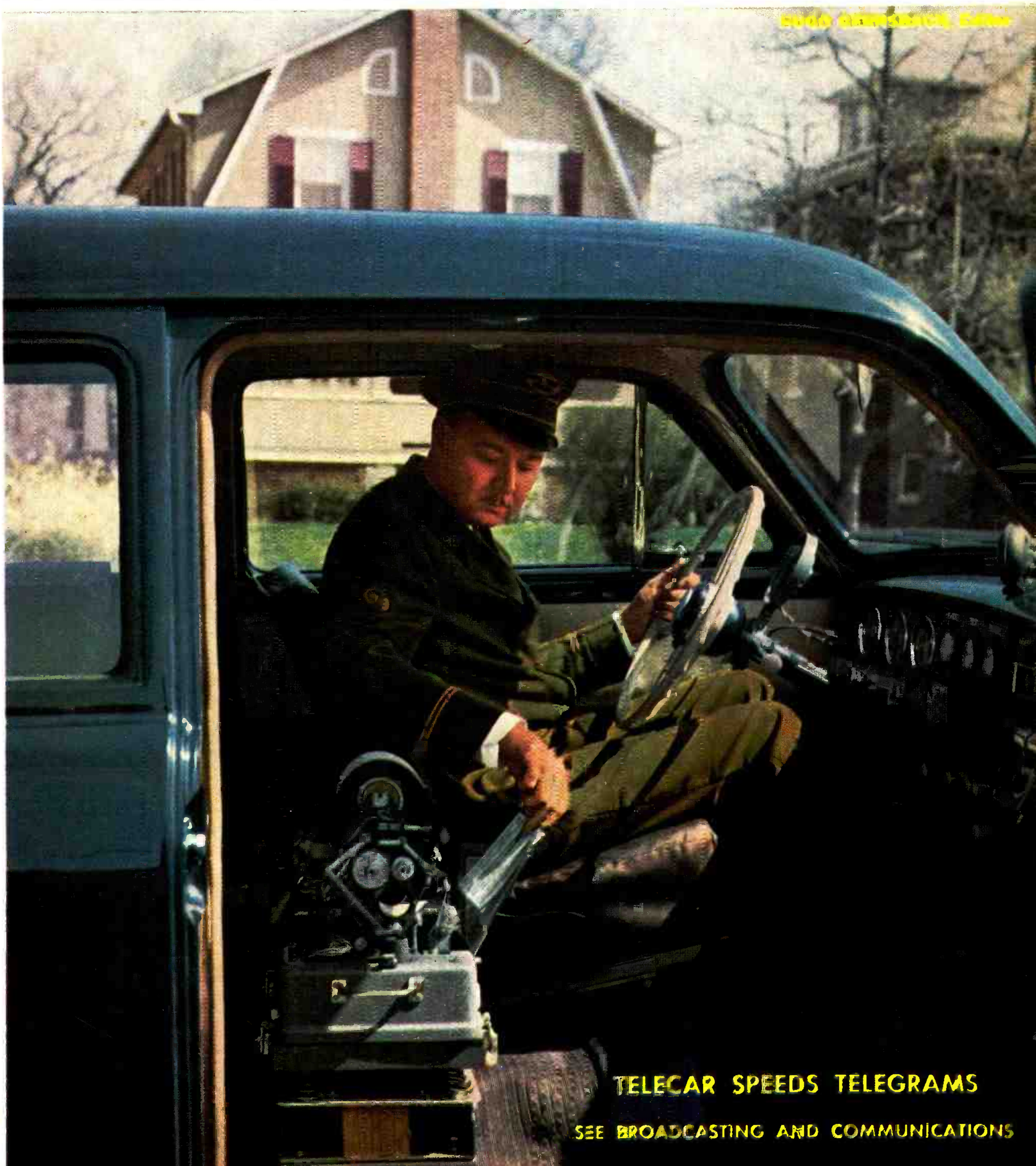
JULY 1951

RADIO-ELECTRONICS

LATEST IN TELEVISION • SERVICING • AUDIO



30¢
U.S. and CANADA

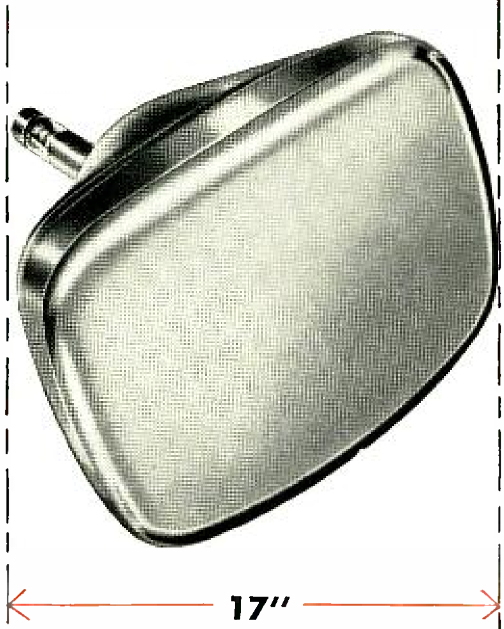
In this issue: **TV Tube Substitutions • Field Strength Meter • Pocket Superhet**

~~FOCUSING CONTROLS, COILS, OR P.M. FOCUSERS~~

the new DUMONT AUTOMATIC-FOCUS Teletron

Completely Eliminates-

- FOCUSING COIL
- FOCUSING CONTROLS
- MECHANICAL FOCUSING DEVICES



Provides-

- AUTOMATIC FOCUSING AT ALL TIMES
- FINE OVERALL FOCUS
- REPLACES ALL 17" GLASS RECTANGULARS WHETHER ELECTROSTATIC OR ELECTROMAGNETIC

Available soon in other sizes

DUMONT Teletrons*

FOR COMPLETE TECHNICAL INFORMATION — WRITE:

TUBE DIVISION — ALLEN B. DU MONT LABORATORIES, INC., CLIFTON, N. J.

*Trade-mark.

RADIO-ELECTRONICS

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SHORT WAVE CRAFT* TELEVISION NEWS*
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CONTENTS — JULY, 1951

ON THE COVER: Western Union Telecar in typical residential area, with pioneer Telecar operator Wallace Woodward at the wheel. Note microphone on steering column. Recorder cover was removed for photography, would normally be in place. *Kodachrome by Avery Slack*

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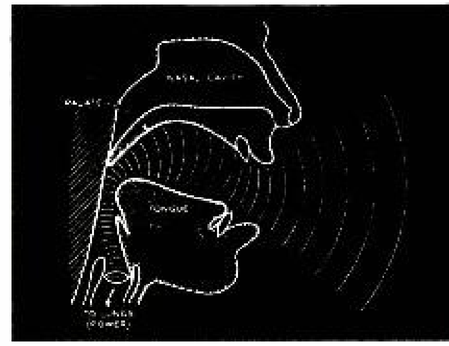
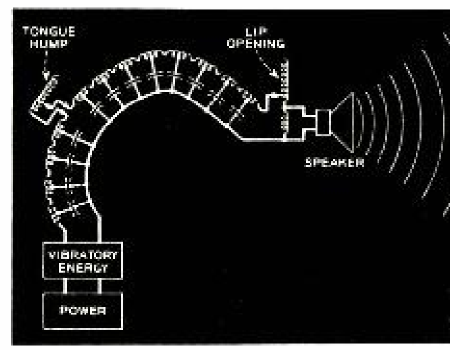
BRANCH ADVERTISING OFFICES: Chicago: 520 N. Michigan Ave. Telephone SUperior 7-1796. **Los Angeles:** Ralph W. Harker, 1127 Wilshire Blvd., Tel. MA 6-1271. **San Francisco:** Ralph W. Harker, 582 Market St., Tel. GArfield 1-2481. **FOREIGN AGENTS: Great Britain:** Atlas Publishing and Distributing Co., Ltd., London E.C.4. **Australia:** McGill's Agency, Melbourne. **France:** Brentano's, Paris 2e. **Holland:** Trilectron, Heemstede. **Greece:** International Book & News Agency, Athens. **So. Africa:** Central News Agency, Ltd., Johannesburg; Capetown; Durban, Natal. Universal Book Agency, Johannesburg. **Middle East:** Steimatzky Middle East Agency, Jerusalem. **India:** Broadway News Centre, Dadar, Bombay #14. K. L. Kannappa Mudaliar, Madras 2. **Pakistan:** Paradise Book Stall, Karachi 3. **POSTMASTER:** If undeliverable send form 3578 to: RADIO-ELECTRONICS, 25 West Broadway, New York 7, N. Y.

It tells how you talk





The machine at the left is saying "Ah!" It's the new electrical vocal system developed at Bell Laboratories. Top sketch shows human vocal system also saying "Ah!" The electrical model is sketched below it. Energy source at bottom of "tract" can emit a buzz sound, like vocal cord tone, or the hiss sound of a whisper.

No one else speaks exactly like you. Each of us uses different tones to say the same words. To study and measure *how* we make speech, acoustic scientists of Bell Telephone Laboratories built a model of the vocal system.

Electric waves copy those of the vocal cords, electric elements simulate the vocal tract, and, by adjustments, vowels and consonants are produced at pitches imitating a man's or woman's voice.

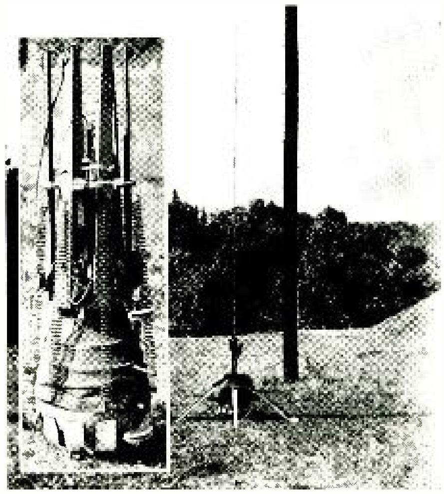
Using this electrical system, telephone scientists will be able the better to measure the properties of people's voices. Knowing more about speech they can find better and cheaper ways to transmit it.

This is another step in the research at Bell Telephone Laboratories which pioneered the exact knowledge of speech. Past work in the field is important in today's fine telephone service. A still deeper understanding of speech is essential in planning for tomorrow.

BELL TELEPHONE LABORATORIES

Exploring and inventing, devising and perfecting, for continued improvements and economies in telephone service.

GRASSHOPPER is the name of a self-contained automatic weather station which transmits weather data by radio. The unit is parachuted by aircraft onto inaccessible territory. It was developed by Percival Lowell and William Hakkarinen of the National Bureau of Standards for the Navy Bureau of Ships.



This Grasshopper sends weather data.

After the station is parachuted to earth controlled explosive charges are used to disengage the parachute, raise the station (springs released; pulling it to an upright operating position; see photo), and erect a telescoping antenna. Weather-responsive devices then cause resistance changes which switch a radio transmitter on and off at a rate translated by a receiving station into temperature, pressure, and humidity readings. The time of transmission is controlled by a clock mechanism.

The developmental model of the weather station has an output of 2 watts. Operating on a frequency of 5 megacycles, it performs reliably over land at ranges of 100 miles. The dry batteries used are good for 15 days of intermittent operation.

TILTING ANTENNAS may be used in future u.h.f. television transmitting installations if tests by RCA are any indication.

Using RCA-NBC facilities, experimental station KC2XAK in Bridgeport, Conn. (RADIO-ELECTRONICS, Aug., 1950) doubled its television signal strength in its program service area by a slight tilting of the transmitting antenna.

The antenna built for the tests was erected on one side of the Bridgeport transmitting tower. By means of a motor-driven arrangement, the antenna was rocked back and forth in a vertical arc of approximately 12 degrees to permit engineers to record the resulting variation in signal strength. Results recorded showed that the received signal was maximum when the antenna was tilted 2½ degrees up or down.

One drawback anticipated, however, is that it is possible that the gain in signal strength may increase interference with distant stations.

The experiment will be tried on v.h.f. TV channels also to see if similar improvement results.

"COMPOSITE COLOR TV," system proposed by RCA, Philco, Du Mont, Hazeltine and General Electric, will, according to Dr. W. R. G. Baker of G-E, "combine the best elements of the furthest advances in existing systems."

Particulars of the plan were stated to include utilization of the present black-and-white standards to transmit brightness or detail, and to add the necessary color information on a subcarrier contained within the video band and transmitted simultaneously with the "brightness" signal. No information was given as to whether the system had been made to work experimentally, but it was stated that the committee responsible for the new development hoped to be ready with a set of proposed standards by the end of the year.

CBS officials, just given the go-ahead sign by the Supreme Court on their color TV system, were unimpressed. "Third and most brazen attempt by a group of officials of black-and-white set manufacturers to impede the CBS system by concocting still another paper proposal," was the way Columbia described the proposed system.

WHIRLWIND ONE is the automatic computing machine doing research on Whirlwind Project now being conducted by Du Mont at M.I.T.

The project was instituted in recognition of the fallibility of human choice in analyzing the problem of distributing available u.h.f. TV channels across the nation. The aim is to eliminate human errors and guesswork. Sample data has already been fed into the machine with promising results. It is expected that a complete report on Whirlwind computations and TV station distribution results will be submitted to the FCC during its coming hearings.

RUSSELL D. VALENTINE, radio pioneer and chief engineer of WQXR, New York City, died at the age of 51, after a long illness. He had been with the station since 1929, when it was called W2XR. In 1934 it became the world's first high-fidelity broadcast station.

Mr. Valentine's radio career began in 1914, with his amateur station 2GX, whose call was known throughout the world.

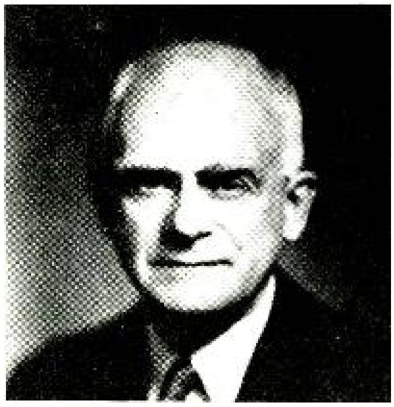
ANOTHER MAJOR STEP in its self-initiated functional reorganization was announced by the Federal Communications Commission in providing for the establishment of a Broadcast Bureau to start operations June 4, 1951.

The new bureau will have an Office of the Chief and five divisions as follows: Aural Facilities, Television Facilities, Renewal and Transfer, Hearing, and Rules and Standards. The effect will be that a single bureau will be responsible to the Commission for discharging legal, accounting, and engineering functions in connection with all broadcast services.

DEBATES on the floor of Congress may be televised in the future if Rep. Jacob K. Javits, R., N. Y., has his way. He is circulating a petition among his colleagues to this effect. The opposition, to date, is stiff.

HERMAN T. KOHLHAAS, a former official of International Telephone and Telegraph Company, died in an automobile accident April 24.

For 42 years Mr. Kohlhaas was associated with I.T.T. and its predecessor companies, serving as editor of *Electrical Communication,* the company's technical magazine, from 1925 to 1945 when he was named assistant vice-president. He resigned in 1947.



He was a fellow of the American Institute of Electrical Engineers, and a senior member of the Institute of Radio Engineers.

CONSTRUCTION WORK was completed recently on the last of 107 radio relay stations along the Bell System's new coast-to-coast communications route. Building west from Omaha and east from San Francisco, construction crews met northwest of Denver.

The final link runs zigzag across some of the nation's most rugged terrain, including the Rocky Mountains, the Sierra Nevadas, and the Coastal Range.

The new system will provide more than 100 "through" telephone circuits between Chicago and San Francisco. The route will be ready for long-distance service by late August. It is hoped that before the year's end the microwave system will be equipped also to handle coast-to-coast television.

COLOR TELEVISION received new impetus from the May 28 Supreme Court Decision upholding FCC's approval of the CBS color system. This leaves Columbia free to carry commercial as well as experimental color programs.

COLORED SOLDER is now being supplied by H. J. Enthoven & Sons of England. One of the difficulties in mass-produced assembly of electronic components is to insure that all wiring joints have been soldered. It is common practice to coat each joint with a colored lacquer on inspection.

By incorporating a colored flux in the solder it is possible to indicate the finished joint automatically, as the flux runs to the edges of the joint and remains as a permanent indicator. The coloring matter does not affect the electrical or mechanical properties of the solder. Four colors are supplied.

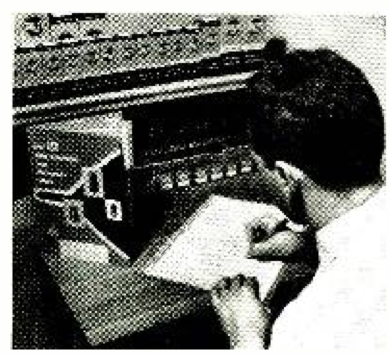
—end—

Merchandising and promotion

General Electric Tube Division, Schenectady, N. Y., released a new 107-page pocket-size handbook which lists the characteristics of every type of receiving tube likely to be found in AM, FM, or TV sets. It contains ratings and other data for fast trouble-shooting. Basing

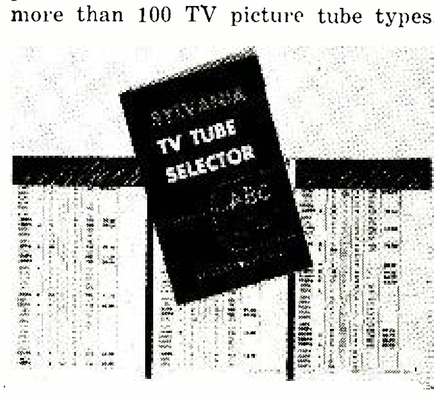
diagrams for each of the 856 different tube types listed are also shown. The handbook is 35¢ and available at G-E and Ken-Rad distributors.

RCA Tube Department, Harrison, N. J., published a new "1951 Tube Movement and Inventory Guide" for service technicians. It is a 16-page book in chart form designed as a year-round master control covering more than 400 receiving tubes and kinescopes. The chart provides a simplified record-keeping meth-



od which permits balanced inventories with a minimum of bookkeeping. RCA tube and parts distributors have it.

Sylvania Electric announced a new vest-pocket TV tube selector which lists more than 100 TV picture tube types.



It indexes them as to shape, construction, and other characteristics. The (*Continued on page* 18)

Golden Opportunity

for men in radio-electronics

to prepare for better pay jobs in

Television Servicing

YOU STUDY AT HOME

In your spare time, you learn pre-tested "How-to-do-it" techniques with "How-it-works" information in easy-to-study lessons. The course is based on the experience of the RCA Service Company in servicing thousands of home television receivers.

No vocational field offers more opportunities for "career" jobs and good pay than television—America's fastest growing industry. The demand for TRAINED and EXPERIENCED TV SERVICEMEN is growing. There is a big shortage of such men now and will be for several years to come.

PLENTY OF GOOD JOBS OPEN TODAY

Radio-Television jobbers, dealers and service companies offer lifelong opportunities with excellent salaries for qualified service technicians. Manufacturers of television receivers are looking for men with good service training as inspectors, testers and troubleshooters. Many experienced servicemen go into business for themselves. Others hold their regular jobs and earn extra money servicing TV receivers in their spare time.

Radio-electronics manufacturers busy with defense equipment contracts offer excellent job opportunities for men with a television technician background. Servicemen called into military service are further reducing the supply of skilled TV servicemen available for civilian activities. Think what television servicing offers *you* in terms of a lifetime career and financial security.

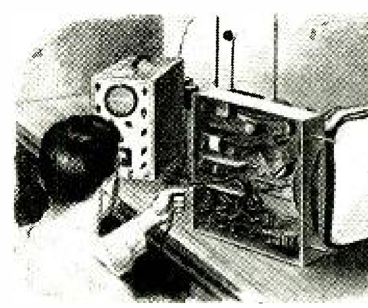
RCA INSTITUTES Home Study Course in TELEVISION SERVICING—

A Service to the Industry

Because of the critical shortage of TRAINED and EXPERIENCED TV SERVICEMEN, RCA Institutes is offering this highly specialized and practical home study course as a service to the working members of the radio-television-electronics industry. Its object is to train more *good* servicemen and to help make good servicemen *better*.

Never before has this course been available to anyone outside of RCA. It is now offered to *you*, through RCA Institutes, one of America's oldest and most respected technical training schools. The course covers most major makes and types of TV receivers. Available exclusively to men in the radio-television-electronics field. Not offered to the general public, or under G.I. Bill.

The cost is low . . . only $9 a unit for 10 units or $90 total, on an easy pay-as-you-learn plan. At successful completion of the course you earn an RCA Institutes certificate that can lead straight to a better job at higher pay.

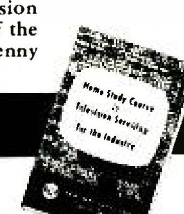


YOU KEEP WORKING ON YOUR JOB

Because you work in the radio-television-electronics industry, your job provides the laboratory work of the course. There are no kits, parts or equipment to buy. Self-employed independent radio and television servicemen are eligible for enrollment.

★ **LOWER RATES FOR GROUPS!** Employers in the radio-electronics industry who desire to enroll six or more of their employees for this course, may do so at lower rates for the group. A special group application form is available for employers desiring to take advantage of this offer. ★

SEND FOR *FREE* BOOKLET. Find out complete details of the RCA INSTITUTES Home Study Course in TELEVISION SERVICING. Don't pass up this opportunity to prepare yourself for a money-making career in the television industry. Illustrated booklet explains all the features of the course. Mail coupon in an envelope or paste on a penny postcard—NOW!



MAIL COUPON NOW!

RCA INSTITUTES, INC.
Home Study Department, RE-751
350 West Fourth Street, New York 14, N.Y.

Without obligation on my part, please send me copy of booklet "RCA INSTITUTES Home Study Course in TELEVISION SERVICING." (No salesman will call.)

Name____________________ (Please Print)

Address____________________

City__________ Zone_____ State________

RCA

RCA INSTITUTES, INC.

A SERVICE OF RADIO CORPORATION of AMERICA
350 WEST FOURTH STREET, NEW YORK 14, N.Y.

Here's a "BOND" That Money Can't Buy... THE RAYTHEON BOND for *ELECTRONIC TECHNICIANS*

It's a bond of integrity — a bond of ability — a bond of confidence between customer and service dealer. It's a bond resulting from Raytheon's desire to improve relationships between customers and service dealers. It's a bond of great value — yet it's yours *at no cost* if you can qualify. It's a bond that's Raytheon's investment in your future.

For more than five years the Raytheon Bond, which cash protects service dealers' 90-day guarantee on TV and Radio Repairs, has helped radio and television shops throughout the country to increase volume, build customer good will and has shielded them against attacks on their integrity. *It can do the same for you!*

Better ask your *Raytheon Tube Distributor* if you can qualify for this outstanding business asset.

RIGHT...FOR SOUND AND SIGHT

RAYTHEON

RAYTHEON MANUFACTURING COMPANY

Receiving Tube Division

Newton, Mass., Chicago, Ill., Atlanta, Ga., Los Angeles, Calif.

Excellence in Electronics

RADIO AND TELEVISION RECEIVING TUBES, CATHODE RAY TUBES, SPECIAL PURPOSE TUBES, SUBMINIATURE TUBES, MICROWAVE TUBES

guides are supplied free by distributors.

Clarostat Mfg. Co., Dover, N. H., assigned members of its sales and technical staff to attend a meeting of the Radio Technicians Guild in Boston. Demonstrations of the company's products were given and the service technicians attending were presented with Clarostat's "TV Control Replacement Manual," and other literature.

New plants and expansions

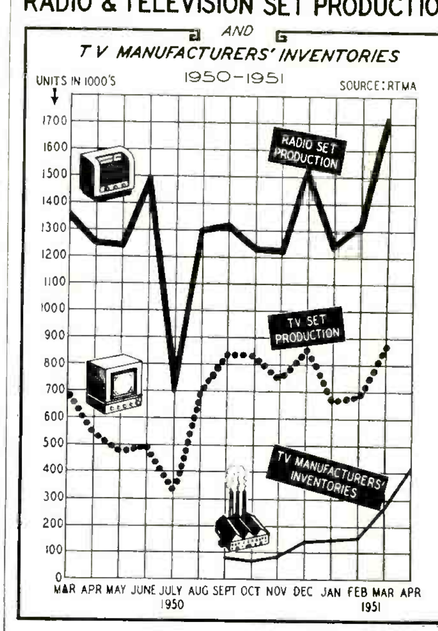
General Electric announced that it will triple the facilities of its Electronics Laboratory at Electronics Park, Syracuse, N. Y. The move will expand facilities for research and development of electronic military equipment.

Westinghouse Electric announced plans to build an electronic tube manufacturing plant on a 70-acre site in Bath, N. Y. The factory will produce electronic tubes for the armed services and for essential industries.

Business briefs

. . . The **RTMA** announced that radio receiving-tube sales reached an all-time high of 44,413,146 in March. Total for the first quarter of 1951 was 118,277,-243, of which 22% were replacements.
. . . The RTMA also reported that 84% of the 1,822,793 TV picture tubes sold in the first quarter of 1951 were rectangular. 94% were 16 inches or larger.
. . . **RCA Victor Division** received a Certificate of Co-operation from the Economic Co-operation Administration for the technical assistance furnished to peoples of Marshall Plan countries.
. . . **Utah Radio Products Co., Inc.**, was formed in Huntington, Ind., as a wholly owned subsidiary of Newport Steel Corp. The company will make radio speakers and allied products. A. H. Schenkel is president, E. V. Norfleet, secretary and treasurer, F. W. Tower, general sales manager, and M. G. Wike, sales manager of the Jobber and Industrial Division.

RADIO & TELEVISION SET PRODUCTION



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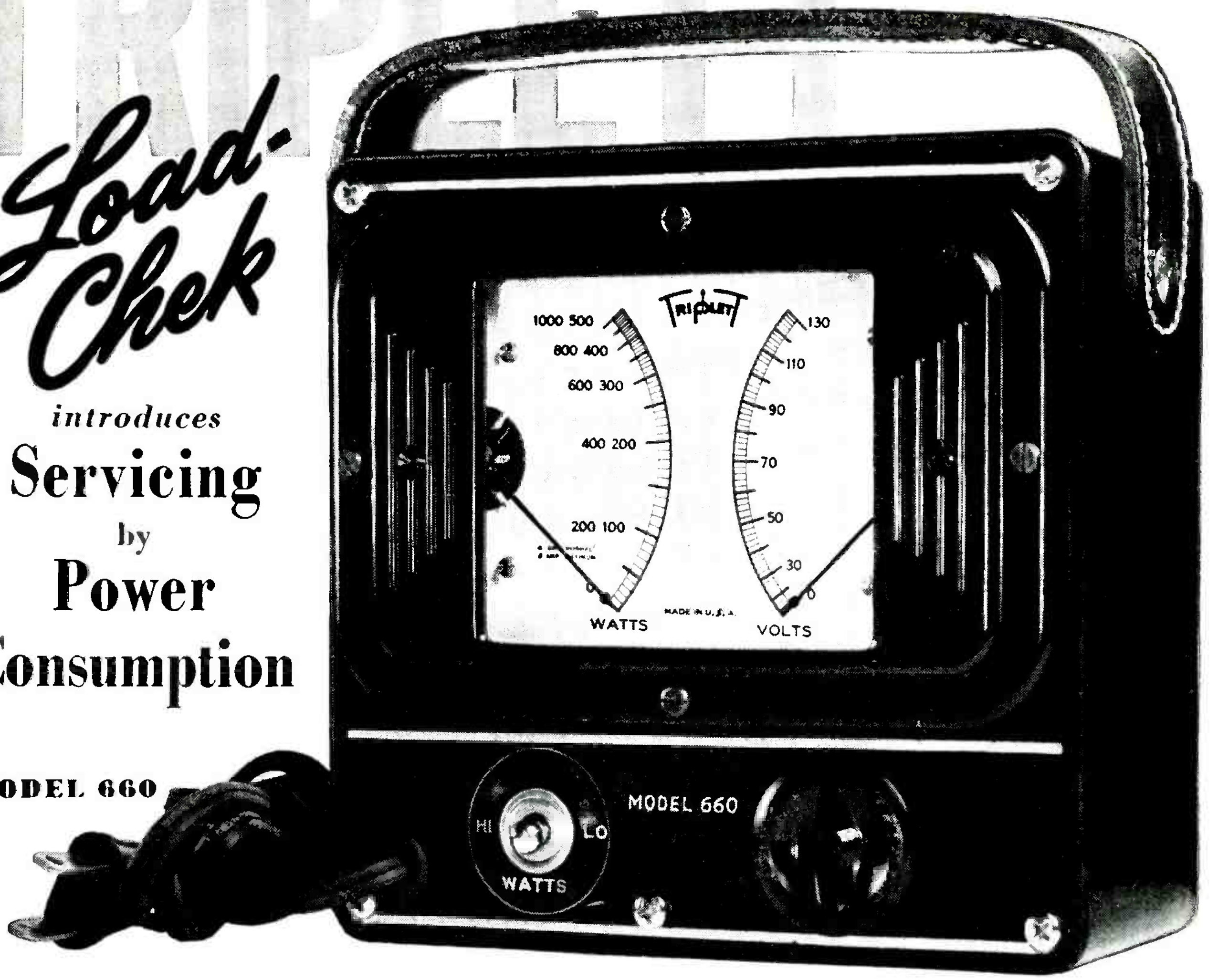
TRIPLETT

Load-Chek

introduces

Servicing
by
Power Consumption

MODEL 660



LOAD-CHEK *for the first time* makes it possible for every technician to utilize what is perhaps the simplest and quickest of all service methods—Servicing by Power Consumption Measurements.

Power consumption measurement has long been proved by auto-radio servicemen as a rapid method of localizing troubles in auto radios. But Triplett's new LOAD-CHEK is the *first* Wattmeter to be produced *at moderate cost*, and with the *proper ranges*, to bring this short-cut method within the reach of *every* radio and TV service man.

Basis of the LOAD-CHEK method is the tag or label on every radio and TV chassis which shows the normal power consumption. The following examples are only two of many time-saving uses of this new instrument.

LOCATING A SHORT—The chassis tag may show a normal consumption of 225 Watts. Simply plug the power cord of the chassis into LOAD-CHEK (there are no loose ends to connect or be in the way). Note the reading—which should be possibly 350 Watts. By removing the rectifier tube you can determine at once which side of the tube the short is on. With a soldering iron and long-nosed pliers you can check through the chassis, locate and correct the trouble without having to lay down tools or to check with lead wires!

