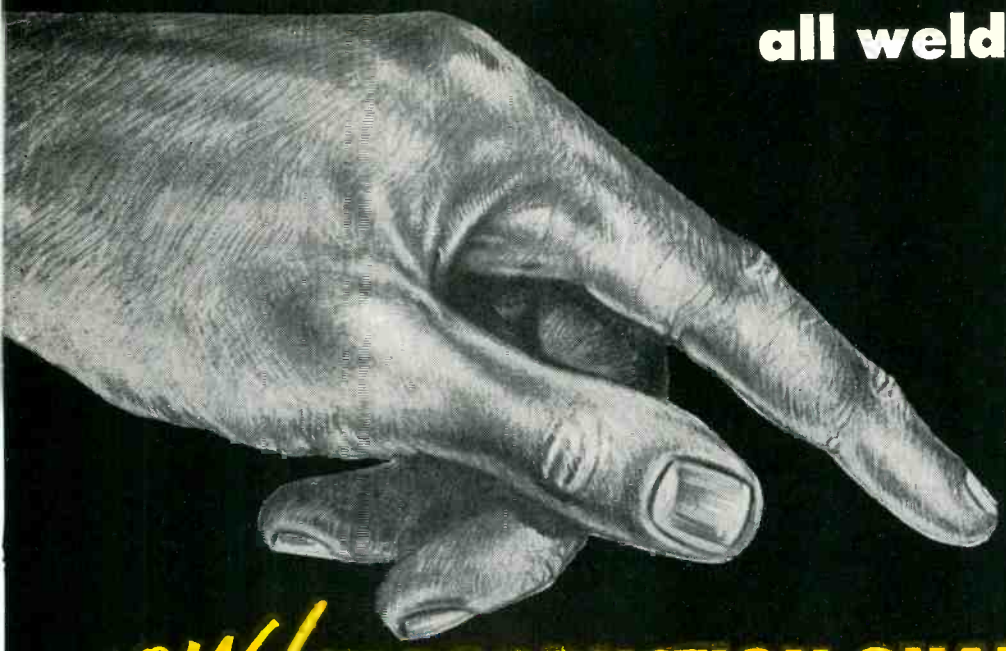
Grant INDUSTRIAL SLIDES

Grant Pulley and Hardware Corporation

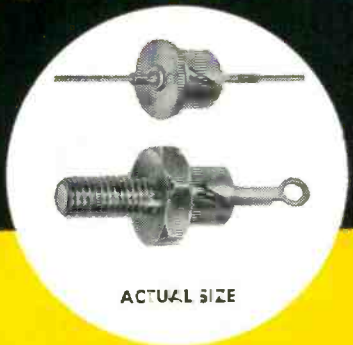
factories: **31-73 Whitestone Parkway, Flushing 54, N. Y.**
944 Long Beach Avenue, Los Angeles 21, Calif.

ONLY available source in all welded construction

STUD MOUNT
PIGTAIL



NOW! IN PRODUCTION QUANTITIES



ACTUAL SIZE

AUTOMATIC SILICON POWER RECTIFIERS

At 150° C quality Automatic Silicon Power Rectifiers really perform, featuring negligible reverse leakage current and sharp zener breakdown, plus the exclusive ALL WELDED CONSTRUCTION on *both* stud-mount and pigtail lead types. These field-proven units *are available in quantity*.

Automatic Silicon Power Rectifiers are *your best buy* for switching circuits, blocking circuits, magnetic amplifiers, power supplies, and dozens of other applications.

Write or wire today for complete technical data. Automatic can supply types 1N253, 1N254, 1N255, 1N256 in conformance with JAN specifications.

TYPICAL DATA FOR 25°C AMBIENTS

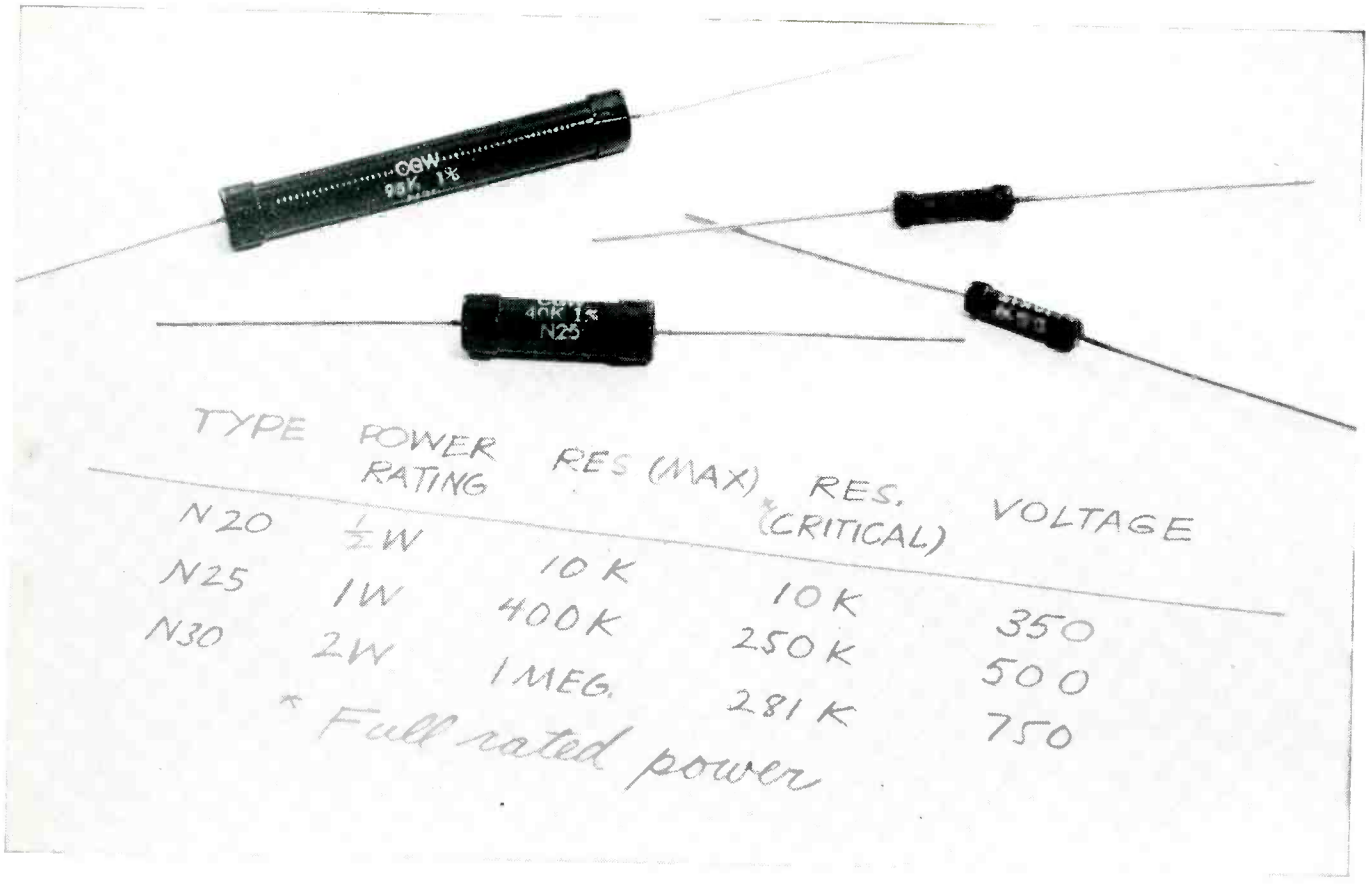
Type No.	P. I. V. (volts)	Average DC Output Current (MA)	Reverse Leakage At Rated P. I. V. (μA)	Mounting
1N440	100	300	0.03	Pigtail Leads
1N441	200	300	0.075	"
1N442	300	300	0.10	"
1N443	400	300	0.15	"
1N444	500	300	0.18	"
1N445	600	300	0.20	"
1N530	100	300	0.30	"
1N531	200	300	0.75	"
1N532	300	300	1.00	"
1N533	400	300	1.50	"
1N534	500	300	1.80	"
1N535	600	300	2.00	Pigtail Leads
1N560	800	300	1.50	"
1N561	1,000	300	2.00	"
1N550	100	500	.05	Stud-Mount
1N551	200	500	.10	"
1N552	300	500	.15	"
1N553	400	500	.20	"
1N554	500	500	.25	"
1N555	600	500	.30	"
1N562	800	500	1.50	"
1N563	1,000	500	2.00	"

AUTOMATIC MANUFACTURING

DIVISION OF GENERAL INSTRUMENT CORPORATION
65 GOUVERNEUR STREET NEWARK 4, NEW JERSEY

MASS PRODUCERS OF ELECTRONIC COMPONENTS

GN



New film multiplies Corning Type N resistance range 10 times on N 25 - N 30 types . . . closer tolerance TC now available

Now you can use rugged, stable Corning Accurate Grade Resistors of high resistivity in your critical circuits.

Corning scientists have developed a new 600 ohms per square resistive film. This new film, which is integrally bonded to the glass core, increases the resistance values for each Type N size as noted above. This table shows you the new ratings.

With this development, you also get a much improved temperature coefficient. It can be guaranteed to ±300 ppm/° C. over the temperature range of −55° C. to ±105° C. referenced to 25° C.

You get these noninductive resistors in standard tolerances of 1%, or closer if you wish. They are stable, have low voltage coefficients and noise levels so low they are difficult to measure. The film and the core are impervious to moisture. Even rough production handling and thermal shock of soldering will not alter values. Corning Type N Resistors meet or exceed MIL-R-10509A specifications.

You can use them in circuits where other precision resistors are unsuitable or in the place of costly wire-wound resistors. With their stable, noninductive, low-noise characteristics, you can use them in test equipment, high-frequency circuits—wherever you're working with low-signal, high-gain amplifier stages.

Our catalog sheet details complete information. We'll send it to you with samples and very interesting price lists at your request. Write us or circle this publication's reader service number.

Ask for information on these other Corning Resistors:

Low-Power 3-, 4-, 5-, and 7-watt sizes. Highest resistance range of any low-power resistor.

Type S—Stable performance to 200° C. Meet MIL-R-11804A specs. Values to 100,000 ohms.

Type R—High-power 2% or 5% resistors, 7 to 115 watts. Range from 10 to 1,000,000 ohms. Noninductive.

Type H—High frequency—Standard ranges from 10 to 1,000,000 ohms and ratings from 7-140 watts.

Type HP—High-power resistors. 17, 30, 70, and 150 watts DC. Tolerances of 2% or 5%. Range from 30 to ½ Megohm.

Type WC-5—5 KW water-cooled. Range −35 to 300 ohms. Versatile, adaptable.

Other electronic products by Corning Components Department:

Fixed Glass Capacitors*, Transmitting Capacitors, Canned High-Capacitance Capacitors, Subminiature Tab-Lead Capacitors, Special Combination Capacitors, Direct-Traverse and Midget-Rotary Capacitors*, Metallized Glass Inductances, Attenuator Plates.

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Components Department, Electrical Products Division

Corning means research in Glass

MICROWAVE
SIGNAL GENERATORS AND SIGNAL SOURCES

EHF

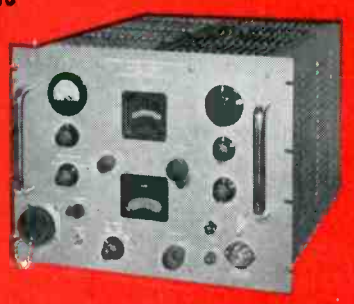
for extremely high frequencies 12,400 to 50,000 mc

Rugged, compact, completely integrated units. Designed to save engineering manhours in the laboratory and on the production line. Operate simply with direct-reading continuously variable dials. No calibration charts.

Frequency is measured by direct-reading reaction-type wavemeters that assure extreme accuracy. VSWR is exceptional—Signal Generators 1.7 to 1; Signal Sources 1.7 to 1 when attenuated. Calibration accuracy is given special attention.

Consult Polarad on all your EHF problems.

SG-1218



POLARAD MICROWAVE SIGNAL GENERATORS
12.4 TO 39.7 KMC

SS-1218

POLARAD MICROWAVE SIGNAL SOURCES
12.4 TO 50.0 KMC

Frequency Range	SIGNAL GENERATORS Model Number	Output Power	SIGNAL SOURCES Model Number	Power Output (Average)
12.4 to 17.5 KMC	SG 1218*	—10 DBM	SS 1218	15 mw
18.0 to 22.0 KMC	SG 1822	—10 DBM	SS 1822	10 mw
22.0 to 25.0 KMC	SG 2225	—10 DBM	SS 2225	10 mw
24.7 to 27.5 KMC	SG 2427	—10 DBM	SS 2427	10 mw
27.27 to 30.0 KMC	SG 2730	—10 DBM	SS 2730	10 mw
29.7 to 33.52 KMC	SG 3033	—10 DBM	SS 3033	10 mw
33.52 to 36.25 KMC	SG 3336	—10 DBM	SS 3336	9 mw
35.1 to 39.7 KMC	SG 3540	—10 DBM	SS 3540	5 mw
37.1 to 42.6 KMC	*External Source Power Measurement Range +10 to +30 DBM Accuracy with Correction: ±2 DB		SS 3742	Approx. 3 mw
41.7 to 50.0 KMC			SS 4150	Approx. 3 mw

Modulation:
1. Internal
   1000 CPS Square Wave
2. External
   a. Pulse
      Pulse Width: 0.5 to 10 Microseconds
      PRF: 50 to 10,000 PPS
      Pulse Amplitude: 10 volts Pk to Pk Min.
      Polarity: Positive
   b. Sawtooth or Sinusoidal
      Frequency: 50 to 10,000 CPS
      Amplitude: 15 Volts RMS Min.

SPECIAL FEATURES OF EHF SIGNAL GENERATORS

- **Unique power measurement system employs waveguide components of unusual design — allows continuous and front panel monitoring.**
- **Attenuation is independent of power set and frequency.**
- **1000 cycles cps square wave modulation and external fm or pulse modulation provided over entire frequency range.**

AVAILABLE ON EQUIPMENT LEASE PLAN

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A complete line of Microwave Signal Generators available in a range of 950 to 11,500 MC and Signal Sources available in a range of 650 to 10,750 MC.

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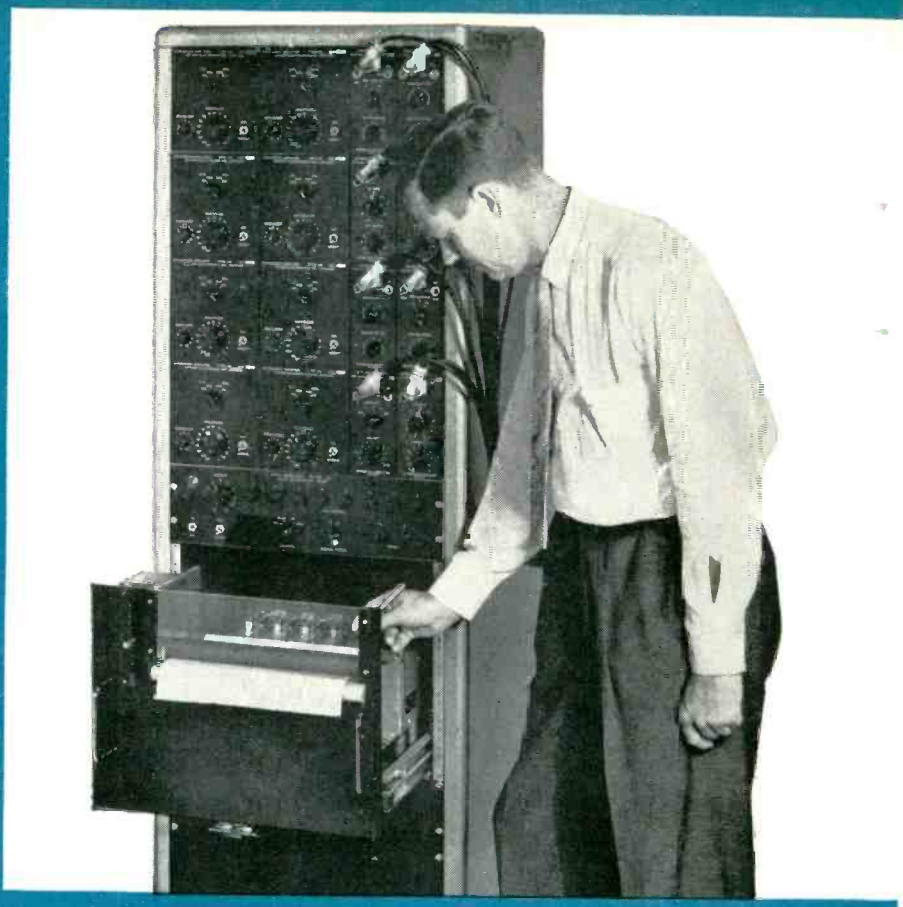


THE OFFNER

DYNOGRAPH

DIRECT WRITING OSCILLOGRAPH RECORDER

unequalled for versatility and performance!

High sensitivity—up to 15 microvolts d-c per mm. • Stable—absolute zero base line drift • Recording media—ink, electric, or heat sensitive • Recording coordinates—curvilinear or rectilinear • No "warm-up"—immediately stable and ready for use • One per cent linearity—for four centimeters deflection • One amplifier—for all recording applications • Large records—easy to read, easy to measure • Rapid pen response—1/120th second deflection time • Alternate mountings—console, rack, or portable.

Compare the Offner DYNOGRAPH with any other recorder—This high-speed, direct writing oscillograph gives you, in a single recorder, three recording media—ink, heat sensitive, and electric sensitive records; with either curvilinear or heat and electric sensitive rectilinear coordinates. You can select the method of recording best suited to each of your applications.

ALTERNATE MOUNTINGS

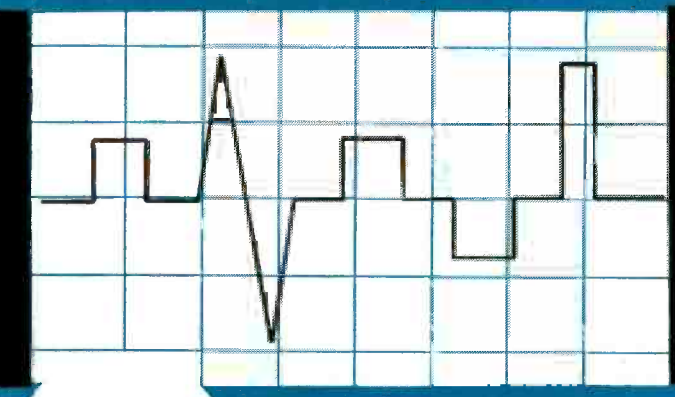
Offner Dynographs are available in rack and console mountings; and portable cases* for one or two channel assemblies.

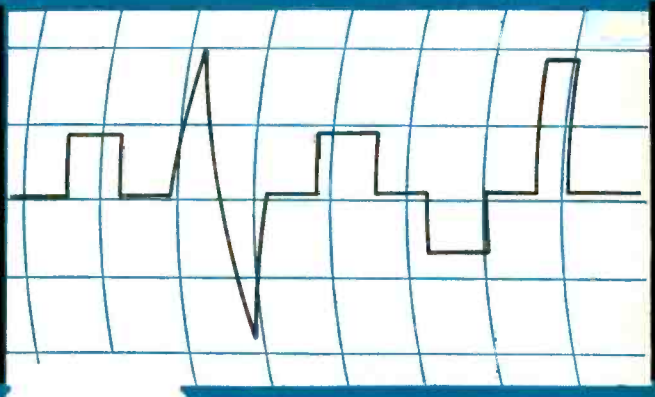
*Portable assemblies, curvilinear only.

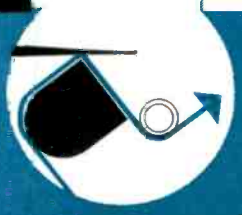
. . . rectilinear recording
. . . curvilinear recording
. . . heat sensitive recording
. . . electric recording
. . . ink recording
IN A SINGLE RECORDER!

The Offner Dynograph . . . unequalled for versatility. Now . . . for the first time, in a single recorder you can have both rectilinear and curvilinear recording; ink, electric, or heat sensitive. You can shift from one recording media to another, and from rectilinear to curvilinear coordinates in a matter of minutes.

Versatility plus performance. The Offner Dynograph combines high speed, high sensitivity and complete stability as a result of Offner's exclusive patented chopper amplifier. The unique circuit employed results in a d-c amplifier of unusual sensitivity and stability that has set new performance standards for direct writing oscillographs.







ELECTRIC AND HEAT SENSITIVE RECTILINEAR RECORDING. Choose the recording medium most suitable for each individual application — record slow phenomena over long periods with heat sensitive recording; use electric sensitive recording for high speed rectilinear coordinates.

INK AND ELECTRIC SENSITIVE CURVILINEAR RECORDING. Change from rectilinear to ink recording in minutes. Use ink for economical general purpose recording — wide speed range and high accuracy. Electric sensitive curvilinear recording is available for special applications such as mobile use.

Write for your copy of the Offner Dynograph Catalog.

Check and compare the Offner Dynograph with any other recorder. It is unequalled for versatility, unmatched in performance. Point for point—you'll select the Offner Dynograph. Write for complete details.

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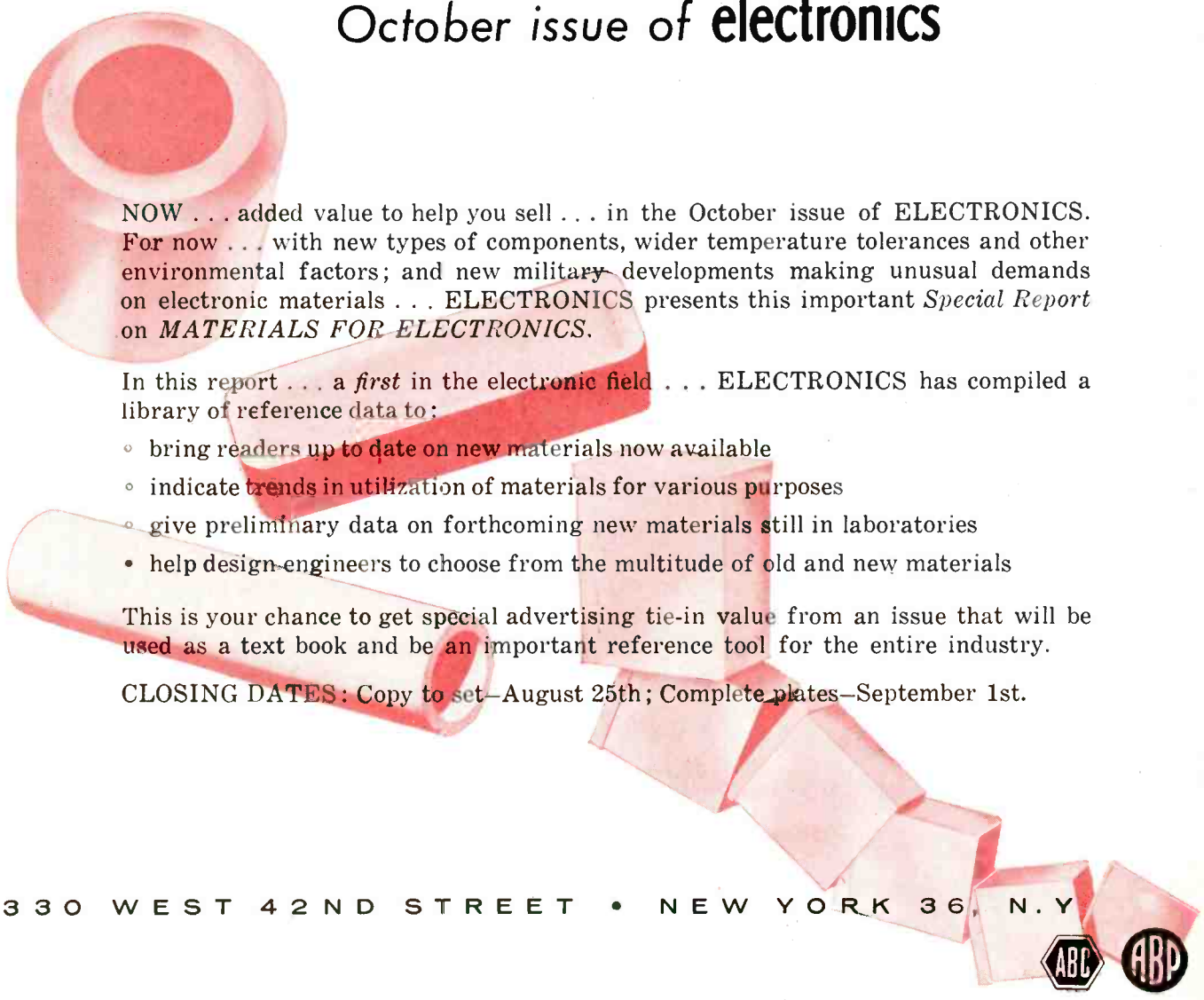
electronics

A McGRAW-HILL PUBLICATION

MATERIALS FOR ELECTRONICS

a Special Report in the October issue of **electronics**



NOW . . . added value to help you sell . . . in the October issue of ELECTRONICS. For now . . . with new types of components, wider temperature tolerances and other environmental factors; and new military developments making unusual demands on electronic materials . . . ELECTRONICS presents this important *Special Report* on *MATERIALS FOR ELECTRONICS.*

In this report . . . a *first* in the electronic field . . . ELECTRONICS has compiled a library of reference data to:

- bring readers up to date on new materials now available
- indicate trends in utilization of materials for various purposes
- give preliminary data on forthcoming new materials still in laboratories
- help design engineers to choose from the multitude of old and new materials

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ABC ABP

DIAGONAL SPRING EQUIFLEX

125500 Series

The new Equiflex vibration isolator pictured above is designed particularly for applications where strict adherence to Government specifications is important.

Barrel-shaped springs of heavier wire are assembled diagonally instead of radially and the result is a rugged, highly damped mount with excellent resistance to prolonged vibration at resonant frequencies. In addition to this improved performance, all the advantages of an all-metal mount with omnidirectional isolation have been retained.

SPECIAL FEATURES

- Low amplification at resonance. Approximately 2 times depending upon input amplitude.
- Resonant frequency between 15 and 20 c. p. s. depending upon mounting angle, input amplitude and location of center of gravity.
- Efficient isolation at high frequencies.
- Efficient isolation at low input amplitudes.
- All metal construction with exception of lubricant.
- Temperature range without change 375 F to –70 F.
- Vibration and shock protection characteristics unchanged by repeated shocks of 22 g's for 11 millisecond duration on all axes.
- Unharmed by hours of resonance with input of .036" double amplitude as outlined in Procedure I of MIL-E-5272A with equipment mounted both horizontally and vertically.
- Available in 1/4#, 1/2#, 1#, 2#, and 3# ratings in Number 1 plate size.

ELECTRICAL ASSEMBLIES Ucinite RADIO AND AUTOMOTIVE

The UCINITE CO.

Newtonville 60, Mass.

Division of United-Carr Fastener Corp.

Specialists in

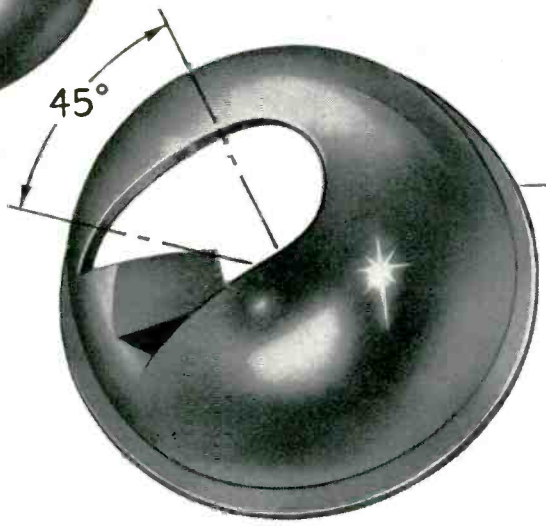
ELECTRICAL ASSEMBLIES, RADIO AND AUTOMOTIVE

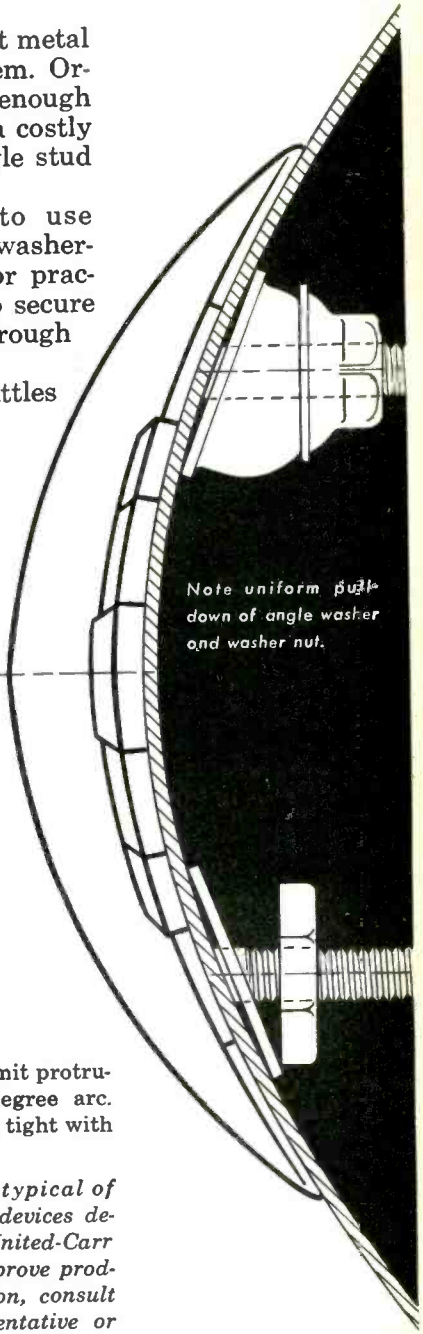
DOT's new angle washer holds cast trim against curves

Fastening die-cast trim to curved sheet metal surfaces can be a troublesome problem. Ordinary nuts jam before they get close enough to hold tight. One solution has been a costly mould construction permitting off-angle stud casting.

The modern cost saving way is to use United-Carr's new angle washer and washer-nut combination. This compensates for practically any curve or can be used to secure studs that protrude at an angle through a flat surface.

Tight fastening is assured and rattles never get a chance to start.





Light, strong metal shell is slotted to permit protrusion of stud at any angle within 45 degree arc. Washer nut matches shape of shell, locks tight with normal wrench torque.

The angle washer and washer nut are typical of thousands of special-purpose fastening devices designed and manufactured in volume *by United-Carr to help speed assembly, cut costs and improve product performance. For further information, consult your nearest United-Carr field representative or write us for his name and address.*

UNITED-CARR Fastener Corp.

31 Ames Street, Cambridge 42, Mass.

MAKERS OF DOT FASTENERS

They're made from standard materials—

WHY DO IRC® RESISTORS OFFER HIGHEST REPRODUCIBILITY ?

Carbon, glass, coating resins, molding powder, copper wire, and a metal alloy—they're the only materials you'd need to make a resistor such as IRC's famous Type BT fixed composition resistor. But the real problem, you'd soon discover, is to make every resistor just like the ones before it and just like those following it. That's where IRC's exclusive processes pay off. They give you resistors that "test out" more alike in mechanical and electrical characteristics than any other resistors of their type. That's why only IRC resistors make possible unvarying performance of your own equipment.

The outstanding thing about IRC production processes is that they provide this uniformity at economical mass-production rates. For example, over 5 miles of carbon filament are drawn every day for film type resistors. And for maximum efficiency and uniformity, this filament is measured and cut while it's being produced. It's this kind of know-how that makes every type of IRC resistor your best buy. Send the coupon today for more facts.

How IRC provides unique reproducibility

FILM RESISTORS

Type BT Fixed Composition Resistors

Type DC Deposited and Type BO Boron Carbon Resistors

Molded Type MD Deposited and Type MB Boron Carbon Resistors

Type HFR High Frequency Resistors

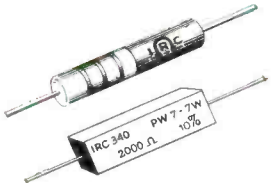
Type MV High Voltage Resistors

Resistance Strips and Discs

IRC film resistors exceed military specifications but the really outstanding thing is that they do it with unusual lot-to-lot uniformity in characteristics. What's the reason for this reproducibility? IRC's secret production processes!

You'll find this kind of production know-how in the making of Type DC Deposited Carbon Resistors, for example. The carbon used and the way the carbon film is formed both assure complete dispersion for better resistor performance. In IRC Boron Carbon Resistors, too, the unique method used to combine gases results in greater uniformity at low cost.

WIRE WOUND RESISTORS



Types BW and PW Low Power Wire Wound Resistors

Types PWW and FRW Power Wire Wound Resistors

Type WWJ Precision Wire Wound Resistors

"PH" Series Encapsulated Precision Resistors

Type CL Insulated Wire Wound Chokes

Type MW Bracket Mounted Resistors

IRC wire wound resistors are exceptionally uniform in their accuracy of adjustment and in characteristics making for long-term stability. The main reason is that they are all automatically machine wound under uniform tension and constant temperature and humidity conditions.

You can see the result of this superior winding skill in the element of the Type CL Insulated Choke, for example. Extremely fine wire is wound so expertly that the element appears to be one smooth, uninterrupted surface! This same winding skill also makes the element of all other IRC wire wound resistors a study in perfection—free from shorted turns or winding strains.

SEE NEW IRC COMPONENTS AT WESCON BOOTH 1023

Insulated Composition Resistors • Deposited and Boron Carbon Precistors • Power Resistors • Voltmeter Multipliers • Ultra HF and Hi-Voltage Resistors.

Wherever the Circuit Says

Low Wattage Wire Wounds • Resistance Strips and Discs • Selenium Rectifiers and Diodes • Hermetic Sealing Terminals • Insulated Chokes • Precision Wire Wounds.

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Please send technical bulletins describing ☐ Fixed Compositions ☐ Deposited and Boron Carbons ☐ High Frequency Types ☐ High Voltage Types ☐ Low Power Wire Wounds ☐ Power Wire Wounds ☐ Precision Wire Wounds ☐ Insulated Chokes ☐ Resistance Strips and Discs.

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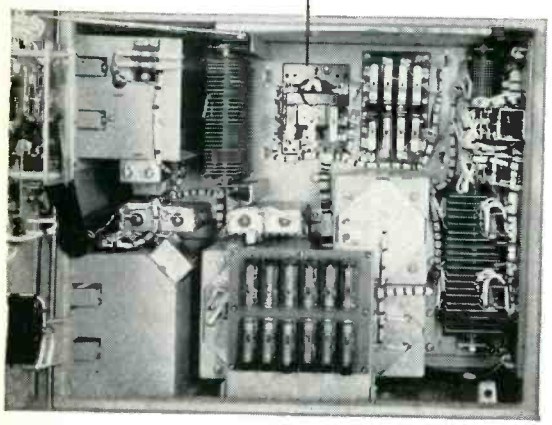
...and Radio Receptor Selenium Rectifiers help make that accuracy possible!

Power supply and amplifier cabinet made by **Belock Instrument Corp., New York,** for U. S. Navy gun fire control systems. Five Radio Receptor rectifiers are utilized in this unit.



The timing and precision of U. S. Naval gunfire depends on complex fire control systems for which Radio Receptor's customer, **Belock Instrument Corp.** manufactures power supply and amplifier cabinets. Five Radio Receptor power rectifiers are included in each unit because the manufacturer knows that ruggedness, long life and reliability are always prime features of every RRco. stack.

On target with the fleet — and in hundreds of other applications for government and industry, RRco. rectifiers constantly prove they can pass the stiffest requirements with flying colors. If *you* have a problem involving rectification, submit your specs to our engineering department. We'll be glad to make recommendations, without obligation of course.

Really RR Reliable

Semiconductor Division

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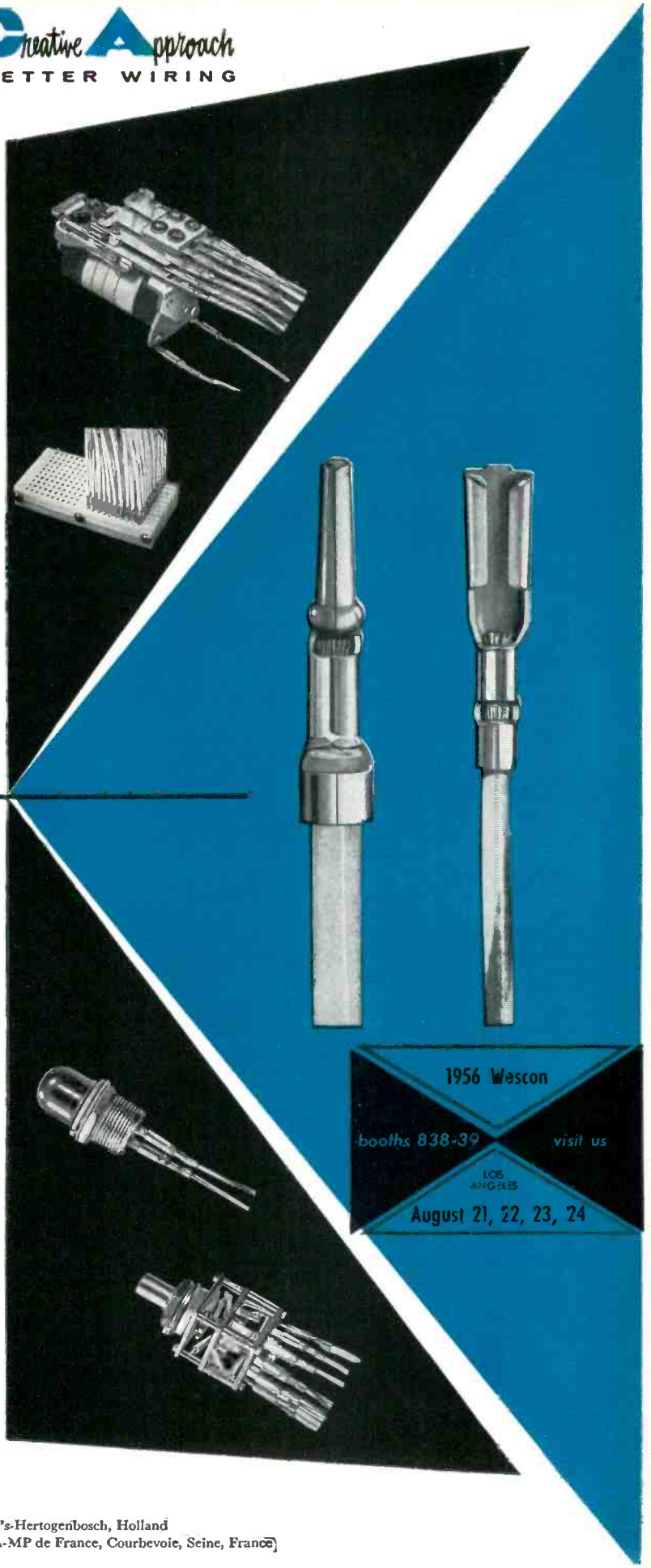
More Confidence... Less Expense with AMP

Taper Technique

A-MP Taper Pins, Taper Bloks, Taper Tips, Taper Tabs and Taper Tab Receptacles offer great freedom of circuit design and insure maximum electrical stability.

They cut material cost . . . cut labor cost . . . and reduce assembly time. Taper Technique is benefiting manufacturers of business machines, aircraft, guided missiles and electronic equipment.

You, too, can benefit by the A-MP Taper Technique. Consult your local A-MP salesman or write to Harrisburg.



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A-MP of Canada, Ltd., Toronto, Canada • A-MP—Holland N.V., 's-Hertogenbosch, Holland
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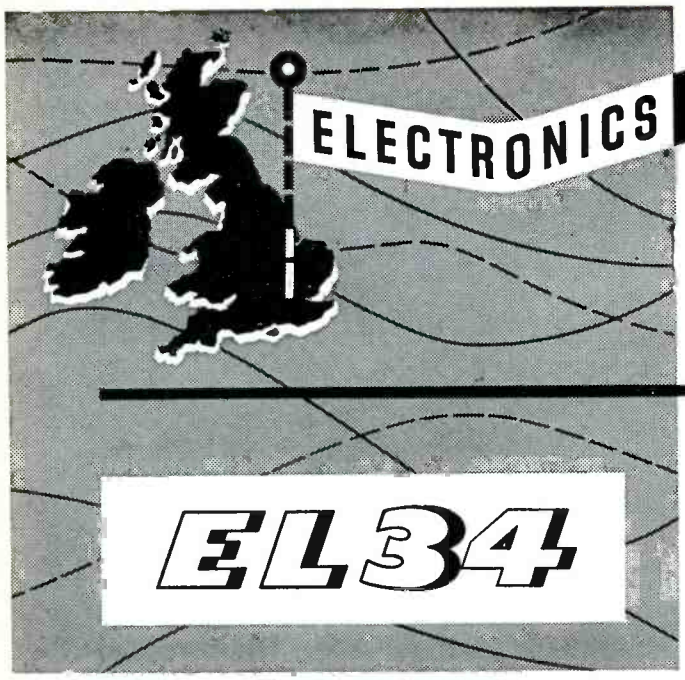

The British Electronics Industry is making giant strides with new developments in a variety of fields. Mullard tubes are an important contribution to this progress.

EL34

Britain's foremost pentode for 25W high fidelity equipment

The Mullard EL34 can be rightly acclaimed as the most efficient high fidelity output pentode tube yet produced in Britain. It is being fitted in many of the British sound reproducing equipments which are becoming increasingly popular in the United States and Canada.

Used in push-pull ultra-linear operation (distributed load), two EL34 tubes will give 32 watts output at a total distortion of less than 1%. The application of negative feedback reduces distortion even further.

The EL34 is equally capable of supplying higher power outputs where an increased distortion level is acceptable. Under class B conditions, 100 watts are obtainable from a pair of EL34 tubes in push-pull for a total distortion of 5%.

Another significant feature of this tube is its high transconductance value of 11,000 μmhos, resulting in high power sensitivity and low drive requirements.

Supplies of the EL34 are now available for replacement purposes from the companies mentioned below.

Principal Ratings

Heater
6.3V, 1.5A

Max. plate voltage
800V

Max. plate dissipation
25W

Max. screen voltage
425V

Max. screen dissipation
8W

Max. cathode current
150mA

Base
Octal 8-pin

Available in the U.S.A. from:—
International Electronics Corporation,
Dept. E8, 81 Spring Street, N.Y.12,
New York, U.S.A.

Available in Canada from:—
Rogers Majestic Electronics Limited,
Dept. 1J, 11-19 Brentcliffe Road.
Toronto 17, Ontario. Canada.

Mullard

ELECTRONIC TUBES

used throughout the world

MULLARD OVERSEAS LTD., CENTURY HOUSE, SHAFTESBURY AVE., LONDON, ENGLAND

Mullard is the Trade Mark of Mullard Ltd., and is registered in most of the principal countries of the world.

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DU PONT

Better Things for Better Living
. . . through Chemistry

ELECTRONIC DESIGN NEWS

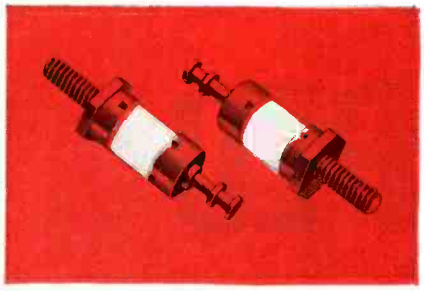
PROPERTY AND APPLICATION DATA
ON THESE VERSATILE ENGINEERING MATERIALS:
"ZYTEL," "ALATHON," "TEFLON," "LUCITE."

No. 8, 1956

Unique properties of Du Pont TEFLON® help solve electronic design problems

Terminals of Du Pont TEFLON® feature high dielectric strength

The toughness, high dielectric strength and heat resistance of TEFLON make it particularly suited for applications such as these terminals manufactured by Cambridge Thermionic Corporation, Cambridge, Massachusetts. Utilizing in a unique manner the toughness of

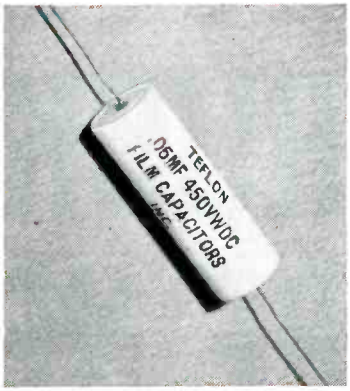


TEFLON, the terminals exhibit excellent resistance to shock and vibration over a wide temperature range.

TEFLON has many electronic design possibilities. Its power factor remains extremely low over the entire spectrum. Volume resistivity is very great even after prolonged immersion. Surface resistivity remains high even under exposure to saturated water vapor. TEFLON does not "track" on exposure to arc. Dielectric strength is high over a considerable temperature range.

To obtain complete property and application data, mail coupon.

An engineer at Eitel-McCullough, Inc., holds sleeve of TEFLON molded by Chase Sales Company, Hayward, California, for use in klystron pictured above.



Capacitors encased in TEFLON are designed especially for sustained high-temperature operation in aircraft, airborne computers and other high-ambient-temperature applications where high insulation resistance must be maintained. *(Manufactured by Film Capacitors, Inc., New York, N. Y.)*

The physical, chemical and electrical properties of Du Pont TEFLON tetrafluoroethylene resin make it applicable to a wide variety of uses in the electronic field. It is especially useful in applications involving miniaturization, high-frequency, high-voltage, high-temperature requirements; and exposure to corrosive action.

TEFLON readily provides continuous service at 260°C., exceeding requirements of Class H materials. Of exceptional thermal stability, TEFLON can be used at extreme service temperatures, ranging from a high of 500°F. to a low of −450°F. The power factor of TEFLON is less than 0.0003 over the measured spectrum (60 cycles to 10^8 cycles). Water absorption (ASTM D570-42) is only 0.005%.

A sleeve of Du Pont TEFLON is used by Eitel-McCullough, Inc., of San Bruno, California, in apparatus to measure the radio frequency power output of high-power UHF microwave amplifier klystrons. The sleeve of TEFLON is mounted in a metal pipe through which the electromagnetic energy output from the klystron travels. The TEFLON acts as a window through which the energy passes into water circulating within the cone-shaped sleeve. Here the energy is dissipated. By measuring rate of flow, and temperature change of the water, tube output can be determined.

If you wish complete property and application data on TEFLON to evaluate for your own use, clip and mail the coupon below.

NEED MORE INFORMATION?

CLIP THE COUPON for additional data on the properties and applications of this Du Pont engineering material.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department
Room 228 Du Pont Building, Wilmington 98, Delaware.
In Canada: Du Pont Company of Canada Limited, P.O. Box 660, Montreal, Quebec

Please send me complete property and application data on Du Pont TEFLON. ☐

I am interested in evaluating this material for

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Name _____

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† Air Express now can practically pinpoint shipments. A key-city network is linked together by private teletype service, tied in with scores of other communities in a nationwide network.

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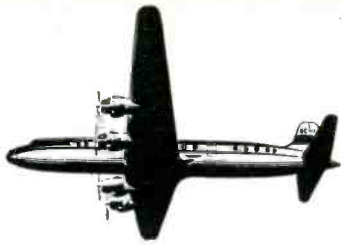
For the world's most efficient, most complete air shipping service–linking some 23,000 U. S. communities, all by one through carrier–call

Air Express

GETS THERE FIRST *via U.S. Scheduled Airlines*

CALL AIR EXPRESS . . . *division of* RAILWAY EXPRESS AGENCY

AEROCOM'S 1046 H.F. TRANSMITTER



POWER + STABILITY

1000 WATTS WITH .003% STABILITY

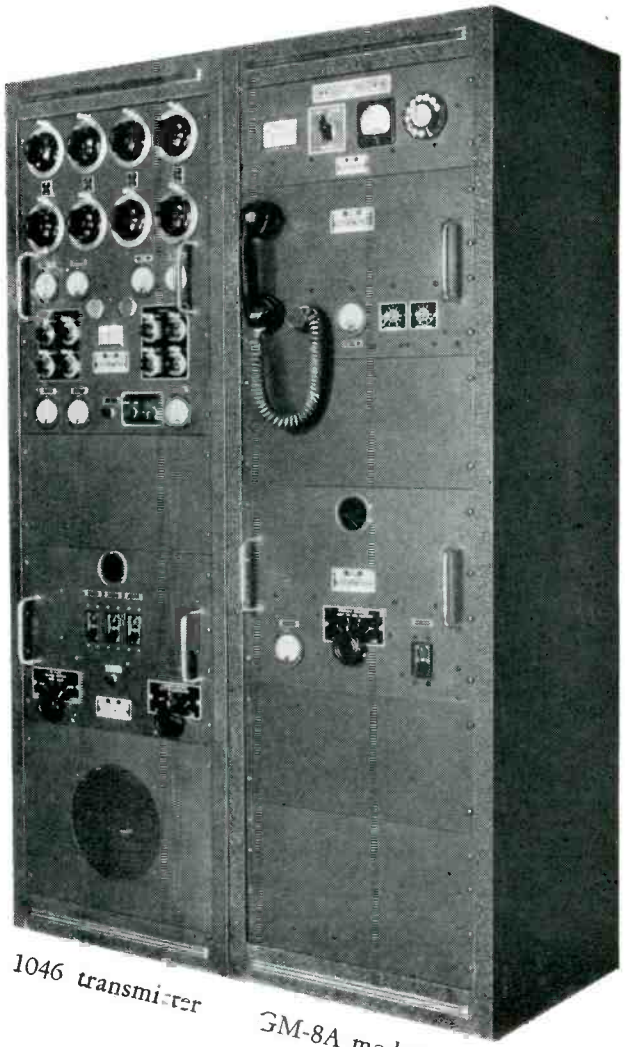
Rugged, versatile general purpose H.F. transmitter—Aerocom's 1046 packs 1000 watts of power and high .003% stability under normal operating conditions (0°to+50°C.). Excellent for point-to-point or ground-to-air communications.

Multi-channel operation on telegraph A1, or telephone A3 with GM-8A modulator... new Aerocom 1046 can be *remotely controlled* with TMC-R at control position and uses only one pair of telephone lines. In A3 operation, the local dial control panel is located in modulator cabinet.

Transmitter cabinet has 8¾ inch panel space available for either local dial control panel or frequency shift keyer.

Model 1046 operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.0—24 Mcs. Operates on one frequency at a time; channeling time 2 seconds. Operates into either balanced or unbalanced loads. Operates in ambient -35° to+50° C. Power supply: nominal 220 volts, 50-60 cycles, single phase.

Complete technical data on request



1046 transmitter GM-8A modulator

Now! Complete-package, lightweight airborne communications equipment by Aer-O-Com! Write us today for details!

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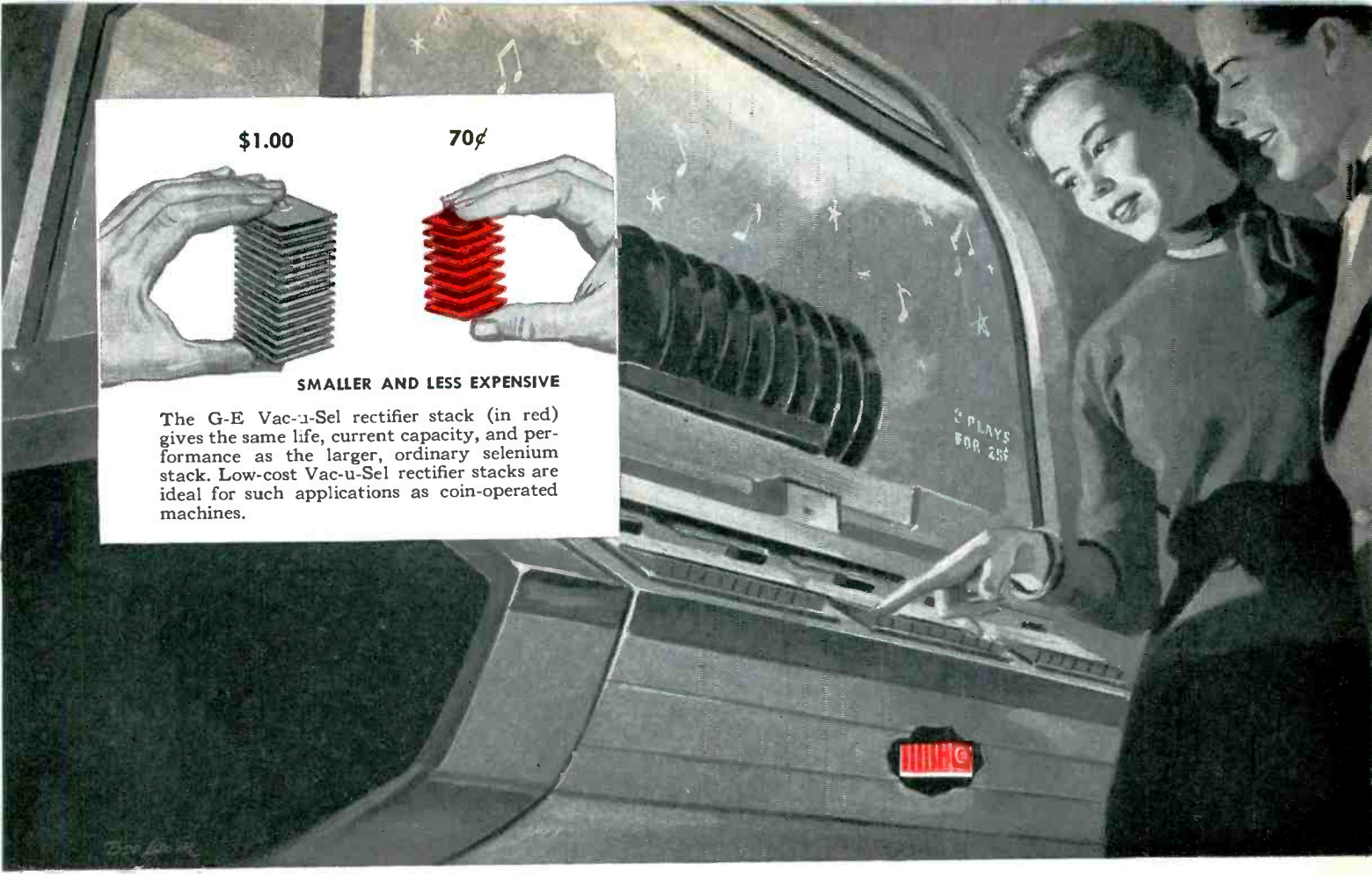


DESIGNED TO HELP YOU MEET PRICE COMPETITION . . .

G-E Vac-u-Sel* Rectifiers Cost You Up to 30% Less

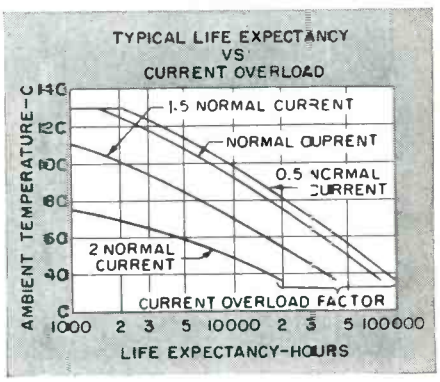
Here is a component rectifier stack that will out-perform ordinary selenium stacks, and yet cost you up to 30% less!

INITIAL COST IS OFTEN 30% LOWER: G-E Vac-u-Sel rectifiers can be made up to 30% smaller for any given application, due to the greater current-carrying capacity of the individual cells. Smaller size means a lower cost to you. These cells are produced by a unique G-E sphere-type vacuum-evaporation process that enables us to accurately predict the output and life characteristics of any model number. We are thus able to give you a stack with the exact life you require. You don't pay for more life than you need.

PICK THE LIFE YOU WANT: You can select a Vac-u-Sel rectifier that will last up to 80,000 hours—or more. But if your application calls for shorter life, we can give you a smaller, less expensive stack, which operates at greater than normal-rated current. You will find that even when overrated these top-quality G-E Vac-u-Sel rectifier stacks will perform with greater predictability than ordinary selenium. So, by tailoring each stack to meet your exact requirements, you receive the benefit of top quality at lower cost.

Contact your G-E Apparatus Sales Office, or write for Bulletin GEA-6273 to: Section 461-41, General Electric Co., Schenectady 5, N. Y.

*Vac-u-Sel is a trade-mark of the General Electric Co. It designates top-quality selenium rectifier cells manufactured by a unique sphere-type vacuum-evaporation process by the Rectifier Department, Lynn, Mass., headquarters for silicon, germanium, selenium, and copper-oxide component rectifiers.



LONG LIFE is provided by G-E Vac-u-Sel rectifier stacks—even at high operating ambients and better than normal-rated current.

Progress Is Our Most Important Product

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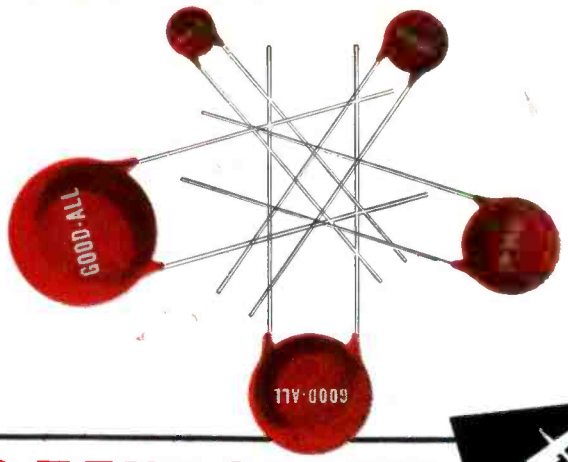


EPOXY COATED CERAMIC DISCS

. . . at No Premium Cost!

Good-ALL capacitors

High Voltage Breakdown Strength
Excellent Moisture Resistance • Durable • Attractive

Good-All's tough, durable EPOXY coated ceramic disc capacitors combine excellent dielectric strength and stability with high humidity resistance. Good-All's exclusive EPOXY coating process results in an intimate bond between the coating and the edge surface of the ceramic. This bond serves to block the voltage breakdown path across the ceramic edge. No wax coating is required on EPOXY coated discs.

TEMPERATURE COMPENSATING EPOXY DISC CAPACITORS

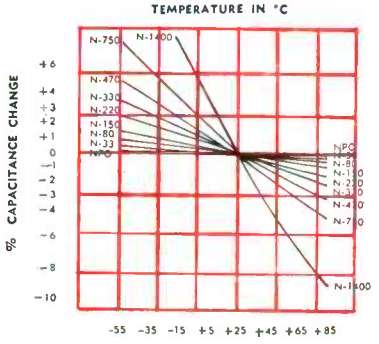
Good-All has designed a full line of TC discs in accordance with RETMA specification REC-107-A (class 1). These units are well suited for resonant circuits or other applications where HIGH Q and STABILITY of capacitance is essential. Small size gives an inherent advantage in VHF and UHF applications.

SPECIFICATIONS—Working Voltage: **600 VDC** • Flash Test Voltage: **1500 VDC** • Power Factor: **Less than .1% @ 1 MC** • Leakage Resistance: **Greater than 10,000 megohms** • Leads: **#22 gage tinned copper wire** • **Capacity Tolerance: ±5%, ±10%, ±20%**

MAXIMUM DIAMETER

Temperature Coefficient	1/4	5/16	1/2	5/8	3/4
P-100	1-3 mmf	4-9 mmf	10-30 mmf	.....	.....
NPO	2-12	13-22	28-60	61-75 mmf	76-110 mmf
N-33	2-15	16-27	28-60	61-75	76-110
N-80	2-15	16-27	28-60	61-75	76-110
N-150	2-15	16-30	31-60	61-75	76-110
N-220	3-15	16-30	31-75	76-100	101-140
N-330	3-15	16-30	31-75	76-100	101-140
N-470	3-20	21-40	41-80	80-120	121-170
N-750	5-25	26-50	51-150	151-200	201-290
N-1400	15-50	51-100	101-200	200-250	251-470
N-2200	47-75	76-100	101-200	201-275	276-470

CAPACITANCE CHANGE VS. TEMPERATURE IN °C



Good-All's complete line of EPOXY coated ceramic disc capacitors are designed to fit both standard and specialized applications. Write or wire today for catalog containing more information on our TC discs and other EPOXY coated disc types listed below.

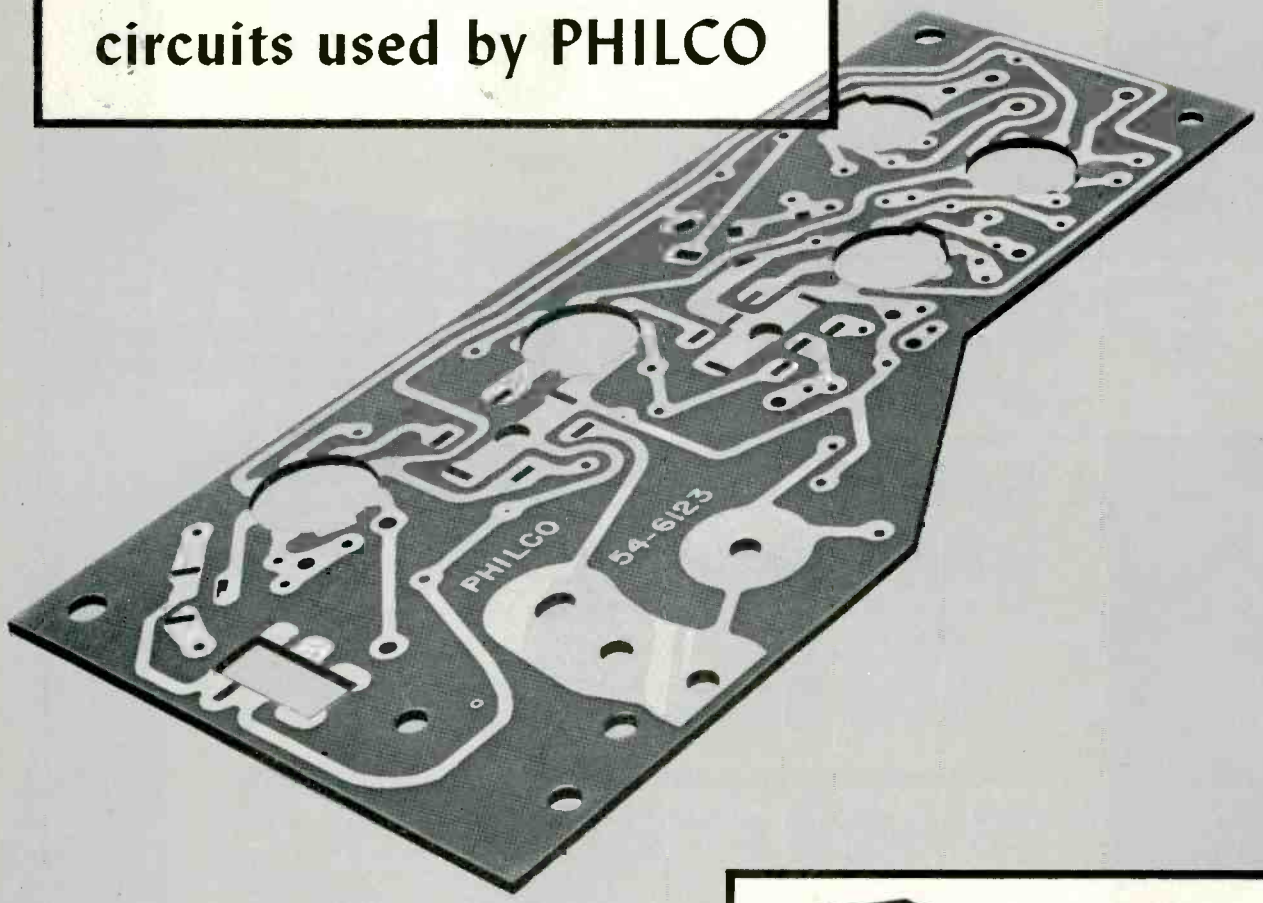
BY-PASS Good-All Type B (RETMA CLASS 2, Z5Z)
DUAL SHIELDED Good-All Type C
AC LINE BY-PASS Good-All Type D
STABLE Good-All Type E and EE
HIGH VOLTAGE Good-All Type G
TRANSISTOR CIRCUIT Good-All Type H

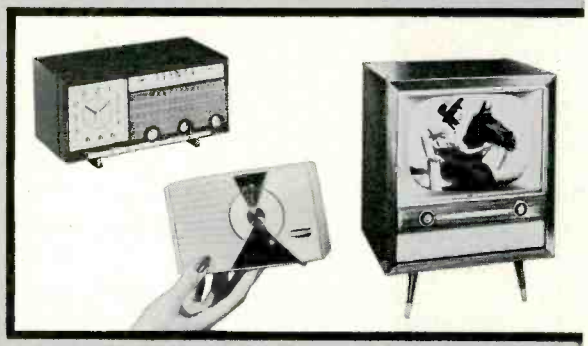
Our Sales Representatives will be happy to supply you with sample EPOXY coated discs for test against your specification.

GOOD-ALL ELECTRIC MFG. CO. OGALLALA, NEBRASKA

A LEADING MANUFACTURER OF TUBULAR CAPACITORS

INSUROK® T-725 printed circuits used by PHILCO





Philco design and production engineers are using Richardson Copper-Clad INSUROK T-725 laminate for printed TV and radio circuits.

Examples are Underwriters approved assemblies for Philco's 21" console TV, Philco's five tube table radio and Philco's transistorized portable radio. All use INSUROK T-725 printed circuits.

In the manufacture of printed circuit materials, the most important single consideration is the laminate. Richardson, a pioneer in the development of printed circuit laminates, has the necessary experience and know-how. Copper-Clad INSUROK T-725 is a laminate of outstanding excellence . . its electrical qualities remain remarkably stable under repeated temperature and humidity cycling.

For further information, write or phone today . . Chicago number, MAnsfield 6-8900.

founded 1858

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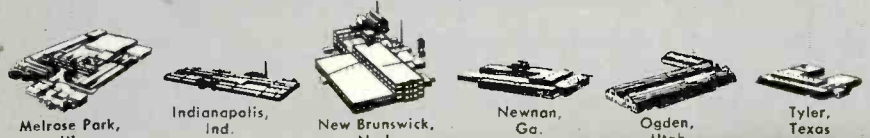
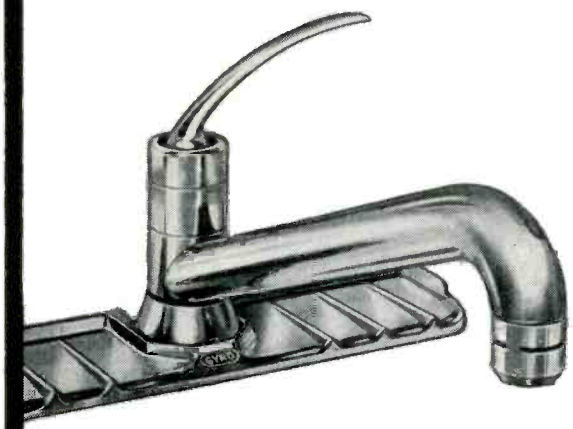


Melrose Park, Ill. | Indianapolis, Ind. | New Brunswick, N. J. | Newnan, Ga. | Ogden, Utah | Tyler, Texas

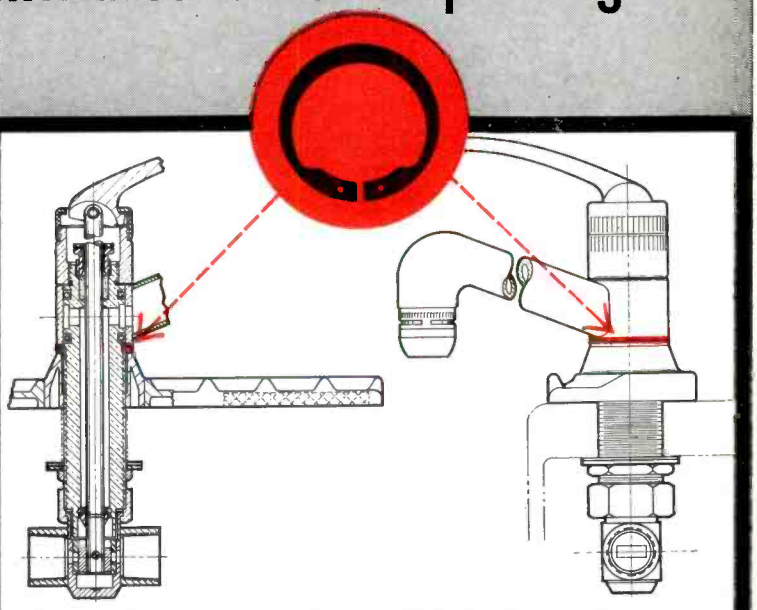
THE RICHARDSON COMPANY
2797 Lake St., Melrose Park, Ill.

Waldes Truarc ring reduces valve body from 1 5/16" to 1 1/16", eliminates chrome plating

GYRO MIXING FAUCET



Single-handle kitchen mixing faucet controls hot and cold water, as well as volume. Radical design has no seals or spindles to replace. One Waldes Truarc retaining ring allows complete assembly and disassembly from either top or bottom of unit.



Aluminum Truarc Ring (external inverted Series 5108) acts as bearing retainer, insures precise alignment of spout and escutcheon, gives uniform shoulder with machining. Truarc ring provides shoulder that would otherwise require machining valve body to 1 5/16" against 1 1/16" used. Also eliminates expensive chrome plating of valve body.

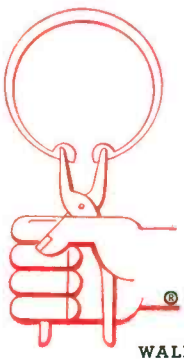
Gyro Brass Manufacturing Corporation of Westbury, L. I., N. Y., uses a single Waldes Truarc retaining ring (Series 5108) both as a positioner and retainer on their Gyro Mixing Faucet. Aluminum Truarc ring not only eliminates expensive machining, but also does away with a chrome plating process that would be necessary if the shoulder were made of the solid material of the body.

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.

More than 5,000 stock sizes of the different Truarc ring types available. Ninety stocking points throughout U. S. A. and Canada.

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!



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WALDES TRUARC® RETAINING RINGS

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

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

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Title.....
Company.....
Business Address.....
City.....*Zone*.....*State*.....

E 088

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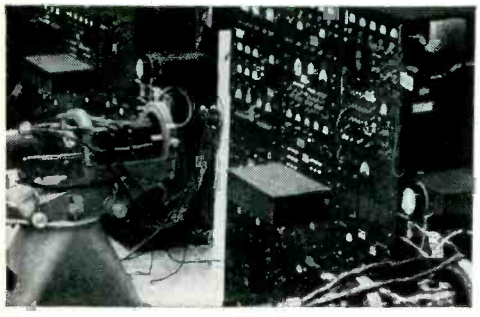
for fast engineering, development and production

a separate Sperry division devoted to



Production test consoles

Out of its many years of pioneering and managing major electronics systems, Sperry is keenly aware of the critical role that sub-systems and support equipment play in the *testing, evaluation* and *performance monitoring* of modern weapons systems.

Now—with emphasis upon faster and more extensive service to the customer — Sperry has organized its broad activity in this area into a streamlined team of specialists. It is the Microwave Electronics Division.

This team is a large and experienced one, resourceful engineers with inventive, systems knowledge supported by skilled technicians and craftsmen to convert ideas quickly into pilot models or quantities of hardware. Development, environmental and materials laboratories plus standards specialists combine their tools and talents to assure that items ranging from components to consoles will perform with certainty in operational use.

In addition to its widely-known Microline* test equipment, the new division is expanding its contributions to the military and industry with advanced weapon support systems, antennas and a broad line of precision components.

Emphasis is being placed too upon new instrumentation and standards for advanced research laboratories, special radar systems, target simulators, computers and evaluators for radar, electronic, missile and inertial guidance systems.

A proven key to the division's ability to solve new developmental problems rapidly is the efficient combination of engineering and development laboratories and shops. Each engineering group is supported by a development laboratory staffed with experienced technicians. Engineers work closely with machinists and assemblers to deliver pilot models on minimum schedules.

For quantity production, a complete manufacturing unit has specialized facilities to supply microwave products ranging from

Weapon system support equipment

microwave electronics

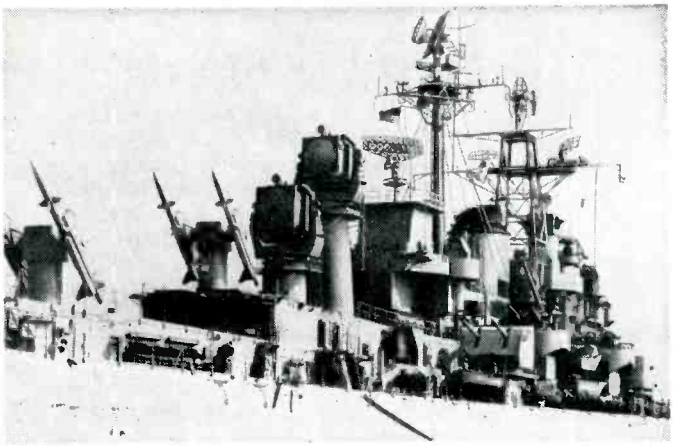
complex waveguide assemblies to complete racks of electronic equipment.

Military agencies or industrial companies concerned with any phase of electronic systems and sub-systems or the testing of such equipment can profit from employing these Sperry capabilities especially organized to speed up important projects and assure their success.

Write us for information about equipment now available or for proposals on new developments.

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

Special antennas and system components



SPERRY

MICROWAVE ELECTRONICS DIVISION

GYROSCOPE COMPANY

Great Neck, New York

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IN CANADA: SPERRY GYROSCOPE COMPANY OF CANADA, LIMITED, MONTREAL, QUEBEC

New trends and developments in designing electrical products . . .

How to determine which General Electric Alnico Permanent Magnet grade offers the optimum set of magnetic and physical properties for a particular application

THE BASIC function of a permanent magnet is to provide a specific magnetic flux across a given air gap. The basic problem for the designer is to select a magnetic material with the optimum combination of magnetic and physical properties to fulfill this function.

Since the permanent magnet has considerable influence on the final size, cost, and efficiency of the product, it is important to know the primary characteristics of each of the seven available General Electric Alnico grades.

Each of these grades offers specific advantages in available energy, unit cost, and physical properties. No one grade excels in all of them.

In terms of energy product, cast Alnico 5 has no peer among magnetic alloys. Its 5 million minimum gauss-oersteds is 43% higher than Alnico 6.

Its demagnetization curve (Figure 1) shows that Alnico 5 has the highest residual induction of all the Alnicos, as well as relatively high coercive force. This means that a smaller cross-sectional area and less total volume will be required to maintain a given air gap density.

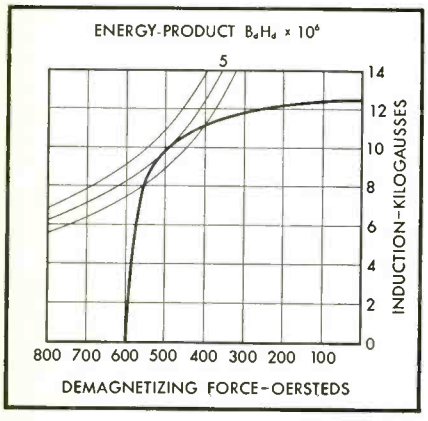

Fig. 1 — Alnico 5 Energy Product and Demagnetization Curves

Thus, where there are space restrictions, as in hearing aids, Alnico 5 has more available energy per unit volume. Where there are weight restrictions, as in airborne magnetrons, Alnico 5 offers more available energy per pound. And where there are cost considerations, as in loud speakers, Alnico 5 provides maximum external energy per dollar.

At the opposite extreme, Alnico 3 has one of the lowest energy products of the Alnicos – 1.38 million gauss-oersteds (Figure 2). About 3½ times more Alnico 3 than Alnico 5 is required to produce a given air gap field energy requirement.

However, because of its lower cost, Alnico 3 offers important savings in applications like toys and novelties, where performance and weight are not critical factors.

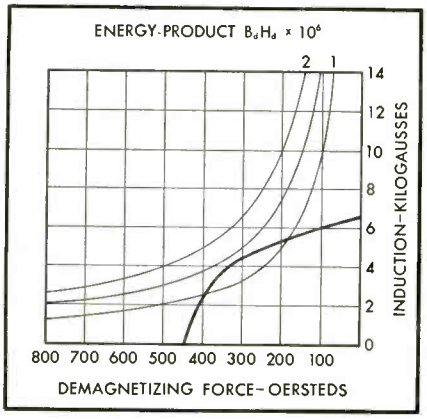

Fig. 2 — Alnico 3 Energy Product and Demagnetization Curves

Despite its relatively low energy product, Alnico 3 still provides more external energy, at lower cost, than does 37% cobalt steel – the best of all the magnet steels.

G-E Alnico 6 has an energy product of 3.5 million gauss-oersteds, ranking second only to Alnico 5. But the primary advantage of this grade lies in its flatter, more stable demagnetization curve (Figure 3, see top of next column).

Alnico 6 has ability to provide useful field energy under dynamic operating conditions. And in certain applications, Alnico 6, despite its lower energy product, will produce a higher gap flux density than Alnico 5.

For motors, generators and lifting applications, where the magnet is operating under varying demagnetizing influences, Alnico 6 offers greater stability and high useful recoil energy.

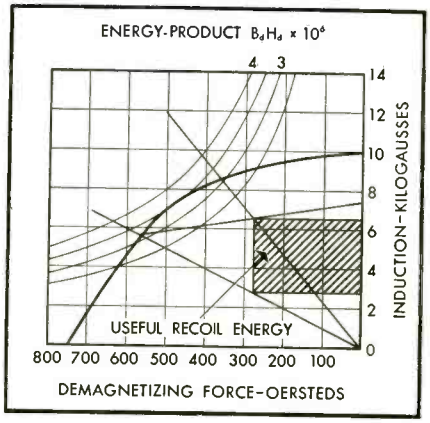

Fig. 3 — Alnico 6 Energy Product and Demagnetization Curves

Generally speaking, permanent magnets' physical properties are seldom the primary consideration when selecting magnetic materials. However, in certain high rotary speed applications, such as rotors, physical strength is of major importance. This necessitates the use of a sintered, instead of a cast, Alnico grade. These sintered magnets have tremendously improved physical properties, with but a slight sacrifice in magnetic properties.

Sintered Alnico 2, for example, has more than 20 times the tensile strength of cast Alnico 2. And, it has 10 times the transverse rupture strength, in addition to more uniform magnetic properties. Approximately the same order of structural improvements holds true for sintered Alnicos 4 and 5.

Selecting the proper magnetic material is a crucial and complex part of the design problem. For the assistance of a G-E Magnet Engineer in this, or any other, stage of your permanent magnet design, write: *Metallurgical Products Department of General Electric Company, 11137 E. 8 Mile Street, Detroit 32, Michigan.*

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TO: SYSTEM DESIGN ENGINEERS

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W. W. MacDONALD, Editor

AUGUST • 1956

CROSS TALK

▶ **BUSINESS** . . . In common with most other major industries, electronics will do well this year when considered overall, despite some soft spots. The economy of the country is growing at a particularly rapid rate and people have money with which to buy. The soft spots are largely in household goods, perhaps because deals and discounts moved some of this year's merchandise late last year.

Even in household goods the picture is not all blue. Portable tv sets have made a hit. And color could bring in important dollars by Christmas.

▶ **MONEY** . . . Talking with manufacturers in the middle west, we learned that planned expansions are being held back a little by the difficulty of borrowing money. Federal Reserve has been keeping a tight rein on credit, to guard against runaway inflation.

Rumour has it that there will be some slight easing of restrictions soon.

▶ **PAY** . . . Heard several speeches dealing with the shortage of engineering manpower, and one thing stood out in all of them; Good starting salaries have shifted men from place to place but have accomplished very little in the way of inducing young men still in high school or just starting college to go into engineering.

Some of these smart youngsters, it seems, have checked up on the vital statistics and note that while engineers are today getting good starting salaries older men who got into the game before the shortage developed have not necessarily stepped up proportionately.

▶ **TECHNICIANS** . . . Ran into a large company that had just completed a survey of technical skills throughout its several plants. Included all kinds of workers.

News here is that the survey uncovered enough people with unknown talent, acquired by various means, to materially help the engineering department at a time of shortage.

▶ **PARTS** . . . With nuclear power already a reality, whole new families of component parts will have to be developed to withstand radiation.

Gamma radiation causes ionization leakage, modifies photoelectric properties of some materials. Insulation breakdown in a radiation field can cause serious leakage even at low voltage. Resistors, for the most part, bear up reasonably well, but capacitors often exhibit sharp increase in dissipation factor and some electrolytics are unusable.

This uncharted wilderness has few signposts but already industry explorers are trudging toward the goal.

LOOKING AHEAD . . .

Suspicion some transistors having theoretically infinite life in service may have finite shelf life just beginning to form in technical circles

Design refinements under way in east indicate post-deflection color-television picture tube may soon be available to manufacturers at substantially reduced price

Interest in all methods of reducing spurious radiation again on increase as result of accidental triggering of guided missiles by internal and external noise

Telephone bells will slowly but surely give way to telephone "beepers"; bells require too much power from transistorized switching systems

By KURT SCHLESINGER
TV Research Department
Motorola, Inc.
Chicago, Illinois

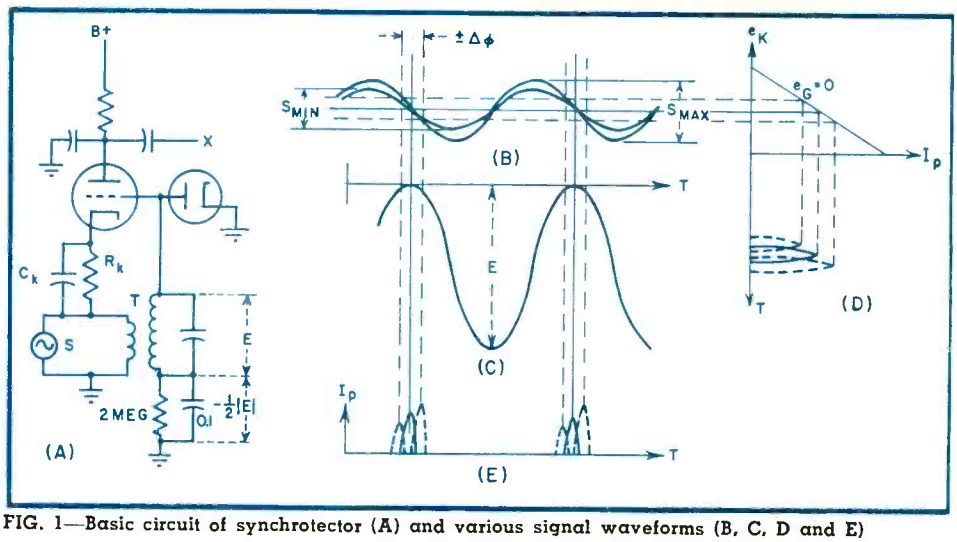

FIG. 1—Basic circuit of synchrotector (A) and various signal waveforms (B, C, D and E)

SAMPLING DETECTOR

ECONOMICALLY, an intercarrier tv receiver sound section is not simple, since it has to be designed for effective suppression of an undesired signal component of pulsed amplitude modulation. Conventional sound sections in monochrome sets, using the ratio detector, are approaching a tube count of five, since more than one sound i-f stage is often deemed necessary for efficient limiting. In color sets, there is the added difficulty of an attenuated signal level, since sound i-f has to be branched off at an earlier video i-f point.[1]

Several attempts at simplification have been made in the past.[2, 3, 4, 5] Recently, techniques studied during the development of triode decoders for color tv[6] have been applied to tv sound. The result is a simple tv-sound detector, using a conventional double triode. In contrast to the above references, this circuit employs a real, rather than a virtual cathode. Space-charge coupling is replaced by interelectrode capacitance and multigrid tubes by triodes. Since the system employs synchronous oscillation and detection, it is referred to as synchrotector.

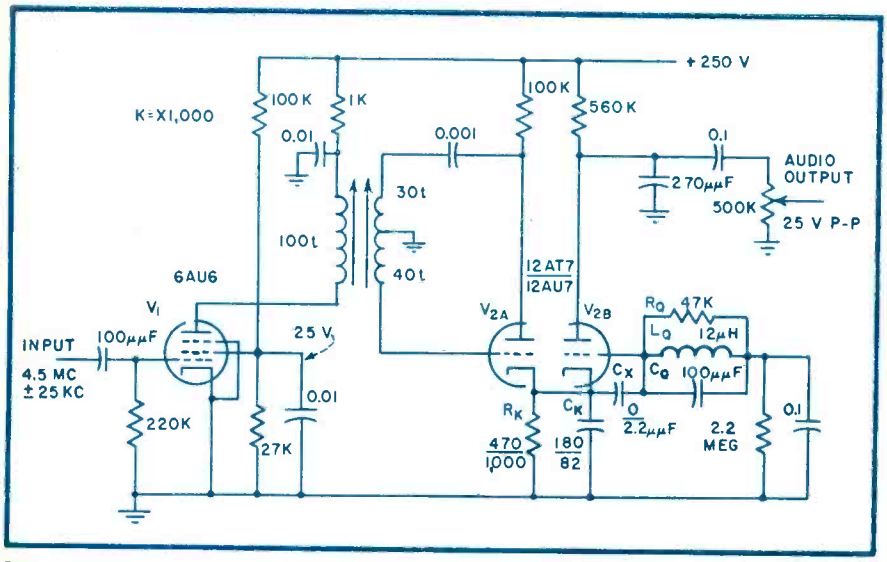

FIG. 2—Practical synchrotector circuit uses either 12AT7 or 12AU7. Upper values shown for R_K, C_K and C_X are for 12AT7 and lower values are for 12AU7

F-M Detection by Sampling

Figure 1A shows intercarrier signals coming from a preamplifier with low output impedance and some limiter action, such as a locked oscillator or simply an overdriven cathode follower. Figure 1B shows this f-m signal with some residual amplitude modulation. Tuned step-up transformer T generates sampling voltage E (Fig. 1C) with a voltage gain of at least 3 to 1.

To sample cathode current at zero passages of the signal, the phase between E and S is not quadrature, but is somewhat less than 90 degrees. The diode clamps the peaks of E at ground potential. This prevents grid current during sampling, since the cathode bias at zero signal is held positive by $R_K C_K$.

As center frequency f_c deviates by Δf, the sampling phase shifts off zero by the amount

$$\Delta\phi = (\pi/2)(Q)(\Delta f/f_c) \qquad (1)$$

For tv sound ($\Delta f = 25$ kc, $f_c = 4{,}500$ kc) and a circuit Q of 30, this phase deviation is ±15 de-

SUMMARY —— Double-triode circuit uses tube and circuit capacitances as coupling elements for synchronous oscillation and detection of 4.5-mc f-m television sound carrier. Technique of sampling near zero passage of carrier yields maximum f-m detection while residual amplitude modulation is ignored. Detector locks on signals of 6 mv or more and produces audio output of 25 v with a-m rejection of 40 to 50 db

for Intercarrier TV Sound

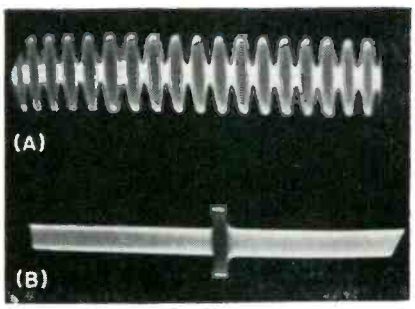

FIG. 3—Test signals of 4.5-mc f-m carrier with 70-percent sine-wave amplitude modulation (A) and same carrier with 60-cps pulsed amplitude modulation (B)

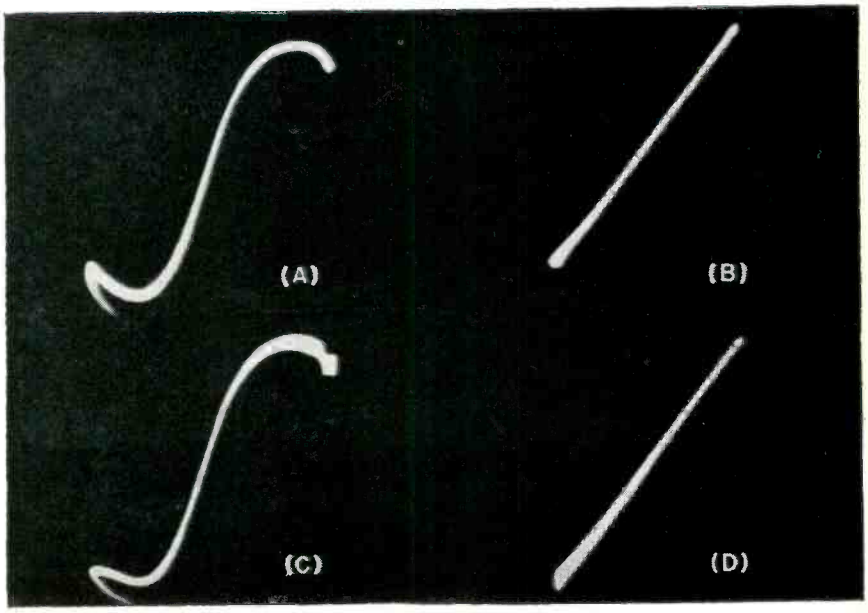

FIG. 4—Detected output at 75 kc (left) and 25 kc (right) deviation. Wave forms at top have a-m crossover on center while those at bottom have cossover off center

grees. The resultant plate-current pulse varies as shown in Fig. 1D. Figure 1E shows the plate current samples as a function of time. These are integrated by the plate bypass capacitor and their average is the audio output at X.

From Fig. 1 it can be seen that the sampling approach seems to offer the inherent advantages of linearity of response and a-m rejection. These features are obtained in conventional f-m discriminators only at the expense of two diodes in a balanced circuit.[7] By contrast, in a sampling type of f-m detector, it should not be necessary to use more than a single signal rectifier.

Linearity of response holds only for sampling during the linear rise of the signal. Amplitude-modulation rejection is strictly true only for a sampling signal E of constant amplitude. However, since the a-m response of synchronous detection changes sign on either side of zero passage, residual a-m may be cancelled in the output by slight off-centering of the sampling phase. Moreover, grid-voltage regulation is assisted by the high impedance of the tuned transformer-secondary. Experience has shown that there are practical circuits whose performance is in line with this idealization.

Practical Circuit

Figure 2 shows the practical form of the synchrotector. The circuit comprises a driver, locked

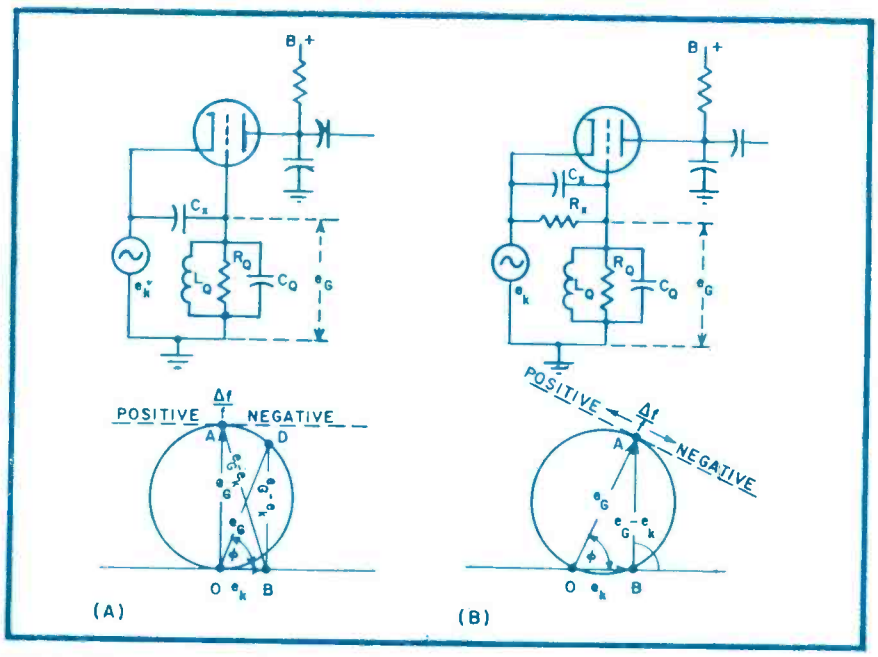

FIG. 5—Phasing for noncoincidence (A) and coincidence of peak output and quieting (B)

oscillator and sampler.

The driver is a conventional r-f pentode with low screen bias. This stage provides overload protection and gain, but cannot be counted on as a limiter, especially at the low signal levels concerned.

The double triode represents the synchrotector circuit proper. Tube V_{2A} is an oscillator with inductive feedback between plate and grid. The oscillator tank circuit forms the secondary of a bifilar transformer, whose primary connects to the driver plate at a step-up ratio of 2 to 1. The tuning slug passes through the triode plate coil, thus insuring good feedback while tuning.

The locked oscillator acts as an overdriven cathode follower. It is coupled to sampling triode V_{2B} through a common cathode connection. For f-m receiver applications, a passive cathode follower may be substituted for V_{2A}. Driving impedance $R_K C_K$ has an important influence on quieting. In all other respects, the function of the sampling triode follows the general outline given before, except that a separate clamping diode was found unnecessary.

Table I—Computed data for circuit constants of Fig. 2

C_X ($\mu\mu$f)	ϕ (degrees)	f/f_c (percent)	f/bandwidth (percent)
2.2	70	1.1	16
5	80	0.5	7

Performance Test

To study the performance of the synchrotector, the signals shown in Fig. 3 were used. Both had a carrier frequency of 4,500 kc, deviated at a 60-cycle rate by either ±25 kc or ±75 kc, as desired. The f-m carrier in Fig. 3A was amplitude modulated by a sine wave of several kilocycles.

In Fig. 3B, the amplitude modulation consisted of a pulse at a repetition rate of 60 cps. This signal was useful for listening tests since it closely simulates the reception of a standard tv signal.

Figure 4A shows the synchrotector output from the signal of Fig. 3A using ±75 kc deviation. At this excessive deviation, the output has the shape of a half-wave as expected. Figure 4B shows the output with 25-kc deviation. At this reduced deviation, the output is linear.

The a-m rejection in Fig. 4A and 4B is balanced (optimized at center frequency). By contrast, the a-m crossover lies at the top end, or at the bottom end of the frequency scale in Fig. 4C and 4D. These conditions result from changing C_K from the value given in Fig. 2. Optimum linearity and output voltage are adjusted by tuning the inductance, L_Q, of the sampling circuit.

The circuit of Fig. 2 has a lock-in threshold of 12 mv with a 12AU7 and 6 mv with a 12AT7. Since the output is 25-v peak-to-peak in both cases, the maximum conversion gains are 2,000 and 4,000. This high sensitivity permits stable operation from the second detector output, thus by passing the video stages.

Phasing Problems

It was found that there is no inherent coincidence in a triode-sampler between maximum signal output and minimum a-m noise. Optimum output happened with the grid tank tuned head-on, while optimum quieting occurred when tuning L_Q to a slightly higher frequency than the carrier.

Inspection of Fig. 1B shows that optimum quieting demands sampling during zero passage of cathode voltage e_K. Since the plate current is determined by the voltage between cathode and grid, this calls for voltage difference $e_G - e_K$

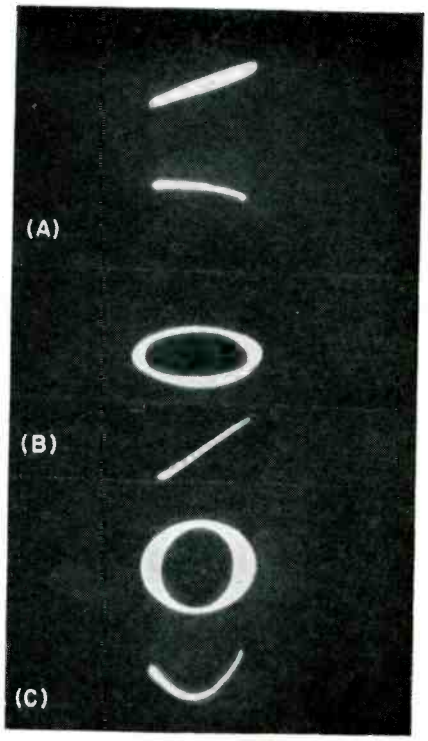

FIG. 6—Output and waveforms for three values of center frequency. Phase angle is 10 deg at upper bend (A) of sampling characteristic and 45 and 80 deg at linear part (B) and lower bend (C)

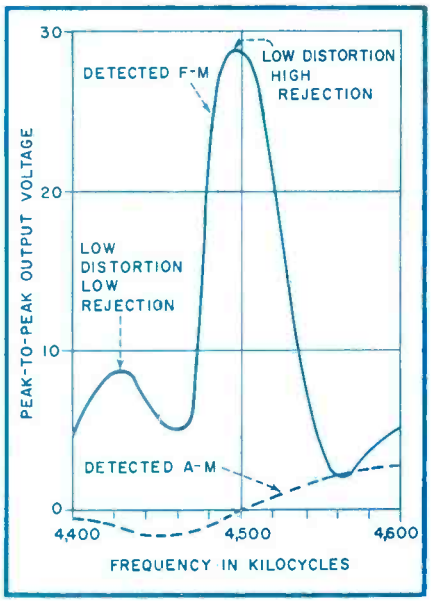

FIG. 7—Synchrotector f-m and a-m response charactertistics

to be in quadrature with e_K for best a-m rejection.

Figure 5A shows voltage e_G, across a tuned grid, coupled to the cathode voltage, e_K, through an ideal capacitance C_X. For this network, the change of grid voltage with tuning is described by a circle diagram whose diameter OA is normal to the cathode voltage axis OB. Vector OA represents tuning for peak grid voltage and offers optimum linearity of phase detection. However, this condition does not coincide with quieting since the sampling voltage, vector $BA = e_G - e_K$ is not in quadrature with e_K. Detuning of the grid circuit to a higher frequency results in a-m rejection at point D ($BD \perp OB$). However, this happens at the expense of linearity since the phase modulation around OD is no longer strictly symmetrical. This is even more true for the second working point E, which is too far from resonance to be usable.

Vector triangle OBA stands for optimum f-m detection and triangle OBD for best quieting. The second condition differs from the first only by a slight detuning of the sampling circuit. As a first-order correction, this detuning can be minimized by circuit design.

The difference Δf for both tuning conditions may be formulated in terms of circuit components; in terms of carrier frequency

$$\Delta f/f = -\tfrac{1}{2}L_Q/(C_X R_Q^2) \qquad (2)$$

and in terms of tank circuit bandwidth

$$\Delta f/f = -1/(2\omega C_X R_Q) \qquad (3)$$

Equation 2 shows how to minimize the percentage detuning by making tank circuit inductance L_Q small, damping resistance R_Q large and by padding, if feasible, the grid to cathode capacitance C_X, with external capacitance.

For the phase angle between grid and cathode voltage,

$$\tan \phi = R_Q \omega C_X \qquad (4)$$

Using the circuit constants from Fig. 2, the data in Table I are computed.

To obtain optimum quieting, the grid circuit has to be detuned to an extent which is small, but not negligible in terms of its own bandwidth. It is therefore desirable to have additional means for centering the a-m rejection after tuning the grid for maximum signal.

Centering A-M Rejection

Figure 5B shows the most desirable mode of operation. The grid tuning function should be made to follow a circle diagram with inclined diameter OA; phase angle AOB, between resonant grid and cathode, being less than 90 degrees. If this relationship exists, grid peaking and minimum distortion becomes coincident with best quieting, since for peak tuning of OA, the voltage difference AB is in quadrature with OB. This mode can be realized by a resistive component R_X in shunt with coupling capacitor C_X. The expected crossover control from this move has been fully confirmed by experience.

In practice, it has been found more convenient to replace R_X by a scaled down value R_K in the cathode return and to adjust its effective value by a small cathode bypass capacitor, C_K, as shown in Fig. 2. It is then found that for best quieting the cutoff frequency $1/(2\pi R_K C_K)$ of the cathode network comes close to one half of the frequency of the intercarrier signal.

Figure 6 shows Lissajous figures for grid and cathode voltage e_G and e_K along with the output waveforms obtained for three separate values of center frequency. The phase angle is about 60 degrees in the linear part of the sampling characteristic and approaches 0 and 90 degrees at the upper and lower bend.

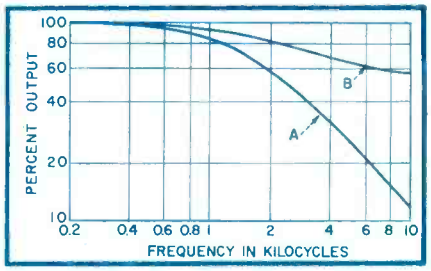

FIG. 8—Synchrotector audio output with constant deviation (A) and 75-μsec pre-emphasis (B)

Figure 7 shows the f-m and a-m response of the synchrotector as a function of carrier frequency. As anticipated from Fig. 1, the response to either type of modulation has the general shape of a cosine or sine function respectively, of the sampling phase. In the main lobe, there is satisfactory coincidence between best f-m detection and a-m rejection. Quieting factors of 40 to 50 db were readily obtained in sustained field tests.

Frequency response of the synchrotector is shown in Fig. 8, both for constant deviation (A) and also on a standard tv sound signal, using a preemphasis network of 75 microseconds in the transmitter (B).[8]

In the early phases of this work, much assistance and cooperation was given by Uziah Galil. The author is further indebted to G. Costello and A. F. Hogg for construction of equipment and testing of monochrome and color receivers using the synchrotector.

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SUMMARY —— Simple R-C degeneration in emitter circuit achieves high-frequency compensation in transistor video amplifier for airborne radar system. Unequal degeneration in cascaded stages offers slight improvement in pulse rise time. Thermistor network can offset loss of gain with increasing temperature. Silicon transistors are employed

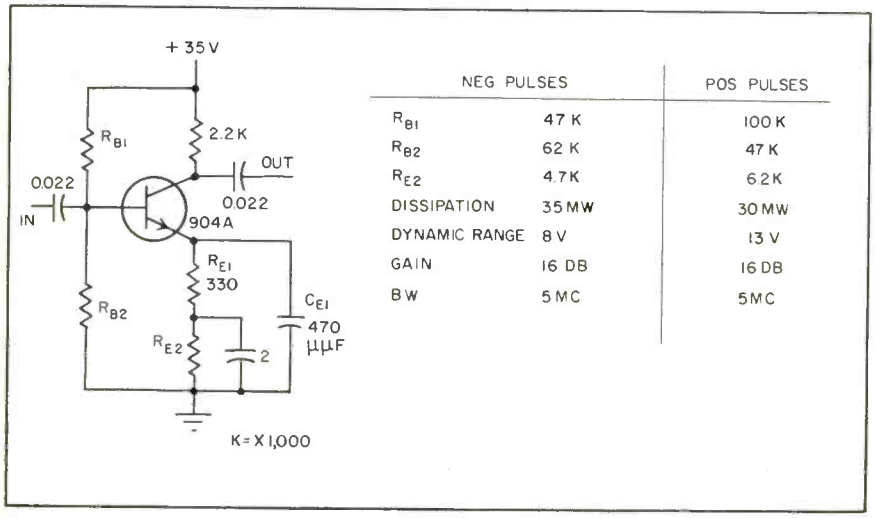
By RICHARD LESLIE

Sperry Gyroscope Company
Division of Sperry Rand Corp.
Great Neck, New York

TRANSISTOR AMPLIFIER

DESIGNED TO REPLACE its electron-tube counterpart in airborne radar systems, the transistor video amplifier incorporates many of the space, weight and power economies inherent in transistorized equipment. In design of transistor circuits for such environment, where large variations in temperature are present, the designer must take into account transistor parameter variations with temperature and minimize their effect.

Grounded-emitter amplifiers are used to obtain economical power gain with cascaded stages. Although the bandwidth of a grounded-emitter 904A silicon transistor is only 300 kc, pulse rise times on the order of a few tenths of a microsecond must be passed, requiring high-frequency compensation. After considerable experimentation with shunt and series peaking it was decided that R-C degeneration in the emitter circuit offered the best solution.



	NEG PULSES	POS PULSES
R_{B1}	47 K	100 K
R_{B2}	62 K	47 K
R_{E2}	4.7K	6.2K
DISSIPATION	35 MW	30 MW
DYNAMIC RANGE	8 V	13 V
GAIN	16 DB	16 DB
BW	5 MC	5 MC

FIG. 1—Grounded-emitter video amplifier stage with values and performance data for both positive and negative-pulse input

A shunt-peaked transistor amplifier was built having a gain-bandwidth product of 4×10^4 mc. Upon removal of the peaking coils and readjustment of the emitter network, the gain-bandwidth product had dropped only to 3×10^4 mc. Aside from the advantages of internal negative feedback, R-C degeneration avoids the difficult adjustments required in series and shunt peaking for optimum response.

Careful attention should be given to the choice of bias point. It is most desirable from standby con-

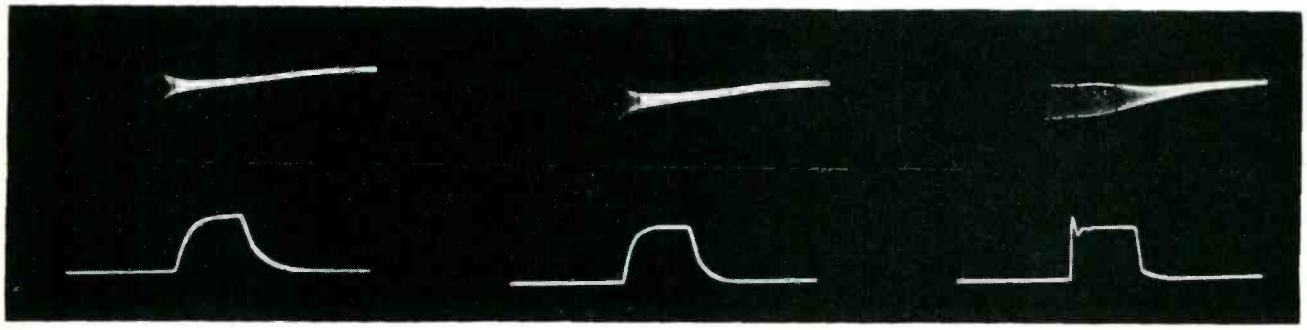
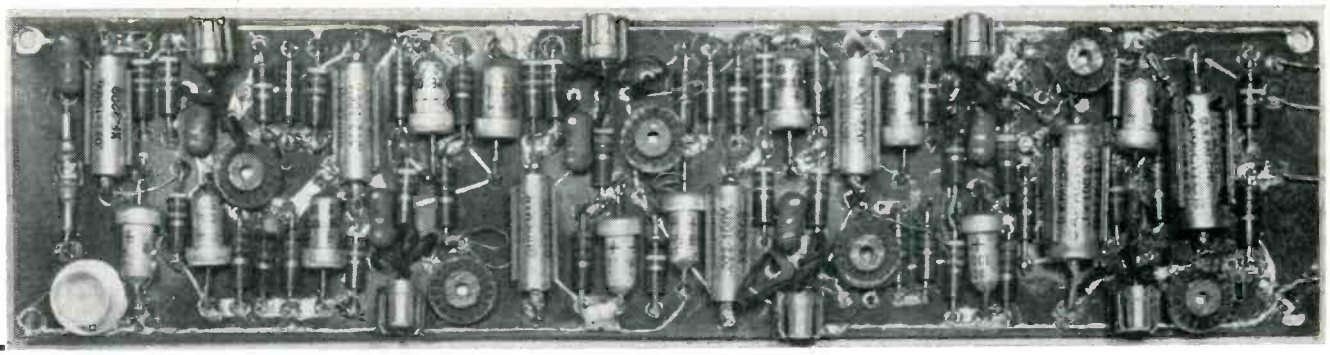


FIG. 2—Bandwidth and response to 2-μsec pulse for single stage. For $C_{E1} = 0$ and $R_{E1} = 0$(A): gain = 37 db, bandwidth = 250 kc and rise time = 1.3 μsec. For $C_{E1} = 0$ and $R_{E1} = 330$ ohms (B): gain = 16 db, bandwidth = 500 kc and rise time = 0.8 μsec. For $C_{E1} = 470$ μμf and $R_{E1} = 330$ ohms (C): gain = 16 db, bandwidth = 5 mc and rise time = 0.07 μsec



Printed-circuit transistor video amplifier. An earlier design, this amplifier uses shunt peaking coils

for RADAR VIDEO

siderations to operate each transistor at a high collector voltage and low collector current. A stage adjusted to amplify positive-going pulses can be so biased, thus favorably affecting bandwidth, stability, dissipation and dynamic range. Bandwidth is increased because of the decrease in collector capacitance and increase in alpha cutoff frequency with large collector-to-base voltages.

A negative-going pulse amplifier, on the other hand, can not be biased too high on the load line without adversely affecting bias stabilization and rise time. An experimental compromise must be reached between collector power dissipation, rise time and stabilization on the one hand, and dynamic range on the other.

A single stage with R-C degeneration in the emitter circuit can be adjusted to maximally flat gain response by fixing the emitter R-C time constant slightly greater than the collector time constant. A further adjustment must be made when cascading such stages because two maximally flat stages when cascaded do not make a maximally flat pair and also because of the loading effect of the second transistor stage on the first.

Temperature Stabilization

Although silicon transistors will operate without failure up to 150 C, the parameters can change as much as 50 percent as the upper temperature limit is approached. Taking the transistor h-parameters as an example, at 100 C h_{12} increases 50 percent, h_{11} increases 25 percent and h_{21} or alpha decreases 20 percent over the room temperature values.[1]

One of the primary goals in bias stabilization is to maintain constant emitter current throughout the temperature range. Although simpler operation results from constant base-current bias because of

Table I—Variation of Amplifier Characteristics With Temperature

Equal emitter degeneration — Fig. 4.			
Temperature	25 C	65 C	100 C
Plateau pulse gain	61 db	60.9 db	60.7 db
Overshoot pulse gain	63.1 db	61.9 db	60.8 db
Rise time	0.25 μsec	0.31 μsec	0.35 μsec
Bandwidth	2 mc	1.5 mc	1 mc
Unequal emitter degeneration — Fig. 6.			
Temperature	25 C	65 C	100 C
Plateau pulse gain	61.9 db	60.7 db	60.5 db
Overshoot pulse gain	64 db	63 db	62 db
Rise time	0.22 μsec	0.33 μsec	0.34 μsec
Bandwidth	2.05 mc	1.5 mc	1 mc

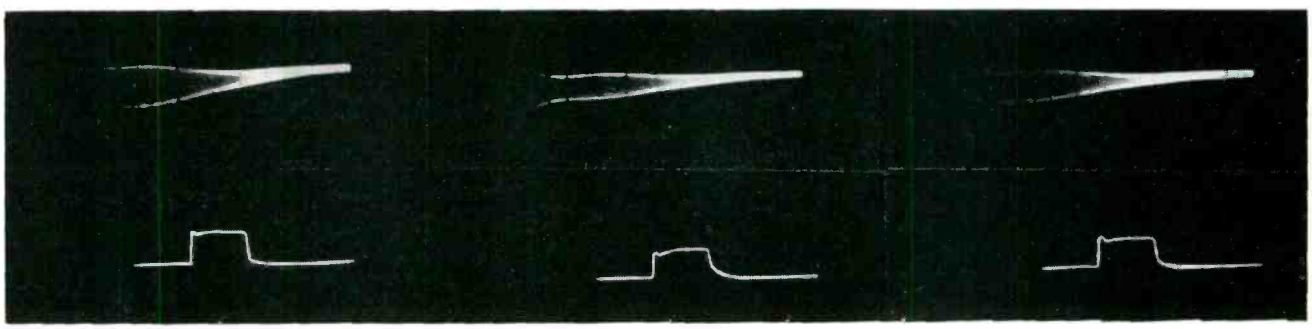


FIG. 3—Bandwidth and response to 2-μsec pulse for single stage. For $C_{E1} = 470$ μμf and $R_{E1} = 330$ ohms: gain = 16 db, bandwidth = 5 mc and rise time = 0.07 μsec when unloaded (A); bandwidth = 1 mc and rise time = 0.2 μsec when loaded (B). For $C_{E1} = 620$ μμf and $R_{E1} = 330$ ohms: gain = 16 db, bandwidth = 4 mc and rise time = 0.15 μsec when loaded (C)

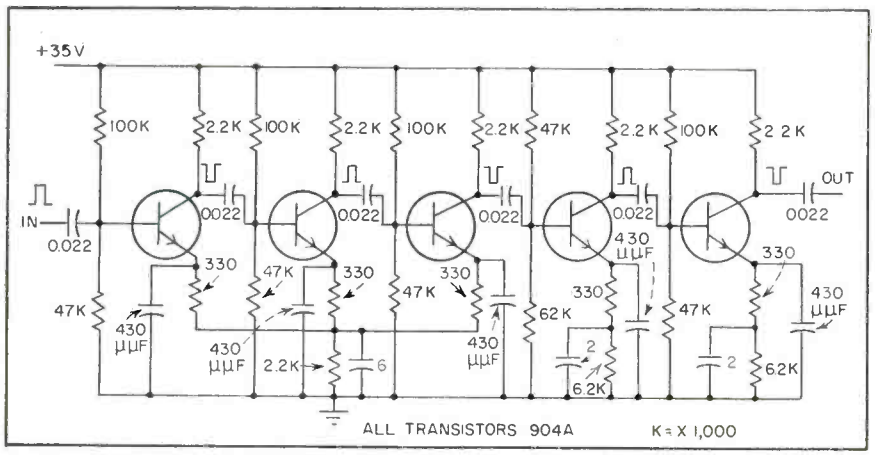


FIG. 4—Five-stage amplifier with equal amounts of degeneration in each emitter circuit

better linearity and higher input impedance, base-current bias permits greater temperature instability.

A principal cause of instability with constant base-current bias is the magnification by a factor of $1/(1 - \alpha)$, in the collector circuit, of the increase in collector cutoff current with temperature.[2] In silicon transistors, I_{co} changes rapidly with temperature but usually remains less than 5 microamperes up to 100 C.

Another phenomenon, even more pronounced in silicon than in germanium, is a change in input conductance which occurs over the entire usable temperature range.[3] This also results in a shift of the operating point and can be minimized by constant emitter-current bias.

Design Considerations

The circuit diagram of a stage with emitter degeneration is shown in Fig. 1. Resistor R_{E1} is partially bypassed by C_{E1} decreasing the degeneration at high frequencies.

The collector circuit capacitance was estimated to be 50 $\mu\mu$f. The load resistor was selected to be 2,200 ohms, a value experimentally found to allow a satisfactory compromise between gain and bandwidth. Hence the emitter time constant should be slightly greater than 0.1 microsecond for maximally flat gain response.

The value of R_{E1}, 330 ohms, was chosen as that necessary to reduce the low-frequency gain to approximately 15 db. Capacitance C_{E1}, calculated from the values of R_{E1} and collector time constant, was 330 $\mu\mu$f. Using a swept frequency oscilloscope display, the optimum value of C_{E1} was found to be 470 $\mu\mu$f, extending the bandwidth to about 5 mc with some high-frequency peaking.

Peaking was necessary to prevent excessive deterioration of rise time at high temperatures where alpha-cutoff frequency decreases. Measurements indicate that this parameter is down 20 percent at 100 C. Figure 2 illustrates the effect of the emitter network.

Emitter Resistance

Temperature stabilization is accomplished by inserting in the emitter circuit a relatively large resistor, R_{E2}, thereby effecting a constant emitter-current bias. The values of R_{B1}, R_{B2} and R_{E2} shown in Fig. 1 are based upon a compromise between the following four considerations:

Given the emitter bias current, 2 ma, and the power which may be expended in stabilization, 26 mw, the emitter to ground voltage and R_{E2} become known. The base resistors should be proportioned to give this d-c emitter voltage.

The ratio R_{E2}/R_{B2} should be as large as possible consistent with gain requirements, thereby increasing stability and lowering the collector current.

Resistor R_{B2} must be made large enough to prevent loading the previous stage.

If dynamic range is important, the operating point should be chosen in accordance with the polarity of the pulse.

The optimum values of R_{B1}, R_{B2} and R_{E2} were determined experimentally for each polarity pulse, and the results are tabulated in Fig. 1.

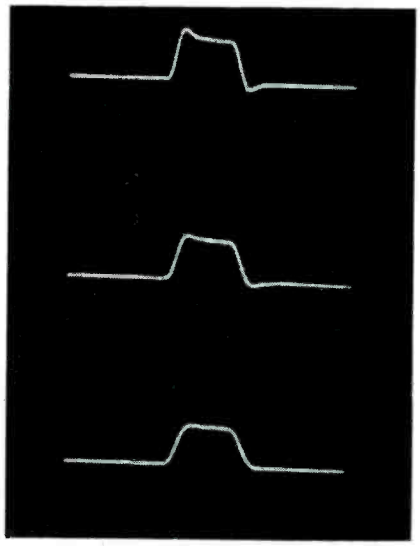


FIG. 5—Response of five-stage amplifier to 2-μsec pulse. Top: at 25 C, gain = 62 db, bandwidth = 2 mc and rise time = 0.25 μsec; middle: at 65 C, gain = 62 db, bandwidth = 1.5 mc and rise time = 0.31 μsec; bottom: at 100 C, gain = 61 db, bandwidth = 1 mc and rise time = 0.35 μsec

Supply Voltage

The higher the supply voltage consistent with allowable dissipation, the better the operating characteristics of the amplifier. A high collector-supply voltage allows a high value of R_{E2}/R_{B2} for a given operating point.

Alpha cutoff-frequency is increased and collector capacitance decreased with a higher supply voltage. A greater dynamic voltage swing is possible, an important consideration in output stages. Typical performance results obtained with a single-stage negative and positive-pulse amplifier are given in Fig. 1.

When two stages are cascaded, both the gain and bandwidth of the first stage are lowered because of the complex input impedance of the second stage. The first two oscillograms of Fig. 3 compare the frequency response of an unloaded stage to that of a loaded stage. The third oscillogram shows how the frequency response of the loaded stage is partially improved by increasing the emitter feedback capacitor from 470 $\mu\mu$f to 620 $\mu\mu$f. Figure 3 also illustrates the pulse

response of one stage under these three conditions.

In a linear amplifier comprising several stages, all transistors with the exception of the last two can be biased at a high collector voltage and low collector current because of the low level of the signals. The last two stages, which may have to accommodate large voltage swings and yet maintain linearity, should be biased in accordance with the pulse polarity.

In a typical five-stage amplifier with the low-level transistors biased identically as shown in Fig. 4, an adequately bypassed common-emitter-bias stabilizing resistor can be used for several stages.

Although this scheme has been used with four stages, it is expedient to limit the number to three because of the large bypass capacitor needed to prevent oscillation. The emitter feedback capacitors have been reduced to 430 $\mu\mu$f to provide maximal flatness for the five-stage amplifier.

Temperature Tests

Figure 5 shows the results of temperature tests on the five-stage amplifier. The average alpha-cutoff frequency of the 904A silicon transistors is 9.9 mc and the average alpha is 0.962. At 100 C, the gain drops slightly over 1 db from the room-temperature value of 62 db, while the rise time deteriorates. At low temperatures the gain decreases slightly, while rise time and bandwidth improve.

With shunt peaking, a better overall amplifier response curve results if the compensation is staggered. Figure 6 shows this idea applied to R-C degeneration in a video amplifier. The high-frequency responses of stages 1, 2, 4 and 5 have been emphasized by increasing their emitter degeneration resistors to 430 ohms. The low-frequency response of stage 3 has been emphasized by decreasing its emitter resistor to 150 ohms. This circuit shows a slight improvement in rise time at 25 C over the unstaggered amplifier of Fig. 4. Comparative data shown in Table I indicates nearly identical performance at elevated temperatures.

The power-supply drain of the amplifier shown in Fig. 4 is 315 mw at 35 v. The base-bias networks and the bias-stabilization networks dissipate about half the power. A similar electron-tube amplifier requires 4.5 w at 150 v, exclusive of heater power.

The six-stage printed-circuit video amplifier shown in the photograph was also temperature tested. This design employs shunt peaking coils. After 20 hr of temperature cycling from 25 to 100 C, the room-temperature gain and rise time had not changed. Moreover gain and rise time at 100 C were nearly identical at the beginning and end of the test.

Tests performed at alternate temperatures of −55 and +100 C for 24 hr in which the B+ voltage was cycled on and off ten times an hour showed no observable deterioration in amplifier performance.

In an application, the output pulse is used to trigger a transistor bistable flip flop. A method to compensate for both the loss in gain of the amplifier and loss in sensitivity of the flip-flop with increasing temperatures is shown in Fig. 7. A thermistor network, synthesized from empirical data, controls the bias applied to the diode gate and keeps constant the trigger threshold referred to the input

A scheme to compensate for loss in rise time with increasing temperature might be to apply positive feedback from emitter to emitter of consecutive stages through series thermistor-capacitor networks.

The author thanks Lawrence Greenspan for assistance in preparing this article.

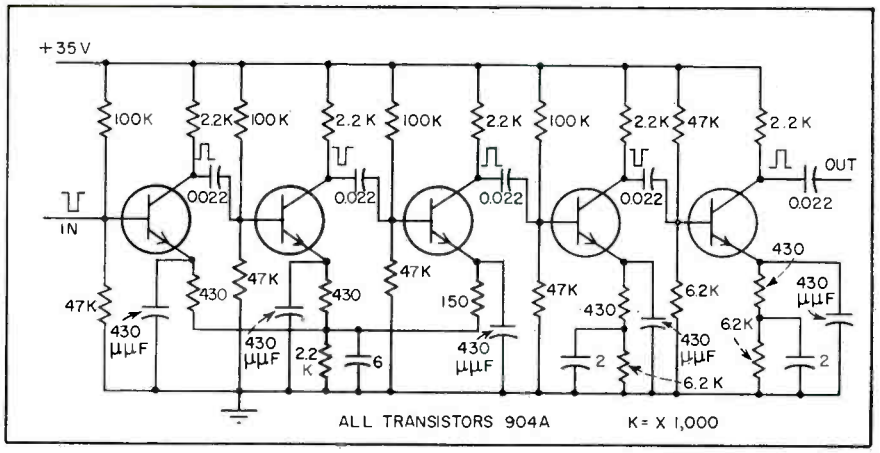


FIG. 6—Five stage amplifier with unequal amounts of degeneration in emitter circuits

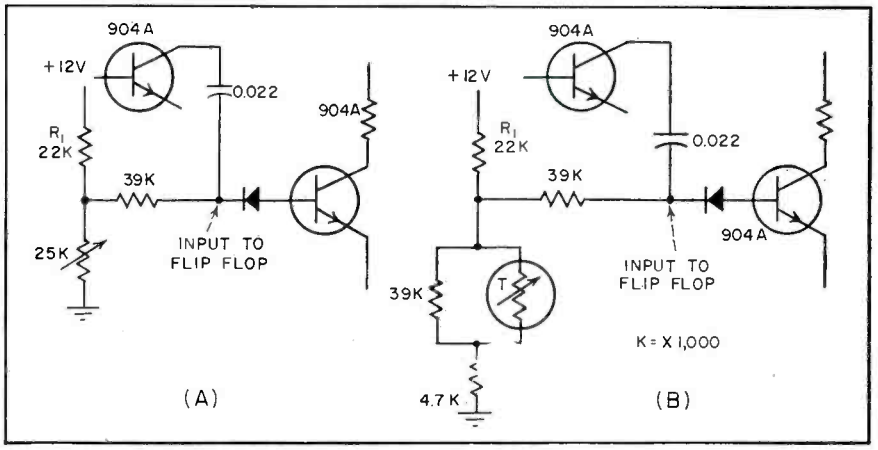


FIG. 7—Method for determining component values for thermistor network (A) and resulting thermistor network is emitter circuit to compensate for loss of gain with increasing temperature (B)

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(3) Temperature Effects in Circuits Using Junction Transistors, License Bull. 979, RCA Laboratories Division, New York, May 1955.

SUMMARY —— One-mc bridge gives rapid indication of capacitance. Laboratory signal generator feeds bridge and electromechanical sweep unit. Bridge output feeds vertical crt plates while sweep unit drives horizontal plates. Modulation-pattern position gives capacitance and dissipation factor. Useful in production-line testing by unskilled operators, system measures capacitance variations of ±0.5 percent at rates up to 3,500 capacitors an hour

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Bridge Tests Capacitors

COMMERCIAL AND MILITARY equipment specifications require capacitance and dissipation-factor measurements of capacitors below 0.001 μf at a frequency of 1 mc.

Available test bridges for laboratory measurements require alternate manual adjustments to balance both the reactive and resistive components inherent at this frequency. Measurements of large quantities of capacitors on such a bridge is time consuming and requires skill.

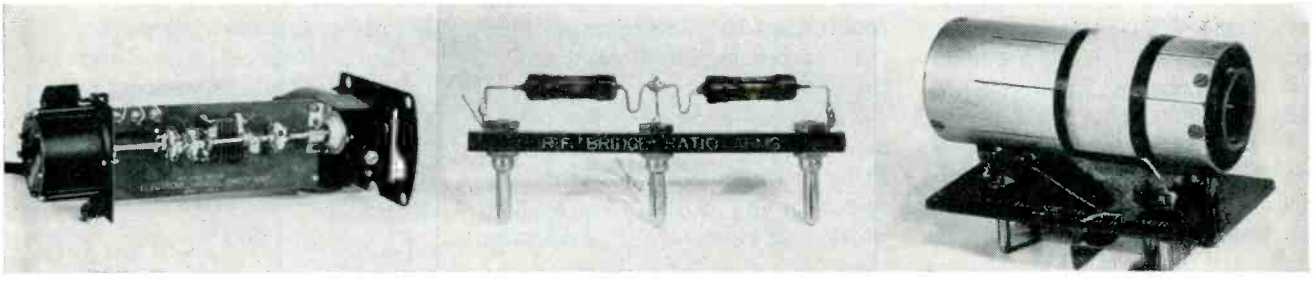
The method to be described uses a unity-ratio-arm bridge. As seen in Fig. 1A, the bridge input voltage is obtained from a shielded r-f generator, set to the required frequency. The bridge output passes through a shielded frequency-selective amplifier and converter (communications receiver) producing an a-f voltage on the vertical plates of a crt. The electromechanical sweep unit seen in a photograph supplies the capacitance variation in synchronism with the linear horizontal sweep voltage applied to the crt horizontal deflection plates through the oscilloscope amplifier.

Bridge Circuit

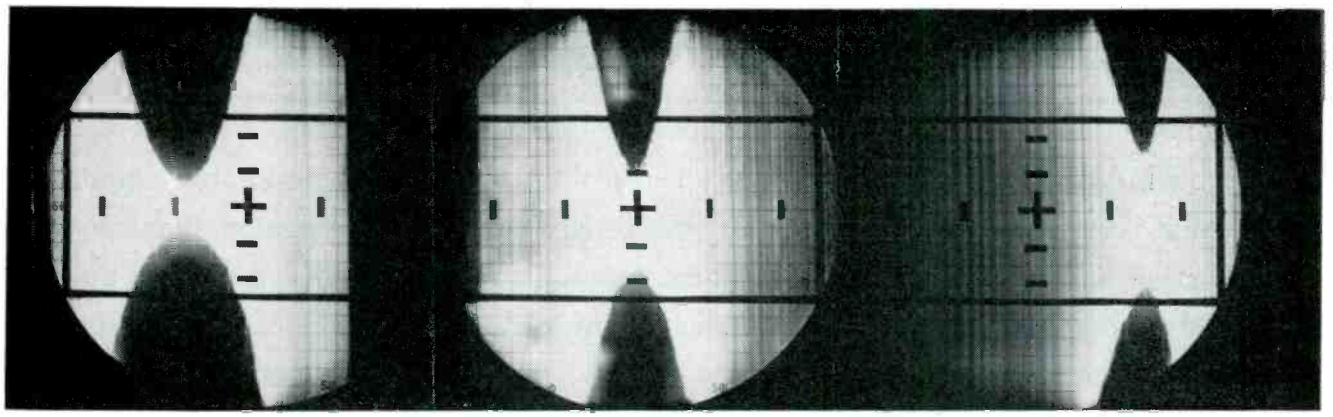
The bridge consists of two equal precision resistors, 100 ohms each, with small and equal residual reactive components, and a precision variable air capacitor, C_3, 500 $\mu\mu$f (maximum capacitance) in parallel with a small variable air capacitor ΔC_3 (35 $\mu\mu$f maximum capacitance). The capacitor to be tested is connected in the fourth arm. The generator voltage is introduced through a carefully balanced and shielded r-f transformer. There is no provision to balance out the resistive component of the unknown capacitor C_4, thus only an imperfect balance may be obtained by adjusting C_3.

The construction and small physical size of the ratio arms shown in a photograph inherently assures small residual values of parameters C_1, C_2, L_1, L_2 and C_c shown in Fig. 1B. Capacitors C_1 and C_2 are of the order of 0.3 $\mu\mu$f, while L_1 and L_2 are about 0.04 μH. Careful symmetrical arrangement of R_1 and R_2 makes the residuals equal from each side to the center. Owing to the small value of R_1 and R_2, the shunting effect of C_1 and C_2 can be neglected at 1 mc and only L_1 and L_2 need be considered. These must be equal for balance.

The ratio arms are balanced by selecting two resistors as nearly equal as possible. The small difference in d-c resistance is eliminated by adding a small length of manganin wire in series with the resistor having the lower value,



(B) Electromechanical sweep unit (left) has potentiometer at left, variable capacitor in center and a-c motor at right. Ratio arms of bridge (center) are balanced either side to center, while bridge transformer (right) is made from copper tube with lengthwise slots



(C) Display on crt shows capacitance 1.0 $\mu\mu$f low, (left) ideal (Center) and 1.5 $\mu\mu$f high (right). Dissipation factor within limits in all cases. For small capacitance tolerances the limit lines enclose a rectangle as shown. For wider variations a trapazoidal pattern results

On Production Line

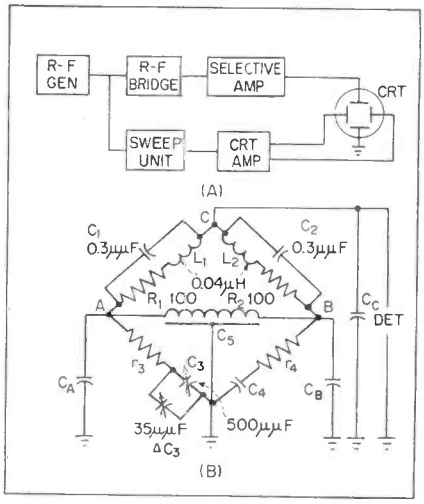


FIG. 1—Block diagram of system (A) and bridge circuit showing residual parameters (B)

until the two halves are equal as checked on a sensitive d-c bridge. The small increase in series inductance introduced by the small manganin loop is counteracted by a similar copper wire loop in the other arm as seen in a photograph. Opening or closing the loop will alter the inductance slightly until complete balance is obtained. Differences in C_1 and C_2 may be eliminated by the small copper flag at one end of the ratio arms. Final balancing is done at two widely separated frequencies in the bridge proper until reversal of the ratio arms does not affect the balance.

The balanced, shielded transformer construction makes C_A, C_B and C_S small and symmetrical with respect to bridge corners A and B. A copper tube with lengthwise slots acts as a Faraday shield between primary and secondary. The primary is wound outside of the shield, while the secondary is wound on a polystyrene tube about half the diameter of the copper shield and is placed in its center. Equalization of C_A with C_B is done by sliding the polystyrene tube with the secondary coil in an axial direction until transposing of the secondary leads leaves the bridge balance unaffected.

Linear sweep for the crt is produced by a rotating linear potentiometer mechanically coupled to a linear variable air capacitor driven by a constant-speed a-c motor.

Bridge Operation

To set up the bridge for large runs of production testing a capacitor with the required characteristics and allowable limits selected by careful laboratory measurements and connected to the unknown terminals of the bridge.

The motor-driven capacitor is set to mid-position corresponding to zero horizontal sweep voltage and the capacitance difference ΔC_3 dial is set to zero. The generator and receiver are tuned to the selected frequency. The gain control and beat-frequency oscillator are then adjusted to give a vertical trace on the crt screen along the Y-axis.

Careful adjustment of the capacitance dial C_3 will produce a distinct minimum balance position. Adjustment of the amplifier gain controls for a convenient amplitude will produce the point corresponding to the nominal value of the dissipation factor. Test capacitors with known dissipation factors are connected across the unknown terminals and the screen is calibrated accordingly, marking tolerance limits by any suitable means.

The Capacitance Difference dial is turned to +1, +2, +3 and so on. Minimum balance points are found by turning the sweep capacitor manually. Corresponding points and limits on the crt screen X-axis are then marked off. The capacitance difference dial is returned to zero and both dials are locked.

Photographs show a typical pattern as seen on the crt screen for a capacitor with the required nominal value of capacitance and dissipation factor.

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EXCITERS MULTIPLEX

SUMMARY —— Audio applied to serrasoid circuit phase modulates signal that is crystal controlled at slightly above 100 kc. Exciter multiplies signal to either 44 to 54-mc or 88 to 108-mc range. A similar exciter generates an audio-modulated 32.5-kc subcarrier to multiplex with main carrier. Units have a total audio distortion of less than 0.2 percent and a crosstalk figure of approximately —55db

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MULTIPLEX TRANSMISSION promises to provide the future for economic f-m broadcasting.[1] The equipment to be described consists of two f-m exciters capable of supplying a main carrier of 100 mc and a subcarrier of 32.5 mc to perform the multiplexing operation. Additional subcarriers may be added to the system whenever it is desired.

The method used to originate the 100 mc multiplex signal is shown in the schematic diagram of Fig. 1. The main channel unit initiates the signal with crystal oscillator V_1 operating slightly above 100 kc. The next two stages shape the waveform into a sawtooth and apply it to V_{4a}.

Assuming a constant train of sawtooth waveforms, the grid volt-

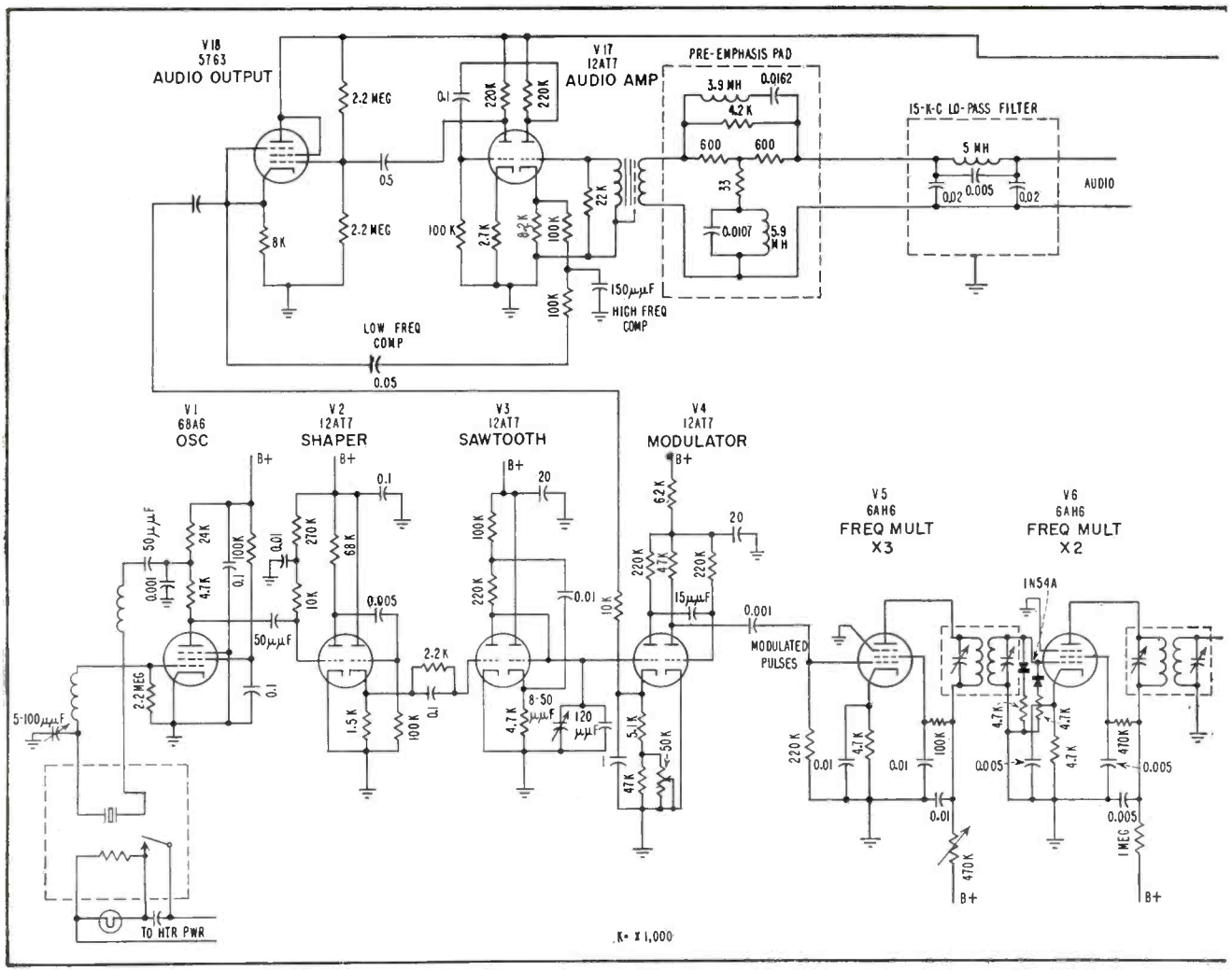


FIG. 1—Complete schematic of exciter capable of producing from 2 to 20 watts output power. Unit is normally used to drive power

age will rise linearly along the leading edge of the saw tooth waveform until the tube conducts, causing a sharp negative-going pulse to appear at the plate of the tube. If audio voltage is applied, it will cause the grid-to-cathode bias to vary at the applied audio frequency rate. The negative-going spikes at the plate of V_{4-A} will appear sooner or later in time, at an audio frequency rate, thus causing phase modulation.

Multipliers

The negative-going pulses appearing at the plate of V_{4-A} are inverted by V_{4B} and applied to frequency multipliers V_5 through V_9. These stages are coupled by double tuned transformers for added selectivity. The coupling is narrowed to the point where it just begins to affect the response at 15,000 cp.

This is done to attenuate spurious sidebands occurring in the vicinity of 100 kc.

Since the subcarrier modulates the main carrier about 10 percent, it starts out with a handicap of roughly 15 or 16 db with respect to 100 percent modulation of the main carrier by audio.

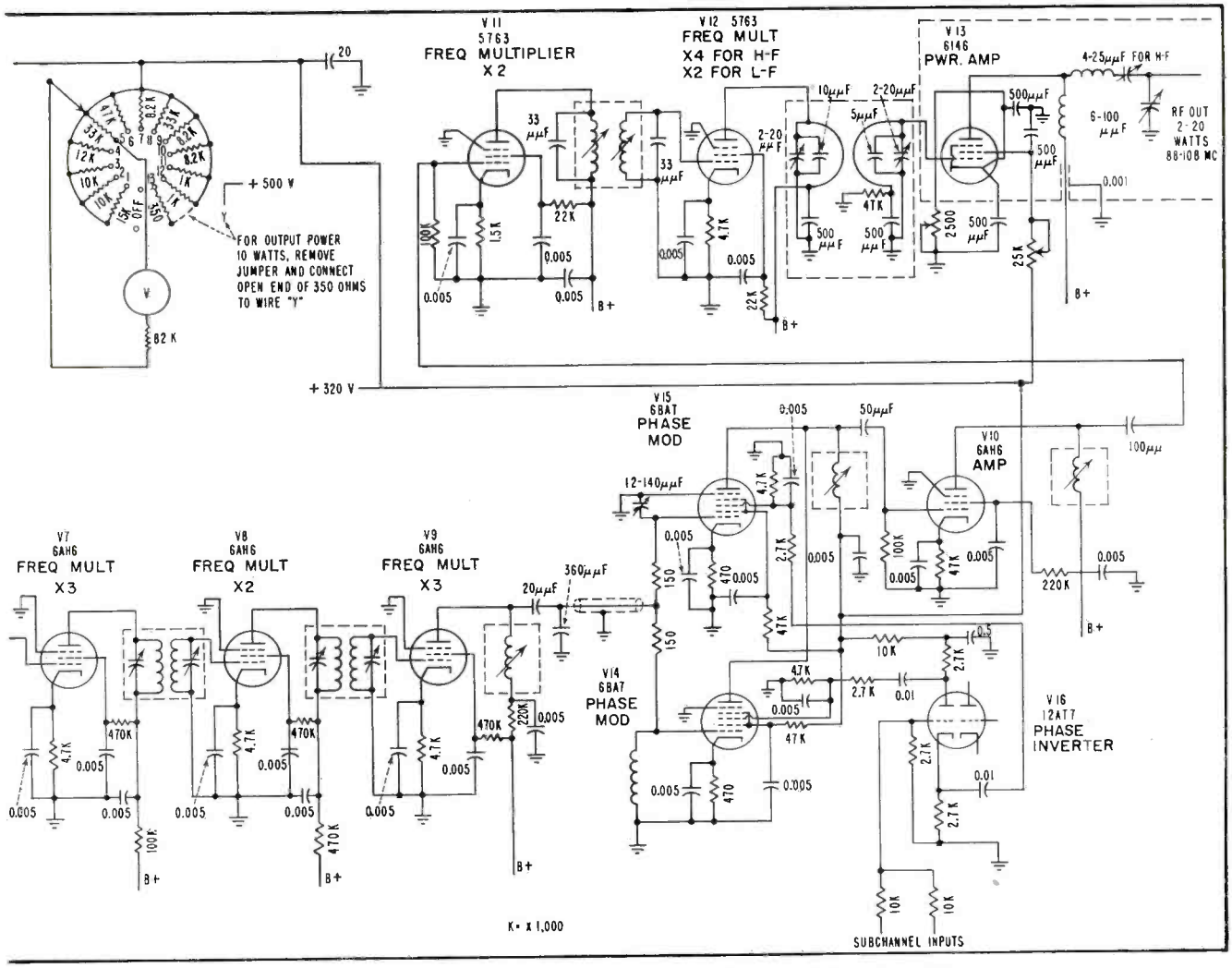
If the 100-kc beats are down 60 db below 100 percent modulation at 400 cycles, they will be only about 45 db down with respect to subcarrier modulation. This puts them in a range where they may affect subcarrier performance since each of these spurious sidebands will carry audio modulation.

Two germanium diodes are connected across the secondary of T_2. They increase the attenuation of crystal frequency beats from −50 to about −65 db..

Modulator

The output of V_9, drives the phase modulator, V_{14} and V_{15}. The subcarrier frequency is injected in push pull. The R-C network between the output of V_{16} and the phase modulator tubes is a de-emphasis circuit that tends to keep subcarrier modulation of the main carrier constant.

The 6146 power amplifier stage normally operates at the output



amplifiers from 250 watts to several kilowatts output by replacing original exciters in existing transmitters

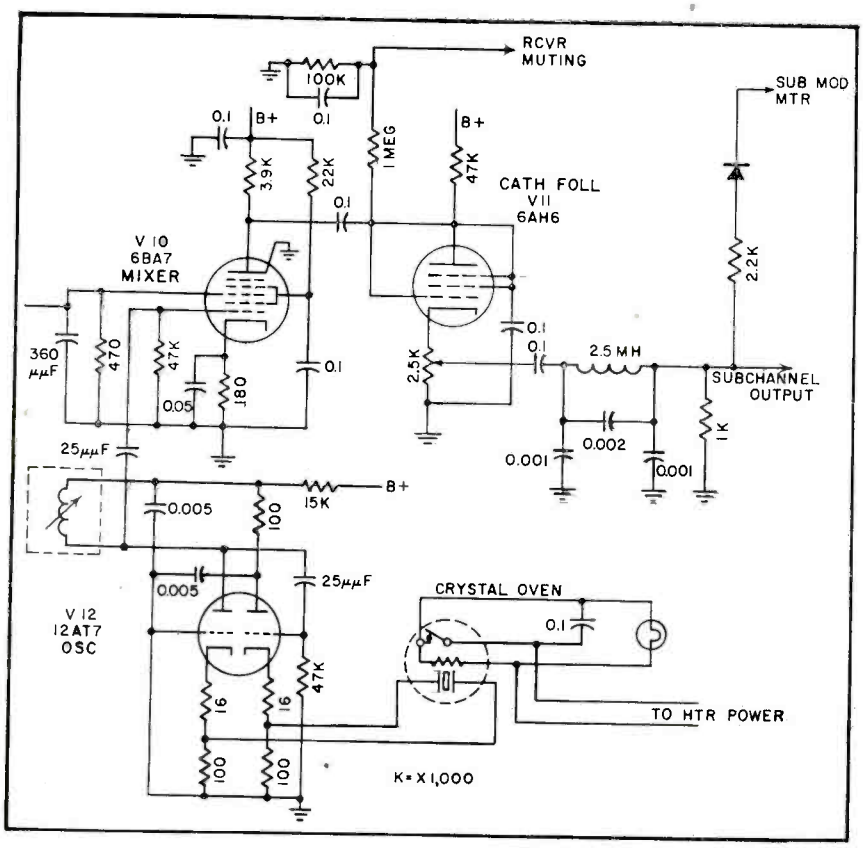


FIG. 2—Subcarrier output circuits. Preceding circuits are identical to those in main channel unit of Fig. 1. Negative voltage (—24 v) applied by voice-operated relay causes receiver muting between musical numbers when desired

frequency unless the exciter is used to drive a transmitter that has its own doubler. Quadrupling in V_{12} may be questioned as it is seldom done, but in this case it proved better.

With 320 volts on the plate of the 6146 stage, it is capable of 10 watts output with efficiencies in the order of 65 percent. When V_{12} is used as a doubler in conjunction with the 6146 stage only 6 watts output could be attained with the same element voltages. A strong spurious signal at half frequency also resulted.

Double-tuned stages were used to attenuate these spurious frequencies. Changing from single to double tuned stages did not appear to affect supcarrier crosstalk to any extent.

Voltages on all multiplier stages were kept as low as practical to prevent overdriving and saturation. This aided greatly in the attenuation of spurious frequencies to the point where they were well below 70 db.

The audio required to modulate the main carrier is supplied by V_{17} and V_{18}. The total distortion is less than 0.2 percent from 50 to 15,000 cycles. The rms value of output audio required to modulate the main carrier 100 percent is approximately 30 volts. Without the pre-emphasis pad, audio response of this amplifier would normally be flat to within 1 db from 50 to 15,000 cps.

However, owing to narrowing of bandpass in the multiplier stages of the exciter, the overall response at 15,000 cycles may fall off. Therefore 2 high frequency compensating capacitors was added. This raised the response approximately 3 db at 15,000 cps over that at 10,000 cps.

Since 50-cycle modulation tends to tax the maximum limits of the serrasoid modulator, a low frequency compensating capacitor was added to bring up the response at this frequency. It may be varied from 0.01 to 0.05 μf and will affect the response 3 to 4 db at 50 cycles with respect to 100 cycles.

Subcarrier Channel

The multiplex subchannel exciter unit with the exception of the last three stages, V_{10}, V_{11} and V_{12} is identical to the main channel exciter unit. A flat pad, in place of pre-emphasis, is normally used in the audio system but may be changed at the option of the broadcaster.

A 10-kc low-pass filter is normally used in the audio chain of the subchannel unit, while a 15-kc, low-pass unit is used in the main-channel exciter. On the main-channel exciter unit, the output of V_9 is fed to the phase modulator. On the subchannel exciter unit, the output of V_9 is fed to the grid of mixer tube V_{10}.

Oscillator

A stable Butler type oscillator, V_{13} feeds the other grid of mixture V_{10}. This oscillator frequency will differ from that of the output of V_9 by the subcarrier frequency. The subcarrier frequency output of V_{10} is then fed to cathode follower V_{11}. Between V_{11} and the output of the exciter a low pass filter is inserted that attenuates frequencies over 40 kc. A coaxial cable then connects the output of the subchannel exciter unit to the input of the main channel exciter unit.

The germanium diode rectifies a portion of this output which is applied to a test meter to read the approximate percentage of subcarrier modulation of the main carrier.

Crosstalk

The value of crosstalk from the main channel into the subchannel varies directly as the percentage of modulation on the main carrier and also varies with a difference in modulating frequency on the main carrier. The modulation frequencies above 4 kc appear to offend the worst. Fortunately, there is usually little energy present at these frequencies in the normal program. The best crosstalk figures obtainable, when sine-wave modulating the main carrier 70 percent, varies between —50 and —55 db.

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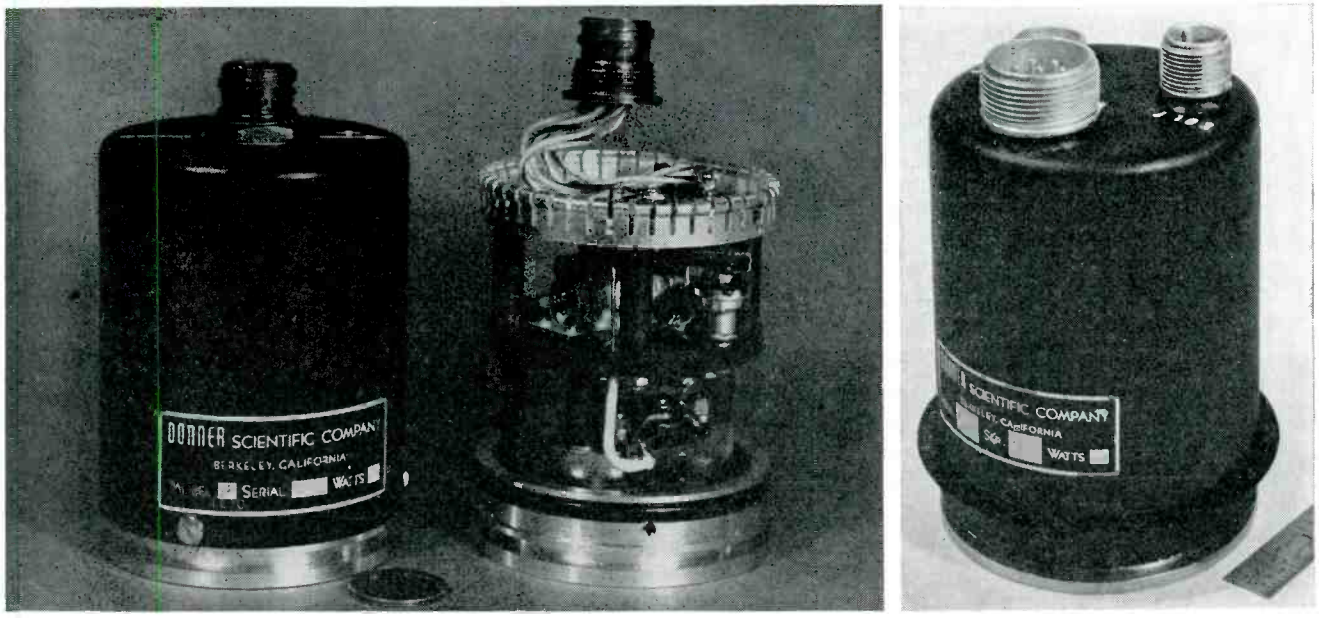

Transducer in its housing, left, transducer removed to show its construction, center, and power-supply in housing, right

Servo Accelerometer Uses R-F Oscillator

SUMMARY —— Instrument for measuring steady-state and low-frequency acceleration data incorporates 200-mc superregenerative oscillator with vane attached to moving coil as one plate of tuning capacitor. Oscillator is detuned in response to accelerating forces. Increased plate current flow through coil restores balance giving an indication of acceleration

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ACCELEROMETERS gage acceleration by measuring the inertial force acting on a fixed mass. Usually the force is measured by deflection of a spring. Spring deflection is proportional to acceleration along the sensitive axis of the device.

Deflection Detection

Several methods may be employed to sense spring deflection. Bonded or unbonded strain gages sense deflection through differential changes in resistance of fine wires under stress. Other accelerometers utilize a differential transformer, low-friction potentiometer or the change in transconductance of a vacuum tube.

In the servo accelerometer shown in the photographs inertial forces on the accelerated mass do not result in spring deflection. Instead the forces are automatically opposed by precisely equal forces which insure negligible deflection of the mass with respect to the accelerating system. The instrument is a miniature self-contained servomechanism which automatically measures input acceleration by a null method of achieving balance between two opposing torques.

The device is comprised of an r-f oscillator, torque mechanism, and power supply and output system. Linear acceleration along the sensitive axis of the transducer causes an input torque on a pivoted inertial system comprised of an unbalanced moving-coil-and-vane assembly. If the input torque is not completely balanced by an opposing torque due to current in the moving coil, an angular displacement of the inertial system results. Only a minute angular deflection of the inertial system is required to produce the current through the moving coil necessary for a precise balance of torques.

R-F Oscillator

The r-f oscillator shown in Fig. 1A uses a 5718 triode in a modified Colpitts or ultraudion circuit. Inter-

electrode capacitances enter into the determination of the drive ratio, which is critically affected by C_2.

The tank circuit of the oscillator is comprised of fixed coil L_1 and C_1 and C_2 in series, each shunted by interelectrode capacitance. Capacitor C_1 is a variable capacitor which links the oscillator to the torque mechanism.

The fixed plate of C_1 is rigidly attached to the main oscillator structure. The variable plate is the formed end of a metal pointer or vane carried by the moving coil of the torque mechanism. Radio-frequency connection to the vane is made from the tank coil through the upper hairspring of the torque mechanism.

The oscillator operates in superregeneration with a primary frequency of approximately 200 mc. Cathode current is not continuous but flows in 1 μsec pulses at the quench frequency. With proper choice of C_2, the quench frequency may be varied smoothly from less than 5 kc to more than 500 kc or above by changing C_1 only 5 $\mu\mu$f.

Over the entire range of quench frequency the amplitude of the plate-current pulses remains substantially constant. Thus a change in C_1 introduces a corresponding change in average plate current through duty-factor modulation.

At a nominal plate-supply voltage of 150 v, average plate current i_p may be changed from less than 1 ma to 8 ma or more as the spacing between the parallel plates of capacitor C_1 is varied approximately 0.002 in. Plate current is roughly proportional to plate-tank capacitance and therefore varies approximately in inverse proportion to the separation of the capacitor plates; see Fig. 1B. This nonlinear relationship between capacitor plate separation and i_p is responsible for a noticeable change in servo loop gain over the operating range.

As C_1 is varied, i_p varies over a range which is entirely positive. However, to achieve torque balance under an acceleration which may be in either direction along the axis of the instrument, a fixed bias current i_b is supplied from a second d-c source. As shown in Fig. 2, net current i_o through R_L may have either direction and arbitrary magnitude, depending upon whether plate current i_p is larger or smaller than bias current i_b. Since the magnitude of i_p is controlled by C_1, changing this capacitor can change the current i_o through R_L over the same range as i_p, but with a division between positive and negative parts of the range which depends upon i_b.

The motor of the servo accelerometer is a precision D'Arsonval movement with the meter pointer replaced by a mechanically strong conducting vane formed at its outer end into the movable plate of capacitor C_1. The hairsprings are replaced with fine conducting filaments with negligible torque rating to insure that input torque arises from acceleration alone. The pivot-and-jewel bearings of the movement are used without change.

Theory of Operation

Fundamental operation of the accelerometer as a servomechanism results when i_o flows through the coil of the torque mechanism. Coil connections provide degenerative feedback, so that with no acceleration the torque arising from inequality of i_p and i_b moves the plate of C_1 toward a position where i_p equals i_b. The separation of the plates of C_1 for $i_o = 0$ is a function of oscillator characteristics, power supply and bias voltages, and the bias resistor. However, if no torque is applied, the only stable position of the system corresponds to $i_o = 0$, or zero output current through the load resistor R_L.

If the transducer experiences an acceleration a along its axis, input torque T_1 is

$$T_1 = b_1 M a$$

where b_1 depends upon the units used and M is unbalanced moment.