REPLACING BURNED OUT RESISTORS—With the chassis to be repaired plugged into a LOAD-CHEK MODEL 660, note the wattage reading with the burned out resistor circuit open. Now replace the resistor. Should the increase in watts be greater than that of the resistor rating being installed, it indicates that an extra load has caused the trouble which has not been cleared.

LOAD-CHEK is made-to-order for the busy service man and can help stop costly "come back" repair jobs. It's a profit-maker because it's a Time-Saver. And at its moderate cost LOAD-CHEK can be standard equipment on *every* service bench. *By all means*, inspect this versatile instrument at your distributor and place your order, for under present conditions we must fill all orders on a basis of "First Come, First Served."

SEE MODEL 660 LOAD-CHEK AT YOUR DISTRIBUTOR'S

FOR THE MAN WHO TAKES PRIDE IN HIS WORK

Triplett

TRIPLETT ELECTRICAL INSTRUMENT COMPANY • BLUFFTON, OHIO, U.S.A.

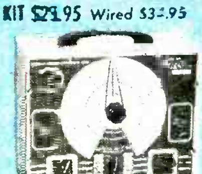
Tele-King Production Test Foreman James Adler and Harry R. Ashley, President of EICO, inspecting the use of the EICO Model 425 Oscilloscope and Model 221 Vacuum Tube Voltmeter at one of the important constant-duty alignment positions on the Tele-King television production line, New York City.

EICO KITS and INSTRUMENTS

New 555K MULTIMETER KIT $[illegible]95 Wired $3[illegible]

320K SIG. GEN. KIT $19.95 Wired $29.95

New 322K SIG GEN. KIT $23.95 Wired $34.95



New 950K COND.-RES. COMP. BRIDGE KIT $19.95 Wired $29.95

New 1040K BATTERY ELIM. KIT $25.95 Wired $34.95

HV PROBE (Wired only) $6.95

For Laboratory Precision at Lowest Cost— the Leaders Look to EICO!

No work in electronics is tougher on test equipment than the manufacture of quality television sets. Every week, every day, set production is pushed to ever greater volume, accelerated to ever faster pace—with no interruptions tolerated. Yet tests must be held to highest precision, costs must be kept to absolute minimum.

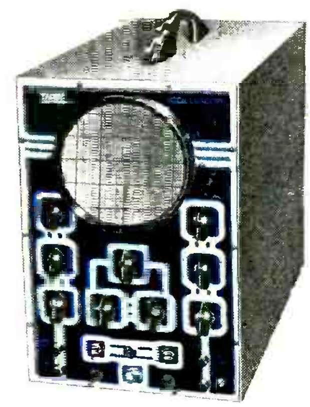
At the many vital testing positions along the production line of the great Tele-King Corporation—day after day, hour after hour—EICO instruments stand guard. From engineer to production chief to line tester, the men at Tele-King know that for speed, precision and utmost dependability, at maximum economy, they can always count on EICO instruments.

From coast to coast, in one famous TV factory after another, EICO instruments again and again prove their superiority. The top-flight TV set makers have discovered—just as over 70,000 servicemen have learned—that *for the industry's greatest instrument values, at the industry's lowest costs—it's EICO!*

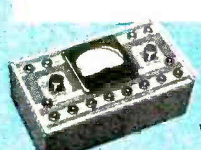
Before you buy any higher-priced equipment, be sure you look at the EICO line! Each EICO product is jam-packed with unbelievable value. YOU be the judge—*compare EICO at your local jobber today*—and SAVE! Write NOW for free newest Catalog 7-C.

FOLLOW THE LEADERS . . . *INSIST ON EICO!*

New 221K VTVM KIT $25.95 Wired $[illegible]9.95



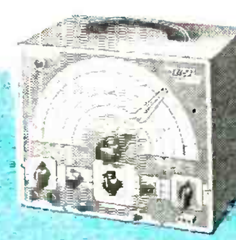
New 425K 5" SCOPE KIT $44.95 Wired $79.95



511K VOM KIT $14.95 Wired $17.95

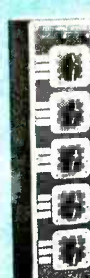
EICO

ELECTRONIC INSTRUMENT CO., Inc.
276 NEWPORT STREET, BROOKLYN 12, NEW YORK



360K SWEEP GEN. KIT $34.95 Wired $49.95

New 526K MULTIMETER KIT $13.90 Wired $16.90



New 1171K RES. DECADE BOX KIT $19.95 Wired $24.95

New 315K DELUXE SIG. GEN. KIT $39.95 Wired $59.95

New 625K TUBE TESTER KIT $34.95 Wired $49.95

145K SIG. TRACER KIT $19.95 Wired $28.95

Prices 5% higher on West Coast. Due to unsettled conditions, prices and specifications are subject to change without notice.

SERVICE BOMBSHELL

. . . Is radio servicing threatened by new competition?

By HUGO GERNSBACK

IN OUR June issue, page 12, we reported briefly that Western Union was sponsoring a new subsidiary, *Western Union Services, Inc.*, which will soon embark in servicing various manufacturers' television receivers throughout the country.

Immediately after Western Union made this announcement late in April, a fierce storm broke over the entire servicing industry, individual service contractors and service technicians' associations denouncing Western Union and Allen B. Du Mont Laboratories, Inc., the first manufacturer to make a contract with Western Union.*

In many localities in the United States the announcement acted like a bombshell. Many of the industry's spokesmen felt that with such a powerful competitor in the business, the radio and television servicing industry was threatened with complete annihilation. The parts industry was no less disturbed. Its spokesmen felt that with such a powerful new competitor in the field, jobber and dealer parts people might be put out of business because the new competitor was powerful enough to buy directly from the parts manufacturers, eliminating the wholesaler, jobber, and distributor.

RADIO-ELECTRONICS magazine, which for over 20 years has sponsored and in many cases represented the service technician, can readily understand the disturbance that a new and powerful competitor could create.

We accordingly thought it apropos to get all the facts in hand before taking sides in the controversy.

After digesting reams of pros and cons we decided to submit a questionnaire to Western Union, which we did late in May. Here are the questions:

1. How soon will Western Union Services start active servicing? 2. In what cities or section is this service available? 3. Does the Western Union Services intend to have servicing stations nationally all over the U.S.? 4. If experience shows the plan successful, about how soon is it expected that the service may be expanded to cover larger areas, or the nation as a whole? 5. Will the Western Union Services do only strictly servicing work, or will they also have stores where television sets, radio sets, and parts are sold? 6. Will Western Union Services make only servicing calls, or will they also receive at their stores sets for repairs left by customers? 7. How many people does the Western Union Services employ at present? 8. Have you determined a price scale to customers? If so, how do you charge (hour rate, or how)?

Western Union promptly answered, not question by question, but in a general letter signed by their vice president, S. M. Barr. Here is the reply:

H. Gernsback, Editor,
Radio-Electronics,
New York, N. Y.

Replying to your letter of May 18 concerning Western Union Services Inc., there is little further we can add at this time as to our future plans beyond what you already have printed on page 12 of your June issue.
Western Union Services Inc. is now in operation in its pilot service center in East Orange, New Jersey, where it offers installation and maintenance service on contract or call which, for the present, is limited to Du Mont telesets. The price scale is uniform with present Du Mont charges as indicated in your June issue. Repair service will be done either at the patron's home or in the service center as required either by the patron or the amount of repair needed. The Company has no intention of engaging in the sale of television sets, radio sets or parts, and plans to confine itself strictly to servicing activity, providing such parts as are needed in making repairs.
The approach to this problem is that of a long range activity on a national scale, but it is too early at this date to forecast the rate or the timing of expanded operations. I trust this gives you the picture we have with respect to this new service.

Western Union Services, Inc.
Signed, S. M. Barr

If Western Union Services, Inc., is vague on some of the points raised, the reason probably is that their policies have not yet sufficiently jelled for the new corporation to know their exact future plans.

It should be readily understood that the present management of Western Union Services, Inc., is not radio or television minded, having had no previous experience in the field. The management is chiefly composed of communication people. That means they will have to learn the business, which they cannot do overnight.

While we can see the future implications to the servicing industry as a whole, we feel—after consulting many people in the field—that the Western Union threat is by no means as acute as first pictured by some of the spokesmen of the servicing industry.

Most of them admit freely that it is the radio servicing industry's own fault that outside interests are now being lured into their field. Since the early 20's the service technicians, independent or employed, have never been able to get together and form a national organization through which they could become recognized all over the country. Instead the various factions fought each other continuously. When well-meaning organizers tried to launch a national association the movement always failed.

This was also true of the writer's former organization "The Official Radio Servicemen's Association" sponsored by this magazine for several years during the early 30's. It proved impossible to make the various local chapters cohere and this was the case also with the RSMA and other attempts made in the past.

Western Union's so-called threat may conceivably prove a blessing in disguise. We do not at all feel that the radio servicing industry will be hurt. On the contrary we do believe that the new competition will bring the various factions together as nothing before ever could do. It will be a powerful incentive to clean house, throw out the irresponsible radio technicians—who now abuse the public and give the entire business a black eye—and then set up a live and vigorous national servicing body.

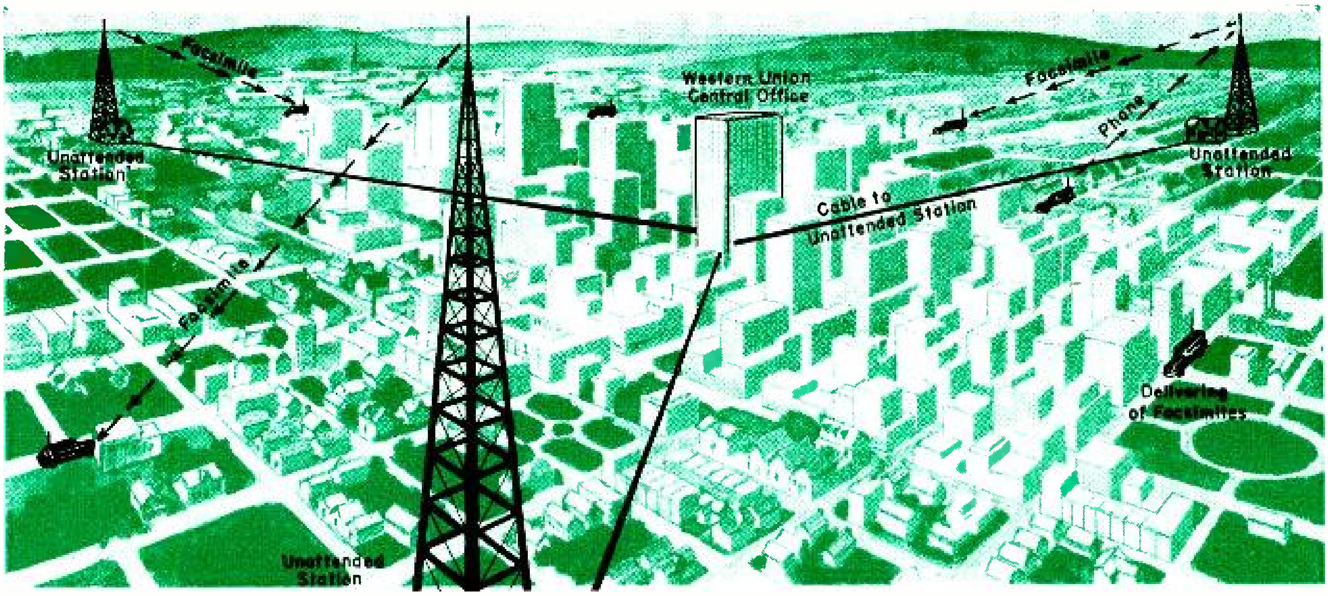
RADIO-ELECTRONICS does not believe that Western Union will put the servicing industry out of business—they may have hard sledding themselves for some years to come—while local service organizations will be in a position to do the work better and cheaper than any big unwieldly body.

BUT THE LOCAL ORGANIZATIONS MUST FIRST CLEAN HOUSE AND BY CONCERTED ACTION PROVE TO THE PUBLIC THAT THEY DESERVE ITS CONFIDENCE.

Perhaps we can do no better than quote Mr. Mort Farr, veteran Upper Darby, Pa., servicing retailer and president of the National Appliance and Radio Dealers Association:

"The new Western Union subsidiary isn't likely to be as tough a competitor as the fly-by-night operators and screw-driver mechanics. It will be a legitimate operation, with a big overhead. The company will probably hire qualified help and won't be able to cut prices dangerously low as do some of the contractors now in business."

* See also "With the Technician" Section, page 86, this issue.



The Telecar system as it might be applied to a city of moderate size. The three unattended stations serve nine Telecars.

Telecar Speeds Telegrams

The modern telegraph messenger is facsimile-equipped

By FRED SHUNAMAN

THE observer is occasionally struck by anachronisms in the march of scientific progress—vestiges of the pre-machine age which survive in this era of electronics and nucleonics. One of these is the messenger-boy system of delivering telegrams on foot, by bicycle, or occasionally in a car. High-speed mechanized networks are in use today through which telegrams flash from origin to destination without manual retransmission at any point en-route. There are facsimile systems capable of transmitting thousands of words per minute; radio links to remote parts of the world; carrier systems, and many other techniques. These have so speeded up telegraph service since the time of Morse that the inventor would hardly believe the present system possible.

In spite of these advances the delivery system—up to a short time ago—was strongly reminiscent of the days of Morse. Since 1925, printing telegraph machines in large business houses, and, more recently, several thousand small facsimile (Desk-Fax) machines installed right on the business-man's desk, have pretty well solved the problem for large and medium-sized businesses. But for the small business and in residential areas, pick-up and delivery of telegrams—even by auto and motor bike—is still the weak spot in the telegraph service.

A method of eliminating this weak spot in our communications system has now been worked out. Already in Baltimore telegrams are being handed to recipients sometimes within a minute of the time they reach the city telegraph office. As the remaining "bugs" are ironed out of the system it will no doubt be extended to other parts of the country.

The Telecar

The device that will take home telegram delivery out of the 19th century is the *Telecar,* a station wagon equipped with a facsimile telegraph receiver and chauffered by a uniformed WU telegraph messenger. Depending on point of view, it is either a radio-and-facsimile-equipped Western Union messenger or a roving branch telegraph station.

Telecars are now cruising the streets of Baltimore. With the exception of messages for the downtown business section, most telegrams received in that city are delivered by them. A telegram destined for a section of the city is routed to one of the Telecars in that territory and is received by its facsimile equipment without the driver's aid. It will even be received if the driver is temporarily absent from the car.

As soon as the telegram is finished and the Western Union messenger-driver, already cruising in his assigned area, sees the address on it, he drives immediately to that point and delivers it. He waits for an answer which he can radio back to the central office by phone. The cars are equipped with radiophone transmitters and receivers.

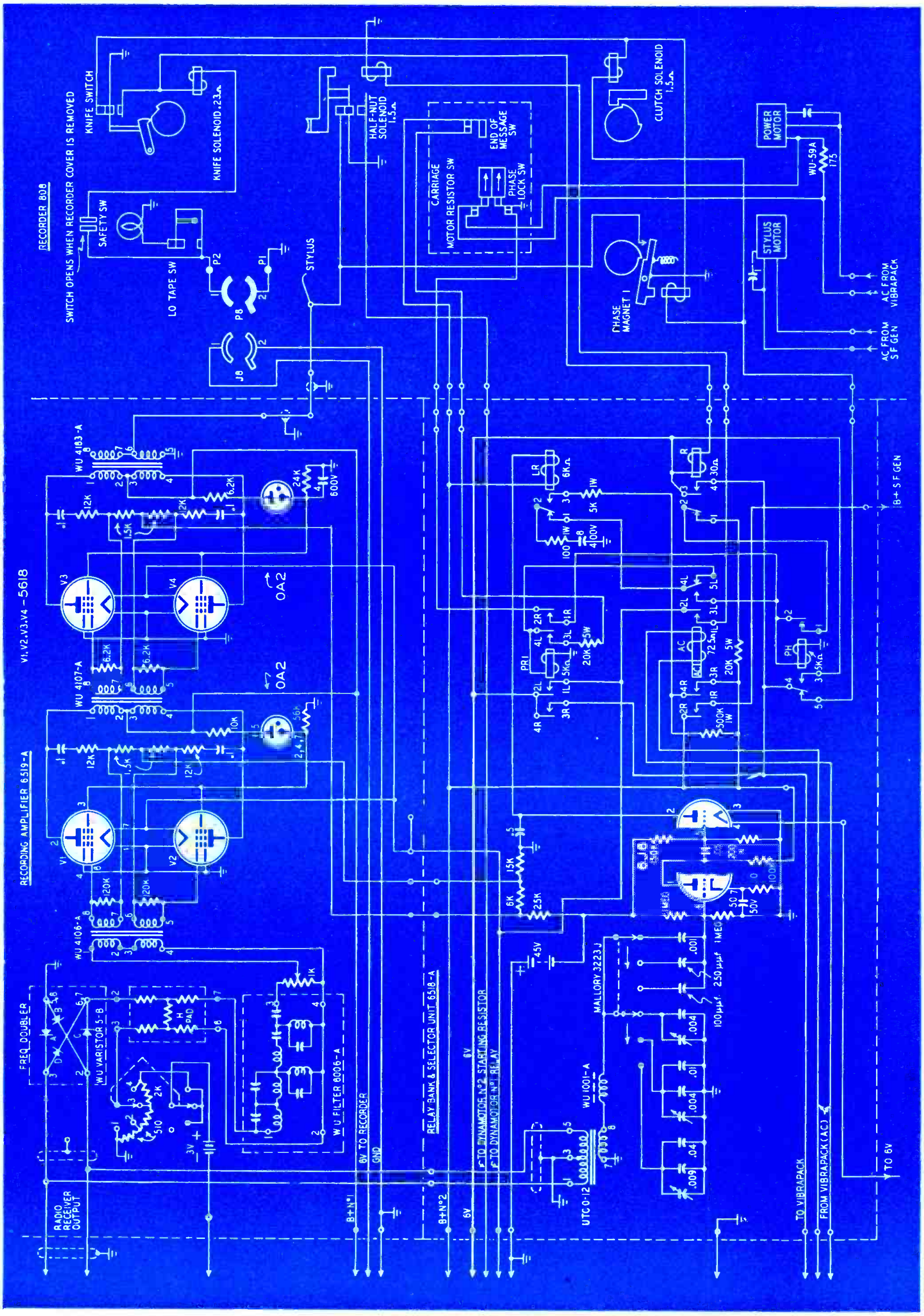
The car radiophone can also be used for receiving instructions from the telegraph central office, except for the time when a telegram is actually being received.

To the radioman the idea seems a good one, sound, reasonably straightforward and simple. Thus thought also the engineers of Western Union. But the usual "bugs" were discovered during "reduction to practice," and the present system is the result of several years' experimental work.

How it operates

All the messages are sent from the central telegraph office in the heart of Baltimore. Messages destined for the business district immediately surrounding the station are handled direct by printer, facsimile, or messenger. Those for the Telecars are transmitted by wire to one of four unattended transmitting and receiving stations which are placed in a quadrangle round the outskirts of the city. They operate in the 30-50 mc range.

The actual facsimile transmitting equipment is standard or modified Telefax apparatus, familiar in many business offices. The messages, as received on printers at the main office from all parts of the nation, are put on vertical cylinders which revolve in front of a phototube. The output of the tube, modulated by the message, is amplified and *inverted.*


RECORDER 808
SWITCH OPENS WHEN RECORDER COVER IS REMOVED
KNIFE SWITCH
KNIFE SOLENOID 23Ω
SAFETY SW
LO TAPE SW
STYLUS
HALF-NUT SOLENOID 1.5Ω
CARRIAGE MOTOR RESISTOR SW
END OF MESSAGE SW
PHASE LOCK SW
CLUTCH SOLENOID 1.5Ω
PHASE MAGNET
POWER MOTOR
STYLUS MOTOR
AC FROM VIBRAPACK
AC FROM S F GEN
B+ S F GEN
V1, V2, V3, V4 - 5618
RECORDING AMPLIFIER 6519-A
FREQ DOUBLER
WU VARISTOR 5-B
W U FILTER 8006-A
RADIO RECEIVER OUTPUT
6V TO RECORDER
GND
RELAY BANK & SELECTOR UNIT 6518-A
TO DYNAMOTOR Nº2 STARTING RESISTOR
TO DYNAMOTOR Nº1 RELAY
MALLORY 3223J
UTC O-12
TO VIBRAPACK
FROM VIBRAPACK (AC)
TO 6V

The reason for inversion is that since the light paper of the telegraph blank produces more current in the phototube than the dark letters, the message is originally a negative. Better results in transmission and reception are obtained by making it a positive—with the black letters producing the stronger signals and the light background remaining at a low level. A further advantage is that the received telegram is a positive instead of a white-on-black negative that would look unfamiliar to the average recipient.

The amplified signal is routed by wire to one of the four unattended stations, each of which has one to three Telecars allotted to it. The station is normally in a receiving condition, awaiting any messages from the Telecars. The "preamble" of the telegram contains signals which turn on the transmitter and switch the antenna from the receiver to it. An audio calling tone is then transmitted for two seconds to select the desired car. After the 2-second tone, a 2-second pause gives the car's relay equipment time to turn on the recorder. Pulses are sent to synchronize the Telecar with the transmitter, and the message is recorded.

As soon as the message is concluded, the car recording equipment is shut down automatically and the receiving equipment reverts to its stand-by condition. The unattended station is also automatically switched from transmit to receive, ready to pick up any query or message from the car.

The mobile equipment

Each Telecar is fitted up with a modified RCA CMV-2A transmitter-receiver. Its transmitter section supplies 30 watts of phase-modulated signal to transmit replies, service messages and inquiries to the unattended stations. Its receiver has an output of 1 watt.

The receiver is mounted near the rear of the car. The equipment directly ahead of it in a cabinet located behind the driver includes a *power pack*, a *standard frequency generator*, a *recording amplifier*, and a *relay bank and selector*. (See page 23 for schematic). The recorder sits beside the driver.

The recording unit

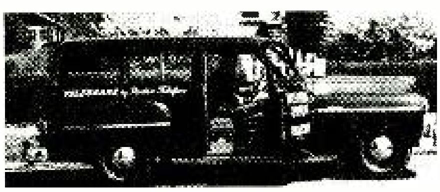
The recorder is a modified Western Union 808 unit. The telegram is "printed" in black on a yellow (Teledeltos) paper with a silvery, conductive back. The paper is fed into the recording position from a roll. When in position to record, its edges rest around two circular flanges which form it into a cylinder, down the center of which the stylus assembly travels while the rotating stylus inscribes its message. Dark marks are made on the paper whenever an impulse from the recording amplifier supplies a pulse of voltage to it.

The carriage assembly is made to travel by a threaded lead screw, against which a threaded "half-nut" is brought into engagement by a relay-actuated solenoid when the carriage is to start in motion. Other relays provide that the stylus start in exact synchronism with the beam of light scanning the telegram at the transmitter. Still other equipment is provided to eject and cut off the telegram when complete, and even to warn the operator when the roll of telegraph blanks is running low (low tape switch).

The most important equipment is that which selects the designated Telecar for a given message, puts its recording equipment into action, and synchronizes it with the transmitter. This is the relay bank and selector unit.

Less dramatic, but equally necessary are the other sections of the apparatus already mentioned. Radio men will find the *recording amplifier* a reasonably standard unit. Its most interesting feature is the *frequency doubler*. Doubling the frequency of the Telefax signals provides more definition at the recorder while avoiding the difficulties that would be encountered with wideband circuits in the radio transmitting and receiving apparatus. The signal to noise ratio is also improved.

Following the frequency doubler is a Western Union filter designed to trap out all but the desired Telefax signals, and a balanced-to-ground push-pull amplifier, with its output connected directly to the receiving stylus.



One of the Telecar fleet in Baltimore.

The power pack consists of two dynamotors which supply power to the recording amplifier and the standard frequency generator, and a vibrapack which supplies a.c. for the motor driving the carriage assembly. All the equipment, including the recorder, is powered from a single 6-volt battery which is charged from a high-current alternator-rectifier arrangement. The primary source of power is, of course, the car's engine.

The motor which rotates the stylus is driven by a special standard-frequency generator, which is a 60-cycle multivibrator controlled by a 240-cycle tuning fork. The output, furnished at exactly 60 cycles by a pair of 6V6's, keeps the recorder stylus in synchronism with the scanning beam on the cylinder of the transmitting equipment. The latter is also powered from a standard frequency generator. All that is necessary is to assure that the beam and stylus start in unison.

Selector and relay bank

The recorder is started and synchronized by signals from the receiver which branch off to the selector just before the frequency doubler. These leads carry not only the 1-, 2-, or 3,000-cycle tones which select the desired car but also the pulses that bring the recorder into step with the transmitter and start it at exactly the right instant.

The selector is a resonant circuit made up of a Western Union 1001-A coil and any one of three capacitor combinations which tune it to any of three frequencies. They are selected with a switch which also connects the resonant circuit to the following amplifier through a coupling capacitor of suitable size for the frequency.

At the beginning of each message, a 2-second tone of one of the three frequencies is transmitted. It is picked up by the car receivers and—on the selector tuned to it—is amplified through the two halves of the 6J6. Relay LR in the plate circuit of the 6J6's second triode then closes, charging an 8-µf capacitor through its contacts 2 and 3. When the 2-second signal stops, contact 2 drops back against contact 1 and the capacitor discharges, closing relay PRI.

The relays click

Thus begins a series of events which lasts another two seconds and prepares the equipment to start recording the telegram. Relay PRI, through its various contacts, turns on the tube filaments in the recording amplifier and supplies plate voltage to them. It also starts the vibrapack through its 3R and 4R contacts and at the same time actuates the phase magnet solenoid.

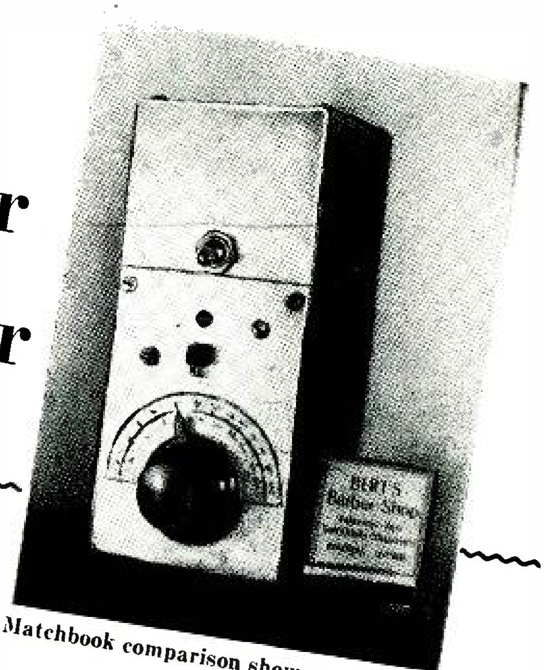
As the vibrapack starts to supply power, relay AC pulls up. Its contacts 1L and 2L supply current to the half-nut solenoid in the recorder, causing the half-nut to engage the lead screw. The carriage starts to move. Contacts 1R and 2R supply voltage to the standard frequency generator which operates the stylus motor. The stylus motor rotates only till the stop on its shaft contacts the dog brought up against it by the phase magnet, and there waits for the phasing pulse that will release it.

Two seconds after the end of the tone signal, short phasing pulses are sent. Relay LR follows them and thus charges and discharges the 8-µf capacitor. Meanwhile the carriage is moving forward. When it has gone far enough to release the phase lock switch and thus clear the short placed across relay PH's coil by contacts 1R and 2R of relay PRI, the discharge from the capacitor closes the contacts of PH. This releases the phase magnet and causes the recorder stylus to start in step with the revolving cylinder at the transmitter.

Recording then starts, and continues till the carriage reaches the end-of-message switch and opens its contacts. This starts a series of actions involving relays PRI, PH, and R, which cause the completed telegram to feed out and be cut off by the knife. The equipment then returns to the standby state, ready to receive another telegram.

—end—

This Signal Generator is Powered by Buzzer



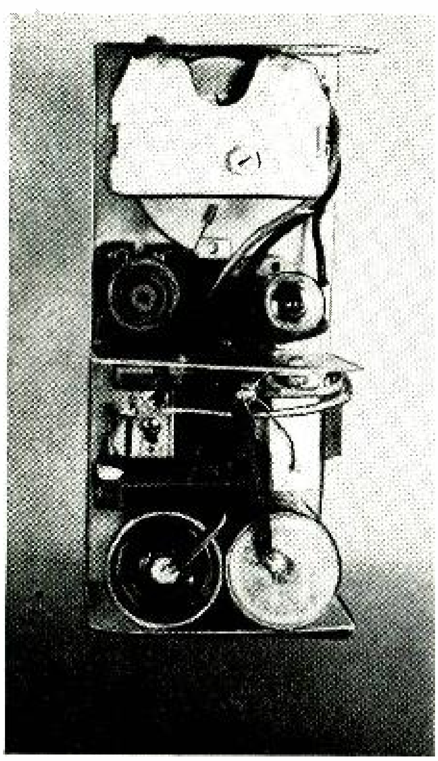
Matchbook comparison shows small size.

Filament and plate are both fed by two flashlight cells

By JOHN A. DEWAR

THIS small signal generator is useful on outside calls and in locations where a.c. power is not available. It is unusual in that it uses a small high-frequency buzzer as a vibrator for the plate supply, thus eliminating the cost, weight, and bulk of a B-battery. Since the total plate and filament consumption is only about 200 ma, two 1½-volt flashlight cells last a long time and their replacement cost is small.

No output attenuator or coupling was found necessary since the generator radiates sufficient energy to put a good signal into the receiver. Radiation is also directional, and excellent attenuation can be accomplished by varying the angle and distance between generator and receiver. The control, in fact, is better than most potentiometers provide. The directional characteristic makes for simplicity and the elimination of external leads.


Note that the power supply is shielded.

L1 is the primary of a standard broadcast antenna coil; L2, the secondary, is phased so that the tube will oscillate. L3 is a coil from a 460-kc i.f. transformer which was placed on the form with the antenna coil. The generator is designed to cover two bands, and L1 provides the feedback for both. C1 and C2 are sections of a small 2-gang condenser. One section is used to tune L2 for the broadcast band (540 to 1600 kc). The other section is connected across L3 so that both sections are in parallel to cover the i.f. range from 150 to 600 kc.