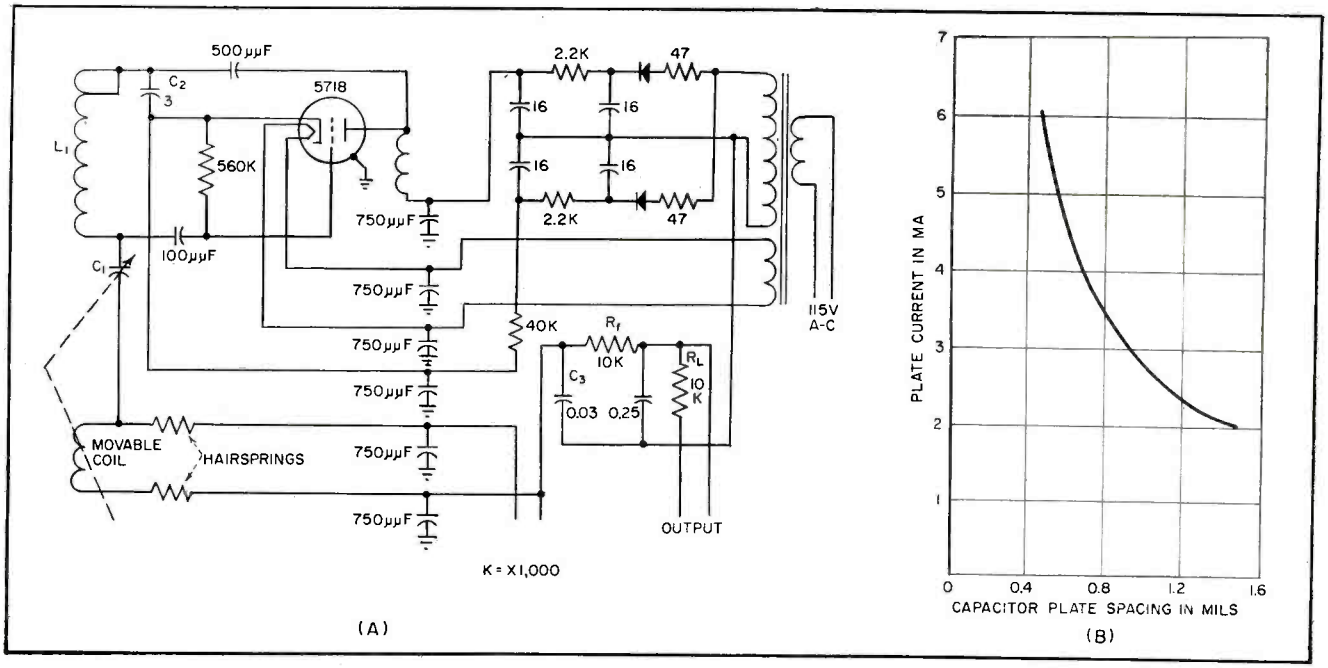

FIG. 1—Superregenerative oscillator shown with its power supply (A) uses 5718 triode in ultraudion circuit. Curve (B) shows how oscillator plate current varies with separation of tuning capacitor plates

Output torque T_2 developed by current i_o through the coil of the torque mechanism is

$$T_2 = b_2 i_o n B$$

where b_2 is a dimensional constant, n is the number of turns on the moving coil and B is magnetic flux density in the air gap. Torque balance is achieved if $T_1 = T_2$, or

$$i_o = b_1 M a/(b_2 n B)$$

Since b_1 and b_2 are constants and M, n and B are parameters fixed by design, input linear acceleration a is measured by current i_o which produce torque balance. The constant

$$k = i_o/a = b_1 M/b_2 n B$$

is a characteristic of an individual transducer known as the current sensitivity. It is commonly expressed as milliamperes per g of acceleration.

The rate of change in i_p with change in C_1 is so large that torque balance is achieved anywhere in the operating range of the accelerometer with a maximum angular deflection of the inertial system from 1 to 3 milliradians with respect to the case.

Basic output of the servo accelerometer is current i_o which is generated by the servo in proportion to applied acceleration. Voltage output of the transducer $i_o R_L$ is proportional to the load resistance across which it is developed. Size of the load is limited by the upper limit of voltage available from the transducer and its power supplies.

The power supply for the instrument operates from 115 v at any frequency from 50 to 900 cps and its power supply furnishes all voltages required for operation of the accelerometer: +150 v at 20 ma, −150 v at 20 ma and 6.3 v a-c at 250 ma. Voltages are not regulated, since closed-loop operation of the servo accelerometer makes the output essentially independent of plate and bias voltages, although the operating range is limited by these voltages.

Full-range output current into any load is approximately ±2 ma regardless of instrument range. Corresponding full output voltage across 20,000 ohms, R_f and R_L in series, is ±40 v. However, as the transducer is normally used, super-

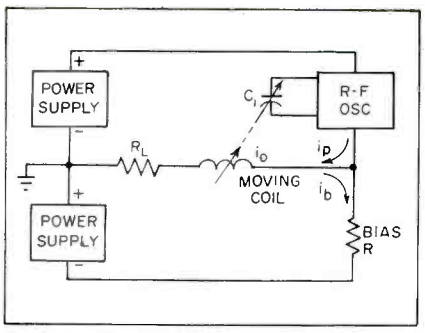

FIG. 2—Bias supply provides direct current through moving coil that permits measuring acceleration in positive or negative direction along transducer axis

regenerative noise is sharply attenuated by the filtering action of R_f and C_f and a smooth output of ±20 v is available across R_L.

Because of the high gain of the servo system, damping must be introduced to provide stability. Shorted-turn conductors carried by the moving coil in the magnetic field of the torque mechanism provide velocity damping. Damping also results from the thin layer of air between the closely spaced parallel plates of C_1. In addition a phase-lead capacitor C_p is selected empirically for optimum transient response.

Characteristics

The servo accelerometer resolves changes in steady-state input acceleration on the order of one part in 100,000 of full range. A typical instrument with a range of more than 2 g responds reliably to input changes of 2×10^{-5} g, corresponding to a tilt of 0.02 milliradian. Such changes are reversible without apparent hysteresis.

Nominal tolerance on absolute accuracy of the transducer at d-c is 0.1 percent of full range. This includes shift in zero due to bearing friction and any deviation from linearity which may be introduced by the combination of linear hairsprings of finite spring constant and a nonlinear error detector. Superimposed on this characteristic is an increase of 0.024 percent in current sensitivity for each degree rise in temperature.

Accuracy is largely independent of changes in circuit parameters, such as those associated with the aging or replacement of the vacuum tube, alteration of supply voltages or drifting of the values of circuit components.

The servo's high closed-loop gain and the low moment of inertia of the moving system result in a natural frequency well above 100 cps. In most ranges the damping is below critical, so the accelerometer is as sensitive to input accelerations up to 100 cps or beyond as to steady-state acceleration. Unless care is exercised, a servo accelerometer intended for sensitive measurements of low-level d-c or low-frequency acceleration can be driven into saturation and overload by higher level accelerations associated with vibration at much higher frequencies. Accurate measurements of acceleration are insured only if the sum of intended input signal and any superimposed noise does not exceed the linear dynamic range of the instrument.

Servo Accelerometer

Among the most interesting applications is inertial stabilization of special aircraft.

Three servo accelerometers with sensitive axes fore-and-aft, right- and left and up-and-down furnish signals which permit rigid automatic control of acceleration, velocity and position of the vehicle in three dimensions. Since each servo accelerometer is a high-gain electromechanical amplifier, electrical attitude corrections may be summed into the instruments so that stabilization of the sensitive axes is not required. Similar techniques are used in another instrument which uses the servo accelerometer to obtain instantaneous vertical velocity.

The servo accelerometer is commonly used for precise telemetering of d-c and low frequency data, but the version pictured is not recommended for use at higher frequencies because of circuit microphonism.

Acknowledgment is due Paul C. Driver, Aviation Ordnance Department, Naval Ordnance Test Station, China Lake, California, for the development of working models of the servo accelerometer and Harold D. Morris and R. Lee Price of the Donner Scientific Company for contributions to the redesign and improvement.

Grid-Switched Gas Tube

SUMMARY —— Application of potential between any cathode strip and anode wire of lattice-structure tube causes glow at intersection. Each of 100 spots is sharply and exactly defined and can be made to glow in any sequence or arrangement. Device operates from coordinate-type inputs and is applicable for display of almost any kind of X and Y information

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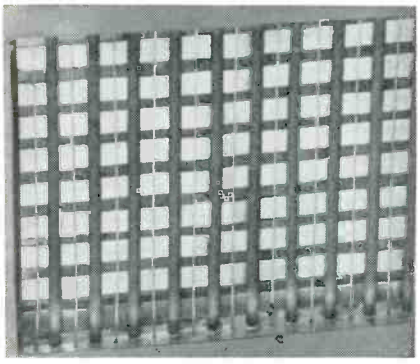
PLOTTING mathematical operations, presentation of information and picture reproduction are some of the potential uses of a new display device under development. The heart of this device is a relatively thin gas-filled tube called a Lattice Videotron.

Tube Construction

The tube's portrayal area is composed of a multiplicity of criss-crossed elements and barrier ridges as shown in the photographs. This composite structure, or matrix, occupies the entire useful face of the tube. The cathodic elements are flat thin-metal strips, which may be of any number and of any width and length. The overlying ceramic barrier ridges are so proportioned that geometrically square islands of illumination are presented for each spot.

Anodic elements are fine wires supported at the ends and placed at right angles to the cathode strips. Neon or other suitable gas is used in the tube to present a brilliant, perfectly defined, cathode glow at each spot where an activated anode crosses an activated cathode. Potential required for this activation is approximately 300 volts. The current obtained in the discharge, which is dependent on the cathode area, is in the order of 33 μa per sq mm and is surprisingly constant from spot to spot.



Closeup of tube face shows lattice of cathode strips and anode wires

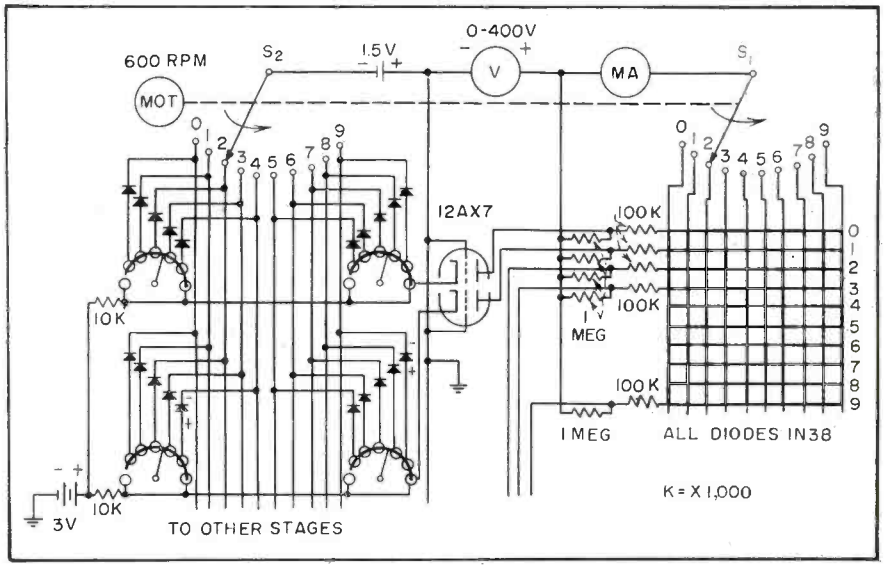


FIG. 1—Lattice-tube circuitry includes five 12AX7 tubes and associated switches, resistors and diodes. Each seven-point switch has contact spanning six points at any instant

Tubes have been built in 10 by 10 and 15 by 15 arrays, giving 100 and 225 spots. There seems to be no limit to the total number of spots that could be developed. No increase in voltages to high values is required, as is usually necessary in large-size cathode-ray tubes.

All the spots in an individual tube will have the same color, although the color may vary from tube to tube depending on the type of gas used. Tricolor reproduction is possible by registering a suitable phosphor mesh with the spot array and deriving the luminescence of the phosphor from excitation by a suitable gas discharge.

Sweeps

Synchronized horizontal and vertical sweeps could be used to sweep the tube. This would give a flying-spot raster similar to that of a cathode-ray tube. Considerably less stringent sweep requirements are obtained by taking

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for Display Presentation

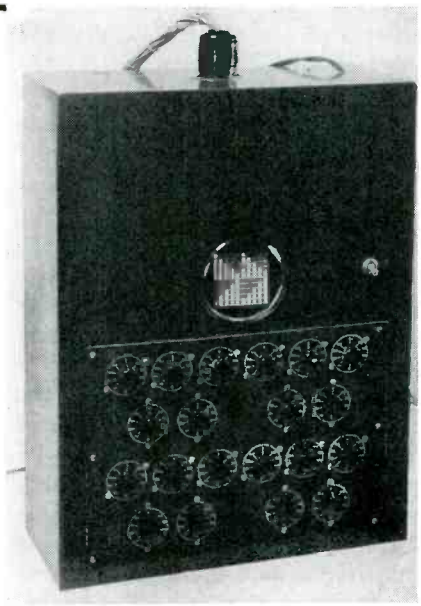

FIG. 2—Demonstration unit incorporates circuit of Fig. 1

advantage of the natural characteristic of the tube, which permits line-by-line sweeping.

In the application shown as a basic circuit in Fig. 1, a sweep is applied to the anodes by using a 10-point motor-driven rotary switch. From a second switch on the same motor shaft, a second sweep is applied to ten bus bars, which are connected to the cathodes through control switches and isolating diodes. Amplifier tubes are used as passing tubes between the switching matrix and the tube.

When any given anode is activated by the anode switch, the second sweep switch contacts the proper bus corresponding to that part of the raster. The control switches, which may be any kind of elements activated by suitable input signals, make contact only to the particular cathodes required for the portrayal at that part of the raster. Hence, a complete line of illuminated or dark spots as required, appears during the passage of the vertical sweep.

With the proper kind of switching, any possible combination of light and dark spots can be built up, to represent simple traces, to patterns and pictures.

The demonstation device shown in Fig. 2 was built to test some of the possible uses of this kind of display medium. A switching system was adopted that simulates the buildup of vertical bar graphs, certain configurations of patterns and crude picture-like arrangements. Figure 3 shows some of the patterns that can be formed using this device.

Pickup and Display

In the device shown in Fig. 4, the switches and isolating diodes are replaced by a Phototron, a 100-element photocell of matrix construction almost identical to the portrayal tube. With this, it is possible to portray continuously moving silhouettes of small objects held between a light source and the photocell face. If an object is held between a light source and the photocell, a silhouette will appear on the display tube due to the fact that the tube face will be dark where the light has been interrupted by the object.

Ring Counter

A ring counter is used in place of mechanical switches. The counter contains ten 12AU7 tubes with the plate of the left-hand section of each tube connected to the anode of the photocell and display tube. One of the 12AU7 triode sections is nonconducting while the other nine sections are conducting, which causes one anode in both the photocell and display tube to be at the supply potential. Application of input pulses to the ring counter causes each succeeding tube to become nonconducting, with the other nine always remaining conducting. The positive end

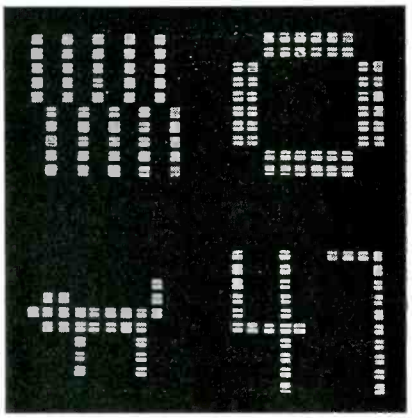

FIG. 3—Patterns generated with Fig. 1

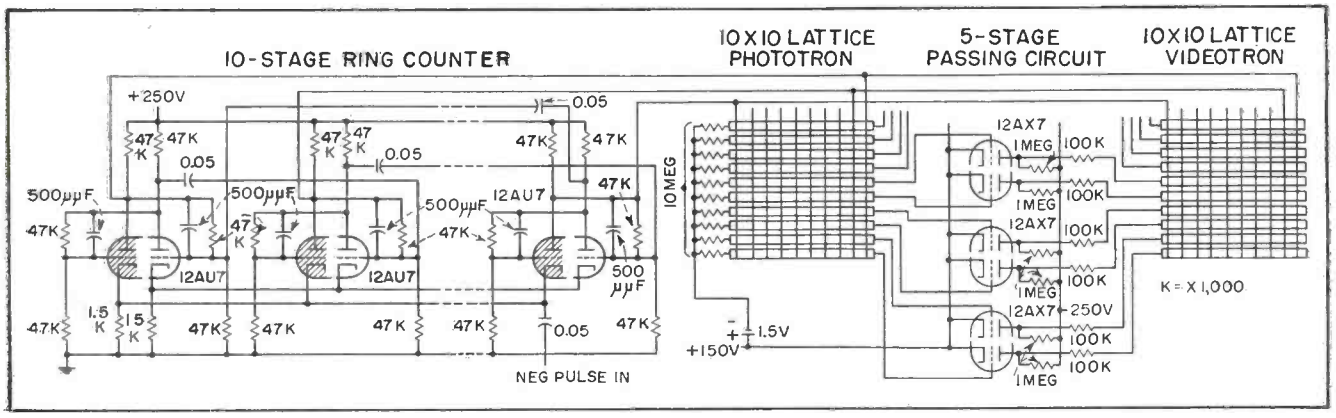

FIG. 4—Lattice tube used in conjunction with 100-element photocell portrays continuously moving silhouettes of objects held between light source and photocell

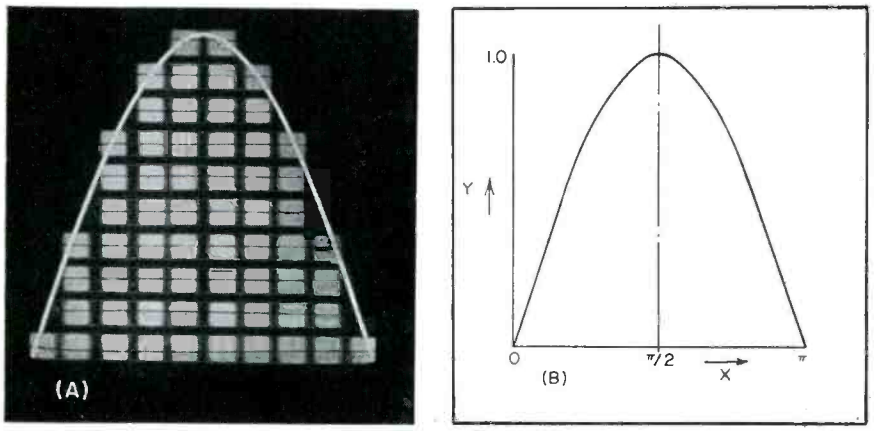

FIG. 5—Integral evaluation using tube face (A) and plot for mathematical evaluation (B)

of the supply is connected in succession to one anode at a time, which permits line-by-line sweep.

When light strikes a cathode of the photocell a current flows through the 10-megohm resistor connected to it, causing one of the 12AX7 triodes to conduct. The plate of the triode is driven negative and the display tube glows in the same place the photocell was excited.

For picture reproduction, the particular tube shown is not practical. However, with a 100 by 100 array of 10,000 spots, which is within the realm of present technology with this tube, a simple image of approximately newspaper quality resolution could be reproduced. This might have some uses in wired television for certain monitoring purposes and for the reproduction of wire photos.

Definite Integral Evaluation

A novel and perhaps useful application in mathematical analysis is obtaining the numerical value of the definite integral for an arbitrary curve. One classical way is to rule off, under the curve, equal squares based to some scale of the curve, and counting these squares to obtain the area under the curve. With this device spots could be switched on within a suitably scaled superimposed curve. Instead of counting the squares, the total courrent delivered to the matrix can be measured by introducing a meter in the return circuit.

An example illustrating the use of this tube in obtaining the value of a definite integral can be shown

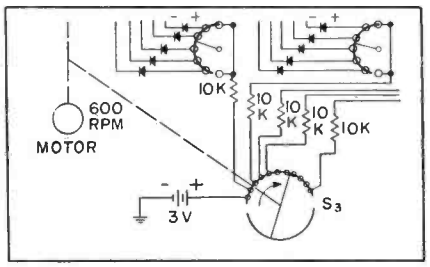

FIG. 6—Circuit for integral evaluation is similar to Fig. 1, with switch S_3 substituted for 3-v battery at left in Fig. 1

with the aid of Fig. 5A. Those spots are lit that most clearly define the area under half a sine wave. The amount of glow that falls outside the curve and the unlit portion under the curve are approximately equal. The anode current for this configuration was found to be 3.4 ma; total current, with all spots glowing, was 5.2 ma.

The plot of half a sine wave, which has an amplitude of 1 unit with the abscissa having π units, is shown in Fig. 5B. The area of the equare enclosing the curve is equal to 1 by π or 3.14 sq units. Using the relationship $A_c/A_T = I_c/I_T$, $A_c/3.14 = 3.4/5.2$, $A_c = 2.05$ sq units, where A_c = area under curve, A_T = total area of square, I_c = current due to glow under curve and I_T = total current.

Mathematically, the area under the curve is given by

$$A_c = \int_a^b y\,dx$$

where $y = \sin x$, $a = 0$ and $b = \pi$. Substituting,

$$A_c = \int_0^\pi \sin x\,dx = 2 \text{ sq units}$$

This result of 2 square units is in close agreement with the result of 2.05 obtained from the display tube.

Evaluation Procedure

In general, to find the definite integral of some function, plot the curve on graph paper and, to the same scale, plot an identical curve on the tube allowing all the spots under the curve to glow. Construct a square on the graph paper that is proportional to the total area of the active tube face. Setting the ratio of currents equal to the ratio of the areas on the graph, permits calculation of the area under any curve.

It is also possible to obtain the integral of a given curve, except for an arbitrary constant, by modifying the method of switching used when determining the value of the definite integral. Suppose it is desired to find the integral curve of some function $y = f(x)$ between certain limits. Integrating the area under curve between a and b,

$$\int_a^b y\,dx = G(b) - G(a) = A_c$$

Replacing b by the variable x

$$A_c = G(x) - G(a)$$

which expresses the integral of the arbitrary curve as a function of x.

Thus, to find the integral curve, the given curve is set up as described for the evaluation of the definite integral. The circuit is similar to that shown in Fig. 1 except that motor-driven switch S_3, is shown in Fig. 6, connects the cathodes to the circut, successively, from left to right in such a way that once having been connected, a cathode will remain connected until all cathodes have been switched; then all connections will be destroyed and the cycle repeated. Flicker can be reduced by rotating switches S_1 and S_2 in Fig. 1 ten times as fast as S_3.

By switching in this manner, the current flowing into the tube at any time during the sweep will be proportional to all of the cathodes between the edge of the tube, point a and the cathode corresponding to the independent variable x. Hence, the total current flowing at any given time will be proportional to the integral of $f(x)$.

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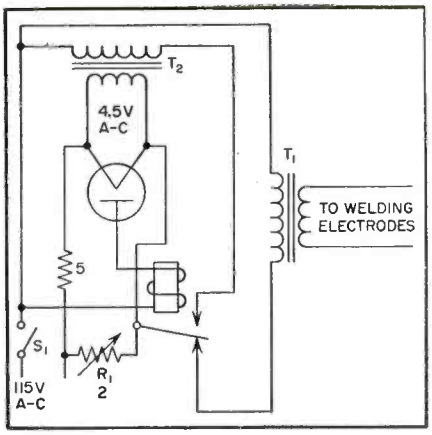

FIG. 1—Current-integrating controller uses tungsten-filament diode

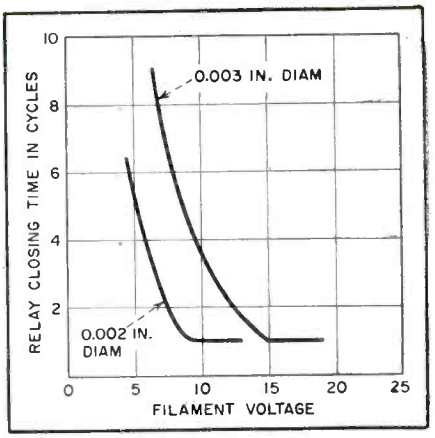

FIG. 2—Relay closing time as a function of diode filament voltage

Controller Integrates Spot-Welding Current

SUMMARY —— Current-integrating relay automatically changes welding time to compensate for changes in weld resistance or line voltage. Simple diode circuit can also be used in repetitive r-f heating cycle applications

CONVENTIONAL TIMERS in small resistance spot welders do not compensate for variations in welding due to changes in weld resistance or line voltage.[1] The controller shown in Fig. 1 automatically compensates for changes in both these factors.

Circuit Operation

The weld is initiated by closing S_1. The voltage developed across R_1 is supplied to the filament circuit of the tungsten-filament diode. The diode filament temperature increases with time until there is sufficient electron emission to operate the relay in the anode circuit and switch off the welding current.

The diode plate voltage is sufficiently high to ensure operation in the saturated region, thus making the plate current independent of the plate voltage. The saturated plate current increases steeply for small changes in filament temperature, thus the relay operates at a precise filament temperature and is independent of small changes in pull-in current.

The relay is held in by heating the filament from T_2 until S_1 is again opened to reset the relay for the next weld. If the welding current is abnormally low or high due to changes in weld resistance or line voltage, then a correspondingly longer or shorter welding time will be taken to close the relay.

Figure 2 shows experimental curves of welding time versus filament voltage for two diodes with different diameter filaments. Filament length was 5 cm in both tubes and relay pull-in current was 8 ma. Each cycle of relay closing time is 0.02 second.

The minimum voltage point on each curve is the least voltage for which the relay would operate reliably. The maximum voltage is that for which the filament burned out before the relay operated. To obtain a large range of welding currents with a given size filament wire, both the current required by the relay and relay pull-in time should be small.

Comparison of Results

A number of test welds between oxidized and clean 0.002-in. diameter tungsten wire and 0.03-in. nickel wire were made to compare the controller with a conventional timer. Welds were attempted with the clean tungsten wire for a line variation of ±10 percent. With the timer, a 10-percent drop in line voltage resulted in no welding at all and a 10-percent rise resulted in all the welds burning through. Good welds were made consistently with the controller over this range of line voltage.

The current-integrating relay can be applied effectively to repetitive r-f heating applications.

The author acknowledges the assistance of D. Stace in obtaining the experimental curves.

REFERENCES

(1) "Industrial Electronics Reference Book", p 609, John Wiley, 1948.

Recorder Amplifier for

SUMMARY — General-purpose low-frequency amplifier accepts input of 0.02 to 80 volts, provides fixed or variable gain and 5-step filter network for flight-test recording of signals from synchro, gyro and servo control systems. Dual-amplifier rack mounting simplifies maintenance

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MANY AIRBORNE control devices utilize a 400-cps suppressed-carrier signal. The recording amplifier used in testing these systems must provide amplification or attenuation, as required, and demodulation for presentation to the end recording device. In many cases, it is also desirable to provide filtering networks to suppress certain frequency components of the signal or to alter its phase.

These requirements have prompted the design of a general-purpose amplifier incorporating several features which increases its utility as a flight-test instrument. Among these are the choice of fixed or variable gain control, a five-step filter and a variable bias control.

The amplifier circuitry is shown in Fig. 1. The attenuator consists of an eleven-position switch and a series of precision resistors providing ten sensitivities.

The signal-amplifier stage consists of a cascaded 12AT7 producing negligible phase shift over the desired range of sideband frequencies. Stabilization is obtained by feedback from the plate of the output stage to the cathode of the input stage. Gain is controlled by varying the feedback voltage. A fixed-gain potentiometer is provided so that the gain may be adjusted to conform to the sensitivity ranges. A variable-gain potentiometer may be selected by a switch. This permits the amplifier-recorder system to be used in a manner similar to that of a vacuum-tube voltmeter with specific full-scale ranges, or as a variable-gain unit where any desired voltage within the limits of 0.02 v and 80 v will produce a full-scale output.

A bias signal is provided equivalent to four times the signal amplitude required to produce full-scale deflection on the recorder. This bias voltage is mixed with the signal voltage at the output of the amplifier. Both phase and amplitude of the bias signal may be controlled by the bias adjustment. This signal may be inserted or removed panel switch.

Both sections of a 12AU7 are connected in parallel matching the input impedance to the ring demodulator. The demodulator input

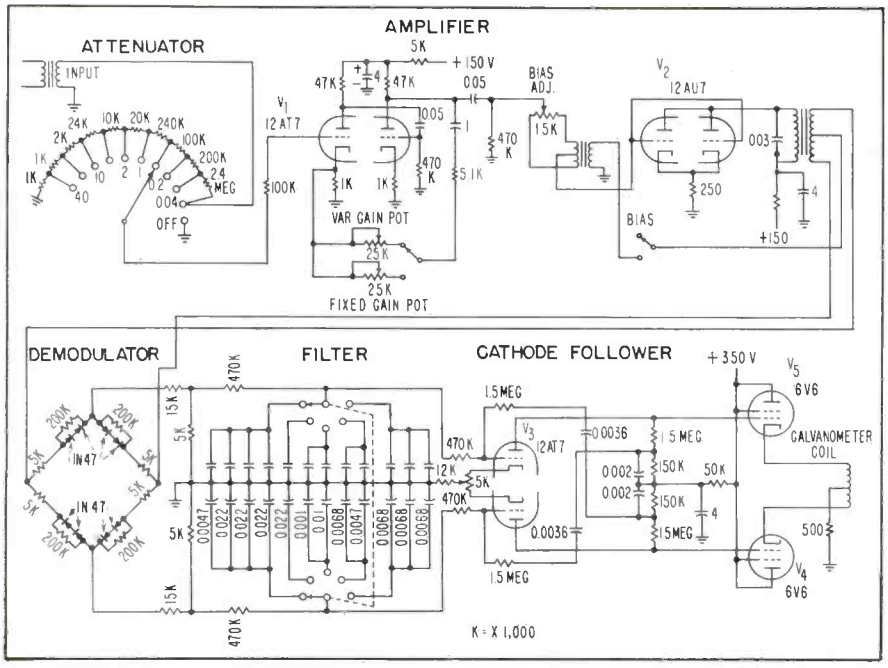


FIG. 1—Amplifier provides cathode-follower output to drive galvanometer coil of pen recorder used in flight testing of wide variety of aircraft electronic equipment

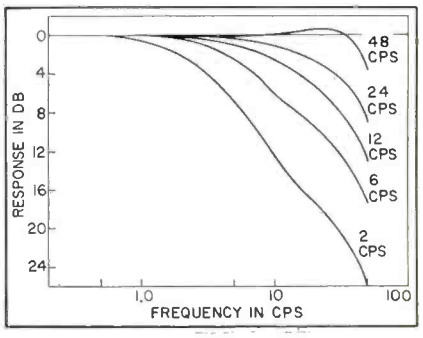
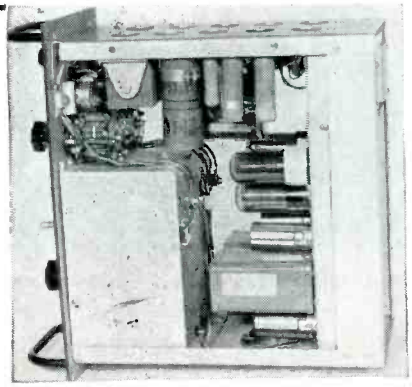
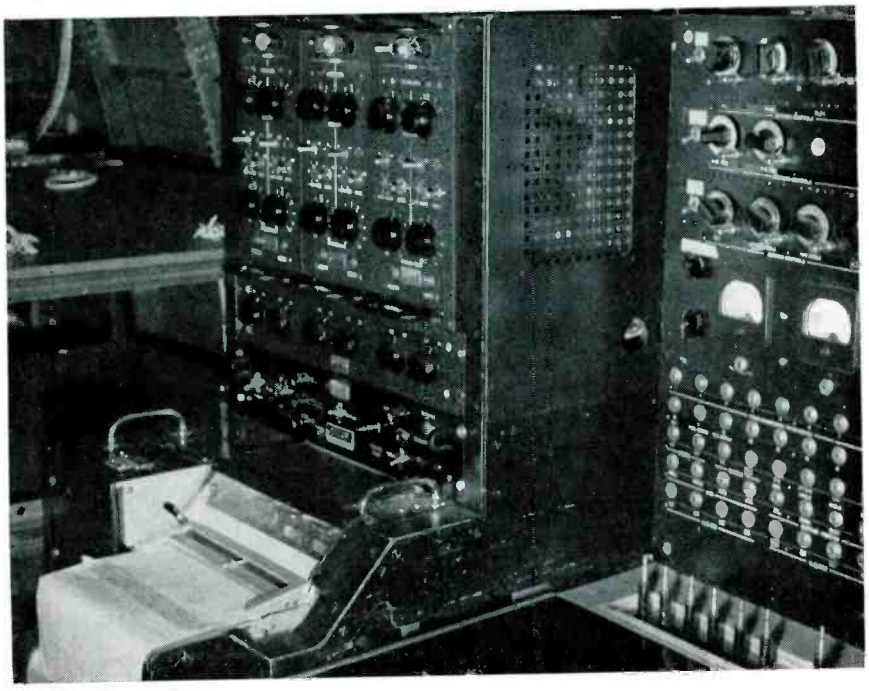


FIG. 2—Characteristic curves for 5-step filter network. Arrangement introduces about 3 db attenuation at each position

FLIGHT TESTING



Two-amplifier rack unit shows placement of parts. Both amplifiers are powered from common supply at top



Bank of six amplifier units mounted above multichannel pen recorder in DC-3 test plane. Linearity of system, is about 2 percent of full scale deflection. Variation between scales is less than 3 percent at full-scale pen deflection

transformer is designed for a high degree of output balance. Secondary windings are identical in configuration and are coupled to the primary winding by a symmetrical core of high quality material. Electrostatic shields eliminate capacitive coupling between the windings.

Demodulation

Galvanometer-type recording instruments require a direct-current input. A ring demodulator is well suited for demodulation because it is insensitive to quadrature components of the suppressed carrier signal. Since the signals to be examined contain only sideband frequencies, it is necessary to insert the carrier before demodulation.

The ring demodulator uses a series-parallel resistor arrangement to minimize output variations due to changes in the diode characteristics. Each crystal is essentially an on-off switch, since the back and forward resistances of the circuit are governed almost entirely by the values of the parallel and series resistors respectively. Forward resistance of each leg of the bridge circuit is a function of the 5,000-ohm resistor and forward resistance of the diodes in series. Since the forward resistance of the diodes is low, the resistance of the circuit is almost entirely a function of the resistor. The back resistance of each leg is a function of the combination of the diodes and the 200,000-ohm resistor in parallel. Since the back resistance of the diodes is high the effective back resistance of the circuit is essentially that of the parallel resistor. Large changes in the diode characteristics have relatively small effects on the bridge balance. Although the circuit is inefficient, it does provide good stability.

The design of the filter network specifies the frequency response of the recording system. In the present case, system response was limited by the response of the galvanometer pen to a value below the desired maximum. Compensation in the form of positive feedback through a lead network was required to raise the overall response to the desired frequency. Response curves for the five filter positions are shown in Fig. 2.

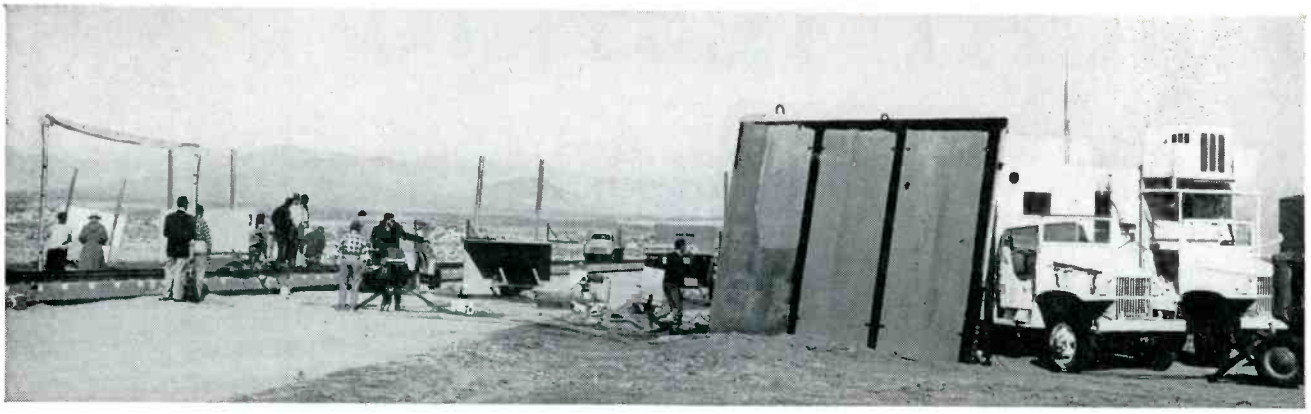
A centering potentiometer is provided in the cathode circuit of the 12AT7 push-pull circuit. This tube is operated with low quiescent current, therefore, unbalance in the two tube elements is minimized and little nonlinearity is introduced by the initial adjustment of the centering potentiometer.

Power Supply

Selenium rectifiers are used in a voltage-tripler circuit in the power supply to obtain the required 350 volts for the cathode-follower. The plate voltage to the signal amplifier stage is regulated by an OA2 tube. The power supply also provides approximately 150-volts bias on the filaments of the 6V6 tubes to bring the cathode-filament voltage differential within ratings.

The amplifiers are packaged with two channels in each unit and use a common power supply. This design is desirable from the standpoint of servicing since any dual unit may be removed from the multichannel recording system for service without disrupting the entire system.

Centering drift was checked by making recordings at one hour intervals for eight hours. The results indicate that the drift is within the reading accuracy of the recording and may be considered negligible.



Installation at Supersonic Naval Ordnance Research Track, NOTS, China Lake, Calif. Electronic flash equipments are tripod-mounted units at center and left. Flash-control equipment is in one of trucks at right

SUMMARY — Control unit limits number of flashes of any one unit, in group of electronic flash units operating simultaneously at high repetition rates, to number necessary for required exposure in photographic stroboscopic study of rapid, nonrepetitive motion. Unit makes extensive use of commercially available plug-in circuits such as triggers, counters and oscillators

COUNTERS CONTROL

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AFTER development of the NOTS mobile high-speed multiple-flash equipment[1], a need arose for greater numbers of flash lamps operating simultaneously at high flash rates. A control unit was designed to limit the number of flashes, in each of two groups of lamps, to the minimum necessary for obtaining the required data.

Previously, triggering of all flash lamps was simultaneous and the lamps were allowed to flash until all the energy in the high-voltage capacitor bank was consumed. Such continuous flashing of all lamps put an overload on the electronic equipment which flashed the lamps and usually resulted in weak photographic images in all but the first flash lamp group.

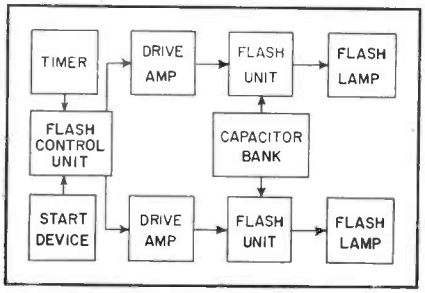


FIG. 1—Complete flash control system

Flash System

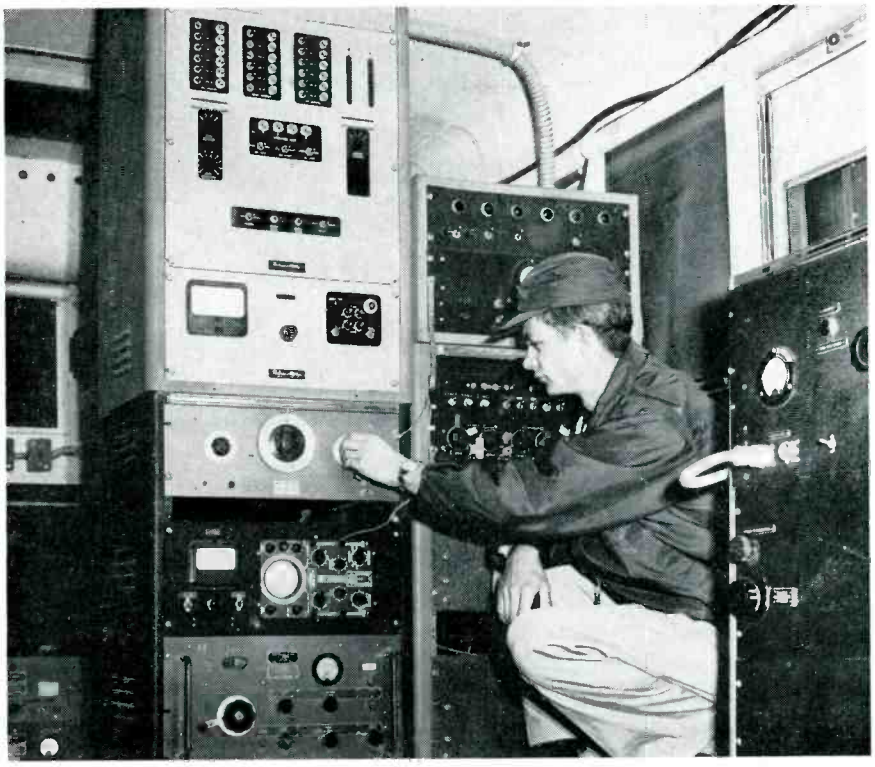
The principal parts of the complete control system are diagrammed in Fig. 1. Only one flash unit and flash lamp are shown following each driving amplifier, although many more are usually used.

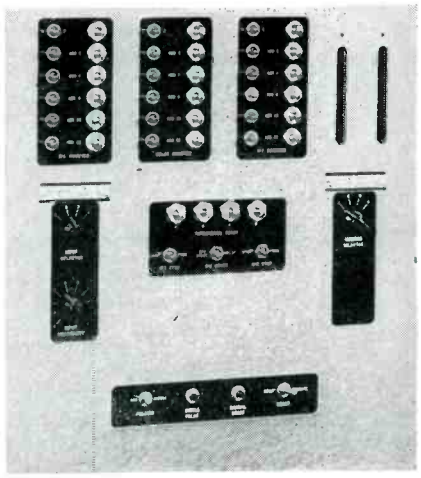
The timing source is a commercial audio oscillator. Its frequency is monitored continuously by Lissajous patterns on an oscilloscope against an accurate 1,000-cps timing signal broadcast by radio link from a centralized location at NOTS or by an electronic frequency counter. The start device can be a microphone, photocell or a make-or-break circuit arrangement.

The signal from the timing source is shaped into pulses and gated. The gating is triggered by the pulse from the starting device and by the outputs of the preset electronic counters within the flash control unit. Gated pulses are amplified by the control unit and the driving amplifiers, then fed into the flash units. The flash units are powered by a capacitor bank charged to a high voltage. When triggered by a pulse from its driving amplifier, each flash unit delivers a predetermined fraction of the energy of the capacitor bank to its flash lamp, causing the lamp to light for an extremely short period of time.

Control Unit

The simplified block diagram of the control unit in Fig. 2A depicts three gates and three counters. Figure 2B shows the sequence of control. Each of the three electronic counters can be preset to re-





Front panel of control unit

Interior of truck containing flash-control equipment. Control unit is at upper left, with audio oscillator, oscilloscope and timing receiver below

HIGH-SPEED FLASH

ceive any number of pulses from 1 through 64 before injecting into its output the type of pulse which will actuate properly the circuits to which the counter is connected.

The start pulse opens the gate to driving amplifier 1 to start its lamps flashing in synchronism with the pulses from the timing source. The pulses which trigger this driving amplifier are also fed into counter 1, preset to count just enough pulses to produce the required number of flashes. At the end of this count, a pulse from counter 1 closes the gate to driving amplifier 1, causing its lamps to stop flashing. The output pulse from counter 1 also opens the delay gate, directing the timing pulses to the delay counter.

At the end of the delay preset into this counter, a period calculated to allow the object being photographed to approach the second station, the output pulse opens the gate to driving amplifier 2, allowing timing pulses to trigger the flashing of its lamps. Counter 2 is preset to stop the triggering of driving amplifier 2 after its lamps have delivered their preset number of flashes. The lamps are flashed only when needed to photograph the passage of the object through their stations, with just a few extra flashes to make certain the flight is not missed.

Timing

Figure 3 is a simplified circuit diagram of the control unit. Extensive use is made of commercially available plug-in units to simplify the under-chassis wiring of the pulse devices. These are indicated as blocks in Fig. 3.

For timing, there is a choice of either the output of the control oscillator (the timing source) or a single-pulse pushbutton. The timing input actuates V_1, a 2C51 Schmitt trigger, which shapes the timing signals into pulses. The 12AU7 start-signal amplifier, V_2, works in conjunction with the input selector switch and feeds the start input to the first 2D21 thyratron trigger, V_3. This switch, its four positions selecting phase inversion or not, with or without positive bias, allows operation on either positive or negative start signals from microphone, photocell, or make-or-break circuits. Semiremote manual operation is provided for testing purposes through the relay and the manual start switch.

Gating

Operation of the gating function is identical for each of the three gates. As an example, the principal parts of the second gate circuit, V_{14}, are shown in Fig. 4. The gating line has three resistances connecting it to the cathode of thyratron trigger V_{13}, to the plate of the thyratron trigger V_{21} and to the negative bias. These resistances are proportioned to cause the following operational sequence: when neither thyratron is conducting, the voltage on the gating line is held so

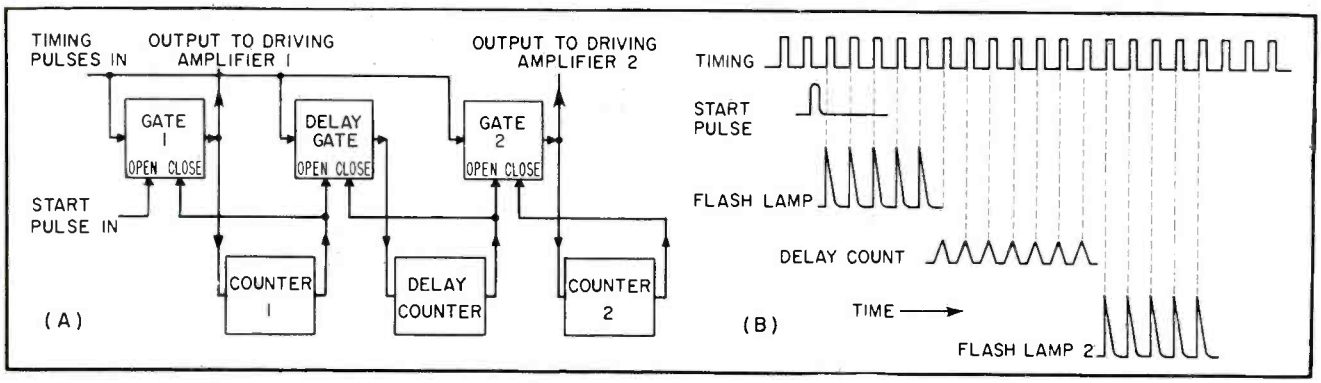


FIG. 2—Simplified block diagram of control unit (A) and sequence of timing pulses (B). Each of counters can be preset to receive one to 64 pulses before producing an output pulse

far negative that the gate is biased beyond cutoff and does not pass any pulses; when V_{13} starts conducting, the rise of positive voltage on its cathode decreases the negative voltage on the gating line sufficiently so that V_{14} is permitted to pass the pulses until V_{21} starts conducting. The drop of voltage on the plate of V_{21} makes the gating line again sufficiently negative to cut off passage of pulses through V_{14}.

Bypass capacitor C in the gating line introduces a small delay as well as decoupling between the thyratrons.

Gate Switches

The switches in the gating lines (Fig. 3) improve the utility of the control unit. The gate 1 stop switch can cause output 1 either to stop on the count of counter 1 or to run free. The same control can be exercised over output 2 by the gate 2 stop switch. The gate 2 start switch permits the start of output 2 either by the delay counter or in synchronism with output 1 from V_5.

Blocking oscillator V_5, a 6J6, feeds output 1; V_{23} feeds output 2. Each of these outputs has two connectors: one yields positive pulses; the other, negative. Double polarity allows the instrument to be used with both positive and negative input driving amplifiers.

In each blocking oscillator, positive pulses are obtained from a resistor between cathode and ground; negative pulses, from a resistor between the plate circuit and the plate

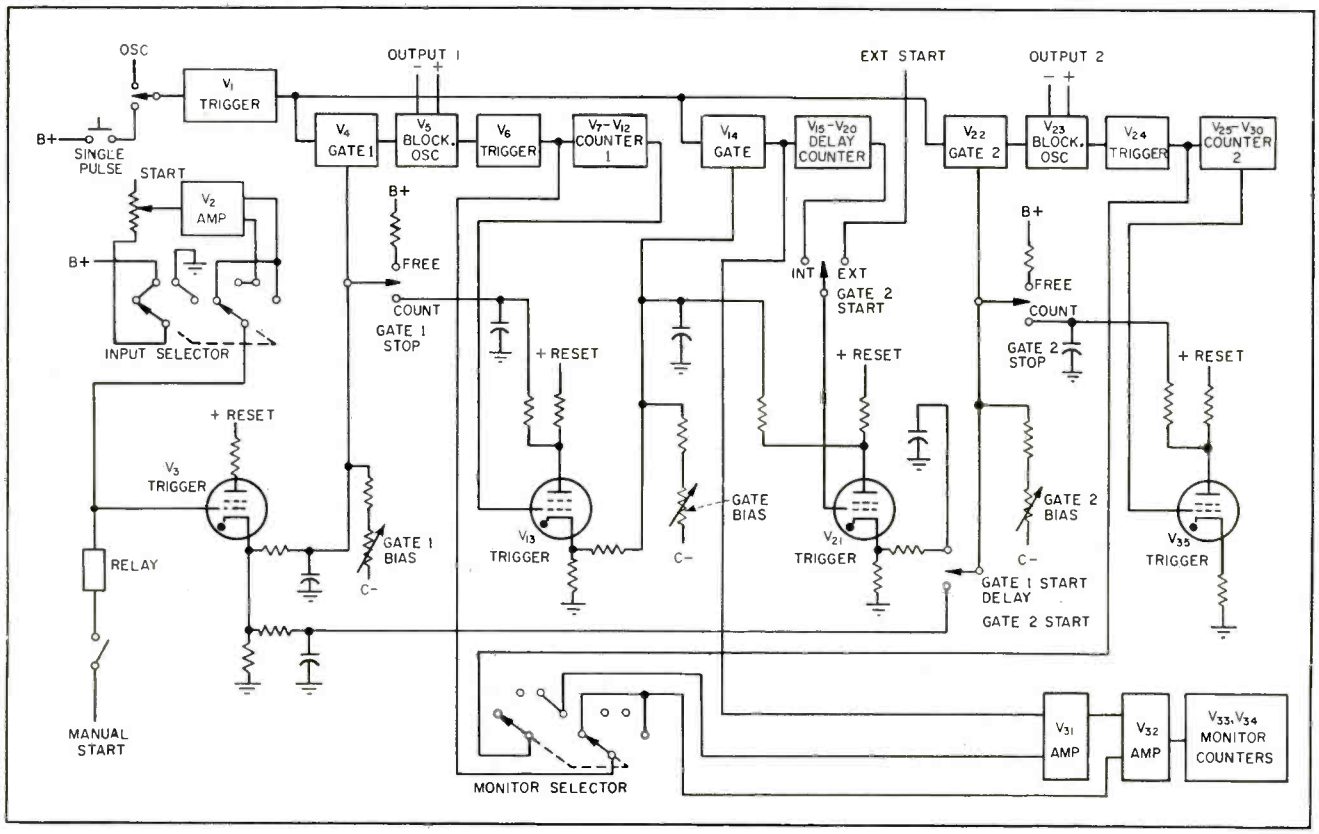


FIG. 3—Complete block diagram of control unit. Blocks indicate commercially available plug-in units

supply. In this way, the undershoot occurring in the transformer at the end of each pulse is prevented from passing into the output. The plates of V_4 and V_{22} are tied to the plates of their respective blocking oscillators for direct drive.

Counters

The 2C51 Schmitt triggers, V_6 and V_{24}, furnish the pulses which drive counters 1 and 2. Delay gate V_{14} drives the delay counter.

Any pulse count from 1 to 64 can be set into each predetermined counter by manipulating the six switches on each counter. Resetting the instrument makes the counter ready and gives indication by lighting the indicator neon lamp adjacent to each switch that is in add position. At the completion of the count, the circuit will generate a positive-going pulse in its output and indicate by lighting all of its indicator lamps.

Each of the predetermined counters is composed of a chain of six 12AU7 Eccles-Jordan binary units with proper switches, indicators and interconnections. The circuit of one binary stage is given in Fig. 5. With the add-nonadd switch in the nonadd position and the unit reset, the right-hand triode of the 12AU7 will be nonconducting. A negative pulse on the input will result in a steep negative-going step in the output. In this case, the binary does not add anything but acts as an amplifier or pass device to the following binary.

If the switch is in the add position and the unit is reset, the right-hand triode will conduct. The left-hand triode will be nonconducting and the indicator lamp will light. A negative pulse in the input of the binary will result in a positive-going step in the output, to which the following binary stage is insensitive. The binary will then have to wait the natural period of the preceding chain of binaries before it can deliver a negative-going pulse to its output. Thus a count of 2^n is added to the overall count of the entire binary chain, where n is the number of preceding binaries.

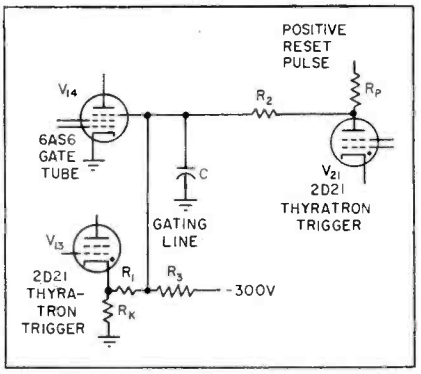


FIG. 4—Principal parts of gate 2

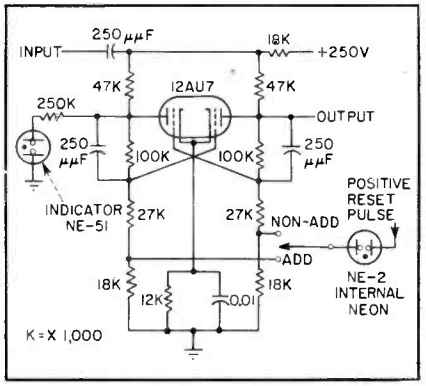


FIG. 5—Binary unit of predetermined counter

The last stage of the binary chain feeds the grid of a thyratron. This type of circuit reacts to a positive-going signal and not to a negative, as binaries do. Therefore, the output of the last binary in the chain is taken from the left-hand plate circuit.

The NE-2 internal neon lamp is not used as an indicator, but as a pass device for the relatively large reset pulses. It acts as an open circuit except at resetting.

The monitor counter consists of a pair of commercially manufactured counter decades, V_{33} and V_{34}, as shown in Fig. 3. These two decades, fed by isolating and mixing amplifiers V_{31} and V_{32}, total the count of the delay counter alone, the delay and 1, the delay and 2 or all three counters, depending on the position of the monitor selector switch.

Maximum Count

The maximum count may be as high as 64 times 3 or 192. The monitor counter displays the count only to 99. The zero or one in the hundreds place can easily be assumed through foreknowledge of the setting of the counters.

Resetting the control unit is accomplished manually by momentary actuation of a three-circuit reset relay operated by a pushbutton switch either on the panel or at a semiremote position. The relay performs the following functions: the thyratrons are reset by the removal and reapplication of the plate supply voltage on their plate circuits; the predetermined counters are reset by the application of a positive voltage pulse through their internal neon lamps (used as pass devices) to their properly selected grid-return circuits; the monitor counters are reset by opening and closing of appropriate grid-return circuits.

Applications

The control unit, in conjunction with the NOTS mobile flash equipment, is used on the aeroballistics test range to make measurements of velocity, drag and other ballistics coefficients on missile models whose flight patterns must be determined before tests can be made in the aeroballistics laboratory.[2,3] On other test ranges at NOTS, the equipment is used to solve such ballistic problems as the behavior of small-caliber ammunition or rockets when fired at various angles from rapidly moving vehicles.[4] One of the photographs shows the equipment on location at the Supersonic Naval Ordance Research Track (SNORT) where such measurements are currently being made.

A control unit such as this, when used in conjunction with apparatus similar to the NOTS mobile flash equipment, can have many applications in industry and research where extremely rapid, nonrepetitive motion demands photographic stroboscopic study.

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MAGNETRON TESTER DETECTS LOST PULSES

SUMMARY —— Foreseeable airborne target speeds require continuous radar information flow otherwise missing transmitted pulses may cause loss of target. Missing pulses in radar magnetron output are detected by this test set using coincidence techniques. Switch sets level, at which pulse is considered missing, in 10-percent steps. Video circuits are not used and only one adjustment is required for calibration

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MODERN MISSILE and aircraft speeds impose stringent requirements on radar magnetrons. To provide the continuous flow of data necessary for tracking and destruction of high-velocity targets a radar magnetron must deliver a virtually uninterrupted succession of output pulses. At foreseeable target speeds exceeding mach 2 the omission of even a single transmitted pulse may easily result in a miss or complete loss of target.

This article describes the types of missing-pulse detectors used at present for production testing of magnetrons as well as a new type developed by the authors.

Definition

In radar terminology a missing pulse is one having an energy content less than a specified percentage, usually 70 percent of normal, at the desired output frequency. Such a pulse may be caused by arcing or moding of the magnetron during all or part of a pulse period. Briefly, moding is oscillation at other than the desired frequency and may occur at frequencies from a few hundred to several thousand megacycles away from the operating frequency.

Test specifications for radar magnetrons give the maximum per-

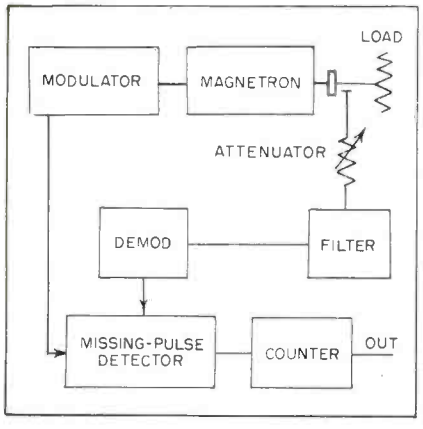


FIG. 1—Basic missing-pulse detection system

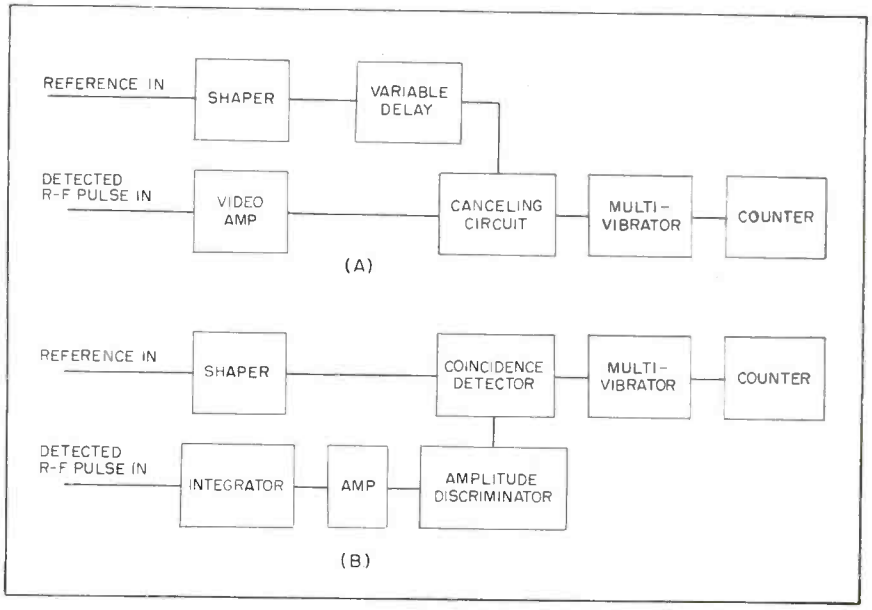
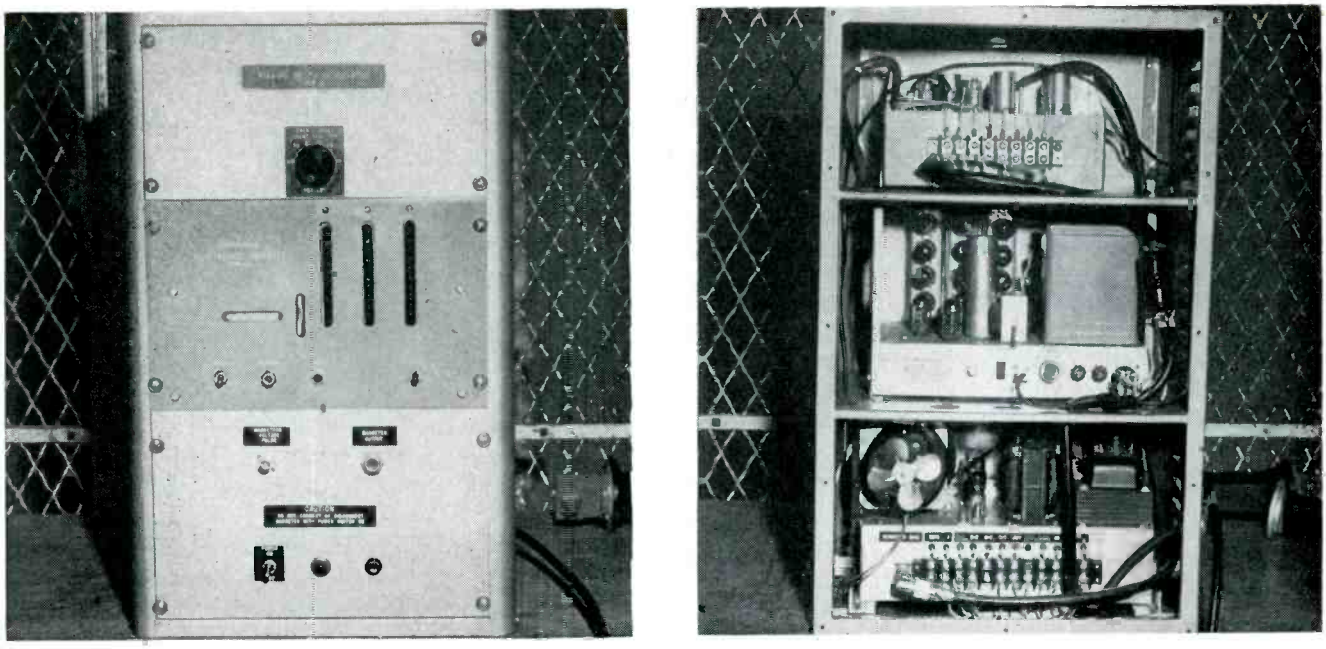


FIG. 2—Comparison of direct-cancellation type (A) and coincidence type (B) missing-pulse detectors



Front and rear views of complete test instrument show the missing-pulse detector (top), the eelctronic counter (center) and regulated power supply (bottom)

missible number of missing pulses as a percentage of the pulse-repetition rate. These range from 0.25 to 5 percent, depending on magnetron type and application. They are usually measured over a five-minute period.

General Concepts

Instruments for the detection of missing pulses must respond to pulses of improper frequency, inadequate amplitude and inadequate width.

A block diagram showing the basic elements of a missing-pulse detection system is shown in Fig. 1. A reference input signal, derived from the magnetron trigger circuit, informs the detector that an r-f pulse should be present. A demodulated sample of the magnetron's r-f output is obtained by a probe or a directional coupler inserted in the transmission line between the magnetron and its load. The probe or coupler is adjusted to provide an average power of a few milliwatts to the detector circuit.

The variable attenuator in the sampling circuit is used to adjust the r-f input level. The frequency filter allows only pulses of the correct operating frequency to reach the demodulator. The action of subsequent circuits is such that pulses at other frequencies will be registered as missing.

Cancellation

Two general types of missing-pulse detectors seem to be in use at present. They are the direct-cancellation type and the coincidence type block diagrams of which are shown in Fig. 2.

In the direct-cancellation type of Fig. 2A the reference input signal is a sample of the magnetron plate-current pulse. This pulse is standardized as to amplitude and width in the shaper and is then applied through a variable-delay network to one input of a canceling circuit. A sample of the magnetron r-f pulse is rectified by a linear crystal demodulator, amplified and applied to the other input of the canceling circuit. This is a pulse-amplitude and pulse-width discriminator circuit.

It may employ either a difference or adding amplifier depending on the relative polarities of the two inputs. In either case there is no output from the canceling circuit when the two inputs are identical. A change in the width or amplitude of the r-f pulse results in an output signal which registers a missing pulse on a standard electronic counter.

The magnetron plate-current pulse occurs a fraction of a microsecond before the r-f output pulse reaches the pickup point. Consequently, a variable-delay network is used in the reference input circuit to assure that both pulses arrive simultaneously at the canceling circuit.

In this system it is difficult to get a suitable sample of the magnetron plate-current pulse for the reference signal. In addition, the internal circuit design is complicated since video frequencies must be handled throughout.

Operating adjustments are extremely critical and susceptible to drift with time. As a result, the equipment must be recalibrated for each test. For proper performance it must be operated by specially trained personnel.

Coincidence

In the coincidence-type missing-pulse detector of Fig. 2B changes in the energy content of the r-f output pulse are converted to changes in the amplitude of a triangular

wave. An r-f sample is applied to a linear crystal demodulator and the demodulated signal fed to an integrator circuit. The integrator output is a triangular wave with a peak amplitude proportional to the energy content of the initiating r-f pulse.

A simple amplitude discriminator, usually a one-shot multivibrator, triggers when the amplitude of the integrated pulse equals or exceeds a predetermined value. The output is then applied to a simple coincidence detector. A shaped reference signal derived from the magnetron modulator circuit is also applied to the coincidence detector.

There is no output when both signals are present. When an r-f pulse is missing the coincidence stage delivers an output signal which triggers a conventional electronic counter.

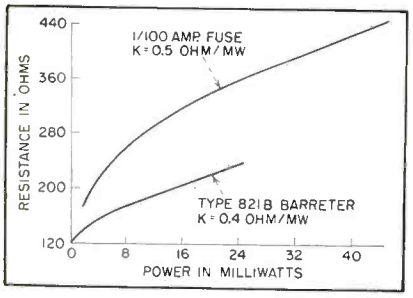


FIG. 3—Power-resistance characteristic of 1/100 amp fuse and 821B barretter

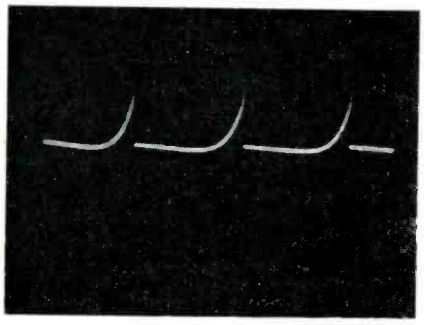


FIG. 4—Barretter output voltage oscillograph

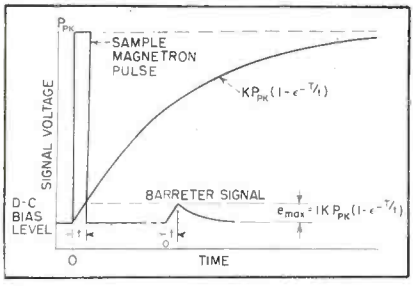


FIG. 5—Barretter voltage-output characteristics

Although this type of missing-pulse detector is less critical than the direct-cancellation type, it involves a large number of operating adjustments as well as the use of an oscilloscope and is not well suited for use by unskilled production-testing personnel. Also, the demodulator crystals burn out frequently and must be operated at low levels to assure a linear relation between r-f energy and demodulator output. The permissible r-f input levels are frequently so low that operating adjustments and measurements are difficult to make.

New Detector

The missing-pulse detector developed by the authors uses no video circuits, does not require a complex setup procedure and has only one operating adjustment. Although similar to the coincidence-type detector, it avoids the crystal demodulator difficulties by using a thermal detector; either a bolometer or barretter. This demodulator delivers an integrated signal having a peak amplitude proportional to the r-f energy content of each magnetron pulse.

When installed in a waveguide or coaxial cable a barretter will convert incident electromagnetic energy into heat, hence its resistance will vary cyclically at the magnetron pulse-repetition rate. The thermal sensitivity converts microwave pulse energy into signals to detect missing pulses. Little fuse type 8AG 1/100-amp fuses or equivalent provide performance equal to that of commercial barretters and permit a substantial reduction in cost.

Typical relations between r-f power input and resistance for a NARDA type 821B barretter and a 1/100-ampere fuse are shown in Fig. 3. The nonlinearities at the lower ends of the characteristics are caused by thermal radiation and conduction losses.

Raising the barretter or fuse temperature above that of its surroundings with a bias current, improves the linearity and minimizes effects of ambient temperature changes. A bias current of 6 ma plus the average energy from the sampled magnetron output is sufficient to put the operating point in the region of linear operation for an 821B.

The bias current also provides the voltage drop which forms the integrated output signal. Thus, changes in resistance produced by the magnetron output pulses produce proportional changes in the potential across the barretter terminals. Figure 4 is an oscillograph showing the signal output voltage obtained when a sample magnetron pulse is applied to the barretter.

The peak amplitude is proportional to the energy content of each output pulse. The resistance change of the barretter element is dependent upon both the peak power P_{pk} and the pulse duration. The rate of temperature change is exponential and may be expressed as T/t, where T is the thermal time constant of the barretter element and t is the duration of the applied pulse.

Output Characteristics

If the slight nonlinear relation between input power and barretter resistance is disregarded these factors may be related by a constant K. The peak value of the barretter output voltage is then

$$e_{max} = I\,KP_{pk}\,(1 - \epsilon^{-T/t})$$

where I is the bias current in amperes, P_{pk} is the peak applied power in watts, and K is a constant of proportionality. This relationship is shown graphically in Fig. 5.

If the barretter thermal time constant T is equal to ten or more r-f pulse lengths, the deviation from linearity during the first 10 percent of exponential change is only 0.55 percent which may be neglected.

The signal voltage across the barretter will be a direct function of pulse duration as well as peak power. Thus, the amplitude of the output signal is closely related to the energy content of each pulse.

The thermal time constant of a 821B barretter is 350 microseconds and that of the 1/100-ampere fuses approximately the same. Both types, therefore, are suitable for use at the pulse lengths usually employed in magnetron testing.

A schematic diagram of a missing-pulse detector that works up to 2,000 pps is shown in Fig. 6.

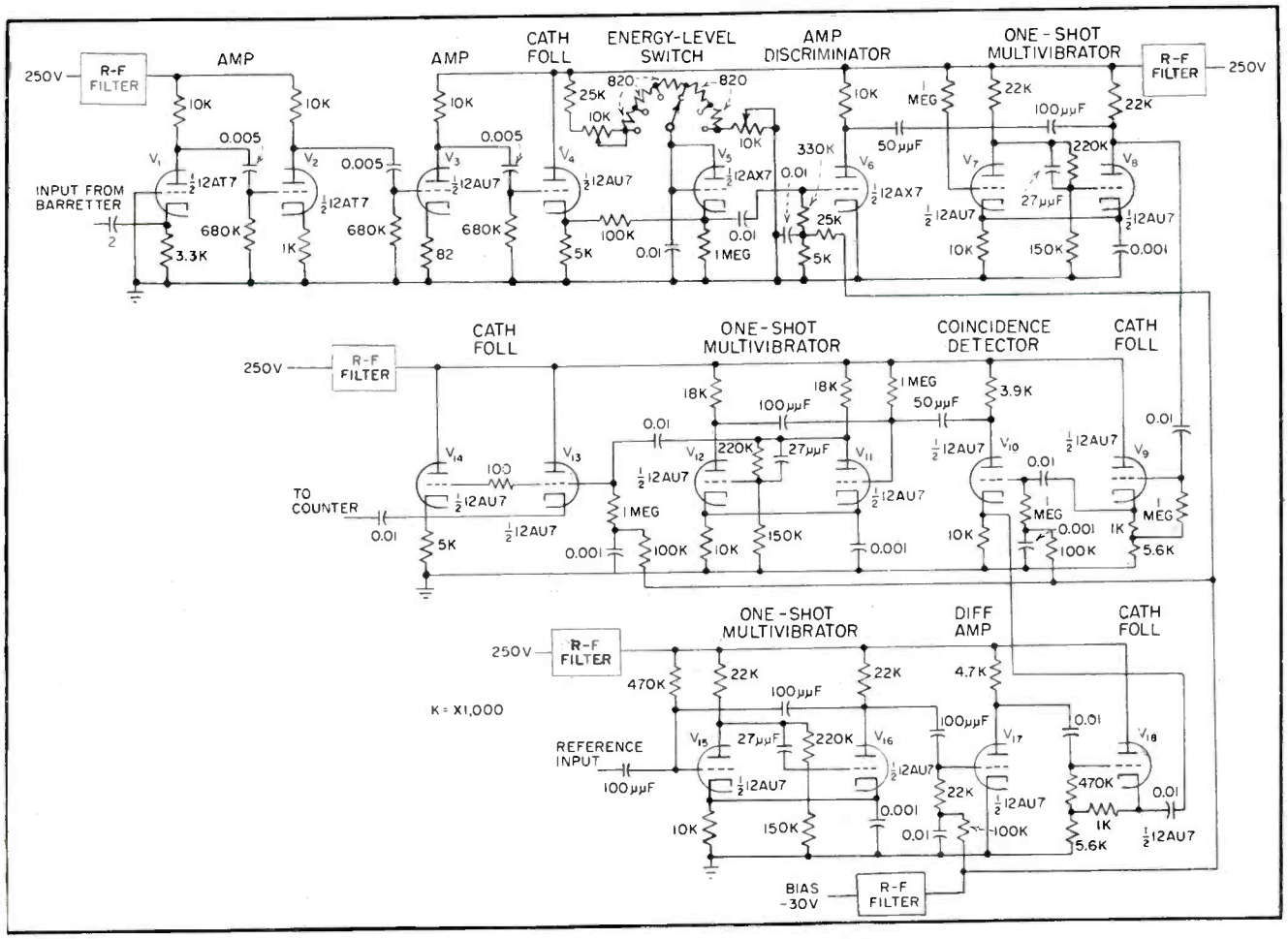


FIG. 6—Missing-pulse detector circuit can operate at pulse repetion frequencies up to 2,000 cps

The r-f signal channel receives the detected pulse from the barretter. The input stage V_1 is operated as a cathode-driven amplifier to match the low output impedance of the barretter. A low-impedance circuit at this point also minimizes stray signal pickup when equipment is in the vicinity of high-power magnetrons.

Detected Pulse Amplifiers

Two additional stages of amplification are provided by V_2 and V_3. The total voltage gain of the three stages is approximately 450, providing an output signal of about 45 v peak from a barretter signal of approximately 0.1 v peak. Because there is no need to reproduce video information the bandwidth of this amplifier is 50 kc.

Cathode follower V_4, is used as a buffer between the third amplifier V_3 and the amplitude discriminator V_5. This discriminator contains the only equipment operating adjustment. The adjustment sets the energy level which pulses must contain not to be counted.

The output of V_4 is applied through a 100,000-ohm resistor to the cathode of V_5, connected as a diode, and is made normally conducting by a positive voltage applied to its plate through the arm of the six-position switch. The switch is a voltage divider whose position determines the potential applied to the plate of V_5. Its six positions permit the selection of relative pulse-energy levels between 50 and 100 percent in 10-percent steps. After calibration it is set to the energy level below which it is desired to make a pulse register as missing.

When V_5 is conducting most of the signal voltage is developed across the 100,000-ohm series resistor because of the low shunt impedance presented by the diode and the plate bypass capacitor. When the signal voltage reaches a sufficiently positive value the cathode will be driven positive with respect to the plate and conduction will stop.

At this point approximately nine-tenths of the signal voltage above the cutoff value will be developed across the megohm cathode resistor. The voltage at which cutoff occurs is determined by the d-c potential of the plate and consequently by the position of the selector switch.

The signal across the 1-megohm cathode resistor is applied to the grid of V_6 which is biased just beyond cutoff to prevent response to spurious signals or power-supply transients.

Amplitude Discriminator

When the input signal is large enough to drive V_5 to conduction, a negative trigger appears at the plate circuit of V_6 and is coupled to the grid of the conducting half V_7 of a single-shot multivibrator. The output signal at the plate of

V_8 the nonconducting half of the single-shot multivibrator is a negative-going 50-microsecond pulse.

This pulse is produced only when the input to discriminator V_5 is greater than the preset value which determines that a normal r-f pulse at the correct operating frequency is produced by the magnetron. The gain obtained in V_6 provides adequate voltage to assure positive, noncritical triggering of the one-shot multivibrator.

The combination of an amplitude discriminator and triode amplifier provides sharp, positive threshold operation and good freedom from drift which might affect the accuracy of count over extended periods of time. Another cathode-follower buffer stage V_9 couples the output of the multivibrator to one input of the coincidence tube V_{10}.

Reference-Pulse Channel

The second input to the coincidence tube is processed through the reference-pulse channel. This input must be present each time the modulator pulses the magnetron and is derived from a negative pulse obtained from the pulse supplied to the magnetron or from any negative-going signal developed by the modulator circuit.

The reference input is used to trigger single-shot multivibrator V_{15} and V_{16}, producing a 25-microsecond pulse which is differentiated by the coupling network consisting of a 100-$\mu\mu$f capacitor and a 22,000-ohm resistor and is applied to amplifier V_{17}. This normally cut-off amplifier responds only to the positive spike or trailing edge of the differentiated pulse which then appears at its plate as an amplified negative pulse. This pulse is fed through the cathode follower V_{18} to the cathode of the coincidence tube V_{10}.

Coincidence Detector

Coincidence detection is accomplished in V_{10} which is noramlly cut off by a 30-v negative d-c grid bias as shown in Fig. 7. The signals derived from the r-f detector channel and reference channel are applied respectively to the grid and cathode of V_{10}.

When an r-f pulse is missing, the negative-going 30-v cathode pulse

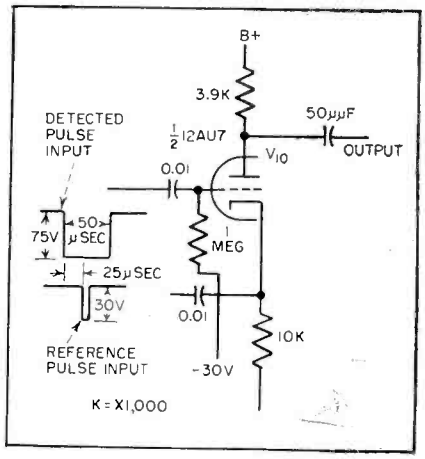


FIG. 7—Coincidence detector with normal input signals

overcomes the 30-v fixed grid bias and develops an output signal at the coincidence detector plate. When both signals are present, the negative-going grid signal of approximately 75 v overrides the 30-v cathode signal and prevents the tube from conducting.

The 75-v negative grid pulse starts before the cathode pulse, and has a duration of approximately 50 microseconds. Consequently, the grid pulse is still present at the grid after the cathode pulse has passed resulting in no output when both pulses are present.

To obtain a standardized output to drive a commercial electronic counter the output of V_{10} is applied to one-shot multivibrator V_{11} and V_{12}. This multivibrator drives cathode-follower output V_{13} and V_{14} in parallel, which delivers a positive 100-v pulse at low impedance.

Adjustment

The initial adjustment of this missing-pulse detector requires an oscilloscope to view both the demodulated r-f input signal and the waveform at the cathode of V_9. The barretter output signal may be easily simulated by a source of short rectangular pulses having a duration of 1 to 5 microseconds and a repetition frequency with a duty cycle of approximately 0.001. These pulses are applied to an R-C integrating network, and the voltage across the integrating capacitor is used as the input signal. Pulse amplitude is adjusted to give a peak signal voltage of approximately 0.1 v.

The energy level-selector switch is first set at the 100 percent or maximum plate-voltage position. The plate voltage on V_5 is then varied by the two 10,000-ohm potentiometers in series with the switch until an output is just produced at the cathode of V_9.

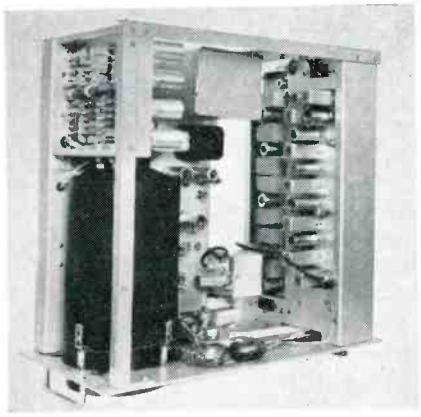
The d-c plate voltage of V_5 is then measured. Signal input is then reduced 50 percent and the 10,000-ohm potentiometers adjusted until output appears at the cathode of V_9. The plate voltage of V_5 should again be measured. The input signal is removed and the two potentiometers again adjusted to provide the two voltages just measured. No further adjustment is necessary.

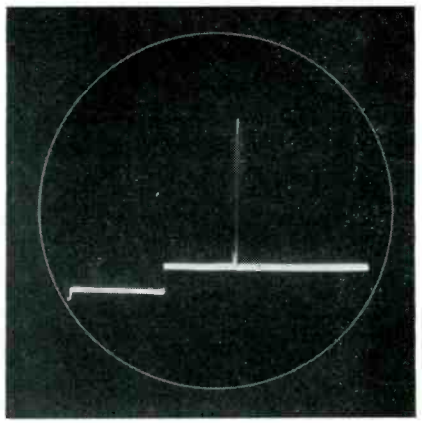
To operate the missing-pulse detector, the r-f signal-input level is adjusted by the variable attenuator, stating from the maximum-attenuation position, until the counter stops counting the pulse repetition frequency. At the beginning of this adjustment the energy-level selector switch is set at the 100-perecent position which automatically calibrates the instrument. The switch is then turned to the energy level at which it is desired to make a pulse register as missing.

Conclusions

Complete shielding of the missing-pulse detector is needed to prevent spurious signal pickup. As an additional precaution against such pickup, low-pass filters were inserted in the power supply leads at the points where these leads enter the instrument. The power supply incorporates voltage regulation to guard against line fluctuations. After several hours of continuous operation the values of certain resistors changed sufficently to cause improper operation. But proper operation could be restored by cooling. To eliminate this, a blower was installed and no further heating difficulty was experienced during several months of continuous operation.

The maximum pulse-repetition frequency which can be used with the instrument is approximately 2,000 cps because the thermal lag of the demodulator element limits the amount of cooling between pulses. However, magnetrons normally operate well within the instrument's capabilities.





Reading on slide-rule dial corresponds to position of step on crt, left. Controllable inductors are in rectangular cans on r-f chassis at right in top view of receiver, center. Panoramic display, right, shows 1-μv and 1,000-μv signals separated by 500 kc

FERRITE INDUCTORS Tune Panoramic Receiver

SUMMARY — Scanning from 100 to 150 mc is accomplished by double superheterodyne that features high sensitivity with low image response. Electrically tracked ferrite inductors in tuned circuits of three r-f amplifiers, oscillator and mixer contribute to image rejection. Step display on crt facilitates measuring frequency of intercepted transmission

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DESIGNING A VHF RECEIVER with rigid specifications on noise figure and spurious-response level becomes a substantial problem when the receiver is a wide-range panoramic. Solving it hinges upon selecting a sweep component which will give the desired frequency coverage and still lend itself to the design of optimum receiver circuitry.

The use of controllable inductors as tuning elements has made it possible to construct a panoramic receiver to sweep from 100 to 150 mc with a noise figure of about 10 db and with spurious responses (cross-modulation) approximately 70 db below signals. Image responses are about 120 db down. A block diagram of the receiver is given in Fig. 1.

In superheterodyne receivers, noise figure and spurious-response level are determined by the front end. Considerations of overall gain and selectivity can largely be deferred to the design of the i-f amplifier. Figure 2 shows the sweep-tuned sections of the receiver including r-f amplifiers, mixer and oscillator.

Of the various elements available for panoramic tuning, controllable inductors offer advantages in size, weight, stability and freedom from moving parts while meeting the requirement for a 2.25-to-1 reactance swing to cover the 100 to 150-mc range. In addition, they are readily ganged for multiple-tuned circuits and can be made to track accurately in quantity receiver production. Simple circuits can also provide adjustable scan rate, sweep width and sweep center frequency if needed.

Controllable inductors selected are CGS type XH-147 Increductor units. The construction of these inductors is shown in Fig. 3A. A rod of high-frequency ferrite material forms the core of the signal winding. The incremental permeability of the core, and hence the inductance of the winding, is varied by the amount of magnetic flux created by current in the control winding and carried in the laminated iron yoke. A bias winding establishes the operating point of each inductor. Tracking between units is obtained by adjustment of the d-c supplied to this winding.

The receiver front end was designed to provide the desired degree of image rejection and spurious-response suppression with due regard for the varying Q characteristic of the controllable inductors. Figure 3B shows measured Q values obtained for a typical XH-147 controllable inductor resonated with a fixed capacitor and tuned over the 100 to 150-mc band. The control current required to accomplish this is also plotted.

Front End

In the receiver front end, the signal is first amplified in a low-noise, cascode stage with tuned input and

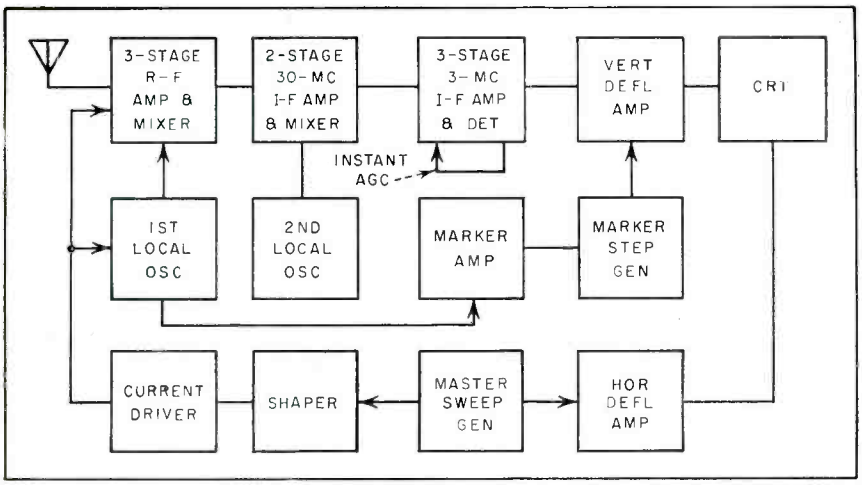

FIG. 1—Double superheterodyne receiver includes five intermediate-frequency stages following sweep-tuned radio-frequency section

output circuits. The use of series-resonant voltage step-up to the input grid makes possible a lower noise figure than is obtainable with untuned inputs.

The input stage is followed by two pentode r-f amplifiers and triode mixer linked by double-tuned interstage networks. The controllable inductors in the tank circuits are individually packaged units with no inductive coupling between them. Hence it is necessary to provide external coupling elements in the form of capacitors C which provide an impedance common to both tuned circuits in the pairs.

A capacitor used in this manner provides a coupling coefficient k which decreases with increasing frequency to compensate for the rising Q of the controllable inductors. The result is a gain-bandwidth characteristic substantially flat over the frequency range of the receiver. The term kQ which determines the ouput voltage of the coupled circuits at resonance is held approximately constant.

The triode mixer receives the output of the r-f stages and the local oscillator, which is tuned by a controllable inductor identical to those in the r-f section. Series and shunt tracking coils adjust the tuning range of the oscillator to the 130 to 180-mc range required for operation with a 30-mc i-f. The tracking inductors are analogous to the series and shunt tracking capacitors commonly used in manually tuned receivers.

I-F and Video

A two-stage i-f amplifier operating at 30 mc is followed by a crystal controlled second local oscillator and a mixer. A second i-f of 3 mc is thus produced. It is amplified in three pentode stages, detected, amplified and applied to the vertical deflection plates of the display tube. The double superheterodyne circuit makes it possible to achieve an effective receiver bandwidth of 30 kc, providing more-than-adequate signal resolution. The practical resolution of current models of the receiver is limited by cathode-ray tube and spot size.

To provide a logarithmic display of signal amplitude on the crt, a fast-acting agc voltage is applied to the grids of the 3-mc amplifiers. This gives these stages a signal-compressing action which causes a 60-db range in signal strength to appear as a 6-to-1 variation in pip height on the display screen.

Control current for all the con-

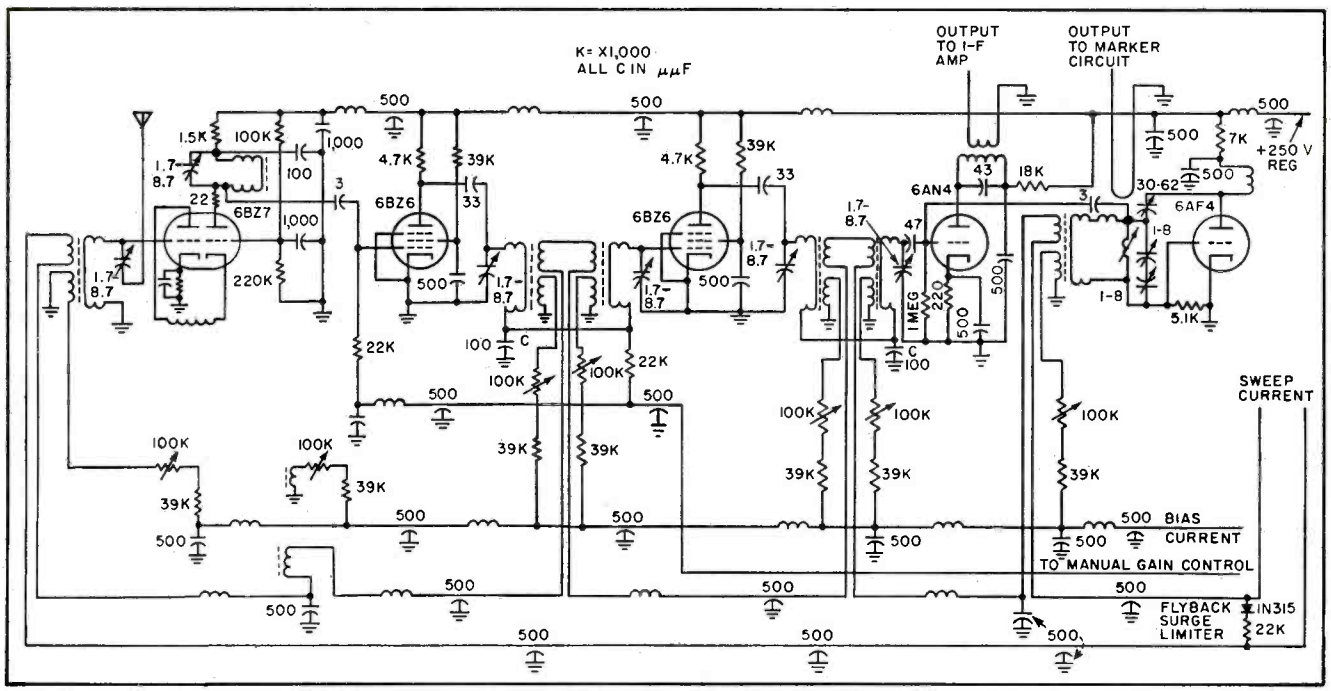

FIG. 2—Seven controllable inductors tune r-f stages, mixer and oscillator. Manually adjusted gain bias is applied to second and third r-f amplifiers. Capacitors C are external coupling elements of controllable inductors

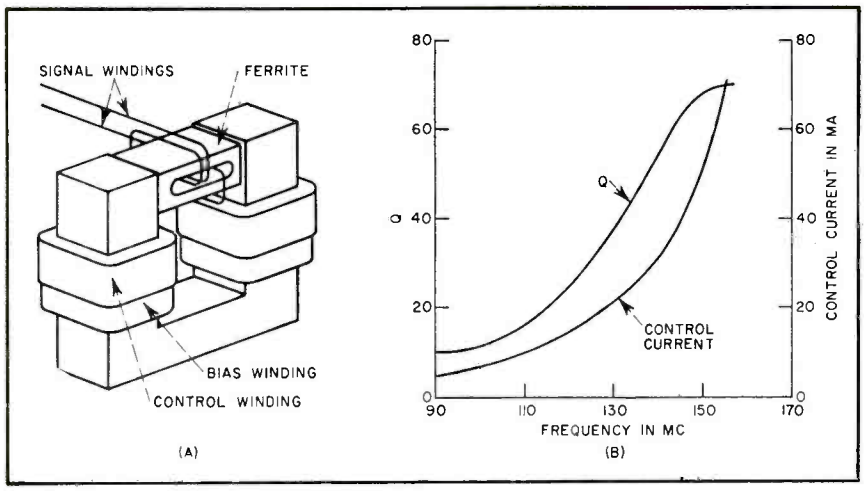

FIG. 3—High-frequency controllable inductor (A) and control and Q characteristics as functions of frequency (B)

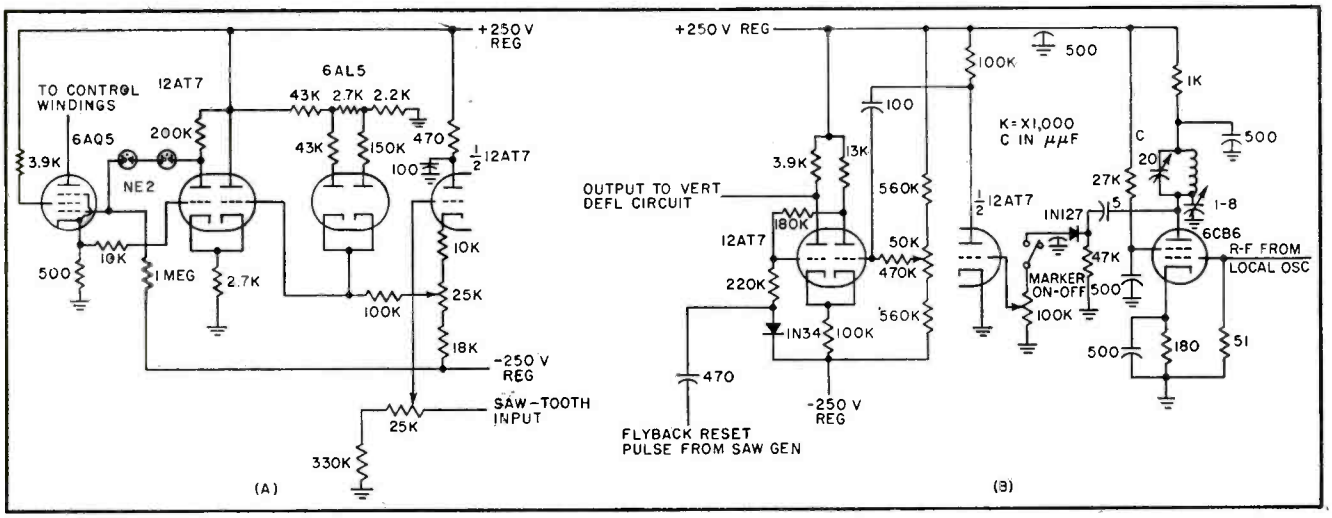

FIG. 4—Biased diodes shape sawtooth signal to produce linear frequency sweep (A). Trigger circuit produces step marker on baseline of cathode-ray oscilloscope (B)

trollable inductors is supplied by a single 6AQ5 with high negative feedback. The tube functions as a high-impedance current source feeding all the controllable-inductor control windings in series. The high-impedance current driver tends to make the current output closely follow the input waveshape despite an inductive load.

The frequency-control current curve (Fig. 3B) reveals a nonlinear relationship. Therefore, some modification of the saw-tooth sweep waveform is needed to produce a frequency sweep which is linear with time. Two successively biased shunt diodes operate on the saw-tooth wave and introduce gradual curvature.

The modified saw-tooth is amplified and applied to the grid of the 6AQ5. The shaper and driver are shown in Fig. 4A. The two neon lamps between the amplifier and current driver act as a d-c capacitor providing direct coupling between the stages while dropping the d-c level to a suitable value.

The receiver is swept at 10 cps. The retrace portion of the sweep waveform resets all the controllable inductors to the same initial magnetic state, thus avoiding mistracking due to hysteresis.

Markers

Frequency measurements of displayed signals are facilitated by a movable, step-type marker on the crt baseline controlled by a knob and calibrated slide-rule dial. The operator adjusts the knob until the vertical step coincides with the pip representing the signal. Frequency can be read from the dial with an accuracy of better than 1 percent.

The marker circuit is passive to avoid oscillator radiation and interference. The marker knob rotates variable capacitor C in Fig. 4B which resonates with a fixed inductor over the range 130-180 mc, the range of the receiver local oscillator. Dial calibration, however, is from 100 to 150 mc.

A sample of the sweeping local-oscillator voltage is amplified and applied to this tuned circuit, causing it to ring briefly when frequency coincidence occurs between the sweeping oscillator and the manually tuned tank circuit. The ringing waveform is rectified and used to turn on a Schmitt trigger circuit connected to the vertical deflection system of the crt. This creates the step in the baseline. The trigger circuit is reset during the flyback interval by a retrace pulse derived from the sweep generator.

The design of receiver and controllable inductors was under the direction of Carl G. Sontheimer and W. Reid Smith-Vaniz.

Magnetic Shift-Register

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SUMMARY — Printed decimal digits 0 to 9 are easily recognized by a magnetic shift register using digital-to-analog converters at each stage. Recognition is obtained using a waveform-fitting function instrumented with the shift-register for correlation. Equipment responds to best fit, hence complete correlation is not necessary to identify input. Unit is thus insensitive to noise from imperfectly formed digits and/or dirt

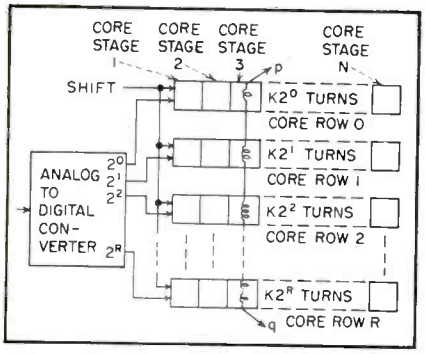


FIG. 1—Block diagram of magnetic shift-register

MAGNETIC SHIFT-REGISTER with simple digital-to-analog converter at each stage is to be described. A waveform-fitting function is presented, which coupled with the shift register, identifies time functions associated with the printed digits 0 through 9.

Magnetic Shift Register

The nature of a magnetic shift register can be reviewed by referring to core row zero in Fig. 1. The register consists of N cores in series. Information is read into the first core where it remains until the register is shifted. The shift windings of the N cores are connected in series. In advancing the information from core 1 to core 2 the shift signal erases the content of core 1. The next shift pulse advances the content of core 2 to core 3, erasing 1 and 2 and advances any second read-in signal in core 1 to core 2 and so forth.

The register of Fig. 1 does not recirculate so that on the shift pulse following that which advances the first bit to the Nth core, the first bit is stepped out of the register. Access to the information in the cores can only occur during the shift pulse time. A single shift signal suffices to advance any information to the next stage from each preceding stage.

Digital-to-Analog Converter

Returning to Fig. 1, assume that the input signal is binary coded and quantized to R bits. Each register core row has one of the R bits as its input data. The R cores of each register stage have $K2^R$ turns of wire wound around each core and these windings are all in series aiding, terminating at points p and q.

This arrangement is illustrated only for stage 3 and $K = 1$. The voltage across terminals pq is $E_{pq} = K\ (a2^0 + b2^1 + \ldots r2^R)$, when the register is shifted, where a, b, . . ., r are either 1 or 0, dependent on whether there is or is not information in core rows a, b, . . ., R.

The digital-analog conversion (dac) action is shown in Fig. 2. Curve (A) is an aperiodic function quantized in amplitude to seven bits and in time to fifteen samples by a binary coder. Curve (B) represents

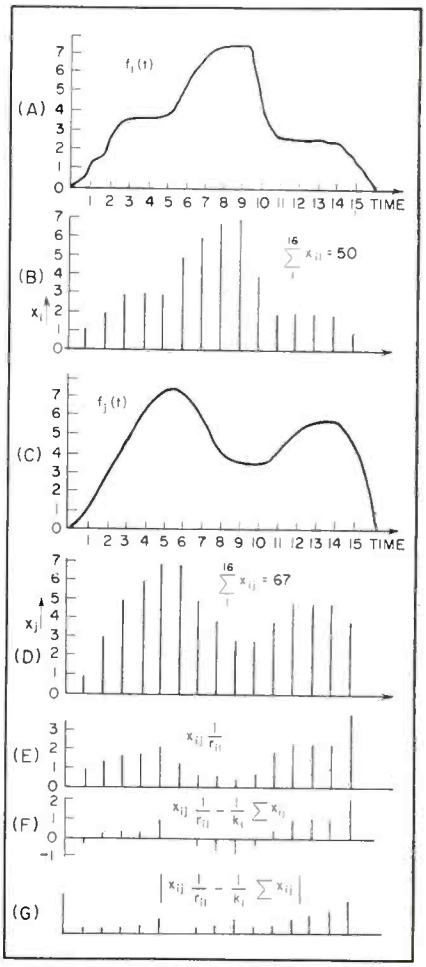


FIG. 2—Reference correlation waveform (A) is quantized (B) and compared with second function (C) obtained from numeral passing by light slit and is shown in quantized form (D). Comparison of quantized wave forms is made by operating on (E) and (F) to obtain auto correlation function (G)

Correlator

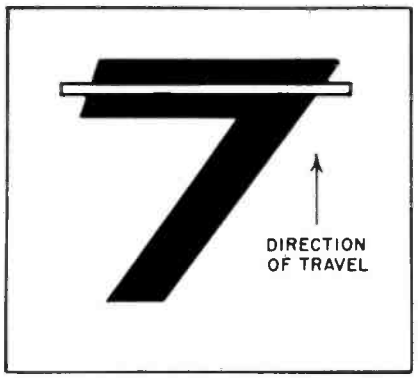
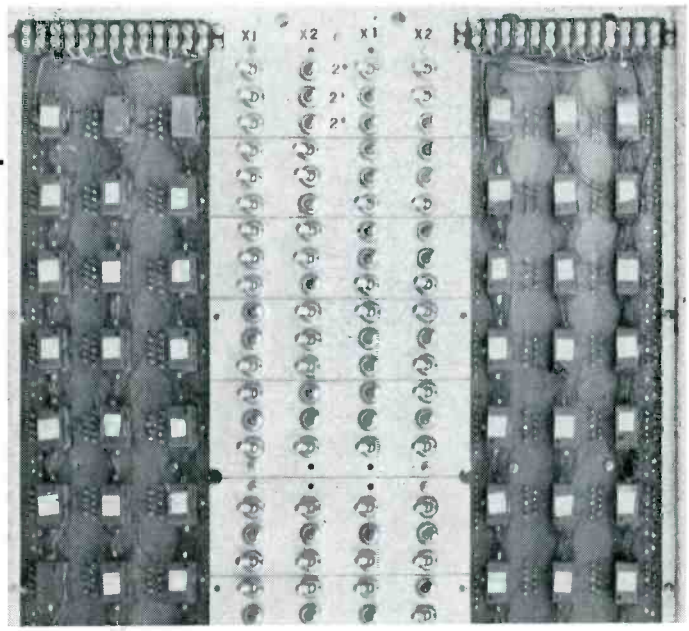


FIG. 3—Digit 7 moving across light slit



Magnetic shift-register correlator. Switches are used to set up storage of any two arbitrary waveforms at one time

the output across the dac winding of the first stage of the register in Fig. 1. The output of the second stage is identical in shape but displaced in time by the time between samples, the shift pulse repetition interval. In general the envelope of the time-amplitude response of the ith stage of the register is similar to that of the input function, from which it is delayed a time i.

The important factors involved in the accuracy of the binary to analog conversion are the current-flux characteristics of the cores, the tolerance range of the capacitors and the spread in diode threshold levels and back impedance characteristics.

Printed-Number Identification

Electrical signals, characteristic to the digits to be recognized, were obtained by moving the numbers across a brightly illuminated narrow slit of light with a germanium photocell mounted nearby. As the number passes the slit, the photocell output varies in time as a function of the amount of black passing by the slit. The long dimension of the light slit is slightly greater than the width of the widest number to eliminate a need for precise lateral registration.

Its narrow dimension is small enough to bisect horizontal strokes that make up the number. The geometry is shown in Fig. 3. Oscilloscope pictures of the waveform characteristic of the ten digits are shown in a photograph.

A theoretical study, for slit-to-number orientations between 0 and ±60 degrees was made to test the efficacy of such well-known criteria as the correlation coefficient and the correlation function to distinguish between the digit waveforms.

Correlation

The final correlation criterion examined and the one that was instrumented, is

$$\theta_{(j,\,l)} = \sum_{i=1}^{n} \left| x_{ij}\ 1/r_{il} - 1/k_l \sum_{i=1}^{n} x_{ij} \right| .$$

The subscript i denotes one of n sampling intervals. The subcript j represents the general unknown or input waveform corresponding to one of the ten digits to be identified. Subscript l represents the general known or reference waveform that is permanently stored in the shift register correlator. The amplitude of the input waveform j at sampling time i is x. The amplitude of the stored reference waveform at sampling time i is μ. When the input is the same as the stored waveform $j = l$, the case of auto-correlation, the first product of the equation is equal to unity for every i.

The summation in the second term of the equation represents the integral of the unknown input and the factor $1/kl$ is chosen to make the second term product unity when $j = l$. The equation is identically equal to zero when $j = l$. For cross-correlation $j \neq l$, the individual i terms of the total summation, which are equally likely to be positive or negative, are made positive by the absolute value brackets.

The number correlation function, $\phi_{(j,\,l)}$ is explained in more detail in Fig. 2. Curve (A) shows an arbitrary function $f_l(t)$ which will be used as a standard with which to compare a second function $f_j(t)$. The ordinate is divided into 7 quanta and 0 to indicate the response of the adc at the sampling times shown on the abscissa. Curve (B) represents the analog to digital conversion as the waveform is shifted into the register. The ordinates have the values $x_{1l} = 1$, $x_{2l} = 2$, $x_{3l} = 3$, $x_{4l} = 3$, etc. and their sum $\sum_{1}^{16} x_{il} = 50$.

Having obtained these values by observation the correlators' $\frac{1}{kl}$ factor is set equal to 1/50 and each

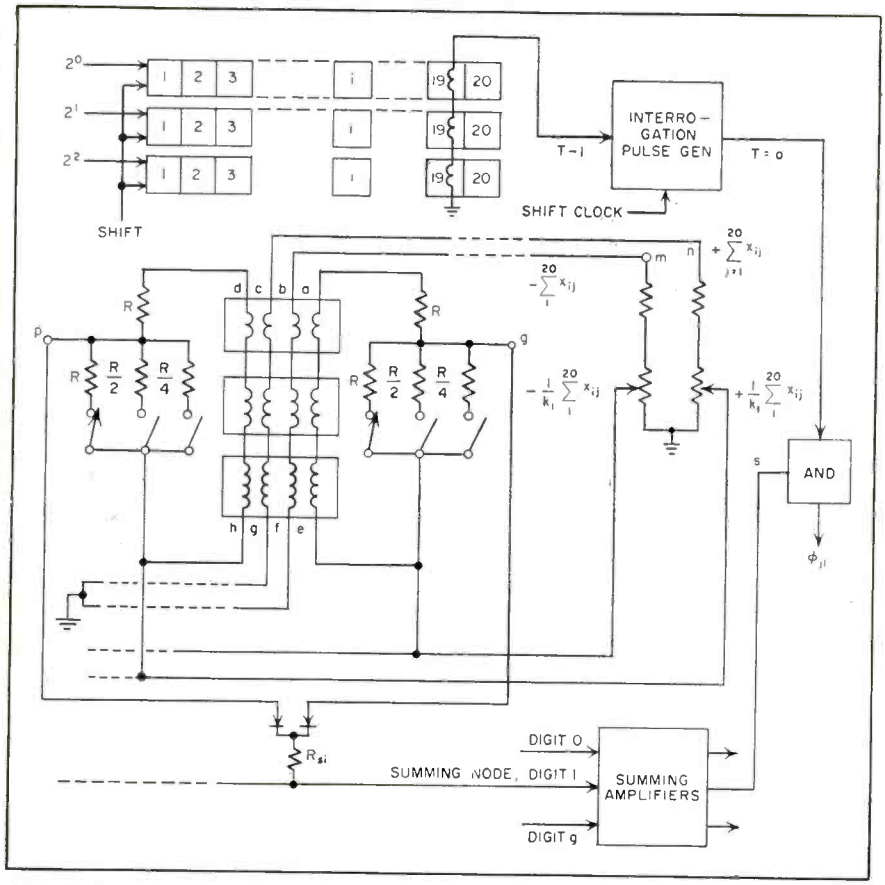


FIG. 4—Instrumentation of correlator

of the $1/r_{il}$ factors is set to make the corresponding x_{il} terms equal to unity: $1/r_{1l} = 1/l$, $1/r_{2l} = \frac{1}{2}$, $1/r_{3l} = \frac{1}{3}$, $1/r_{4l} = \frac{1}{4}$, etc. Each term of the sum is thus unity and the function nulls for autocorrelation.

Curves (C) to (G) show the details of cross-correlation where a second function $f_j(t)$ is compared to the reference function $f_i(t)$. Curve (D) shows the unknown after digital conversion. The ordinates x_{ij} have the values $x_{1j} = 1$, $x_{2j} = 3$, $x_{3j} = 5$, $x_{4j} = 6$, etc. and their sum $\sum_{1}^{16} x_{ij} = 67$.

Curve (E) illustrates the first term of the equation $\frac{x_{ij}}{r_{il}}$

The numerator takes the values of the (D) curve and the denominator the (B) curve:

$$\frac{x_{1j}}{r_{1l}} = \frac{1}{1}, \frac{x_{2j}}{r_{2l}} = \frac{3}{2}, \frac{x_{3j}}{r_{3l}} = \frac{5}{3},$$

$$\frac{x_{4j}}{r_{4l}} = \frac{6}{3}, \text{ etc.}$$

In (F) each ordinate in (E) has $\frac{\Sigma x_{ij}}{k_l}$ subtracted from it. The numerator is 67 while the denominator's value is 50, the sum of the ordinates of the reference function (B). Comparison of (F) and (G) shows the advantage of taking the absolute value in order to get a maximum spread in response between cross and autocorrelation.

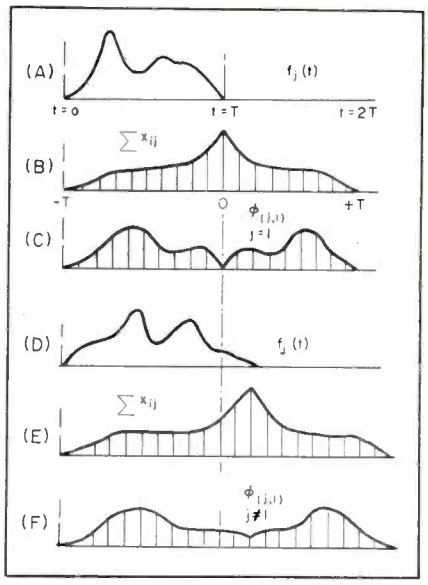
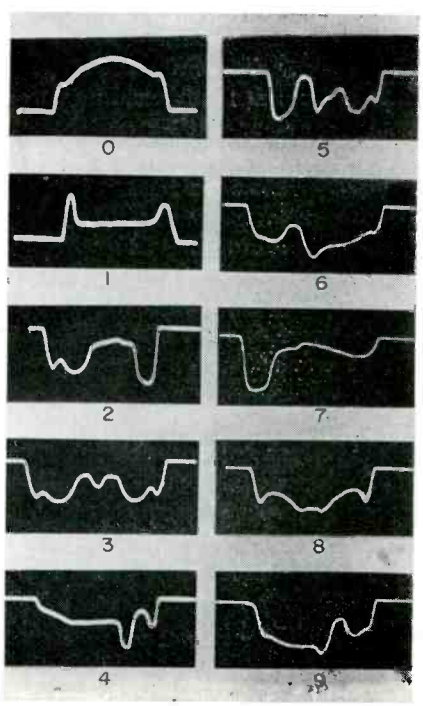


FIG. 5—Curves show the significance of time response in autocorrelation

Figure 4 illustrates the instrumentation of the correlating function. After time and eight-bit amplitude quantization, the function is shifted into the 20-stage shift register. Since all stages are identical, only the ith stage is singled out and exploded. The voltage across terminals a-e is $+x_i$ and across d-h, $-x_i$. Windings b-f and c-g are run serially and additively through all 20 stages of the register, with opposite sense, so that the voltage at m and n is minus and plus $\sum_{i=1}^{20} x_{ij}$ respectively.

The multiplier constant $\frac{1}{r_{il}}$ is established by the resistors between a-e. With the given resistor ratios, the binary switches can set in attenuation factors varying from 1 to $\frac{1}{8}$. This range accommodates the 7 quantized values of x_i. The switches are so ganged that x_{ij} and $-x_{ij}$ are always attenuated by the same factor. (The multiple resistors and switches were for experimental purposes. In practice, only two each are required for $+x_i$ and $-x_i$). The outputs across q-e and p-h are then respectively plus and minus $\frac{1}{r_{il}} x_{ij}$, representing the first term of the



Waveform characteristic of digits 0 to 9

correlation function. The second term of the function is developed at s and t where $\pm\sum_{i=1}^{20} x_{ij}$ is attenuated by $1/k$. The subtraction of the two terms within the absolute value bracket is made by connecting s and t to terminals h and e, the low potential ends of the $\pm x_{ij}$ windings and the difference appears between ground and points p and q.

There appears from p to ground $-\frac{x_{ij}}{r_{il}} + \frac{x_{ij}}{k_l}$, and from q to ground $+\frac{x_{ij}}{r_{il}} - \frac{\Sigma x_{ij}}{k_l}$

The diodes connecting p and q to the common resistor R_{si} serve as full wave rectifiers and the absolute value of the ith term of the total sum appears across this resistor. Similar connections to the summing node are made from the other 19 stages. This indicates that the absolute value of the 20 terms of the total summation are all collected by the summing amplifier whose output is then the desired function

$$\theta_{(j,l)} = \sum_{i=1}^{20} \left| \frac{x_{ij}}{r_{il}} - \frac{1}{k_l} \sum_{i=1}^{20} x_{ij} \right| .$$

Time Response

As the waveform is shifted into the register it progresses from left to right and is said to be in registry when the leading edge is in the Nth register change.

The number of core stages N is equal to or greater than the number of times the function M is sampled by the adc. The function in registry defines time $T = 0$ and, for autocorrelation, it is at this time that the $1/r$ factor in the Nth stage of the register attenuates the first ($n = 1$) time-sampled ordinate of the unknown such that $\frac{x_l}{r_n} = 1$.

Carrying this on, for autocorrelation, at $T = 0$ the remaining $\frac{1}{r}$ factors are set such that each of the following products is equal to unity: $\frac{x_2}{r_{N-1}}, \frac{x_3}{r_{N-2}}$, etc. Also at this time xi, the integral of the function, is reduced to unity by the $\frac{1}{k}$ factor.

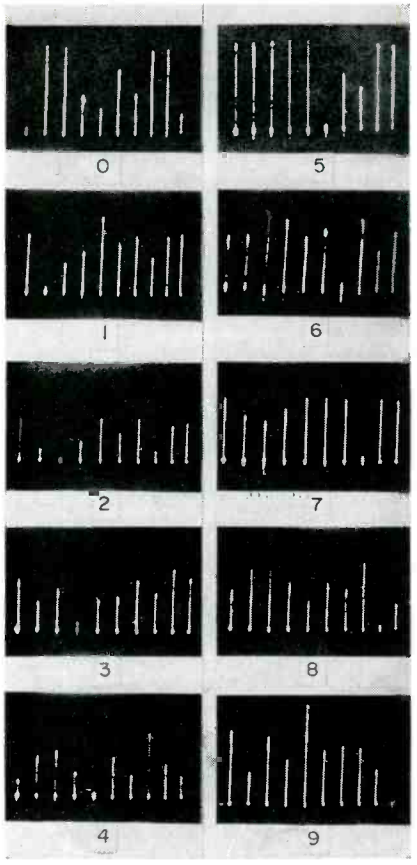


FIG. 6—Waveforms shown quantized

The significance of the time response is reviewed in Fig. 5. Diagram (A) shows an input function that will be autocorrelated When the function is in registry, the core stage and sum attenuators reduce each term of the function to unity making the sum equal to zero. Curve (B) shows the construction of the integral from the time the $i = 1$ ordinate (leading edge) shifts into the first core stage until the $i = T$ ordinate leaves the final core stage N.

The maximum occurs when the ordinates are in registry at $T = 0$. Curve (C) shows autocorrelation at $T = 0$ when the $i = 1$ ordinate is in core stage N and the $i = T$ ordinate is in the core stage $(N - T)$. Instrumented as in Fig. 4 the curve appears at the output of the summing amplifier and the $T = 0$ point on the curve is selected in the AND gate which is opened only at $T = 0$ by the interrogation signal.

The output is zero for autocorrelation. The curve in (D) represents a second function to be correlated with that in (A). Its integral, shown in (E), is diplaced to the right since its time duration is longer. The integrals in (B) and (E) can reach peak value at the same time. Regardless of the duration the $T = 0$ ordinate in (B) and (E) can be equal or unequal.

Curve (F) shows the cross-correlation observed at the output of the summing amplifier in Fig. 4. In this case the output of the AND gate is greater than zero.

Digit Storage

To store the waveforms associated with the ten digits there are ten sets of windings on each core stage, a $1/r$ and $1/k$ attenuator associated with each set and ten summing amplifiers each gated with the $T = 0$ (interrogation) pulse. Ten lines, so gated, corresponding to the digits 0 through 9 go to an amplitude selector having ten output lines.

The characteristic of this selector is that a pulse appears only on the output line whose corresponding input was the smallest of the ten input signals. Signals appearing on the output lines could operate terminal equipment, such as printers, sorters and accumulators.

Complete correlation is not necessary to identify the input waveforms since the equipment responds to the best fit. The correlator is thus insensitive to noise such as caused by imperfectly formed digits and dirt on the printed media.

The correlator has two complete sets of windings on each of the core stages and by changing the binary ordered toggle switches it can be made to store any two arbitrary waveforms at one time.

The waveforms in Fig. 6 were taken at the $T = 0$ gated output of a summing amplifier with the numbers corresponding to the waveforms in a photograph going under the photocell in the sequence 0, 1, 2, 3, . . . 9.

The authors acknowledge the assistance of J. S. Shipman, H. Rubinstein, M. E. Hale and R. C. Preece, staff members of the Laboratory. The work was sponsored by the Chase Manhattan Bank.

SUMMARY —— Synchronously switched biased diodes insert impedance in control circuit during power half-cycle to increase voltage gain by factor of three or four over half-wave amplifier, while maintaining effective 10,000-ohm input. Simplified design reduces number of components by one-half to two-thirds that of conventional system

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Transient-Controlled

HALF-WAVE bridge-type magnetic amplifiers have found extensive application for the solution of various instrumentation and control problems. However, mutual coupling between signal turns and power turns requires the installation of a series control resistor to avoid loading amplifier and signal source during the power half-cycle. Additional amplifier stages are then required to increase the circuit gain back to a satisfactory level.

These considerations suggest the use of a synchronously operating on-off switch to insert an impedance in the control circuit during the power half-cycle only. One electrical synchronous-switch analogy is the biased-rectifier shown in Fig. 1. When point 1 goes positive, the rectifiers conduct and signal current through R_L is equal to E_{signal}/R_L providing $E_{supply}/R_S \geqq E_{signal}/R_L$. When point 1 goes negative, E_{signal} sees the impedance $R_S + R_L$, which is usually high if $E_{supply} >> E_{signal}$.

Application

The application of this technique to the standard half-wave magnetic amplifier is shown in Fig. 2A. Providing the bias resistances are sufficiently high, the signal source may be considered to be isolated from the amplifier during the power half-cycle. During the reset half-cycle, the bias rectifiers conduct and the signal may be assumed impressed directly across the control windings.

With this arrangement, the voltage gain of the standard amplifier increased by a factor of three or four while maintaining an effective 10,000-ohm input.

The transient controlled amplifier uses a Supermalloy core. This material has a narrower hysteresis loop than Orthonol, signifying a reduced magnetizing-current level. A second important characteristic is the core state after the removal of magnetizing and saturating

*Work done while with Magnetics Division, Naval Ordnance Laboratory, White Oak, Md.

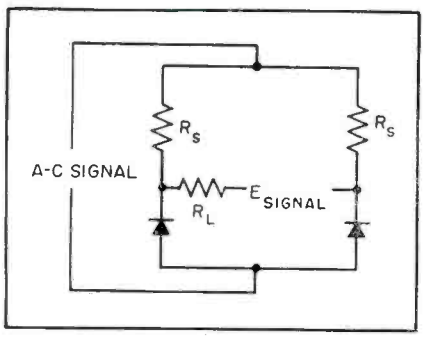


FIG. 1—Biasted-diode synchronous switch used in transient controlled amplifier

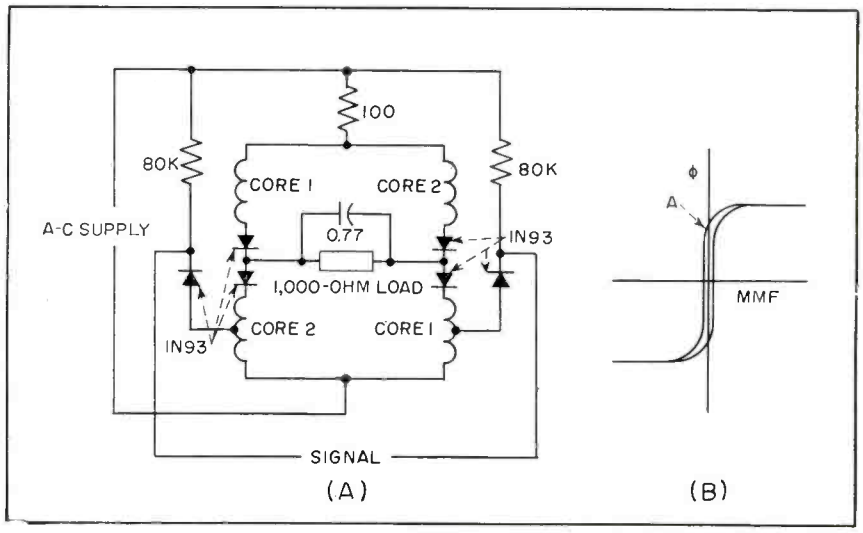
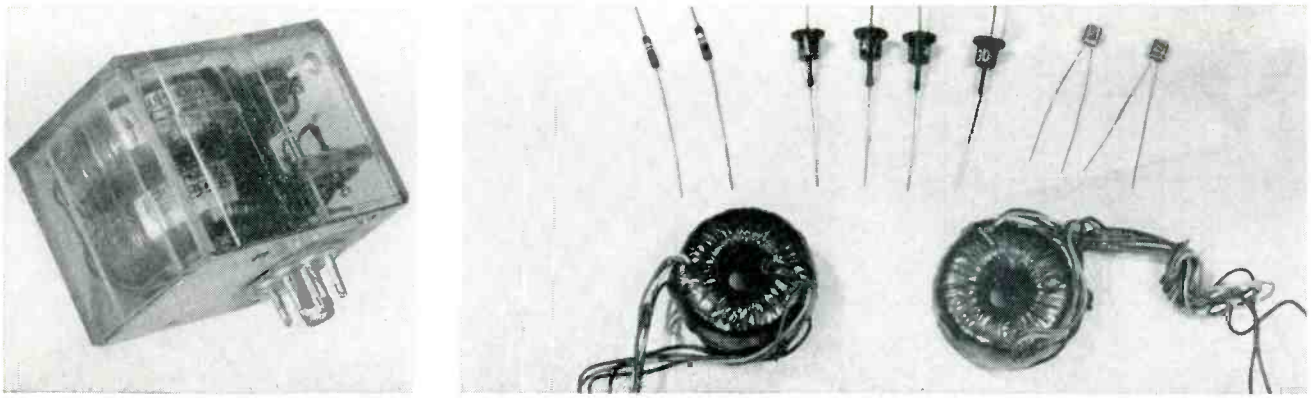


FIG. 2—Transient-controlled magnetic amplifier circuit (A) uses Supermalloy core material having hysteresis loop shown at (B)



Transient-controlled magnetic amplifier encased in plastic plug-in, left, mount uses only a few more components than conventional half-wave amplifier circuits. All components are shown at right

Magnetic Amplifier

force. The flux-operating point is then at Point A of Fig. 2B which, for Supermalloy, represents a less saturated core condition and consequently a high impedance.

Core Action

Figure 3A shows the core action during the power half-cycle. Application of a signal of polarity shown opposes the reset action of core 1 and this core will fire first in the power half-cycle. On conducting and with proper adjustment of C_o and R_{Line}, the resultant transient current is made to approach zero previous to firing of core 2. The core-1 flux is then positioned at point A of Fig. 2B. The core is then a high impedance, and requires volt-time area before it can again saturate. The current established when core 2 fires, therefore, takes a path through its own power windings and is displaced in time from the core-1 current as shown in Fig. 3B. As a result of this cross-firing effect the capacitor voltage reverses in polarity as shown in Fig. 3C and a charge of polarity shown in Fig. 3A will exist on C_o at the end of the power half-cycle.

In Fig. 3D, it is seen that during the control half-cycle, the capacitor is free to discharge through rectifier D_1 and D_1' via the core-1 power windings and the supply source. The discharge-current wave shape

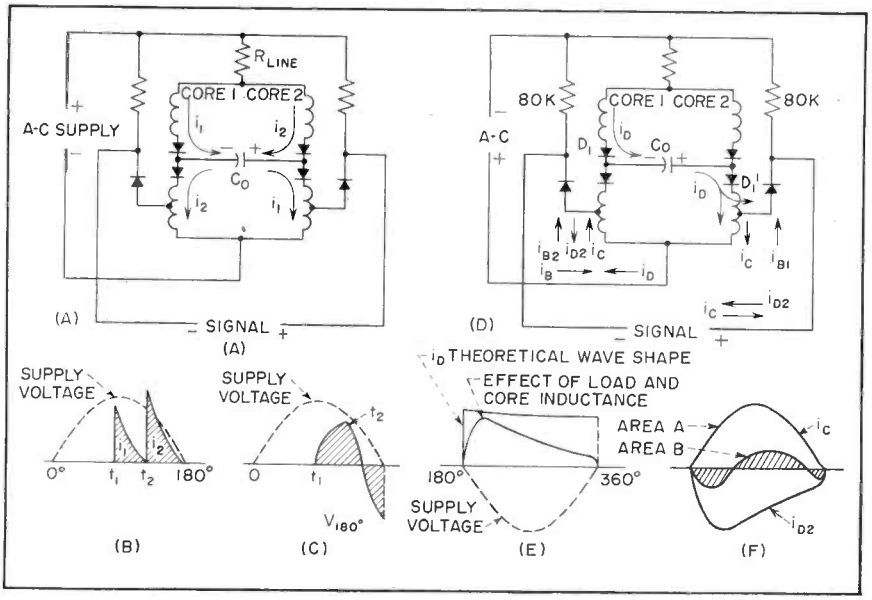


FIG. 3—Amplifier action during power half-cycle (A) with circuit waveforms (B and C). During control half-cycle (D) waveform is as shown at (E). Input impedance can be determined from net control circuit current

is shown in Fig. 3E. A portion of this current, i_{d2}, passes through the control winding of core 2 via the signal source. This component opposes the normal flow of signal current and also negates the control action on core 2. However, the overwhelming effect of i_d on core 1 control results in a net increase in circuit gain. Any current flow opposing i_d through rectifiers D_1 and D_1' during this period is countered by the autotransformed bias current.

The signal-source component of i_d and i_{d2} is limited by biased rectifier D_1. The condition imposed is that $i_{d2} \gtrless i_b - i_c$. (1) with the chief result that i_{d2} is increasingly ineffective at higher signal levels.

From Fig. 3F, the amplifier input-impedance level may be expressed as

Z_{in} (with capacitor) = Area A/Area B Z_{in} (no capacitor) (2)

Design of this circuit is concentrated on obtaining the maxi-

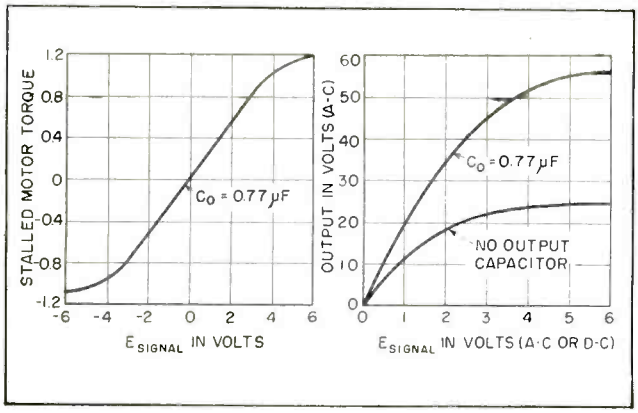


FIG. 4—Gain curves for transient controlled magnetic amplifier with a 400-cps servo motor and tachometer system (left) and with 1,000-ohm resistive load (right)

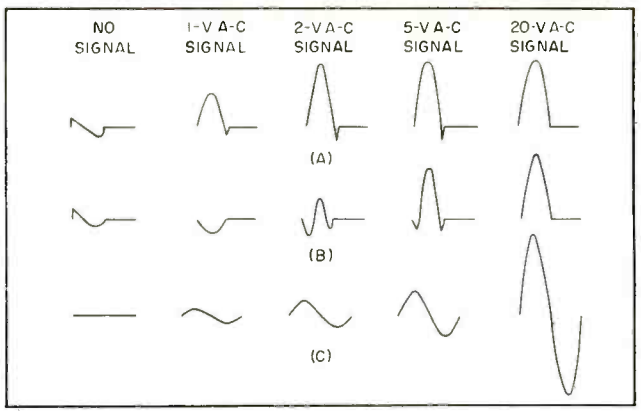


FIG. 5—Control current waveshapes for transient controlled magnetic amplifier without (A) and with (B) output capacitor; waveforms for similarly designed half-wave amplifier (C)

mum gain with minimum control-circuit current. The core mean length of magnetic path should be as short as possible. Also a high ratio of power turns to control turns is necessary for voltage gain.

Operation of this amplifier is dependent on near-perfect rectifier characteristics. Selenium rectifiers were found unsuitable for this application; silicon diodes were satisfactory, with germanium rectifiers a substitute when temperature requirements are not critical.

This amplifier is not suitable where a proportional d-c output is required. The circuit is phase-sensitive and equally responsive to either a-c or d-c signal inputs. The output capacitor is free to discharge through a parallel load during the reset half-cycle. The magnitude of the fundamental frequency contained in the output is thereby increased and the amplifier approaches full-wave operation.

Amplifier Performance

The operation of this circuit allows insertion of a load in parallel with the output capacitor. The amplifier was initially adjusted to operate a typical 400-cycle instrument-type servo system and a load-resistor value then chosen so that the various effects of the output capacitor would be apparent.

The amplifier components are given in Table 1. The gain curves are shown in Fig. 4. Measurements of amplifier delay showed a value of 1 cycle of the supply frequency or less.

The control-circuit current levels were measured by a harmonic wave analyzer for determination of amplifier input impedance. Control current wave shapes are drawn to scale in Fig. 5 for comparison. The quiescent control-circuit current in the biased-rectifier circuit is believed due to core and rectifier mismatch.

The amplifier performance was checked with a 400-cps servo system. For damping, tachometer feedback was placed in series with the control transformer to avoid loading effect. This increased the amplifier input-impedance level by approximately 2,500 ohms. The control transformer-to-motor gear ratio was increased until the system was damped with no loss.

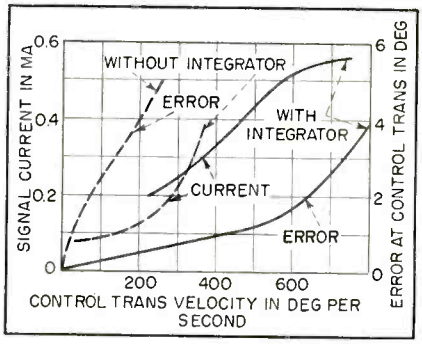


FIG. 6—Velocity characteristic of servo system using transient-controlled magnetic amplifier

Table I—Design Data for Transient Controlled Magnetic Amplifier

	Uncompensated Servo	Compensated Servo
Core	1 x 1⅜ x ⅜ in. wound 0.002 in. Supermalloy tape	
Windings N_p	3,400 turns, No. 32 wire	3,400 turns, No. 32 wire
N_c	150 turns (tap at 3,250 on N_p	225 turns (tap at 3,175 on N_p)
R_{line}	100 ohms	80 ohms
C_o	0.77 μf	0.64 μf
Integrator C_f	—	7 μf
Integrator R_f	—	44,000

Perhaps the only unfavorable characteristic noted was the velocity error caused by the electrical characteristics of the tachometer. To correct for this a capacitor-resistor combination was installed. The capacitor is charged by core-transformer action during the power half-cycle and is free to discharge through the control windings during the reset half-cycle when the bias rectifiers conduct.

To avoid undesirable unbalance effects with the integrator, the circuit was compensated, as shown in Table 1. These adjustments give linear velocity-error correction, as noted in Fig. 6. By increasing feedback, velocity errors of less than 1 deg were obtained at speeds near the maximum slewing speed of the servo motor. The control-circuit current increased with velocity, rather than with signal voltage.

The author wishes to acknowledge the work of J. J. Suozzi, who first applied the biased-rectifier technique described, to the Orthonol-core half-wave amplifier.

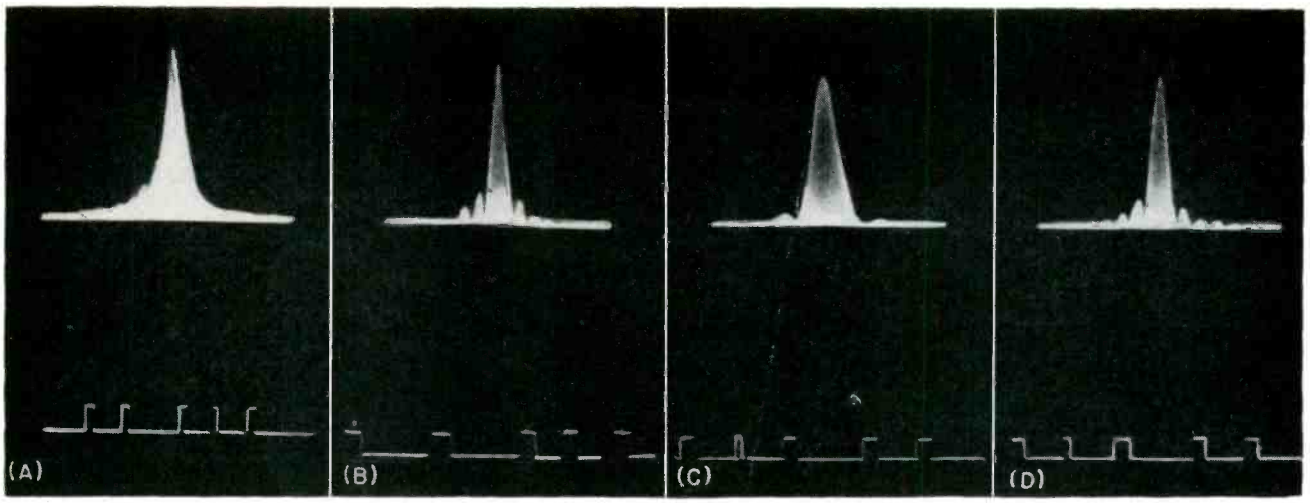


FIG. 1—Superimposed spectra of five-pulse group (A) are separated by selector to show spectrum of first (B), second (C) and third (D) pulse. Intensified pulse display of selector is shown below each envelope

Gate Selects Pulses for SPECTRUM ANALYSIS

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SUMMARY — Selector passes single pulse from train to spectrum analyzer for investigation. Pulses from 0.2 to 150 μsec wide at repetition rates up to 10,000 pps can be chosen for individual analysis. Auxiliary display shows pulse train with selected pulse intensified for identification and as aid in setting gate-width controls to pass entire pulse

IN THE DESIGN and development of systems utilizing multipulse groups it is necessary to separate, observe and identify the spectra of the individual r-f pulses which comprise the group. The rise time, width, separation, distribution of energy and other characteristics of the individual pulses must be determined. To do so, each pulse must be isolated.

A spectrum analyzer display alone is unsatisfactory since it would consist of the spectra of the individual pulses superimposed upon one another as shown in Fig. 1A.

To obtain the spectrum of an individual pulse, the system must be sensitive to that pulse, and insensitive to all others. This can be done by gating one of the elements in the system to switch the spectrum analyzer on, when the pulse under observation occurs, and off, when all undesired signals appear.

An oscilloscope display is therefore required to show both the pulse group being observed and the position of the gate. Figures 1B, 1C and 1D show the selector display and the resultant pulse spectrum on the analyzer. Width and position controls adjust the location of the gate to cover any one of the desired r-f pulses.

First Pulse Gating

To select the first pulse in a group, the gate must begin before the pulse and remain on until the pulse is over. This cannot be done with conventional gate generating circuits, since there is always a delay between the occurrence of the initial pulse and the action of the circuits generating the gate. In the multipulse spectrum selector the switch is left open at all times and the trailing edge of the first pulse is used to generate a rejection gate.

Diode Switch

The switching method chosen places the keying instrument between the mixer and first i-f stage of the spectrum analyzer.

The keying device is a coaxial diode switch shown in schematic

* Work done while with Polarad Electronics Corp.

Control panel of multiple-pulse selector

diagram, Fig. 2. The 1N23B crystals, designed for coaxial mounting, are placed in series in a 50-ohm coaxial line terminated in a 52-ohm resistance. A d-c bias is placed on the crystal through an isolating choke. When the crystals are biased on by an externally applied d-c voltage, the attenuation through the line is 15 db. When the crystals are biased off by reversing the voltage, the attenuation is over 60 db. This switch is used in the 50-ohm line between the spectrum analyzer mixer and the spectrum analyzer i-f amplifier. Fixed external bias is applied to maintain the switch in either the on or off condition. Bias is applied through R_1. Gate pulses are superimposed on the bias by the mixing action of R_1, R_2, and R_3.

A block diagram of the method in which the switch was used is given in Fig. 3. The output of the spectrum analyzer mixer is detected and used to trigger the circuit that generates the gate, closing the switch and allowing the proper pulse to pass through the system. The video from the detector is also displayed on an oscilloscope so the gate can be adjusted properly.

This gating system requires no external trigger and will work quite satisfactorily on the r-f pulses alone. The system operates in the region from −40 dbm to 0 dbm with pulse widths from 0.2 to 10 microseconds and down to a minimum spacing of 0.2 microsecond. Maximum overall pulse-group length can be up to 100 microseconds.

The 160-mc spectrum analyzer mixer output is fed to the spectrum selector i-f, a ±12.5-mc bandwidth amplifier shown in the circuit of Fig. 4. One output is taken from the i-f amplifier and fed to the diode switch for application to the spectrum analyzer. A second output is applied to the trigger and deflection circuits of the spectrum selector. The signal to the spectrum analyzer is amplified 10 db by the first three i-f stages, which form a stagger-tuned triplet, and is then inductively coupled to the diode switch. The signal to the spectrum selector is amplified by an additional six i-f stages for a total gain of 60 db.

First Pulse Operation

With the selector in the FIRST-PULSE position a negative bias is applied to the diode switch. The attenuation offered to the spectrum analyzer signal is 15 db and the switch is effectively closed. A positive trigger, occuring after the first pulse in the group, flips the bistable-multivibrator reject-gate generator. The output of the reject-gate generator is applied to the switch through cathode follower V_{20} (Fig. 4), blocking the signal to the spectrum analyzer for the remainder of the pulse group. An end-of-group trigger from the phantastron then resets the reject-gate generator and opens the switch.

In the OTHERS position of the switch, no bias is applied to the diode switch and the r-f signal is attenuated 60 db. All pulses are then blocked except for the duration of a negative gating pulse generated by accept gate V_{27} and applied through cathode follower V_{20}. By controlling the timing and width of the accept-gate triggering pulse the desired pulse is chosen from the group.

The signal to be applied to the spectrum selector is amplified by the additional six i-f stages, detected and used to provide the crt display and to trigger the selector control circuits. Automatic gain control is used with the i-f amplifier to prevent overloading on large signals. The Schmitt multivibrator V_{15} shapes all pulses alike so that they may be used for triggering the sweep phantastron V_{16}.

Two outputs are taken from the phantastron, a sawtooth and a gate. Their duration of 10 to 100 microseconds is determined by the setting of the GROUP LENGTH control. This control is set by the operator so that the sawtooth is slightly longer than the pulse group. The sawtooth is fed through sweep expander V_{24} to provide crt horizontal deflection.

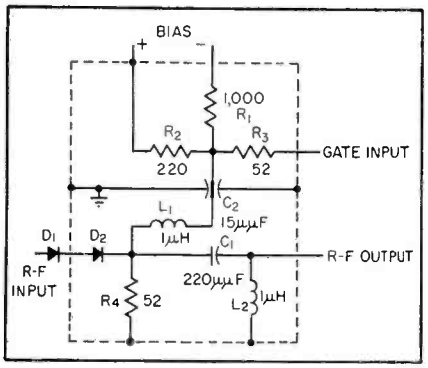

FIG. 2—Crystal-diode switch used to gate spectrum analyzer i-f input selects individual pulse for analysis

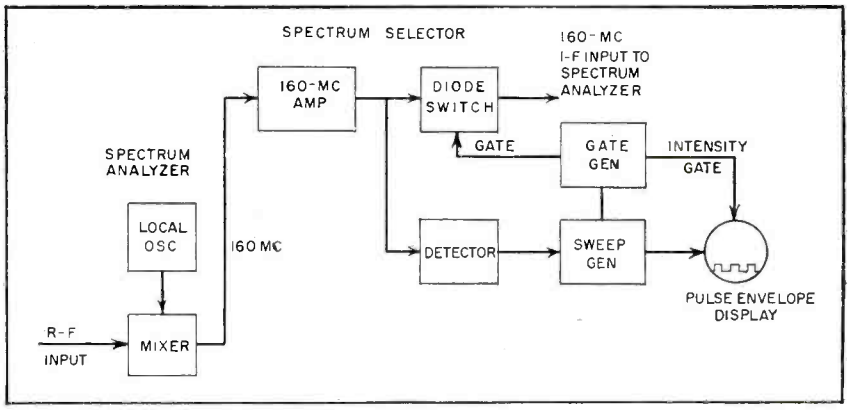

FIG. 3—Selector is inserted between mixer and i-f of spectrum analyzer

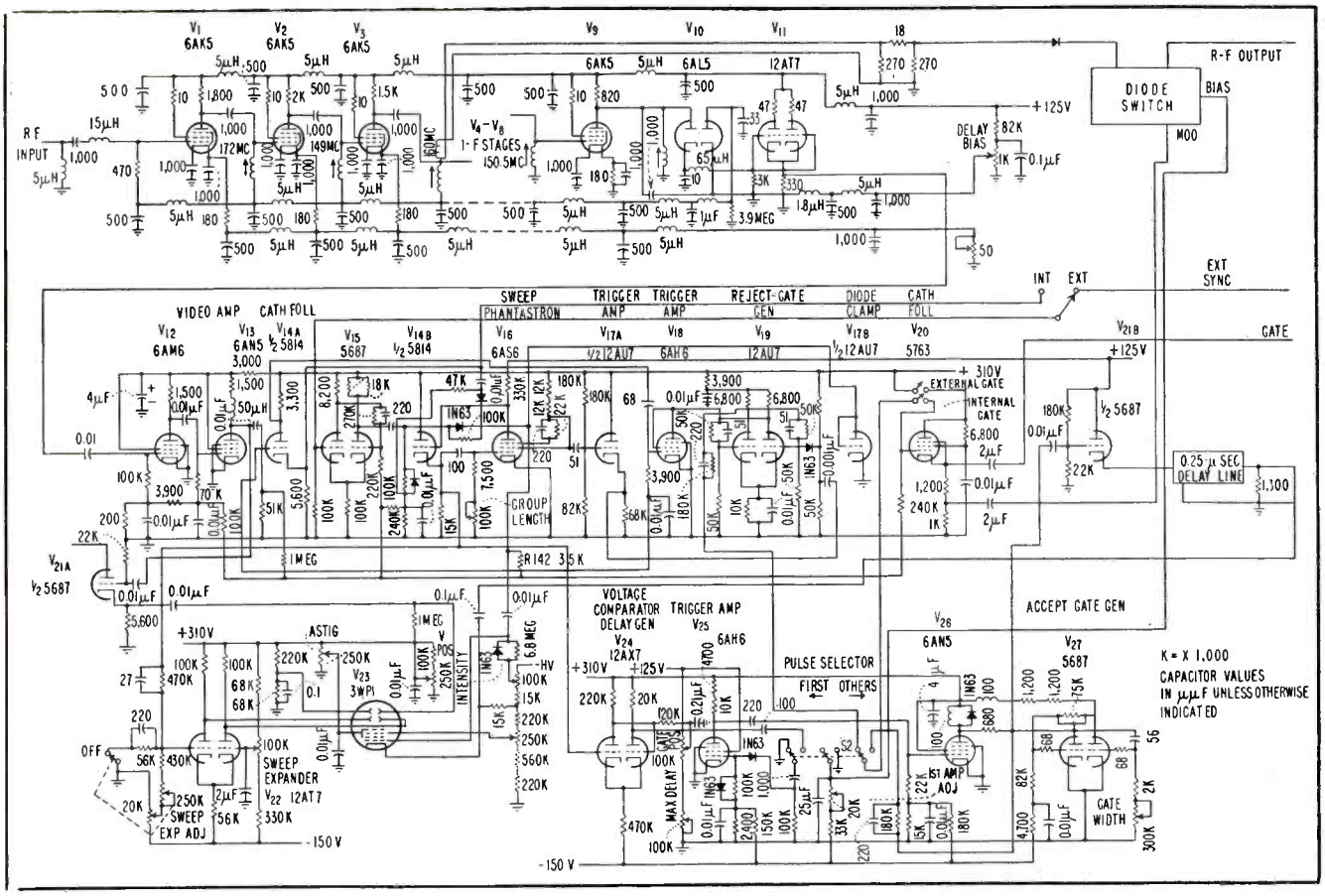

FIG. 4—Pulse selector circuit includes 3-in. cro to show pulse train with selected pulse intensified as aid in identification

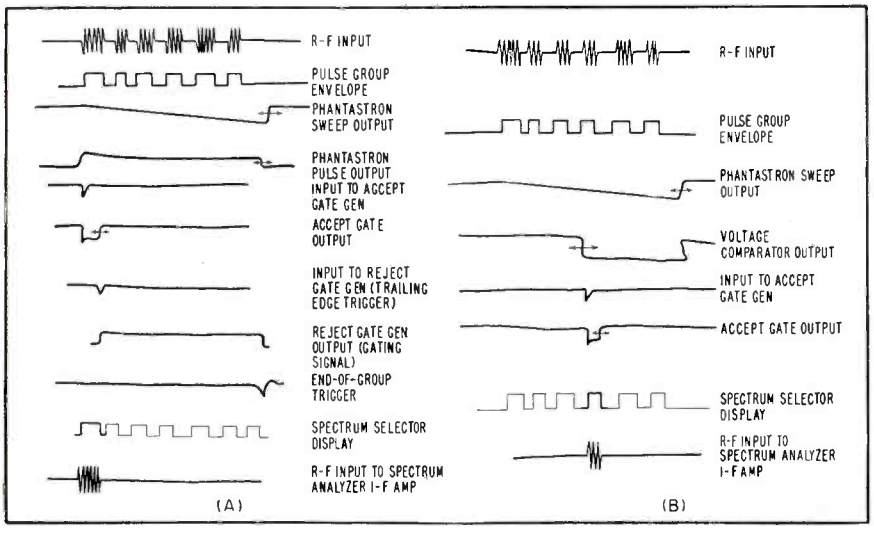

FIG. 5—Waveforms at various points in selector circuit for first pulse (A) and other pulse (B) setting of selector switch. In first pulse position, selector functions only to close gate at end of initial pulse

The gate, which occurs simultaneously with the sawtooth, is differentiated and amplified. The leading-edge trigger pulse is used, in FIRST-PULSE position, to trigger accept-gate generator V_{27}.

The width of the V_{27} output pulse is set by the GATE-WIDTH control. The lagging edge of the V_{27} pulse provides the trailing-edge trigger which flips reject-gate generator V_{19}.

The positive pulse output of V_{19} opens the crystal-diode switch. The lagging edge of the differentiated phantastron gate, end of a group trigger, is used to reset the reject-gate generator and return the crystal switch to its normally closed state. Thus the first pulse is passed while all other pulses are blocked.

Time Relationships

Figure 5A illustrates the time relationships between the r-f signal pulses, the sawtooth, the triggers, the spectrum selector display and the spectrum analyzer display for the FIRST-PULSE position.

In the OTHERS position the phantastron sweep output is fed to voltage comparator delay generator V_{24}, the ouput of which is a negative pulse. The position of the leading edge of this pulse is set by the gate positioning control. A negative pulse derived by differentiation from the leading edge of this pulse triggers the accept-gate generator. The negative output pulse of the accept-gate generator closes the normally open crystal-diode switch, permitting the signal to pass to the spectrum analyzer. The desired pulse is thus selected by the positioning control and the proper width set by the width control. Figure 5B illustrates the time relationships in the OTHERS position.

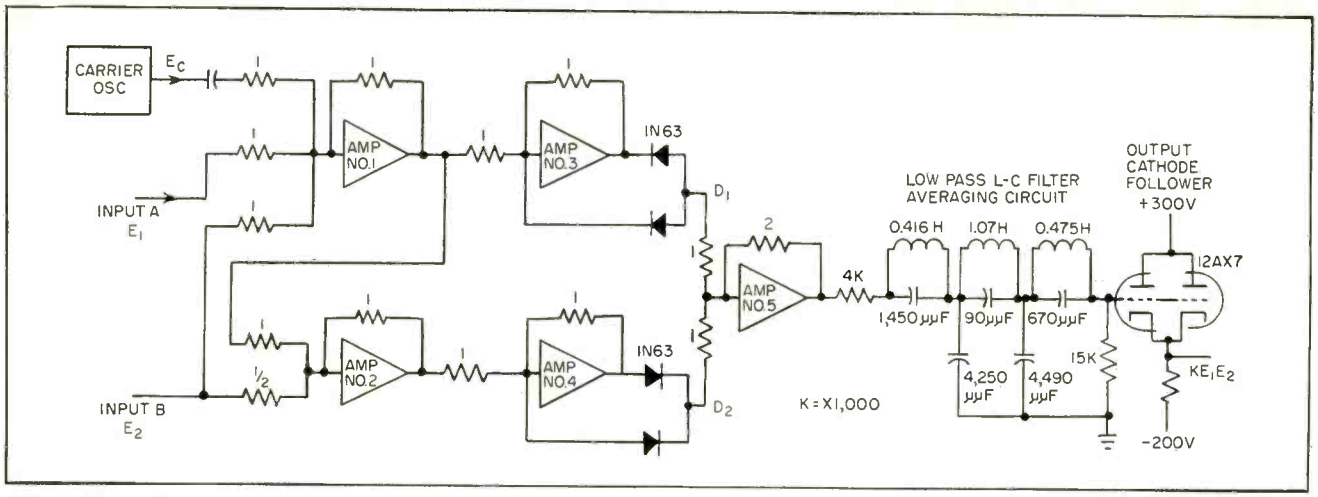

FIG. 1—Block diagram of triangular-wave function multiplier. Circuit provides an absolute accuracy of 0.7 percent from 56 mv to 20.6 v, with a usable range of 10 mv to 37 v. Stability is better than 0.08 percent full scale with a precision of approximately 0.1 percent full scale and frequency response between 0 and 1000 cps

TRIANGULAR-WAVE

By R. A. MEYERS and H. B. DAVIS

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David Taylor Model Basin
Carderock, Maryland

SUMMARY — Four-quadrant electronic multiplier for analog computers uses triangular-wave carrier-oscillator signal added to input voltages to achieve an absolute accuracy of 1 percent with a dynamic range of 500 to 1. Actual precision is better than 0.1 percent of full scale. Circuit is independent of tube characteristics and free of balancing adjustments

UNDER DEVELOPMENT for the U. S. Navy's Bureau of Ships, a new electronic multiplier aids in the solution of ship-design problems.

The chosen design has produced an instrument which is independent of tube characteristics, has an excellent dynamic range and is free of balancing adjustments.

Multiplier Development

Multiplier development is based on the difference in magnitudes method.[1] This method can be stated by

$$K\,E_1E_2 = \mathrm{Av}\,[(E_1 + E_2 + E_c) - (E_1 - E_2 + E_c)] \quad (1)$$

Equation 1 is valid if the assumptions are made that Av is the average value of the quantity included in the brackets, taken over one cycle of the carrier E_c, E_c is the carrier voltage whose waveform varies linearly with time, E_1 and E_2 are signal voltages which vary arbitrarily with time, E_o is the difference function and K is a constant of proportionality.

Further the peak value of the quantity $|E_1 + E_2|$ should never be greater than the peak value of $|E_c|$ or $|E_1 + E_2| \leqq |E_c|$, and the frequency of the carrier voltage E_c should always be at least ten times higher than the highest frequency component of E_1 or E_2.

Figure 1 explains the solution of Eq. 1. The operation is as follows: A carrier oscillator generating a triangular waveform provides the carrier voltage for the instrument. This carrier, E_c, is added to the two input functions E_1 and E_2 in operational amplifier No. 1. In amplifier No. 2, the output of amplifier No. 1 is added to the input function $2E_2$. To perform the subtractions of the absolute magnitudes, constant polarity signals with absolute magnitudes of $|E_1 + E_2 + E_c|$ and $|E_1 - E_2 + E_c|$ are needed. Mixing is done in two full-wave rectifiers D_1 and D_2. Amplifiers No. 3 and No. 4 are used to produce a push-pull signal to feed D_1 and D_2.

By making the output of rectifier D_1 negative and rectifier D_2 positive, the difference of the two absolute quantities is obtained directly by adding in amplifier No. 5. The output of amplifier No. 5

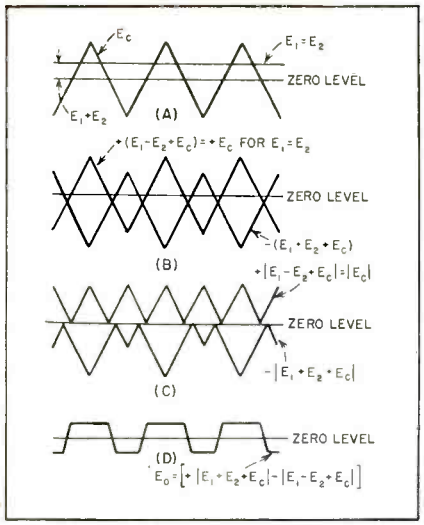
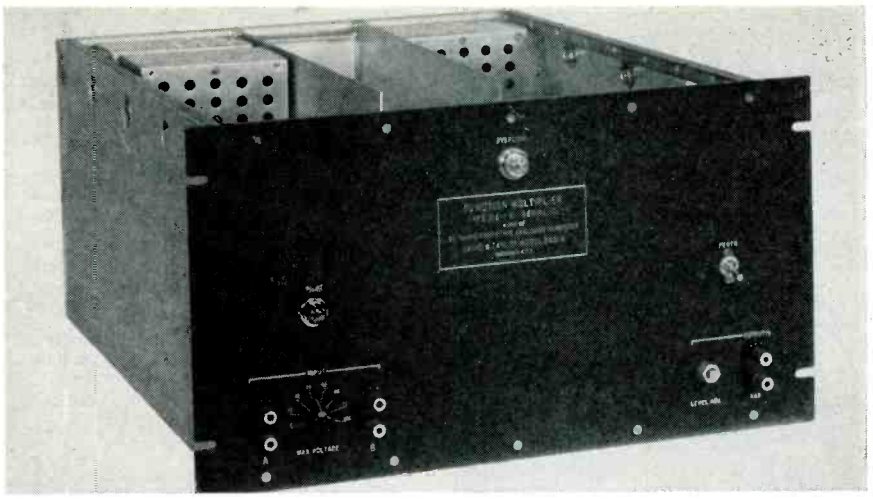


FIG. 2—Direct-current input and carrier waveform (A) are amplified and output (B) fed to rectifiers. Rectifier outputs (C) are amplified and filtered (D)



Function multiplier helps solve ship-design problems. Two analog input-voltages may vary arbitrarily with time and may contain components in the frequency range from 0 to 150 cps. The unit can detect products as low as 5 mv and has a drift of less than 10 mv over an 8-hour period after a half-hour warm up

Analog Multiplier

is averaged by a low-pass filter. This filter output is proportional to the desired product KE_1E_2.

Figure 2 shows the theoretical waveform appearing at different points in the multiplier for equal d-c voltage inputs.

Figure 3 shows the actual waveforms of the difference function E_o appearing at the output of amplifier No. 5.

Design Considerations

From Eq. 1, a method of accurately adding and subtracting the function E_1, E_2 and E_c must be devised.[2] Operational amplifiers such as are used in analog computers were chosen.

Only d-c operational amplifiers can be used to meet the zero frequency requirement of the multiplier. To minimize errors due to straight-line approximations, the fundamental carrier frequency should be at least 10 times the highest input frequency. Input functions having frequencies up to approximately 200 cps were anticipated. This input frequency brings the amplifier requirement to 2 kc, assuming a sine-wave carrier. However, the carrier must vary in a linear manner and the amplifier must pass the fundamental frequency plus higher harmonics if the carrier waveform is not to be distorted.

By using input and feedback resistors of 150,000 ohms for the amplifier, the frequency response remains reasonably flat to approximately 50 kc. The significant carrier-voltage harmonics must be held within this limit. Since the amount of output voltage from the multiplier depends directly on the amount of signal-amplitude swing of the amplifiers, it is desirable to make this swing as large as practical. A peak voltage swing of ± 80 v, without noticeable distortion, is sufficient for the amplifier. With the limitation in mind that $E_o \geqq |E_1+E_2|$, E_c was chosen to have a constant peak amplitude of ±40 v, leaving a maximum of ±40 v peak swing for the sum of E_1 and E_2. An input attenuator is provided to maintain the above conditions over the range from 0 to ± 200 v peak.

Direct-current drift is an additional problem encountered using d-c operational amplifiers. Since the multiplier must go to zero frequency, there will be no difference in an applied d-c input signal and a d-c drift. For this reason, chopper stabilization is used on operational amplifiers. A circuit diagram of the d-c amplifier is shown in Fig. 4.

Carrier Voltage

A triangular-waveform carrier is used in this multiplier largely because of amplifier bandwidth limitations and filter considerations.