A midget output transformer is used to step up the a.c. for the plate supply and provides 100% modulation at the buzzer's audio frequency. C3 acts as a buffer capacitor and is necessary to cut down high-order harmonic peak voltages. It is advisable to shield the power supply from the r.f. section to eliminate spurious radiation.

To keep power consumption low the buzzer should have a coil resistance of 20 ohms or more. The common connection between the coil and reed is connected (in most types) to the buzzer casing, and it is necessary to insulate it from ground and make one side of the voice-coil connection to the shell. Mount so that the adjusting screw is accessible and can be set for best operation.

The generator case was made from thin, soft aluminum which can be bent without cracking, and the parts mounted directly on it. The dial consists of a semicircle of paper glued to the panel and hand calibrated, either from stations of known frequency or from another signal generator. A coat of lacquer will prevent the dial from soiling with use.

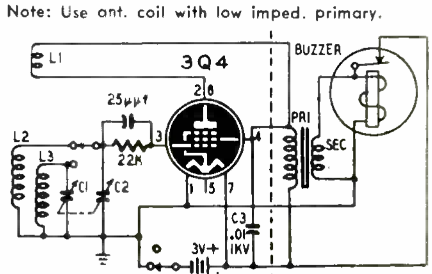
The over-all size, 6¾ x 3 x 2½ inches, can be reduced further by using a midget tuning capacitor and penlite cells. Short wave bands were not included, for the sake of simplicity and also because the writer prefers to use WWV for spot frequency checks.

On repair calls sometimes, this signal generator may enable the radio technician to decide whether to "pull" a set and carry it down to the shop. In some cases, alignment can be checked by attaching a VOM to the voice coil and feeding a constant signal in from the pocket generator.

It is important to stabilize the frequency of this unit before any extensive work is done. This can be done by allowing it to warm up before calibrating it against a known broadcast station's frequency.

Materials for signal generator
1—replacement broadcast antenna coil; 1—coil from 450-to-460-kc i. f. transformer; 1—midget output transformer, 50L6-to-voice coil; 1—2-gang tuning capacitor, 365 μμf per section; 1—midget mica capacitor, 25 μμf; 1—paper capacitor, .01 μf, 1,000 volts; 1—resistor, 22,000 ohms, ½ watt; 1—switch, s.p.s.t., toggle; 1—switch, s.p.d.t., slide type; 1—miniature socket, 7-prong; 1—3Q4 tube, 2—flashlight cells, 1½-volt; hookup wire, dial, hardware, etc.

Note: Use ant. coil with low imped. primary.



A simple oscillator circuit is used.

—end—

BC-453 as Service Aid

By JOSEPH ZELLE*

THE BC-453 receiver, long popular among radio amateurs for highly selective reception, also makes a handy instrument around the radio service shop. This little command set tunes from 190 to 550 kc, covering the most common intermediate frequencies of superheterodyne receivers. It works as a kind of *low-frequency* meter and makes i.f. checking very easy.

It is good policy anyway to make a quick check of the operating frequencies of every receiver that comes in for servicing. Hardly any receiver escapes some tuning or adjusting, and fundamental misadjustments thus can be spotted instantly.

To make the check, connect a lead from the BC-453 antenna post to the grid or diode plate of the second detector of the set under test. Then tune the BC-453 until you hear the signal and note the frequency on the dial. You can interpolate the dial readings closely enough for all practical purposes because these units are very stable at such low frequencies. The BC-453 may be checked against known radio-range stations for calibration. The interpolated i.f. should check with the receiver manufacturer's specifications.

If the receiver is defective, the BC-453 unit is useful as a signal tracer. Clip the same lead from the antenna post on the plate of the last i.f. amplifier, then the grid, and in this way work toward the antenna end of the set until the signal can be picked up in the BC-453. In this way, you can locate failure in a particular circuit with ease. Of course, the BC-453 must be tuned to the intermediate frequency of the set under test and the receiver stages must be at least roughly aligned. Secondly, the testing can go back only to the mixer or converter stage, where the i.f. first appears.

This surplus receiver is much more useful for aligning. With the signal generator feeding r.f. to the broadcast receiver at the high-frequency end of the band, connect the BC-453 to the grid or diode plate of the second detector to serve as an aural indicator. With the BC-453 set at the correct i.f. you can be sure the i.f. stages of the receiver will be tuned to the correct frequency.

A beat frequency of 456 kc (or whatever the i.f. may be) can be produced by beating the local oscillator either higher or lower than the incoming r.f. signal. For example, at 1500 kc, either 1956 kc or 1044 kc will produce an i.f. of 456 kc. This may cause a good deal of trouble in aligning a receiver.

*Technical Staff, WERE, Cleveland, Ohio.

In most superheterodynes, the local oscillator (first detector) tunes at a frequency higher than the incoming r.f. signal (at 1500 kc in the case above). Therefore, screw the oscillator padder tight. Then with the test setup in operation, unscrew the padder screw slowly until the i.f. signal is heard in the BC-453. This will be produced by the low-frequency side of the oscillator (or 1044 kc of the above example). Unscrew the padder still farther now, until the signal again appears in the BC-453. This is the result of the higher oscillator frequency (or 1956 kc of the example). You may be able to find only one signal, which ordinarily will be the correct setting for the oscillator.

The correct frequency for the oscillator is important for tracking. In fact, if various stations do not appear at their proper places on the receiver dial, either the i.f. or the oscillator frequency is wrong. With the correct i.f. use the frequency for the oscillator which gives better tracking. In some superheterodynes only one correct beat frequency can be tuned with the oscillator. In that case tune the oscillator to produce the required i.f. After the i.f. and oscillator frequency have been determined and tuned, trimming and padding can be done with the assurance that the receiver will track correctly over the full broadcast band.

A signal generator is not even necessary for this tuning process. First connect the BC-453 to the second detector as before, and set its dial to the required intermediate frequency. Next, tune the receiver to be serviced to the frequency of a known local broadcast station (preferably around 1,000 kc). Then tune the oscillator until the particular broadcast station is brought in on the BC-453. Should the receiver under test be so badly out of tune, that the station cannot be heard (assuming the receiver is not defective) move the lead from the BC-453 up a stage or two toward the mixer, and again try tuning the oscillator to the correct frequency. Then move the clip back, stage by stage, toward the second detector and tune the stages each time for maximum response. With the various stages now tuned so that sufficient signal is available in the final i.f. stage, the whole set can be aligned as described before. Trim and pad at the high and low ends of the dial, using local radio stations as r.f. signal sources.

When making the final tuning adjustments, remove the BC-453 coupling lead, since it loads and detunes the circuit to which it is connected. Final alignment can be made with the serviced receiver's own audio system.

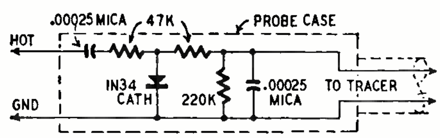
This handy service gadget is reasonable in cost on the surplus market. It requires 24 volts for the filaments and 250 volts for the B-supply. By connecting all the tube filaments in parallel, 12 volts will supply them. In some cases, where complete power and 6.3-volt filament supply is available, it may be better to replace the tubes with equivalent 6.3-volt types. Some changes in bias circuits will be necessary in the latter case.

Besides serving as an i.f. checker, the BC-453 receiver offers 360 kc of radio stations, mostly radio range and weather, on frequencies below the broadcast band.

—end—

POLYMETER IMPROVEMENT

The radio man who owns a type 134 Sylvania Polymeter can improve its performance quite a bit by adding a shielded d.c. test probe and jack. The shielded probe is a useful device for making dynamic tests in which critical d.c. voltage measurements must be made without detuning the receiver under test.



To make the addition, mount a midget open-circuit phone jack on the Polymeter panel. There is plenty of room above either the AC VOLTS jack or RF VOLTS jack. Wire the high terminal of the jack directly to the MA-DC VOLTS jack inside the instrument. Use ordinary unshielded hookup wire. This connection will not interfere in any way with operation of the MA-DC VOLTS pin jack, which still can be used for milliampere measurements and for d.c. measurements when shielding is not required.

Ordinary microphone cable may be used for the shielded test lead. Inside the shielded test prod, connect a 1-megohm, ½-watt carbon resistor as close as possible to the probe tip. Connect the other pigtail of the resistor to the center conductor of the shielded cable. Terminate the far end of the cable with a standard phone plug. Connect the center conductor of the cable to the ball of the plug, and the cable shield braid to the plug sleeve. The figure shows the circuit inside the test prod.—*Rufus P. Turner*

The Customer is ALWAYS Right!

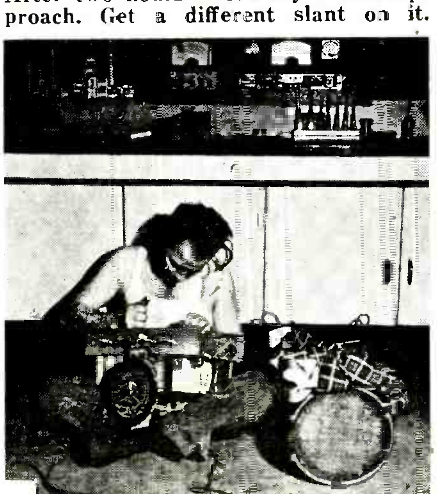
My radio—there's something wrong with it. Fades out. Maybe you could fix it?

By ERIC WAHLEEN

EVERY radio repair technician knows that often more time is spent repairing a set than can be charged to the customer. But here is the tragic tale of the inexperienced repairman who made the fatal mistake of telling his customer that a 50-cent capacitor was the cause of the trouble. Our hero has the frustrated feeling—but of course he'll know better next time.

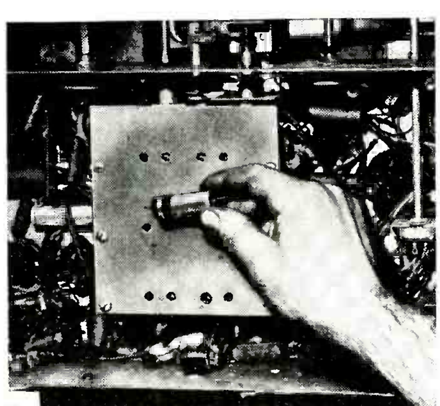
1

After two hours—Let's try a new approach. Get a different slant on it.



2

Six hours have passed swiftly. Cause of fading still not tracked to its lair!

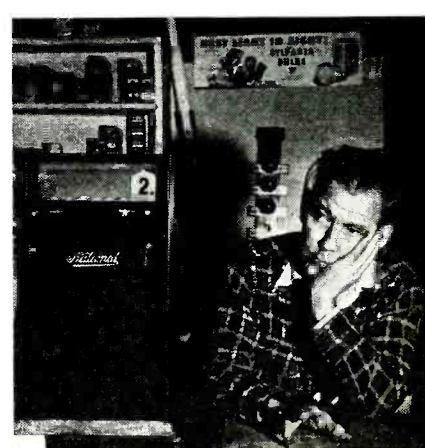


3

At last! A bypass capacitor that tests O.K. but which works only occasionally.

4

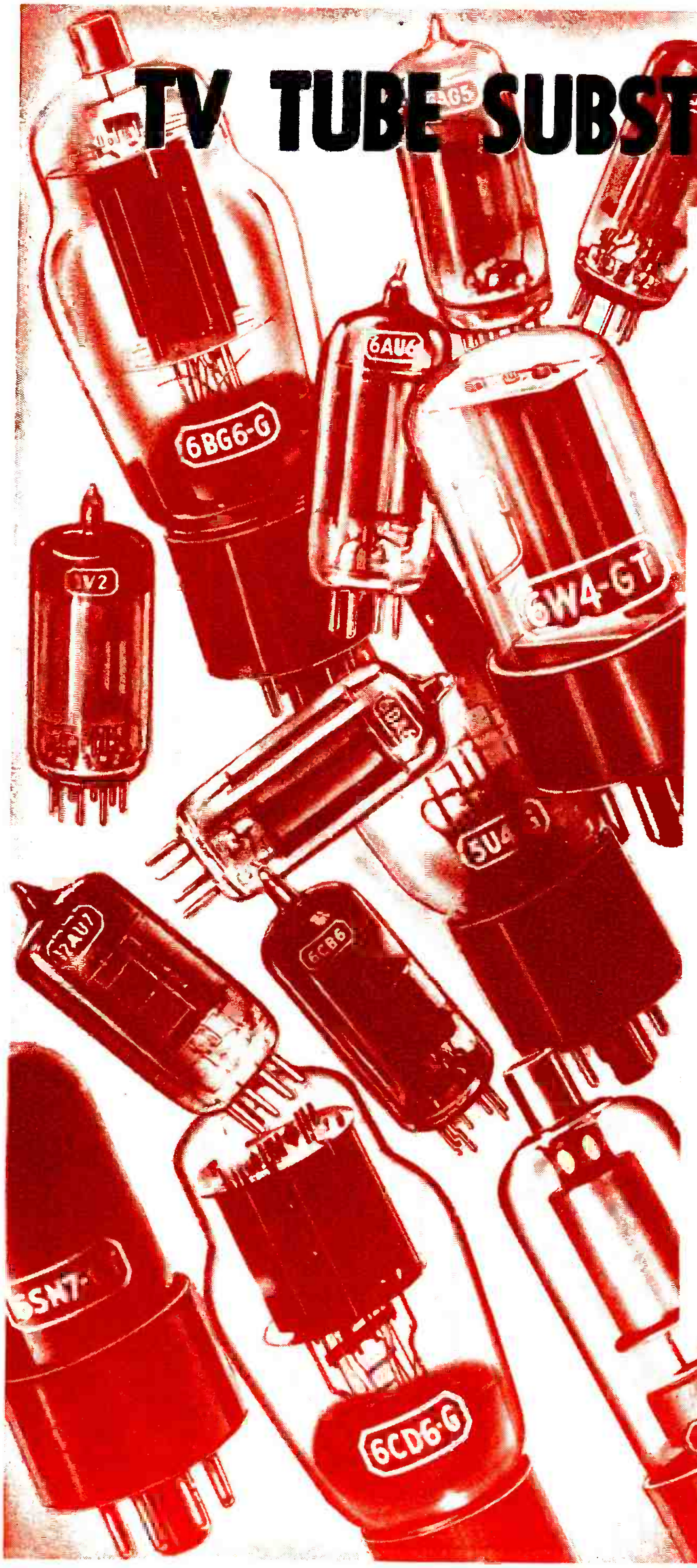
The customer is burned up too. "You got some nerve charging five bucks for that."



5

Our hero is slightly singed also. There must be a better word than frustration.

TV TUBE SUBSTITUTIONS



By EDWARD J. LOCKE

HOW long can the television broadcaster, and service technician continue "business as usual" if the present tube shortage continues? If the situation grows worse or even remains in its present state, the answer may well be found in the industry's ability or ingenuity to substitute older or more available tube types for those now at a premium.

The tubes listed here are types found in practically all present-day TV receivers. Some of the types listed as replacements will operate perfectly, while others may result in decreased gain, loss of picture definition, and other deficiencies, and in some cases may require circuit realignment or circuit changes. However, it is much better to return your customer's receiver in at least an operating condition than to leave him with a "white elephant," even if you have to go to considerable length to do it.

Above all, make sure that any substitutions or changes are explained so that your customer will know what to expect in the way of performance. And, for the benefit of other technicians who may service the set later, or for your own information on future calls, paste a note or circuit diagram in the back of the set, explaining the changes made.

Adapters vs. socket changes

It is probably better to make all temporary substitutions by using an adapter, rather than changing the socket or rewiring circuit connections. In some cases lack of space will rule out the adapter. Here the only alternative—unless the correct tube replacement can be obtained within a reasonably short time—is to replace the socket if a different type is required, or to change the socket connections to accommodate the new tube. Suitable adapters can easily be made up by wiring the desired type of socket into the top of a discarded tube base. Terminal connections are pulled through and soldered as indicated in the accompanying socket diagrams or by consulting a tube manual.

Tube substitutions

1X2-A (High-voltage rectifier). Replacement with a 1B3-GT will improve results in many cases (maximum and average peak plate currents of a 1B3-GT are, respectively, 17 ma and 2 ma as compared to 10 ma and 1 ma for the 1X2-A). An adapter to change from 9-pin miniature to standard octal socket is required (Fig. 1 to Fig. 2).

5AZ4 (Low-voltage rectifier). Electrical equivalent of 5Y3-GT. Replace socket or use adapter.

5U4-G (Low-voltage rectifier). Directly interchangeable with 5T4. A 5Z3 can be used with the proper adapter (4-pin to octal); rewire connections from Fig. 3 to Fig. 4. A 5R4-GY may be directly substituted if available. A 5X4-G may be used with an adapter (the socket can be rewired to accommodate either the 5U4-G or 5X4-G by tying pin 4 to pin 3, pin 6 to pin 5, and pin 7 to pin 2). *Do not* use a 5V4-G, 5W4, 5Y3-GT, or 5AZ4 to replace a 5U4-G. Socket connections are the same, but these types do not have sufficient current ratings. Early tube failure will result.

5V4-G (Low-voltage rectifier). Directly interchangeable with 5Z4-GT, and 5Y3-GT in circuits where maximum ratings of replacement are not exceeded. An adapter can be used with types 5Y4-G, or 80.

6AC7 (Sync stripper, 2nd video amplifier, or reactance tube). Directly replaceble with 6SH7. A 6SJ7 can be used as a direct replacement on an emergency basis in most sync stripper and 2nd video circuits. Operation may or may not be satisfactory in horizontal a-f-c circuits (horizontal discriminator transformer can usually be adjusted to work satisfactorily). It may be necessary to insert a 700-ohm resistor in series with original resistor for correct cathode bias. Although the gain will be reduced by substituting the 6SJ7, operation in strong-signal areas should be satisfactory. (Fig. 6).

6AG5 (Video i.f., sound i.f.). Directly replaceable with 6BC5. Check effect of interlectrode capacitance differences on alignment, especially in video i.f. chain. *Caution:* The 6AG5, 6AK5, and 6BC5 have suppressor and cathode tied together internally and then connected to pins 2 and 7 (Fig. 9). The 6AU6 and 6BA6 have cathode brought out to pin 7 and suppressor to pin 2 (Fig. 8). Just to be different the 6CB6 has cathode to pin 2 and suppressor to pin 7 (Fig. 7). If the circuit in which these tubes are to be used has cathode *and* suppressor directly grounded, no trouble occurs and all of them can be used with no socket wiring change. But if cathode bias is used, look out. It may or may not be necessary to change socket connections to pins 2 and 7, depending on which tube is replacing which (and sometimes on the set manufacturer's schematics; make sure the connections on the socket are the same as those on the diagram). A circuit check *must* be made before substitution.

6AG5 (Reactance tube). Try a 6BC5 or 6BA6. (See Caution Above) Readjust discriminator transformer if necessary.

6AH6 (2nd video amplifier). Replace with a 6AC7 or 6SH7, using an adapter or changing socket connections as shown from Fig. 5 to Fig. 6.

6AK5 (Video or sound i.f., r.f.). In most circuits a 6AG5, 6AU6, 6BC5, or 6CB6 can be directly substituted. (See 6AG5 Caution.) Interelectrode and mutual conductance differences may require some minor circuit readjustments. See Fig. 9.

6AK6 (Horizontal oscillator). Change socket or use adapter to accommodate a 7B5, or 6K6-GT. A change in value of the series-hold resistor may be necessary.

6AK6 (Power-pentode amplifier). Replace with 6G6G and adapter if space permits

6AQ5 (Beam-power amplifier). Although its characteristics are somewhat different, a 6AR5 may be used if available, provided pin 7 of the 6AQ5 socket is tied to pin 1. A *single* 6AQ5 may be replaced with a 6AS5 if minimum Class A ratings are being used for the 6AQ5. An adapter or circuit changes from Fig. 10 to Fig. 12 will be required.

6AQ5 (Horizontal oscillator). Directly replaceable with 6AR5. No socket changes necessary unless the original circuit uses pin 7 as one of the control grid terminals. In this case, it will be necessary to tie pin 7 to pin 1 on the 6AQ5 socket to maintain circuit continuity. Series-hold resistor may require changing to keep range coverage. Fig.10.

6AQ5 (2nd video amplifier). Use a 6AR5 as direct replacement. (Check bias voltages for proper values.) Some peaking adjustments may be required in critical circuits. Fig. 10.

6AQ6 (Discriminator, 1st audio). Directly interchangeable with 6AT6. A 6AQ7-GT may be used if socket changes are made from Fig. 13 to Fig. 14. A 6SQ7-GT may be used with adapter if space permits.

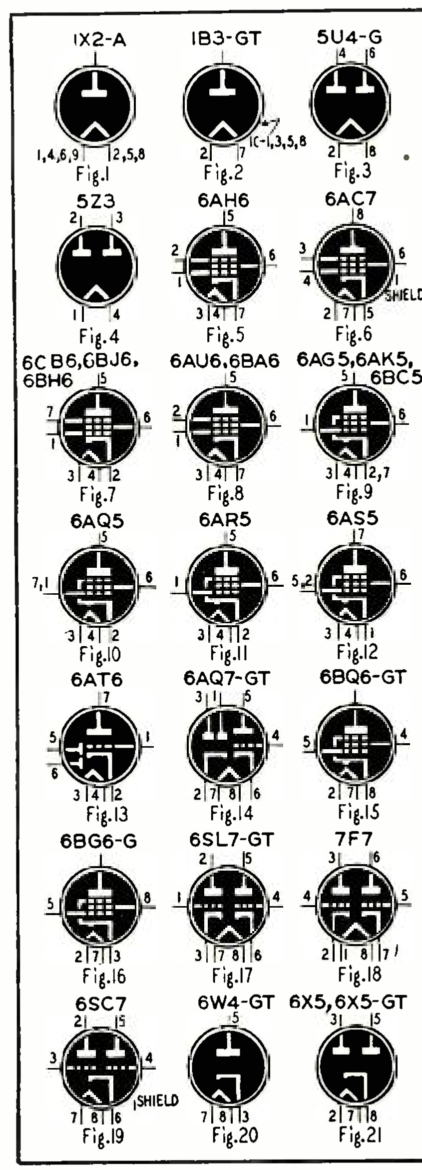
6AQ7-GT (Discriminator, 1st audio). May be replaced with 6T8, 6S8 or 6AW7 in cases where the circuit permits. Check each case with the tube manual and set schematic and use adapter or rewire socket as required.

6AR5 (Video amplifier). Replacement with a 6AQ5 is not recommended but may work satisfactorily in strong-signal areas. Peaking readjustment may be required. Fig. 11.

6AS5 (Beam-power amplifier, horizontal oscillator). Replaceable with a 6AQ5 or 6AR5 by using adapter or rewiring socket. The base connections are shown below in Figs. 11 and 12.

6AT6 (Discriminator, 1st audio). Directly replaceable with 6AQ6. The 6AQ7-GT has the same characteristics and may be used if the 6AT6 socket is replaced and circuit connections are changed from Fig. 13 to Fig. 14. The two cathodes of the 6AQ7-GT (pins 2 and 6) should be tied together. If the above types are not available, use a 6SQ7-GT and adapter.

6AU6 (Video and sound i.f.). Can be replaced directly with a 6BC5, 6BA6, 6AG5, or 6AK5 (see 6AG5 Caution). The 6CB6 will result in much greater gain. Addition of a tube shield, if not already in use, should be made to prevent oscillation. Solder the shield to chassis instead of riveting or bolting. This will make a low resistance joint. The 6BC5 has somewhat less gain than the 6CB6, but will still be an improvement over the 6AU6. Single 6BA6's



Socket connections of most tubes listed.

may be used as direct replacements in sound i.f. and in r.f. stages. In video i.f. stages it is recommended that all 6AU6's be replaced simultaneously with 6BA6's in order to maintain the same degree of interelectrode changes in each stage. Slight realignment may be necessary.

When replacing the 6AG5 or 6BC5 with a 6CB6, 6AU6, or 6BA6 it may be necessary to change the value of the original cathode resistor to obtain the proper cathode voltage (approximately 1.5 volts).

Some receivers using 6AG5's, 6BC5's, or 6AU6's take the plate voltage from a 300-volt point. When 6CB6's are used, it may be necessary to reduce this voltage by inserting a series-dropping resistor or moving the plate-supply lead to a 200-volt point.

6AU6 (Limiter, a.g.c.). The above substitutions may or may not work in these circuits without modifications or changes in parts values. Try substitutes in various receivers to note the effects (Fig. 8).

6AV6 (1st audio, bias clamp). Directly replaceable with 6AQ6 or 6AT6 (Fig. 13) with some loss in gain. A 6AQ7-GT, 6SQ7-GT, or 6SZ7 may be substituted with the proper adapter.

6BA6 (Sync amplifier). The 6CB6 and 6BC5 are replacements (see Caution on 6AG5). The 6AU6 can be used in some cases (high signal-strength locations). A 6AG5 or 6AK5 can be tried if no others are available (Fig. 8).

6BC5 (Video i.f., sound i.f.). Replaceable with 6AU6, 6AG5, 6AK5, 6BC5, or 6CB6 (see Caution on 6AG5).

6BJ6 (R.f. amplifier). Directly replaceable with 6BH6 and 6BC6, with increased gain and sharper cutoff characteristics. The 6AG5, 6AK5, 6AU6, 6BC5, and 6BA6 may be used with an adapter (Fig. 7). (Note the Caution under 6AG5.)

6BH6 (R.f. amplifier). Directly replaceable with 6BJ6 and 6BC6. The substitutions listed for the 6BJ6 may be made with an adapter as stated (Fig. 7).

6BL7-GT (Vertical oscillator). Directly interchangeable with 6SN7-GT. (6BL7-GT has greater gain than the 6SN7-GT.)

6BQ6-GT (Horizontal output). No direct substitute. A 6BG6-G can be used if socket connections are changed from Fig. 15 to Fig. 16. If the 6BG6-G does not draw proper current, change the value of the screen-dropping resistor.

6CB6 (Video i.f., sound i.f.). May be replaced with 6BC5, 6BA6, 6AU6, 6AG5, or 6AK5 in most cases (see Caution on 6AG5) (Fig. 7).

6K6-GT (Audio output, 2nd video output). A 6V6-GT or 6F6-GT can be used as direct substitute in most cases. Audio output will be increased from 4.5 watts to 5.5 watts with the 6V6-GT. It may be necessary to change the bias for distortion-free operation at all volume levels.

6S8-GT (Discriminator, 1st audio). (Used in some older models). Where only two of the three diodes are used, try a 6Q7, 6R7, 6SQ7, or 6SR7. Socket connections must be changed accordingly. A 6AQ6, 6AQ7, or 6AT6 can be used with an adapter or socket replacement.

These substitutions have been made with sets having parallel-connected heaters in mind. Heater currents may differ considerably, but that should make little difference unless a set is running dangerously near its maximum transformer capacity, or unless several heavy-current filament tubes are inserted in the same set.

Where filaments are connected in series, it is important to check the heater current of any tube to be substituted. If a lower-current tube is available, it can be shunted by a resistor. If the tube draws a higher current, substitution is less likely to be practical, although in extreme cases a resistor shunting all the other heaters may be used.

In general, when the tube available for substitution has not the same current and voltage rating as the one to be replaced, the substitution becomes a special job and must be checked carefully against the conditions of the given case. *Use your tube manual!*

Many other combinations or tube substitutions may be possible. Experiments with various tubes in different circuits in the course of servicing will show just how for substitutions may be carried. Remember, in closing, *always to note any tube or part replacement* on the chassis inside the cabinet for future reference.

Our thanks to RCA Tube Division for the photographs of tubes

6SH7 (Pulse stripper). A 6AC7, 6SG7, 6SD7-GT, and 6SE7-GT are direct replacements. Try each type and note its effect on circuit operation. It may be necessary to connect suppressor and cathode pins on socket when using 6AC7, 6SD7, or 6SE7. Types such as the 6AG5, 6BC5, 6BH6, 7G7, 7H7, 7L7, or 7T7 will work in many cases with the proper adapter.

6SL7-GT (Vertical oscillator). Make up an adapter or rewire socket for a 7F7 (Fig. 17 to Fig. 18) or for a 6SC7 (Fig. 19) if both cathodes of the 6SL7-GT are being used in parallel. A 6SN7-GT can be used as direct replacement in some cases. Slight changes in series-hold resistor value may be required. A 7F8 with adapter may be used if bias voltages are changed.

6SN7-GT (Vertical oscillator). A 6AH7-GT, 6F8-G, or 7N7 should work with an adapter. The series-hold resistor may need to be changed. The 6AH7's heater current 0.3 amp, that of the other tubes 0.6 amp.

6V6-GT (Audio output). Directly replaceable with 6K6-GT. A decrease of approximately 1 watt may result. See 6K6-GT for bias note.

6W4-GT (Half-wave rectifier; damper). No direct replacement. The 6X5 may work in emergencies if both plates are paralleled and socket connections changed from Fig. 20 to Fig. 21, or an adapter is made up. Paralleling the 6X5 plates will allow a peak plate current of approximately 410 ma as compared to 600 ma for the 6W4. Heater currents are different—1.2 amp for the 6W4 and 0.6 for the 6X5.

6Y6-G (Audio output). Replace with a 6U6-GT, 6W6-GT, or 6L6. No socket changes required.

7B5 (Sync separator; audio output). Change socket and rewire for 6K6-GT or 6V6-GT, or use adapter with these tubes.

7C5 (Vertical or horizontal sweep). Change socket and rewire for 6V6-GT or 6K6-GT, or use adapter.

7F8 (Vertical and horizontal sync amplifier). Try a 7F7, 6SL7-GT, or 6SN7-GT. An adapter or socket replacement will be necessary. Bias voltages should be checked and value of cathode resistor changed if necessary.

7W7 (1st and 2nd sound i.f.). Replace with a 7V7 or 6AB7 (adapter or rewiring required).

7Y4 (Low-voltage or bias rectifier). May be replaced with a 7Z4. (7Z4 has greater current-carrying capacity than 7Y4.) A 6X4 or 6X5 with adapter may be used. The socket connections of the 6X5 are shown in Fig. 21.

7Z4 (Low-voltage or bias rectifier). *Do not* replace with a 7Y4 if total current drain exceeds 70 ma (7Z4 supplies 100 ma). A 6W4-GT which supplies 100 ma but which has a heater current of 1.2 amp. can be substituted if the receiver power transformer is able to supply this.

12AT6 (Discriminator, 1st audio). Replace with a 12SQ7-GT and adapter.

12AU7 (1st and 2nd video amplifier; or vertical oscillator).Directly interchangeable with 12BH7 (12BH7 has greater gain). A 12SN7-GT for series-connected 12AU7 heaters) or a 6SN7-GT (for parallel-connected heaters) can be used by changing the socket where space permits or by using an adapter.

35W4 (low-voltage rectifier). Replace with 35Z5-GT and adapter.

50B5 (Beam-power output). Replace with 50L6 (adapter or socket changes).

—end—

TV Field Strength Meter is Helpful

Correct installation of antenna is insured by using this sensitive instrument

The meter has a sensitivity of 50 µv.

By H. O. MAXWELL

IN any locality, the performance of a TV receiver is no better than that of its antenna. In primary signal areas, the signal strength may run into thousands of microvolts yet the picture may be poor if the antenna is not correctly installed and oriented. In some cases, a slipshod installation may get by if the receiver needs only a small part of the available signal to produce a satisfactory picture. In fringe and weak-signal areas, the set needs every available microvolt of signal for good picture reception.

Selection and orientation of the antenna is greatly simplified by using a TV field-strength meter. The instrument should tune to all TV channels and should have sufficient sensitivity to indicate slight changes in the level of the signal applied to it.

The Simpson model 488 TV field-strength meter meets these requirements. It is essentially a small a.c.-operated superheterodyne receiver which tunes to the video carrier frequencies of the TV channels and indicates the signal strength in microvolts on an open-face 4½-inch meter. The instrument is housed in a gray hammerloid-finished round-cornered cabinet 11 inches wide, 8 inches high, and 8½ inches deep. The unit weighs 11½ pounds.

The circuit

The model 488 is designed around a type TV 278 Standard Coil tuner which can be used with 300-ohm balanced or 72-ohm unbalanced transmission lines. The channels are selected by switching in the proper coils which are housed in a turret. A fine-tuning control is provided for carrier centering.

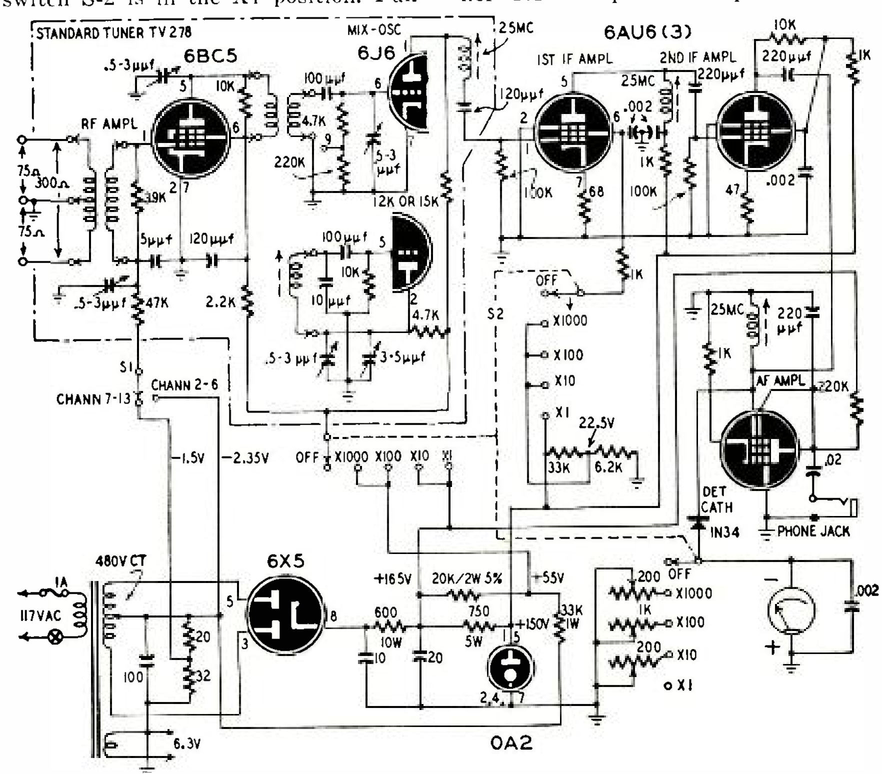
The incoming signal is amplified by the 6BC5 r.f. amplifier and fed to the 6J6 mixer-oscillator where it is converted to 25 mc by heterodyning with the signal from the local oscillator (see diagram). The mixer works into a 2-stage i.f. amplifier peaked at 25 mc—the video carrier frequency. Peaking the amplifiers provides greater gain than can be obtained by stagger-tuning as in TV receivers. Peaking is permissible because the service technician is interested in carrier strength and not so much in sideband width.

Following the second 6AU6 i.f. amplifier is a 1N34 video detector which has a meter as its load. The detector removes the carrier and the sync pulses appear across the meter. The tips of the pulses are always at the same level so the voltages which they develop can be used to indicate carrier strength.

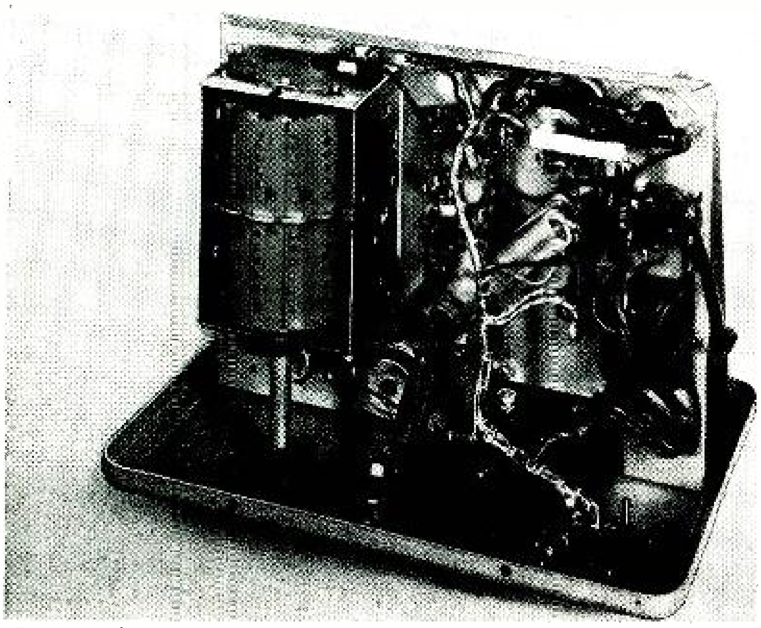
The field-strength meter is calibrated so that a 50-µv signal at the antenna terminals produces a full-scale deflection on the meter when the multiplier switch S-2 is in the X1 position. Full-scale readings are 50, 500, 5,000, and 50,000 microvolts when S-2 is set for X1, X10, X100, and X1,000 respectively.

S-2 has three sections. Two of these vary the supply voltages for the tuner and i.f. amplifier. The third shunts the meter to insure accuracy on the X10, X100, and X1,000 ranges. A s.p.d.t. toggle switch S-1 controls the grid bias on the r.f. amplifier tube. Bias is minus 2.35 volts on the low band. It is reduced to 1.5 volts on the high band to provide additional gain. Meter accuracy is maintained under varying line-voltage levels by supplying the 6AU6 i.f. tubes from a point stabilized at 150 volts by a 0A2 voltage-regulator tube.

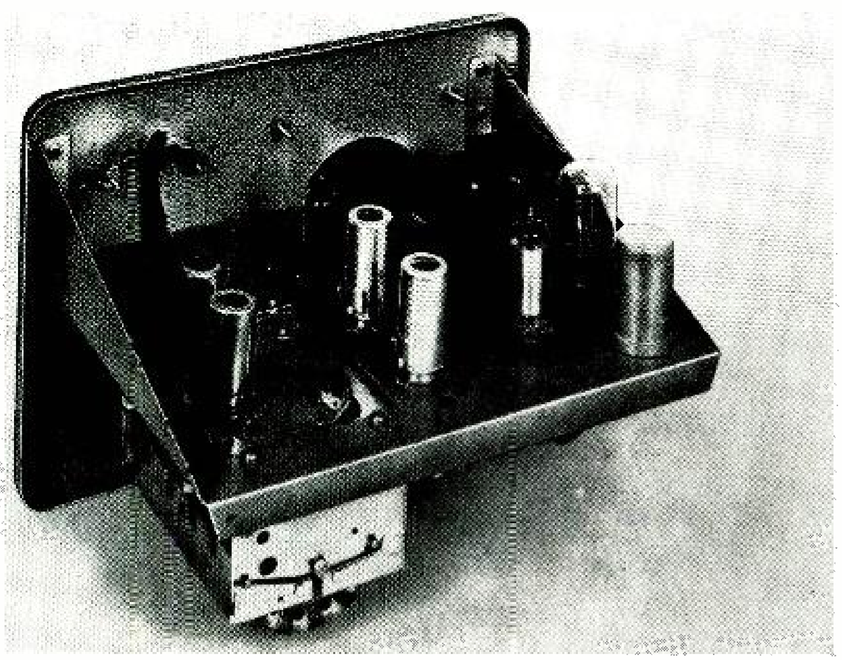
The third 6AU6 is the audio amplifier for headphone reception. It am-



The Simpson model 488 schematic shown above uses a Standard Coil tuner unit.



Bottom view of field strength meter shows turret tuner and simple wiring.



Top view of unit shows neat layout of parts and sturdy construction of frame.

plifies the detected signal and applies it to the phone jack. The phones are used to identify interference which may appear in the picture and to identify a station when its call letters are not known (see below). This feature is useful when the meter is used in areas where it is possible to receive two TV stations on the same channel. When there is no interference on the picture channel, the vertical sync pulses will be heard as a rough 60-cycle buzz.

The i.f. amplifiers are peaked so sharply that the audio carrier cannot be received when the tuner is set on the desired channel. To receive the audio carrier, the tuner must be set to the next higher channel and the fine-tuning control set to the low-frequency end of its range. Because there are breaks or gaps in the band between channels 4 and 5 and between 6 and 7, it is not possible to receive the sound carriers of channels 4 and 6. The tuner does not tune to a frequency higher than channel 13, so the sound carrier of this channel cannot be received.

The model 488 is also useful to amateur radio operators and operators of other radio equipment which operate on subharmonics of the TV channels. By setting up the meter and measuring the strength of various harmonics, the effects of traps and tuning adjustments can be studied without making on-the-air tests. Potential sources of interference can be detected and eliminated before going on the air. The meter will also prove useful when adjusting variable capacitors and inductors in filters designed to pass or reject TV frequencies.

—end—

MONEY IN TV SERVICING

By OLIVER HORNING

TV repairman Jim was up to his neck in trouble again. Two hours of chassis banging, tapping those tubes and praying for a capacitor, a transformer or something to break down, but that receiver would not act up, lose it's contrast, show a negative picture, or anything else. Jim must have felt like a dentist who had scared away a patient's pain.

"I'm beginning to think," spoke up Jim, "that there isn't a thing wrong. Who ever told you to bring it here?"

"It belongs to a lady friend," explained Police Detective O'Rourke. "You must have read about her—the D.A.'s wife whose valuable ring was stolen right in her house just yesterday. . . . The Chief has me on that case."

"Oh, I *do* see," exclaimed Jim. "You failed to find the ring, you don't want the Chief to suspend you, so now . . ."

"No, it's not what you're thinking," interrupted O'Rourke. "It's that six-year-old brat she has for a son . . . poking his nose and fingers into everything. Says he: 'You're not *Martin Kane* . . . I know! You'll never find it. I know . . .!' That's all I hear; he was drivin' me nuts! I had to think of some excuse or favor to get me out of the house a bit."

"And there was really nothing wrong with this set? Just because you let me park my car in the alley is no reason why you should. . . ."

"But, there *was* plenty wrong with it! Sounded like that Hopalong fellow was firing a machine gun. That rat-tat-tat was also drivin' me batty."

"So that's it! Why didn't you tell me it was only a speaker rattle? And all this time I've been using my *bench* speaker."

An indignant Jim hurriedly grabbed some extension leads, attached the owner's speaker and heard a rattling cone at its worst. He gave the speaker a quick glance, then picked a scriber from among the tools on the rack behind the bench.

Poking down through the partly-torn grille cloth with the hook end of this instrument, he paused to inquire: "Why doesn't Mrs. Duffy offer a reward for the recovery of her ring?"

"Sure and she did," answered O'Rourk, "$100 to anybody finding it."

"Not bad," remarked Jim, carefully disentangling the hooked end of the scriber from the works of the speaker, "nor would I mind buying Mrs. Duffy's brat a double-decked ice cream cone if. . . ."

"You just stopped the rattle," spoke Detective O'Rourke.

"Sure enough," said Jim, now holding a diamond-studded ring at the end of the scriber. "Who would have thought this hook would net me one hundred dollars?"

—end—

Replacing Tuners for Higher Gain and Interference Rejection

These typical tuners, used in new sets, are available for replacement purposes and can be installed easily.

By MATTHEW MANDL*

IN THE latest television receivers, among the number of improvements perhaps the most noteworthy is the exceptional gain and interference rejection of the new tuners. Added to these two features is the fact that virtually all are much more simple in construction than the older ones, and therefore are much easier to service and align. Many of these front ends are now available for replacement purposes, so the technician can improve older model receivers considerably by replacing outmoded tuners with the new. Because set owners always want to get better reception and have the latest improvements, this will be found a profitable field.

The work of installing the newer type tuners is not at all complicated. Most of the new front ends require less space than the old ones and no chassis fabrication is needed. There are only five soldered connections to make, and since the tuners are prealigned it will rarely be necessary to track them or to align i.f. stages. A variety of tuners are available, so one can easily be chosen which will match the intermediate frequency of the receiver in which it is to be installed.

Typical tuners used in present-day sets which are also available for replacement purposes are: The Standard Tuner and the Spiral Tuner.

The Standard tuner

Fig. 1 is the *Standard* tuner manufactured by the Standard Coil Products Company. It is used in a number of television receivers, including some models of Admiral, Emerson, and Philco. A turret-type tuner, its rotary drum holds the necessary r.f.-mixer-oscillator coils for the 12 television channels. A schematic of the tuner appears in Fig. 2. The tubes used are a 6AG5 pentode radio-frequency amplifier, and a 6J6 double triode for the mixer and oscillator circuits.

The dashed rectangular outlines enclose the two coil sections which are switched to tune the various television channels. One coil section contains the antenna input primary as well as the coupled secondary which applies the signal to the r.f. amplifier input. The second coil section contains the interstage transformer (primary and secondary) as well as the oscillator winding which transfers the oscillator signal into the mixer grid circuit by inductive coupling.

The inductance of the coils, combined with the interelectrode capacity of the tubes, forms the resonant circuit for the desired frequency. All coils are preset at the factory.

Five connecting wires, each color-coded as shown in Fig. 2, are provided to facilitate replacement. When the old tuner is removed from the receiver, its connections to the picture and sound grids, as well as plus-B, filament, and bias, must be established. The new tuner is then bolted to the chassis and the leads cut just short enough to reach the connecting points previously ascertained.

The white lead of the Standard tuner goes to the a.g.c. connection in sets having this feature, otherwise is connected to the bias terminal—for the bias in sets without a.g.c. is usually regulated by the contrast control.

When using this tuner for the conventional stagger-tuned i.f. system the bare lead is attached directly to the grid of the 1st picture i.f. tube and the green lead is connected to the grid of the 1st sound i.f. tube. If, as in a few receivers, the sound i.f. is taken off after the 1st or 2nd i.f., the green lead is not used and therefore should be disconnected from the tap on L12. It is also omitted in intercarrier receivers. The coil (L12) can be removed entirely in such instances to prevent any absorption of sound intermediate frequen-

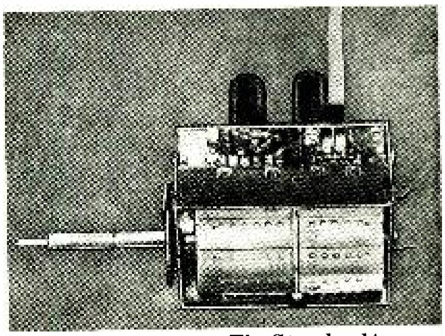


Fig. 1—Turret-type: The Standard tuner.

cies, or the 68-μμf capacitor can be disconnected, opening the circuit. If a 19.75-mc trap is required, replace the 68-μμf with an 80-μμf capacitor.

Inductor L11 is designed as the first frequency in a stagger-tuned system (usually 21.8 mc). However, it can be

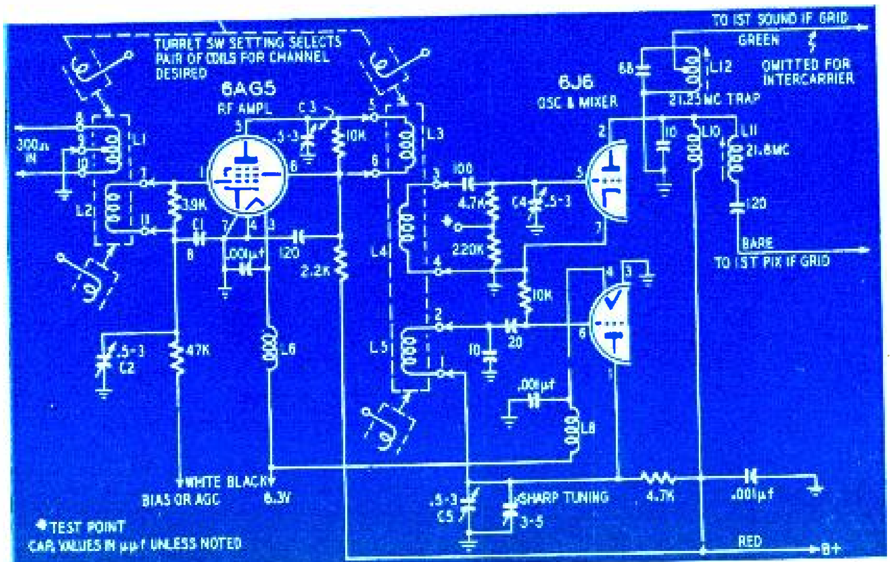


Fig. 2—Schematic of the Standard tuner: 5 connecting leads simplify replacement.

*Technical Institute—Temple University

adjusted over a limited range for other frequencies.

Adjustments for tracking are provided on top of the tuner, as shown in

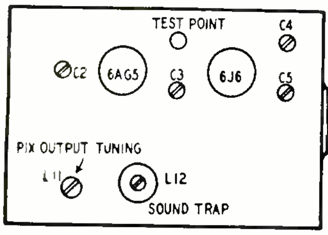


Fig. 3—Standard's tracking adjustments.

Fig. 3. An insulated loop of wire is also provided. Its terminals can be used for scope connections during the tracking process, a test point at the mixer grid, or for injecting an r.f. signal during alignment procedures. As with most modern tuners, an exposed contact panel is available at the side for r.f. signal generator connections to other points, including the r.f. amplifier grid.

The tuner is tracked and aligned at the factory, so it should not be necessary to make any adjustments except possibly a slight retouching of L11 and L12. For precise adjustment, an accurately calibrated r.f. signal generator can be connected to either the antenna terminals or the test point loop, with a v.t.v.m. across the video detector load resistor in the receiver chassis. With the generator set at 21.25 mc, tune L12 for *minimum* reading on the v.t.v.m. (Do not overload the input system—keep signal generator output as low as possible.) Reset signal generator to 21.8 and tune L11 for *maximum* voltage on v.t.v.m.

Fringe-area reception

For fringe-area reception the 6AG5 r.f. amplifier tube may be replaced with a 6BC5. It is directly interchangeable with the 6AG5 and provides higher gain. Both sets of coils for the weak channel can also be adjusted to reduce coupling, thus increasing the *Q* of these circuits and also the gain. The spacing should be increased between the coils experimentally until the desired results are obtained, for excess spacing will again decrease gain. Bandwidth of course is reduced as the *Q* is raised. While both 300-ohm and 73-ohm inputs are available, the 300-ohm twin lead has less loss and is preferred for fringe-area reception.

The Spiral Tuner

A television front end of unusual design is the Spiral Tuner, which features continuous tuning through both the television and frequency-modulation bands. The Spiral Tuner is a product of the Mallory Corporation and is used by Du Mont and Crosley in many of their latest TV receivers. The schematic of the model used by Du Mont is shown in Fig. 4 and a photo of it in Fig. 5. It is designed to be used with overcoupled i.f. stages, with a video intermediate frequency of 26.25 megacycles and a sound i.f. of 21.75 mc. Like its forerunner, the Inductuner, the Spiral Tuner is also available for replacement purposes and can be used with either 72-ohm or 300-ohm input. The output can also be modified to accommodate the particular receiver for which it is to be a replacement part. The Spiral Tuner, in its latest form, has the same general and compact external appearance as the two tuners previously discussed.

The coils are wound in spiral form and present four tuned circuits: tuned r.f. input, tuned r.f. output, tuned mixer input, and tuned oscillator. Wiping contact points move over the coils as the shaft is rotated for station selection. By shorting out sections of the resonant circuit coils, the sliding contact gives continuous tuning from 54 to 216 mc, which of course includes the 88–108-mc frequency-modulation spectrum. The spiral coils are indicated in Fig. 4 as L102A, L102B, L102C, and L102D.

A 6J6 grounded-grid amplifier circuit is used for the r.f. stage, with both halves of the dual triode connected together. While the grids are at r.f. ground because of C105 and C106, the d.c. potential is ungrounded and is applied by the a.g.c. circuit of the receiver proper.

The grounded-grid type circuit isolates input and output circuits. Thus a triode can be used without neutralization. Triodes have a much lower noise factor, and the four tuned circuits of the Spiral front end give excellent selectivity and gain. The increased selectivity reduces adjacent channel interference as well as the type interference set up by FM broadcast stations.

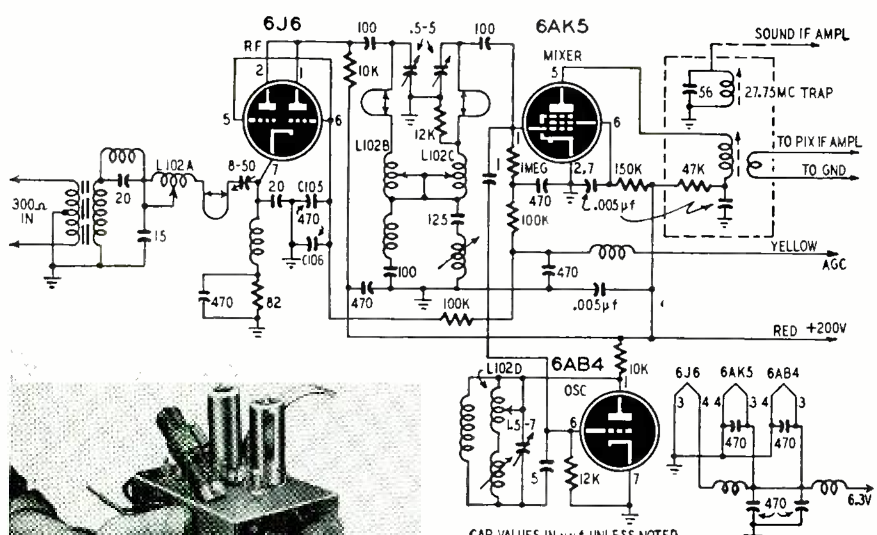
A 6AK5 is used for the mixer circuit, and a 6AB4 tube is employed in the Colpitts oscillator. A double-tuned band-pass circuit couples the output of the r.f. amplifier to the input of the mixer stage. This provides the proper signal transfer while maintaining the desired selectivity over the entire tuning range.

As with other replacement tuners, all adjustments are preset at the factory. Tracking or alignment should not be necessary when such a tuner is used for modernizing an older receiver. The output circuit of the replacement tuner is modified somewhat from that shown in Fig. 4 to adapt it to the input stages of other receivers. The dotted section shows connections to the audio i.f. stage. If the sound i.f. is taken from after the first or second picture i.f. (or with intercarrier) no connection is made to the 27.75-mc trap. The picture output shown in Fig. 4 is a link coupling to the grid of the first video i.f. stage.

The Inductuner is a trade name applied to the Mallory-Ware Inputuner and the Spiral Tuner by Du Mont Laboratories, Inc. Thus, the Du Mont Inductuner and the Mallory-Ware Inputuner refer to the same basic circuit.

Several further precautions should be observed by the service technician if he has to replace the front-end for one reason or another. First, make sure that the impedance of the antenna system in use will match the tuner selected. Second, even though the tuners come from the factory and presumably are perfect, peaking of the unit will without a doubt improve the over-all reception. For example, stray capacitance should be compensated for. Finally, nothing could be worse than for the customer to come back and say (after an expensive tuner replacement job) "my set played better before you fixed it." Keep it for a while, check it over thoroughly, and make sure it's "right." Though these sets are factory-fresh, anticipate mechanical troubles that may arise after use for a while and check wear points carefully.

—end—



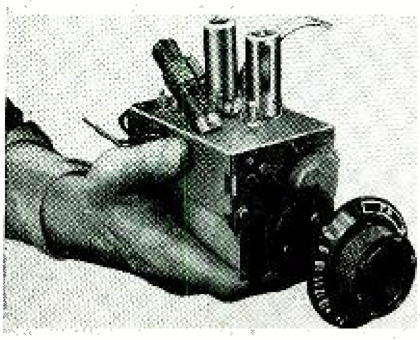


Fig. 4—The schematic of the model used by Du Mont is shown above. It is designed to be used with overcoupled i.f. stages with 26.25-mc video i.f. stages and 21.75 sound i.f., and can be used with 72- or 300-ohm input. Fig. 5, left—Photograph of the tuner.

Television Service Clinic

Conducted by ROBERT F. SCOTT

A NUMBER of inquiries indicate that many readers are having trouble eliminating rounded corners and dark, blurred areas at the corners and edges of the screen. These dark areas are *neck shadows.* They are produced when the electron beam strikes the neck of the tube before it has scanned the edges of the screen.

Many complaints arise when sets have been converted to use a wide-angle tube without using the appropriate deflection yoke. With the correct yoke, most cases of neck shadow can be corrected by properly positioning the yoke, focus coil, and ion trap on the neck of the tube.

View the tube from the side and make sure that the neck is parallel to the chassis. Use shims, additional padding, or other means to raise the low end of the tube. Move the deflection yoke up against the flare of the tube and center it on the neck. Center the focus coil on the neck approximately one-quarter inch behind the deflection yoke.

Turn on the set and keep the intensity very low until the ion trap is properly set. Move the focus coil from side to side and up and down to center the raster without shadows. If the shadow is not completely removed, adjust the ion trap for maximum brightness with good line structure visible in the raster. Do NOT USE THE ION TRAP TO ELIMINATE SHADOWS IF THEY ARE PRESENT WHEN THE ION TRAP MAGNET IS ADJUSTED FOR MAXIMUM BRIGHTNESS.

If it is impossible to remove all shadows by adjusting the yoke and focus coil, try rotating the tube in its mounting. The neck of the tube may be slightly off center or tipped to one side. Rotating the tube may make it possible to remove shadows when other measures fail. Lengthen the high-voltage lead if necessary after rotating the tube.

If these procedures do not help, reverse the leads to the focus coil. This reverses the operating functions of the centering controls but does not harm the operation of the set. If the set has enough vertical and horizontal deflection voltage, you can make the picture larger and move it slightly off center so the shadow is hidden by the mask.

Poor horizontal linearity

My set is a G-E 16C110. The picture cannot be exactly centered horizontally, and the left side of the picture is fuzzy and stretched. It is hard to get the picture to fill the screen on the right side. Nothing that has been done will bring in the full picture on the left side although the left-hand wedges of all test patterns are nearly ¾ inch longer than those on the right.—A. L. Groves, Brooke, Va.

The trouble is probably caused by a change in the value of the 0.1-μf C374 capacitor between the cathode of the damper tube and the B-minus bus. (See Fig. 1.) This capacitor is very critical. Improper values affect the time-constant of the damper-tube circuit and result in defective damping and poor linearity because of nonlinear current through the deflection coil. The value of this capacitor is probably too low. Try replacing it with a 0.1-μf, 600-volt paper unit. If this does not help, try shunting it with 600-volt paper capacitors of approximately .0005 μf until the correct value is found or it is obvious that the trouble cannot be corrected by this means.

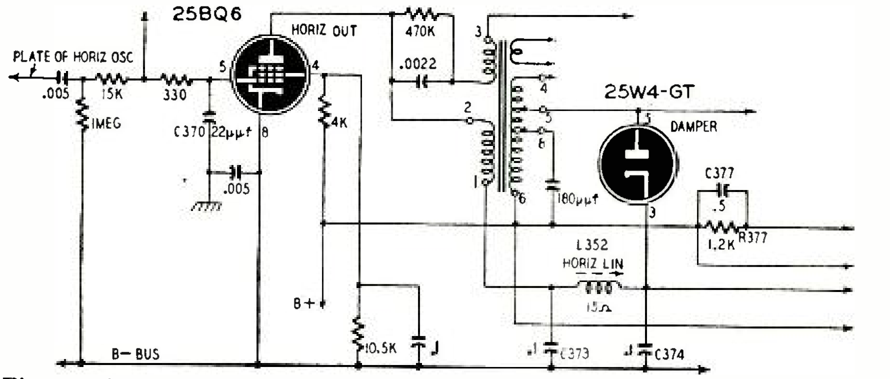


Fig. 1—Change in value of C374 capacitor affects horizontal linearity.

Check the horizontal linearity coil L352 for shorted turns. The correct resistance is 15 ohms.

Check the 22-μμf capacitor (C370) between pin 5 of the 25BQ6 and ground. Leakage there could cause the troubles you are experiencing. If this unit is suspected, replace it with a 22-μμf, 500-volt silver mica unit.

Check C377 and R377 for short circuits or changes in value. R377 is 1,200 ohms and C377 is 0.5 μf, 600 volts, paper. Replace if necessary. A short circuit or radical change in value of either of these components will change the value of current through the deflection coil and cause the picture to shift horizontally so it cannot be centered with the focus-coil adjustment.