A comparison of the Fourier analysis of the triangular waveform and the saw-tooth waveform shows that the triangular waveform contains no even harmonics and the amplitude of harmonics above the seventh is so small as to be negligible. The saw tooth contains both odd and even harmonics of relatively large amplitudes out to at least the tenth harmonic. Therefore, for a given amplifier bandwidth, a higher frequency carrier can be used.

A check of amplifier response for a triangular-waveform carrier showed that the highest frequency

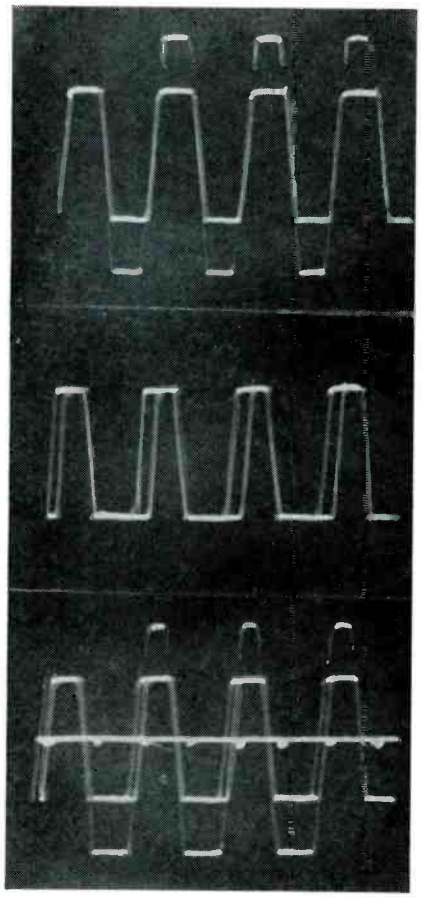


FIG. 3—Waveforms show effect of increasing E_2 with E_1 zero (top), holding E_2 constant and varying E_1 (center) and varying both inputs (bottom). Varying E_1 while holding E_2 constant changes symmetry but not amplitude. Varying both inputs changes both amplitude and symmetry

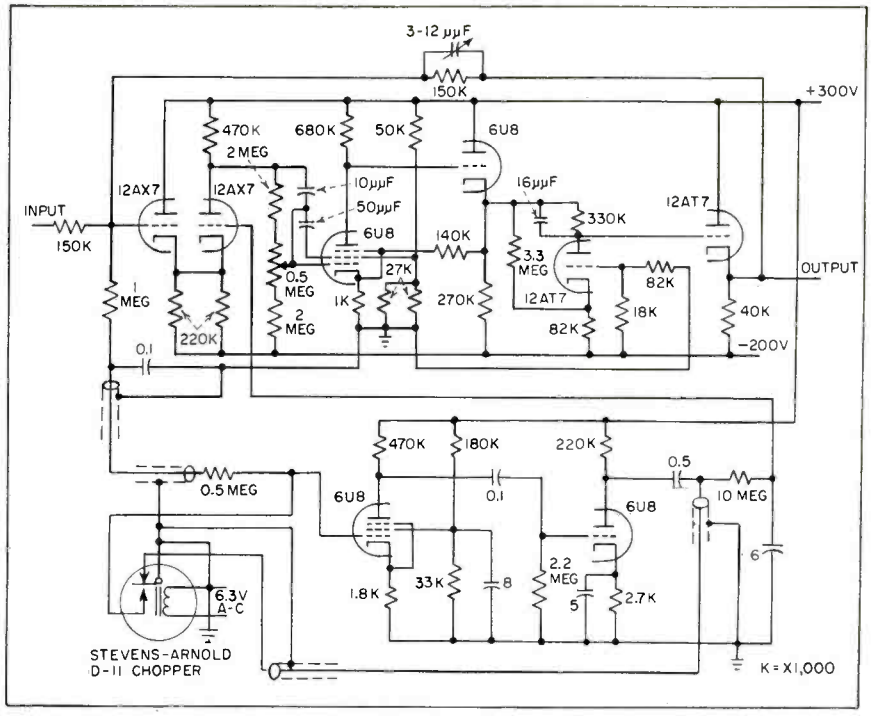


FIG. 4—Direct-current operational amplifier with chopper stabilization

that could be passed without distortion was approximately 6.3 kc, hence this frequency was used. Harmonics above the seventh do not appreciably affect the linearity of the triangular waveform. A circuit diagram of the carrier oscillator is shown in Fig. 5.

Following the combining of the signals in amplifiers No. 1 and No. 2, it is necessary to take the absolute magnitude of the signals. This is done by the full-wave rectifiers. The subtraction is accomplished in amplifier No. 5 by adding a positive signal from one rectifier to the negative signal from the other.

The output of amplifier No. 5 is a difference function E_o, which may bear little similarity to the output waveform obtained after averaging. Averaging is done in a conventional L-C filter circuit. By filtering out the sinusoidal waveforms contained in the periodic function, the voltage remaining is the desired average or d-c value of the input waveform.[4]

If a 150-cps signal is being ap-

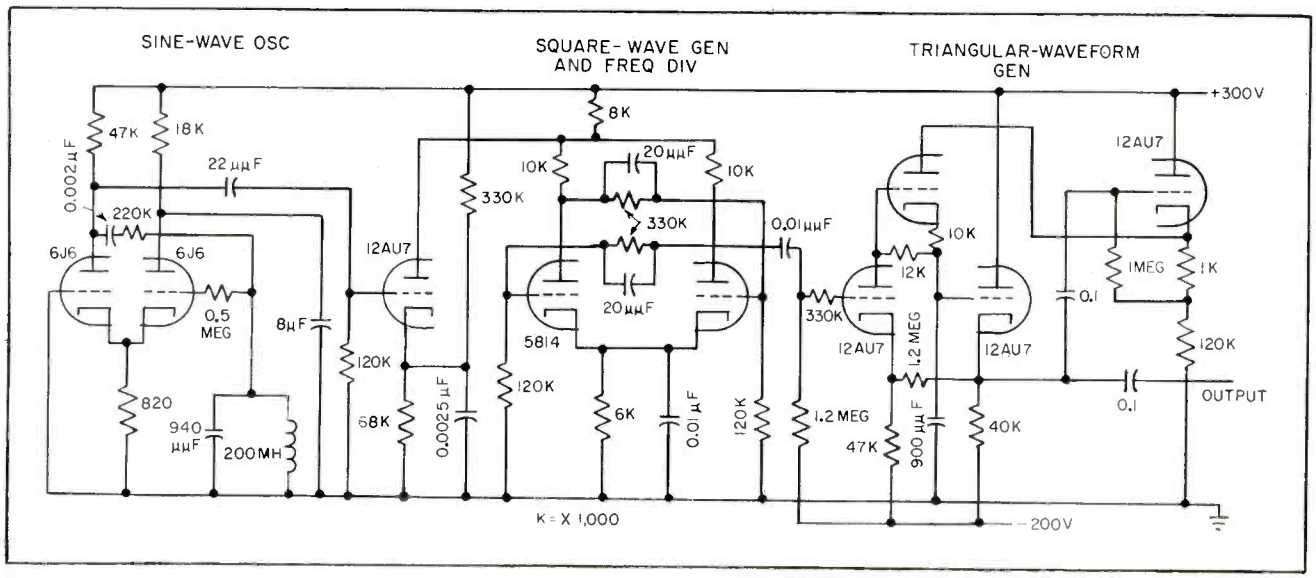


FIG. 5—Triangular-wave carrier-oscillator circuit

plied to each multiplier input and it is desired to pass the 300-cps output frequency with zero phase shift while completely suppressing the carrier, an attenuation of 50 db or more is required at the carrier frequency. To reach this attenuation it was necessary to accept a phase shift of 15 degrees at 300 cps.

Performance

Accuracy is usually specified as a percentage of full scale. Based on an output of 21 v, the error as a percentage of full scale is better than 0.1 percent. A more useful method of specifying the accuracy is in terms of the absolute magnitude of the error at the output. Absolute error is the percentage by which the indicated product varies from the correct product.

A test over the range of from 0.056 to 20.6 v peak gave an average error of 0.7 percent. Errors did not exceed 5 percent between the limits of 0.035 to 26 v peak output.

The precision or the accuracy to which results may be repeated is better than 0.1 percent of full scale. This percentage is nearly the accuracy to which the measuring instruments could be read or estimated and is not necessarily the precision of the multiplier alone.

The frequency response of the multiplier is flat to approximately 1,000 cps. However, the useful range is limited either by the permissible phase shift of the product, or by the allowable distortion as the signal frequency approaches the carrier frequency. Practically all of the phase shift is due to the filter.

Instrument drift is assumed to be due primarily to the output cathode follower. After approximately a 30-minute warmup, the drift about the zero point did not exceed 10 millivolts. A drift test of the instrument from a cold start is shown in Fig. 6A.

A check of the linearity was made on the 20-v input range. Linear curves were obtained keeping one input constant and varying the other input. The results, seen in Fig. 6B, show a variation of less than 0.5 percent.

The dynamic range is considered as the ratio of the output obtained with maximum input signal to the output obtained with no input signal. Since the output with maximum input is 37 v peak and the output with no input is 7 millivolts peak, the actual dynamic range is better than 5,000 to 1. The absolute error decreases as the dynamic range is decreased. For example, if it is desired to use the instrument over a dynamic range in which the absolute error is 0.7 percent or better, then the dynamic range should be 20.6/0.056 = 368 to 1.

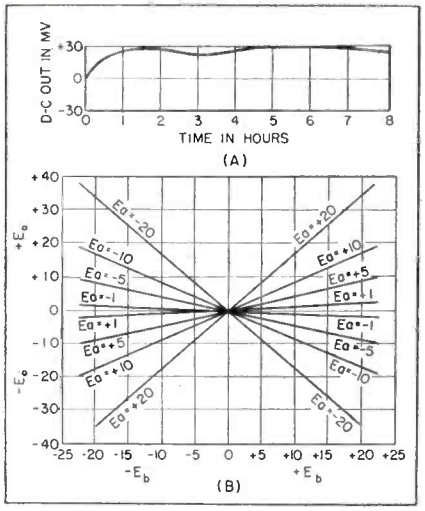


FIG. 6—Curves show results of drift test (A) and linearity test (B)

Results

Operation of the multiplier may be judged by the waveforms shown in Fig. 6. In these oscillograms the upper figure of each group shows the input waveform which is applied to each multiplier input, and the zero reference.

Figure 7 shows the 100-cps sine wave applied and the double frequency and d-c level shift produced by multiplying (top). Center and bottom are similar patterns produced by triangular and square-wave inputs, respectively.

It is expected that a larger dynamic range could be obtained with as good accuracy and precision by inserting two identical L-C filters as the load for the full-wave rectifiers. The advantages would be larger dynamic range, lower output impedance and elimination of the cathode-follower output. The disadvantages would be that the output amplifier would have to operate at a gain of 7 or more to attain the larger dynamic range and that two filters would be required instead of one.

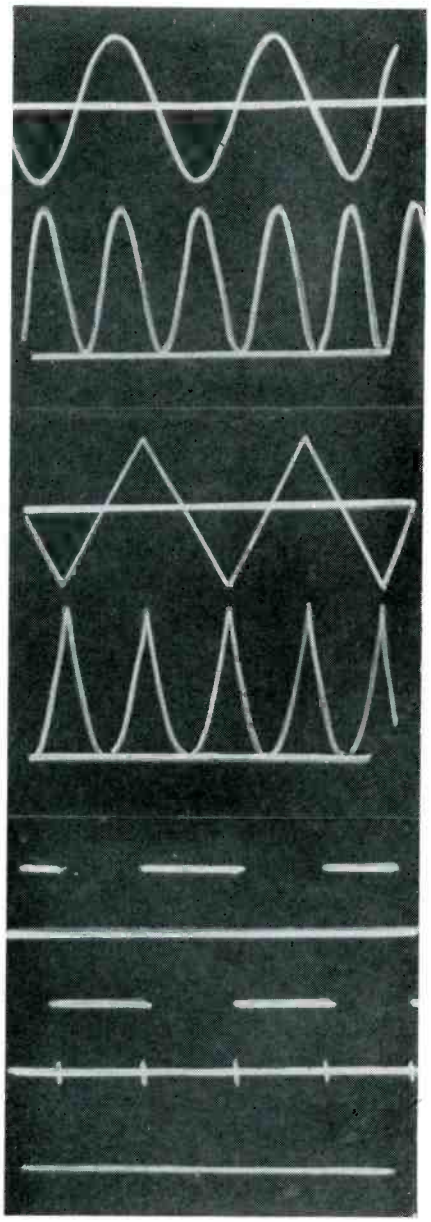


FIG. 7—Multiplier test patterns show 150-cps input with 300-cps output (top), 100-cps triangular-wave input with 200-cps parabolic wave output (center) and 8-cps square-wave input with d-c output (bottom). Horizontal lines are zero references

REFERENCES

(1) R. L. Mills, A New Electronic Multiplication Method Involving Only Simple Conventional Circuits, Magnolia Petroleum Co. Technical Report No. 680 (00)-4, Nov. 1953.

(2) J. R. Ragazzini et al, Analysis of Problems in Dynamics by use of Electronic Circuits, *Proc. IRE*, May 1947.

(3) H. B. Davis, A Stable D-C Operational Amplifier, David Taylor Model Basin Report 898, May 1954.

(4) W. J. Cunningham, Performance Curves for M-Derived Filters, Cruft Laboratory, Harvard University, Cambridge, Mass., Sept. 1944.

Design Of Triple-Tuned Circuits

SUMMARY —— Procedure and curves based on normalized low-pass filter enable the design of triple-tuned circuits having a maximally flat response and taking parasitic dissipation into account. Typical circuits and examples are given for interstage and band-pass filters

By PHILIP R. GEFFE

Director, Research and Development
Hycor Division of International Resistance Co.
Sylmar, California

CONVENTIONAL DESIGN procedures for interstage triple-tuned circuits have the disadvantages that formulas taking parasitic dissipation into account are not generally available and that conventional designs work between equal terminations. The latter causes a 6-db loss in voltage gain, in addition to the insertion loss of the filter.

Low-Pass Prototype

The chart in Fig. 1 gives the element values of a low-pass filter normalized for a one-ohm source, open-circuit load and cutoff at one radian a second.

To design a low-pass filter to work from a source of R ohms and cutoff at f_c only impedance and frequency scaling to the normalized filter need be applied, using the following equations:

$$L' = RL/2\pi f_c \quad (1)$$
$$C_1' = C_1/2\pi f_c R \quad (2)$$
$$C_2' = C_2/2\pi f_c R \quad (3)$$

The result will be a low-pass filter having the flat-loss given in the chart and attenuation varying with frequency as follows:

(Continued on page 188)

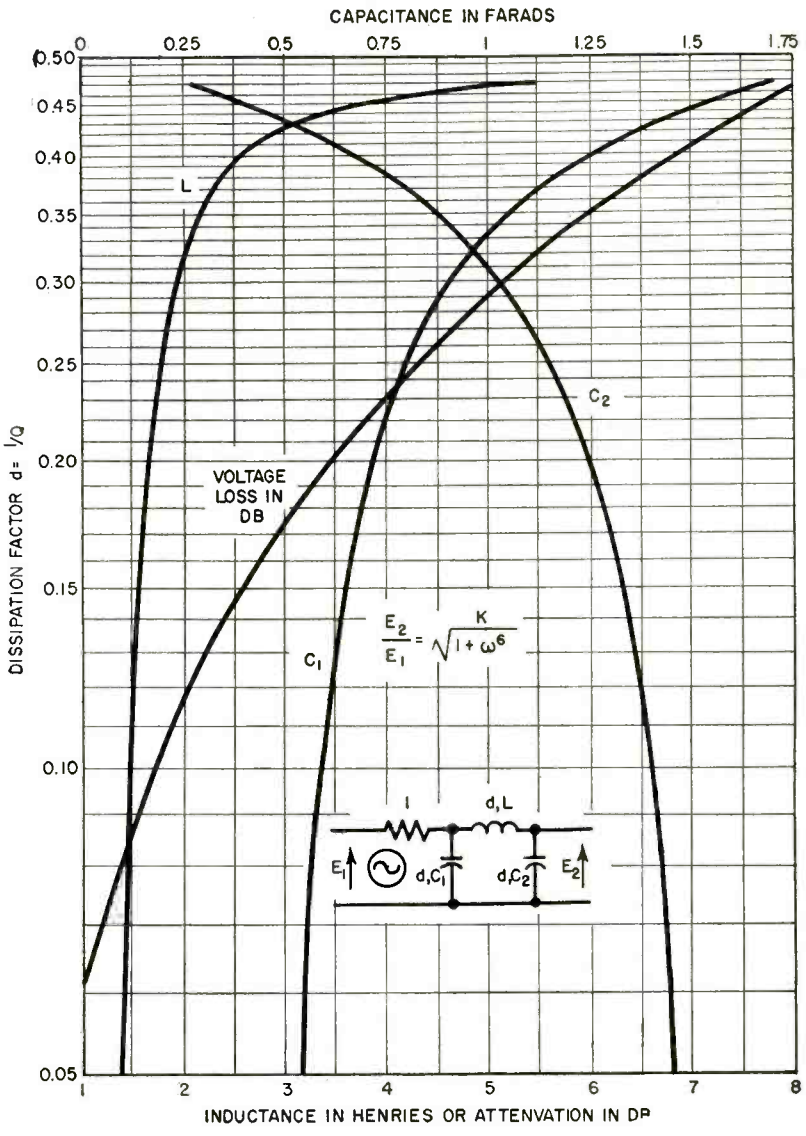


FIG. 1—Curves give normalized values of L, C and d used in design procedure

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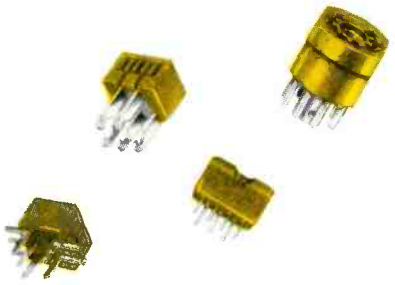

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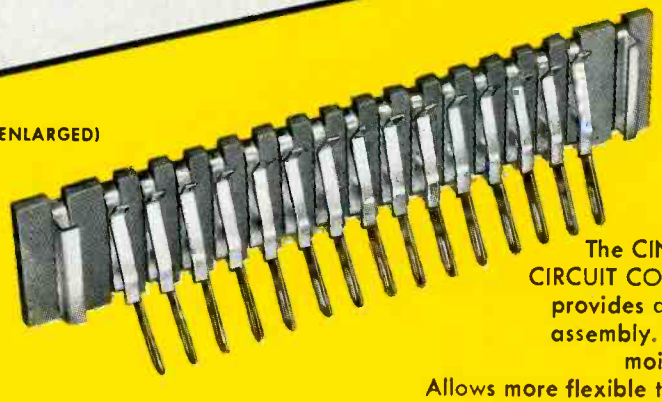

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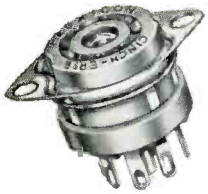

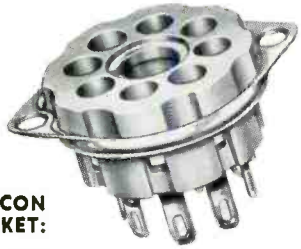

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Design of Triple-Tuned Circuits

(Continued from page 186)

$$A = \sqrt{1 + (f/f_c)^6} \quad (4)$$

for any frequency f.

Where $d < 0.05$ the following approximate formulas give good accuracy

$$C_1 = \frac{1}{2 - 3d}, \quad L = \frac{4 - 12d}{3 - 12d} \quad (5)$$

$$C_2 = \frac{3 - 12d}{2 - 7d} \text{ and Loss} = 20 \log_{10} (2d^2 - 2d + 1) \text{ in db}$$

By setting $d = 0$ in Eq. 5 the correct values for lossless inductors and capacitors are obtained, hence

$$C_1 = 1/2,\ L = 4/3,\ C_2 = 3/2 \text{ and Loss} = 0 \text{ db} \quad (6)$$

To choose the value of d a relationship between the band-pass filter and its low-pass prototype, must be used, thus $d = f_0/Q_{BP}\ (f_2 - f_1)$ (7) where Q_{BP} is the Q that is used in each branch of the band-pass filter, f_2 and f_1 are the cutoff frequencies of the band-pass filter and $f_0 = \sqrt{f_2 f_1}$. The value of d obtained from Eq. 7 is used to obtain element values and flat-loss from the chart. This value of flat loss will apply both to the band-pass filter and to its low-pass prototype.

Low-Pass to Band-Pass

To transform from a low-pass to a band-pass filter, scale the normalized low-pass filter to an impedance level of R ohms and cutoff f_c. The cutoff frequency is equal to the bandwidth, $f_2 - f_1$, of the desired band-pass filter.

Next, tune all three branches of the filter to f_0 by inserting a capacitor in series with L' and inductors in parallel with C'_1 and C'_2, as shown in Fig. 2. Thus L' and C' resonate at f_0 as do L'_1, C'_1 and L'_2, C'_2.

Performance

If the flat-loss is ignored the relative attenuation is

$$A = \sqrt{1 + y^6}, \text{ where} \quad (8)$$

$$y = b(f/f_0 - f_0/f),\ b = f_0/f_2 - f_1 \quad (9)$$

For calculating the attenuation at frequencies remote from the pass-band the following approximation may be used

$$A \cong y^3 \text{ or } 20\log_{10} A \cong 60\log_{10} y \text{ in db} \quad (10)$$

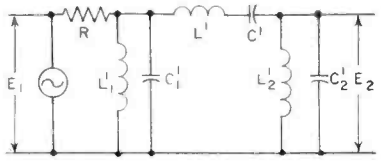

FIG. 2—Transformed band-pass filter

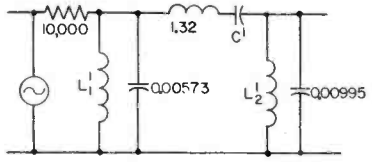

FIG. 3—Scaled band-pass filter designed from chart

Tolerances of from 1 percent to 5 percent on element values and 15 percent on Q will usually give satisfactory results provided that each branch of the filter is adjusted to resonate accurately at f_0.

Examples

As an example, design an interstage filter to work from a 10,000-ohm plate resistance, having 3 db points at 9 and 11 kc, coil Q of 25 and giving 50 db attenuation at 20 kc.

Here $f_0 = \sqrt{f_1 f_2} = \sqrt{99} = 9.95$ kc, $b = 5$, at $f = 20$ kc, $y = 7.56$ hence $20 \log_{10} A = 60 \log_{10} 7.56 = 52.7$ db.

Evidently one triple-tuned circuit will have sufficient attenuation. From Eq 7, $d = 0.20$. Entering the chart at $d = 0.20$ obtain $C_1 = 0.720$, $L = 1.66$, $C_2 = 1.25$, Loss = 3.5 db.

Scaling the normalized prototype to 10,000-ohm impedance level, and cutoff at 2 kc, obtain $C'_1 = 0.00573\ \mu F$, $C'_2 = 0.00995\ \mu F$ and $L' = 1.32H$. So the band-pass filter will have the configuration shown in Fig. 3.

Choosing C' to resonate with $1.32H$ at 9.95 kc gives $C' = 194\ \mu\mu F$. Similarly, $L'_1 = 44.6$ MH, $L'_2 = 25.7$ MH. Since the series coil is large enough to cause difficulty with its self resonant frequency, tap L'_1 and L'_2 at 10 per cent of their inductance. This will reduce the impedance level of the series arm by a factor of 10 to give the final design shown in Fig. 4.

As another example, a 200-cps signal varies by ± 5 per cent, and it is desired to measure the second harmonic present while attenuating the fundamental and a large third harmonic by 80 db. Design a filter which will work from a 20,000-ohm source. Inductor Q's of 16.6 are available.

If cutoff frequencies of 370 cps and 430 cps are chosen, then $f_0 = 399$ cps and $f_2 - f_1 = 60$ cps. Then $b = 6.65$. To check the attenuation in the pass-band, write $y = 0.682$ at $f = 420$ which is the maximum signal frequency and $A = 20 \log_{10} \sqrt{1 + (0.682)^6} = 0.426$ db.

At 600 cps, the third harmonic, $y = 5.58$, $A = 60 \log_{10} 5.58 = 44.8$ db.

From these calculations it is apparent that two triple-tuned circuits will be needed, and the pass-band variation is 0.85 db.

From Eq. 7, $d = 0.4$ which gives $C_1 = 1.25$, $C_2 = 0.68$, L = 2.57 and loss = 6.8 db.

Raising this filter to a 20,000-ohm impedance level and a 60 cps cutoff gives $C'_1 = 0.166\ \mu F$, $L' = 136.3\ H$ and $C'_2 = 0.0902\ \mu F$.

Finding values to resonate with C'_1, L', C'_2 at 399 cps gives $L'_1 = 0.958\ H$, $C' = 0.00117\ \mu F$ and $L'_2 = 1.76\ H$ and the configuration shown in Fig. 5.

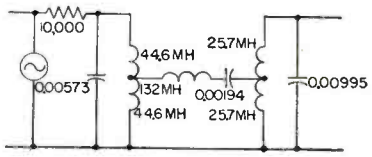

FIG. 4—Final interstage filter design derived from circuit of Fig. 3.

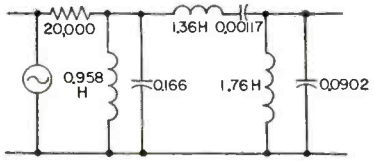

FIG. 5—Final band-pass filter configuration for second harmonic of 200-cps

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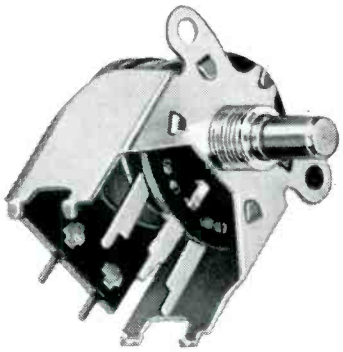

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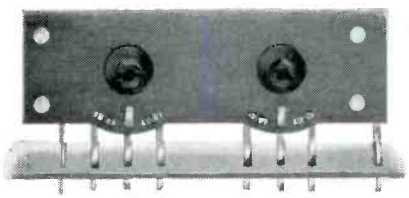

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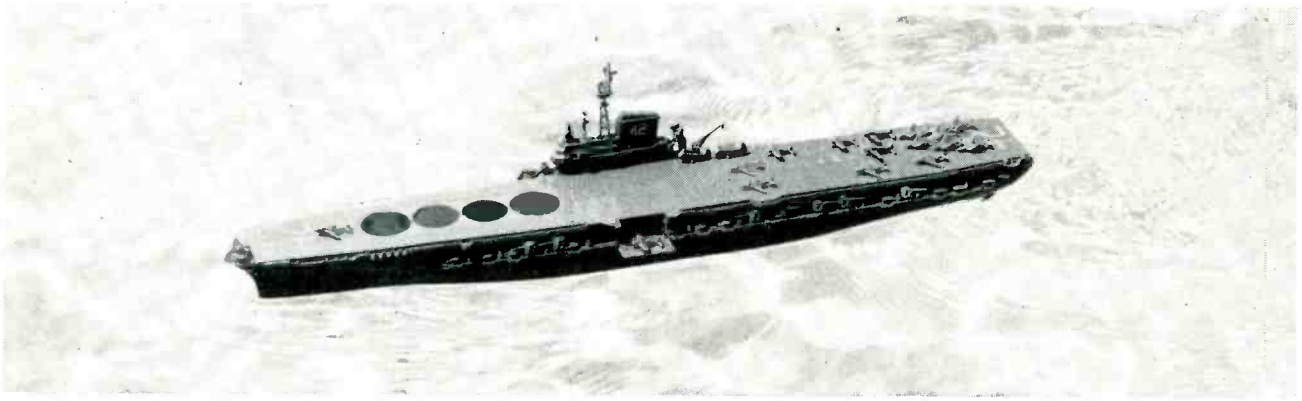
Electrons At Work

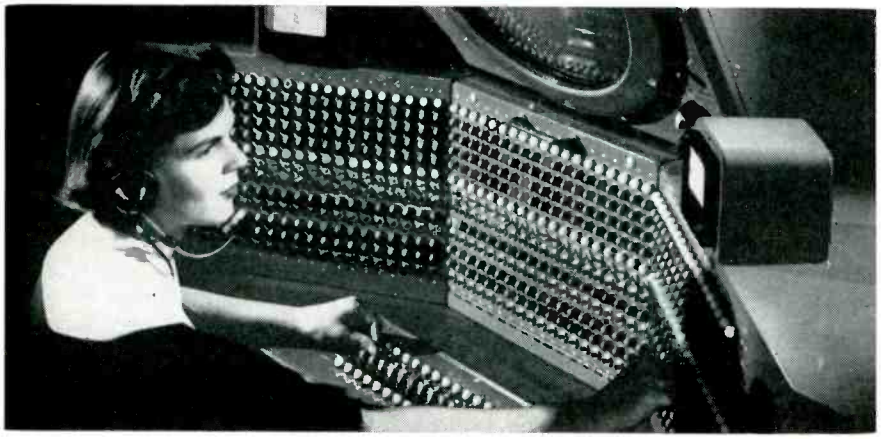
Edited by ALEXANDER A. McKENZIE

Forecast Of Propulsion By Solar Power



Model aircraft carrier powered by four silicon cells shown on deck moves through water when sun shines. According to Hoffman Electronics Corp. engineers, the sun delivers a kilowatt of power on every square yard of the earth's surface at full sunlight

Air Traffic Control System Speeds Landings



Volscan monitor console built by Crosley for the Air Force can handle as many as 120 landings an hour. The system comprises radar and computers. When an aircraft 40 to 60 miles away is picked up by the operator on the radar screen, its location is spotted with a light gun. The computers in which solutions to approach problems are stored assign a cube in space to the arriving aircraft. Heading, altitude and air speed are transmitted by radio to the pilot who brings his craft, by a unique path, to an entry gate at 1,000 feet and two miles from touchdown. Either GCA or ILS takes over for final leg of the approach

Meltback Process Increases Transistor Range

A METHOD of controlling the distribution of impurities in grown-junction transistors, called the "meltback" process, is described by Robert N. Hall of the GE Research Laboratory. The technique will make it easier to manufacture transistors with useful power gains at high frequencies.

P-layers as thin as 0.2 or 0.3 mil have been produced, using the meltback technique. This is now being done reproducibly.

Several years ago, the "rate-growing" system for producing transistor crystals was developed. This process takes its name from the fact that the solid crystal is drawn out of a pool of molten semiconductor at varying rates. In the pool are dissolved such "impurities" as antimony and gallium. When the crystal grows quickly, one type of impurity predominates in the layer then being formed. When the crystal grows slowly, the dominant impurity is of the other type. The crystal ingot formed in this way is thus made of a succession of layers, distinguished from one another by the predominant type of impurity. After the ingot has cooled it can be sliced into thousands of pellets, each with three layers, n-p-n.

The meltback method takes this process one step further. After a crystal of germanium or silicon has been grown (in this case at a steady

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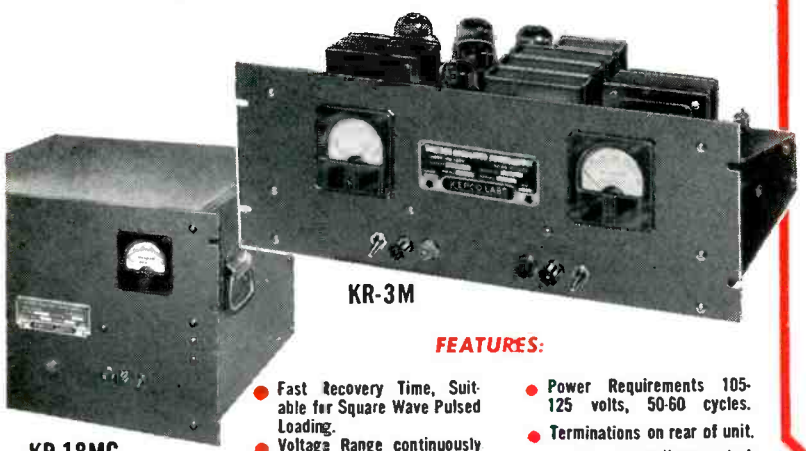

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KR17	100-200	has two	19"	12¼"	17"	$625
KR18	195-325	15 Amp.	19"	12¼"	17"	$695
KR19	295-450	outputs	19"	12¼"	17"	$695

600 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount W	H	D	Price
KR 8	0-150	Each supply	19"	10½"	13"	$330
KR 5	100-200	has two	19"	10½"	13"	$240
KR 6	195-325	10 Amp.	19"	10½"	13"	$240
KR 7	295-450	outputs	19"	10½"	13"	$250

300 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount W	H	D	Price
KR 12	0-150	Each supply	19"	7"	11"	$270
KR 3	100-200	has two	19"	7"	11"	$180
KR 4	195-325	5 Amp.	19"	7"	11"	$180
KR 10	295-450	outputs	19"	7"	11"	$190

125 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount W	H	D	Price
KR 11	0-150	Each supply	19"	7"	11"	$180
KR 1	100-200	has one	19"	7"	7½"	$ 90
KR 2	195-325	3 Amp.	19"	7"	7½"	$ 90
KR 9	295-450	output	19"	7"	7½"	$ 97

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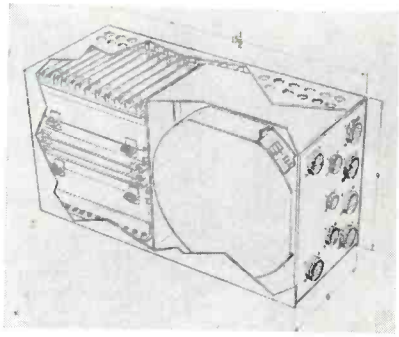
The Front Cover

SHOWN on the front cover are the capsule standard cockpit unit and details of the new type of instrumentation that will be used in it.

Among the hazards from which a modern pilot must be protected are solar radiation and its effects on structures and materials, instrumentation and vehicle temperature. There are also cosmic radiation, winds and turbulence, meteoroids and the chemistry of composition, dissociation and ionization that effect the pilot and his immediate environment.

A central digital computer shown here will handle the computation and control functions of aircraft. The so-called flat television tube, although transparent, will handle information display.



Computer for T2V capsule cockpit with magnetic drum at right

Douglas Aircraft is Navy's BuAer prime contractor. Litton Industries is building the 18-pound computer. In an emergency, the standard cockpit, complete with instruments will be ejected from its aircraft.

rate), long thin slivers, like wires, are cut from it. The tip of each of these wires is then melted and refrozen, forming alternating layers, as described above. A pellet is then cut from the end, and the process is repeated.

Since the area of the wire tip that is melting and freezing is so much smaller than the corresponding cross-sectional area of the parent crystal, the cooling process takes place not in 20 minutes but in less than a second. In this short time the number of impurity atoms migrating from their proper layers into adjoining ones is reduced to about 1/30th the former figure. The entire cycle of melting, cooling, and removal of the finished pellet takes less than a minute.

One characteristic of the new process is that the concentration of impurities in the crystal's emitter region is much richer than that found in the remainder of the transistor. This is due to the fact that the emitter region does not pass through the final melting-freezing cycle, but is merely separated from the rest of the crystal "wire". The *n*-type emitter layer consequently possesses the concentration of impurities that is to be found in the wire as a whole.

The concentration of impurities in the wire itself is much higher than in the layers which have melted and frozen, because during the recrystallizing process these layers have drawn from the melt only a small percentage of the available impurities.

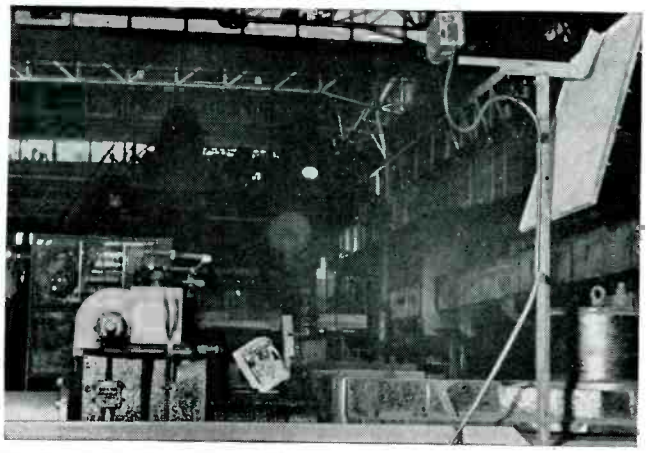
For example, a germanium crystal, growing at a moderate rate, will pick up 1/10th of the concentration of gallium in the melt but only 1/300th of the amount of antimony. Consequently 10 units of gallium and 300 units of antimony must be present in the wire in order to cause one unit of each of these impurities to appear in the final pellet.

As a result of this high concentration in the original wire, the emitter region of a meltback transistor will contain 290 units of excess donor impurities, compared with approximately one unit for the corresponding region of a rate-grown transistor.

Performance can best be described in terms of power gain and the upper frequency at which the transistor will oscillate. Germanium meltback triodes have been produced with power gains of as high as 25 decibels at a frequency of five megacycles per second. Some

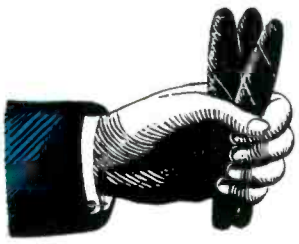
Mill Operates After Breakdown Using TV Eye

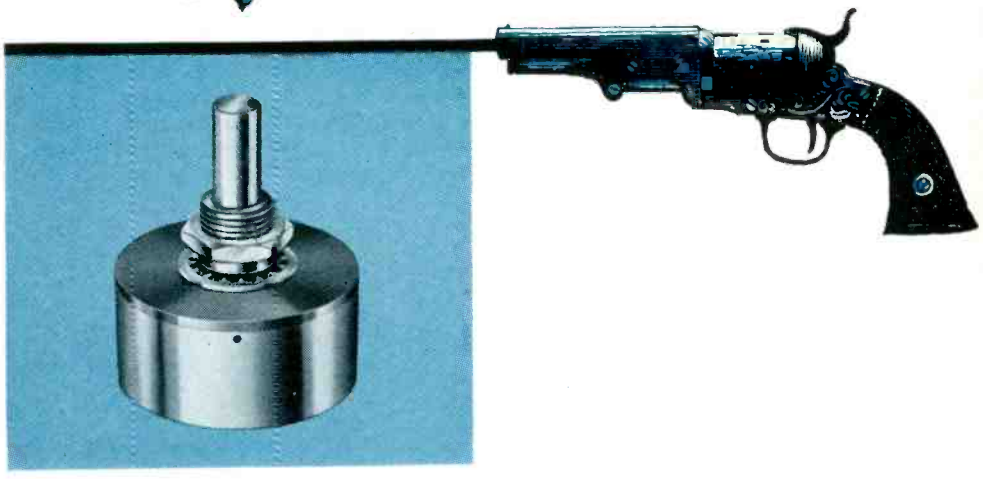
Operator at controls of slab rolling mill watches position of the ingot shown on the screen of tv monitor (left center) as seen by camera (upper right). Equipment on order from Marconi by Abbey



Works of The Steel Co. of Wales was rushed into operation after failure of slab manipulator necessitated use of a crane at the far side of damaged turnover mechanism, out of view of operator

Another product surprise from Helipot!





Fanfare & Cigars

Tooting a symbolic clarion and passing out imaginary cigars, Helipot introduces one of its new-born offspring . . . the series 5300 precision potentiometer.

A single-turn unit, it's 1-1/4 inches in diameter . . . designed for bushing mounting. With its innards comfortably ensconced in an accurately drawn one-piece aluminum cup, the 5300 gives you ruggedness, compactness and long life. We proud papas direct your attention to such salient features as the range of total resistance . . . from 25 to 49,000 ohms . . . linearity as close as ±0.25% . . . and considerable improvement in torque, noise and mechanical runout.

For vital statistics on this prodigy of a progeny, write for data file 801.

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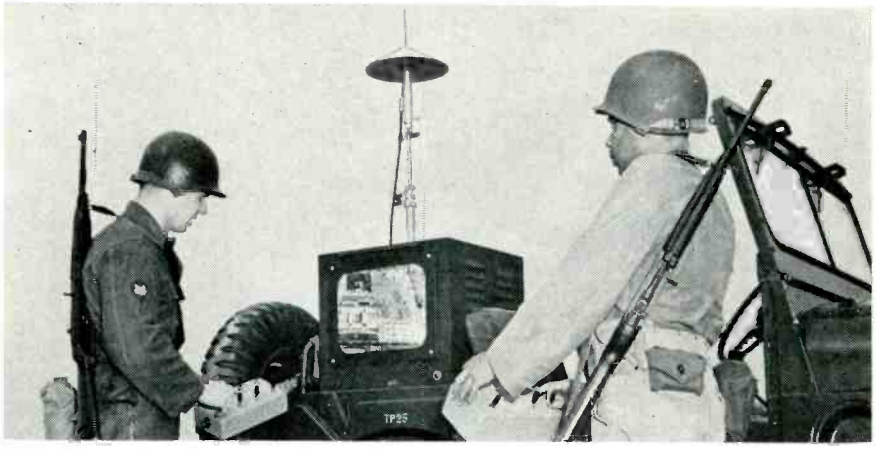
of these triodes have reached oscillation limits of 100 mc, and limits of 50 mc are common. Tetrodes have oscillated at frequencies as high as 200 mc.

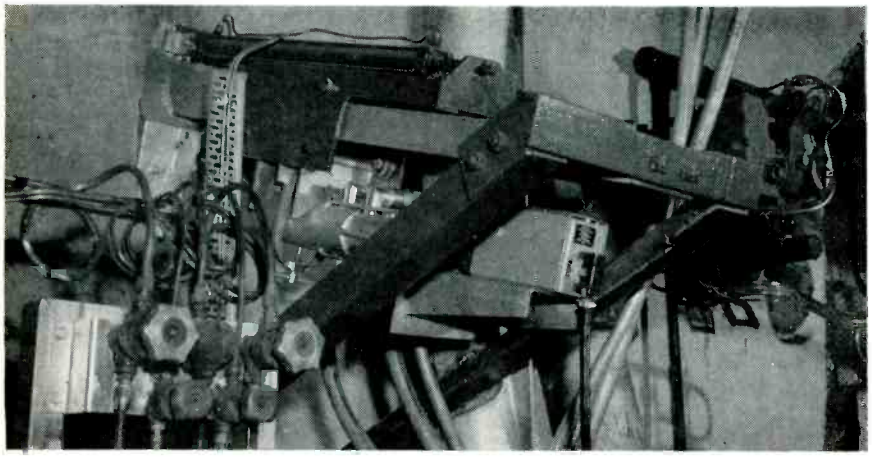
The same qualities that make meltback transistors operate well at high frequencies—thin base regions and large impurity gradients at the emitter junction—also cause them to exhibit good low-frequency characteristics. Grounded-emitter current gains of several hundred are typical with values in the thousands being common. Furthermore, this gain remains high, up to collector currents of a hundred milliamperes, many times higher than with those produced by earlier methods.

Drone Television Reconnaissance



Television pickup from an experimental aerial drone system makes it possible to send back views of sites 40 miles distant. Developed at Signal Corps Engineering Labs, Fort Monmouth, N. J., the 135-pound tv station is carried in a converted L-17 aircraft. Separate electronic equipment is required to control flight from the ground as shown above

Periscopic Television In A Furnace



In modern boiler furnaces, it is essential that jet-injected pulverized fuel remain ignited at all burners lest a serious explosion result. A new periscopic television unit developed by Babcock and Wilcox, Ltd. and manufactured by Marconi enables all burners to be observed on one television screen. The periscope, containing lenses and prisms, is water-cooled. An air blast keeps fly ash from settling on the lens windows. The unit is retracted during normal operation at which time photoelectric monitoring is employed

Compensating Voltage Dividers for Frequency

By Lyman W. Orr

Electronic Defense Group
University of Michigan
Ann Arbor, Michigan

Certain difficulties in constructing frequency-compensated voltage dividers arise often enough to deserve comment. Attention will be confined here to the deleterious effect of stray capacitance C_{s1} from the input resistor R_1 in Fig. 1 to the grounded shield. This difficulty is prominent in high-voltage dividers where the physical dimensions of R_1 are necessarily large. A method of compensation is shown in Fig. 2.

An example is a 200-to-1 divider for 50-kv input having $R_1 = 200$ megohms and C_1 4 $\mu\mu$f.

Resistor R_1 is a cylindrical type $\frac{1}{2}$ inch in diameter and 4 inches long. When centrally located inside a metal enclosure $3\frac{1}{2} \times 6 \times 8$ in., the stray capacitance from R_1 to the case, though only a few $\mu\mu$f, is large enough to cause serious difficulty.

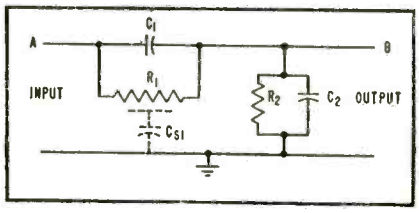


FIG. 1—Voltage divider uncompensated for stray capacitance

In the absence of such strays, a simple adjustment of C_2 making $R_2 C_2 = R_1 C_1$ is sufficient to produce a flat frequency response. In this case the step function response is similar to Fig. 3A.

Althouh a low stray capacitance is desirable between node A and ground, its presence does not produce an undesired effect on the response of the divider itself. The presence of a stray capacitance between node B and ground is of no consequence because it is in shunt with C_2 and can be compensated by appropriately adjusting the latter.

When the distributed stray capacitance C_{s1} is present it is impossible to produce a flat frequency

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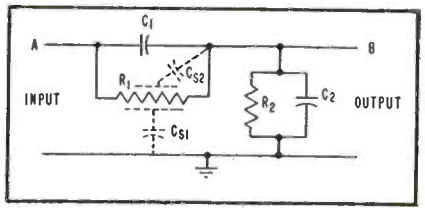


FIG. 2—Voltage divider compensated for stray capacitance with metal plate

response by adjusting C_2. Here the step-function response, when $R_2 C_2 = R_1 C_1$, is similar to Fig. 3C. This compromise gives equal sinusoidal response at very high and very low frequencies with a dip at some intermediate frequency.

To compensate for this, it is possible to design a structure that gives a distributed capacitance C_{s2} between R_1 and node B of the divider as indicated in Fig. 2. The added structure may consist of a small metal plate or open wire mesh placed near R_1 and connected to B. Its correct placement can best be found by adjustments and examination of the step-function response as illustrated in Fig. 3. In taking these oscillograms the square-wave generator was set at 120 cps for the entire series of tests.

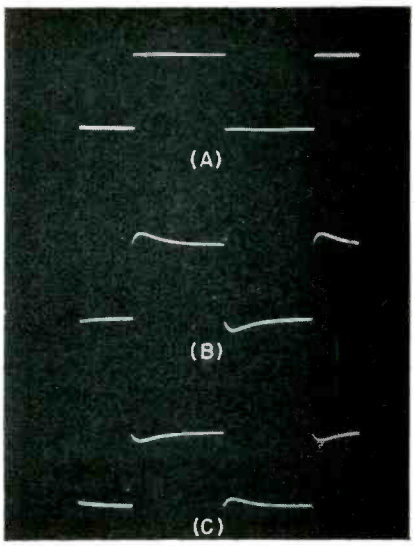
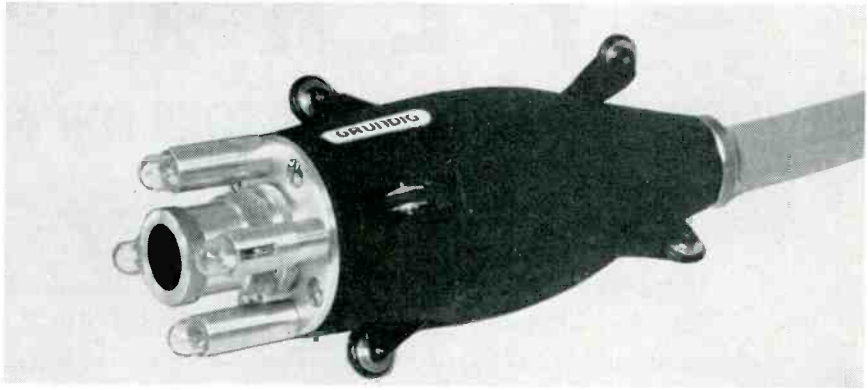


FIG. 3—Step function response with correct adjustment (A) strays overcompensated (B) and strays uncompensated (C)

Tiny TV Checks Boiler Tubes



Called the smallest tv camera in the world, the device shown has rollers to ease its passage through boiler tubes and four lamps to supply illumination for inspection. It is made by Grundig of Germany

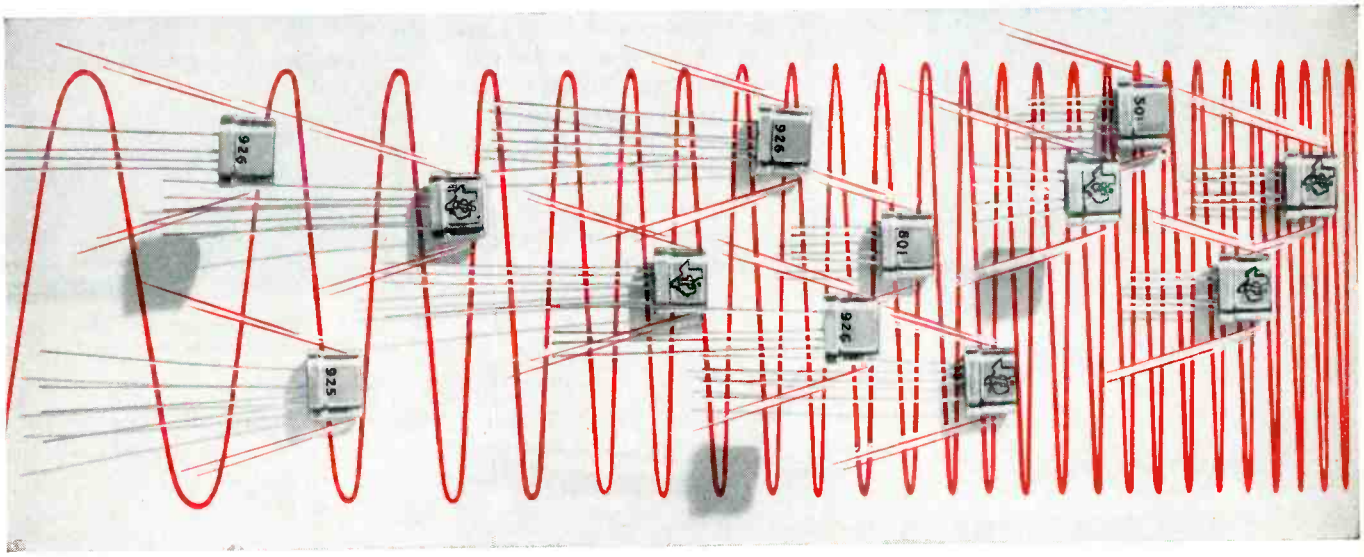
Manganese-Bismuth Magnets in Production

LATEST ACCOMPLISHMENT in the long line of research leading to more effective use of magnetic alloys is the purification and combining of manganese and bismuth by Westinghouse engineers for Air Research and Development Command (ELECTRONICS, p 7, July 1956).

The special characteristics of the alloy—which was named Bismanol by U. S. Naval Ordnance Laboratories—have been previously described (ELECTRONICS, p 198, June 1953).

According to Clarence Zener, Westinghouse has developed a method of grinding together man-

VHF transistors NOW!



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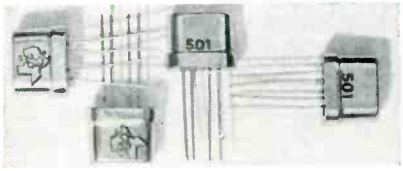

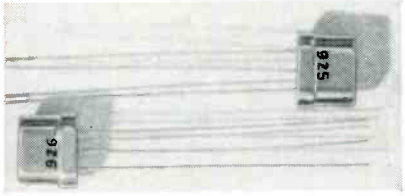

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ganese and bismuth under an inert atmosphere of helium gas. If the mixture were exposed to oxygen in the air it would burst into flame spontaneously.

The mixture is sealed in a glass vessel under low-pressure helium. The manganese and bismuth are caused to unite chemically at about 520 F. The resulting product is reground to a fine powder and the particles are imbedded in a plastic matrix, oriented in a powerful magnetic field and molded to the desired shape.

Weighing manganese-bismuth compound in gas chamber to prevent ignition

▶ **Easier Working**—Besides being at least ten times less likely to suffer demagnetization than most commercial magnets, the fact that individual grains of powder are insulated from each other makes the finished magnet nonconducting, as contrasted with conventional types.

Whereas most magnets must be machined to shape, the new forms can easily be drilled, tapped or cut, the ease depending upon the plastic binder used.

Because bismuth is in short supply, the cost and volume of the new material will cause no competitive threat to existing commercial magnets. Its use will probably be in research or military applications.

Transformerless Line Output Preamplifier

By RUFUS P. TURNER
Consulting Engineer
Los Angeles, Calif.

DEVELOPMENT of a miniature, transistorized preamplifier having an input impedance higher than 100,000 ohms, output impedance in the order of 500 ohms, good frequency response, fair voltage and power gains and low d-c drain, but using no transformers whatever, has recently been completed.

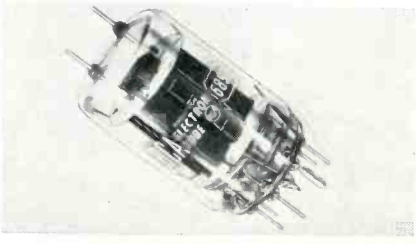
The common-emitter circuit is customarily used in transistor-type preamplifiers because this arrangement provides good gain at low battery drain. The common-emitter circuit suffers, however, from an inconveniently low input impedance (1,000 ohms or less) and also from an output impedance (20,000 ohms or higher) which often is too high for some applications. Unless input and output transformers are permissible, this circuit therefore cannot be substituted readily for its vacuum-tube counterpart.

A suitable R-C amplifier circuit was obtained by cascading three transistors, as shown in Fig. 1. The input transistor, Q_1, is connected as a common-collector to provide high input impedance. This stage has slightly less than unity voltage gain but does provide power gain in the order of 12 db.

The second transistor, Q_2, is operated as a common-emitter and supplies reasonable voltage and power gain in spite of the mismatch at its input. The output transistor Q_3, like the input stage, is connected as a common-collector.

The common-collector circuit is similar to the vacuum-tube cathode

Mobile Amplifier



A new twin-beam power tube, registered as 6524, has been designed for use in the region of 100 to 470 mc. According to RCA, it can be used in intermittent service as a push-pull r-f class-C f-m telephony amplifier with power output up to 20 watts at 462 mc or 56 watts at frequencies up to 100 mc

follower in the respect that its input impedance is high and output impedance low, power gain is provided and voltage gain is under 1. The output impedance of Q_3 is 500 ohms.

Although the common-emitter and common-collector circuits require d-c bias voltages of opposite polarity, use of a single battery has been made possible in this preamplifier circuit by operating an *npn* transistor in each of the common-collector stages and a corresponding *pnp* transistor in the common-emitter stage. Maximum d-c drain is 600 microamperes.

At 1,000 cps, the measured input impedance of the preamplifier is 0.2 megohm. Higher values may be obtained by selecting transistor Q_2 individually for this characteristic. Maximum input voltage before the onset of peak clipping in the output waveform is 4 millivolts rms.

Corresponding maximum output voltage is 0.2 volt rms. Power gain is 56 db and voltage gain is 34 db, or 50 times. Total harmonic distortion at 1,000 cps is 1.2 percent. Figure 2 is a plot showing frequency response, with respect to the response at 1,000 cps.

Space requirements for the amplifier are modest. By employing ¼-watt composition resistors and subminiature tantalum electrolytic

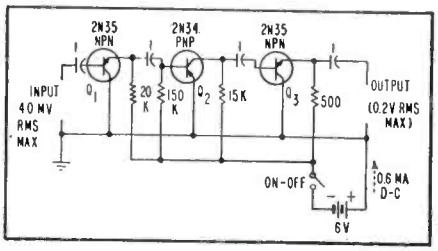


FIG. 1—Transistorized preamplifier has 0.2-megohm input impedance and 500-ohm output impedance

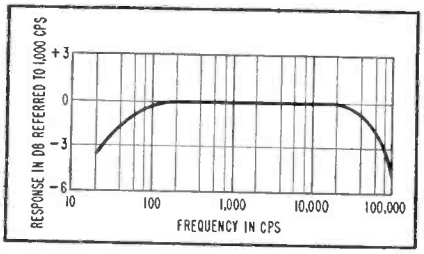


FIG. 2—Frequency response of preamplifier is essentially flat from 200 to 20,000 cycles

capacitors, the entire amplifier, exclusive of batteries, may be mounted on a 3 x 2 in. card. The lenient d-c requirements enable the use of flashlight cells for bias.

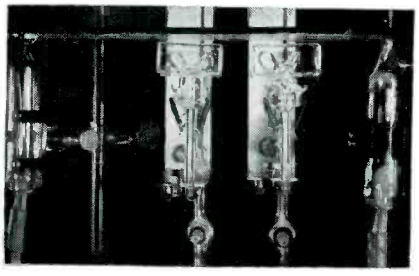
If a volume control is required in the preamplifier, a 15,000-ohm potentiometer may be substituted for the 15,000-ohm load resistor in the collector circuit of Q_2. The slider of this potentiometer would be connected to the 1-μf coupling capacitor leading to the base of Q_3.

Pulsed Light Generator Aids Plant Research

By R. W. Treharne, C. R. Nosker and P. R. Rambow
C. F. Kettering Foundation
Yellow Springs, Ohio

Photosynthesis is the process whereby living plants convert carbon dioxide from air and water into sugars, starches and other carbohydrates using sunlight as a necessary energy source for the chemical reactions.

In addition to the more obvious chemical reactions that sunlight must produce in the living plant, there are important chemical reactions that proceed best in darkness at the expense of chemical energy formed in the light. A unique means for separating these light and dark reactions is to use light



Single cell plants in containers at center are mounted above platform made of neon tube folded back on itself a number of times

pulses of controlled repetition rate.[1]

In the instrument described here, flashing light pulses are controlled by an astable multivibrator. As shown in Fig. 1, the output of multivibrator V_1 is used to trigger mono-

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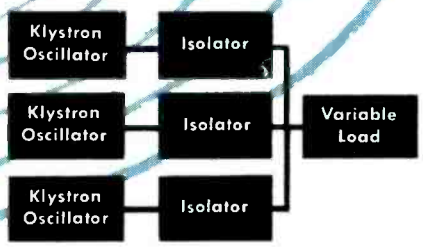
-hp- X365A employs the Faraday principle of field rotation. Two axially magnetized ferrite rods mounted inside a round, vaned waveguide, rotate the planes of polarization 45° each. This rotation, in combination with precisely located attenuator cards, permits forward power to pass almost without loss, while reverse power is virtually cancelled out.

-hp- X365A Isolators are precisely machined and finished, yet ruggedly constructed of top quality materials. *-hp-* 365A series Isolators for other waveguide bands will be announced soon.

TYPICAL APPLICATIONS

Arrangement for using *-hp-* X365A Isolator to prevent shifting of klystron oscillator frequency due to load variations.



Arrangement for using *-hp-* X365A Isolator to prevent mutual coupling of klystron oscillators.

BRIEF SPECIFICATIONS

Frequency Range:	8.2 to 12.4 KMC
Minimum Reverse Attenuation:	25 db
Maximum Forward Attenuation:	1.5 db
Maximum SWR (either end):	1.2
Maximum Power Dissipation:	5 watts
Overall Length:	9¾"
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stable multivibrator V_2, which serves both as an amplifier and pulse shaper to drive hydrogen thyratron V_3. A specially designed neon tube with heavy nickeliron or tungsten electrodes is in the plate circuit of V_3.

The flash tube is made of ¼-inch glass tubing folded back upon itself three times to form a 12-inch long platform of light above which a small vessel containing single cell plants (algae) can be suspended. The tube is half silvered on the bottom to concentrate light up into the

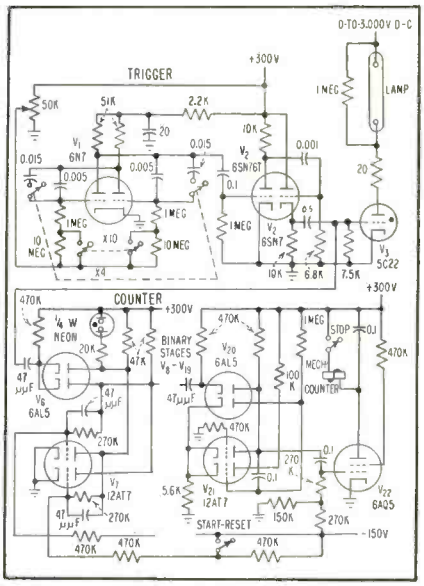

FIG. 1—Pulsed light generator for photosynthesis research. Binary chain counts number of pulses

algae vessels and is filled with neon at 15-mm pressure. Other gases can be used to produce any desired light spectrum.

Power for the light pulses is obtained from a high-voltage rectifier circuit. The time constant of the filter components in the high-voltage power supply is chosen to permit sufficient power storage recovery between flashes for intense light pulses at the highest flash rates.

The flash rate is continuously variable from one per second to 180 per second. The light-pulse duration is about 70 microseconds at all flashing rates.

A one-megohm resistor across the lamp maintains plate voltage on the thyratron preparatory to triggering. The thyratron grid regains

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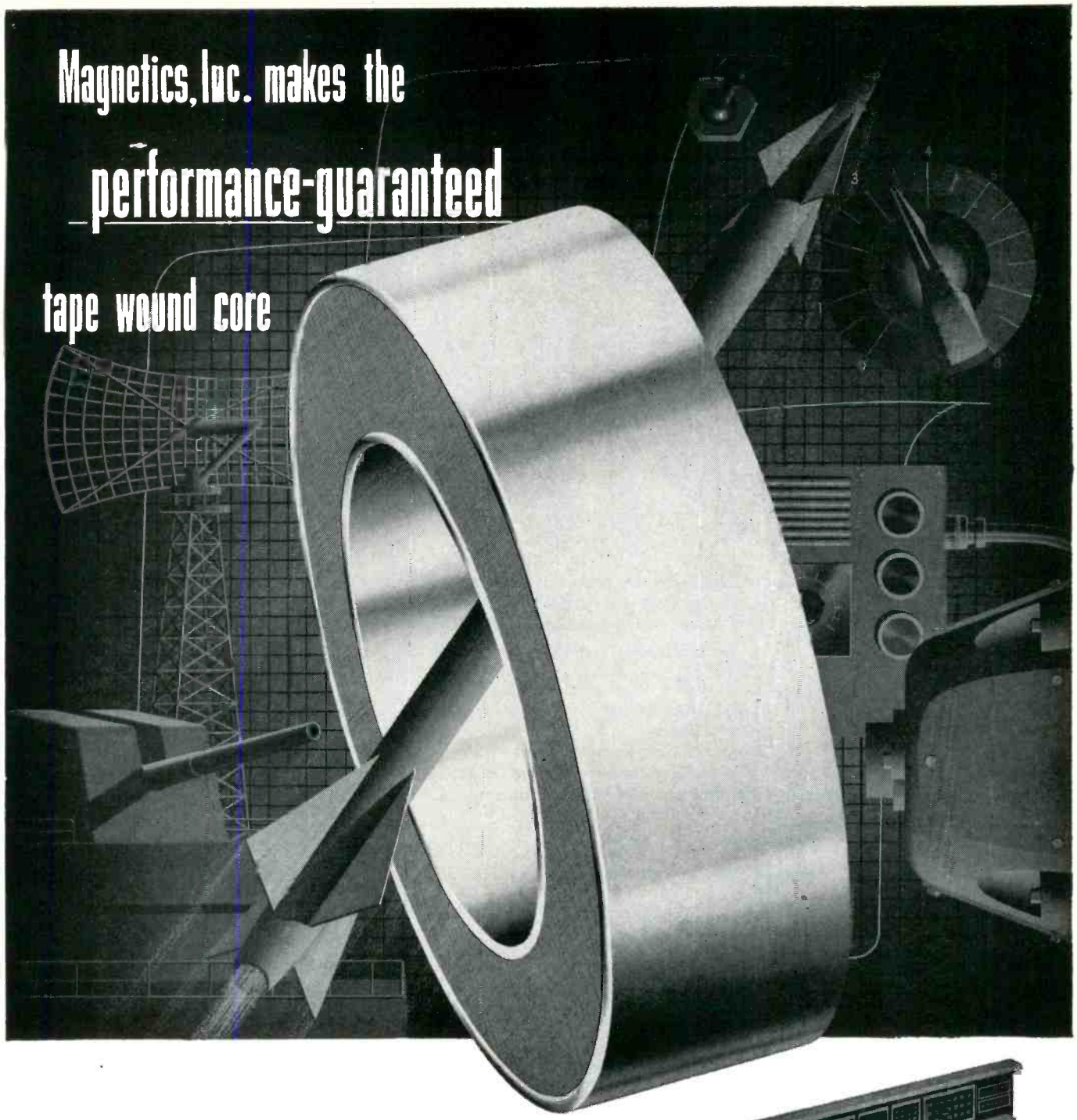

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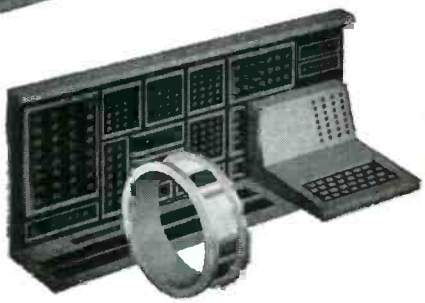

Magnetics' bobbin cores, too, are performance-guaranteed!

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control when the plate voltage drops owing to the heavy conduction current through the flash tube during discharge.

The total number of light pulses for a given experiment is controlled by a binary counter circuit consisting of tubes V_6 through V_{20}. The mechanical relay registers once for every 256 counts and neon interpolation lights are added to give the total flash exposure for each experiment.

A considerably simpler modification of this equipment can be made if a third trigger electrode can be used on the flash tube. The trigger circuit is shown in Fig. 2. Such an electrode consists of a few turns of

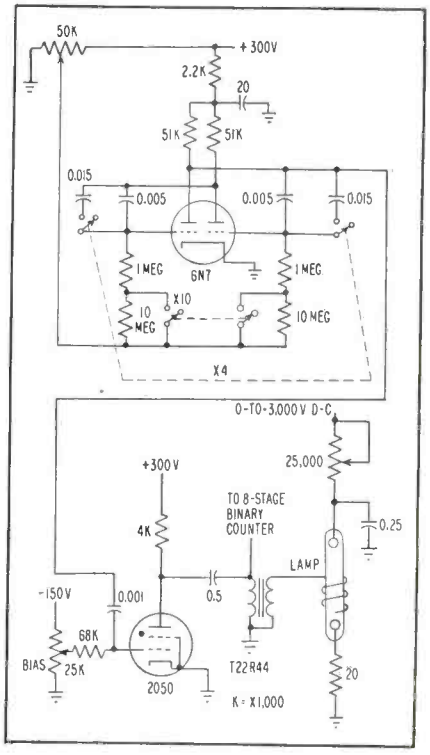
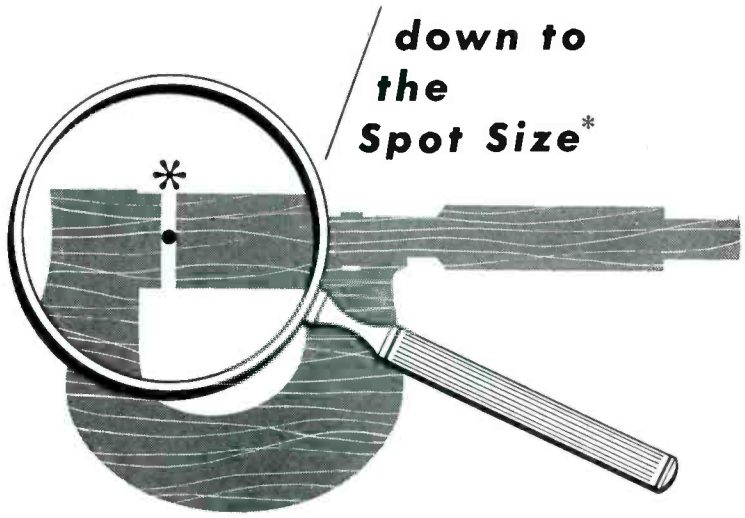


FIG. 2—Alternate simplified triggering system can be used if light source is not submerged in a conducting medium

wire wrapped around the outside of the flash tube at about the center of the tube. A trigger voltage from a 2050 thyratron is sufficient to cause ionization of the flash-tube gas to start the main power supply discharge through the tube.

The experimental procedure for studying photosynthetic reactions in algae calls for the immersion of the flash tube and vessels containing the algae into a constant tem-

PRECISION



329-A

In one phrase, that's the story of the Du Mont Type 329-A. From the input attenuators, right through to the cathode-ray tube, tolerances have been held to a level that **means what you can read – you can trust.** Accuracy of measurement is limited primarily by the size of the fluorescent spot (and with the superb characteristics of our mono-accelerator cathode-ray tubes, that's an especially significant statement).

Prove to yourself what the extra precision and convenience of the Type 329-A will mean to you. Call your nearest Du Mont representative for a demonstration, or write to Technical Sales Dept. at the address below.

CONTINUOUS SWEEP CALIBRATION. If you can read numbers you can make precise time measurements. Adjust the event to be measured to fill exactly a major interval on the screen. Then read time directly from the large legible dial **with no interpolation,** no need to count squares. Accuracy? Better than 5% (including sweep generator and cathode-ray tube).

REAL SWEEP LINEARITY. Our test spec reads "no 10% increment of sweep shall vary from another 10% increment by more than 5% in time interval represented." In short, any non-linearity of sweep will be **less than a trace-width!**

CALIBRATED SWEEP EXPANSION. Exclusive Du Mont "Notch" speeds a segment of the sweep by a factor of exactly 10. Result – effectively two calibrated rates during the same sweep. Expanded portion is displayed in proper relation to the unexpanded portion. Uncalibrated notch offers greater expansion (up to 100 times on lower sweep ranges).

AMPLITUDE CALIBRATION. Accurate (±2%) voltage standard is applied by a flick of a convenient front-panel switch to calibrate screen in any of 11 full-scale ranges from 0.2 to 400 volts.

HIGH PRECISION TYPE 5ATP- CATHODE-RAY TUBE. Only a tube built to our stringent tolerances could exploit fully the precision inherent in the circuitry of the Type 329-A. Based on the mono-accelerator principle, the Type 5ATP- offers the superb deflection linearity as well as the freedom from spot and field distortions required to render measurements valid right down to the resolving power of the trace.

DC TO 10 MC (30% DOWN) VERTICAL RESPONSE is the nominal bandwidth of the Type 329-A. But owing to the gradual fall of the frequency response beyond this point, the amplifier is usable to 20 mc and beyond. Unique amplifier design assures display of d-c signals **with no d-c slump.**

HIGH-LOW-GAIN SELECTOR permits doubling deflection sensitivity (at some sacrifice in bandwidth) to 0.05 volt per major scale division for studies involving very low signal levels.

DUAL INPUT CONNECTORS permit switching from one signal source to another without changing leads.

MAJOR SPECIFICATIONS

Frequency response: dc to not more than 3 db down at 10 mc; rise time, .035 usec

Deflection factor: 0.1 d-c volt/major division†; high-gain switch gives optional double sensitivity at 5 mc bandwidth approx.

Sweep rates: driven or recurrent sweeps, continuously variable, calibrated from 1 sec to 0.1 usec/major div.†; max. rate, 7"/usec (20 milli-micro-seconds/minor scale division).

Sweep expansion: notch expansion, variable or calibrated rate, 10 times sweep rate on most ranges with calibrated notch and up to 100 times rate with uncalibrated variable notch

Amplitude Measurement: 11 full-scale ranges from 0.2 to 400 volts full scale

Cathode-ray tube – Type 5ATP- Mono-accelerator, operated at 6000 volts (equivalent light output to post-accelerator tube operated at 10KV. **Price $1090.00**

TYPE 336-A

The **Type 336-A** offers all of the superb measuring facilities of the **Type 329-A,** but has a vertical frequency response extended to 18 mc (3 db down) at a sensitivity of 1 dc volt full scale. With pulse response of 0.02 usec, the **Type 336-A** is particularly well suited for measurement of very high-speed phenomena. **Price, $1125.00**

*Spot Size = 0.02" (approx.) †Major scale division = 0.7 inch (10 minor divisions)

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perature water bath. The growing plant takes in carbon dioxide and gives off oxygen. Photosynthetic reactions can be detected, therefore, by measuring the oxygen evolution at constant temperature and pressure conditions.

The trigger electrode system for the use of a flash lamp under water presents some difficulties. If any conduction or capacitive losses exist between the trigger electrode and ground, the trigger voltage may not be of sufficient magnitude to produce initial ionization of the flash tube gas.

These losses can occur in a water bath containing excessive amounts of ionic impurities. Under such conditions there would be a shock hazard to the operator. For applications where water immersion of flash tube is not required however, this alternate circuit because of its simplicity is more desirable.

The authors acknowledge the ideas and assistance contributed by H. A. Tanner, director of research and K. A. Clendenning, biochemist of the C. F. Kettering Foundation.[2]

REFERENCES

(1) R. Emerson and W. Arnold. A Separation of the Reactions in Photosynthesis by Means of Intermittent Light, *Journ of Gen Physiol*, Mar. 20, 1932.

(2) K. A. Clendenning and H. C. Ehrmantraut. Photosynthesis and Hill Reactions by Whole Chlorella Cells in Continuous and Flashing Light, *Archives of Biochem*, Dec. 1950.

Glo-Balls Measure Electric Fields

By JOHN D. SALISBURY
University of California
Radiation Laboratory
Livermore Site
Livermore, Calif.

ELECTRIC FIELD distribution in resonant cavities can be measured simply and directly.

A thin-wall, glass ball (see Fig. 1) containing gas at a low pressure is introduced into the cavity at a point where the voltage gradient is to be measured. Input power is raised until the gas within the ball ionizes. The voltage induced in a monitor loop is read the instant before the ball glows, giving the maximum meter reading since the induced voltage drops somewhat

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STANDARD UNITS

SYNCHRO FUNCTION	CPPC TYPE	ROTOR Input V400cy	Input Amps	Input Watts	Ohms (DC)	Output Rotor	Sensitivity (MV/deg.)	STATOR Output Volts	Sensitivity (MV/deg.)	Input Volts	Input Amps	Input Watts	Ohms (DC)	IMPEDANCE Zro	Zso	Zrss	Phase R-S	Shift S-R	Nulls (MV)	Possible Error	Possible Spd.	Length in inches
Torque Transmitter	CGC-8-A-7	26.0	100	.5	37	—	—	11.8	200	—	—	—	12	54+j260	12+j45	76.4+j19.6	8°	—	30	7′	14′	1.240
Control Transformer	CTC-8-A-1	26.0	.050	.25	143	24	410	11.8	200	11.8	.090	.23	25	220+j740	28+j110	246+j60		8.5°	30	7′	14′	1.240
Control Transformer	CTC-8-A-4	—	—	—	381	24	410	—	—	11.8	.037	.09	60	508+j1680	67+j270	640+j190	—	9.2°	30	7′	14′	1.240
Control Differential	CDC-8-A-1	—	—	—	36	11.8	200	—	—	11.8	.085	.21	25	38+j122	27+j120	48.6+j13.8	—	9°	30	7′	14′	1.240
Electrical Resolver	CSC-8-A-1	26.0	.039	.43	230	23.2	400	10.6	180	11.8	.084	.27	27	280+j600	38+j136	70+j136	20°	11°	30	7′	14′	1.240
Torque Receiver	CRC-8-A-1	26.0	.100	.50	37	—	—	11.8	200	—	—	—	12	54+j260	12+j45	85.1+j20.4	8°	—	30	30′	30′	1.240
Vector Resolver	CVC-8-A-1	1-26	.057	.34	78	—	—			11.8	.294		27	103+j444	28.8+j27.9		10.2°	—	1MV/V			1.240

TYPICAL SYSTEM MEASUREMENTS

SYSTEM	Input V400cy	Input Amps	Input Watts	Output Volts	Sensitivity (MV/deg.)	CPPC TYPES	Input Z	Output Z	Phase Shift	Nulls (MV)	REMARKS
Transmitter→C.T.	26	.110	.74	23.6	408	CGC-8-A-7→CTC-8-A-4	58+j226	626+j233	19°+	50	Hi Z Load on CT
Transmitter→C.T.	26	.111	.75	23.3	407	CGC-8-A-7→CTC-8-A-4	58+j226		19°	50	50K Load on CT
Transmitter→C.T.	26	.111	.83	20.8	363	CGC-8-A-7→CTC-8-A-4	64+j221		17°	50	5K Load on CT
Transmitter→4 Parallel CT's	26	.145		21.8	381	CGC-8-A-7→4‖ CTC-8-A-4			28°	40	CT Interaction ½° Max.
Transmitter→Differential→C.T.	26	.134	1.78	19.5	340	CGC-8-A-7→CDC-8-A-1→CTC-8-A-4		748+j364	40°	40	CT Output to Hi Z
Series Vector→Electrical Resolver	1→26	.103	.67	4.9	85	CVC-8-A-1→CSC-8-A-1	55+j230	32+j68	32°	40	$E_o = .19\ E_1 \sin\theta_1 \sin\theta_2$
Series Vector Resolvers	1→26	.110	.55	5.2	91	CVC-8-A-1→CVC-8-A-1			20.2°	40	$E_o = .2\ E_1 \sin\theta_1 \sin\theta_2$
Transmitter→Receiver	26	.200	1.0	—	—	CGC-8-A-7→CRC-8-A-1			—	—	Torque 2400 mg.mm/deg.

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when ionization takes place.

The magnitude of the gradient at the measured point, corresponding to any arbitrary loop voltage, can be calculated easily if the gradient required for ionization is known and the ionization point of the ball is stable. Measurements can be made at a number of points, and a profile of the magnitude variations of the electric field intensity due to the pertubing effects of drift tubes can be plotted. Integration of the plot will yield end-to-end voltage for a given loop voltage. Such measurements have been made on a large linear accelerator.