Television interference

When my neighbor works in his garage, he creates some type of interference which causes my picture to jump around. Will a high-pass filter cure this trouble?—Alfred Martins, Avon, N. J.

Whether or not a high-pass filter will eliminate the interference depends on the type of equipment causing it. Interference caused by industrial heating equipment or modern diathermy machines can be prevented from entering the set via the antenna by connecting a high-pass filter between the set and the lead-in. As additional precautions, try a good line filter and a shield around the receiver chassis. High-pass filters can be purchased at most radio supply houses. You can construct your own using the diagrams in Figs. 2 and 3. Fig. 2 is a filter for 300-ohm lines and Fig. 3 is for 72-ohm coaxial cable.

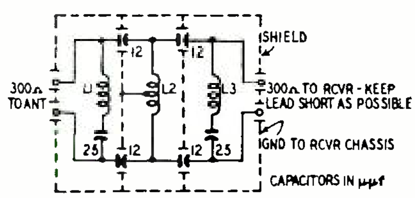


Fig. 2—Circuit of a 300-ohm filter. L1 and L3 are 15 turns of No. 20 enameled wire closewound with an inside diameter of ½ inch. L2 is a center-tapped coil consisting of 16 closewound turns and which has an inside diameter of ¼ inch.

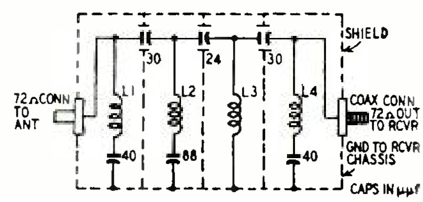


Fig. 3—A 72-ohm high-pass filter. All coils are wound with No. 22 enameled wire. Each coil is ½ inch in diameter and ½ inch long. L1 and L4 have seven turns. L2 has four and one-half turns, and L3 consists of four turns. Shield the filters for highest efficiency.

If—as is much more likely in your case—the interference is from arc welders, electric motors, or other devices which generate *damped waves,* it may be partially suppressed by installing line filters *at the source of the trouble.* This is a job for the owner of the offending equipment. If he does not take measures to eliminate the interference, contact the radio inspector in your district or write to the Secretary of the Federal Communications Commission, Washington 25, D. C. If the interference is not frequent, it might be wiser to overlook it.

Stabilizing line voltage

My set is an RCA 6T72. Every time my electric refrigerator comes on, there is a noticeable change in picture size and contrast. Does this interference harm the set in any way? How can I eliminate this condition? I've tried connecting the set to different outlets in the house without any noticeable improvement.—John Stronski, Baltimore, Md.

The trouble is caused by excessive voltage drop on the power lines when the refrigerator comes on. Most likely, this drop is on the line between the distribution panel and the receptacles. This can be checked by measuring the voltage across the line in the various receptacles and lamp sockets when the refrigerator is running. If the voltage is low on the receptacles but not on the lighting circuit, the voltage drop is confined to the line feeding the receptacles. The effect is not harmful, but may be annoying. You can eliminate it by having a special heavy line run to the refrigerator outlet. If the voltage drops on the lighting circuits as well, it may be caused by using too small a wire between the meter and distribution panel. Have an electrician check the lines for voltage drop and install heavier lines where necessary.

If it is impractical to change the power lines, install a constant-voltage transformer between the receptacle and the TV set.

X-burn

My set has a 17BP4 rectangular picture tube. For the last few weeks, I have noticed a brown cross consisting of lines running from the diagonally opposite corners of the screen. What causes this and how can I remove it?—David Bender, Dayton, Ohio.

The brown stain is an ion burn. The cross—called an X-burn—is characteristic of rectangular picture tubes. It corresponds to the round or oval ion spot on round tubes. There is nothing that can be done to remove the burn but you can take steps to prevent it from getting worse and you may be in time to avoid serious damage to the gun structure.

The 17BP4 uses a single-magnet type ion trap. Slip the ion trap over the neck of the tube just in front of the tube base. Rotate it so the magnet is opposite the high-voltage connector. Turn on the receiver with the brightness control set to a low-intensity position. If a raster appears, move the trap slowly forward while twisting it slightly from side to side. Reduce the setting of the brightness control as the intensity of the raster increases. The brightest raster should be obtained with the ion trap magnet *behind* the flags (pole pieces) on the gun of the tube. Replace the trap with one having a stronger magnet if the brightest raster is obtained with the trap ahead of the flags. (If the raster does not appear when the brightness control is turned slightly above halfway, turn off the set and swing the magnet around to the opposite side of the neck.)

Advance the brightness control until the raster is slightly brighter than normal. Adjust the focus control until the line structure is clearly visible in the raster. Touch up the setting of the ion trap with the brightness control set to the maximum position at which good line focus can be maintained.

Always check the setting of the ion trap whenever the chassis has been moved from the cabinet or the set has been moved about. The ion trap should always be checked whenever the focus coil is moved or the focalizer adjusted.

—end—

V BEAM FOR DX

By L. A. DUCK

A simple but excellent antenna for TV fringe reception (if you have the necessary space) is the V-beam shown in Fig. 1. It has very high gain and sharp directivity. The V contains 70 half-wave elements, all working and all beam-forming. The dimensions shown are for channel 13.

The booster at the antenna end is needed because the antenna has an impedance of 800 ohms, and the signal would get lost on a 300-ohm line. A Regency booster is specified because it uses 6J6 tubes in a circuit that is very efficient on channel 13. Most other boosters use 6AK5's which have a higher internal noise level and the boosters do not have much gain on the high channel 13.

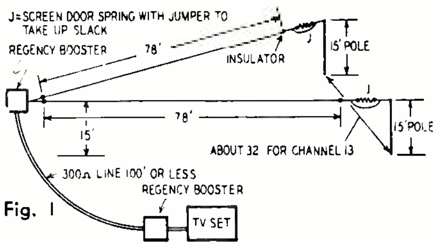


Fig. 1

Orienting the 78-foot legs is simple. Lay one wire on the ground, and stretch the other in the general direction of the transmitter to be received. Walk the far end of the stretched wire back and forth. Two definite signal peaks will appear, with almost complete lack of signal between these two points. These maximum points are where the two 15-foot antenna masts are to be located.

The 78-foot length is used because a shorter one will give less gain while a longer one will cause time-delay effects. A 150-foot length would tend to cross two picture elements. This delay is independent of frequency, so the antenna can be used just as well with any channel. However, the separation of the legs does depend on the frequency, but the exact separation is not critical because the booster is tightly coupled to the antenna. Tuning the booster changes the effective separation of the legs.

—end—

TV DX Predictions for July

Television reception conditions in July will be generally similar to those observed during June. The sporadic-E skip season will have ridden over its peak for 1951 in the latter part of June, but will continue with considerable momentum through July. Tropospheric propagation will be generally good over all sections of the country.

As sporadic-E skip development is more or less directly associated with solar phenomena, major openings usually recur on a cycle of about 27 to 28 days, the period required for one complete solar rotation with respect to the earth. Thus, the best indication of when to expect important skip developments will be the dates when the most widespread and strongest openings occurred in June. The most active periods will probably be between the 11th and 14th and the 22nd through the 25th, though short bursts of sporadic-E reception may be expected on the lower channels almost any time during July.

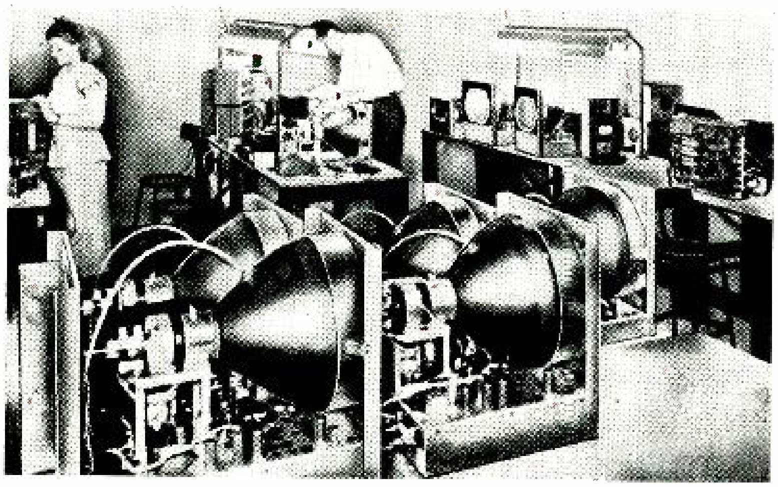
The most likely time of day to watch for openings will be the late morning hours and the period between 5 and 10 pm, local *Standard* Time. A few openings will develop after midnight; these will offer late-retiring eastern viewers an opportunity to look for far-western stations.

Usually July produces at least one strong aurora borealis display. Such events are usually only an annoyance to TV viewers. The net effect of the multipath reflections from the auroral curtain is a picture fuzziness not unlike the snow of fringe-area reception. When aurora effect is noted, or when the northern lights are visible, owners of directional arrays equipped with rotators will do well to swing the beams north and try all channels. Much remains to be learned about v.h.f. propagation via the aurora, and careful observation may well contribute to this end.

Tropospheric refraction will spring some surprises during July, particularly on the high-band channels. Especially during the late hours of the evening, on nights when the air is stable and calm, and the barometer high, the high channels may produce dx up to several hundred miles. Watch the daily weather maps in your local newspapers, and try the high channels when large stable high-pressure areas are shown near your locality.

—end—

TV TROUBLE LEXICON



(*Courtesy Midwest Radio & Telev. Corp., Cincinnati, Ohio*)
Laboratory technicians checking TV receiver troubles in final assembly line.

More Trouble Shooting Tips On Common Faults In TV Receivers

By JOHN B. LEDBETTER*

Hallicrafters

T-54, 505, 506. No picture (raster and sound O.K.). Defective 6C4 oscillator tube.

Insufficient width, width control ineffective. Open 47,000-ohm plate resistors in 12SN7-GT horizontal amplifier. (See Fig. 1.)

505. Picture deflected toward upper right of screen (vertical or horizontal centering controls ineffective). Leaky .05-μf, 6-kv coupling capacitor C73 (Fig. 1), .0005-μf, h.v. 6-kv capacitor C72. (A defect in one of the other deflecting capacitors may cause deflections to upper left, lower right, lower left, etc).

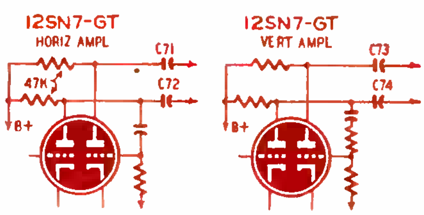


Fig. 1—Horizontal and vertical amplifier circuits of Hallicrafters 505.

No raster (sound normal). Defective 6C4 r.f. power-supply oscillator. Improper setting of r.f. power-supply trimmer. Check range of capacitor where oscillator falls in and out of oscillation; adjust trimmer to its maximum capacitance within this range. This provides maximum operating stability of r.f. oscillator.

Insufficient picture height. Defective 12SN7-GT vertical oscillator or vertical amplifier. Change in value of vertical height control. Defective plate resistor R78, vertical oscillator, mfrs. diagram.

*Engineer, WKRC-TV

Erratic picture, crackling in audio. Excessive dirt and moisture on base and socket of picture tube. H.v. arcing. Impending failure of filter capacitor. Defective (leaky) h.v. oscillator trimmer capacitor.

T-67. Intermittent picture, variation in intensity. Arcing at base of 1B3-GT or picture tube. Intermittent contact between filament leads and base pins of 1B3-GT. Check for evidence of arcing; resolder base pins, socket connections.

Kinescopes

Cathode-heater shorts. If a resistance check between these elements shows a low-resistance short, try flashing or burning it out with a temporary application of 110 v.a.c. or other high-voltage low-current source. Typical indication of this trouble is a low-intensity, washed-out picture.

Magnavox

CT214, -218, -221. Picture weaves and ripples on changing scenes (certain scenes distorted). Defective 6AL5 sync separator. (Replace this tube even though it checks good.) Defect in d.c. restorer circuit.

Horizontal oscillator failure. Defective horizontal oscillator tube. Defective grid coupling capacitor.

Stretching of picture (left side) after few minutes operation. Picture linearity returns to normal if set is allowed to cool. Adjustment of horizontal speed or horizontal drive causes left-hand side of picture to jump or move suddenly. Defective 6BG6-G.

Cross-modulation interference on strong signals. (R.f. amplifier operating on nonlinear portion of curve and acting as detector). Excessive signal overloading r.f. stage. Remedy: Remove grid return and solder to chassis ground (at point of lead shield ground). In exceptional cases, padding the antenna may be necessary.

Small picture segments (regularly spaced) displaced from main body of picture. Defective 6BG6-G, causing spurious oscillation.

Motorola

TS-5. No raster. Misadjustment of ion trap. Defective 6V6-G horizontal oscillator, 6J5 horizontal discharge, 6BG6-G horizontal output, or 1B3-GT h.v. rectifier. Open or shorted primary in horizontal output transformer. Open 1B3-GT filament winding.

Small raster. Weak 6BG6-G. Weak 5U4-G low-voltage rectifier. Shorted .03-μf horizontal deflection coupling capacitor C122 or .05-μf C123. Shorted vertical deflection coupling capacitors C86B (50 μf) or C87B (10 μf). Low line voltage.

Trapezoidal or nonsymmetrical raster. Improper ion trap adjustment. Incorrect focus coil adjustment. Defective deflection yoke.

Wrinkles on left side of raster. Defective 5V4-G damper.

Picture smear. Low bias on 6AU6 first video amplifier or 6AC7 second video amplifier. Leaky .05-μf video amplifier coupling capacitors C61 or C62. (See Fig. 2.)

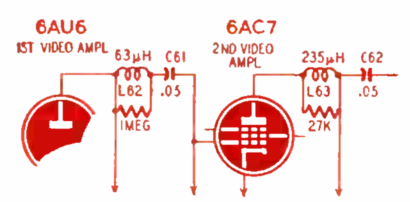


Fig. 2—Coupling circuits of the video amplifier as used in the Motorola TS-5

Poor resolution (picture stable). R.f. tuner or video i.f. badly out of alignment. Open peaking coils in 6AL5 video detector plate (L59 or L60), or in first or second video amplifier plates (L62 or L63). (See Fig. 2.)

TS-5 (VK-101). Sound bars (stippled effect) in picture. Improper adjustment of fine tuning control. Low-frequency trap L50 open, shorted, or misadjusted.

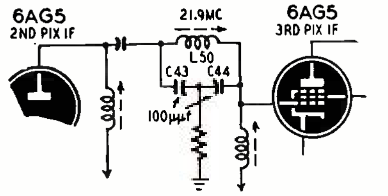


Fig. 3—Low-frequency trap trouble.

Open or shorted 100-µµf parallel-trap capacitors C43 or C44 (see Fig. 3).

Poor focus. Low line voltage. Open 1,000-ohm resistor R116 in series with focus coil and focus control.

Vertical black lines in picture. Defective 6BG6-G horizontal output or 6V6-GT horizontal oscillator. B+ lead to tuner picking up horizontal pulses. Replace with shielded lead and reroute so that 250-volt end ties to terminal strip end of 39,000-ohm resistor R67 in the screen-grid lead of V-14. Ground the shield at several points.

TS-9. **Loss of brightness.** Defective 1B3 or 6BG6-G. Open or leaky h.v. filter condenser. Increase in value of 820,-000-ohm filter resistor R108 in h.v. supply.

TS-18. **Poor vertical linearity.** Defective 6SL7-GT vertical output. Defective 22-meg feedback resistor R61 (vertical output to vertical oscillator). (Fig. 4.)

Poor vertical sync. H.v. corona arcing. Open .01-µf integrating capacitors in 12SN7-GT sync clipper output.

Loss of vertical sync. (Not corrected by adjustment of vertical hold control or replacement of vertical oscillator and amplifier tubes). Check value of 1,000-µµf grid capacitor C69. (Fig. 4.)

No vertical deflection. Defective 12SN7-GT vertical oscillator or 6SL7-GT vertical amplifier. Defective .05-µf coupling capacitor C72 or .01-µf charging capaci-

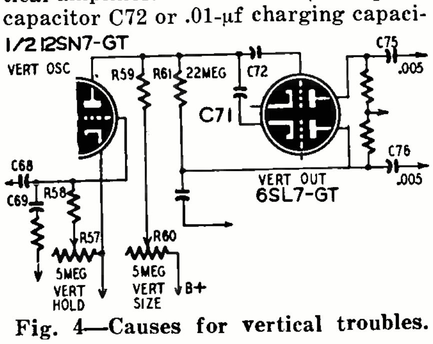


Fig. 4—Causes for vertical troubles.

tor C71. Failure of vertical hold or vertical size controls R57 and R60. (Fig. 4.)

Insufficient height. Defective 6SL7-GT vertical output tube. Defective vertical size control R60. Open h.v. coupling capacitors C75 or C76 (.005µf, 6,000 v.) from vertical amplifier plates. Shorted 250-µµf r.f. filter capacitor C77. Shorted ballast tube, causing excessive heater voltage on vertical amplifier. (Fig. 4.)

Vertical jitter. Vertical hold control needs readjusting. Defective 250-µµf vertical oscillator coupling capacitor C68. (Fig. 4.)

Vertical bars on left half of picture. Defective damping resistors R88 or R51 across primary and secondary of horizontal blocking transformer T5. (Fig. 5.)

Poor horizontal linearity. Defective horizontal sawtooth capacitors C62 (680-µµf) or C63 (900-µµf). (Fig. 5.)

No horizontal deflection. Defective 12SN7GT horizontal oscillator. Defective horizontal hold or horizontal size control (R49 or R53). Failure in horizontal oscillator blocking transformer

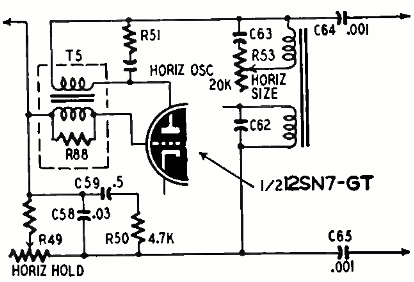


Fig. 5—Horizontal circuits of TS-18

T5. Shorted horizontal sawtooth capacitors C62 or C63 (680 and 900-µµf). (See Fig. 5.)

Insufficient width. Defective 12SN7-GT horizontal oscillator, defective horizontal size control R53. Open h.v. coupling capacitors C64 or C65 (.001-µf, 6,000 volts) going to horizontal deflection plates. Open .03-µf capacitor C58 across horizontal hold control and series resistor. Defective ballast tube, causing low heater voltage on horizontal oscillator. (Fig. 5.)

Horizontal fold-over (left of picture). Incorrect setting of horizontal hold control. Increased values in horizontal sawtooth capacitors C62 or C63 (680 and 900-µµf). (See Fig. 5.)

Excessive picture size, low brightness. Defective 25L6-GT h.v. supply oscillator or 1B3-GT h.v. rectifier.

10VK12. **Poor vertical linearity.** Defective linearity control. Shorted 100-µf cathode capacitor in vertical output stage.

12VK11RA. **Black horizontal line at bottom of picture.** Improper adjustment of vertical hold or vertical centering controls; defective vertical hold control. Defective 6SN7-GT clipper, 6J5-GT vertical oscillator, or 6V6-GT vertical output.

VT-71M. **"Pie-crust" oscillation covering entire screen.** Picture-tube mount touching shield cover of r.f. h.v. power supply. Insulate with cardboard or fiber strip.

Horizontal white line (stationary). Defect in h.v. supply; open or leaky filter or bypass condensers. Check to see that line is not a burn-in from a possible previous failure of vertical scan.

VT-105, 107; VK-106. **Horizontal white line (moves with adjustment of vertical hold control).** Defective 6SN7-GT vertical oscillator or vertical amplifier. Defective vertical coupling or sweep discharge capacitors.

Olympic

DX950. **Vertical damping bar on left of screen.** Defective 6BG6-G horizontal output or 6W4 damper. Misadjustment of horizontal drive control. Insufficient value in deflection yoke capacitor (replace original 47-µµf unit with higher capacity, up to about 100 µµf). Insufficient shielding between deflection yoke and video amplifier stages. Yoke leads too close to other kinescope leads.

Philco

48-700, 1000, 1001, 1050, etc. **Weak reception, instability.** Defective 6J6. Dirty, loose contacts on turret tuner. Defective contact springs on turret.

Intermittent picture and sound. Same as above. Look also for cold-solder joints in tuner.

48-1001. **Vertical black line on picture.** Caused in early models by regeneration from the 0.1-µf capacitor connected from the 6BG6-G screen to ground. Remove capacitor entirely (this has been done in all later production models).

48-1000, 1050. **Weak sound and picture.** Defective 6J6. Shorted 10-µf 6J6 plate filter capacitor C409 or 22-µµf grid coupling capacitor C404.

1075. **Picture jumps, tears horizontally (to right).** Defective 6BG6-G. Defective leads on 0.5-µf capacitor C522 connected from 5V4-G damper to horizontal deflection coils.

48-2500 (Projection). **Poor linearity on background objects.** Improper adjustment of keystone magnets inside optical barrel. Adjust according to manufacturer's specifications.

49-1475. **Fine tuning control ineffective.** Defective 6AL5 picture discriminator which controls automatic tuning.

48 Series. **Sound bars on channel 4.** If bars are eliminated when one of the sound i.f. tubes is removed, they are being caused by a beat between channel 4's video carrier and 3rd harmonic of sound i.f. Realign sound i.f. at 22.0 mc and realign video i.f. 100 kc lower.

48 and 49 Series. **Receiver drift.** Defective 6J6 oscillator. Improper alignment of sound i.f. Signal too weak to operate a.f.c. In earlier models, drift can be reduced by installing improved discriminator transformer and 10-µµf negative-coefficient oscillator grid-tank compensating capacitor (available in kit form as Philco part No. 45-9535).

(continued next month)

Audio Feedback Design

Part IX—Discussing mu-beta effect in design of feedback amplifiers.

By GEORGE FLETCHER COOPER

EVERY writer on feedback opens with a light barrage of mathematics, in which the gain of an amplifier with feedback is shown to be

$$K' = \frac{K}{1 + K\beta}$$

Where K is the gain without feedback, and β is the attenuation of the feedback path. Then there is a discussion of this, and out of the hat comes $K = 1/\beta$. Blinded with science, the reader rubs his hands and reaches for

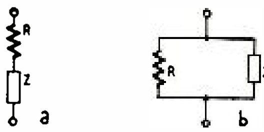


Fig. 1—Two-terminal network problems.

a soldering iron. Obviously, however, the gain without feedback is not always large, and if we are concerned with low-gain amplifiers, or with effects at the edge of the band, we must go back to the basic equation. We can write this in the form:

$$K' = \frac{1}{\beta} \times \frac{K\beta}{1 + K\beta}.$$

When we work in decibels, we have: gain in db =

$$20 \log \frac{1}{\beta} + 20 \log \left(\frac{K\beta}{1 + K\beta}\right)$$

You will notice an interesting term enclosed in the parentheses. This is what we have been looking for, because: the first term on the right-hand side is just the traditional approximation; the second term is the gain component of what is called the "mu-beta effect." This unexpected name was provided by the godfathers. Dr. Bode uses μ (mu) where we have used K. In the classical papers you will find the fundamental equation written

$$G = \frac{\mu}{1 - \mu\beta}.$$

In this form, β is negative in the important regions if we have negative feedback, while I have assumed that we would let the signs look after themselves by using the table given in Part VIII. We must watch this rather carefully now, because the mu-beta effect calculator is designed from the Bode notation.

Before going on to discuss the refinements in calculation which are provided by the exact formula, let us look at the reasons for using it. Some of them will probably never affect some of my readers, but in special circuit designs this technique is invaluable. For one thing, it takes the use of positive feedback out of the cut-and-come-again class, and there's a big future in positive feedback, if only to help out in the component shortage.

The first use of the exact equation is to check what happens at the edges of the band when the gain of the amplifier varies. If you look up the JAN specifications for the tubes you are using (British readers will find their valves in the Services Preferred List), you will see that when the maker says boldly, $g_m = 5{,}000$ micromhos, he really means something between 4,000 and 6,000, or, if you are not a military customer, even wider limits. Roughly speaking, that means that the gain per stage can vary over a range of about 4 decibels: in three stages, 12 db, will be the range for a typical audio amplifier.

Actual stability, under these conditions, may be a headache in its own right, but the maintenance of a specified frequency response often may cause a lot of trouble. A batch of tubes on the high side may result in the measured

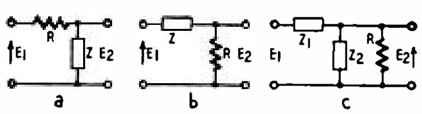


Fig. 2—Some typical impedance problems in four terminal network analysis.

frequency response falling outside the customer's limits. Try telling him his tubes are too good!

The second major use for the exact equation is in one of these multiple feedback loop amplifiers we discussed in Part VII. If we want to design this right to the bitter end, we must determine the gain and phase characteristics of the first subamplifier with its positive feedback to draw the phase and amplitude responses for the complete amplifier, to which the main negative feedback is applied.

A mu-beta calculator

These more refined calculations became really practicable in October, 1949, when Jean Felker of the Bell Laboratories published a paper called "Calculator and Chart for Feedback Problems" (*Proc. I.R.E.* 37, 1204). The calculator is a sort of circular slide rule for performing the necessary phase and amplitude calculations.[1]

Let us go back to the mathematics again, and see what we are dealing with. The mu-beta effect is

$$\frac{K\beta}{1 + K\beta}.$$

In general, both K and β include a phase shift. Let us take the total phase shift in the amplifier and feedback network at a particular frequency to be θ. This is the phase which we use when we draw the Nyquist diagram. Since we now have to watch our signs, we must notice that in the middle of the working range $\theta = 180°$, while at the danger point for stability, $\theta = 0$. Thus when you draw diagrams like Fig. 5 of Part III, you must put the phase zero at the bottom, and the point B (marked 150° in Fig. 5/III) becomes 30°. θ is thus what we have called the phase margin. We can write the mu-beta effect as

$$\gamma \underline{/\phi} = \frac{|K\beta| \underline{/\theta}}{1 + |K\beta| \underline{/\theta}}$$

Where γ (gamma) is the magnitude of the mu-beta effect, and ϕ is the phase. We know the phase shift in the feedback network, because we can calculate it using the templates: call this ψ (psi). The phase shift through the amplifier is then $(180 + \phi - \psi)$. When ψ is zero, this is $(180 + \phi)$ instead of the value without feedback, $(180 + \theta)$.

The gain of the amplifier is γ decibels plus the ideal gain, $20 \log \frac{1}{\beta}$ db. These Greek letters have been used because they are the same as those in the Felker paper: the only difference is

[1] Available from Graphimatics, 201 N. Taylor Ave., Kirkwood 22, Mo.

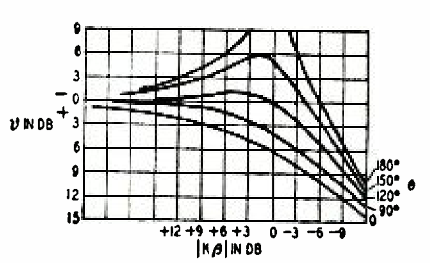


Fig. 3—Impedance forms plotted in db.

that our β must have **a** negative sign.

For some purposes it is rather useful to turn the mu-beta effect upside-down. Let us write υ (upsilon) $= 1/\gamma$. Then

$$\upsilon \underline{/-\phi} = \frac{1 + |K\beta|\,\underline{/\theta}}{|K\beta|\,\underline{/\theta}} = 1 + \frac{1}{|K\beta|\,\underline{/\theta}}.$$

I did not do this bit of mathematics just to show how clever I am: this particular form is rather a useful one. Consider the impedance shown in Fig. 1-a. Z is any impedance, and R is a resistance. Taken together the impedance is R + Z, and this can be written R(1 + Z/R).

Remembering that Z is a general impedance, we can write this as

$$R\left(1 + \left|\frac{Z}{R}\right|\,\underline{/\theta'}\right).$$

If we put $\theta = -\theta'$ and $K\beta = R/Z$ the impedance of the two-terminal network is thus $R\upsilon \underline{/-\phi}$.

In much the same way, the admittance of the circuit in Fig. 1-b is

$$\frac{1}{R}\left(1 + \frac{R}{Z}\underline{/\theta'}\right)$$

and we put $K\beta = Z/R$ and also put $\theta = \theta'$, to make the admittance equal $\frac{1}{R}\upsilon \underline{/-\phi}$.

We can go even further, and apply this expression to the networks of Fig. 2. If we take the ratio $\frac{E_1}{E_2}$, which is the most useful when we want to convert to decibels, we have for this ratio:

a. $= 1 + |R/Z|\,\underline{/\theta'}$;

b. $= 1 + |Z/R|\,\underline{/\theta'}$;

c. $= 1 +)1 + |R/Z_2|\,\underline{/\theta'_1})\,\left|\frac{Z_1}{R}\right|\,\underline{/\theta'_2}$.

Even the impedance forms are useful in decibels, because when we connect an impedance as the plate load of a pentode, the gain is $g_m Z$, or (20 log g_m + 20 log Z) decibels. For that reason, the curve of υ given as Fig. 3 shows υ in decibels.

We could, of course, proceed to use those curves to determine the mu-beta effect, but the Felker calculator is much more convenient. This chart is reproduced as Fig. 4. The rotatable arm should be cut out, fastened to a suitable backing of thin card or plastic, and attached to the center of the circular chart. One end of the moving arm is longer than the other, and in use this end moves over the upper semicircle, which represents the mu-beta phase scale.

Figs. 5 and 6 have been constructed to enable us to work out an example. Three circuits of 6 db per octave are assumed, with characteristic frequencies at 1, 2, and $4\sqrt{2}$. The most feedback which could be applied without instability is 21 db, and for this example we shall assume that we are applying 15 db of feedback. We therefore construct the second scale, marked MU-BETA, with its zero at the 15 db down level on the GAIN BELOW MAXIMUM scale. In Fig. 6 we provide a new phase scale, working down from a zero at the old 180° level.

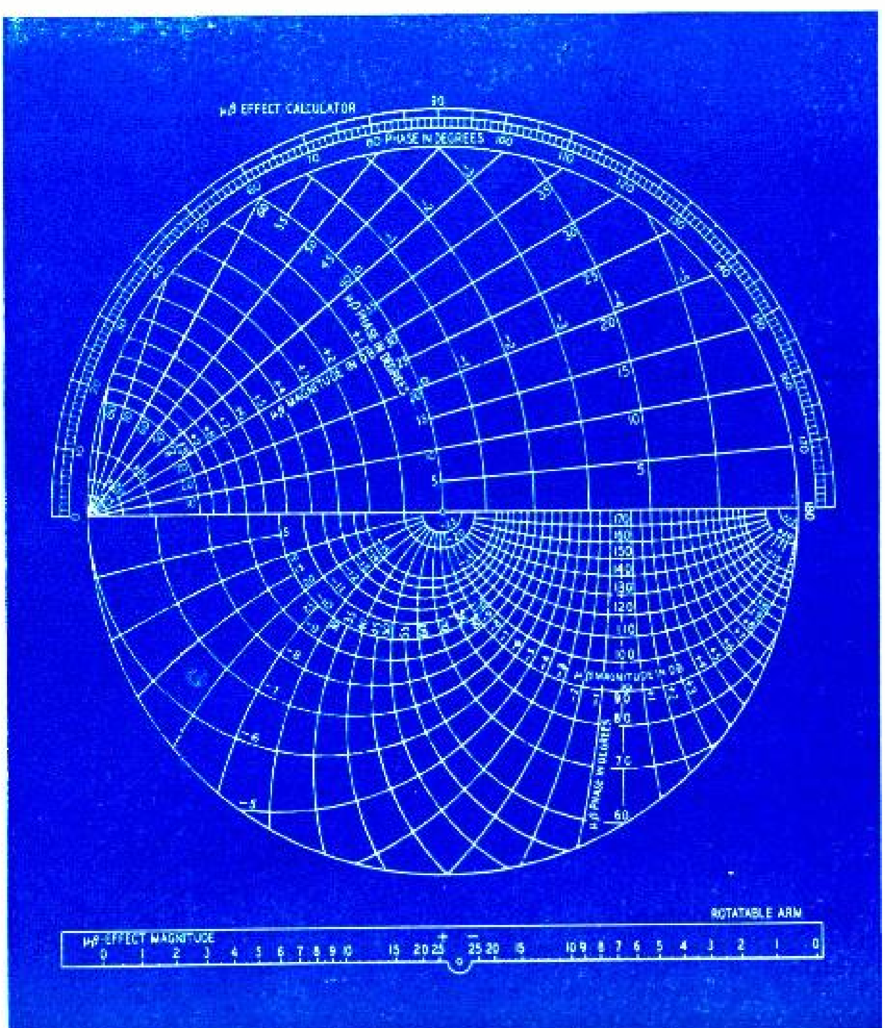


Fig. 4—This is a simplified version of the Felker chart described in the text.

Using the calculator

Now take the calculator. At $\omega = 2$, we have mu-beta = +4db and $\theta = 50°$: find the point where mu-beta = + 4 and mu-beta phase = 50°. It is up near the top left-hand side (I almost wrote corner) of the chart. Turn the rotating arm until it passes through this point, and read off the mu-beta effect magnitude, on the arm itself, and the phase, on the semicircular scale. We find + 2.3 db, 40°. Repeating the calculation at other points, we get + 6.2 db, 92° at $\omega = 2\sqrt{2}$, and so on. All these values have been plotted in on Figs. 5 and 6; on Fig. 5 you will remember that this mu-beta effect is the deviation of gain from what we expect in the simple theory. We use the mu-beta scale for plotting the response. As you can see, the "flat" gain is about 1.5 db below the zero determined by the simple theory. The phase shift is, at most frequencies, much less with feedback, but at the edge of the working band it rushes sharply upward. You can see how dangerous this can be in a multiple-loop amplifier, by considering the values at $\omega = 4$: with feedback the gain is 1.5 db above the standard value. but the phase shift has practically hit the 180° mark. As a subamplifier in a complicated multiloop system this particular system could give you enough headaches for a lifetime.

Suppose that in place of the gain we planned, the amplifier has in it rather old tubes, or low-limit tubes. The gain without feedback K, which we are calling mu in this article, may have dropped 6 db. The feedback term, β, remains the same, however, so the product $K\beta$ (mu-beta) is down 6 db. The mu-beta scale zero, on the left of Fig. 5, should now be set at 9 db on the "gain below max" scale. At $\omega = 2$ we have $\mu\beta = -2$db $\theta = 50°$, so that the $\mu\beta$ effect is +0.2db instead of +1.6db. As $\omega \rightarrow 0$, the response, for $(\mu\beta) = 9$db and $\theta = 180°$, is 2.6 db: the response therefore has risen 2.8 db at $\omega = 2$ for this low-gain case, instead of 3.1 db for the normal-gain case. The mid-band gain has dropped 1.1 db.

I am not inclined to discuss this application of the mu-beta calculator any further. The time that would be spent reading further discussion can be spent more profitably in working out some examples with the aid of the calculator itself. However, here is an important thing to be aware of: When the feedback network contains reactances, which usually will be capacitors, the response calculated is that which appears at the output of the feedback network. Therefore it is necessary to subtract the response of the feedback network from the calculated response given by the mu-beta calculator to get the response for the over-all system. This is shown in the basic equation:

$$\text{gain} = 20 \log \frac{1}{\beta} + \text{mu-beta effect.}$$

Here is another use for the mu-beta calculator: It can be used for calculating the stability margin directly. As you

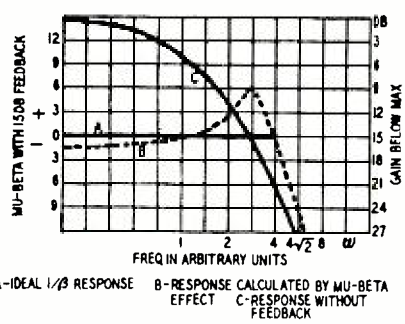


Fig. 5—Three design curves of amplifier.

may remember, we showed in Part VI that a quantity called the stability margin was a very useful measure for the safety of a design. This quantity is

$$\frac{K'}{K} = \frac{1}{1+K\beta}$$

in our notation. The mu-beta effect, you will remember, is

$$\gamma = \frac{K\beta}{1+K\beta} = \frac{1}{1+\frac{1}{K\beta}}$$

If we have a value of, say, 6 db for $K\beta$, and we calculate the $\mu\beta$-effect corresponding to −6 db, the quantity we obtain is the stability margin. Let us draw up a table from Figs. 5 and 6:

ω =	1	1.4	2	2.8	4
$K\beta = \mu\beta$ =	+10	+7.5	+4.2	−1	−6.3 db
θ =	97°	75°	50°	26°	4°
$\mu\beta$ effect =	−0.8	+0.3	+2.3	+6.2	−0.5 db
Stability Margin =	−10.8	−7.3	−1.8	+ 7.2	+5.8 db

The last line was calculated directly, taking the (−10 db, 97°), (−7.5 db, 75°) etc. points on the chart. This means that it is not necessary to pass through the response, mu-beta effect, over-all response system in order to check the stability margin. When the feedback path has a nonuniform response this can be very helpful, because all that need be done is to plot the two pairs of curves, for mu-beta and for beta, and then determine the stability directly.

There is a very attractive phrase which you can find in British patents: "Having now particularly described and ascertained the nature of the invention . . ." Well, we've done that, but just in case the explanation has not been sufficiently certain, Fig. 7 shows how the calculator is actually set to fish out the results at $\omega = 2$. The point marked A is at mu-beta = +4.2 db, mu-beta phase = 50°: the rotating arm OA has been turned until the edge passes through this point, and the mu-beta effect is read off at A on the scale printed on the arm. The phase of the mu-beta effect is read off on the circular scale. For the stability margin we hunt out point B, −4.2 db, 50°, and twist the arm to pass through this point. The stability margin is read off from the arm.

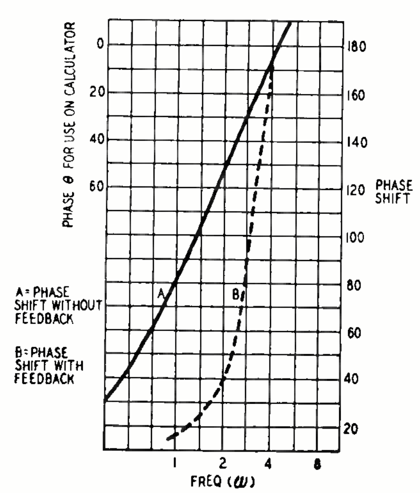


Fig. 6—Two curves showing phase shift.

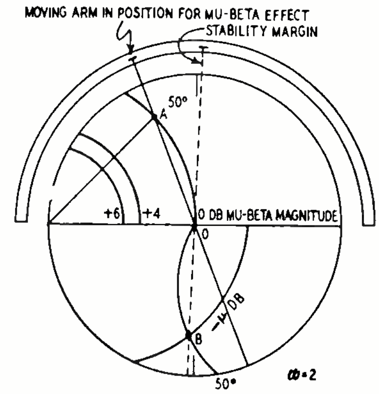


Fig. 7—The calculator solves a problem.

Wary readers may have noticed that almost everything I have discussed in this series of articles deals with the analysis of feedback circuits, and not the synthesis. We guess a circuit, and test it, on paper, to see if it will work. Nearly everything in the field of circuit design boils down to this in the end: The main differences appear in the methods of testing. At one extreme you wire up the circuit and pray; at the other extreme you test on paper in such a general way that you never come to a practical answer. These articles are aimed at a reasonable compromise. They do provide all the information needed by the average professional designer, but at the same time I hope that they are not too forbiddingly mathematical for the man who wants to build just one amplifier, but wants to build it right. Anyway, you can always skip the mathematics.

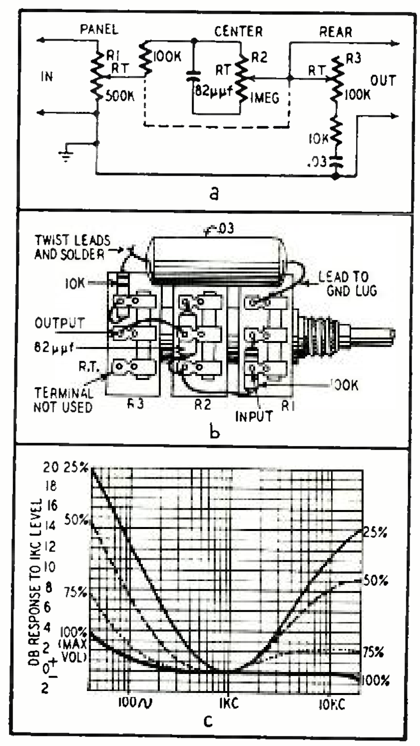
The important thing to learn here is: mu-beta simplifies design work.

(continued next month)

VARIABLE LOUDNESS CONTROL

Loudness controls are special volume controls which provide increasing amounts of bass and treble boost as the volume is reduced. This compensates for the variations in response of the human ear so the output of the amplifier will appear balanced at all volume levels. Tapped volume controls provide a limited amount of compensation. This is greatest when the arm of the control is resting on the tapped point. Step type controls require a large number of components. They are difficult to construct and require special care in shielding to prevent hum pickup and feedback.

A continuously variable loudness control requiring only seven inexpensive components is described in a release by I.R.C. The circuit of this control is shown at *a* and its physical construction is shown at *b*. R1, R2, and R3 are IRC controls type Q11-133, M13-137, and M13-128 respectively. The first is a standard type control and the others are multisections designed for making dual, triple, and quadruple controls. The curve *c* shows the increase in bass and treble boost as the control is turned toward the minimum-volume position.



This control has a 6-db insertion loss which must be made up elsewhere in the amplifier if full output is to be realized.

Electronics and Music

Part XIII Stroboconn, precise frequency meter, measures sound accurately to hundredths of a semitone

By
RICHARD H. DORF*

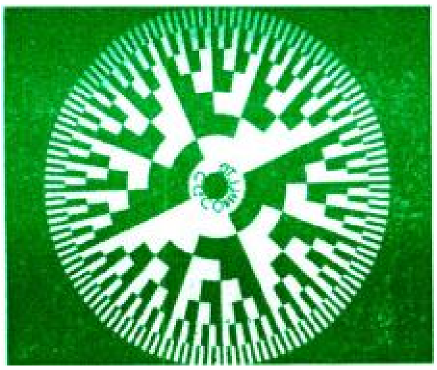


Photo A—Discs used in Stroboconn.

WHILE this series is concerned with electronic musical instruments, the *Stroboconn*[1] is so closely allied with electronic music and so useful with electronic organs as well as more conventional acoustic instruments that it should be of great interest to all who work with both electronics and music.

The Stroboconn is in essence an extremely accurate frequency meter. It was specifically designed as an aid in tuning musical instruments, by the manufacturer of the Connsonata—an electronic instrument we shall describe later in the series. It is also highly effective in the laboratory and in industry for measuring vibrations, oscillations, and other periodic phenomena within its frequency range.

*Audio Consultant, New York

The instrument is in effect a super-stroboscope. Twelve discs, each a replica of the one shown in Photo A, revolve at different speeds. Each disc corresponds to a note of the tempered musical scale and revolves faster than the preceding lower one by a ratio of almost exactly the 12th root of 2. A special large neon lamp is excited by a microphone-fed amplifier. When the microphone is placed near a source of sound—a piano tone, for example, or an organ note—the neon lamp flashes at the frequency of the sound, illuminating the discs stroboscopically. If the speed of one of the discs is such that the number of black segments passing a given point per second is the same as the audio frequency being measured, the pattern appears to stand still. Calibrations on the Stroboconn then indicate the frequency. All 12 discs can be seen through small windows, as Photo B shows.

Photo C is a photograph of one of the windows, exposing a segment of the disc behind it in motion. As Photo A indicates, each disc has seven concentric rings of patterns, each ring having twice the number of black portions as the adjacent inner one. Thus each disc takes care of the same note in seven succeeding octaves. In Photo C the narrow part of the window exposes the innermost ring on the disc. The first three rings are invisible because the frequency being measured corresponds to that of the fourth ring, in which the stopped pattern can be seen. This tone apparently has some harmonic structure, for the fifth and sixth rings are also stopped, though they are illuminated less well.

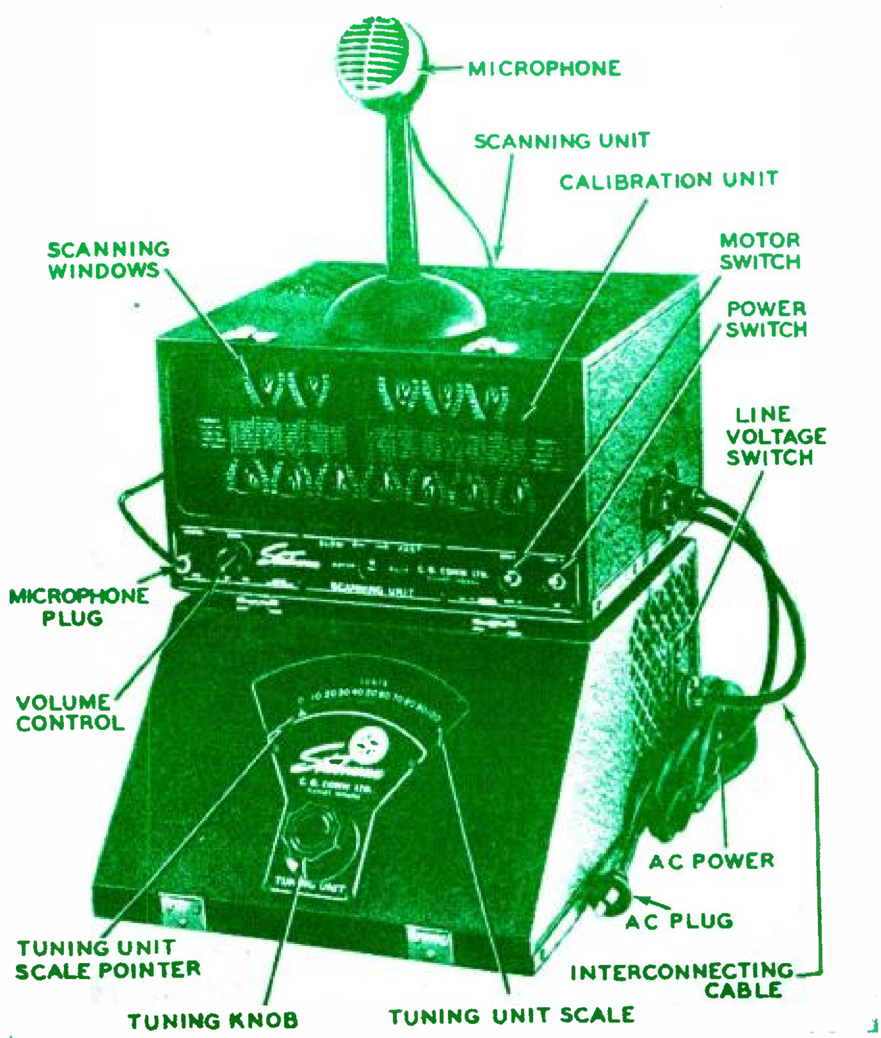


Photo B—The Stroboconn is in two sections. In use they are removed from covers and the scanning unit placed atop the tuning unit. Either an air or contact microphone may be employed, being placed near source of sound.

Electronic circuitry

The most essential requirement for accuracy in an instrument of this kind is that the motor driving the discs run at constant speed. In the Stroboconn this regulation is provided by driving the motor with a tuning-fork-excited amplifier, diagrammed in Fig. 1. The tuning fork is made of a special alloy, called Connivar, which has an extremely low temperature coefficient. The metal is so stable that the accuracy of the fork varies only a maximum of .002 percent per degree Centigrade. For musical purposes a pitch accuracy of

0.1 percent is considered very high and few people (if any) can perceive pitch variations so small. In continuous operation the entire instrument, including gears, fork, and all other variants, is accurate to within .05 percent.

The fork is driven by a regenerative circuit, in which respect it resembles electronic oscillators. The pickup coil (Fig. 1) drives the first grid of a 6SC7. The plate output is fed to the grid of the second section, part of whose plate load is the fork drive coils. Thus the output of the fork is fed back in the correct phase to furnish driving signal, the driving power being supplied by the B-voltage source, a standard rectifier-filter combination.

The fork-controlled signal is then fed through a 6SN7-GT phase inverter to a push-pull-parallel 6V6-GT output stage. The secondary of the output transformer drives the synchronous disc motor.

The normal frequency of the tuning-fork oscillator is 55 cycles, but the frequency can be varied at will. Photo D shows the fork and the sliding weights whose position can be changed to vary resonant frequency. The varying mechanism is operated by a knob which appears at the bottom of the lower unit in Photo B.

The upper of the two units in which the Stroboconn is mounted contains the motor, discs, and flashing amplifier, diagrammed in Fig. 2. The amplifier is entirely conventional: a voltage amplifier, phase inverter, and push-pull output stage. A special, large, U-shaped neon lamp is fed by the secondary of the output transformer. The lamp is large enough to provide light behind all the discs, which are translucent.

The power connections in Figs. 1 and 2 are rather confusing. The scheme is shown better in Fig. 3, an extract from the other two diagrams. Two power switches are supplied. One, called the POWER SWITCH, is in series with one side of the 117-volt a.c. line and a protective fuse. The other, the MOTOR-RUN WARM-UP switch, is a double-pole, double-throw unit. In the warm-up position in which it appears in Fig. 3 (and with the power switch closed) 117-volt, 60-cycle power is fed to the motor and the output of the tuning-fork amplifier is dummy-loaded by a 500-ohm, 50-watt resistor. After the motor and fork have warmed, the switch is thrown to the run position in which the motor is connected to the fork amplifier and the flashing amplifier power transformer is energized. After the flashing amplifier has warmed up, the instrument is ready for use.

The discs are run by the motor through a system of gears. Since the 12th root of 2 is not a rational number —it can be carried to an infinite number of decimal places—the gear ratio from one disc to the next is not quite correct; no one has yet been able to design gears with a nonintegral number of teeth! It is so close to correct, however, that the difference is not perceptible.

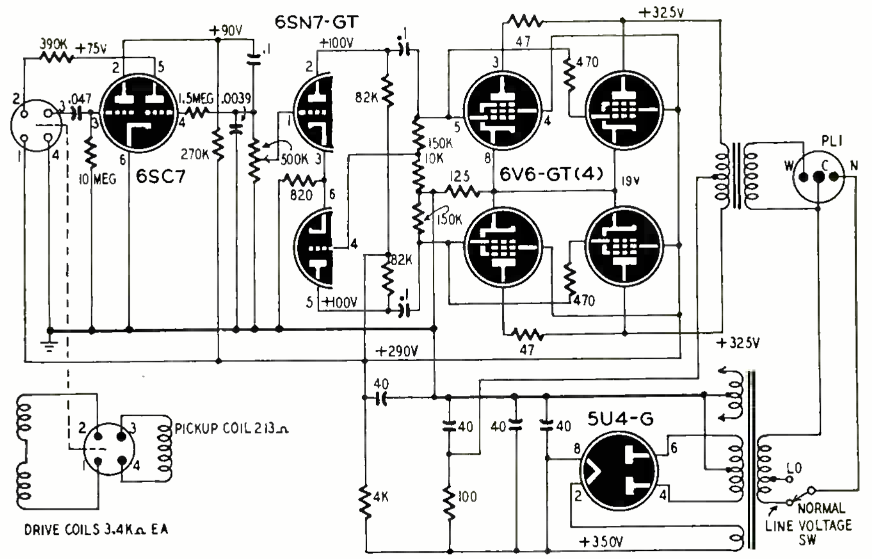


Fig. 1—The motor of the Stroboconn is driven by this tuning-fork-controlled amplifier. The fork is made of Connivar, has very small temperature co-efficient.

Reading frequency

The normal position for the tuning unit control is at zero. The tuning fork weights are then set so that the oscillation frequency for the synchronous motor is 55 cycles per second. The motor is so geared to the discs that the A disc rotates at 27.5 revolutions per second. The first (inner) ring has two black portions so that a black portion appears in a given position 2 times 27.5, or 55 times, per second. The fourth ring has 16 black portions; thus one appears 16 times 27.5, or 440 times, per second. If the signal fed into the microphone is at 440 cycles, the lamp will flash once each time that a black mark appears in the fourth ring and the marks will appear to stand still. At 440 flashes per second, however, each black mark of the first ring is illuminated 8 times each time it appears, so it does not stand still. As a result the fundamental frequency of whatever tone is being measured is indicated by the innermost stopped pattern. Octave harmonics of the tone are indicated by the stopping of additional rings toward the outer edge of the disc (or the wide portion of the window).

Each ring of each disc is numbered around the windows in accordance with the ordinal number of the note. The calibration strip between the two sets of windows indicates the exact frequency of each note, based on an A of 440 cycles. That calibration is not necessary, of course, for routine instrument tuning, but is helpful for other purposes.

Interpolation

Probably the feature most responsible for the Stroboconn's versatility in both music and nonmusic applications is the ingenious provision made for reading with great accuracy any frequency within its range. The basis of this is the knob-controlled, calibrated sliding

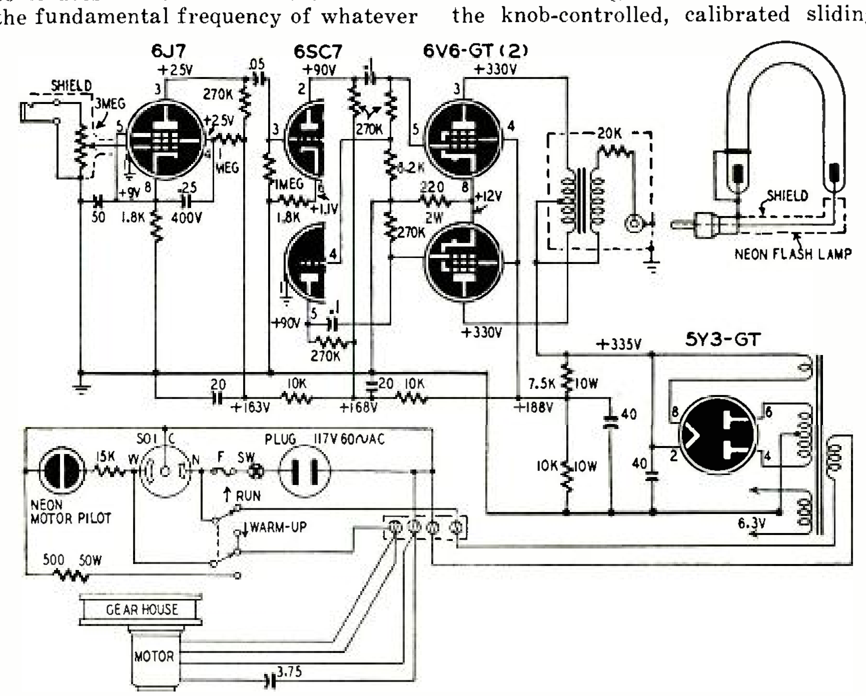


Fig. 2—Diagram of the scanning unit. The neon flash lamp is of special design.

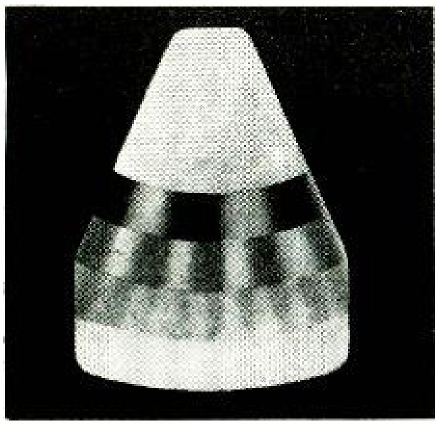


Photo C—Photo of a scanning disc in operation shows stroboscope patterns.

weight on the tuning fork. Referring again to Photo B, as the tuning unit knob is rotated the pointer on the scale above it reads the frequency change in terms of hundredths of a semitone. These small intervals are known as *cents*. Since the musical scale is built on a logarithmic, not an arithmetic, basis, a cent represents a constant *percentage* change in frequency rather than a constant numerical change. A semitone or halftone (the interval between, say, C and C♯ or E and F) represents a frequency ratio between the two pitches of the 12th root of 2 (see August, 1950, issue). One cent therefore represents a ratio of

$$\sqrt[12]{2}/100$$

which works out to approximately .058%. As an example, a 1-cent increase in the frequency of A-440 is 440 × 1.00058, or 440.25 cycles.

In practical terms the meaning of the above is quite simple. If the middle A is sounded on a piano or organ being tuned with the Stroboconn, ring No. 57 should stand still. Suppose it rotates very slowly to the right, indicating the tone is sharp, then to tune it to exact pitch the tuner adjusts the musical instrument until the pattern stands still. Or, to find out just how sharp it is, he rotates the tuning unit control upward from zero until the pattern stands still. If the pointer is then at 1 cent, he knows it is 0.25 cycle sharp.

Tuners rarely need to know how sharp or flat a tone is except for the "stretching" techniques described below. Of greater value is the fact that any frequency of an oscillator, or vibration, or anything else in laboratory or industry may be measured in this way. A book of tables is furnished with the Stroboconn. With its aid the operator can discover the exact frequency (to five significant figures) of anything that can be either fed to the flashing amplifier or picked up by the microphone. He merely manipulates the tuning knob until one of the patterns is stationary, then refers to the tables for the frequency.

Piano tuning

The old-time piano tuner was usually a craftsman of great skill and years of experience. Many of the best of them started their careers in piano factories, working up by stages to the exacting job of adjusting new pianos before they were shipped. Expert tuning has always required an intimate knowledge of piano construction, a first-class ear for pitch, and much practical experience.

One of the reasons that tuning has never been a purely mechanical job is that an expert tuner does not actually tune the piano notes to theoretically correct pitch, except in the middle octaves. The overtones of a struck string are not true harmonics of the fundamental but are instead slightly sharper—higher in pitch—than the true harmonics would be. If the entire piano is tuned to exact pitch, the upper overtones of the middle octaves are sharper than the corresponding fundamentals of the upper octaves. Too, the upper harmonics of the lower octaves are sharper than the corresponding fundamentals of the middle octaves. The result is, as any musician who has ever heard a piano so tuned will instantly say, that it does not "sound right."

To make it sound more natural, the tuner "stretches." He tunes the upper

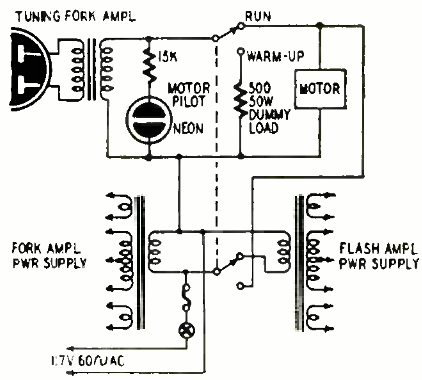


Fig. 3—The motor start circuit redrawn.

octaves sharp and the bass ones flat. Most tuners, aware of the fallacy of tuning an entire instrument to true pitch, balk at the idea of using an electromechanical device.

However, the variable, calibrated pitch adjustments of the Stroboconn overcome the difficulty. After a little experiment, a tuner determines just how sharp or flat each note of these "stretched" octaves should be tuned to suit his and his clients' tastes and he notes the pitch change in cents. In future tunings, he needs merely to shift the tuning knob according to his notes and tune for a stopped pattern. The time saved and the accuracy gained are well worth while. The accuracy is especially valuable when two pianos, to be used in duo-piano playing, are tuned, for then it is essential that they correspond. For tuning the lower octaves it is not even necessary to experiment and make notes. The tuner simply adjusts the piano so that with the pointer on zero cents, the higher overtones of the bass notes, which appear in rings outside that of the fundamental, give stopped patterns. In this way, he is actually tuning the overtones of the notes to true pitch, not the fundamentals, which will automatically be slightly (and desirably) flat.

In next month's article we shall begin our discussion of tone coloring in electronic instruments. Following that article on this important phase of electronic music we shall present a detailed description of the Hammond organ.

[1]C. G. Conn, Ltd., Elkhart, Ind.