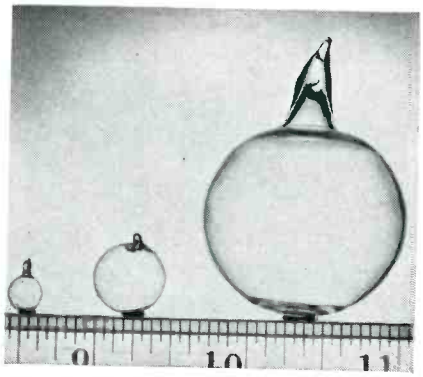


FIG. 1—Glo-balls with diameters of ¼, ½ and 1⅜ inches are used respectively at 100, 25 and 50 mc, while the larger ones are for 12.5 mc

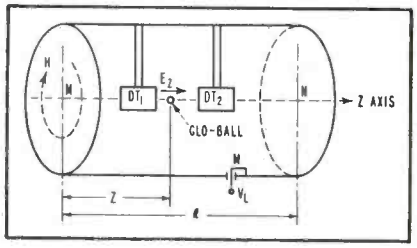
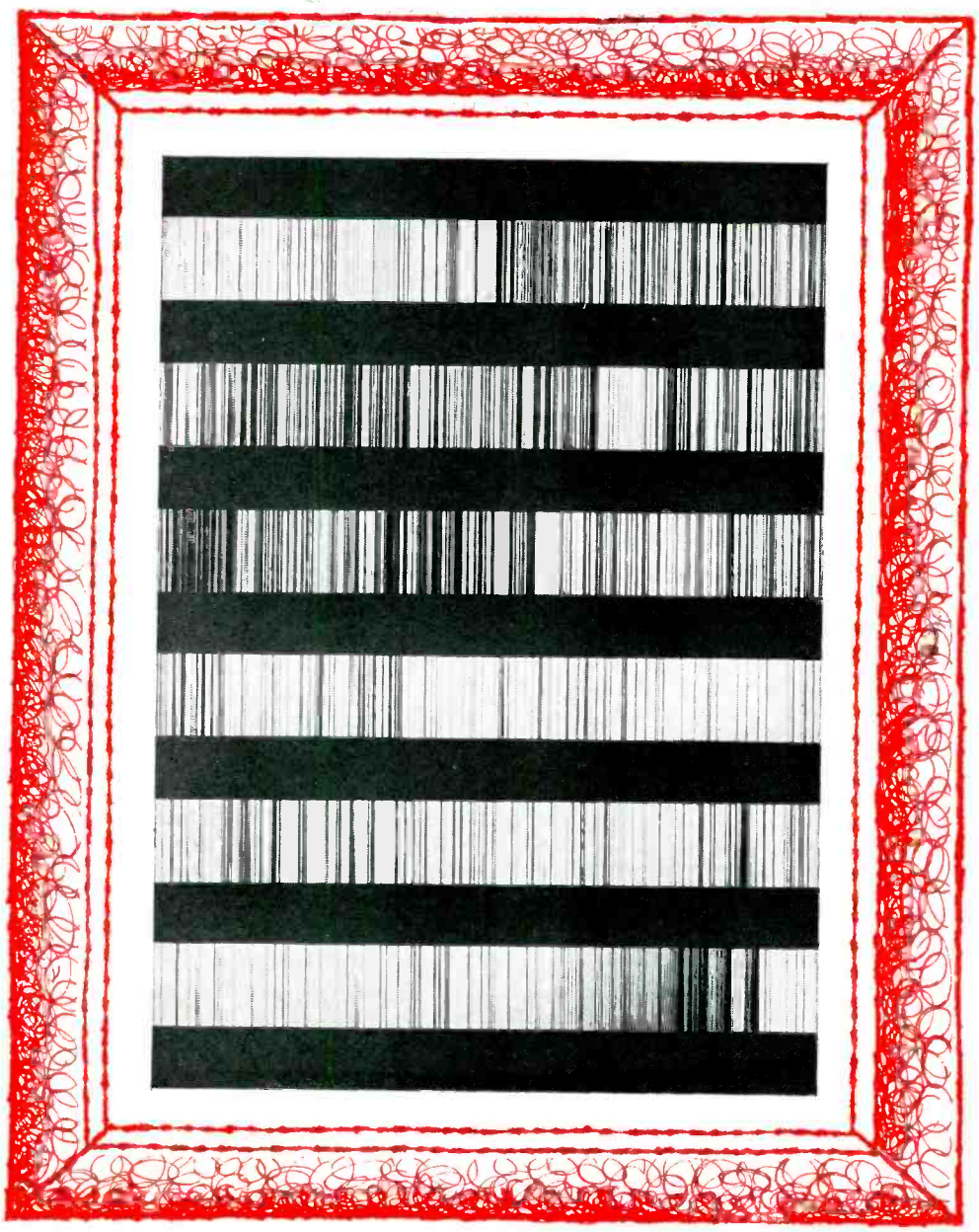


FIG. 2—Simple representation of a linear accelerator cavity

▶ **Past Method**—Distribution of the electric field intensity E in a cavity resonator is of interest. Perturbations owing to drift tubes increase the complexity of mathematical calculations to a point where solutions are unreliable or impossible. It is therefore necessary to perform measurements either on models or on full-scale cavities to obtain this information.

Electric field intensity measurements within cavity resonators have been made in the past by the

PORTRAIT OF A CHAMPION



Nichrome*, the famous alloy whose spectrogram you see here, is as truly a masterpiece as any Rembrandt or DaVinci hanging in the galleries—and for largely the same reason.

For the principal elements in Nichrome, *anyone* can combine. What gives Nichrome its unapproachable superiority over all other heat-resistance alloys, is the truly personal elements that go into its making—the all-important, highly specialized skills of the Driver-Harris technicians.

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And in recognition of its unique properties, the United States Patent Office in August, 1908, granted solely and exclusively to us the trade-mark NICHROME.

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field-perturbation or BB method. This method consists of introducing a metallic or dielectric sphere (BB) into the cavity at a point to be investigated, observing the resulting frequency shift Δf and from this, calculating the relative field intensity at the point.

If the sphere is of dielectric material and if its volume is small compared to that of the cavity, the frequency shift is proportional to the volume of the sphere and to the square of the electric field intensity at the point.

The method requires a considerable amount of special frequency-measuring equipment, as well as ideal conditions. It is preferred to sample as small a volume as possible, but there is a practical limit because as the size of the BB is reduced the resulting frequency shift is also reduced, so that even with a mechanically rigid cavity and precise frequency measurements the Δf is lost in the inherent random variations of the system.

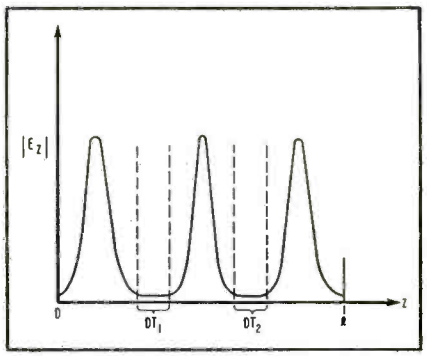

FIG. 3—Magnitude of E field along axis of cavity for constant end-to-end voltage

The glo-ball circumvents the frequency drift problem because its ionization point is, for all practical purposes, unaffected by frequency changes normally encountered during a run. It can be made many times smaller in diameter than the BB and therefore it can be used to explore regions where size is a limiting factor, such as the bore of a drift tube in a linear accelerator.

Also in regions of rapidly changing field intensity, it is desirable to make each measurement over a volume as small as possible, since the field intensity is a point func-

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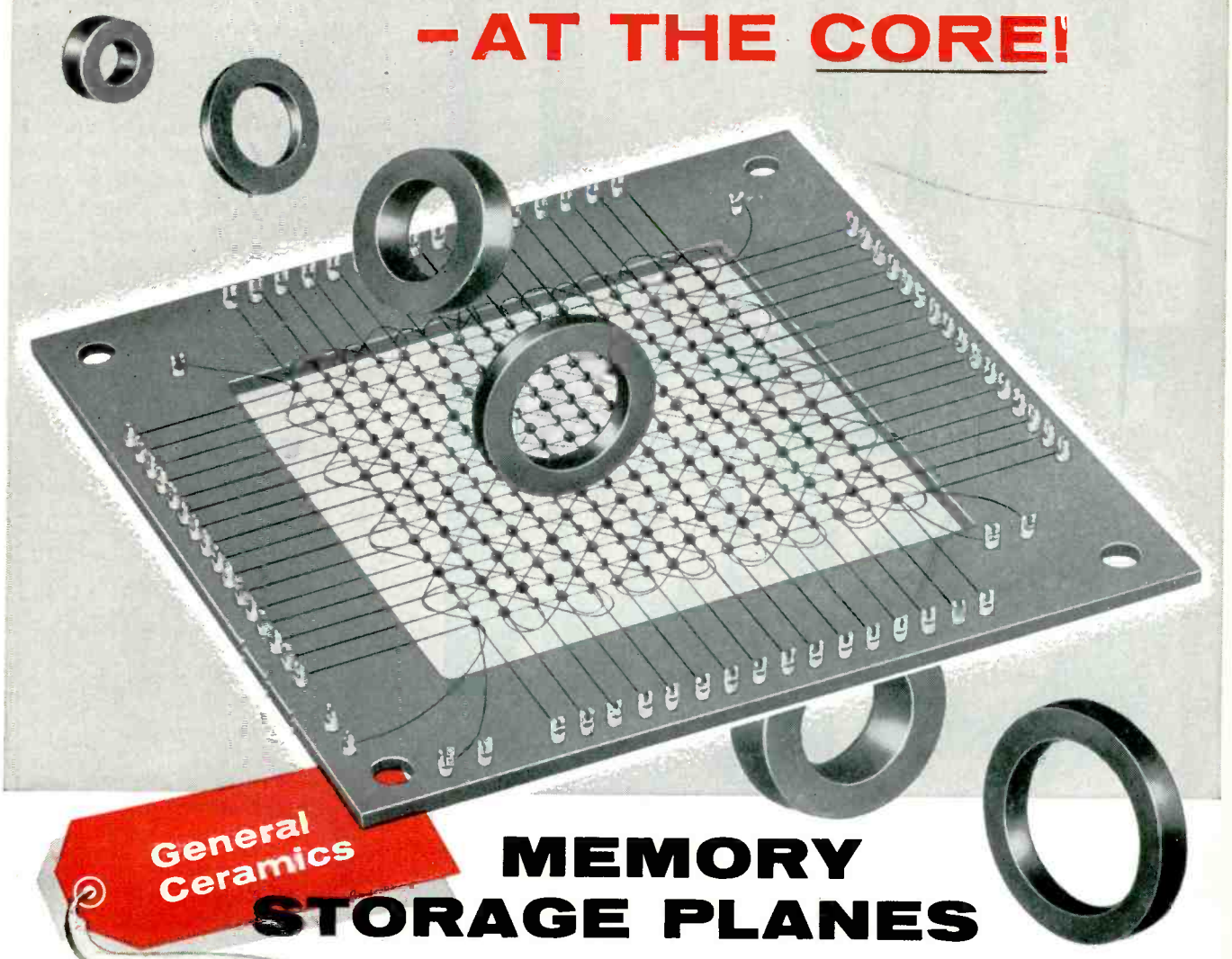

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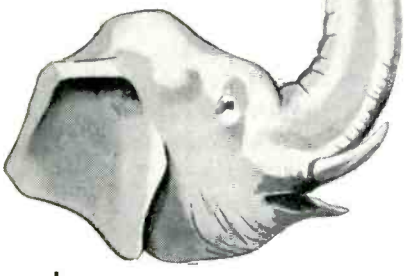

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tion and the glo-ball integrates the field over its diameter. The center of the ball is therefore a position reference to plot the data that consists of the average values of field intensity for the space occupied by the ball.

▶ **Operation**—In use, the glo-ball is pulled through a cavity on a line along which it is desired to know the field magnitude distribution, for example, the axis of a linear accelerator. At various points along the axis, the ball position is recorded and the cavity energy is raised until ionization or glow occurs. At this instant, the voltage on a monitoring loop is recorded and the energy level is quickly lowered to zero.

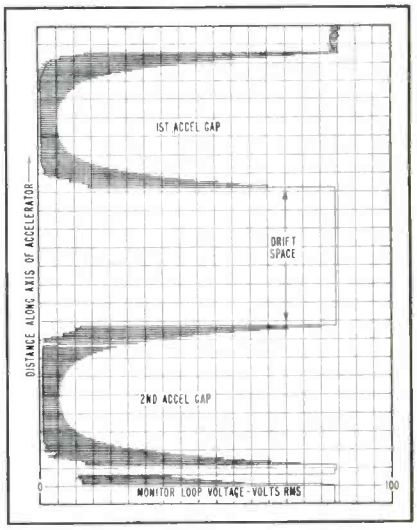

FIG. 4—Section of recorder chart shows monitor loop voltage plotted against glo-ball position for two gaps of a long linear accelerator tube

The latter action is necessary to preserve the stability of the ionization point. Because the ball ionizes at a constant magnitude of electric field, it is apparent that the data obtained consist of monitoring loop voltages versus ball position for this value of electric field.

Referring to Fig. 2, the voltage on monitoring loop M is noted at the time of ionization of the glo-ball located a distance z from m on the z axis. Since this is also the axis of the accelerated particles, it is normally the only path along which the distribution is of interest. As indicated, the desired

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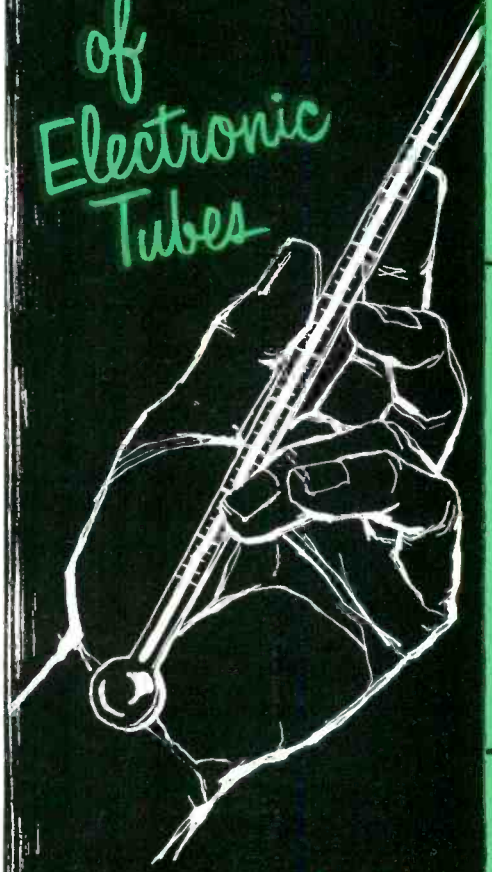

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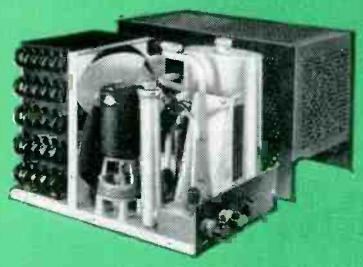
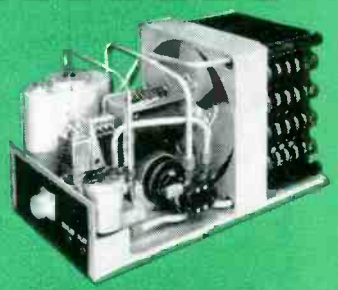
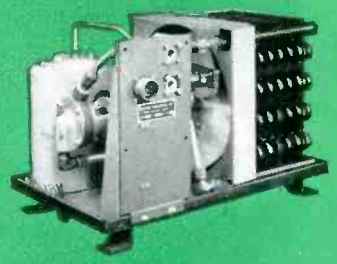


MODEL MB-175, TYPE 200 DISSIPATION: 2,000 watts. **ALTITUDE RANGE:** sea level to 50,000 feet. **POWER REQUIRED:** 28 volts D.C. **WEIGHT:** 25 pounds. **SIZE:** 10" x 15-15/16" x 10¾" high.

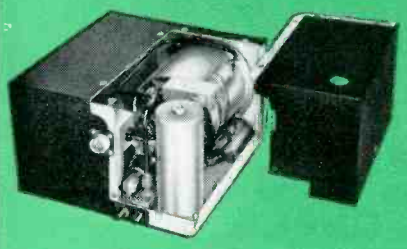


MODEL E/HT-205, TYPE 200A DISSIPATION: 1600 watts. **ALTITUDE RANGE:** sea level to 5,000 feet. **POWER REQUIRED:** 28 volts D.C. **WEIGHT:** 25 pounds. **SIZE:** 10" x 21" x 10" high.

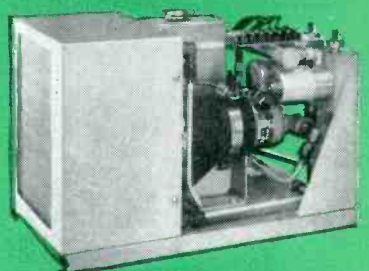
MODEL MB-177, TYPE 202 DISSIPATION: 1700 watts. **ALTITUDE RANGE:** sea level to 50,000 feet. **POWER REQUIRED:** 110 volt, 400 cycle, 3 phase. **WEIGHT:** 27 pounds. **SIZE:** 10" x 19 15/32" x 7⅜" high, per JAN-C-1720A, size B1-D1.



MODEL E/HT-210, TYPE 200 DISSIPATION: 1500 watts. **ALTITUDE RANGE:** sea level to 10,000 feet. **POWER REQUIRED:** 208 volts, 400 cycle, 3 phase. **WEIGHT:** 35 pounds. **SIZE:** 11¼" x 19½" x 12½" high.



MODEL E/HT-200, TYPE 201 DISSIPATION: 1,000 watts. **ALTITUDE RANGE:** sea level to 50,000 feet. **POWER REQUIRED:** 28 volts D.C. **WEIGHT:** 14½ pounds. **SIZE:** 10" x 10" x 6" high.



MODEL NO. 5-A DISSIPATION: 1,000 watts. **ALTITUDE RANGE:** sea level to 5,000 feet. **POWER REQUIRED:** 100 to 110 volts D.C. **WEIGHT:** 10 pounds. **SIZE:** 7¼" x 13½" x 9-1/16" high.

mode has the E vector parallel and the H vector transverse to the axis of the cavity, a right circular cylinder. In the unloaded cavity E is constant with respect to z, but the presence of the drift tubes DT_1 and DT_2 perturbs the field, producing one of varying magnitude similar to that of Fig. 3. The shape of this curve can be obtained by plotting values of inverse monitoring loop voltages obtained during the glo-ball run. This is because the field intensity E at a point in the cavity is proportional to the voltage V_L, generated in a fixed loop which couples part of the magnetic flux. That is $E_z = k_z V_L$ where k_z is a function of position.

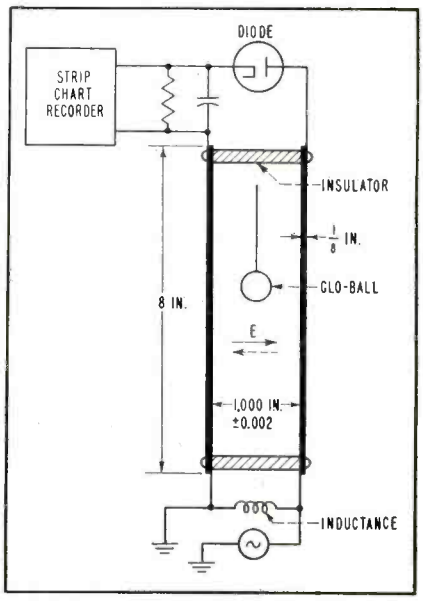


FIG. 5—Parallel-plate calibrator

At a given point in the cavity, k_z is constant for a particular mode of operation and a fixed monitoring loop.

Figure 4 shows part of a recorder chart (2 gaps) which was taken during a glo-ball run on a long linear accelerator.

▶ **Construction**—When the first glo-balls were made, approximately 10 percent had the required sensitivity and stability. They ranged in size from ¼ inch to 1¼ inches in diameter with a considerable range of sensitivities. In general, the sensitivity decreases with decreasing ball diameter and increases as the frequency of the r-f power in-

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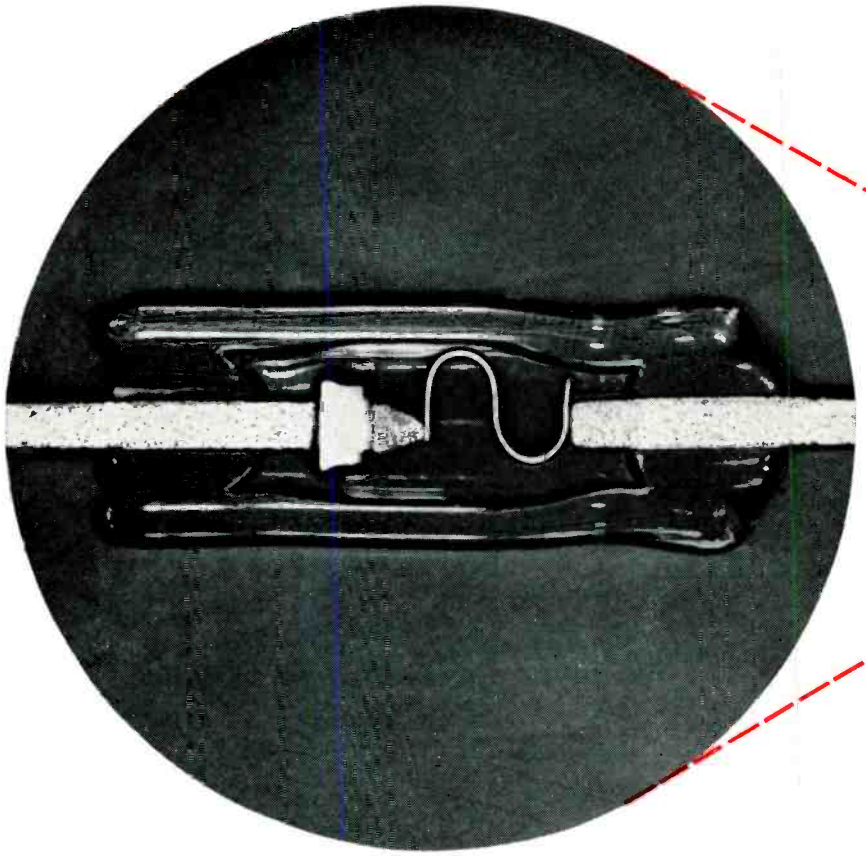

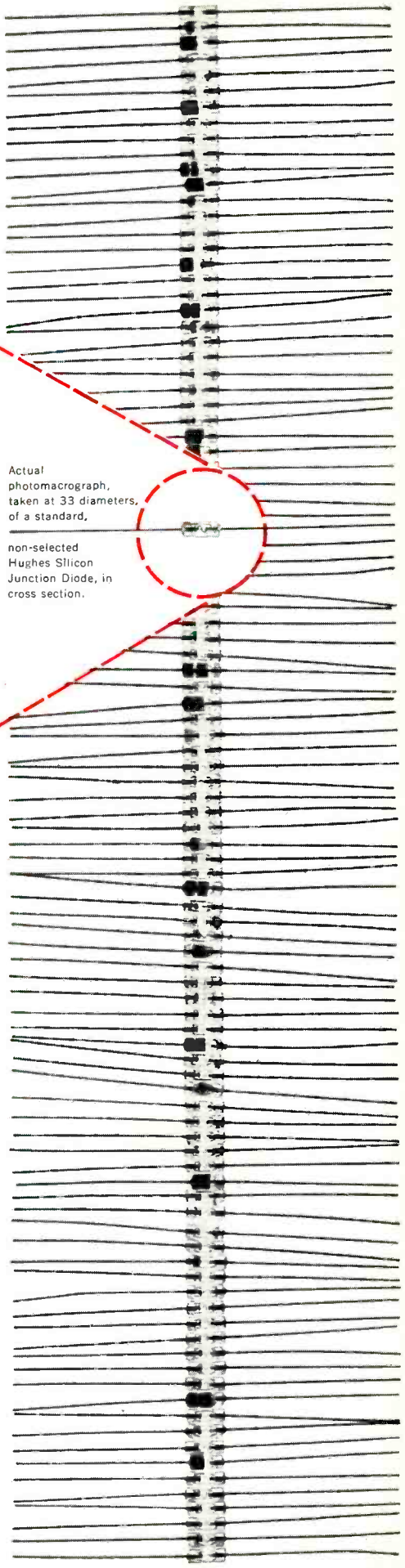

Actual photomacrograph, taken at 33 diameters, of a standard, non-selected Hughes Silicon Junction Diode, in cross section.

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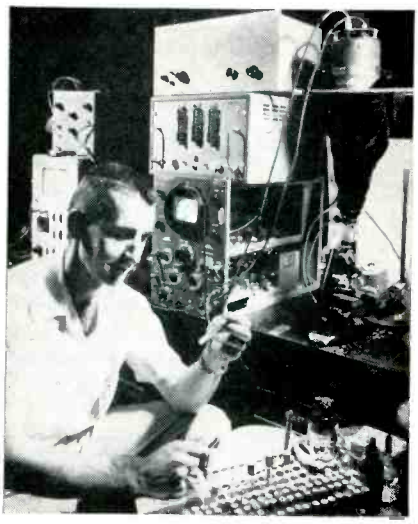
creases.

The balls were pumped to about 15 microns and outgassed for one hour in an oven. They were then filled with helium to a pressure of about 1,000 microns and sealed. Further work by J. F. Steinhaus has shown that additional treatment and somewhat higher pressures, about 15 millimeters of mercury, produced more stable balls and a higher percentage of useful ones. A typical, sensitive, ½-inch diameter ball will ionize in a field of about 170 volts rms per inch at a frequency of 50 mc.

A localized static charge of electricity has been found to cause as much as 50-percent increase in the ionization point. With successive firings this effect gradually diminished as the charge leaked off. As a precautionary measure, all glo-balls are now dipped in antistatic solution prior to the initial calibration.

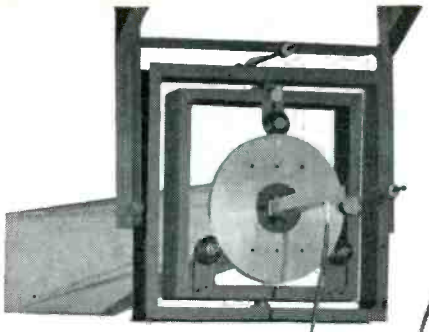
The calibration procedure consists in suspending the glo-ball between two parallel plates of diameter equal to about 8 times the spacing, which normally was one

Breeding Better Cattle

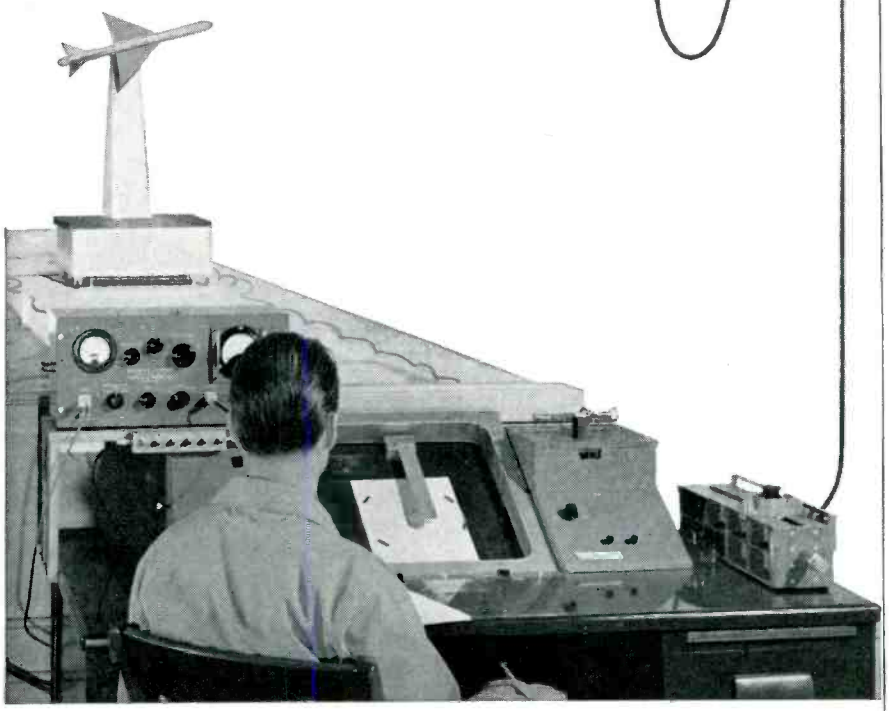


In the photograph, a professor of dairy physiology at the University of Illinois uses a microscope, multiplier phototube, cathode-ray oscilloscope, electronic counter, line selector and tv camera monitor to study motility of cattle sperm cells. The Du Mont equipment shown may make possible fast and accurate selection of high-fertility specimens for producing better cattle

Your future in **MICROWAVES** *at the*



HUGHES RESEARCH LABORATORY



The Microwave Laboratory at Hughes conducts fundamental research and long-range development in the field of microwave components and techniques. The antenna program is concerned with research on linear and two-dimensional arrays of slot radiators; transmission and radiation of surface-guided waves; very high resolution radar antennas; and the development and engineering of airborne communication, navigation and fire control antennas.

Instrumentation is developed for new measuring equipment to meet needs of the program. This has included development of automatic impedance and antenna pattern recorders, microwave power supplies stabilized in amplitude and frequency, microwave circuitry, and microwave applications of ferrite devices.

Scientific Staff Relations

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RESEARCH AND DEVELOPMENT LABORATORIES
HUGHES AIRCRAFT COMPANY
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These positions in the Microwave area are open now in the Hughes Research Laboratory:

MICROWAVE ENGINEERS

with experience in magnetrons, klystrons, microwave transmitter and receiver circuitry, microwave mixers, duplexers and cavities.

VIDEO CIRCUIT ENGINEERS

with experience in video amplifiers, pulse circuitry, coding and decoding circuits, and delay lines.

MICROWAVE STANDARDS ENGINEERS

to do precise calibration from primary and secondary standards, using the finest facilities available for standards calibration.

MICROWAVE ENGINEERS

to participate in basic research on microwave breakdown in gases or wave propagation in ionized gases.

MICROWAVE ENGINEERS

to participate in development of new techniques for measurement of the magnetic and electric properties of materials at microwave frequencies.

You are invited to send resumes of your education and experience to the address at left.

VACATIONING IN SOUTHERN CALIFORNIA? YOU ARE INVITED TO VISIT HUGHES.

inch. The ball as shown in Fig. 5 is located at the center of the plates where the *E* field is collimated. The plates are then excited by a steadily increasing r-f voltage at the frequency at which the ball is to be used. At the instant of ionization the voltage is turned off leaving a record of its maximum excursion on the recorder chart. During successive trials, this value of maximum deflection is found repeatable to better than 1 percent for a stable ball. Its calibration is therefore the voltage at ionization divided by the plate spacing.

It was necessary to provide a low-resistance direct-current path, such as a choke, between the plates to prevent the formation of a d-c field, which seriously affects the calibration.

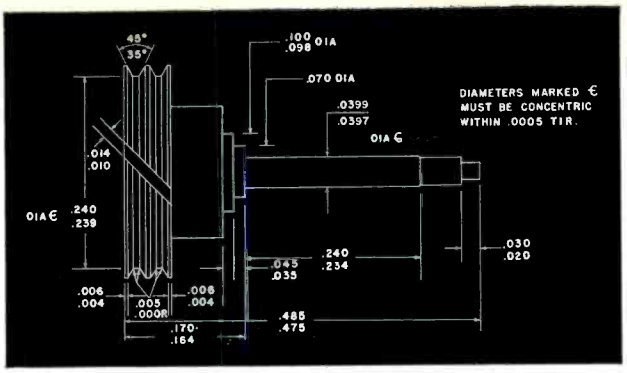
▶ **Instrumentation**—During a glo-ball run it was found desirable to use a high-voltage monitoring loop to avoid large errors owing to the nonlinearity of diodes at low r-f voltages. This did not eliminate the necessity for measuring a relatively low voltage when cross-calibrating the temporary to the permanent loops, but this operation was only done once and considerable care could be expended to insure accuracy.

The conception of the glo-ball, its construction and application and the development of much of the associated electronic equipment now in use was due to O. A. Fredricksson, W. W. Klein and the author. Many persons have contributed to the further development and application of the glo-ball technique. This work was done under the auspices of the U. S. Atomic Energy Commission.

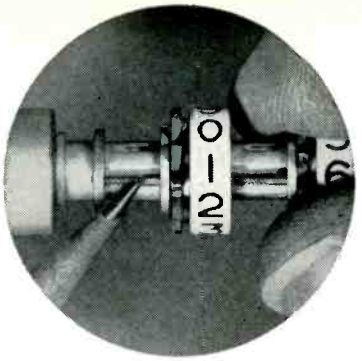
Transhorizon Circuit Authorized

FIRST international radiotelephone circuit using tropospheric overhorizon techniques will be operated by American Telephone and Telegraph Co. together with Radio Corporation of Cuba using 840 and 880 mc.

Although military circuits have for some time been in operation, this is the first intercompany serv-



Inspection of incoming precision shafts took 10 to 15 minutes each by mechanical gaging—involved concentricity, diameters, shoulder locations, and other tough-to-measure dimensions to tolerances of .0002". Doing the work on a Kodak Contour Projector cut time to 2 to 3 minutes per shaft.



The problem was to check many small calculating machine parts averaging about 13 critical dimensions for each with shapes mostly complex. With carefully engineered mechanical gages, inspection time averaged 50 seconds each. Optical gaging on a Kodak Contour Projector brought the average down to 12 seconds.

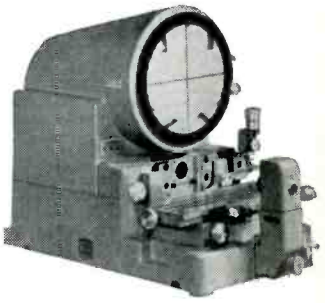
Spacing the parallelism of a special tuning condenser for electronic test equipment had to be held to very close tolerances. "Use of the Kodak Contour Projector," the company reports, "permits economical measurements of parallelism to an accuracy impossible to obtain by other methods."

On a flexible rubber-like part, rejects ran as high as 30%. By using a Kodak Contour Projector to measure the parts and then plotting results by statistical quality control methods, production changes were made that resulted in rejects dropping from 30% to less than ¼ of 1%. Optical gaging eliminated distortion of the part while gaging, and proved 4 to 5 times faster than usual methods.

One instrument inspects these varied parts

Here is another economy optical gaging can provide: switching from one part to a second part requires only a change of chart and fixture. You still use the same basic instrument. And with a Kodak Contour Projector, the variety of parts you can check is almost without limit. Here's why:

1. *Capacity*—Screen size on an optical comparator does not restrict the size of parts you can handle, for multiple-position fixtures allow the handling of parts larger than the screen itself. What's important is the staging area—and Kodak's unique relay lens provides uniform ample clearance regardless of magnification. The distortion-free image lets you measure anywhere on the viewing screen. The choice of lenses, of horizontal or vertical projection, and of surface or shadow illumination gives you the greatest possible flexibility.
2. *Ease of operation*—Kodak Contour Projectors are designed for maximum speed and minimum operator training. The bright screen image reduces fatigue, lets you use the instrument in normal room light. Images are erect and unreversed at all magnifications. Finger-tip controls are within convenient reach of the operator.
3. *Optical stability*—The adjustment-free optical elements on Kodak Contour Projectors eliminate the need for operator adjustments. Rigidly mounted lenses and mirrors maintain alignment and position. Rugged construction withstands rough and heavy use.



Whether you are now using optical gaging or just considering it, you should have a copy of the booklet, "Optical Gaging with Kodak Contour Projectors." It gives complete details on Kodak optical gaging equipment and how it can work for you. Write to *Special Products Sales Division.*

EASTMAN KODAK COMPANY, Rochester 4, N. Y.

the KODAK CONTOUR PROJECTOR

Kodak
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ice, which will serve subscribers in Cuba and the United States via Florida City, Fla., a distance of 180 miles.

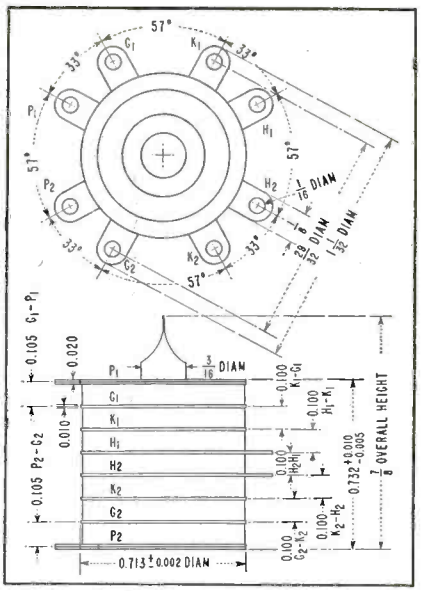
Television transmission service will be offered later.

Metal Ceramic Miniatures

SEVERAL new tubes for use at high temperatures and under conditions of considerable acceleration have been constructed having the form of cylinders from which flat tabs radiate (ELECTRONICS, p 12, June 1956).

The Eimac type CD-16 is a dual triode that will withstand 15 g acceleration at frequencies up to 2,000 cycles and envelope temperatures up to 300 C for extended periods. The location of the electrodes and the orientation of the connection tabs is shown in the drawing.

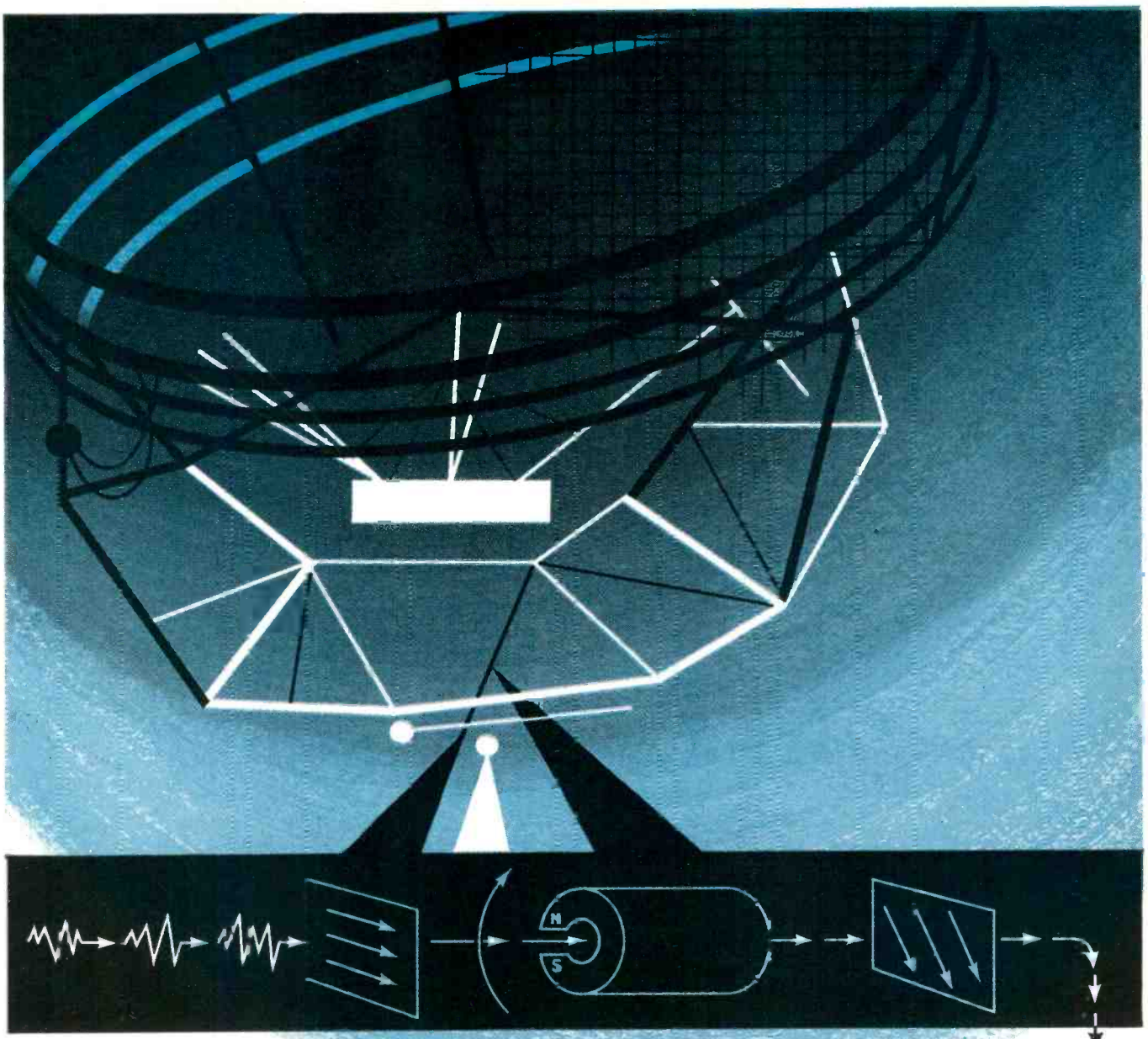
Operating at 250 volts with a plate current of 9 ma, the noise



Twin-triode receiving tube construction

output across a 2,000-ohm plate-load resistor will not exceed 75 millivolts with 15 g acceleration in any direction at any frequency from 0 to 2,000 cycles. No mechanical resonances exist in this range.

Type CD-18 is a miniature sharp-cutoff pentode. At plate and screen supply voltages of 120 v d-c with a cathode resistor of 200



in radar load isolators, too

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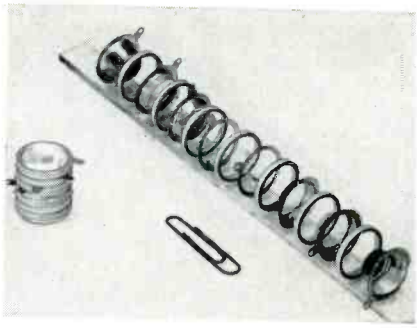
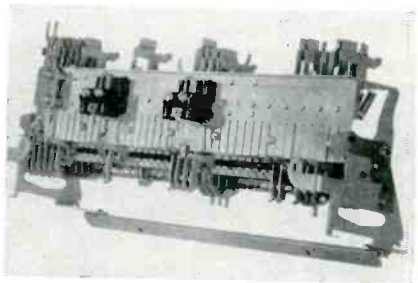


Exploded view of Eimac 33C3A2 dual triode

ohms, less than 100 millivolts noise voltage will develop across a plate loading resistor of 10,000 ohms at 15 g in any direction between 20 and 2,000 cycles.

The terminal structure of both tubes has been designed to adapt these tubes for integration into automatic circuit module construction.

Teleprinter Performs Stunts



So-called stunt box used with Teletype Corp. model 28 printer may have as many as 42 functions, of which 10 are reserved for conventional actions such as line feed, shift and carriage return. Up to 32 circuits can thus be controlled by groups of character combinations sent in a predetermined sequence

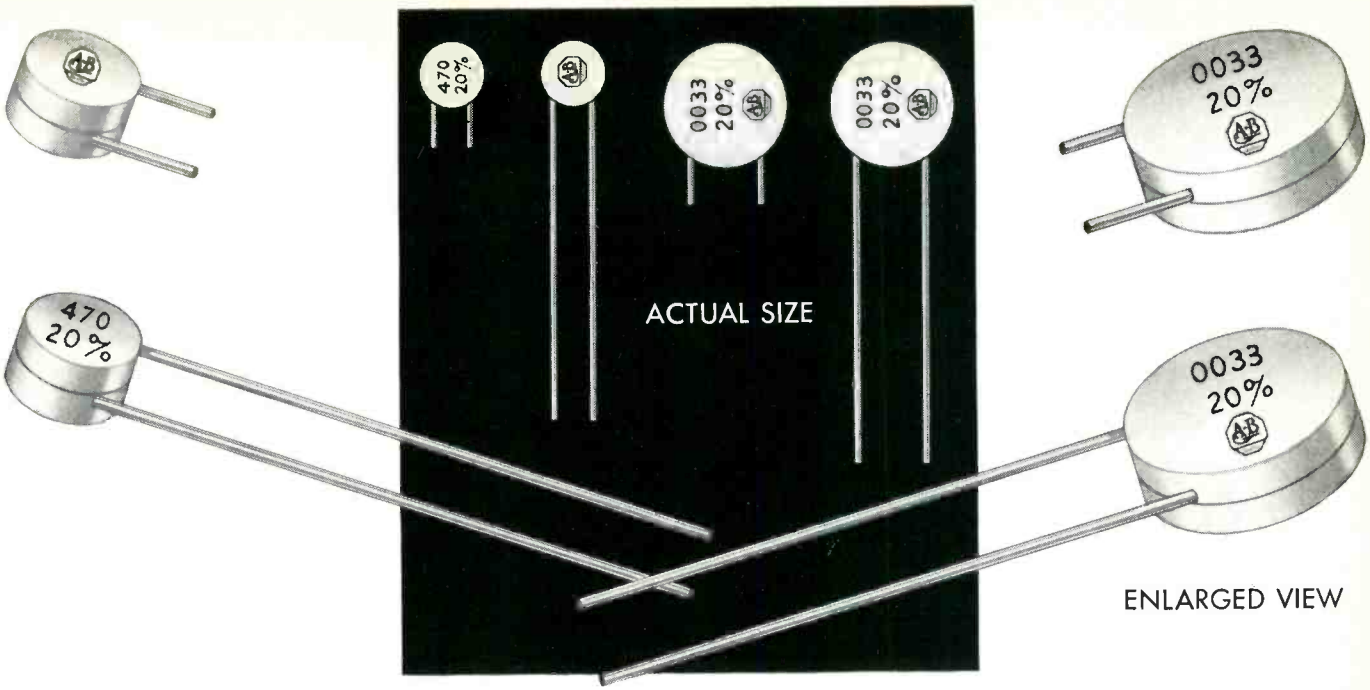
PERTINENT PATENTS

By NORMAN L. CHALFIN
Hughes Aircraft Co.
Culver City, Calif.

NEED for patent examiners is probably greater than ever before. Details of employment opportunities for engineers in this field are appended following the patents reviewed this month.

Character Writing

Two recently issued patents represent an interesting technique in



Ceramic Encased Capacitors for Continuous Operation

AT 150 C AMBIENT TEMPERATURE

These Allen-Bradley capacitors are encased in a ceramic shell—an excellent insulation. They can, therefore, be mounted adjacent to "live" parts without danger of leakage or voltage breakdown. They are available in RETMA and MIL values from 2.2 to 3300 mmfd.

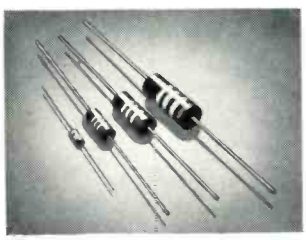
Allen-Bradley encased capacitors are rated at an ambient temperature of 150 C (continuous operation at 500 volts d-c). Ordinary uninsulated capacitors have a maximum ambient temperature rating of only 85 C. Also at a given capacitance at 25 C, Allen-Bradley encased capacitors, over a temperature range from minus 55 C to plus 150 C, will not vary more than plus or minus 30%. These encased capacitors are uniform in configuration and dimensions, a feature of great value in automatic assembly operations. Being completely free of wax, sticking together and gumming up of production machinery are eliminated.

Since the ceramic shell takes the place of the usual resin coating, there is no resin on the lead wires, making it possible to solder closer to the dielectric disc with resultant lower series inductance. These capacitors can be supplied with long or short leads for manual or automatic assembly operations.

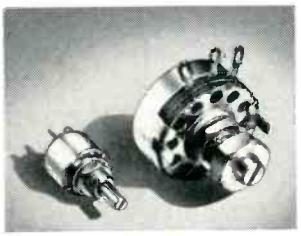
Allen-Bradley encased capacitors are another contribution to the military effort to obtain superior electronic components. Send for data on these ceramic encased capacitors, today.

Allen-Bradley Co., Milwaukee 4, Wis. • In Canada—Allen-Bradley Canada Limited, Galt, Ont.

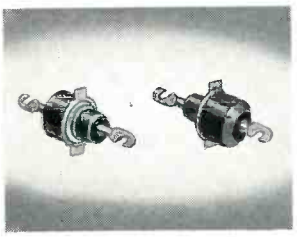
OTHER QUALITY COMPONENTS FOR RADIO, TV & ELECTRONIC APPLICATIONS



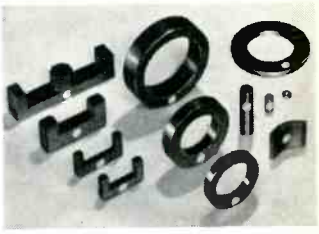
Fixed Molded Resistors
1/10, 1/2, 1 & 2 watt



Variable Molded Resistors
1/2 & 2 watt



Ferri-Cap Feed-thru Filters
with ferrite material



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Please send me technical data on the A-B ceramic encased capacitors.

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the use of cathode-ray tubes.

Patent 2,728,872 was awarded to H. M. Smith, for a "Direct Viewing Storage Tube with Character Writing Electron Gun". The patent is assigned to Hughes Aircraft Company of Culver City, California.

As shown in Fig. 1, the invention consists of a cathode-ray tube in which there is a beam-forming system followed by a first set of deflection plates. Beyond the first set of deflection plates there is a character mask. Details of the mask are shown in Fig. 2.

The first beam-deflecting system under control of appropriate deflection-voltage generators directs the beam to the position of a given letter position of the character mask. The beam that passes through the character-shaped opening of the mask now has a cross-section of the character shape. Electron lenses

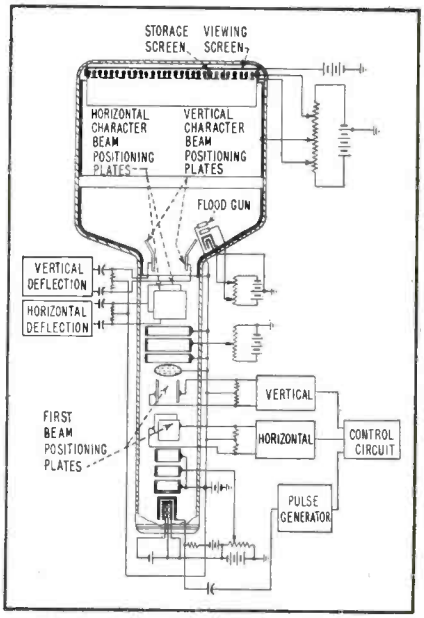


FIG. 1—Elements of the character-forming tube

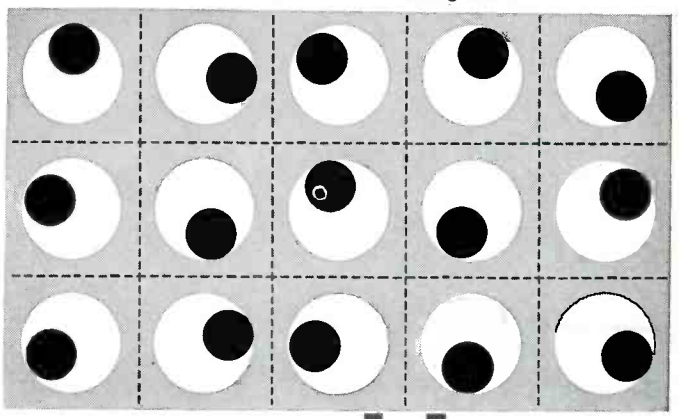
sharpen this character-shaped beam and a second set of deflection plates direct the character-shaped beam to the viewing screen.

Each selected character is positioned to follow the last in succession and when a complete line of text has been displayed the next character appears on the line below. Any message typed on the viewing face of the cathode-ray tube may be stored on the face by the storage screen as long as the storage screen

a quick release fastener that...

solves alignment problems

Illustration indicates infinite variety of positions assumed by screw fastener to compensate for misalignment.

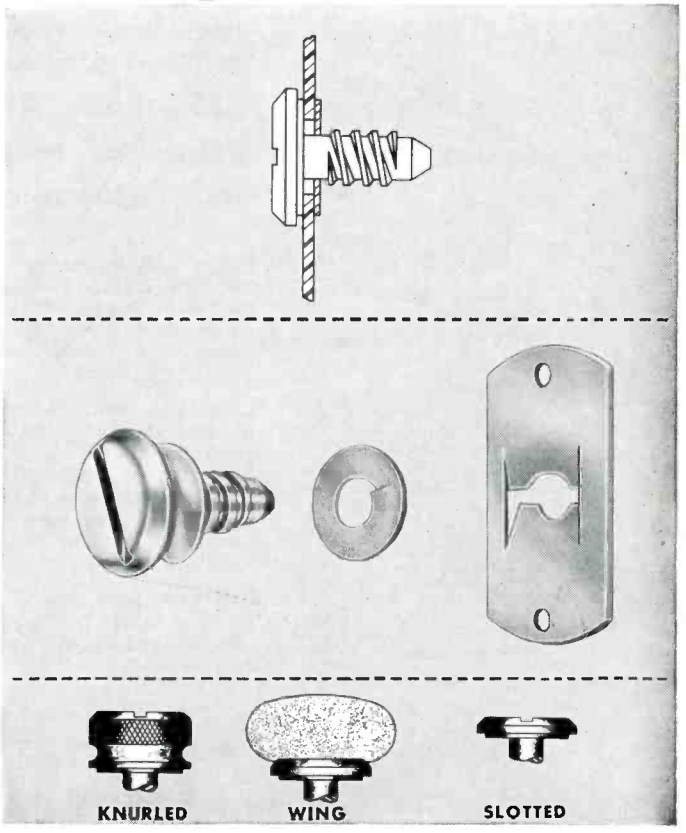


"FLOATING SCREW" ASSEMBLY COMPENSATES FOR OUT-OF-LINE DOORS AND PANELS

Installation of access doors and panels is made easy and production is speeded with Southco Quick-Release Fasteners. The wide alignment tolerances of Southco's "Floating Screw" adjust automatically to misalignment, saving mechanics' time. Also, the Southco "Floating Screw" insures accurate and uniform closure throughout the life of the equipment, compensating for warpage and bends resulting from hard usage.

One Southco grip length can meet most panel thicknesses on the average assembly— no need to specify many fastener sizes!

For complete information, write Southco Division, South Chester Corporation, 233 Industrial Highway, Lester, Pa.



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SOUTH CHESTER CORPORATION • LESTER, PENNSYLVANIA

is activated. So long as the flood gun activates the storage screen the stored image may be viewed. Deactivating the storage screen removes the image and a new message may be written.

► **No-Storage Type** — In Patent 2,735,956 awarded to J. T. McNaney for "Cathode Ray Apparatus" a similar apparatus is shown without the storage elements. This patent is assigned to General Dynamics Corp.

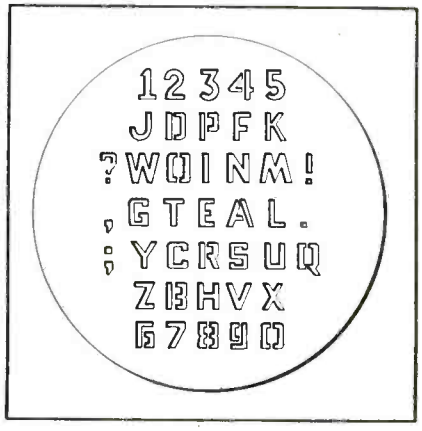


FIG. 2—Mask used in storage tube

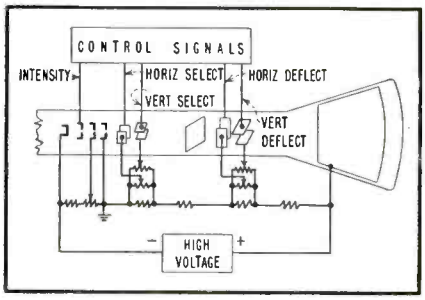


FIG. 3—One-line character tube

In Fig. 3 the elements of the McNaney system are shown. It would appear that this device might be intended for film recording use rather than for direct viewing since from the description it appears that a single line of letters only may be displayed.

A form of the device is shown in the McNaney patent for use with ppi type displays and in connection with radar identification systems.

Combined Tuner

In a recent patent 2,686,221 issued to J. Avins of RCA a combination a-m/f-m/tv receiver system is described wherein sound signals from any one of the three are de-

modulated in a common i-f channel.

In Fig. 4 a simplified block diagram illustrates how this inventor proposes to employ his system.

Two tuning systems are involved. One provides a-m or f-m signals. The other provides the tv signals.

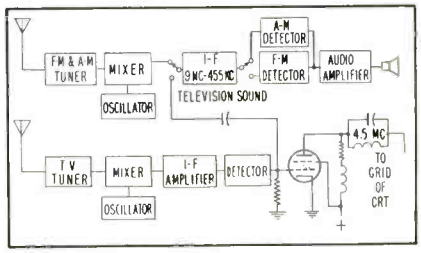


FIG. 4—Combined tuner for audio programs

The sound channel of the tv receiver at 4.5 mc is applied to the audio portion of the audio-radio receiver at 9 mc. This can probably be done by a frequency doubling diode system.

When used as an f-m receiver—the i-f is 9 mc and the i-f for broadcast is the standard 455 kc. A switch selects a-m or f-m detectors.

Patent Examiners

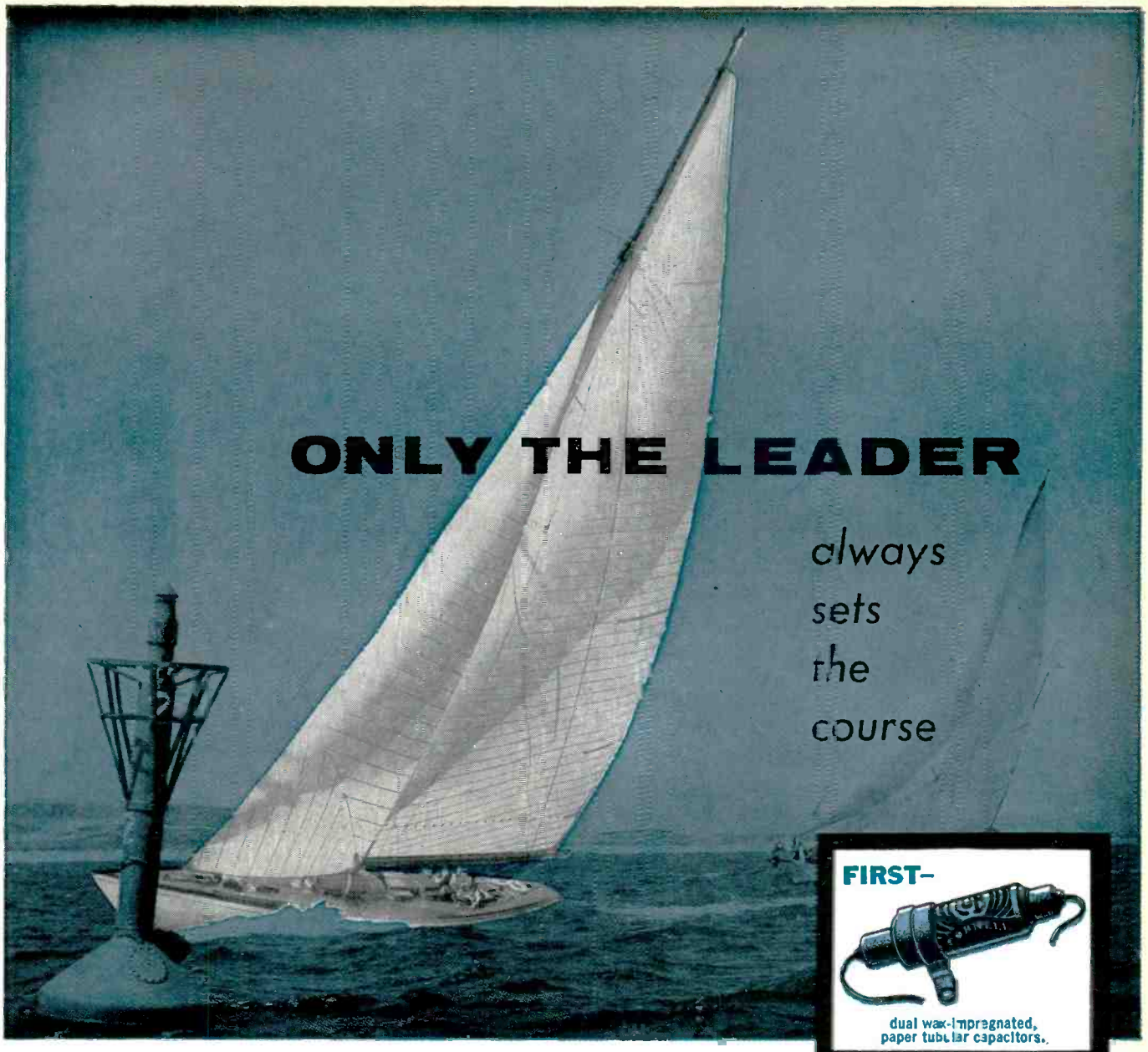
The U. S. Patent Office has advised that there are a number of openings for recent engineering graduates in the Patent Examining Corps.

Patent examiners after a short training period review patent applications submitted to the U. S. Patent Office to determine the novelty of the invention in relation to the prior art.

Engineers whose interests and abilities are especially directed towards electronics and even more particularly to electronic computers are urged to consider joining the corps.

The starting salary for a graduate with a B. S. degree is GS-5 ($4,480) or for a master's degree or six months experience is GS-7 ($5,335). Rapid promotions to $7,570 in 4½ or 5 years are possible and depend only upon ability and initiative.

Requests for further information about the openings and applications should be directed to The Commissioner of Patents, Washington 25, D. C.



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capacitor used in proximity fuse.

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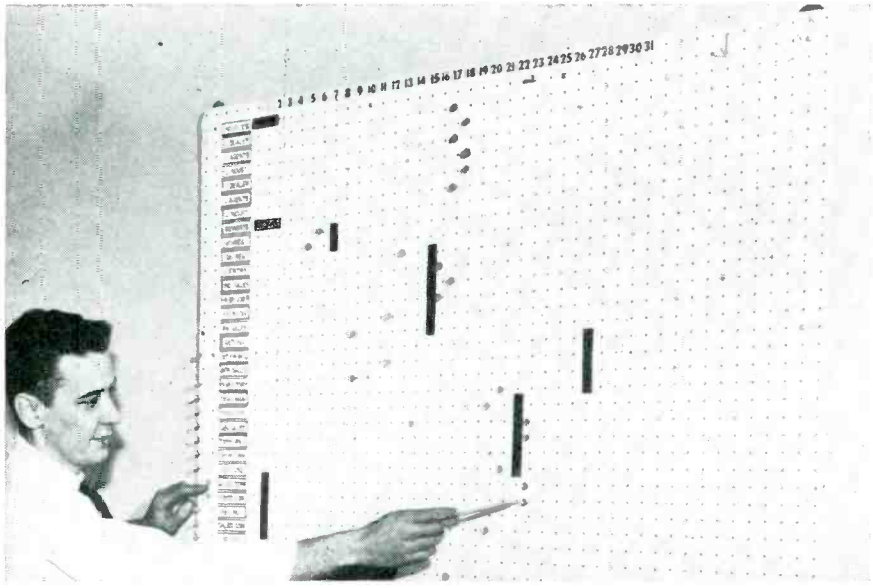
THERE ARE MORE C-D CAPACITORS IN USE TODAY THAN ANY OTHER MAKE

Production Techniques

Edited by JOHN MARKUS

Production Control Chart Uses Golf Tees in Peg-Board



Supervisor points to golf tee inserted in board to indicate completion of project on 23rd of month. Different colors of tees can provide additional information

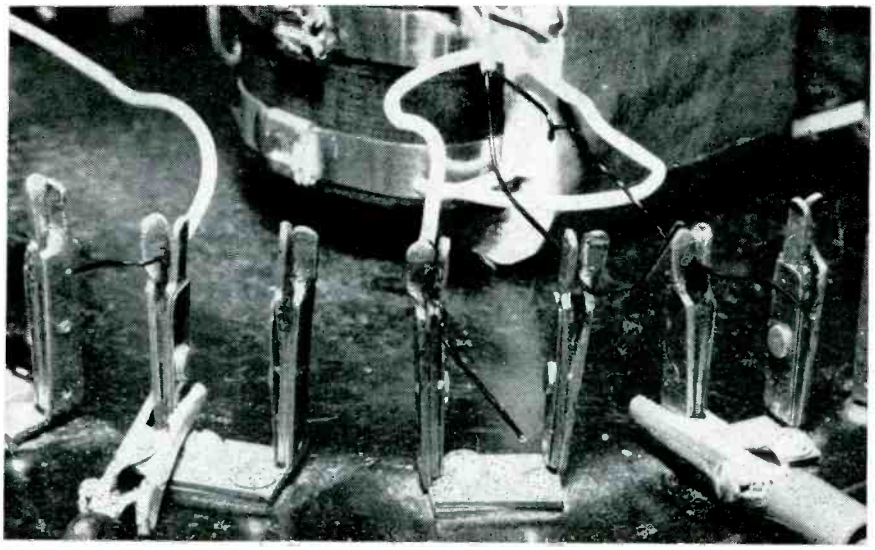
THE FACT THAT molded plastic golf tees fit snugly into the holes of Masonite Peg-Board panels makes it possible to set up a variety of production control boards quickly on plant floors with these materials.

Numerals for the days of the month can be cut out from any convenient calendar and pasted over vertical rows of holes across the top of the board. Gummed or pressure-sensitive labels can be used at the left side of the board for horizontal rows representing jobs in production. Vertical strips of red Scotch tape can be used to represent delivery dates of jobs. Other colors of tape can be used for various intermediate stages of a contract. The tees can be inserted to indicate completion dates.

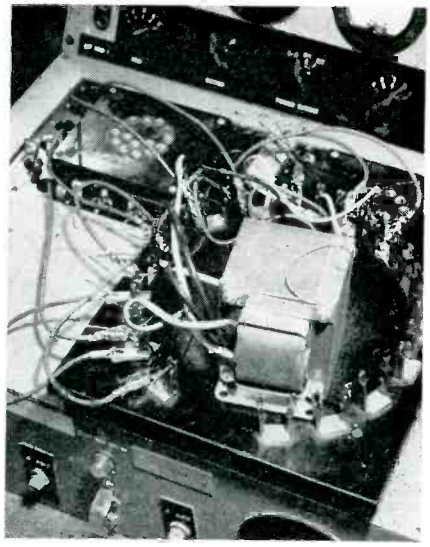
Filed-Edge Test Clips Cut Enamel Insulation

KNIFE-EDGED BRASS test clips (a modification of the Rapid test clips made by Rapid Specialties Co., Chicago, Ill.) are used by Lenkurt Electric Co., San Carlos, Calif., to cut through heavy enamel insulation on lead wires. This obviates a separate lead-stripping operation in the testing of certain components.

▶ **Modification**—Normal brass test clips were modified by turning the tips of one of the blades at right angles to the bases of the blades, then filing the inside edges. When enameled lead wires are slid into the modified clips, the sharp and roughened inside edges of the



Brass test clips modified to eliminate lead-stripping operation. One blade of each clip is twisted at right angles to the other and the inside edge is sharpened and roughened by filing. When insulated lead is inserted, teeth cut through enamel



Testing of power transformer, using modified test clips for convenient lead connections without stripping insulation

going...

going...

gone!

KESTER "44" RESIN, PLASTIC ROSIN AND "RESIN-FIVE" FLUX-CORE SOLDERS owe their production line popularity to the simple fact that they provide the exactly right solder for every soldering application. It's not difficult to realize why Kester is consumed so rapidly . . . because of its great adaptability to so many different soldering operations.

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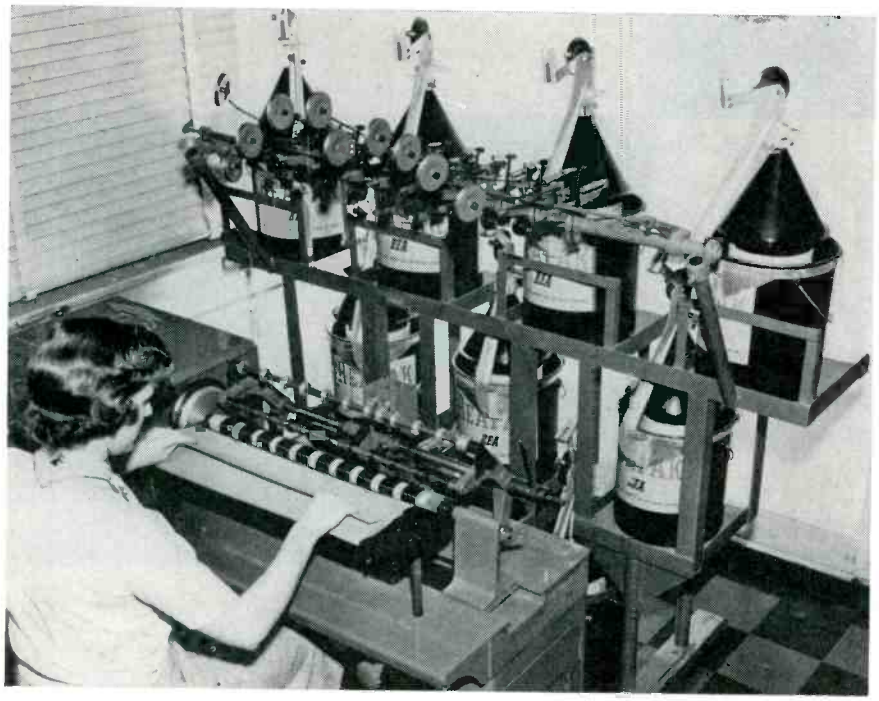
right-angle blades cut through the enamel insulation and make contact.

▶ **Application**—In the transformer department the clips are mounted on a board in a ring large enough to enclose reactors and power transformers, which are tested prior to canning and mounting of header boards. Before development of the modified test clips, the department relied on an acid bath to strip enameled leads for this test operation.

Steel Pails Replace Spools for Shipping Magnet Wire



Coil-winding machine pulls wire directly out of steel pails, each holding as much wire as ten 6-inch spools. Only modification needed on machine was mounting of plastic guide cone over each pail

New pail holds 100 lb of magnet wire, random wound around 7-inch fiber core fitting over raised part of bottom

STEEL PAILS solve the problems of packaging, shipping and dereeling magnet wire. Use of the pail as a wire container results in manufacturing economies, simplifies material handling, eliminates a complete bookkeeping phase and minimizes transit and storage damage for the wire itself.

The steel pail was developed cooperatively by Jones & Laughlin Steel Corp. (Container Division, 405 Lexington, New York, N. Y.) and the Rea Magnet Wire Company, Inc., of Fort Wayne, Indiana.

▶ **Advantages**—The wire pail reduces down-time of winding machines tremendously. A 6-inch spool holds 9 to 10 pounds of magnet wire, whereas the steel pail holds 90 to 100 pounds. Use of the wire pail gives a 90-percent reduction in down-time for reloading wire. Since many winding machines use several hundred pounds of wire in an eight-hour shift, the time-saving and economy are considerable.

The wire pail also eliminates the need for expensive, highly polished cast spools and the complicated bookkeeping associated with the handling of these spools. These spools require a deposit by the customer which is refunded when they are returned. After being returned, they must be inspected and reworked if damaged.

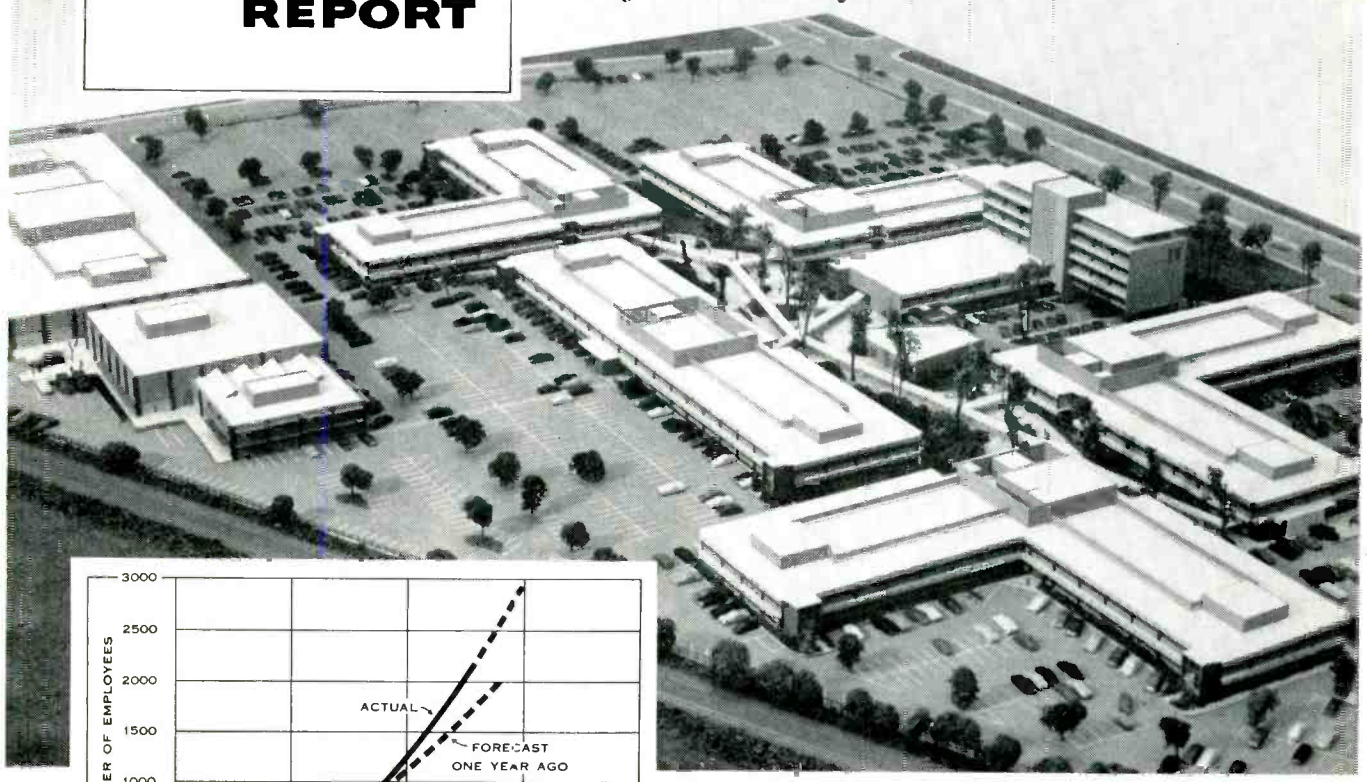
In contrast, the 26-gage steel pail is in itself an extremely rugged shipping container, yet its cost is

Pails are readily palletized for handling by fork truck and for trailer shipment

Setup for crimping covers on pails in one speedy operation at magnet wire plant

PROGRESS REPORT

After Thirty-Four Months...



RESEARCH AND DEVELOPMENT PERSONNEL The above curve shows the growth in Ramo-Wooldridge personnel which has taken place since our Progress Report one year ago. A significant aspect of this growth is the increase in our professional staff which today is made up of 135 Ph.D's, 200 M.S's and 265 B.S's or B.A's. Members of the staff average approximately ten years' experience.

FACILITIES Within the past few months, construction has been completed at our Arbor Vitae complex, which now consists of eight modern buildings of 350,000 square feet, four of which are illustrated at the bottom of the page. Nearby is the R-W flight test facility, including hangar, shop, and laboratories, located on a 7-acre plot at International Airport.

To provide additional space for our continuing growth, construction has been started on an entirely new 40-acre Research and Development Center, located three miles from the Arbor Vitae buildings. The photograph above is of a model of the Center, which we believe will be one of the finest research and development facilities in the country. The first three buildings, now under construction, will total 250,000 square feet.

A second major construction program is underway on a manufacturing plant for quantity production of electronic systems. The initial unit of the plant, located on a 640-acre site in suburban Denver, Colorado, will be completed next spring and will contain approximately 150,000 square feet.

PROJECTS Our current military contracts support a broad range of advanced work in the fields of modern communications, digital computing and data-processing, fire control systems, instrumentation and test equipment. In the guided missile field, Ramo-Wooldridge has technical direction and systems engineering responsibility for the Air Force Intercontinental and Intermediate Range Ballistic Missiles. Our commercial contracts are in the fields of operations research, automation, and data processing. All this development work is strengthened by a supporting program of basic electronic and aeronautical research.

THE FUTURE *As we look back on our first three years of corporate history, we find much to be grateful for. A wide variety of technically challenging contracts have come to us from the military services and from business and industry. We have been fortunate in the men and women who have chosen to join us in the adventure of building a company. We are especially happy about the six hundred scientists and engineers who have associated themselves with R-W. Their talents constitute the really essential ingredient of our operations. We plan to keep firmly in mind the fact that the continued success of The Ramo-Wooldridge Corporation depends on our maintaining an organizational pattern, a professional environment, and methods of operating the company that are unusually well suited to the special needs of the professional scientist and engineer.*

The Ramo-Wooldridge Corporation

5730 ARBOR VITAE ST. • LOS ANGELES 45, CALIF.

low enough to permit use as a no-deposit, no-return item. The welded seams of the pail are perfectly smooth, providing an inner surface which cannot injure the delicate insulation.

▶ **Dereeling**—The heavier sizes of magnet wire down to No. 14 have been dereeled from the pails at speeds up to 5,000 feet a minute, by pulling directly out of the top of the pail. To facilitate dereeling at speeds in excess of 2,000 feet a minute, a metal or plastic cone with a nylon guide is placed over a pail after loading on a winding machine.

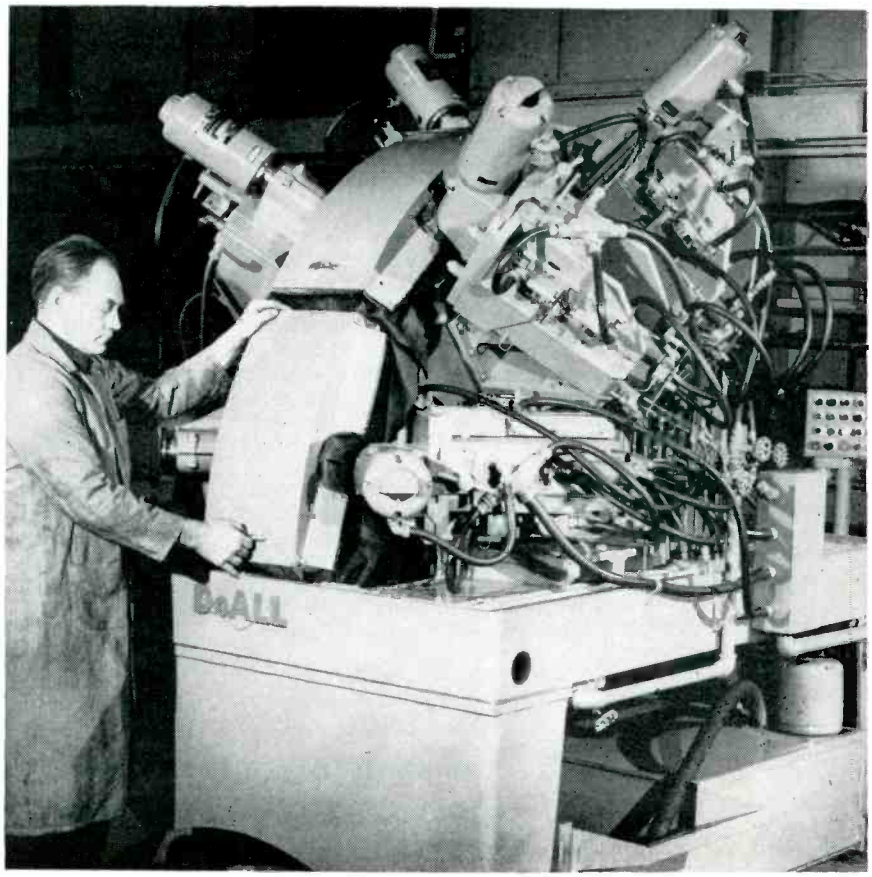
A deep-drawn bottom on the pail accomodates a fibre core around which the wire is coiled. Metal bails and wooden grips facilitate handling. The design permits safe staking and palletizing. Pallets of 18 pails, totaling 1,800 pounds, are strapped together and efficiently loaded by fork truck into trailers. The pallets are unloaded in the same manner at the customers' plants.

Automatic Grinder for Ferrite Yokes

FOUR-SEGMENT FERRITE cores for deflection yokes of color television picture tubes are automatically ground to desired dimensions, finish and flatness in an RCA plant at a production rate of one piece every 3 seconds, on a special automatic three-section precision segment grinder built for the purpose by The DoALL Co. of Des Plaines, Ill.

The deflection yoke is made of four coils, used with a core molded in four segments to provide the desired electrical characteristics. These segments are molded from a special ferrite mix, then sintered by firing at high temperature, after which they are hard enough to cut glass.

To get maximum efficiency from



Special twin-spindle, three-station grinder for color tv deflection yoke segments. Turntable with holding fixtures passes vertically between pairs of motor-driven grinders, first pair of which are between arms of operator here

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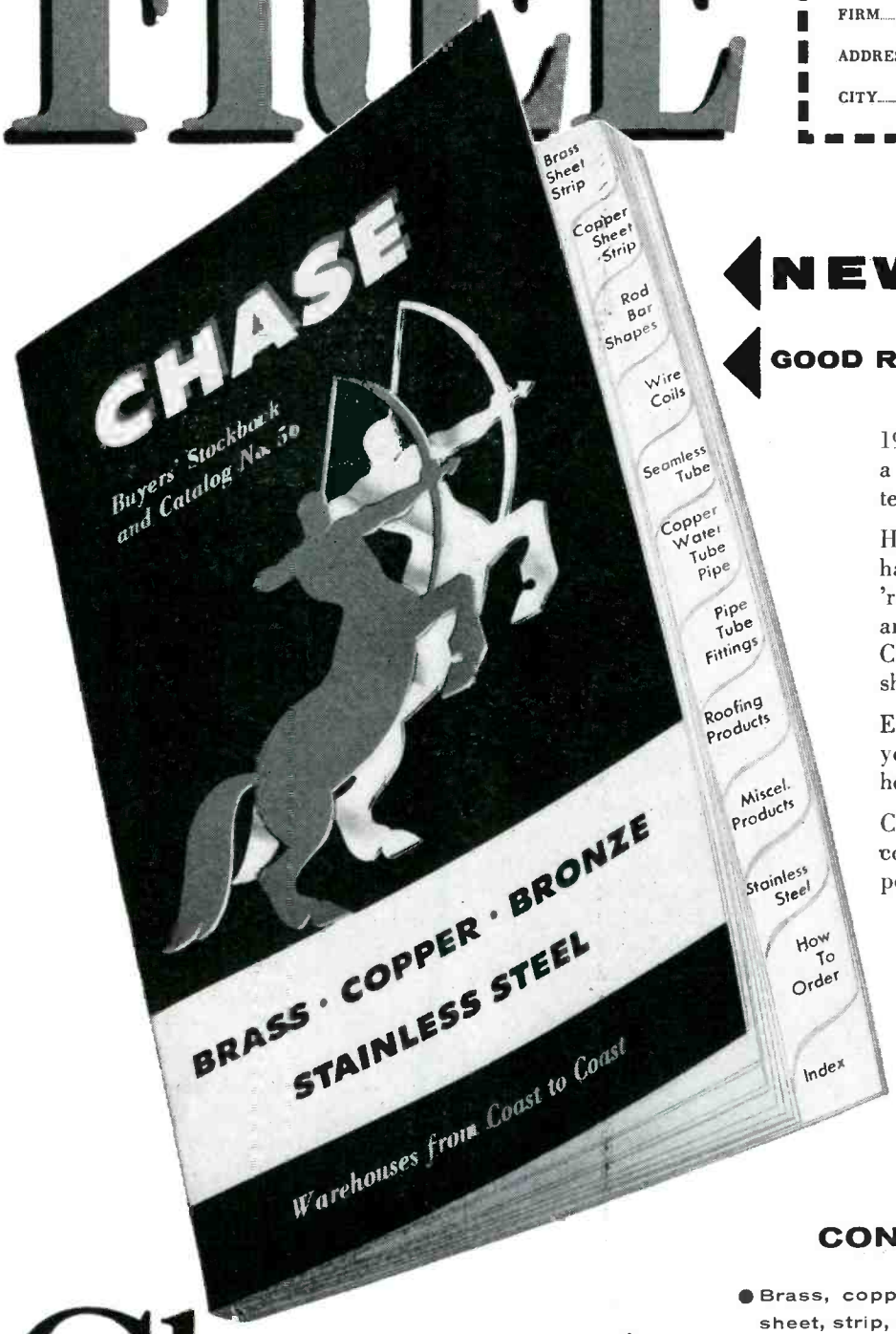

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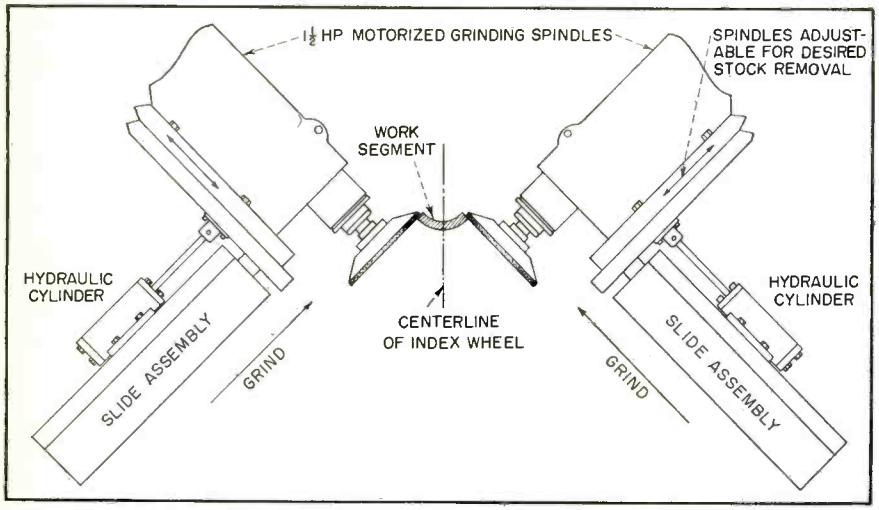


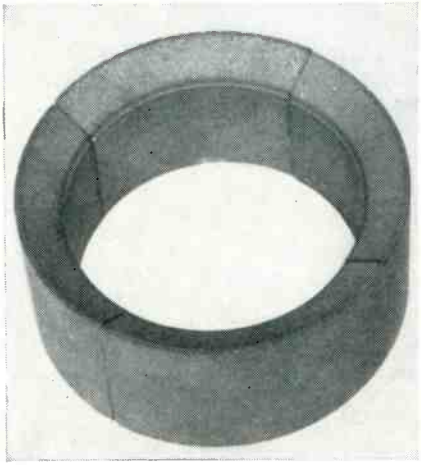
Travel paths of grinding heads with respect to loaded core segment on turntable, for grinding both surfaces of segment simultaneously

these cores it is necessary to grind the eight mating surfaces between the four segments accurately to produce an exact cylinder. The machine grinds both ends of the segment simultaneously, taking them down to the desired dimensions, finish and flatness in three fast, successive grinds. The finish is 16 microinches rms, and flatness is within 20 millionths across the entire surface. Planes of the ground ends are at 90 degrees to each other within 50 microinches over the ⅞-inch end width.

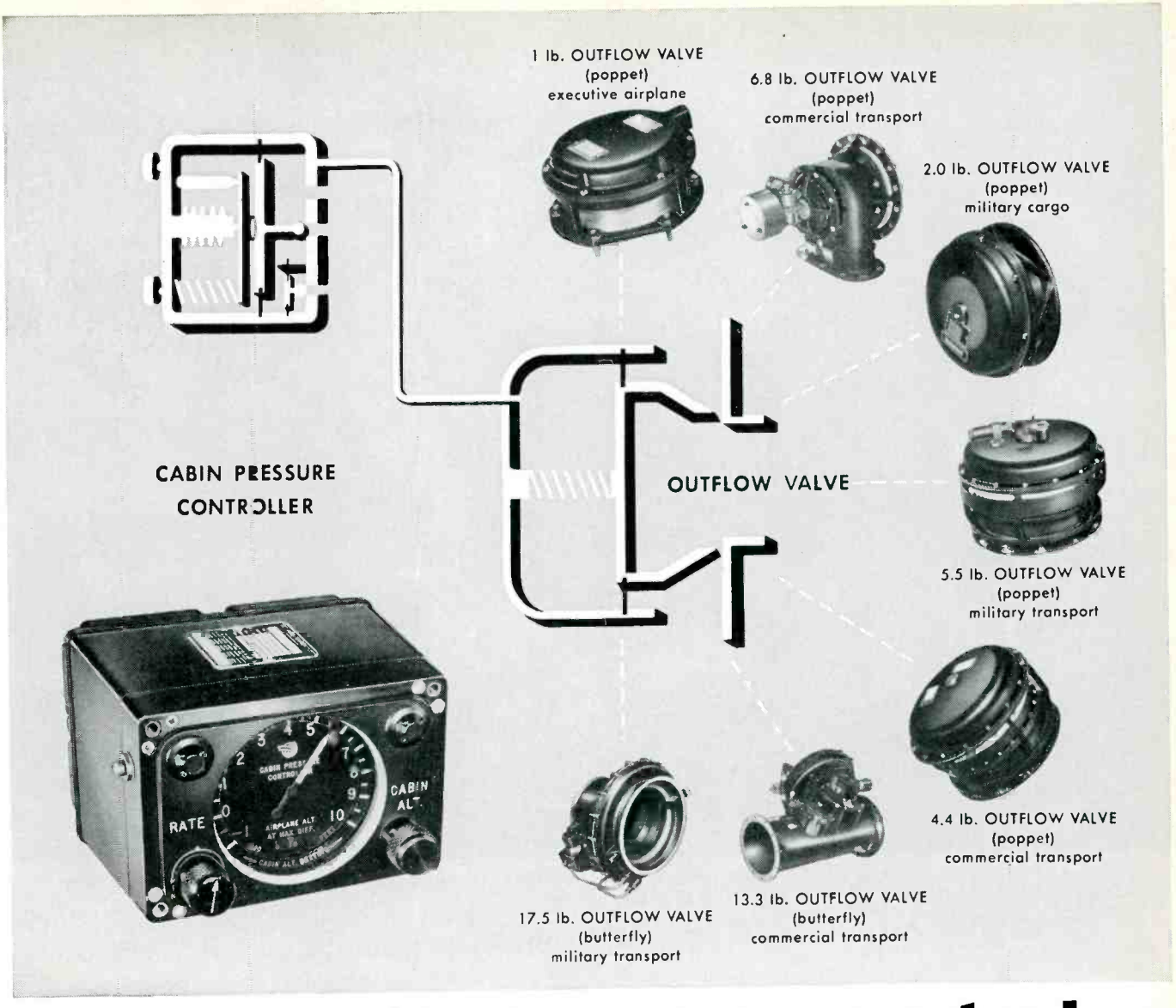
▶ **How It Works**—Molded ferrite segments are stacked in a vertical hopper, ends facing out from the machine. A hydraulic loader at the base of the hopper pushes the bottommost segment into a fixture, one of 36 mounted on the periphery of a 48-inch-diameter vertical motorized wheel called the index wheel. Upon seating the segment, the loader also pushes a lever that causes the fixture to clamp the segment securely in place.

When a part has been loaded, the wheel vertical indexes 10 degrees, moving the loaded fixture up toward the first pair of grinding spindles and moving the next empty fixture up to the loader. The work pieces are carried through three grinding stations. At each station, the index wheel stops and is accurately positioned by a hydraulically actuated locking pin. After the index wheel is securely locked, twin grinding spindles, moving hydraulically on hand-scraped ways, carry diamond-cup grinding wheels across the segment faces. At the first station, all but 0.035 inch is removed and at the second, 0.025 inch more. At the third station, the final 0.010 inch of stock is removed to bring the piece to size and generate an extremely smooth surface flat and square to 20 millionths.

After completing their pass, the grinding spindles withdraw to starting position, the index wheel rotates through 10 degrees and the loader seats another segment in an empty fixture while the spindles advance again on a grinding pass toward the adjacent fixture. The work piece is carried past the final position where an automatic ejector



End surfaces of four-segment core must be ground at 90 degrees to each other with 16-microinch finish and flatness within 20 millionths, to assure efficient magnetic circuit for deflection yoke



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Dr. S. H. Browne (left), Assistant Director of Research, J. H. Carter, Associate Director of Research and Staff Scientists P. L. Taulbee and E. V. Stearns discuss weapon requirements for defense of continental United States.

SYSTEMS PLANNING

▲ ▲ ▲

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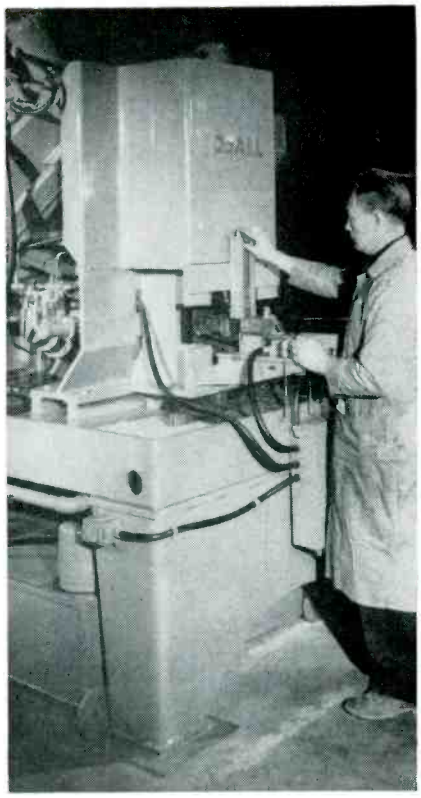
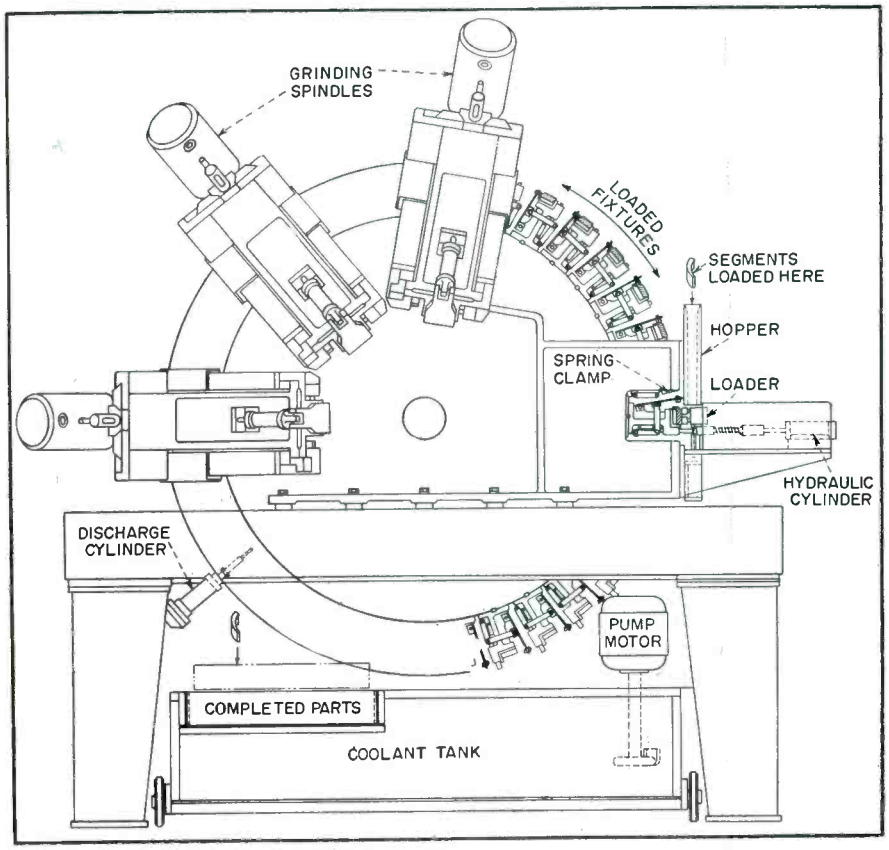
drops it to a conveyor which carries it away from the machine.

▶ **Holding Fixtures**—In designing the 36 work-holding fixtures, several severe limitations were dealt with. The work piece of sintered powdered metal is extremely hard, brittle and rough. The pieces vary considerablly due to distortion that takes place during the sintering operation. The fixtures must withstand a bath of grit-laden coolant and be strong enough to support the work pieces under grinding loads. Their location on the periphery of a revolving wheel and the flood of grit-laden coolant makes either hydraulic or electrical actuation impractical.

The ultimate solution was a compact lever-actuated spring clamp. Locating pads in the fixture are made of hardened tool steel and are designed for easy removal and replacement. Sufficient adjustment has been provided to permit compensation for possible variation between runs of the sintered parts. The part is held in place by a leaf

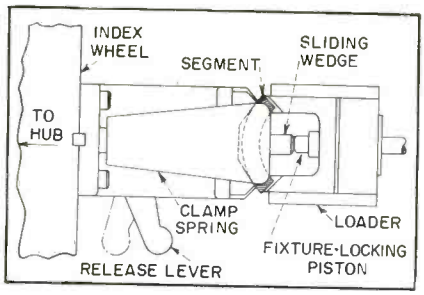


Loading core segments into hopper of automatic grinder. Completed segments drop into tote box on cart which can easily be rolled out from under grinder



Side view of grinder, showing location of loading station at right, vertical turntable and discharge cylinder (left) that allows finished parts to drop into tote box on coolant tank cart under machine

spring to which are attached hardened fingers which contact the tapered lip of the segment. A simple link arm and wedge system, actuated by the hydraulic loader, locks the spring-mounted fingers against the piece. A second arm is actuated by the hydraulic discharge mechanism to push the locking wedge back, permitting the fingers to release their hold and drop the finished part upon a conveyor running through the hydraulic tank at the bottom of the machine.



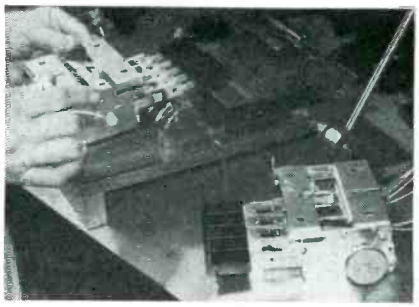
Top view of holding fixture on turntable, showing position of loaded core segment. Lever protruding below is tripped by hydraulic piston at end of grinding cycle to release finished part

▶ **Index Wheel**—The wheel is indexed by a hydraulically actuated rack and pinion operating through a cone clutch which is also engaged hydraulically for the indexing stroke and disengaged to permit the rack to return.

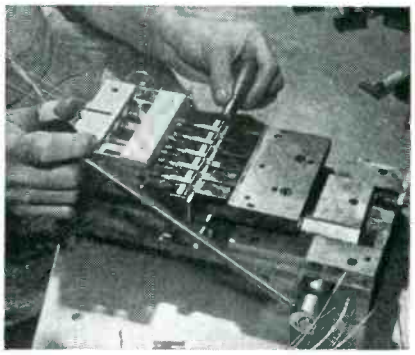
As an indexing movement ceases, the locking locating pin moves under hydraulic action to engage the adjacent bushing in the index wheel. At the same time, another cylinder applies pressure against the opposite side of the wheel to support the wheel and thereby prevent any deflection that might be caused by the pressure of the locking pin against the wheel. The short taper of the pin and bushing makes these members self-centering.

Installing Pushbuttons on Auto Radio Tuners

FIVE BUTTONS at a time are pushed into position on the slides of an auto radio tuner with a special fixture developed by Radio Condenser Co., Camden, N. J. The operator places each button on the end of



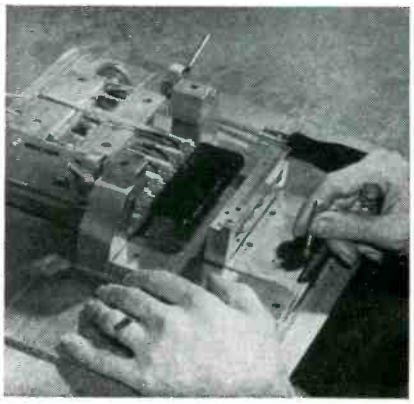
Placing tuner in button-pushing fixture after setting a button loosely in position on each slide



Operator inserts stiff metal rod through holes in fixtures and in slides of tuner to withstand thrust, then pulls lever forward with right hand to push buttons over slides

its slide with proper orientation, then drops the tuner into position on the fixture. Next, she inserts an icepick-like tool through matching holes in the five slides and the fixture to prevent transfer of pressure to the tuning mechanism. Pulling the operating lever of the fixture then brings forward a bar that pushes all five buttons firmly down on their slides in precise alignment.

▶ **Checking**—The tuner next goes to a checking position, where it is



Tuner in position on fixture used to detect bent slides

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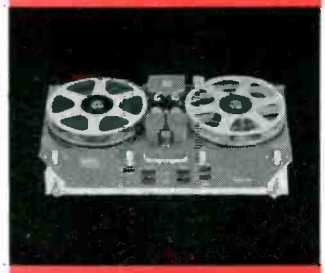
FR-100 — Overall performance specifications are the best of any magnetic tape recorder now in production. Modular design of the FR-100 provides broad scope that gives engineers and scientists a freedom to experiment and develop advanced data gathering techniques.

6 tape speeds 1⅞ to 60 in/sec; D-C to 100,000 cycle/sec. frequency response; choice of 3 recording methods on any track by plug-in interchangeable amplifiers.

MOBILE



800 — For airborne, shipboard or vehicular use, this recorder combines excellent performance specifications with ruggedness, compactness and light weight. It is also resistant to shock, vibration and environmental extremes. The 800's versatility is second only to the FR-100.

4 tape speeds; D-C to 30,000 cycle/sec. frequency response; choice of 3 recording methods on any track by plug-in interchangeable amplifiers.

DIGITAL

FR-200 — This magnetic tape transport fulfills the fast start-stop requirements of digital handling. It also provides a unique single loop threading feature which greatly simplifies tape change and minimizes chance for faulty threading by inexperienced personnel.

Tape attains full speed or full stop within less than 5 milliseconds; standard machine has 30 in/sec. tape speed and 7 tracks on ½-inch tape; other combinations on order.

REPEATABLE

S-359 — The endless tape loop handled by this transport serves a number of special needs: time delay, repeating signal for analysis, monitoring with "infinite" time limit, and various programming functions. Loop length is continuously variable from 3½ foot minimum to 25, 50 or 75 foot maximum.

Available for ¼, ½ or 1-inch tape; same tape speeds, heads and other characteristics as Ampex reel-to-reel recorders.

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300 SERIES — These are Ampex's long established line. For many applications where the great versatility and extremely high performance specifications of the newer FR-100 are not needed, a 300 series machine provides high quality performance and great reliability at less cost.

Available for various types of recording: 303 for pulse-width modulation; 306 for FM-carrier recording; 307 for direct recording; also combinations.

A mark of the Ampex leadership in magnetic tape recorders is the fact that every machine produced equals or exceeds all published performance specifications. A general tape instrumentation brochure and descriptive literature on various models are available on request. Write Dept. E-2788

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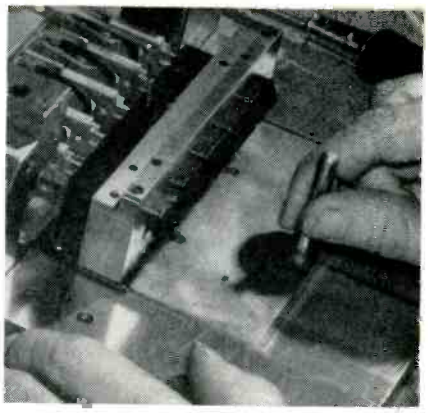

Window of sliding portion of fixture is here pushed over buttons. This slide must move freely over the buttons without touching them

loaded into a bench fixture having two locking clamps that insure precise positioning of the tuner body. The operator pushes a slide having an opening for each button over the buttons. If this slide can be moved back and forth freely over the buttons, the tuner will mount properly in the auto radio with the buttons moving freely through their escutcheon.

Induction Soldering on Conveyor Line

FEED-THROUGH terminals on the chassis of a vhf television tuner are automatically soldered into position in one passage down a slat-

Conveyorized induction soldering line for feed-through terminals. Conveyor is unloaded by operator at rear

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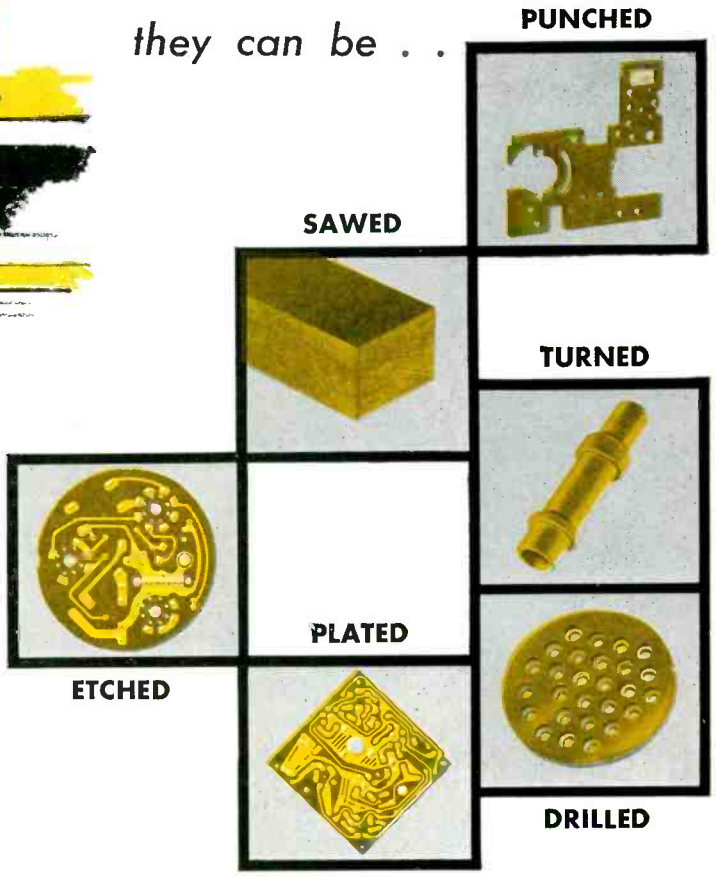

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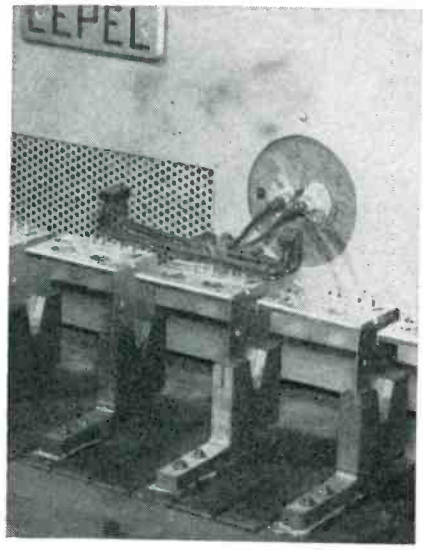
type conveyor line over which is mounted a two-turn oval work coil of a Lepel high-frequency induction heater. This conveyorized setup at Radio Condenser Co., Camden, N. J., gives a production rate of over 600 chassis units per hour, each having four feed-through terminals.

The units are loaded into slots cut into heat-resisting fiber fixtures bolted to the slats of the conveyor.



Method of mounting two-turn work coil for fusing solder preforms as conveyor moves feed-through terminals under coil

Operators standing alongside the conveyor, ahead of the work coil, load chassis units into the fixtures, then drop in the terminals and the doughnut-shaped solder preforms. One operator at the end of the conveyor takes care of unloading the soldered pieces. Control of conveyor speed is achieved by combining a gear box with a pulley and belt type of speed reducer driven by an electric motor.

Stapling Back Cover Hinge to Television Cabinet

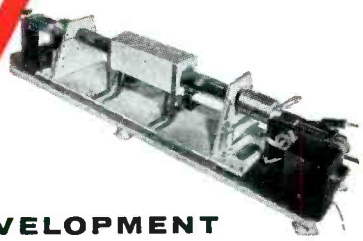
A SINGLE operation of an air stapler attaches the hinge strap of the removable pressed wood back cover to the rear edge of each television cabinet on Emerson's assembly line in Jersey City, N. J. This strap is applied in accordance with underwriter requirements, to prevent

RESEARCH

Solid state devices for not-so-distant future applications command continuous study by Tung-Sol engineers. In this instance the purifying of silicon is under close scrutiny.

DESIGN

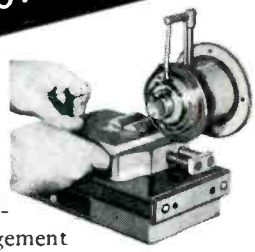
Efficiency and utility are among the foremost considerations of all Tung-Sol semiconductor blue-printing. Here the resistivity of single germanium crystals is being measured.



DEVELOPMENT

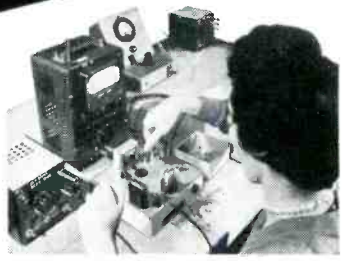
Ever alert to the intensified and varied demands made by transistorizing, Tung-Sol provides full-scale development of new semiconductor types. Here the latest techniques of germanium diffusion are explored.

New Production Facilities for Tung-Sol Semiconductors



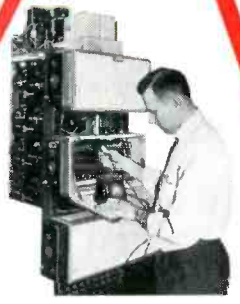
PRODUCTION

A complete manufacturing division—with its own full-time engineering and management staffs—handles every phase of the critical production process from metal refining to finished product. Here germanium ingots are being sliced into 15/1000" blanks.



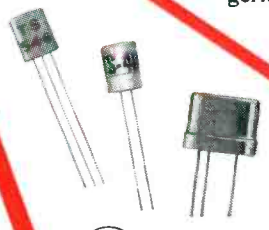
TESTING

100% testing—life, mechanical and electrical—characterizes the Tung-Sol manufacturing program. In this illustration, transistors are 100% checked for noise factor.

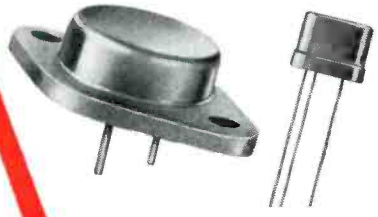


QUALITY CONTROL

Every step of Tung-Sol semiconductor manufacture is subjected to intensive quality control that permits no compromise with premium quality. Here transistors are life-tested under conditions in excess of their ratings.



TUNG-SOL®
SEMICONDUCTORS



For technical information write to Commercial Engineering Division

TUNG-SOL ELECTRIC INC., Newark 4, N. J.

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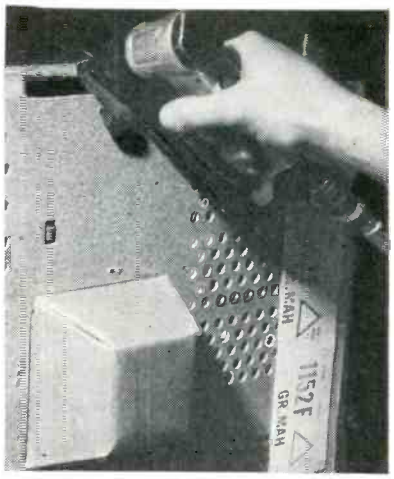


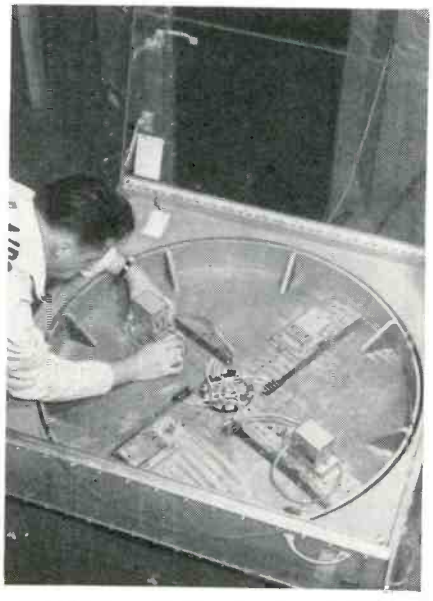
Attaching cover-hinging strap to back of television cabinet with air stapler. Below is new pressed cardboard type of cup for picture tube socket

servicing inside the set without first disconnecting the interlock. During servicing, the cover is swung upward to rest on top of the cabinet.

The woven cloth strap is threaded through a punched slot in the back cover at an earlier subassembly position and the strap ends are lightly stapled together to prevent the strap from falling out.

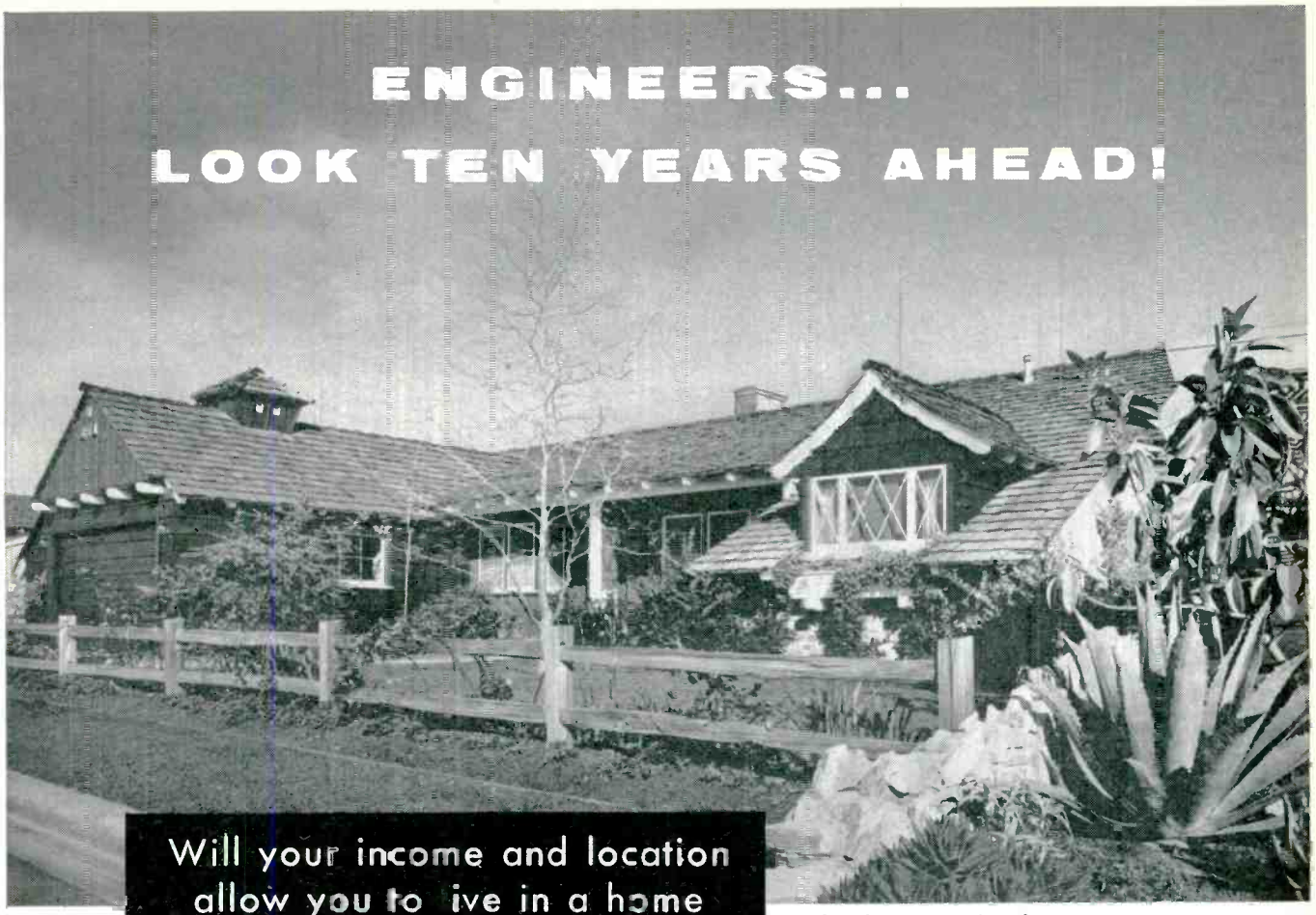
Simple Centrifuge Tests Missile Components

A SIMPLE CENTRIFUGE capable of testing electronic components under stresses up to 100 g, in the



Installing component on centrifuge. Transparent plastic hinged covers are closed before starting drive motor under centrifuge

ENGINEERS...
LOOK TEN YEARS AHEAD!



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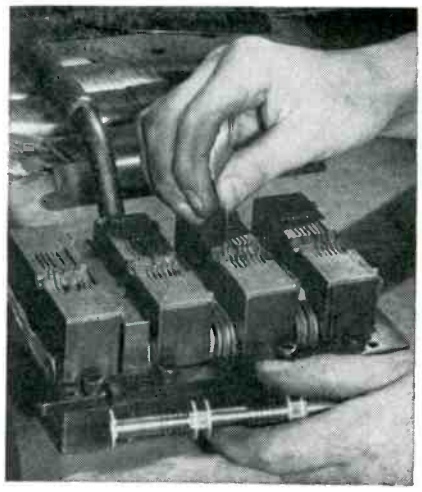
Hawthorne, Calif. guided-missile plant of Northrop Aircraft, Inc., is only 30 inches in diameter. Four components, each pair of equal weight, can be tested on the device at one time. Wires leading from test items go through slip rings to instruments which indicate functioning of the electronic devices under the extreme loads. Vernier scales beside the component mounts allow precise settings to determine the loads. The tests are made before parts are installed in the USAF Northrop SM-62 intercontinental Snark missile.

Tuning Capacitor Assembly Fixture

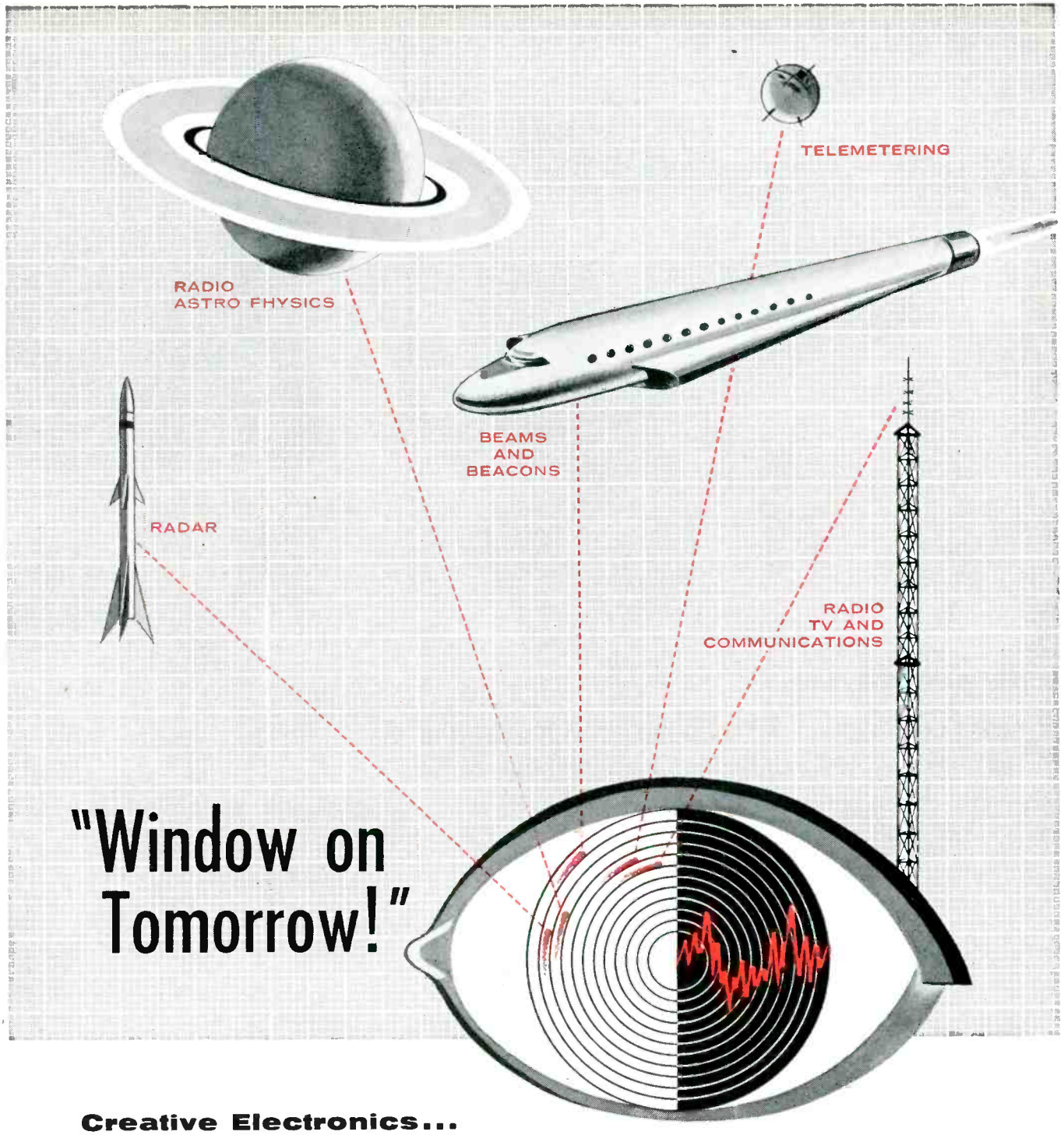
ROTOR plates for a four-gang tuning capacitor are swaged to the rotor shaft in a single operation of a large press in the Camden, N. J. plant of Radio Condenser Co. The required precision of positioning is achieved with the aid of a special fixture on which are four floating nests, each having individual machined recesses for rotor plates.

▶ **Loading**—The operator first inserts the serrated rotor plates in the appropriate end recesses of the nest, then fills the remaining recesses with plain plates. These drop in rapidly from a stack held in the hand.

The rotor shaft is next placed over the plates and tapped partly down into position, with a weighted soft fiber rod serving as a hammer,

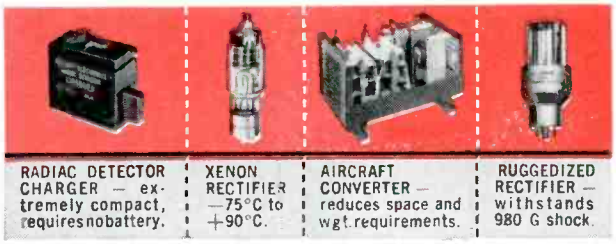


Loading plates into fixture



Creative Electronics...

CHATHAM ELECTRONICS AT WORK



RADIAC DETECTOR CHARGER — extremely compact, requires no battery.	XENON RECTIFIER —75°C to +90°C.	AIRCRAFT CONVERTER — reduces space and wgt. requirements.	RUGGEDIZED RECTIFIER — withstands 980 G shock.

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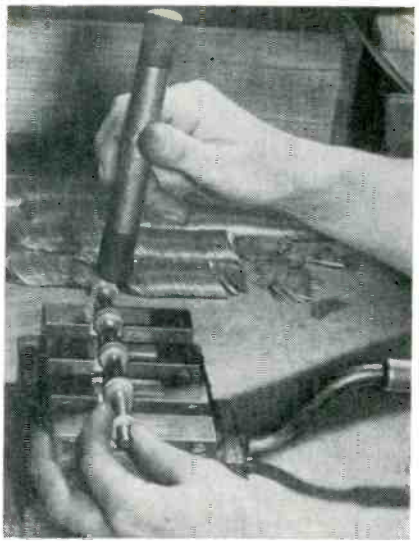
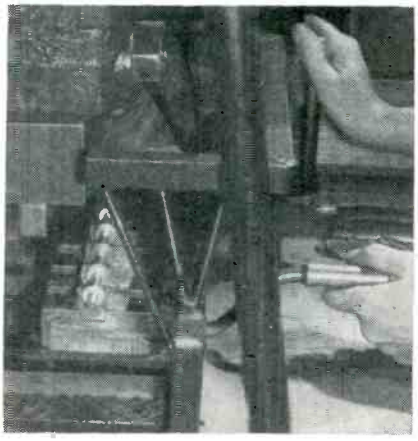


Tapping shaft down into position over loaded fixture

to insure that each plate is properly started into its groove on the shaft. The blanking die used for stamping out the individual plates is designed to provide a starting taper; this is required because the plates are thicker than the grooves in the rotor shaft. The result is an interference fit of from 2 to 5 ten-thousandths of an inch, as required to hold the plates rigidly in position.

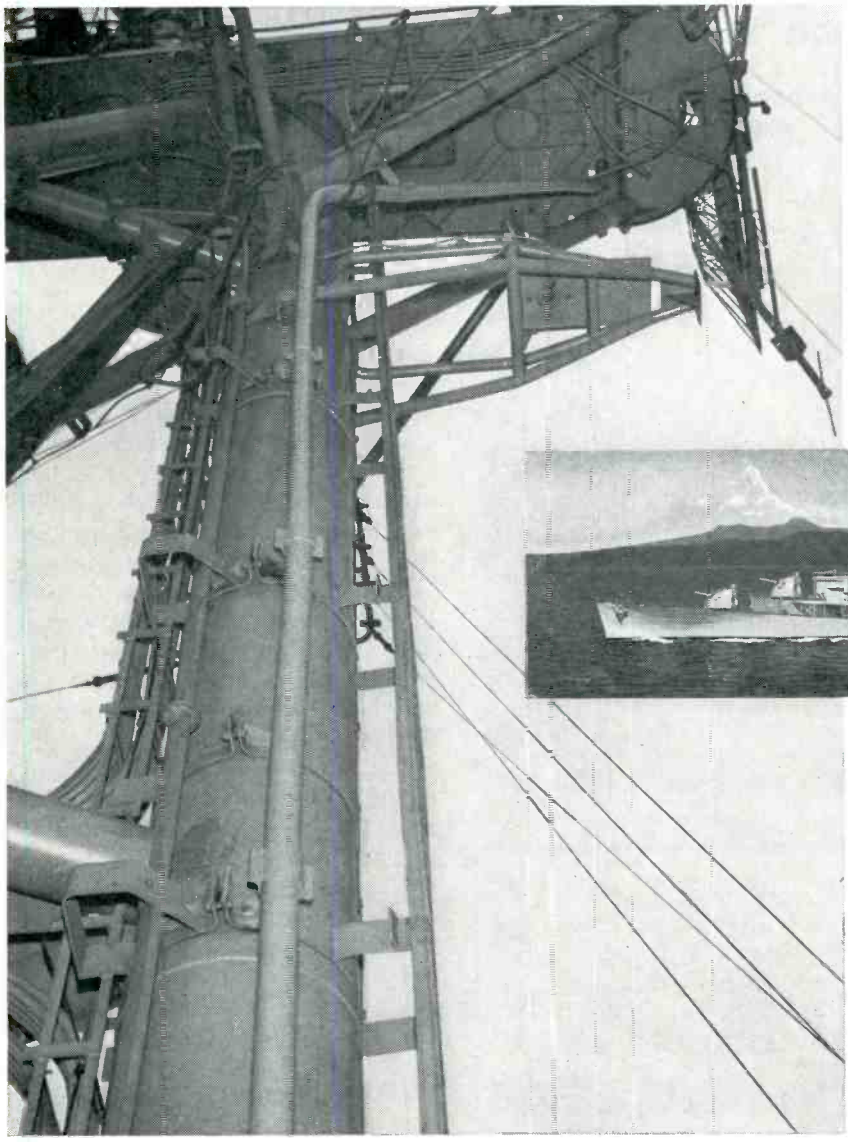
▶ **Pressing**—With the fixture loaded, the operator grasps its handle and pushes it into position under the head of the press. Guide bars bolted to the bed of the press aid in positioning the fixture accurately for the final operation. Operation of the press first serves to bring down heavy rubber pressure pads that hold the plates firmly



Pushing loaded fixture into position under press

Styroflex Coaxial Cable

Goes to Sea With the U. S. Navy!



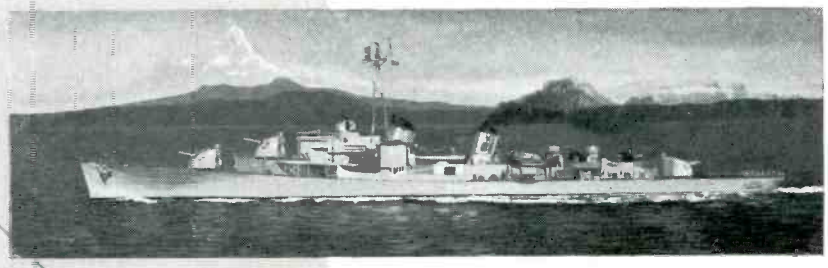


PHOTO COURTESY OF U. S. NAVY

During the overhauling of the U. S. S. Hank, the Navy Department installed 3⅛" 50 ohm Styroflex coaxial cable as the transmission line in the ship's SRa air search radar system.

Since this installation, results show that positive identification of air targets has been made at *twice the distance* possible before Styroflex was put into service on the ship.

Other Styroflex qualities which helped determine its selection by the Navy include its ease of installation, resistance to shock from gunfire and stable electrical characteristics.

Perhaps Styroflex can answer your particular transmission problem, too. Inquiries are invited by our engineering staff.

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Checking assembled rotor with special feeler gage

down in the recesses of the fixture. Next, a die with semicircular recesses comes down over the rotor shaft and drives the shaft home.

As the press retracts, it brings up a bar under the press table, which in turn pushes steel pins up through the fixture so that they bear against the rotor shaft and thereby serve to push the finished assembly out of the fixture. Portions of the head of the press are still holding down the fixture during this ejecting operation.

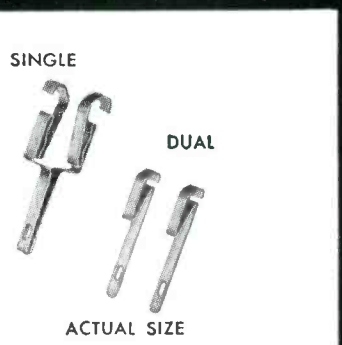
When the press is all the way up, the operator pulls out the fixture, lifts out the assembled rotor by hand and reloads.

A special gage is used to check for proper positioning of the rotor shaft. This gage has a U-shaped channel, with the ends of the U resting on the rotor plates and with the sensing rod of the gage resting on the top of the rotor shaft. The gage is easily calibrated by setting it on a steel block machined for the purpose, having a raised central portion corresponding in height to the desired projection of the rotor shaft above the plates. Rotor swage depth must be within 0.002 inch of specifications and alignment of rotor sections within 0.005 inch.

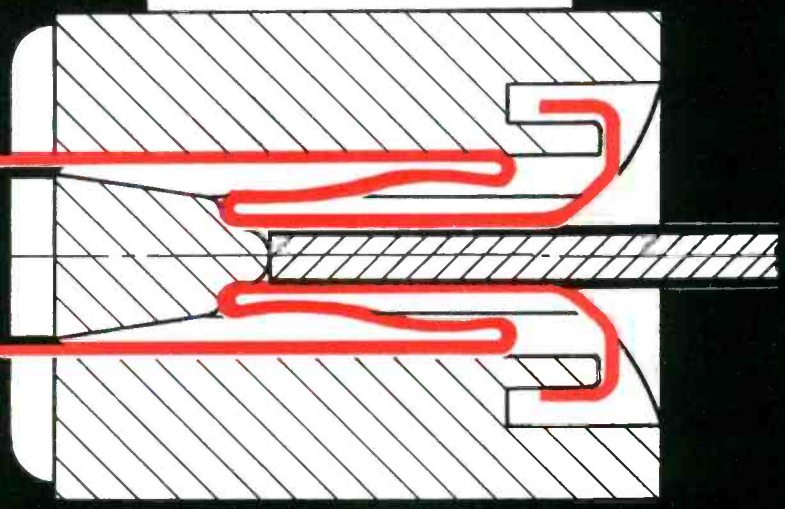
Transistor Can Welder

PROTECTIVE METAL CANS are welded over tiny transistor assemblies with a few cycles of 60-cps power in a simple yet precise resistance welder

"Bellows Action"* gives you 100% printed circuit board contact



Actual photograph of single and dual "Bellows Contact."*

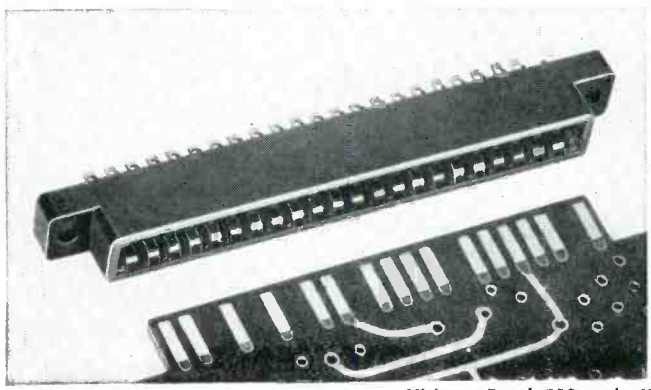


"Bellows Action Contact" cross-section shows printed circuit board inserted in contact.

Continental Connector "Bellows Action Contact"*

"Bellows" spring action grip clasps board firmly over 100% of printed circuit contact area. Gold-plated phosphor bronze spring retains tension, adjusts to oversized or undersized board while maintaining low contact resistance—less than 20 millivolts at 5 amps! On ⅛" board, for example, "Bellows Action" Contact grips .115" board as well as .135" board.

*Patent Pending



Printed Circuit connectors are available for ⅛", 3/32" and 1/16" boards . . . various molding compounds . . . 3 wiring styles . . . and 6 to 28 contacts.

Photo shows typical Continental Connector receptacles utilizing "Bellows Action Contacts." CONTACTS: 6, 10, 15, 18, 22, 28 contacts in single or double rows. WIRING STYLES: eyelet lug for soldering, wire wrap lugs, or 90° angle dip soldering direct to board. MOLDINGS: Mineral-filled Melamine and Plaskon reinforced (glass) Alkyd 440A. Other molding compounds on request.

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Squeezing potting compound from lead-foil tube into transistor can. Filled cans are stored in self-stacking metal trays as at upper left

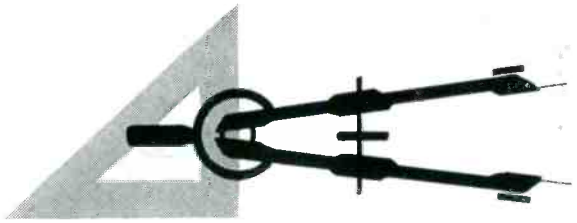
Placing transistor assembly in lower electrode of welder with tweezers. Welder output is indicated by counter, actuating arm of which is linked by string to moveable upper electrode of welder

setup used in the Lansdale and Spring City, Pa. plants of Philco Corp.

► **Potting**—To achieve the equivalent of a hermetic seal without actually evacuating the housing, a special potting compound is put into each can before assembly. This jelly-like material is purchased in toothpaste-type foil tubes having special nozzles for squeezing the material directly in to each tiny can in turn. Filled cans are set into holes drilled partly through metal trays, to prevent spillage when transferring the cans to the assembly position and to handle them through a vacuum bake process.

► **Assembly**—The filled metal can is pushed over the stem of a finished transistor and the assembly

Engineered to meet your specifications . . .



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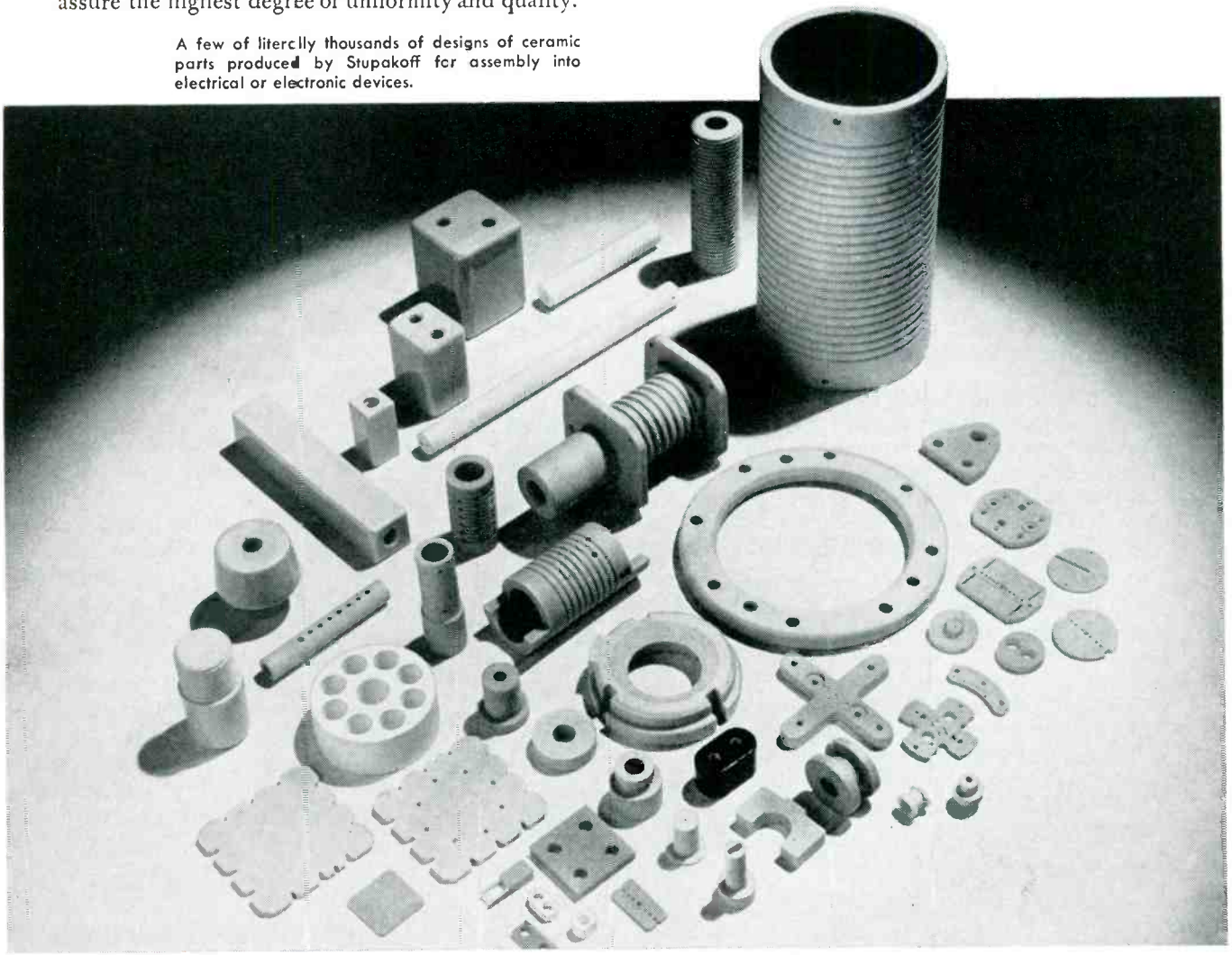
A few of literally thousands of designs of ceramic parts produced by Stupakoff for assembly into electrical or electronic devices.

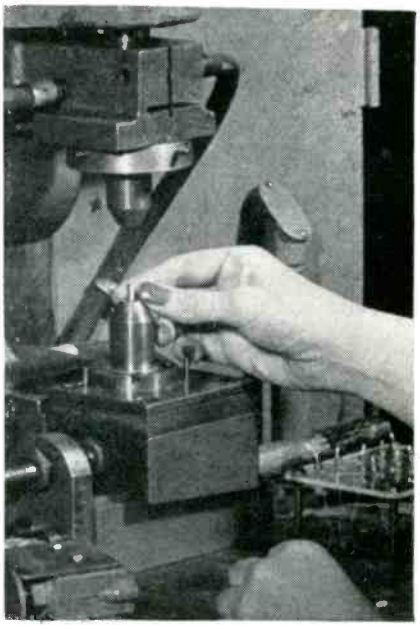


Stupakoff
DIVISION OF
The CARBORUNDUM Company

Write Dept. E
LATROBE, PENNSYLVANIA

is inserted in a hole on a circular tote tray with the leads projecting down through the hole.

A loaded tray is brought to the welding position, where the operator picks up an assembly with tweezers and drops it into the tubular lower electrode of the welder. Pressing a foot pedal then brings down the upper tubular electrode and automatically initiates the welding cycle.



Closeup of electrodes on another welder being used for same purpose. Welding electrodes are easily changed to accommodate other sizes of transistors

Electrode pressure is maintained for a few seconds after welding, to conduct heat away from the weld. The weld is produced between the outward-flaring flanges of the can and the transistor stem. Perfect centering is achieved by maintaining close tolerances between base and can diameters and the holes in the electrodes. Copper-alloy electrodes give long life without corrosion while maintaining uniformity of welds.

Easily Molded Adapters Extend Test Bench Use

A SIMPLE adapter plug, consisting of two different standard Cannon disconnect plugs and a molded Plexiglas body, makes possible quick and efficient connection of

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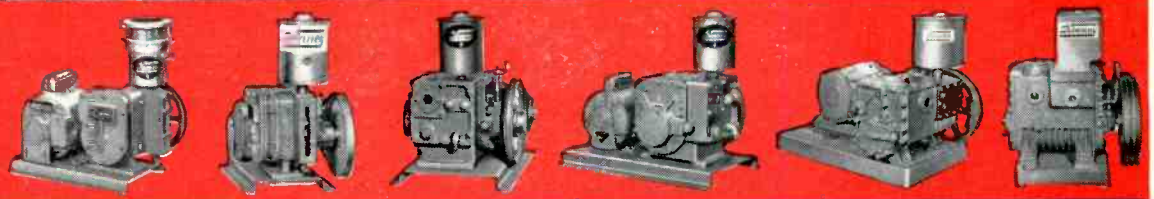
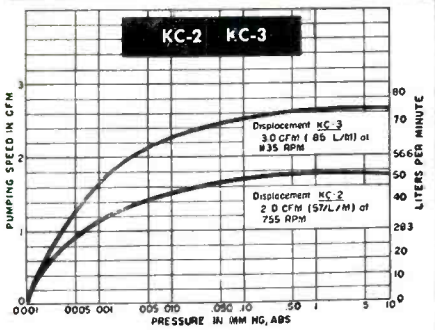
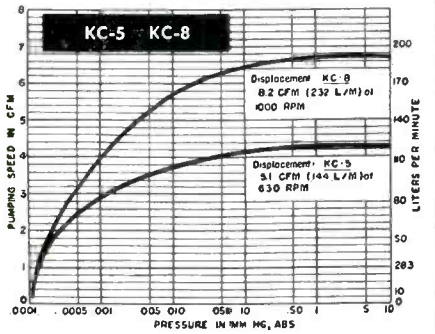
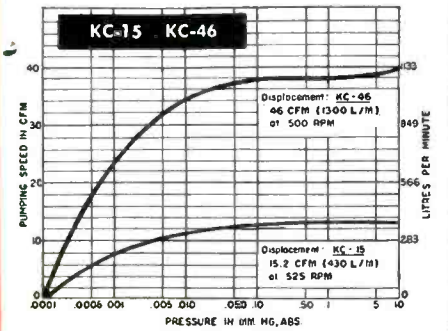


SPECIFICATIONS	MODEL KC-2	MODEL KC-3	MODEL KC-5	MODEL KC-8	MODEL KC-15	MODEL KC-46
Free Air Displacement	2.0 CFM	3.0 CFM	5.1 CFM	8.2 CFM	15.2 CFM	46.0 CFM
Free Air Displacement	56.5 Liters/min.	85.0 Liters/min.	144. Liters/min.	232. Liters/min.	430 Liters/min.	1300 Liters/min.
Free Air Displacement	.95 Liters/sec.	1.41 Liters/sec.	2.4 Liters/sec.	3.9 Liters/sec.	7.2 Liters/sec.	21.7 Liters/sec.
RPM	755	1135	630	1000	525	500
Motor H.P.	1/4	1/3	1/3	1/2	1	3
Motor RPM (syn.)	1800	1800	1800	1800	1800	1800
Oil Capacity	6 oz.	6 oz.	1⅓ pt.	1⅓ pt.	2 qt.	1 gal.
Shaft Diam.	¾"	¾"	¾"	¾"	¾"	1⅛"
Inlet Connection	¾" Screwed	¾" Screwed	1" Screwed	1" Screwed	2" Screwed	3" Screwed
Outlet Connection	None	¾" Screwed	1" Screwed	1" Screwed	1¼" Screwed	1½" Screwed
Net Weight, Complete	70 lb.	78 lb.	140 lb.	148 lb.	300 lb.	585 lb.







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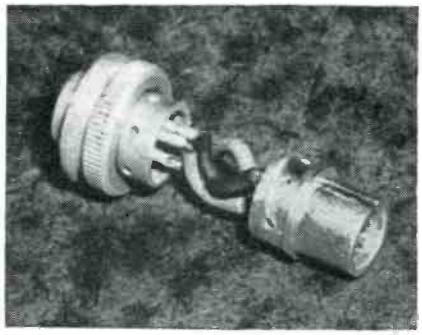
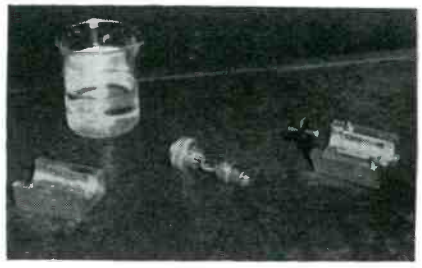
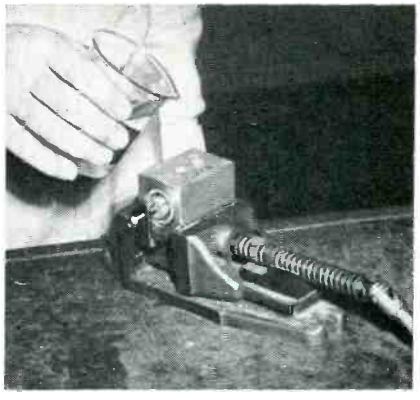


Assembled adapter plugs before molding, showing how two Cannon plugs are connected together with wires soldered to plug-ins



Molding setup, showing two-piece aluminum mold with mating pins and pouring hole. Liquid Plexiglas is poured from beaker into mold. Bracket and adjustable screw on right-hand mold hold plug firmly in machined recess of mold to prevent leakage of liquid Plexiglas



Pouring liquid Plexiglas into mold held in vise, while screw-on bracket holds plug tightly in end of mold

production control equipment to an electronic test bench for final check-out.

► **Bench Designed** — The adapter was developed by a liaison engineer in the Anaheim Division of Robertshaw-Fulton Controls Co. for use on its test bench, which consists of four rows of eight outlets each. All outlets in one row are identical, providing for multiple testing of production items. The four rows contain four different types of con-

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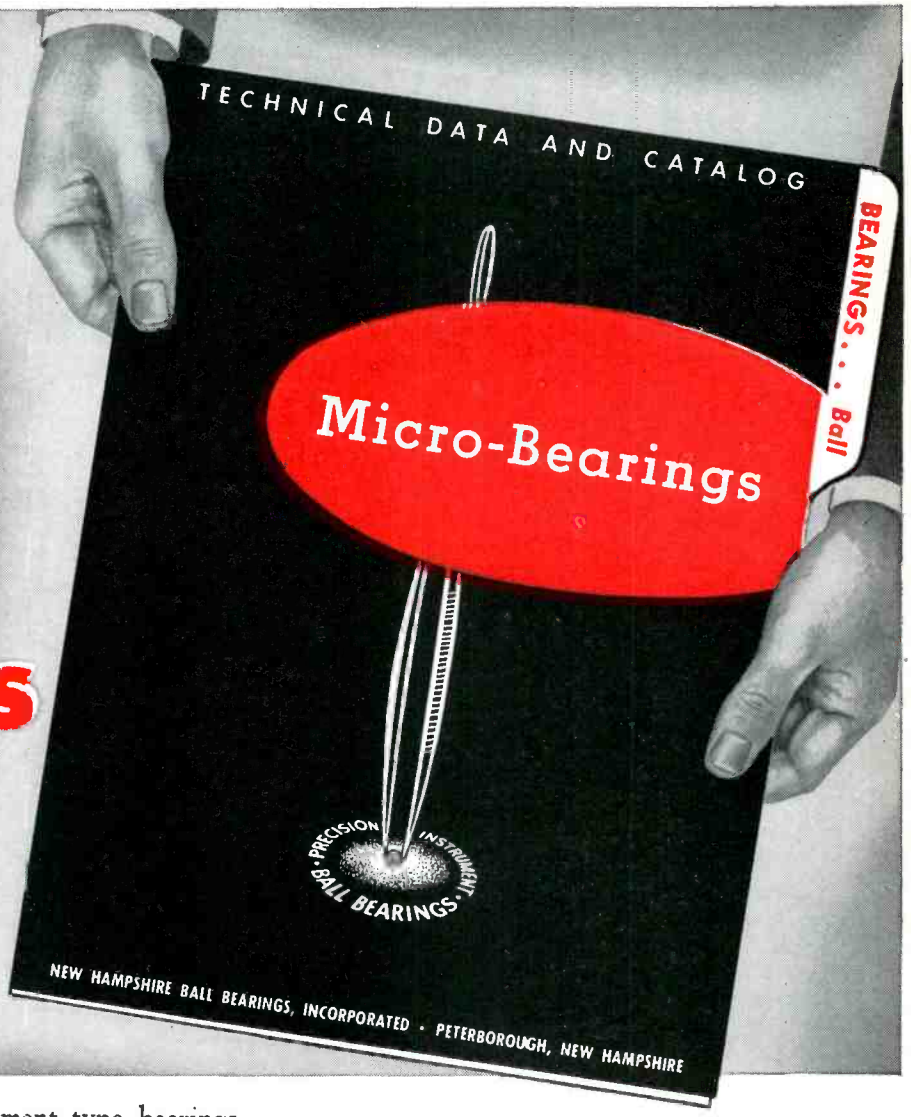

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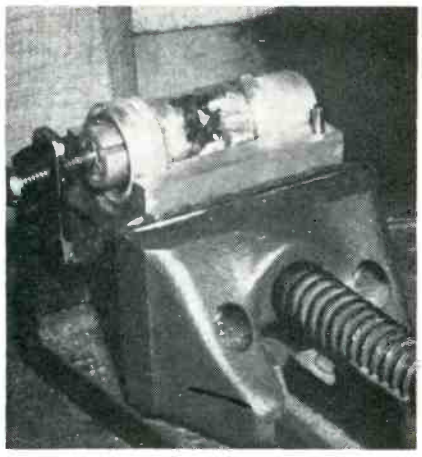


Removing top half of mold after Plexiglas has set

nectors. This means that the test bench, without the adapter, can be used for testing equipment having only four different pole arrangements or connector sizes.

▶ **Versatility**—With the proper adapter plug, production items with any arrangement of poles in their connector plugs, or with any connector size, may be checked out. Adapter plugs have been made up with a wide variety of pole arrangements and sizes of upper connector. The lower connector is a standard size for mating with the test bench plug.

As many or as few poles as desired may be utilized in either the top or bottom connector of the adapter. The number used is determined by the number of components that are to be tested at one time.

▶ **Molding Technique** — Adapters are fabricated with a simple mold-

Completed adapter

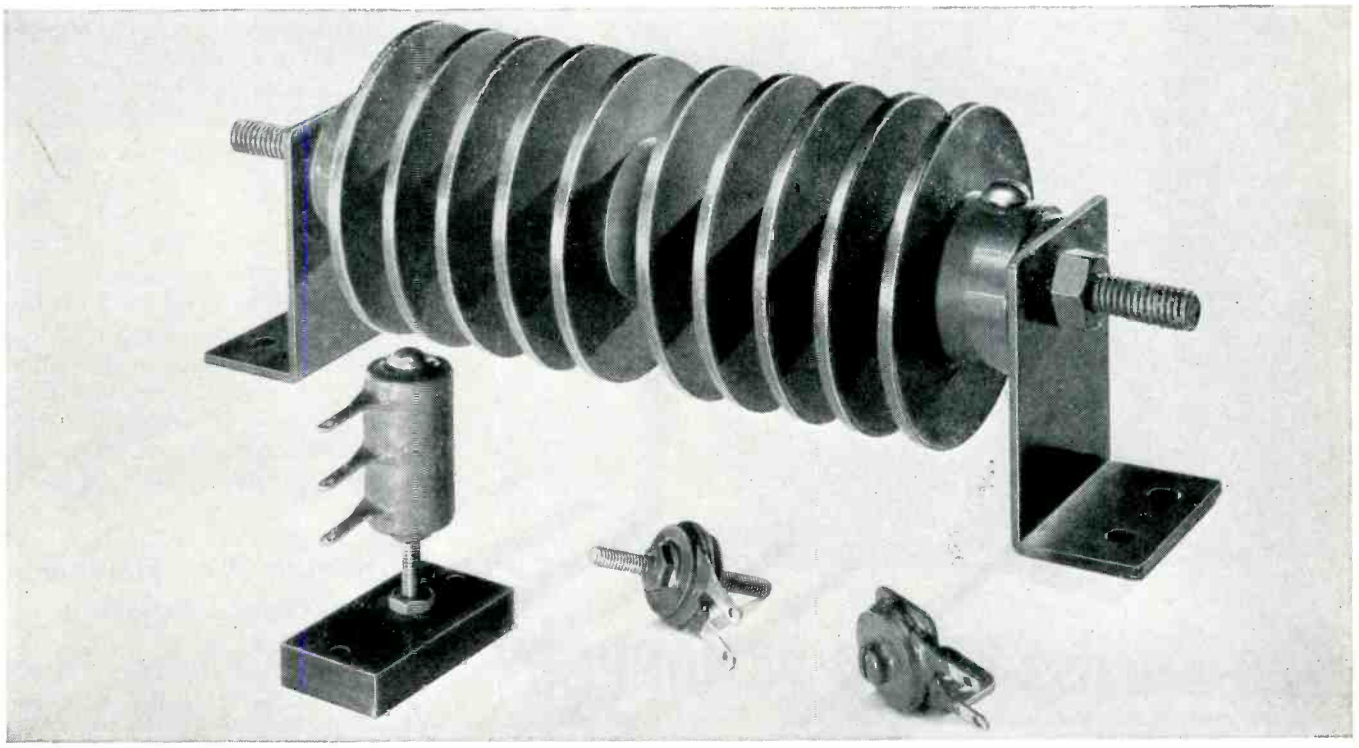
Q: *Where can I get* **CUSTOM-ENGINEERED** *resistors for my circuit...* **IN A HURRY?**

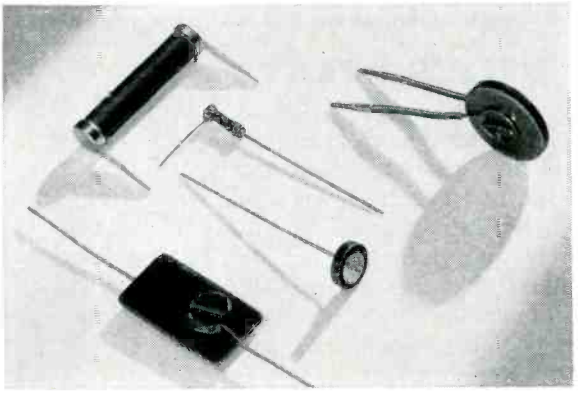
A: **GLOBAR®** *Ceramic Resistors*

Thermistors • Varistors • Fixed Non-Inductive Resistors

by **CARBORUNDUM**

REGISTERED TRADE MARK





COMPLETE ASSEMBLIES . . . like these recent designs . . . are engineered by Globar resistor specialists to meet the particular electrical, thermal and packaging requirements of *your* circuit.

SPECIAL TERMINATIONS can be designed for Globar Thermistors and Varistors of any size and shape.

GIVE US YOUR PROBLEM . . . whenever you require single or multiple resistor assemblies, or special resistor terminations. You'll get prompt attention from competent, experienced engineers, plus Globar's flexible manufacturing facilities to meet your tightest delivery schedules for *production quantities.*

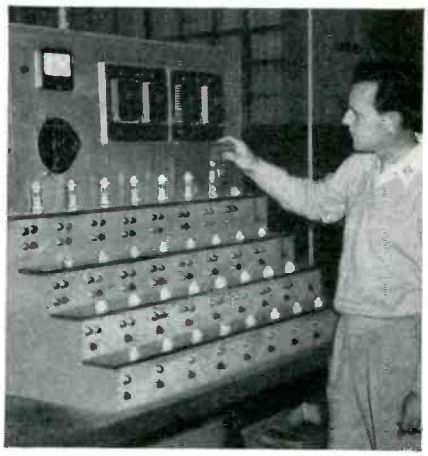
A GLOBAR DIVISION Sales Engineer will be glad to discuss your application. Or send details of your problem direct. Write Globar Division, The Carborundum Company Dept. E 87-629, Niagara Falls, N. Y.