—end—

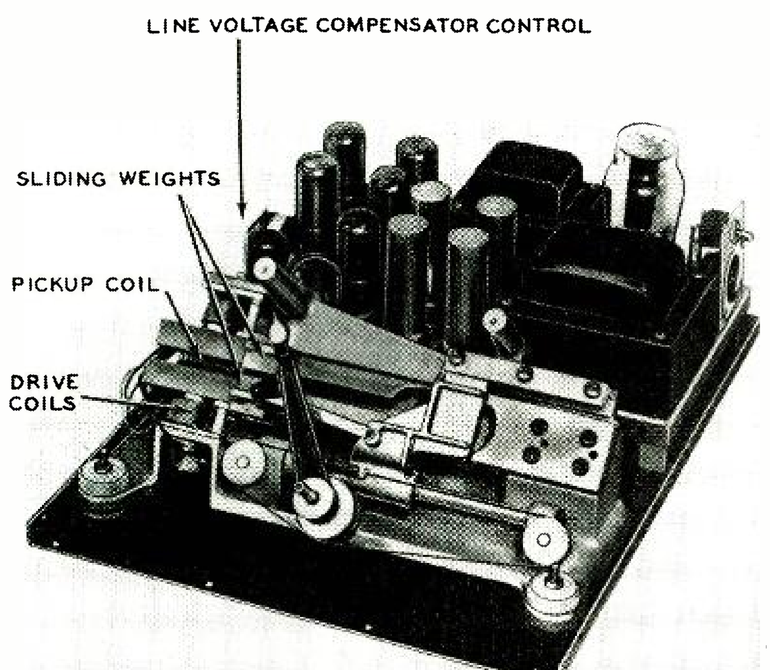


Photo D—The tuning unit. The tuning control slides weights on fork.

Rico Amplifier Operation

Hi-Fi operation obtained only by proper adjustment of three channels

By
JACINTO SUGRANES

Home Installation showing professional appearance of the Rico amplifier

THE circuits of the three-channel Rico amplifier were discussed in some detail in last month's issue. Now let's look into the adjustment and operating procedure for getting the best results from the amplifier.

The first step, once the circuits are wired up and in working order, is to adjust the bias on the three pairs of output tubes. This is an important adjustment, because the 2A3's are fairly sensitive to changes in bias, and any unbalance in any of the three pairs will introduce distortion. Furthermore, this balance should be checked at frequent intervals. This is not difficult, because the metering circuits are all built in.

Fig. 1 shows the phase inverter and push-pull output stage of one of the three channels. The other two channels are identical except for the values of the components marked C1 and R1, and these have no effect on the adjustment procedure.

The bias is adjusted by setting potentiometer R3 until the plate currents of the two tubes are equal. Switch S1 back and forth between positions 1 and 2 until the meter readings for these two positions are equal. Actually the meter reads the voltage drop across the two halves of the output transformer winding and not the plate currents. The d.c. resistance of the two windings therefore must be equal, as is usually the case with the better output transformers. In the Rico amplifier, pilot lamps are connected to a second deck on the meter switch, so that a lamp indicates which plate circuit the meter is measuring. Colored jewels for these lamps can be selected in color pairs to make identification easier.

If the two halves of the transformer winding are not equal, the balance can be checked by measuring the plate current of each of the tubes. This can also be arranged by switching, but a somewhat simpler method is to install closed-circuit jacks in each plate circuit and plug in the meter to the circuit being measured. The meter should have a 100-ma full-scale deflection, as the normal plate current of each tube in this circuit is about 50 ma. A third way to check the bias is to measure the voltage directly from grid to cathode, but this requires a vacuum-tube voltmeter and therefore is not as easy to build in. The method described is adequate.

The bias for the 2A3's is developed across the 720-ohm resistor in series with each filament, half of the 160-ohm potentiometer R3, and the series filament string made up of the 12AH7's and the 12SC7 shunted by the 250-ohm resistor. The bias on each of a pair of 2A3's cannot be varied independently of the other, and R3 is used only to balance the pair. If for any reason the bias is not correct for the tubes when balanced, it must be adjusted by changing the value of the 720-ohm resistors in the filament circuits until the combined current for each pair of 2A3's is about 100 ma. This will change after use, and should be checked.

A 1-ma meter need not be used in the

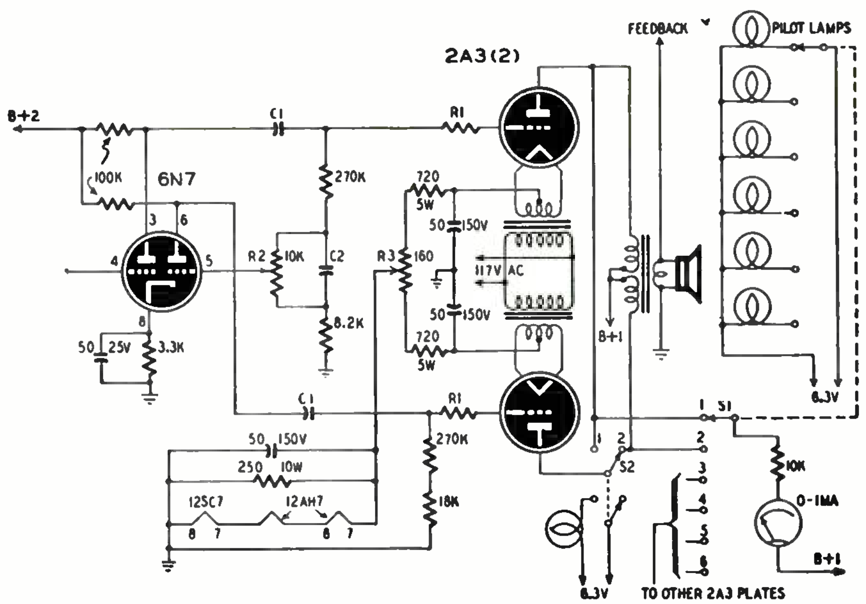


Fig. 1—Phase inverter and push-pull output stage of one channel.

plate metering circuit, as almost any unit of less than about 500-ma full-scale reading will do. It is necessary only to adjust the resistance in series with it so that normal plate current produces a reading well up on the scale. The actual value of the resistance is not important, as the meter is used only as a comparator and not to obtain actual values.

Phase inverter setting

For good push-pull operation, the voltage supplied to the output tube grids must not only be 180° out of phase, but must also be equal in amplitude. Phase inversion in this amplifier is adjusted by the potentiometer R2. The inverter itself is simply a dual triode in which a fraction of the output of one section is fed to the grid of the other.

To adjust the inverter, set switch S2 to position 1. This connects the two plates of the output stage in parallel, so that if the signals on the two grids are equal and 180° out of phase, the amplified signal on the plates will be cancelled. Then adjust R2 until the signal is no longer heard at the speaker. Any convenient signal source may be applied to the amplifier input. Almost any record that is convenient may be used. This adjustment must be made for each of the three channels, and the other two channels must be silenced during the operation. Once the phase inverter is balanced, lock the controls securely and switch S2 back to position 2. S2 also controls a pilot lamp which indicates which position it is in. The phase inverter adjustment is fairly stable and normally needs no resetting unless the inverter tube or the output tubes are changed.

Each channel has its own volume control. These are used to adjust the over-all balance among the three channels. All except the tin-eared can usually do a good job of this by using a record as a test signal. Use a good quality record, preferably a familiar piece with full orchestra. This method is perhaps better than using an audio oscillator at the input, because the frequency ranges at the output overlap, and the only simple way to get an over-all response curve would be to use a calibrated microphone near the speakers.

These individual volume controls can be used as tone controls, but it is better to leave them alone once they are adjusted. Separate tone controls are provided in the treble and bass channels (R3 and R8 in complete schematic, June issue).

Two gain controls are used in the amplifier input circuit. One is the usual potentiometer type, the other a compensated gain control. The potentiometer is adjusted so that the maximum signal which can be expected at the input will not overdrive the amplifier. This can be done by playing a loud record while making the adjustment. The compensated volume control is used as the general control. It keeps the balance between highs and lows regardless of how softly the amplifier is played.

While the large number of controls on this amplifier give it an unusual degree of flexibility, they also make the adjustments somewhat more complicated. The correct setting for each of the controls depends on the setting of the others, so that some trial and error will be necessary to get the best results. But the discriminating music lover should get many hours of enjoyment from this amplifier.

—end—

Universal Hi-Fi Preamplifier

By M. G. O'LEARY

THE recommended G-E reluctance pickup preamplifier is designed to start boosting the bass at a turnover point of about 780 cycles. This turnover is a good average for American 78-r.p.m. records, but where the recorded turnover point is as low as 500 cycles, the bass may be excessive. London ffrr 78-r.p.m. records and most other European 78-r.p.m. pressings have a turnover of around 250 to 300 cycles. Many of these are superb recordings but they sound atrocious on our reproducers with the high bass-boost point.

The recommended G-E preamplifier can easily be modified to give a variable bass turnover point at the cost of a selector switch and a few paper capacitors. In Fig. 1 the assembly shown within the dotted lines replaces the usual .01-µf capacitor in series with the 33,000-ohm resistor and ground. The table shows the values. The 2.2-megohm resistors may be used to prevent switch clicks. The switch itself should be of the shorting type.

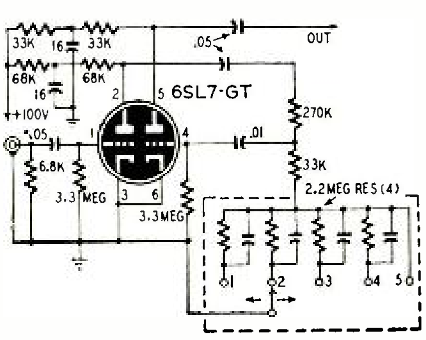


Fig. 1—Variable bass turnover circuit.

Most American records will sound best at position 1, but some will sound better at positions 2 or 3. European recordings will probably be most satisfactory at positions 3 or 4. LP's will probably sound best on positions 1 or 2. Position 5 is optional and is only included where the amplifier might be used with a low-level microphone.

Position 5 might be substituted by a 2-megohm variable resistor to provide for a variable bass boost. However, this is not recommended, as the amount of boost provided without it is normally required, and, if anything, more than this amount of boost may be necessary to compensate for amplifier and speaker shortcomings or low-level playback. It seems logical to use the equalization in the preamplifier to equalize the recording characteristics. Another stage in the amplifier proper can be designed to boost the bass to compensate for the other factors. Otherwise compensation in the preamp stage only, to be flexible enough to compensate for all records at many reproducing levels, would be extremely complicated.

The additional bass-boost stage is shown in Fig. 2. The 2-megohm variable control gives a variable boost from flat to about 18 db at the very low frequencies. C1 should be found by experiment. If the amplifier and speaker have a good bass response, C1 at .01 µf will probably best equalize for the apparent loss of bass due to low-level playback. With poorer speakers and less expensive amplifiers, other values of C1 may give better results.

Finally, if the amplifier and speaker system have a good treble response, one

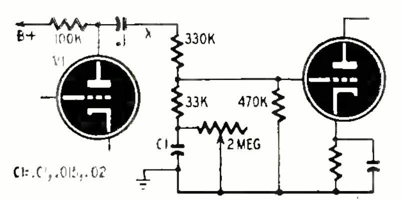


Fig. 2—Additional bass-boost stage.

of the standard tone controls consisting of a plate bypass capacitor in series with a variable resistor can be added to control the excessive brilliance of reproduction resulting from the treble-pre-emphasis in the recordings. Here again the capacitor value can best be determined by experimenting. If such a control is added at point X in Fig. 2,

Table of RC Values

Switch Position	Capacitor Value (µf)	Bass Turnover Point (Cycles)
1	.01	780
2	.015	500
3	.02	390
4	.025	310
5		flat

use .015 to .02 µf if V1 is a low-mu triode. This should give a treble turnover of approximately 1,000 cycles.

—end—

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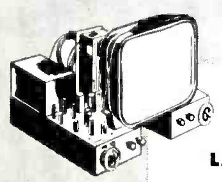

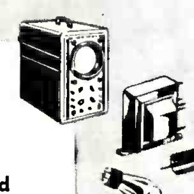

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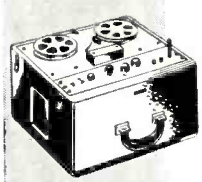

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Radar Tracks Shooting Stars

Using radar echoes, the speeds of meteors coming from outer space are recorded at 100,000 miles per hour

By PROF. A. C. B. LOVELL and J. G. DAVIES*

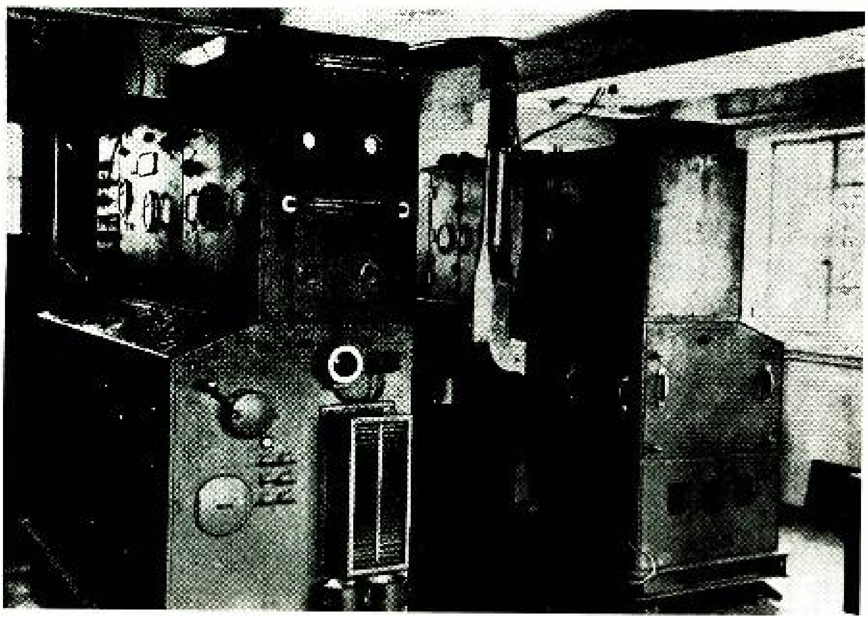


Fig. 1—Search transmitter at Cheshire, England, uses ex-army radar equipment.

METEORS, or "shooting stars," are tiny pieces of stone or iron which rush into the earth's atmosphere at speeds thousands of times faster than an express train. Fortunately for us they get very hot by friction in the highest layers of the atmosphere and burn up. They rarely penetrate lower than about 50 miles above the earth's surface. In this process of evaporating they leave a trail of light several miles long.

Until recently the visual or photographic study of these meteor trails was the only way to obtain information about them. Although they could not be observed in daylight, and although their study was severely handicapped by cloud or bright moonlight, we knew that 100,000 millions of these pebbles were pouring into the earth every 24 hours. We also knew that occasionally the earth rushed through an extraordinary concentration of this debris, producing what is known as a meteor shower. But in spite of more than 100 years of observation the astronomers do not know for certain where these vast numbers of pebbles come from.

During the last few years radio has been used to study these meteors and several of the outstanding problems are beginning to be solved. In this article we shall describe some of the basic radio techniques which are now in use.

*Jodrell Bank Experimental Station (University of Manchester) Cheshire, England.

Meteor detection by radio

When the meteor burns away in the high atmosphere it leaves behind for a very short time a dense trail of electrons, as well as the streak of light by which we see it. This electron trail enables us to detect the meteor by radio. The fundamental process is very simple. A radio wave sets the electrons in the trail into vibration, and while they are oscillating they reradiate a small amount of the energy in the incident radio wave. This energy will travel back toward the earth, and if we have a sensitive enough receiving set, we can detect these radio waves which are scattered from the trail. Both pulse and c.w. methods are used. The frequencies used are generally higher than 20 mc. otherwise one gets trouble from the reflections from the ionized E and F regions, and the results are difficult to interpret.

There are many more faint meteors than bright ones. Thus the more sensitive the apparatus the more meteors will be detected. For example, in a pulse equipment, using a peak transmitter power P, an aerial with a power gain G, a receiver note factor ε, and a wavelength λ, it can be shown that the faintest meteor detectable will depend on:

$$G\sqrt{\frac{P\lambda^3}{\varepsilon}}$$

In this article we shall first describe a pulse apparatus working on 72 mc in which the transmitter power and receiver sensitivity were such that the number of echoes seen corresponded very closely with the number of meteors which could be seen by a single visual observer on a clear night.

72-mc pulse apparatus

In this apparatus—now in use at the Jodrell Bank Experimental Station in Cheshire, England—an ex-army radar transmitter forms the basis of the meteor transmitter shown in Fig. 1. The transmitter consists of an oscillator stage with two British Service tubes, type VT-98 triodes (Fig. 2). These run

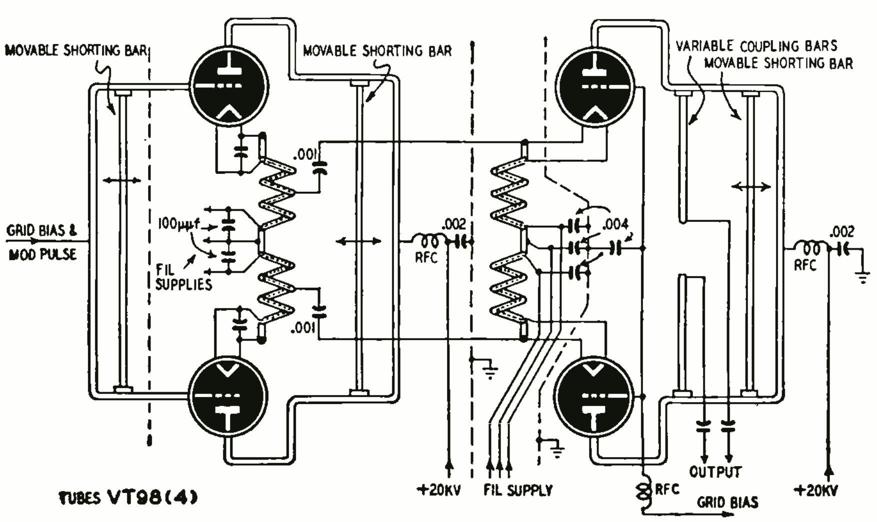


Fig. 2—Radar transmitter circuit has 50-kw output with 8-microsecond pulses.

at 20 kv on the plates and are tuned with resonant lines in the plate and grid circuits. The oscillator is cathode-coupled to a grounded-grid amplifier stage of two similar tubes, and the output is tapped off the plate lines. This transmitter gives a peak power of about 50 kw for 8-microsecond pulses at a repetition frequency of 600 pulses per second. The filament supplies are fed to the cathodes via coaxial ("unity-coupled"—*Editor*) chokes, which also act as coupling transformers.

The receiver is a normal superhet with grounded-grid triodes in the first two stages to give maximum sensitivity. The i.f. is at 10 mc, and has a bandwidth of 1 megacycle. Negative pulses can be applied to the suppressors of three of the five i.f. tubes to suppress the receiver during the transmitter pulses, and to blank out unwanted echoes from the local hills.

Both transmitter and receiver are connected to the same aerial system with a spark-gap switching arrangement. Sometimes a simple dipole aerial is used, but more often it is the array of Yagi elements mounted on an old army searchlight shown in Fig. 3. This gives a beam of ±10 degrees width, and can be pointed at any part of the sky. The output of the receiver is displayed on an A-scope display, which can be seen in Fig. 4. It also goes to an automatic recorder which will be described later.

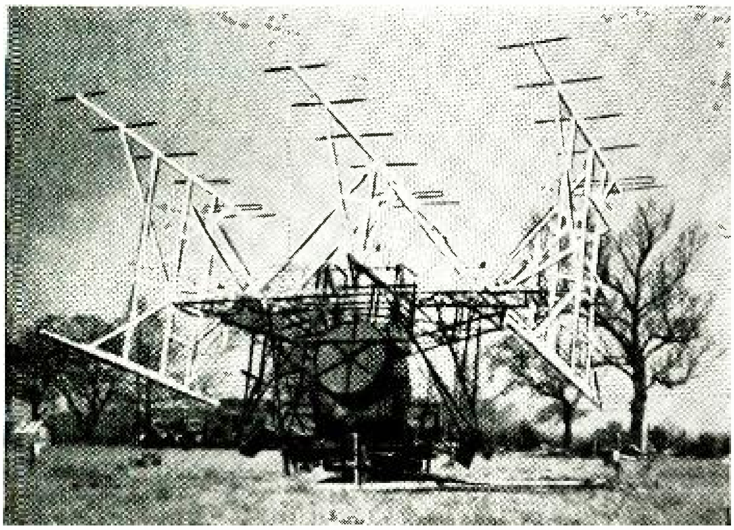


Fig. 3—A Yagi antenna mounted on army searchlight scans sky.

A photograph of a typical echo from a meteor trail is shown in Fig. 5. The number of meteors seen with this apparatus is close to that seen by a visual observer under good dark sky conditions, and is normally from 2 to 10 per hour. When the showers occur the hourly rate rises to 50 or 60 for several nights in succession. During a remarkable event on October 10, 1946, it increased by 5,000 times to 160 per *minute* between midnight and 3:30 a.m. On this occasion the earth passed close to the Giacobini-Zinner comet, and was bombarded for six hours as it crossed the orbit.

In similar piece of equipment on 73 mc, two fixed beamed aerials are used, each consisting of six Yagi elements, shown in Fig. 6. The signals from these two aerials are fed separately into two intensity-modulated displays and photographed on a continuously moving film. An echo from a long-duration meteor trail on this apparatus is shown in Fig. 7. The pulses are doubled for easy identification of the short-duration echoes against the noise background.

Such radio techniques enable observations to be made in daylight. Through this ability some striking discoveries have been made. The apparatus described above has been used at Jodrell Bank since 1946, and a remarkable sequence of intense meteor showers only active during the summer daytime was discovered in the summer of 1947.

Measurement of velocities

Perhaps the greatest hindrance to rapid progress in the study of meteors has been the very great difficulty of measuring the speed with which they enter the atmosphere. Since they are travelling at a speed of nearly 100,000 miles per hour, it is not surprising that this measurement has been hard to make. Without an exact knowledge of the speeds of meteors it is not possible to decide where they come from—nor even to decide whether they are all localized in the solar system or whether some come from interstellar space. It was therefore important to develop radio methods for velocity measurement. The one to be described was developed at Jodrell Bank and has been in regular use since 1947 for measuring these high velocities.

The radio echo seen on the apparatus described above comes from the completed electron trail of the evaporated meteor. The velocity recorder works by studying the echo from the trail *while it is being formed.* The apparatus measures the speed with which the electron trail is made. While the trail is being formed there are intensity fluctuations in the echo returned to the receiver which are exactly analogous to the fluctuations in the light near the edge of a sharp shadow on a screen—the familiar optical phenomenon known as diffraction. The fluctuations in amplitude to be expected as the meteor passes the per-

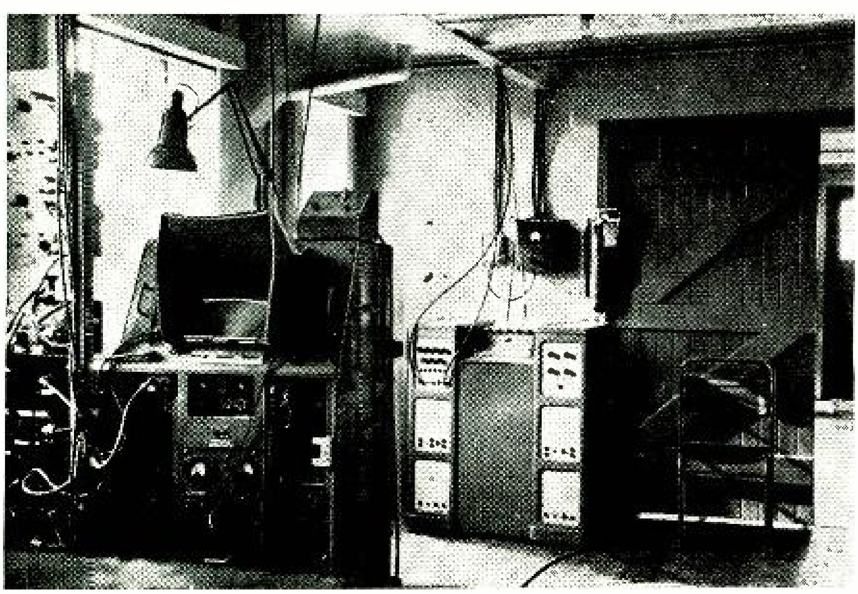


Fig. 4—Receiver at Jodrell Bank site is viewed on A-scope unit seen here.

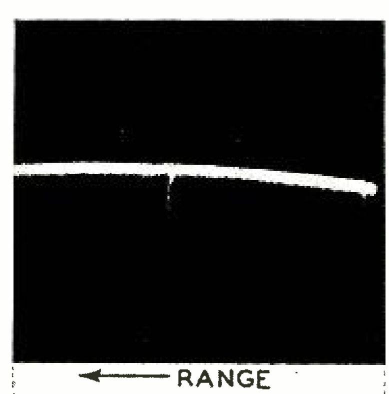


Fig. 5—A picture of a meteor trail.

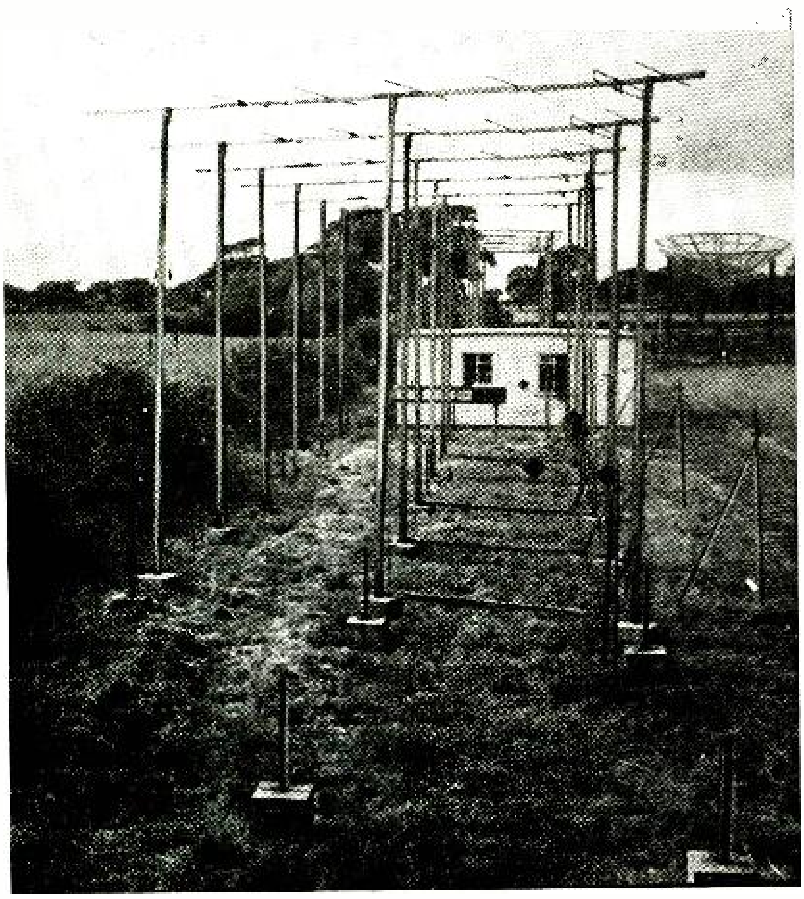


Fig. 6—Two fixed beam antennas are used on 73 mc, each having 6 Yagi elements.

pendicular point from the station to the trail are shown in Fig. 8. The horizontal spacings OA, OB, OC, etc., can be shown to be $1.2\sqrt{R\lambda}$, $1.9\sqrt{R\lambda}$, $2.3\sqrt{R\lambda}$. λ is known, the range R can be measured on an A-scope display. Hence if we can measure the time T_{AB} for the trail to form from A to B etc., then the velocity of the meteor is given by: AB/T_{AB} etc. The great difficulty is in measuring these time intervals. If

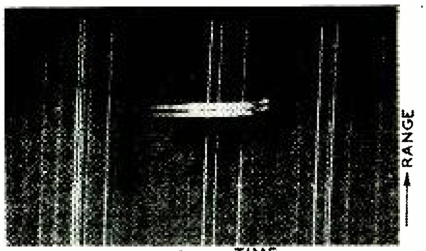


Fig. 7—Long duration meteor trail echo.

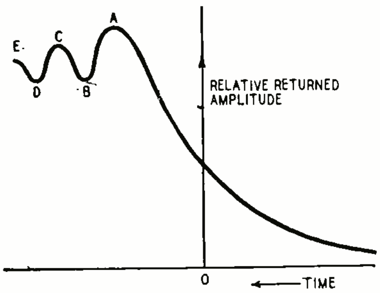


Fig. 8—Meteor position amplitude curve.

typical values, $\lambda = 4$m, $R = 300$ km, are inserted, we see that OA is only about 1 km. But an average meteor is moving at about 40 km per second, hence the time interval between O and A is only of the order of 0.025 seconds or 25 milliseconds.

In the velocity recorder, which can be seen in Fig. 4, photographs are taken of two cathode-ray tubes, each with a single-stroke time base. One time base lasts for about 10 milliseconds, and is used to measure the range of the meteor by standard radar methods; the second time base lasts for 0.1 seconds, and displays the first 60 echo pulses received side by side. A photograph of these pulses appears in Fig. 9. The time bases are triggered simultaneously, by the first echo pulse received that is greater than a given amplitude—about twice the receiver noise level. The transmitter is pulsed at 650 pulses per second, so that the separation between pulses is 1-5 milliseconds. Thus the time intervals between the maxima and minima can be measured with great accuracy.

The recorder unit

A block diagram of the recorder is given in Fig. 10. The output from the receiver is fed to the cathode-ray tubes via an amplifier, and is also used to trigger the time bases via the discriminator unit. This unit is required to separate the echoes from impulses caused by atmospherics or ignition systems. Its operation will be described in detail below, and a schematic of the discriminator unit appears on page 54.

In addition, a set of relays is triggered from the discriminator. This flashes a light onto a clock, recording the time of occurrence, and, after the photograph has been taken, operates the camera motor and resets the instrument for the next echo. The direct signal from the transmitter, and the echoes from ground sources nearby, are removed by suppressing the receiver for the period during and immediately after the transmitter pulses.