Globar® *Ceramic Resistors*

by **CARBORUNDUM**

REGISTERED TRADE MARK

6
87-29

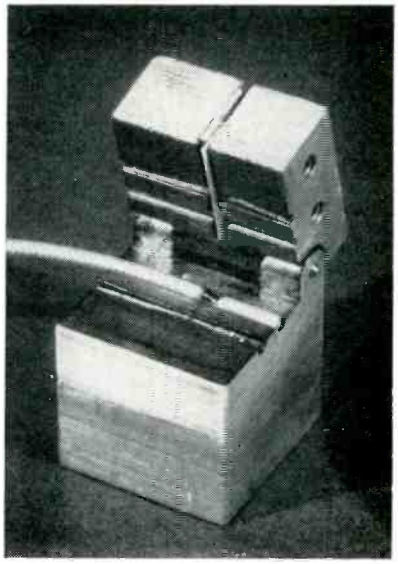


Plugging actuator motor into adapter on test bench

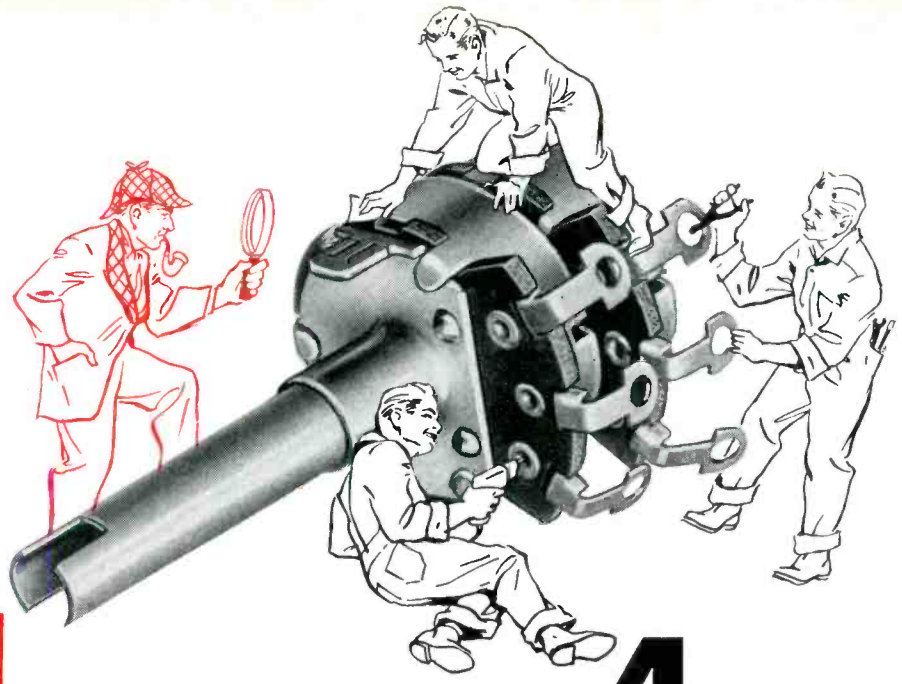
ing jig in which top and bottom connectors are positioned as the liquid plastic is poured around them. Almost any combination of connectors may be joined together in the jig. The adapter plugs eliminate all strain on connecting wires and provide foolproof insulation, rigidity and permanent bonding.

Precision Wire-Stripper Cuts Teflon Insulation

A NEW tool developed by Martin for aircraft electronic work successfully strips the insulation from a special wire composed of strands too fine for commercial wire strippers. The tool contains a recess into which the wire is placed. The stripping blade is set to cut the



Construction of wire-stripper, showing wire after cutting and partial stripping



1 OUT OF EVERY 4 WORKERS ON STACKPOLE CONTROLS IS AN *Inspector!*

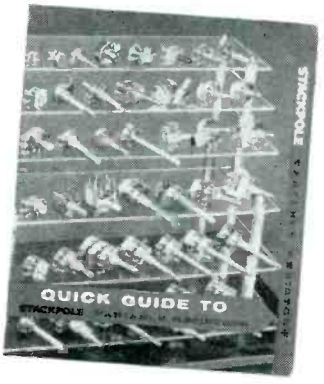
Few components call for greater manufacturing care and precision than variable resistors.

That is why approximately every fourth worker on Stackpole tone and volume controls is an inspector.

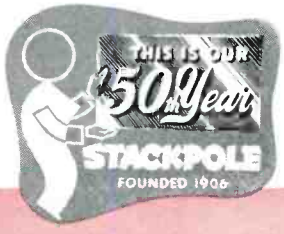
This, in turn, is why leading users report that Stackpole Controls not only minimize their incoming inspection problems but reduce subsequent field service as well. Full quality control from raw materials through every step of manufacture, is a feature of *all* Stackpole electronic components.

A COMPLETE SELECTION OF VARIABLE RESISTOR TYPES

write for your copy of this latest QUICK GUIDE to Stackpole variable composition types and adaptations. Provides essential data in handy condensed form for wall, desk or file use.



Electronic Components Division
STACKPOLE CARBON COMPANY
St. Marys, Pa.



STACKPOLE

FIXED AND VARIABLE COMPOSITION RESISTORS • MOLDED IRON CORES • CERAMAG®
FERROMAGNETIC CORES • MOLDED COIL FORMS • LOW VALUE GA CAPACITORS
LINE SWITCHES • SLIDE SWITCHES • CERAMAGNET® CERAMIC PERMANENT MAGNETS

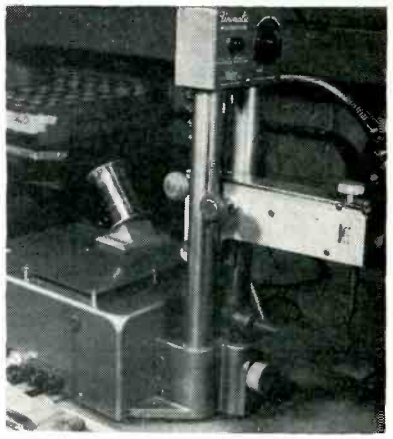
Want more information? Use post card on last page.

Finished terminal, showing how end is stripped by tool without damaging fine strands

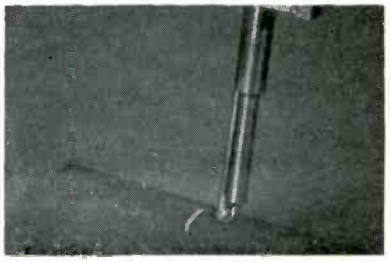
Teflon insulation close to the wires, without nicking or damaging them. When the tool is closed, the wire rotated and pulled through, the end of the wire is stripped and the gossamer strands are left intact, ready for use.

Capacitor-Discharge Welder Uses Offset Electrode

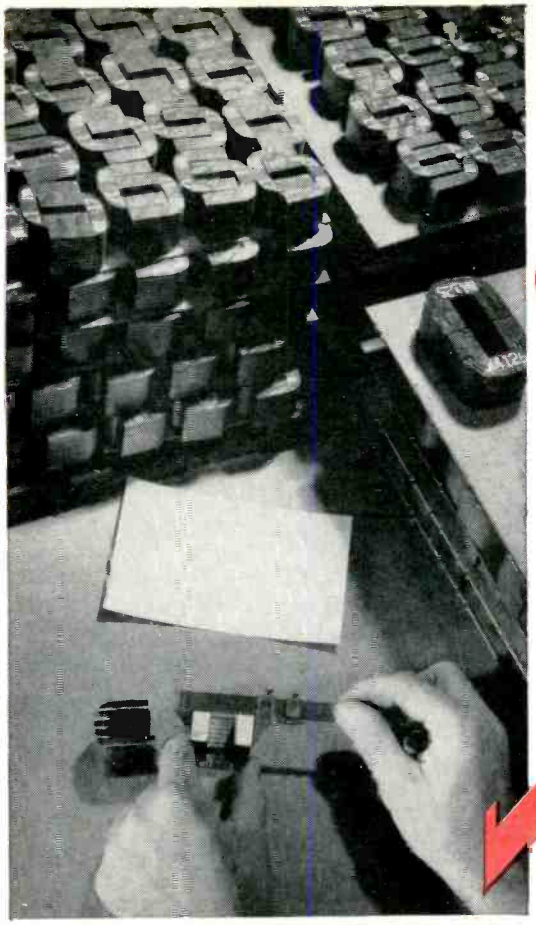
VISIBILITY is achieved for critical welding operations in difficult locations by using a uniquely curved rod as an electrode on a Unitek welder in Fairchild's Hicksville, N. Y. plant. The arrangement permits consistent high-quality welding during assembly of resistance elements in the housings of precision potentiometers.

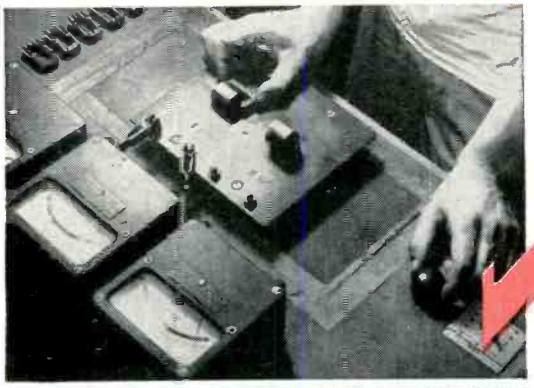


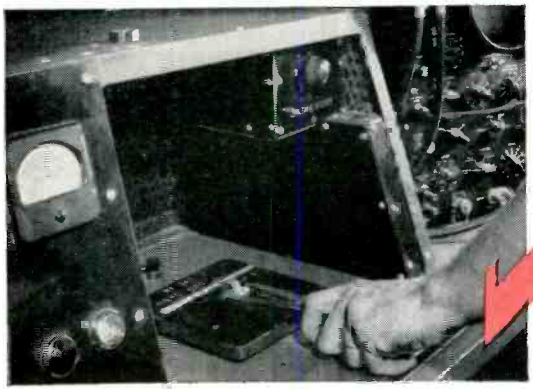
Offset electrode on 500-watt capacitor-discharge welder used in assembling potentiometers



Closeup of welding electrode







MOLONEY HyperCore ELECTRONIC CORES

Check and double Check

HyperCore 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 finished cores have the desired electrical qualities. All HyperCore electronic cores *must* test well within industry tolerances. Special tests for specific operating conditions can be made also 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 HyperCore Electronic Cores are wound cores of cold-rolled oriented silicon steel, they are smaller and lighter.

ME56-17

Specify HyperCore Cores for smaller, low loss transformers

Write for Catalog SR 206 "HyperCores for Magnetic Components" and Catalog ST 3506 "Magnetic Components for Electronic Applications."

MOLONEY ELECTRIC COMPANY

Plate and Filament Transformers • Chokes • Unit Rectifiers • Modulation Transformers and Reactors • Pulse Transformers and Charging Chokes • HyperCores for Magnetic Components Developmental Magnetic Components • Power and Distribution Transformers

SALES OFFICES IN ALL PRINCIPAL CITIES • FACTORIES AT ST. LOUIS 20, MO. AND TORONTO, ONT., CANADA

New Products

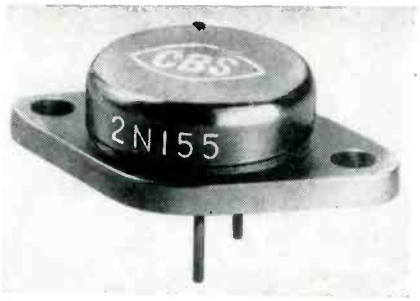
Edited by WILLIAM P. O'BRIEN

80 New Products and 63 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

POWER TRANSISTOR

for automobile radios

CBS-HYTRON, A Division of Columbia Broadcasting System, Inc., Danvers, Mass., is manufacturing the 2N155, a power transistor designed especially for the audio output stage of automobile radio receivers.



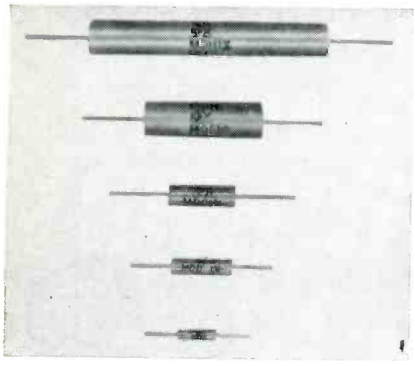
Designed to operate from a 12-v battery, this *pnp* germanium-alloy junction transistor features high power gain, uniformity and exceptional reliability. It is plug-in for easy installation.

Highly efficient heat dissipation is characteristic of the unit. Its heavy copper flange mounting permits the flow of heat from the power transistor to the chassis, thus providing a large radiating area.

Engineering bulletin E-259 giving additional data may be obtained by writing the company.

MOLDED RESISTORS

in 5 different ratings



INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia 8, Pa. Type MD and MB molded deposited carbon and molded baron carbon resistors are now available in ratings of $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, 1 and 2 w. Double protection is provided by the addition of a molded plastic housing which protects the unit against mechanical damage and the effects of environmental and atmospheric conditions.

▶ **Uses**—The resistors are particularly suited for applications where unmolded units cannot be used due to the risk of mechanical damage to their coating, insulation breakdown or moisture change. They are recommended for computer and amplifier circuits requiring superior resistance-temperature characteristics and stability, voltmeter multipliers, decades, divider circuits and bridge circuits and other applications where precision wire-wound resistors are too expensive, too heavy or too large.

DIGITAL OHMMETER

measures to 5 digits

ELECTRO INSTRUMENTS, INC., 3794 Rosecrans St., San Diego 10, Calif. A new digital ohmmeter automatically measures and digitally displays resistance measurements to 5 digits. Model D050 has a range of 0.1 ohm to 10 megohms, and is accurate up to 0.01 percent ±1 digit, depending upon the range.

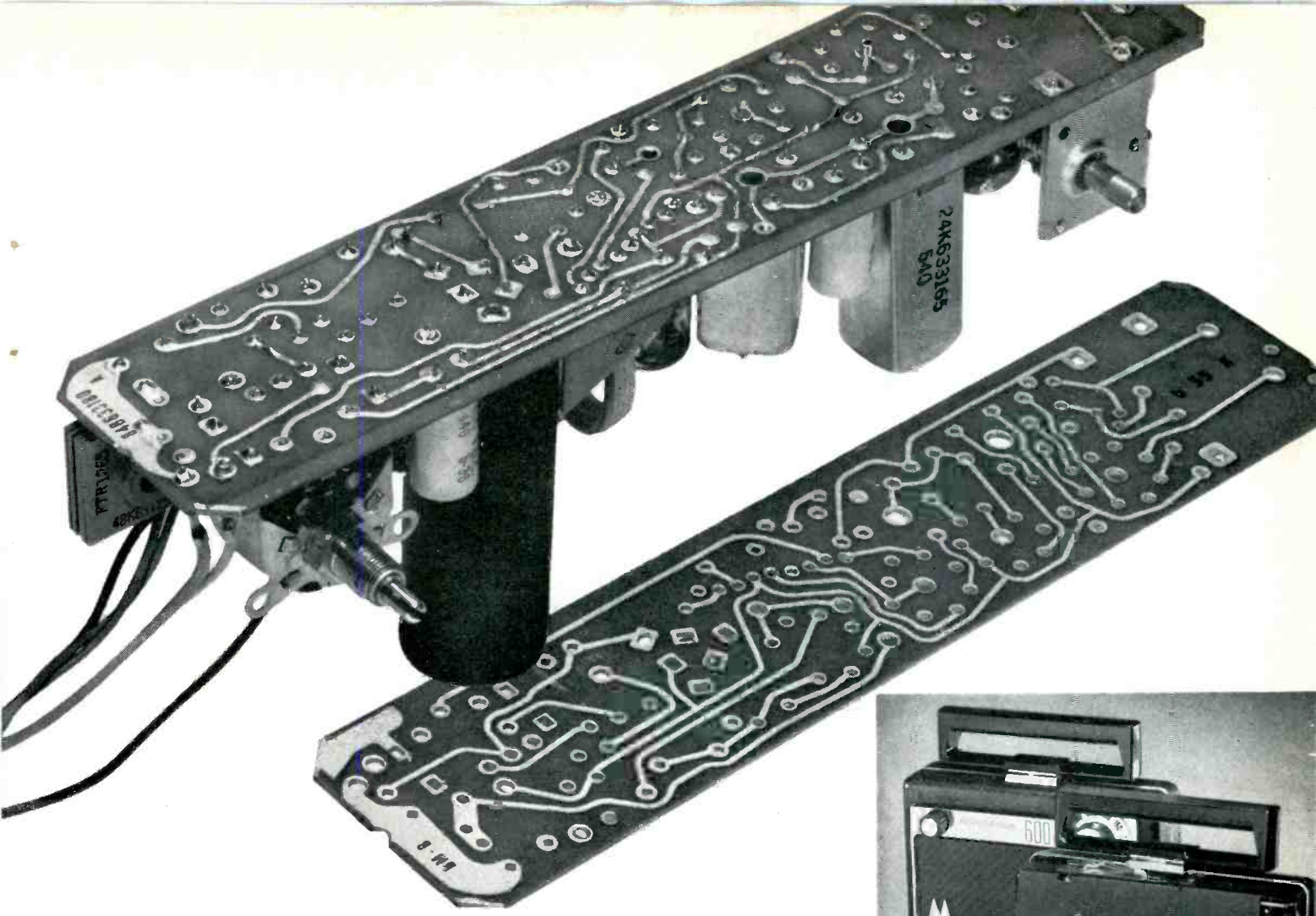
Measurements are made automatically and are presented on a digital in-line readout with 1-in. numerals. No interpretation is required. Average reading time is 1 second. Range switching is automatic.

▶ **Application**—The instrument can be used with the company's input scanner (IS100) and machine print-out to sequentially scan and record 100 resistance values, providing a complete automation system.

OSCILLOGRAPH TUBES

two 5-in. types

RADIO CORP. OF AMERICA, Harrison, N. J. Two new 5-in. magnetic-de-



The Motorola "Ranger" achieves compact, sturdy construction and fast assembly with plated circuits on laminated stock produced by **Farley & Loetscher Mfg. Co.,** Dubuque, Iowa, using BAKELITE Laminating Varnishes.

What this resin does for Motorola's plated circuits

- **. . . gives a good base for bonding of copper firmly to the laminate**
- **. . . provides high insulation resistance and low dielectric loss**
- **. . . forms a translucent laminate permitting easy checking of reverse side circuit alignment**
- **. . . withstands 500° F. heat of dip-soldering**
- **. . . results in a lamination that exceeds U. S. Government standards and NEMA specifications.**

All these advantages are found in BAKELITE Brand Phenolic Resin CLSA-3914, a superior hot punch laminating varnish used in the Motorola "Ranger" portable radio shown here. When high surface resistance is needed, CLSA-3914 is used on paper stock pre-treated with 12 to 16 per cent of a water-miscible resin, such as BAKELITE Phenolic Resin BLL-3913. Both XXXP and XXXP-1R grade laminates are produced by this method.

Technical information on BAKELITE Laminating Varnishes made especially for printed circuits is available by writing Dept. SO-50.

BAKELITE
BRAND
PHENOLIC RESINS

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

flection oscillograph tubes (RCA-5AHP7 and 5AHP7-A) have been introduced. Both feature low-voltage electrostatic focus and a long-persistence characteristic, and differ only in the aluminized screen that is used in the 5AHP7-A to provide increased brightness and improved image contrast.

▶ **Uses**—The tubes are intended particularly for pulse-modulated applications, such as radar indicator service, but are also useful in general oscillographic applications where a temporary record of electrical phenomena is desired.

The low-voltage electrostatic focus gun featured in the tubes facilitates use of these types in lightweight equipment; assures uniformity of focus over the entire screen; and permits focus to be maintained automatically with variations of line voltage and over a wide range of adjustment of image brightness.

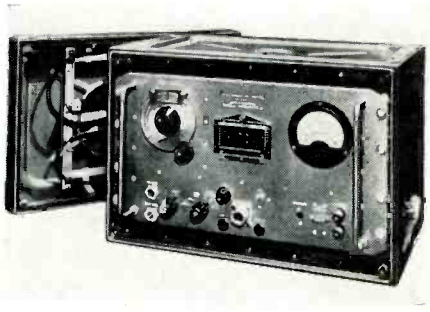
Each tube type has a maximum overall length of 11⅜ in., a minimum useful screen diameter of 4¼ in., and a deflection angle of 53 deg.

Literature is available.

DEVIATION METER

a wide-range unit

MARCONI INSTRUMENTS, 44 New St., New York 4, N. Y. Extended range and high stability are features of a new f-m deviation meter developed for telemetering and other wide deviation systems. Carrier frequency is 20 to 500 mc; deviation is measured to an accuracy of 3 percent in the range of ±2 to ±400 kc, and crystal standardization is built in. The instrument accepts modulation frequencies from 50 cps to 120 kc.

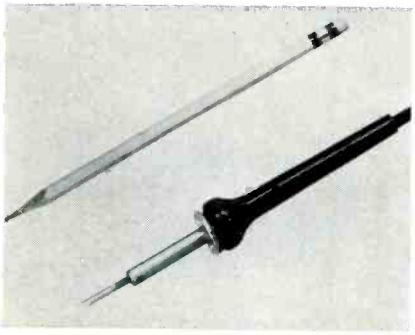


A counter type discriminator is used since this has the advantage of linearity and freedom from drift. There is provision for aural or visual monitoring of the carrier modulation.

Design of the instrument is extremely rugged. The steel case is waterproof and the chassis is shock mounted.

SOLDERING IRON

small and light



WALL MFG. CO., Grove City, Pa., has announced a new industrial soldering iron. In spite of its midget size—(the iron weighs only an oz., and has a ⅛-in. tip)—the new pencil model is designed and built to survive production line punishment. It also features thermostatic action, without fragile thermostats, which controls heat so perfectly that fusing and tip-burning are eliminated.

▶ **Uses**—The iron is designed for delicate precision work on regular radio and tv circuits, printed circuits and any intricate electrical work. It cause no interference with radio, tv or radar, and reaches production heat four times faster than any soldering iron of equal tip size. The handle is kept cool with the company's chimney feature.

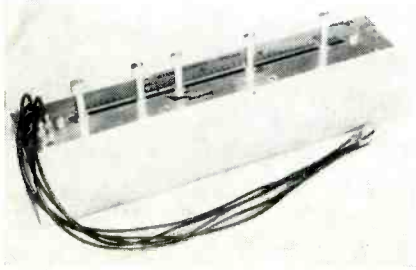
Overall length is 7½ in., with either copper or special Walloy tip. A free catalog is available on request to the company.

DELAY LINE

with infinite settings

DELTIME, INC., 608 Fayette Ave., Mamaroneck, N. Y. Continuously variable settings, rather than usual step-by-step taps, set apart the magnetostrictive delay line units recently developed. Applications include high access rate temporary storage for computers, replacing drum-type storage; time or frequency determining elements of passive nature; digital circuitry and registers.

Infinite time-delay settings are provided by individual pickup coils positioned and locked in place along the slotted and calibrated microsecond delay scale. Model 103 has a 40 μsec delay range and four adjustable pickup coils. Extra pickup, even to a maximum of 20, can be added without noticeable reduction of output due to loading.



▶ **Operation**—The delay line operates on well-known properties of nickel and other substances to short in length when placed in magnetic field. Construction is equivalent to shock wave which propagates along magnetostrictive medium with time delay equivalent to 5.25 μsec per in. of path length. Pickup coils are placed at any position along path to receive pulse. Pulses of 0.05 μsec have been gen-

For ACCURATE HIGH SPEED SWITCHING..

Specify

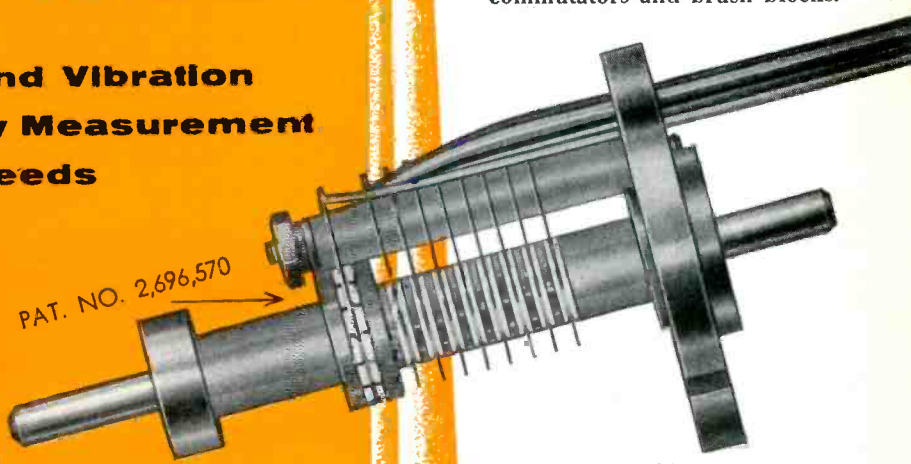
ELECTRO TEC

miniature ultra-low torque

Precision Selector Switch

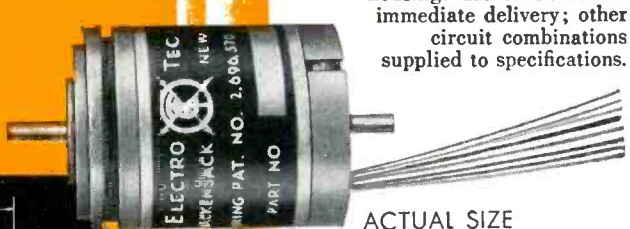
- Withstands Shock and Vibration
- Offers High Accuracy Measurement
- Operates at High Speeds

This new Electro Tec Precision Selector Switch is ideal where miniature size, low friction torque, high accuracy, and low electrical noise at high speeds are requirements. Simplified circuits and long service life recommend it for a wide variety of uses including sampling, pulse generation for precision measurement, telemetering and strain gage applications, in aircraft, missiles, servos, computors, etc. Switch design incorporates many exclusive features that have gained industry-wide acclaim for Electro Tec precision slip rings, commutators and brush blocks.

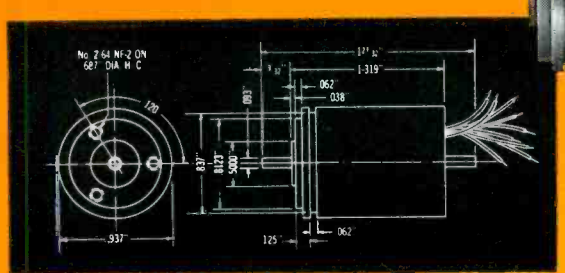


CALL OR WRITE FOR ILLUSTRATED BROCHURE

8 or 10 position switches in standard size 10 synchro housings are available for immediate delivery; other circuit combinations supplied to specifications.



ACTUAL SIZE



Electro Tec Corp.

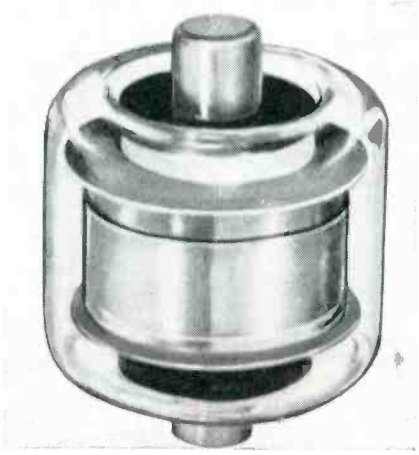
SO. HACKENSACK
NEW JERSEY
Tel.: HUbbard 7-4940

erated and propagated down the line for a total of 200 μsec.

CONNECTOR
for miniature equipment

SCINTILLA DIVISION, Bendix Aviation Corp., Sidney, N. Y. The Pygmy electrical connector has been developed especially for application to miniaturized electronic equipment. It is available in both the A and E styles; in a series for potting; with jam nut receptacles; and with hermetically sealed receptacles. Both a double-stub quick action thread and a three-point bayonet lock are offered for the convenience of users.

Either cadmium plate or alumilite finishes are available. Resilient Scinflex inserts are being used to resist vibration effects.



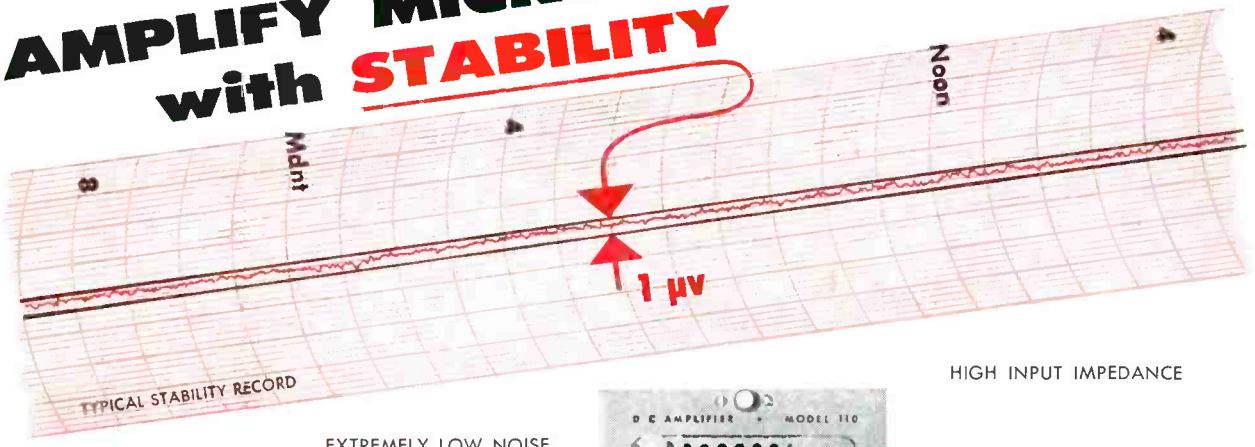
VACUUM CAPACITORS
rated at 500 μμf

DOLINKO & WILKENS, INC., 1907 Summit Ave., Union City, N. J., offers a new addition to their line of fixed vacuum capacitors. Type

KAY LAB
CALIFORNIA

DC DECADE AMPLIFIER

AMPLIFY MICROVOLTS with STABILITY



EXTREMELY LOW NOISE

10 ACCURATE GAIN RANGES

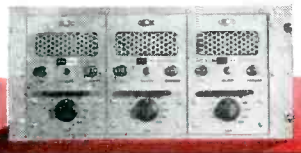
INSENSITIVE TO OUTPUT LOAD IMPEDANCE CHANGES

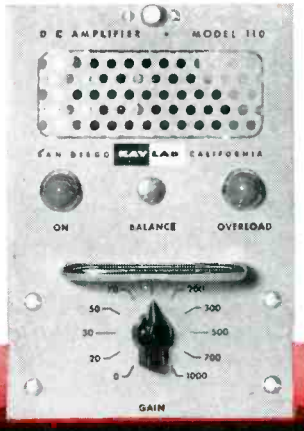
HIGH LEVEL OUTPUT LEVEL ± 25 VOLTS

HIGH INPUT IMPEDANCE

± 2 μV DRIFT

PLUG-IN MODULE DESIGN





The new KAY LAB Model 110 Amplifier is a low drift, high gain, chopper stabilized, broad band DC amplifier incorporating proven KAY LAB chopper amplifier circuitry. Small modular plug-in construction makes it ideally suited for group rack mounting as a part of permanent instrumentation facilities or as a general laboratory instrument in a portable cabinet. Ten precise feedback controlled gain ranges are provided. Low noise allows accurate amplification of microvolt signals. A completely new and unique output circuit provides unsurpassed linearity and dynamic performance — unaffected by output load impedance variations over a wide frequency range.

APPLICATIONS: Ideal strain-gage amplifier . . . vibration studies . . . transducer amplifier . . . scope preamplifier . . . single or multiple channel recorder driver . . . impedance matching "DC transformer" . . . general laboratory instrument wherever precise gain is required for amplification of microvolt signals.

SPECIFICATIONS

Gain	0, 20, 30, 50, 70, 100, 200, 300, 500, 700, 1000 ± 1% DC
Input Impedance	100,000 Ω
Frequency Response	± 3% DC to 10 kc, less than 3 db down at 30 kc
Phase Shift	Less than 5° to 2 kc
Equivalent Input Drift (over 40-hour period)	± 2 μv when used with regulated line voltage ± 10% change in AC input causes less than ± 5 μv change after 10-minute warm-up
Equivalent Input Noise	0 to 3 cps, less than 5 μv peak to peak 0 to 750 cps, less than 5 μv RMS 0 to 50 kc, less than 12 μv RMS
Chopper Intermodulation	Less than 0.1%
Linearity	Better than 0.1% to 2 kc
Output Impedance	Less than 1 Ω in series with 25 μh
Output Capability DC	0 to ± 25 volts with load impedance greater than 1000 Ω 0 to ± 25 ma with load impedance from 10 to 1000 Ω

POWER REQUIRED	0.9 watt each unit plus 0.6 watt each adaptor
Dimensions: Amplifier unit	5" wide, 7¼" high, 14¼" deep
Unit in cabinet	6" wide, 9⅞" high, 18⅜" deep
Rack adaptor for 3 units	19" wide, 8¾" high, 18¼" deep
Net Weight	15 lbs.
Shipping Weight	30 lbs.

PRICE: Amplifier Unit	$500.00
Cabinet (with fan and connector)	50.00
Rack Adaptor (with fans & connectors)	150.00

Kay Lab reserves the right to change specifications and prices without notice.

. . . the Standard in chopper-stabilized instruments

KAY LAB

STABILITY *locked in!* WITH CHOPPER AMPLIFIERS

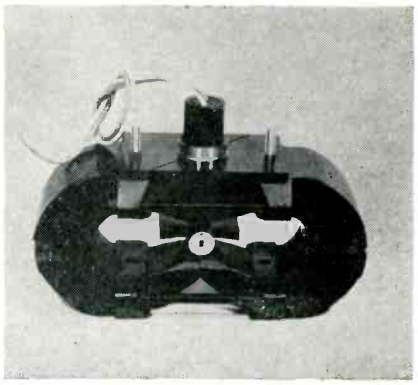
Representatives in all major cities.

5725 KEARNEY VILLA ROAD • SAN DIEGO 12, CALIFORNIA • BROWNING 7-6700

Want more information? Use post card on last page.

VC500-10 is rated at 500 $\mu\mu$f capacitance, 10 kv peak, and 42 rms amperes. Dimensions are: 4 in. overall length, $4\frac{1}{4}$ in. diameter, $3\frac{1}{2}$ in. mounting centers, and $\frac{7}{8}$ in. contact diameter. This type features reversed copper-to-glass seals for maximum voltage path in minimum space.

Low inductance, practically loss-free characteristics, and rugged construction result from this design which is especially suited for medium and high power oscillators and transmitting equipments.



MAGNETRON
for radar applications

SYLVANIA ELECTRIC PRODUCTS INC., 1710 Broadway, New York 19, N. Y. A high-power, pulsed fixed-frequency magnetron, designated as type 6799, has been announced.

The new tube, a power-producing component for radar applications, operates in the 34,512 to 35,208 mc range. Its minimum peak power output is 100 kw. With this output, the type 6799 provides high performance over long distances for radar equipment operating in its frequency range.

COAX CONNECTOR
Teflon h-v uhf type

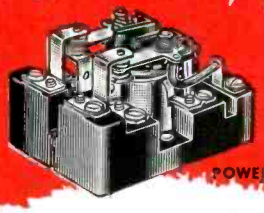
THE COAXIAL CONNECTOR CO., 37 N. 2nd Ave., Mt. Vernon, N. Y., is producing Teflon h-v uhf type coaxial connectors.

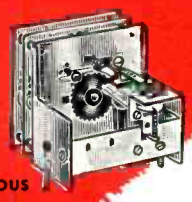
Types 259 and 239 are designed expressly for h-v application where

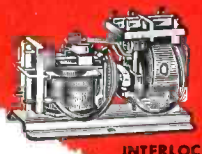
for Improved Electronic Control...

GUARDIAN®

RELAYS SOLENOIDS


POWER


CONTINUOUS ROTATION


INTERLOCK


TELEPHONE TYPE

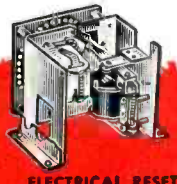

RATCHET


SHORTING


PLATE CIRCUIT


MINIATURE SEALED


ADD/SUBTRACT


ELECTRICAL RESET


ALL PURPOSE

EXPERTLY ENGINEERED... *the well-rounded line!*

● Units here typify the wide range of Guardian Products available to meet the control requirements of every industry. We welcome an opportunity to consult with you on your circuitry control for product *improvement* or development.

write for literature today!

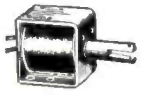
STEPPERS SWITCHES

A.C. INDUSTRIAL SOLENOIDS D.C.

INTERMITTENT AND CONTINUOUS

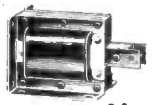
A Complete Line for Every Industrial Application

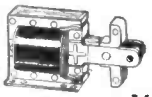

1A

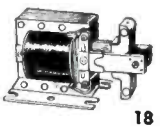

2 & 4


11


12


14


16


18

Available in both intermittent and continuous duty types. Intermittent types should not be energized for more than 5 consecutive minutes, or be permitted to rise more than 85° C. above 24° C. ambient rating without giving sufficient time to cool between operation cycles. Continuous duty types are designed so they will not rise more than 85° C. above the 24° C. ambient temperature rating when operated at rated load. Plunger has slotted end with ⅛" diameter hole for coupling.

WRITE for SOLENOID BULLETIN "SOL-8"

GUARDIAN'S 25th YEAR

GUARDIAN ELECTRIC

1625-J W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF CONTROLS SERVING AMERICAN INDUSTRY


Engineer's CONTACT SWITCH KIT

RG cable is used in conjunction with power supplies. These connectors are rated for 5,000 v d-c.

Assembly of the cable to the connector employs the same techniques as the conventional UG, uhf type connectors. These connectors are not impedance matches but may be used in the same circuitry where the S0239 and PL259 are employed.

DIGITAL VOLTMETER
with automatic calibration

ELECTRO INSTRUMENTS, INC., 3794 Rosecrans St., San Diego 10, Calif., has announced a new 4-digit digital voltmeter with 1-digit accuracy, automatic calibration and 0.01 percent stability. Model 1040 has a voltage range of 0.001 to 999.9 v. Input impedance is 1,000 megohms on 9.999 scale and 11 megohms on other scales. Calibration is continuous and automatic, as are polarity and range switching.

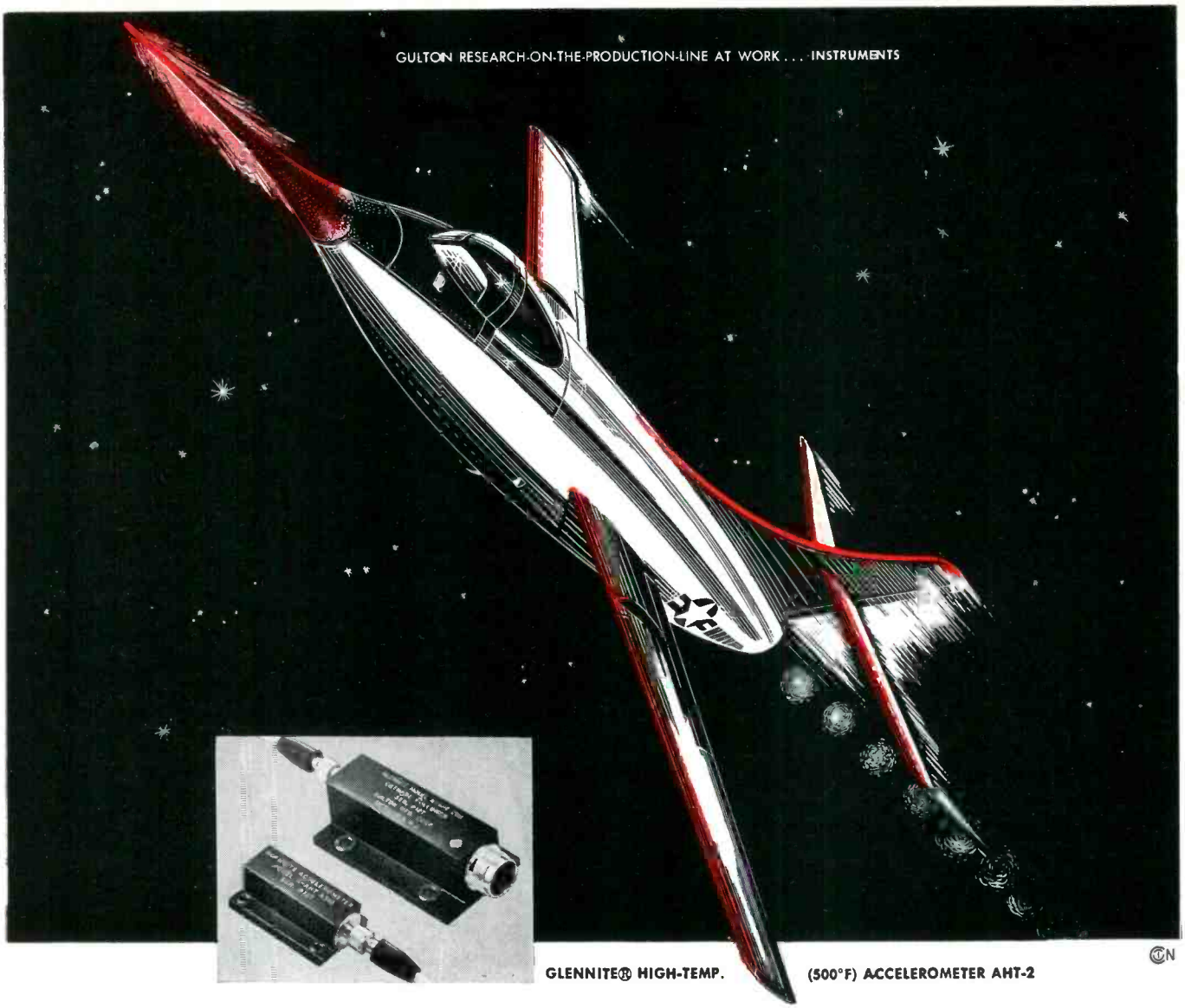
The instrument features the digital, in-line read-out common to the company's other equipment. The read-out may be remoted or miniaturized, if desired.

Model 1040 measures 7 in. by 19 in. for rack mounting. It operates on 115 v, 60 cps, 80 w. Warmup time for 0.01-percent stability is 30 seconds.

DECADE CAPACITORS
available in four ranges

FILM CAPACITORS, INC., 3400 Park Ave., New York, N. Y. A new line of Polystyrene and Teflon decade capacitors with accuracies down to 0.5 percent and a rating of 400 vwdc has been announced.

The special electrical characteristics of these capacitors make



ceiling unlimited

. . . FOR ACCURATE MEASUREMENTS AT HIGH-TEMPERATURES

THE PROBLEM: *The fabulous heat barrier . . .* awesome enemy of supersonic flight. It lies in wait for trespassers, today's experimental aircraft which spearhead the attack on ultra-fast motion. Their metallic "skin" glows red hot at these extremely high speeds . . . internal temperatures skyrocket, too . . . stresses multiply, *both* man and machine are strained to their endurance limits. And accurate measurements of structural vibrations due to these increasingly damaging environments can spell the difference between success and failure . . . but conventional shock and vibration instruments can't operate under these conditions.

THE SOLUTION: The GLENNITE Piezoelectric Accelerometer System KAHT-310, one of a completely new series of high-temperature units that give dependable measurements up to 500°F — *more than 250° f higher than ordinary instruments — without any cooling!*

Special design techniques, housing materials and miniaturized GLENNITE Components make it *extra-compact*, extremely lightweight . . . Completely self-generating, the precision built KAHT-310 measures up to 300 g's and from 10 to 2000 cps. Other GLENNITE high-temperature types weigh as little as 3 grams and measure up to 20,000 cps! More examples of why Gulton Mfg. Corp. is one of the leading manufacturers of shock and vibration measuring equipment, calibrating instruments, systems.

Pioneering efforts have also been made in self-recording, self-amplifying, differential transformer and potentiometer accelerometers. In addition, Gulton offers a complete line of standard units for every conceivable application . . . send for engineering information . . . today.

West Coast Representatives:

Perlmuth Electronic Assoc.
2419 So. Grand Ave.
Los Angeles 7, California

Harry Levinson Co.
1117 Second Avenue
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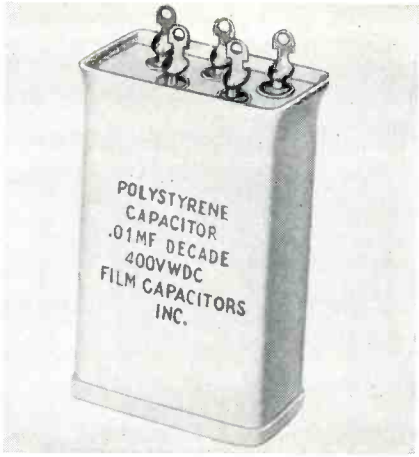
GULTON INDUSTRIES, INC

GULTON MFG. CORP.

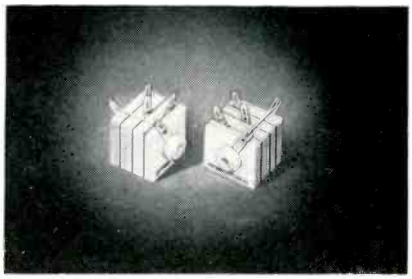
associated with GULTON INDUSTRIES, INC. Metuchen, New Jersey

PIONEERS IN MATERIALS RESEARCH. ELECTRONIC COMPONENTS. PRECISION INSTRUMENTS AND SYSTEMS ENGINEERING



them ideal for use in test equipment, experimental layouts, and as standards for bridge set-ups. All units are stabilized to remain within 0.1 percent of their original values for exceptionally long periods, on the order of 12 to 24 months. They are furnished in hermetically sealed cases with metal-glass hermetic terminals.

The polystyrene units may be operated at ambients up to 80 C, while the Teflon units may be operated at ambients up to 200 C. Four ranges are available: 0.001 μf per step, 0.01 μf per step, 0.1 μf per step and 1.0 μf per step.



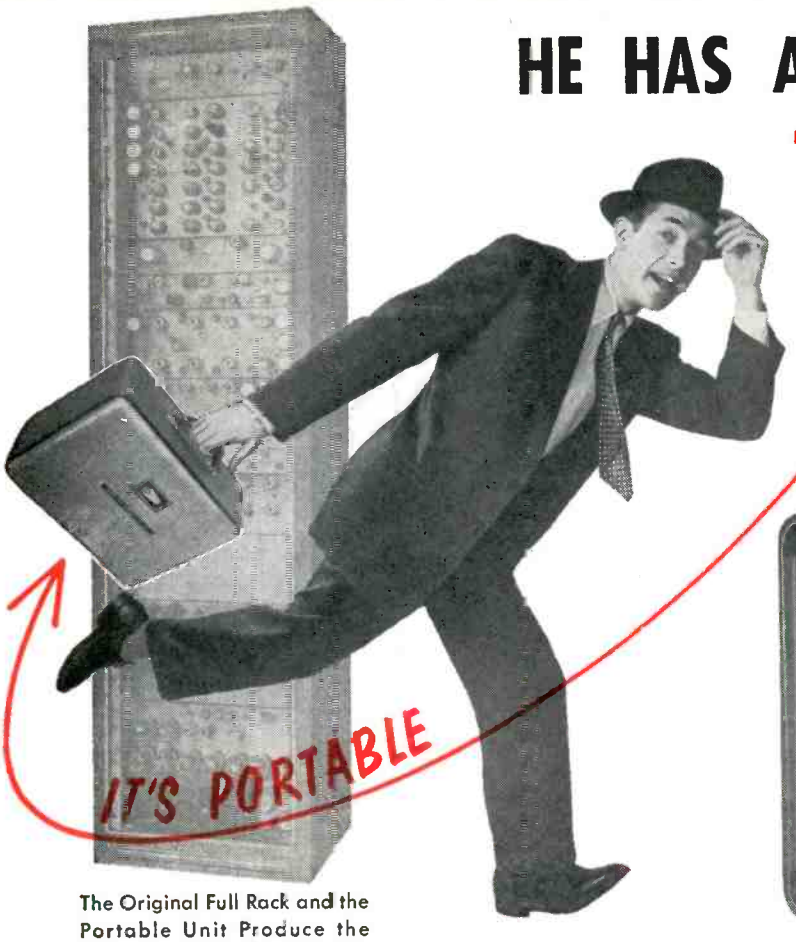
SELENIUM RECTIFIERS
for magnetic devices

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif., has developed type 61-2020, a single-phase full-wave bridge rectifier, to fill the need for additional small compact and inexpensive selenium rectifiers for operating magnetic devices. This unit is designed to deliver 90 v d-c at 175 ma for an rms voltage input of 130 v maximum. The rectifier occupies only 1 in. by 1 13/32 in. by 1¼ in. overall volume and can be mounted with a No. 8 (0.164 in.) machine screw, through the hollow brass eyelet.

This type combined with types

HE CAN CHECK VIDEO ANYWHERE

HE HAS A NEW VIDEO TRANSMISSION TEST SET



The Original Full Rack and the Portable Unit Produce the same Precise Test Signals.

TELECHROME INCORPORATED Model 1003-A

Video Transmission Test Signal Generator

★ Completely self contained ★ Portable ★ Multi-frequency burst ★ Stair-step ★ Modulated stairstep ★ White window ★ Composite sync ★ Regulated power supply.

Now, Telechrome Video Transmission Test Equipment is available as *a completely portable* 12¼" standard rack mounting unit.

Everyday these Test Signals generated by Telechrome equipment, are transmitted Coast-to-Coast by NBC, CBS, ABC, the Bell System, Conadion Bell and leading independent TV stations throughout the U. S. and Canada. Hundreds of network affiliated TV stations and telephone TV centers thus check incoming video signals.

The compact, inexpensive, portable Model 1003-A is all that is required to generate signals for local and remote performance checking of your entire video, cable, or micro-wave facilities.

MULTI-FREQUENCY BURST

AMPLITUDE vs FREQUENCY. Check wide band coaxial cables, micro-wave links, individual units and complete TV systems for frequency response characteristics without point to point checking or sweep generator.

WHITE WINDOW

LOW & HIGH FREQUENCY CHARACTERISTICS. Determine ringing, smears, steps, low frequency tilt, phase shift, mismatched terminations, etc. In TV signals or systems.

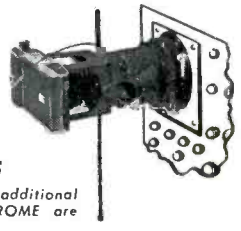
STAIRSTEP SIGNAL modulated by crystal controlled 3.579 mc for differential amplitude and differential phase measurement. Checks amplitude linearity, differential amplitude linearity and differential phase of any unit or system.

MODULATED STAIRSTEP signal thru high pass filter. Checks differential amplitude.

MODULATED STAIRSTEP signal thru low pass filter. Checks linearity.

Model 608-A HI-LO CROSS FILTER for Signal analysis.

1521-A OSCILLOSCOPE CAMERA —Polaroid type for instantaneous 1 to 1 ratio photo-recording from any 5" oscilloscope.



DELIVERY 30 DAYS

Literature on these and more than 150 additional instruments for color TV by TELECHROME are available on request.

TELECHROME INCORPORATED

The Nation's Leading Supplier of Color TV Equipment
88 Merrick Road Amityville, N. Y.
AMityville 4-4446

D-3575F and 60-9150 gives the electronic design engineer a wider range of single-phase full-wave bridge rectifiers with output voltages of 90 v to 180 v d-c at currents of 100 ma to 175 ma.

Some applications include solenoids, counters, relays, variable speed controls and field supplies for small d-c motors. Bulletin SR-134 gives further information.

R-F DUMMY LOAD
and calorimeter

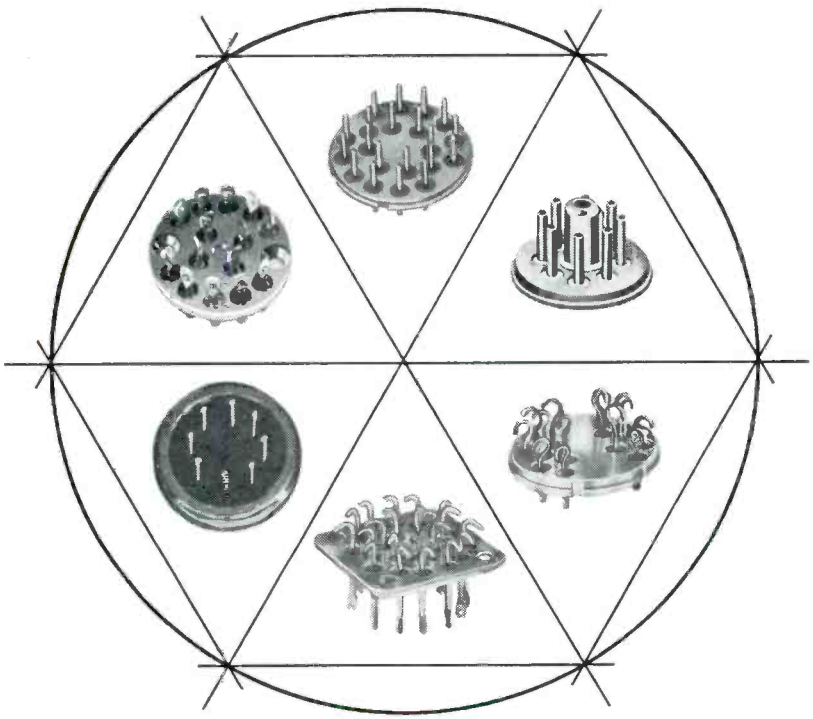
LEVINTHAL ELECTRONIC PRODUCTS, INC., 2760 Fair Oaks Ave., Redwood City, Calif. A completely self-contained r-f dummy load and calorimeter is designed for applications to high peak powers or high power installations. As an r-f dummy load, the unit is capable of handling in excess of two mw of peak power. The closed-circuit cooling system with its pump and heat exchanger permits satisfactory cooling at greater than 10 kw of average power.

For calorimetry, the unit uses a substitution method for greatest accuracy. A completely separate L-band waveguide, with a waterload tube containing a 60-cycle Nichrome heater wire is used as a calibrating load. A controllable amount, of 60-cycle power, metered by a 1-percent wattmeter, can be fed to this calibrating load by means of an externally operated Powerstat.

Flow rate is controlled by a flow regulator and metered by a flowmeter. Thermopiles across the input and output water measure temperature differential and actuate a millivoltmeter which is calibrated to read directly in r-f watts. Temperature differential for 10-kw in-

Constantin
ENGINEERED GLASS-TO-METAL SEALS

seal failure out . . .
seal reliability in

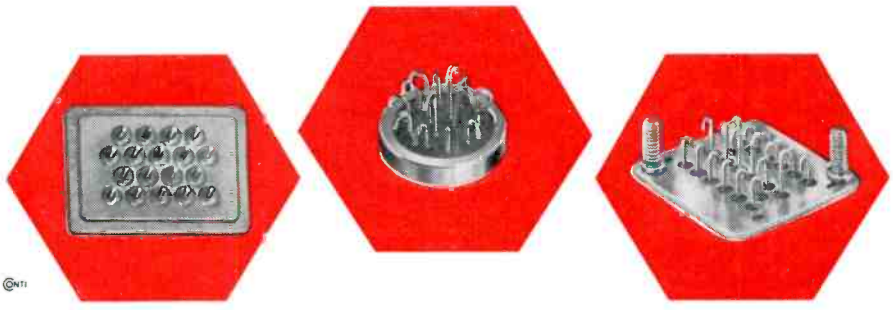


Constantin glass-to-metal seals improve component performance because they are impervious to sub-zero conditions, high pressure, oils, swamp test, compounds, most chemicals, corrosion, salt water immersion, and spray . . . withstand temperature cycling and vibration conditions . . . assure superior performance because of meticulous engineering.

Constantin has available for you a complete, quality line of precision multi-headers — transistor mounts and covers — end seals — single headers — crystal holders — connectors — terminals — electro-mechanical assemblies. Where a standard item cannot be used, Constantin will custom-engineer an exact unit for your particular requirement.

Write today for complete technical data about *all* Constantin products.

"QUALITY WITH CONFIDENCE"



L. L. Constantin & Co.

MANUFACTURING ENGINEERS

Route 46, Lodi, N. J. • 187 Sargeant Ave., Clifton, N. J.

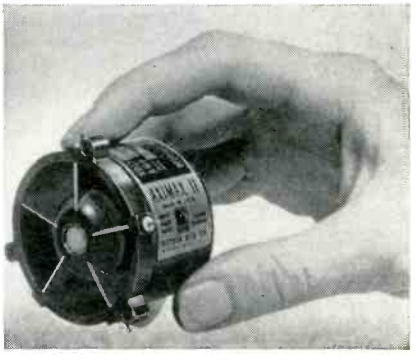
TRANSISTOR MOUNTS • SINGLE TERMINALS • COMPRESSION HEADERS • END SEALS • CRYSTAL BASES • CONNECTORS • MINIATURIZATION

West Coast Representative: Heim and Scheer, 11168 Santa Monica Blvd., Los Angeles 25, Calif. — GRanite 7-3208

put is about 12 F and power indicated by the meter differs from that calculated by about 1 percent.

MULTIPLIER PHOTOTUBE
for geophysical work

ALLEN B. DU MONT LABORATORIES, INC., 750 Bloomfield Ave., Clifton, N. J. The ¾-in., ten stage multiplier phototube, type K1382, will make available subterranean areas hitherto unreached in geophysical exploratory work. It has a rated average gain of 300,000 at 105 v per stage. At the same potential, maximum dark current measures 0.1 μa, photo-cathode sensitvity is 40 μa per lumen, and the average anode sensitvity is 12 amperes per lumen. It is designed with potted base and jacketed leads to eliminate moisture leakage.



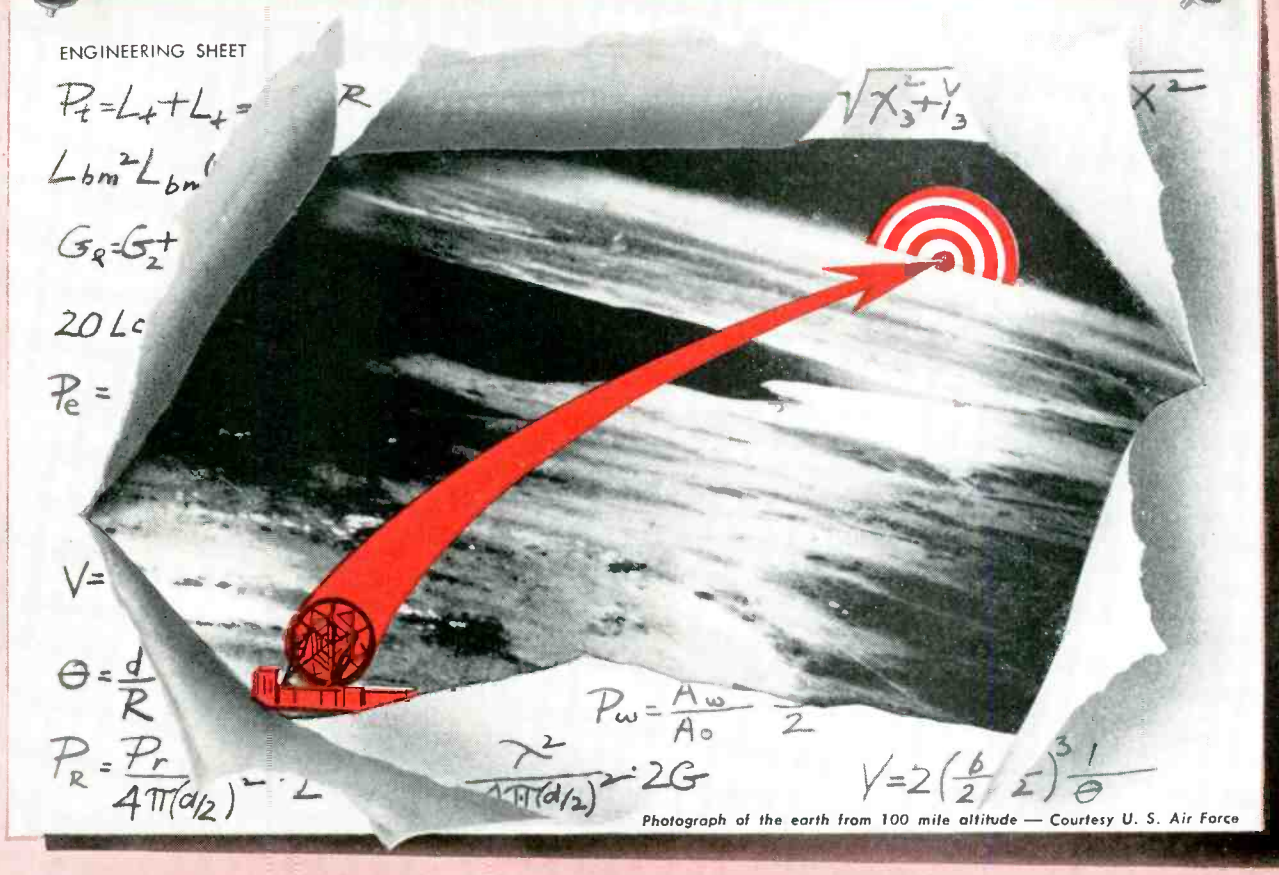
VANEAXIAL FAN
designed for missile use

ROTRON MFG. CO., Schoonmaker Lane, Woodstock, N. Y., has announced the AXIMAX II, a miniaturized cooling fan for missile use. The vaneaxial design is novel in that the motor is of the inside-out construction whereby the electrical rotor and the air moving impeller are integrally cast in one piece.

▶ **Specifications**—Only 2 in. in diameter and 1½ in. long, this fan moves 58 cfm at free delivery and

A NEW DESIGN APPROACH . . .

WESCON SHOW
BOOTHS 508 & 509



Photograph of the earth from 100 mile altitude — Courtesy U. S. Air Force

. . . BEYOND-THE-HORIZON TRANSMISSION

BEYOND-THE-HORIZON TRANSMISSION

The newest military and commercial long-range communications systems are turning towards the advantages of "scatter" transmission. By transmitting *directly* to stations well beyond the horizon, scatter transmission systems eliminate the construction and maintenance of intermediate microwave stations and avoid cables and repeaters of wire systems, while retaining the wide bandwidths available at high frequencies. This *direct* transmission can span water or inaccessible terrain while giving predictably high signal reliability and freedom from interference.

A NEW APPROACH . . . CONTROLLED SYSTEM DESIGN

A complete analysis including the effects of climate, multipaths, modulation, diversity and prolonged equipment operation combined with an exclusive experimental method of simulating every proposed link enables Hycon Eastern, Inc. to *hit the performance target more precisely*. We can reduce the expense of a large margin for error and eliminate the possibility of costly site relocations by careful assessment of each customer's needs and operating conditions that will provide him with an optimum design.

HYCON EASTERN OFFERS AN INTEGRATED SERVICE

Within the areas of Hycon Eastern, Inc. and its associated companies can be found complete facilities not only to design, engineer and specify equipment for Beyond-the-Horizon Transmission Systems, but to design Central Offices, Connecting Wire Networks, perform Communication Traffic Density Surveys, Aerial Surveys and Mapping to determine the most efficient routes for land lines and for various radio links such as UHF/SHF line of sight. After the necessary facts have been gathered there further exists the experience to evaluate them and to specify practical equipment with complete independence of judgment necessary to create a complete communications system that will fulfill present and projected needs.

H E

H Y C O N E A S T E R N , I N C .

75 CAMBRIDGE PARKWAY • DEPT. A-8 • CAMBRIDGE 42, MASSACHUSETTS

Affiliated with HYCON MFG. COMPANY, Pasadena, California

Want more information? Use post card on last page.

35 cfm at 2-in. static pressure. The unit weighs only 4 oz. It runs at 20,000 rpm and is wound for 400 cps, only either 200 v, 3 phase or 115 v, 1 phase. Both types have an input of only 35 w resulting from a high mechanical fan efficiency and electrical motor efficiency.

The fan is fitted with solder-type hermetic terminals rather than lead wire, a feature which allows the little unit to be inserted air-tightly in a closed piping system.

ACOUSTIC CALIBRATOR
accuracy less than 1db

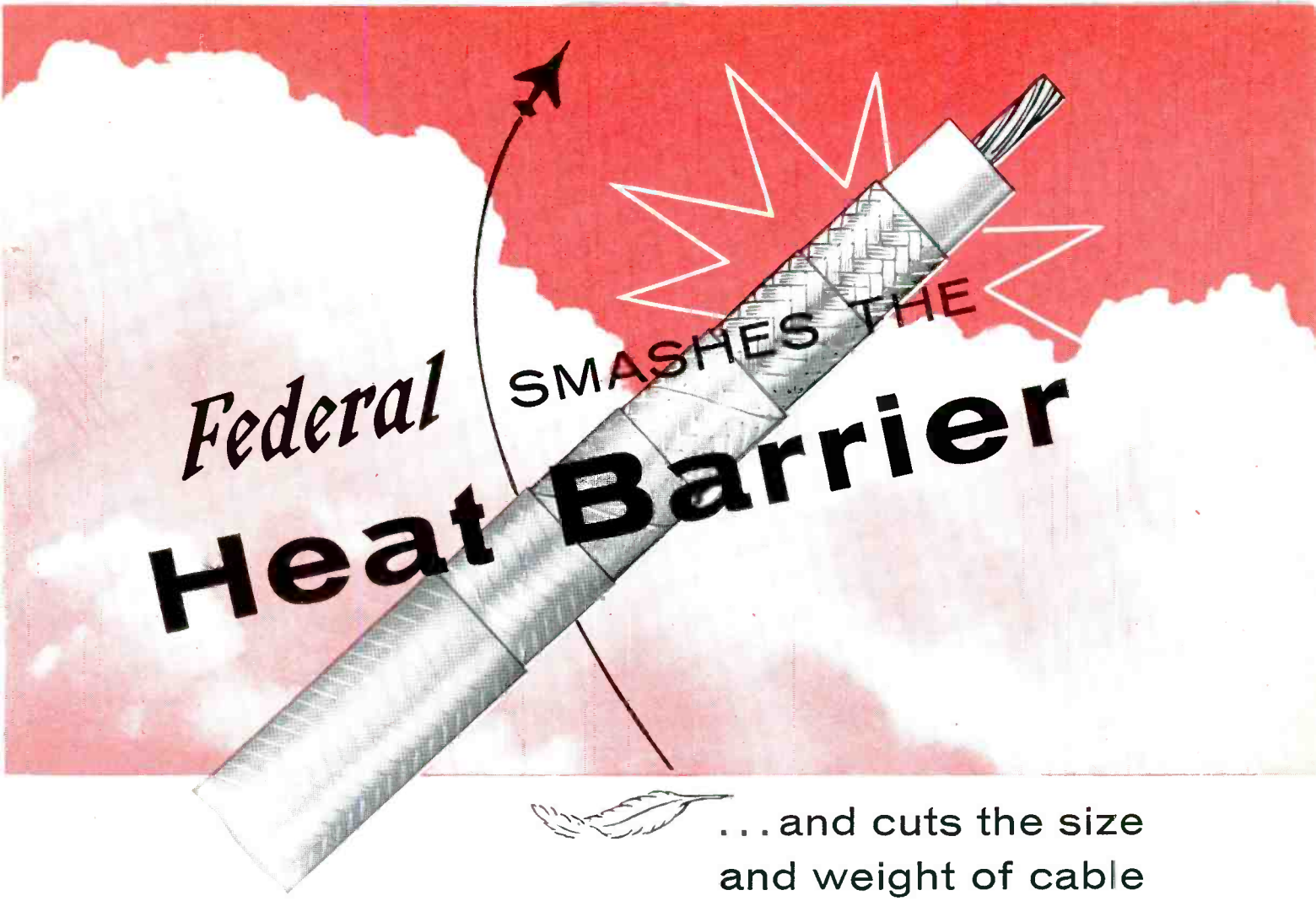
ALTEC LANSING CORP., 9356 Santa Monica Blvd., Beverly Hills, Calif., now offers the 12185 acoustic calibrator to pressure calibrate 21-BR type microphones used for measuring high intensity sounds in the jet engine and missile fields. It consists of the L1 pressure unit mounted so as to provide a cavity of 1CC. A sound pressure level of 140 db can be obtained with 1v input. Maximum safe input is 5 v and maximum sound pressure level, 155 db.

The unit provides rapid check on overall sensitivity of systems using all 21-BR microphones so the microphone can be standardized on the recording apparatus before and after each measurement in field or laboratory. Accuracy of measurement obtained is less than 1 db. Temperature coefficient is 0.02 db per deg F.

CONTACT SOCKETS
color-coded, press-fit

SEALECTRO CORP., 186 Union Ave., New Rochelle, N. Y., has announced color-coded, space-saving press-fit miniature contact sockets to take 0.080 in. test probes. They are available in three different probe sizes—0.040 in., 0.050 in. and 0.080 in. Bushing or insulator body measures only 0.185 in. diameter with 0.218 in. diameter front face which means spacing as close as $\frac{1}{4}$ in. between centers if desired.

Despite miniaturization, these contact receptacles are rugged and positive, due to beryllium-copper silver-plated-with-gold-flash contact members. For color-coding pur-



. . . and cuts the size and weight of cable

Federal's miniature coaxial cables—about ¼ the size of comparable RG types—save critical space and weight in aircraft and instrument uses.

Challenged by the high temperature and minimum weight requirements of jet aircraft and guided missiles, Federal has designed RG cables that perform perfectly at a blistering 500° F.! New Federal miniature coaxials have a top temperature rating of 150° C. . . . up to 200° C. with an impregnated fiber glass jacket!

The key to these new cable developments lies in advanced designs.

Based on utilization of "Teflon," this superior dielectric maintains its excellent low loss and high voltage characteristics through a temperature range of 500° F. to −100° F. "Teflon" has no measurable water absorption; it is chemically inert . . . unaffected by alkalies, acids, aromatic fuels, aromatic organic solvents, and highly corrosive aviation hydraulic fluids.

If your cable problems involve heat, space or weight, it will pay you to consider Federal's new "Teflon" insulated cables. For information, write Dept. D-913B.

"TEFLON" HIGH TEMPERATURE CABLES

RG-87A/U 50 ohms; 69.5% V.P.; 29.5 mmfd/ft. Cap; 4,000 operating volts.

RG-140/U 75 ohms; 69.5% V.P.; 29.5 mmfd/ft. Cap; 1,700 operating volts.

RG-141/U 50 ohms; 69.5% V.P.; 29.0 mmfd/ft. Cap; 1,500 operating volts.

"TEFLON" MINIATURE COAXIAL CABLES

K-256 50 ohms; 29 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 13 db/100 ft. Atten. at 400 mc; 0.095 O.D. dielectric; 7/30 silver-plated Copperweld conductor; 0.135 O.D. jacket.

K-257 70 ohms; 21 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 14 db/100 ft. Atten. at 400 mc; 0.095 O.D. dielectric; 7/34 silver-plated Copperweld conductor; 0.135 O.D. jacket.

K-258 93 ohms; 16 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 15 db/100 ft. Atten. at 400 mc; 7/38 silver-plated Copperweld conductor; 0.135 O.D. jacket.

"TEFLON" HOOK-UP WIRE—Type E, EE and FF Hook-Up Wires meet MIL-W-16878A. Available in all standard colors.

Federal
A DIVISION OF IT&T

Federal Telephone and Radio Company

A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

COMPONENTS DIVISION • 100 KINGSLAND ROAD • CLIFTON, N. J.

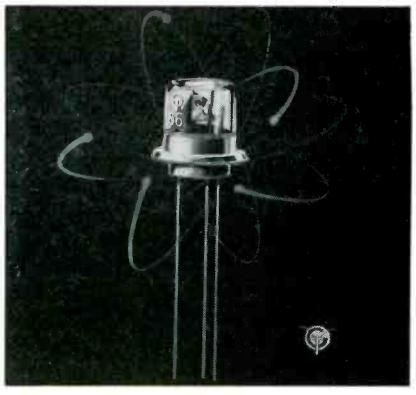
In Canada: Standard Telephones and Cables Mfg. Co. (Canada) Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., New York

poses, the contact sockets come in 8 RETMA colors—white, brown, yellow, blue, red, orange, green and gray, with coloring throughout Teflon body.

IMPULSE GENERATOR
operates at high temperatures

MINATRON CORP., 14 Cliveden Place, Belle Mead 14, N. J. The midget impulse generator, as a smaller companion to the model 50-A, likewise provides a self-generated output frequency proportional to the velocity of any ferromagnetic material passing the sensitive end of the pickup. It is designed to be used where space is at a premium and output requirements are moderate. The device provides an accurate means of measuring, counting or detecting movement, vibration or speed of a shaft or other part.

Stock units, enclosed in a stainless steel and Teflon housing, are only $\frac{3}{8}$ in. in diameter and 1 in. long. Construction is such that it will stand operating temperatures to 500 F. Units may also be had with sensitive end contoured for maximum sensitivity.



PHOTOTRANSISTOR
pnp three-lead type

GENERAL TRANSISTOR CORP., 130-11 90th Ave., Richmond Hill 18, N. Y., announces production of a new germanium *pnp* alloyed junction three-lead phototransistor. Known as type GT-66, it is a miniature, light-sensitive photocell intended for use in circuits employing a-c amplification for modulated light. It may also be used as a two-lead device with d-c (unmodulated) light. It

let RHEEM

RIGID BARRIER* PACKAGING

reduce your shipping, packaging and handling costs ...and keep your product safe

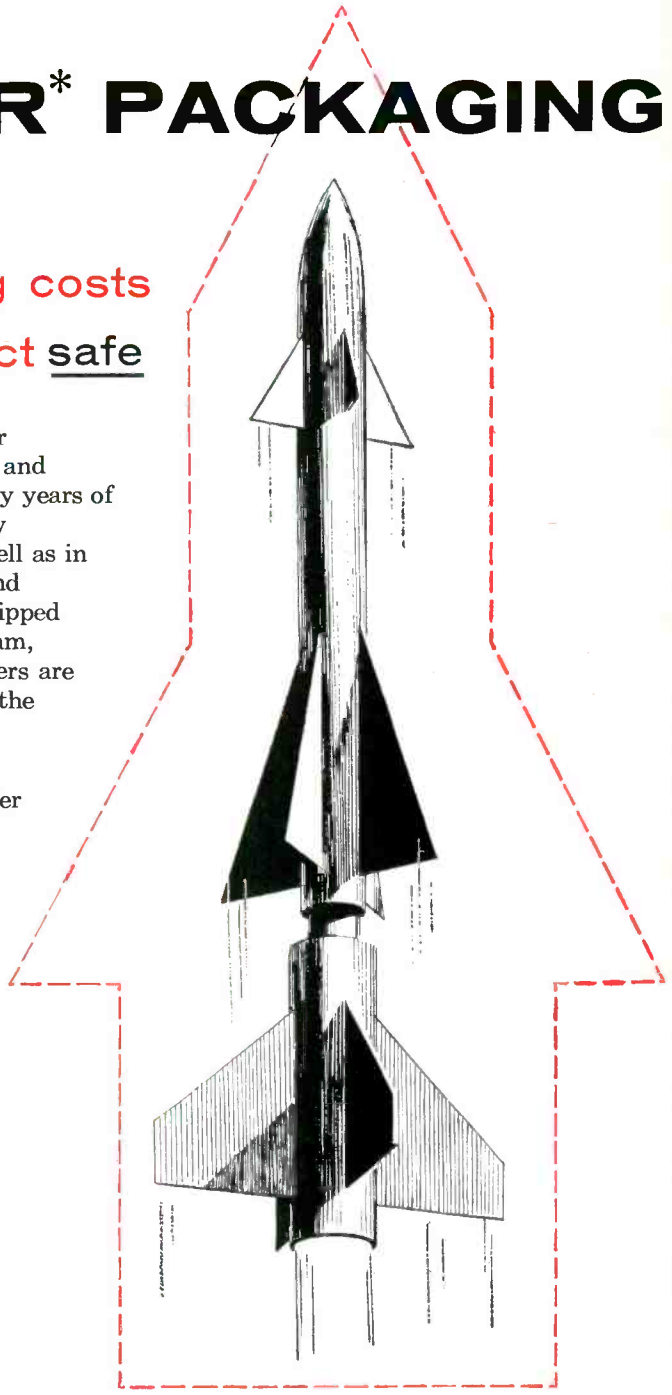
Rheem's complete and specialized Rigid Barrier Packaging Department is staffed with creative and expert packaging engineers. They have had many years of experience in designing all types of hermetically sealed containers for all kinds of products, as well as in selecting the best dunnage material for shock and vibration isolation. And these men, who are equipped to take over all or part of *your* packaging program, are proving that Rheem Rigid Barrier Containers are the safest, and most economic way to ship even the most intricate and delicate products.

Rheem's vast facilities are also utilized in producing Rigid Barrier "AN" Containers under military specification MIL-C-6054, meeting the requirements of MIL-P-116B specifications. "AN" Containers are available in a range from 1½ to 55 gallons, including multiple lengths and capacities. In other words, Rheem can solve any packaging problem from small engine parts to complicated electronic gear.

Rheem also has a complete line of light gauge Rigid Barrier Containers for industrial use—electronic tubes, automotive and diesel parts, precision instruments, or any other product requiring special packaging protection. And for pennies extra, Rheem will lithograph a container with your trademark, or design, and in any number of colors.

Whatever your product, chances are that Rheem engineers have already found a way (or can quickly find one) to package it safely in steel. And probably more economically than before, whether the container is for re-use or one-time shipment. Why not write today for details!

*Trade-Mark of Rheem Manufacturing Co.



Rheem designs and produces Rigid Barrier Containers for Guided Missiles, Electronic Tubes, Telephone Equipment, Precision Instruments, Aircraft Engines, Torpedoes, Auto and Diesel Parts, and other hard-to-ship products.

YOU CAN RELY ON Rheem

WORLD'S LARGEST MANUFACTURER OF STEEL SHIPPING CONTAINERS

RICHMOND AND SOUTH GATE, CALIF., HOUSTON, CHICAGO, NEW YORK, NEW ORLEANS, LINDEN, N.J., AND SPARROWS POINT, MD.

RHEEM MANUFACTURING COMPANY — RIGID BARRIER PACKAGING DEPARTMENT
1701 W. Edgar Road, Linden, New Jersey

Please send me information on the RIGID BARRIER

PACKAGING OF_____

NAME_____

POSITION_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____

E-8

is capable of performance at a level sufficient to operate a relay.

▶ **Uses**—Some possible applications include: tape and punch card reading, optical sound playback, liquid level control, tv receiver automatic brilliance control and industrial safety devices. It is also sensitive to relative position of the light source making it useful in positioning controls.

PANEL METER
with 0.5-μa sensitivity

GREIBACH INSTRUMENTS CORP., Metuchen, N. J., has developed an edgewise panel meter with full-scale meter sensitivity of ½ μa. Model 700 is the first of a complete series of edgewise panel instruments for voltage, current and resistance measurements.

All Greibach edgewise meters incorporate the bifilar suspension movement which minimizes friction losses and prevents damage even under high external stress. The units are characterized by features such as high overload capacity, relatively small energy input, and accuracies up to 0.25 percent.

PULSE CIRCUITS
transistorized plug-ins

TRIPL-T CO., Box 352E, Pasadena, Calif. Transistorized plug-in pulse circuits are now available. Multivibrators, binary counters, one-shot multivibrators, triggers, gated integrators, buffers, pulse inverters, blocking oscillators, crystal oscillators, and relay drivers in compatible circuitry are mounted with standard noval plugs.

▶ **Specifications**—Units are ⅞ in. in diameter by 2 5/16 in. high, weighing about 20 grams. Circuits will