The discriminator operates on the duration of a single echo pulse. This is equal to the transmitter pulse length, and is about 8 microseconds, while the duration of a single noise impulse is determined by the receiver bandwidth and is 2 or 3 microseconds.

The circuit diagram is given in Fig. 11, and the waveforms in Fig. 12. Tubes V1, V2, V3-a, and V4 form an a.v.c. amplifier with cathode follower output, the receiver noise at the cathode of V3-a being about 20 volts peak-to-peak, and positive in sign. V5 is a limiter stage, with about -20 volts bias on the grid. Hence it is normally cut off, but begins to conduct as soon as any signal rises much above the noise level. Grid current limits the signal at about twice the receiver noise level, producing waveform B (Fig. 12) on the plate of V5. V7 comprises the discriminator stage, in effect an infinite impedance detector circuit, and a cathode follower, the output from which is shown at C in Fig. 12. On the leading edge of the pulses, the first half—originally only passing about 150 microamperes—is cut off, and the cathode falls at a rate determined by its stray capacitance. On the return stroke, however, the tube conducts heavily, and hence returns very rapidly to its original potential. This is important, as interference caused by ignition systems frequently consists of a train of impulses with very little interval between them, and such interference could be confusing.

The effect of this circuit is first to reduce all impulses to the same amplitude, and then to give them an amplitude that depends on the duration

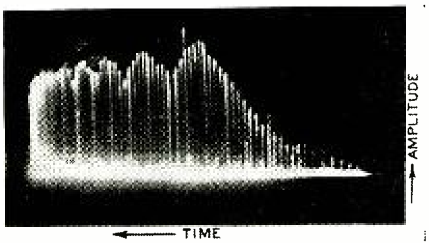


Fig. 9—Recorder unit time base photo.

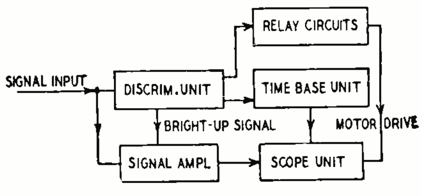


Fig. 10—Recorder unit, block diagram.

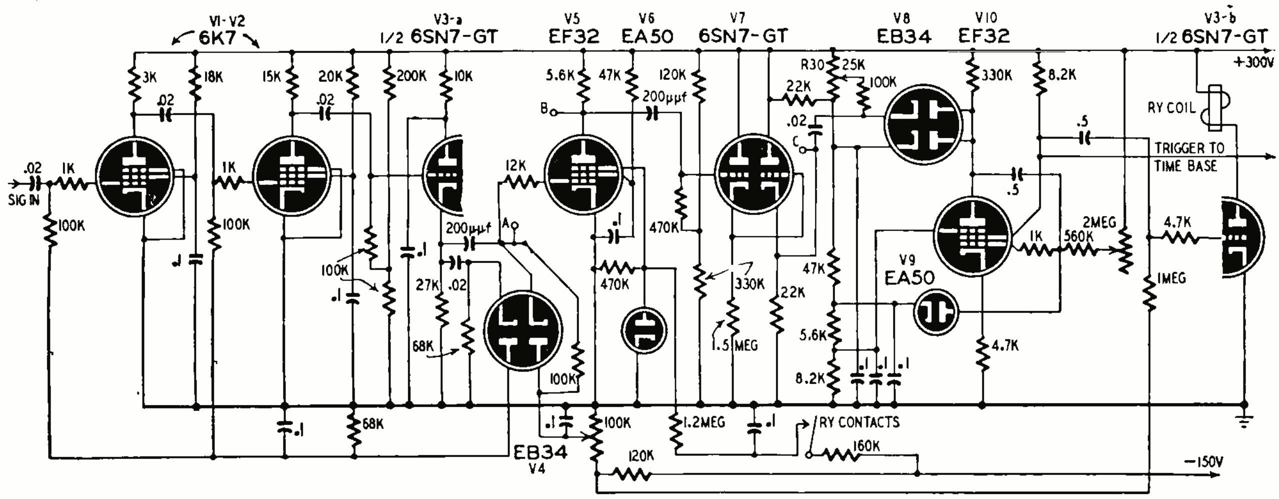


Fig. 11—The discriminator unit which detects the meteor echo pulses and passes them to the camera relay circuits.

of the pulse. The remaining circuit consists of a phantastron set to trigger on pulses greater than a certain duration (set by R30) which triggers the time-base circuits, and operates the relay coil RY. The contacts on the suppressor grid of V5 are closed by the relays, and prevent the circuit being retriggered until the camera is reset.

Many thousands of meteor velocities have been measured by this type of recorder, enabling great progress to be made in some of the fundamental problems of meteor astronomy.

Great use has been made by workers at Ottawa and Stanford of c.w. techniques for special purposes. For example, if c.w. is used, the above diffraction photographs appear as continuous records and more zones can be measured. This is especially true if the reflected wave from the trail is allowed to beat with a local ground wave. In this case the fluctuations can be seen before the perpendicular point O (Fig. 8), since a local reference phase is available be-

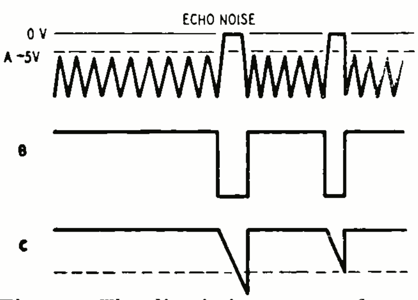


Fig. 12—The discriminator waveforms.

fore the perpendicular reflection takes place. Of course the range of the meteor has to be measured by using a subsidiary pulse apparatus. Incidentally these c.w. fluctuations can be heard as the so-called Doppler whistles, since the period of the oscillations lies in the audible range. Such whistles have been picked up by amateurs and can be heard easily if they can tune to an unmodulated carrier at several miles distance on a frequency of about 20 or 30 mc.

In this short article we have concentrated on describing some basic techniques used in the radio observation of meteors. The results obtained during the past few years have revolutionized the science of meteor astronomy. The work is also of very great interest in physics, since a new tool now exists for studying the conditions in the high stratosphere, and invaluable data is being obtained about such diverse subjects as upper atmosphere wind motions and the processes of ionization.

—end—

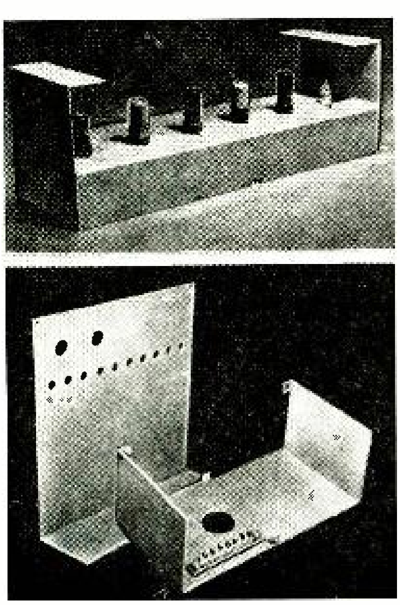
AN EXPERIMENTAL CHASSIS

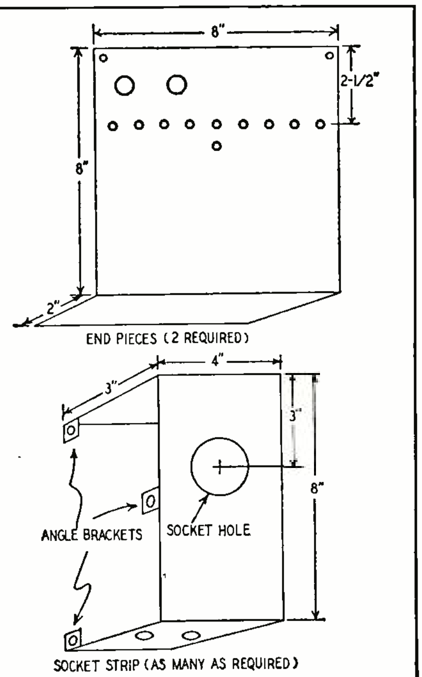
Like most ardent experimenters, I never seemed to have a chassis which was punched just right for the circuit I happened to be building at a particular moment. Tiring of using the same old battered chassis for every experiment, I developed two small basic units from which larger chassis can be constructed. This setup has the following advantages: (1) Socket holes are always where I want them; (2) wiring can be systematic with easy access to A-, B-, and ground leads; and (3) the chassis can be used for breadboard experiments or for a finished product.

The drawing shows the shapes and sizes for the basic units. The U-shaped socket strip is punched in the top for a socket and in one side for two potentiometers or similar controls. An eight-point mounting strip is located close to one side of the socket strip to support power leads which run the length of the completed chassis. Each socket strip has three small angle brackets on each open side. These brackets are aligned so the strips can be bolted together or to the end pieces.

The end pieces have 10 holes for mounting pilot lamps, insulated jacks, plugs, terminals, and rotary switches. Two additional mounting holes are provided for toggle switches. The bend in the end pieces makes a steady support for the chassis when upside down.

The photos show an amplifier constructed on the chassis and the end piece and socket strip.— *Otto von Guericke*





How an Electronic Brain Works

Part X—The product of two binary numbers.

By EDMUND C. BERKELEY* and ROBERT A. JENSEN

IN THE two previous articles we discussed how a brain built around electronic tubes can store information, add, and subtract; and we drew up schematics for an adder and a subtracter (RADIO-ELECTRONICS, June 1951, page 39).

The basic components which are required for an electronic brain have been labeled as we have indicated in the table below:

Symbol	Name
A	an AND circuit, or gate
O	an OR circuit, or buffer
E	an EXCEPT circuit, or inhibitory gate
nP	a delay line, delaying pulses for n pulse times
F-F	an electronic switch, or flip-flop

Now let us see how we can use these components to design an electronic multiplier, which can multiply two binary numbers together and give the product.

A circuit which will multiply is shown in Fig. 1. It contains 17 components, which are connected by lines bearing arrows, along which pulses travel in one direction. This circuit has seven input lines, numbered terminal 1 to terminal 7, and one output line, num-

* Author: *Giant Brains*, John Wiley & Sons, Inc.

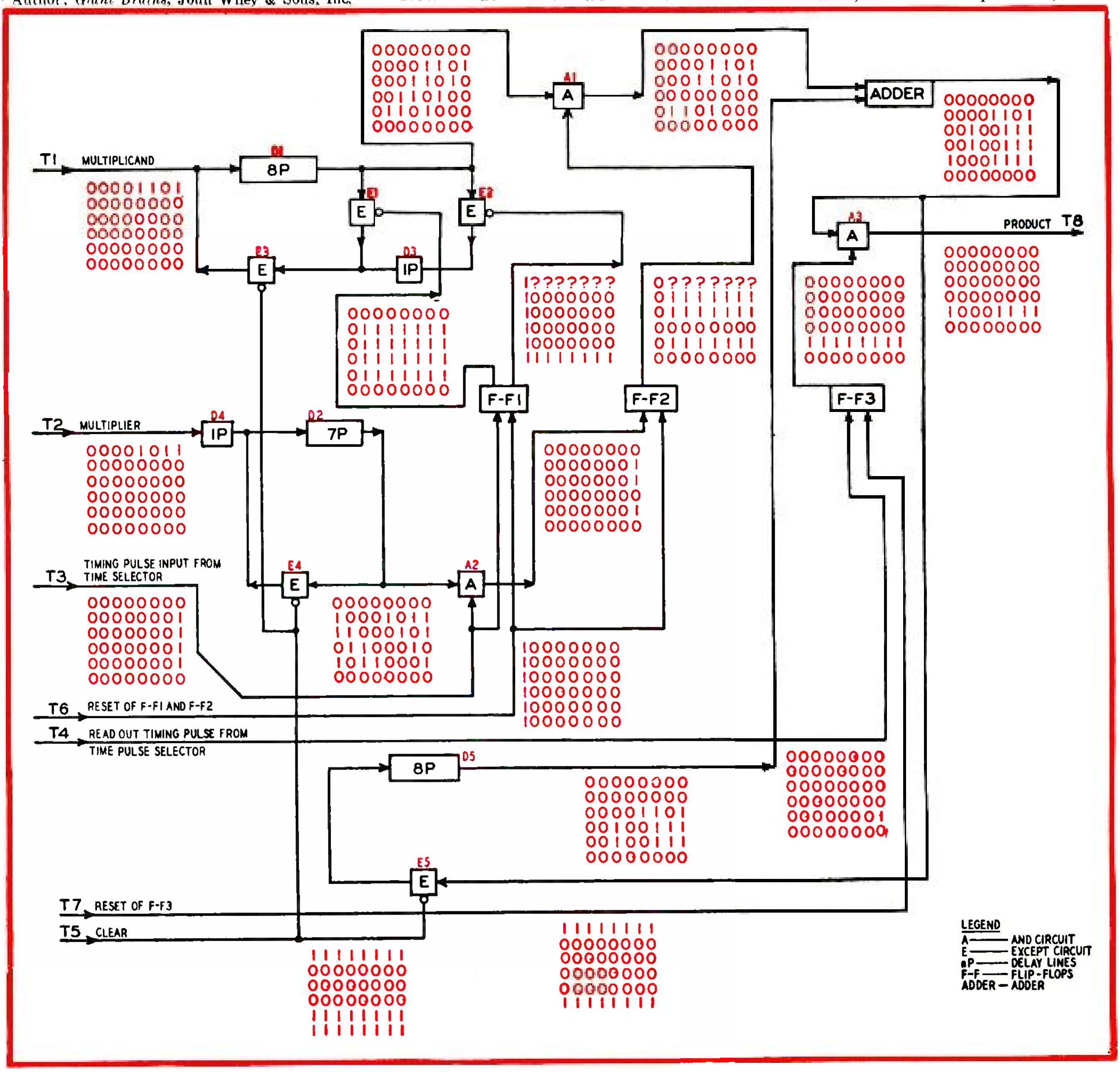


Fig. 1—This multiplier circuit has 17 components. There are 7 input lines and 1 output line where the product appears.

bered terminal 8. The result of the multiplication, the product, comes out on the output line, and the two factors of the multiplication, the multiplicand and the multiplier, come in on lines T1 and T2.

All information travels through this circuit in pulses serially along one line, and so the scheme of the circuit could operate for binary numbers as large as 50 or 100 digits, just by altering the length of the delay lines. To explain the circuit operation, we shall assume that we are going to multiply two four-digit binary numbers. We shall multiply binary number 1101 (one-one-oh-one, or one eight plus one four plus no two's plus one one, or thirteen) by the binary number 1011 (one-oh-one-one, or one eight plus no four's plus one two plus one one, or eleven). The answer will be 10001111 (the sum of 128, 8, 4, 2, and 1, or 143, which of course equals 13 times 11). Since the answer will be eight binary digits long it is convenient to specify that the multiplier circuit operates in six machine cycles, each handling eight pulses corresponding to eight binary digits. The reason for eight pulses is obvious; that for six cycles will appear later.

This example of multiplication, by the way, is the same example worked out with relays that was discussed in the December, 1950, article of this series, Part III. The comparison of the multiplication there using relays and the multiplication here using electronic tubes is instructive, if any reader cares to look it up.

In the first cycle, the multiplicand 1101, in the form of a series of eight pulses, or a binary number, 00001101, enters along line T1. The number shows the timing of these pulses *represented in order from right to left, the earliest pulse being at the right.*

Note well that on any line where the direction arrow points to the right, a regular binary number will represent pulses in the proper time sequence. We have avoided writing binary numbers, or series of pulses, on lines directed to the left because the sequence of pulses and the regular way of writing digits in the number would be opposite. For later cycles, we write the binary numbers of eight digits one under another. This helps to see without difficulty the pattern of as many as 40 or 48 consecutive pulses.

The series of eight multiplicand pulses go into the 8-pulse-time delay line D1, and they will accordingly issue in cycle 2 as 00001101, and apply for admission at the door of AND circuit A1, EXCEPT circuit E1, and EXCEPT circuit E2.

FLIP-FLOP F-F1 controls admission to the EXCEPT circuits E1 and E2. Because of the pattern of reset pulses (see later discussion) coming to this flip-flop, the EXCEPT circuit E1 is inhibited, while E2 is not inhibited. Consequently, the pulses go through E2, and through the one pulse-time delay line D3, through the noninhibited EXCEPT circuit E3, and round the loop through D1 again. As a result, *the multiplicand is shifted, to the left one digit* and the output from the delay line D1 of the numbers applying for admission to the AND circuit A1 is therefore as follows:

Cycle	Number
1	00000000
2	00001101
3	00011010
4	00110100
5	01101000
6	00000000

In the first cycle also, the *multiplier* 1011 enters as a series of pulses 0000-1011 into the one pulse-time delay line D4 and the seven pulse-time delay line D2, and goes round the loop through delay line D2 in such a way that there issues from the loop the following numbers:

Cycle	Number
1	00000000
2	10001011
3	01100010
4	11000101
5	10110001
6	00000000

The first digit is carried around to the eighth digit's place by D2 and E4 in each cycle. Because the delay line is only 7 pulses long it advances the pulses one step. In cycle 3, for instance, we no longer have the number 1011 at the right-hand side, but 101, the other one having been attached to the end (left side) of cycle 2, where it replaces the zero that would otherwise be there. The *first* digit in any one of these numbers, in the sequence in which they pass through the circuits, is at the *right*, and the *last* one at the *left*. This follows our regular practice in adding or multiplying on paper, but not in writing down figures. These numbers now continue and apply for admission at the door of AND circuit A2.

The other line going into AND circuit A2 is line T3, called "timing-pulse input from time-pulse selector," and the pulses (or numbers) that come in on this line are as follows:

Cycle	Number
1	00000000
2	00000001
3	00000001
4	00000001
5	00000001
6	00000000

These are standard pulses and would accordingly apply for any four-diget multiplier.

Their purpose is, we shall see later, to allow a single digit of the multiplier to go through the AND circuit, and the timing is such that just the proper digit of the multiplier is allowed to go through the AND circuit.

Now an AND circuit performs the operation of "both," i.e., logical multiplication, operating digit by digit, pulse by pulse. Consequently, the numbers that issue from the AND circuit are the logical product, according to the following very simple table, of the numbers coming in:

	0	1
0	0	0
1	0	1

So the numbers (or pulse series) coming out of AND circuit A2 are now:

Cycle	Number
1	00000000
2	00000001
3	00000001
4	00000000
5	00000001
6	00000000

The output of AND circuit A2 leads to the "set" side or left side of FLIP-FLOP 2. The "reset" side or right side of FLIP-FLOP 2 receives a series of reset pulses (see later discussion) as follows:

Cycle	Number
1	10000000
2	10000000
3	10000000
4	10000000
5	10000000
6	10000000

These are the two inputs of the flip-flop. So what comes out?

A flip-flop conducts on one side and not on the other side, depending on the last pulse that has come in on either side. Specifically:

Input: Last Pulse Received on Left Side	Right Side	*Output:* Conducting on Left Side	Right Side
1	0	1	0
0	1	0	1

The operation of a flip-flop is ambiguous, not defined, if the last pulse comes in simultaneously on both left and right sides. So before any inputs are acceptable to a flip-flop there must be no cases of 1 and 1 occuring at the same time.

Applying this rule we can calculate the output of FLIP-FLOP 2 as follows:

	Input		*Output*	
Cycle	Left Side	Right Side	Left Side	Right Side
1	00000000	10000000	0???????	1???????
2	00000001	10000000	01111111	10000000
3	00000000	10000000	01111111	10000000
4	00000001	10000000	00000000	11111111
5	00000001	10000000	01111111	10000000
6	00000000	10000000	00000000	11111111

Wherever we see a zero on one side of the flip-flop output, we must see a one on the other side. This is merely equivalent to saying that one side or the other, but not both sides, of the circuit are conducting at any given time.

We may note that the output of the right side of FLIP-FLOP 2 is not used in this circuit, but is available and might be useful somewhere else in the computer. The output of the left side, however, goes to AND circuit A1 and is there very useful. The flock of 1's on cycles 2, 3, and 5 allows the shifted multiplicand to go through A1 in the case of the first, second, and fourth multiple, and this is precisely what we want. Furthermore, the fourth multiple of the multiplicand will never be more than 7 digits, and so the change of the flip-flop at time 8 in each cycle does not interfere with the multiples of the multiplicand.

ADDER at cycle 2 takes in the first multiple of the multiplicand, adds it to 0 coming in on the other line, and passes it around the loop through the noninhibitory EXCEPT circuit E5 to the partial sum register, the 8 pulse-time delay line D5. One cycle later this first multiple comes out, going to the adder. But now it is matched in time (cycle 3) with the second multiple, and the adder produces the sum of the two of them, and

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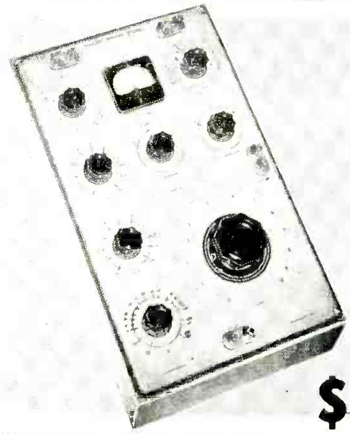

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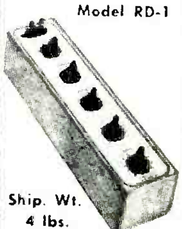

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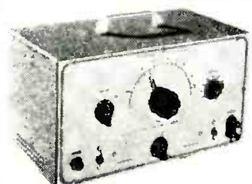

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sends that around the loop to the partial-sum register again. In this way, the multiplication proceeds by successive addition of selected shifted multiples, and a breakdown of the problem will then appear as follows:

Multiplication	Partial Sum at Cycle
1101	
× 1011	
1101	2
+ 1101	
= 100111	3
+ 0000	
= 100111	4
+ 1101	
= 10001111	5

We must now get the final answer 10001111 out of the circuit into some other part of the machine where we can make use of it. We use FLIP-FLOP 3, operating it with a "readout timing pulse from the time selector" on the left side as follows:

Cycle	Number
1	00000000
2	00000000
3	00000000
4	00000000
5	00000001
6	00000000

together with a reset pulse on the right side of the flip-flop will then be as follows:

Cycle	Number
1	11111111
2	00000000
3	00000000
4	00000000
5	00000000
6	11111111

Here is where—and why—we need a cycle 6 in the multiplier circuit: to be certain that no stray pulses come out on the output line after we have received the product. The output of FLIP-FLOP 3 accordingly will then appear as follows:

Cycle	Number
1	00000000
2	00000000
3	00000000
4	00000000
5	11111111
6	00000000

This is the input on one side of the AND circuit 3. The other input coming from the adder is:

Cycle	Number
1	00000000
2	00001101
3	00100111
4	00100111
5	10001111
6	00000000

and as a result it may be seen the output is:

Cycle	Number
1	00000000
2	00000000
3	00000000
4	00000000
5	10001111
6	00000000

In order to clear the multiplicand, the multiplier, and the partial-sum registers, the EXCEPT circuits 3, 4, and 5 are used. The input to all of them comes in on line T5, and is in the usual listing, as follows, and after this the multiplicand, the multiplier and partial-sum registers are ready for new signals.

Cycle	Number
1	11111111
2	00000000
3	00000000
4	00000000
5	11111111
6	11111111

In the same way, to reset the flip-flops, the input of standard pulses from the time-pulse selector is as follows:

Cycle	Flip-Flop 1 and 2	Flip-Flop 3
1	10000000	11111111
2	10000000	00000000
3	10000000	00000000
4	10000000	00000000
5	10000000	00000000
6	10000000	11111111

The circuit is, of course, a block diagram. To convert it into working hardware, a good deal of attention will have to be given to the shape of pulses, the precise detailed timing of them, microsecond delays due to the length of cables along which they are traveling, etc. Descriptions or circuits of the components inside the blocks were given last month.

It should be emphasized once more that there are many ways in which the circuit can be improved, or otherwise designed. Some improvements will doubtless occur to readers of this article.

For example, F-F1, E1, and E2 can be avoided if we give up optional storage of the multiplicand unchanged in register D1; that is, if we make sure that the multiplicand and the multiplier do come in simultaneously to the multiplying circuit. Actually, in a serial computer it will be more convenient to have the multiplicand come in at one time and wait in the multiplicand register until the multiplier is ready and comes in at a later time. The circuit in Fig. 1 has provided for this second more convenient scheme.

Acknowledgment is made to Henry W. Schrimpf for many of the features of the multiplying circuit in this article.

Division

If we replace the adder by a subtractor, and put in some kind of circuit for comparing the divisor with the partial remainder from successive subtractions, and in still other ways modify the circuit of Fig. 1 so that we can use the method of dividing that was illustrated in Part IV (January, 1951) of this series for a relay computer, then we can design a division circuit for binary numbers.

But divisions do not occur as often as multiplications. Studies made some time ago in the Harvard Computation Laboratory indicated that a division occurred once for about every fourteen multiplications. So why spend money on equipment for division, which you may use less than 8% of the time, if we can get division some other way?

You can get the result of dividing the number M by the number K if you multiply M by the *reciprocal* of K, which is 1/K. And you can get the reciprocal 1/K by a process using multiplication. First, find some kind of reasonable first approximation X_1; second, use the following formula over and over:

$$X_n = X_{n-1} \times (2 - KX_{n-1}).$$

It can be shown that a reasonable first approximation X_1 is any number between 0 and 2/K.

For example, suppose that we want to find 1/3, which we know is equal to .33333 to five decimals, and suppose that we start off with a guessed first approximation .5. Then:

$$X_1 = .5 \text{ (guess)}$$
$$X_2 = .5\,[2-3(.5)] = .25$$
$$X_3 = .25\,[2-3(.25)] = .3125$$
$$X_4 = .3125\,[2-3(.3125)] = .33203$$
$$X_5 = .33203\,[2-3(.33203)] = .33333$$

Thus we can get a fine result with just a few steps in multiplication. We can have our computer carry out division by programming our computer. We yield time; we save equipment. Over and over again this kind of compromise occurs in computer design. Division by successive multiplication, with special circuits for sensing good first approximations (which saved on the number of multiplications necessary), was the process built into the Harvard Mark II computer, now at the Naval Proving Ground, Dahlgren, Va.

This kind of scheme for use in automatic computers was first proposed, we believe, by Prof. Howard H. Aiken of Harvard.

(continued next month)

AUTOMATIC-FOCUS KINE

New picture tube with built-in-automatic focus has been announced by Du Mont. It eliminates the need for a focus coil, a focus control or other focusing methods used in magnetic and electrostatic kinescopes.

The new tube, the 17KP4, is an all-glass rectangular, magnetic- deflection, electrostatic-focus tube, with a gray-filter face plate and an external conductive coating. It is designed to work with an anode voltage of 16,000 and a maximum negative bias value of 125 volts.

"Left, I said! Wassamatter, aren't you tuned in?"

5-Tube Superhet Fits Pocket

Featuring big set performance, this subminiature receiver was built with hearing aid methods

By W. D. PENN

Photo of the little set. It uses five tubes for full coverage of AM band.

MIDGET radio receivers have always aroused a great deal of interest. Back issues of RADIO-ELECTRONICS reveal many ingenious receivers designed to be carried by the listener. However, to the author's knowledge, none of these has been a true *pocket* radio receiver and at the same time having such desirable features as the following:—Complete coverage of standard AM band with a calibrated single dial control; no external antenna; complete self-contained unit of light weight, batteries included, in one small case; long and economical battery life; and high-fidelity response.

Techniques and components originally developed for hearing aids, together with the use of powdered iron core tuned r.f. and i.f. circuits make all these features possible.

General design

The set is a five-tube superheterodyne, using a germanium diode second detector. All five tubes are Raytheon type CK522AX pentodes. These are low-drain filamentary type hearing-aid tubes which operate with a 1¼-volt filament supply and a 22½-volt B supply. A single mercury cell such as a Mallory RMB-4 or Sprague S16A is used for A-supply. Plate and screen voltages are provided by a 22½-volt hearing-aid B-battery such as Eveready No. 412-E or its equivalent.

Total filament current for the five tubes is 100 ma and total B-current is approximately 1.5 ma. With these current drains, the A-battery gives about 40 hours use and the B-battery lasts slightly longer. The total cost per hour of operation will average around 3 cents; a quite reasonable figure.

The set consists of one r.f. stage followed by a converter, two i.f. stages, a germanium diode second detector, and transformer-coupled a.f. amplifier. Fig. 1 shows the circuit. Iron-core tuning is used in both the r.f. and i.f. sections of the set for greatest compactness.

The input of the r.f. amplifier and the oscillator portion of the converter are tuned by a single slide-rule type dial which is calibrated from 550 to 1600 kc. The i.f. is 455 kc. A hearing-aid type potentiometer in the grid circuit of the a.f. amplifier is used for volume control and also includes the ON-OFF switch. A.v.c. is applied to the r.f. stage and the two i.f. stages.

All electrical components are of the subminiature type. Capacitors are of the "micro-size" variety, using ceramic dielectric to obtain minimum size for a given capacitance. In addition, ceramic capacitors are more reliable than paper types under extreme conditions of temperature and humidity. Resistors are ⅓-watt units, 3/32 inch in diameter and ¼ inch long.

Signal pickup is obtained directly from the r.f. input coil. Although there is some directive effect with this method of pickup, it is not nearly so sharp as with loop antennas. The input coil is tuned with an iron core mechanically connected to the tuning core of the oscillator coil. The plate load of the r.f. stage consists of an untuned choke coupled to the converter stage through an R-C network.

The only available subminiature converter tube, the type 2G21, has a B drain of 1.5 ma at 22½ volts and an A drain of 50 ma at 1¼ volts. These drains are much too heavy for satisfactory battery life. Consequently, instead of using a standard converter circuit, a modified form of autodyne circuit is used with a single pentode tube used as both oscillator and mixer. The oscillator section consists of a tuned plate circuit which is coupled to a bifilar winding in the filament leads. The r.f. signal is fed to the control grid and the i.f. component is obtained by placing the i.f. coupling coil in the screen circuit.

Each i.f. coupling impedance is a single parallel-tuned circuit instead of the usual coupled-circuit type. The coil is placed in a powdered-iron cup which increases the inductance and shields the coil from other components. Moveable iron cores passing through the center of the cups tune these coils. For frequencies above the i.f. of 455 kc., the impedance of the parallel resonant i.f.

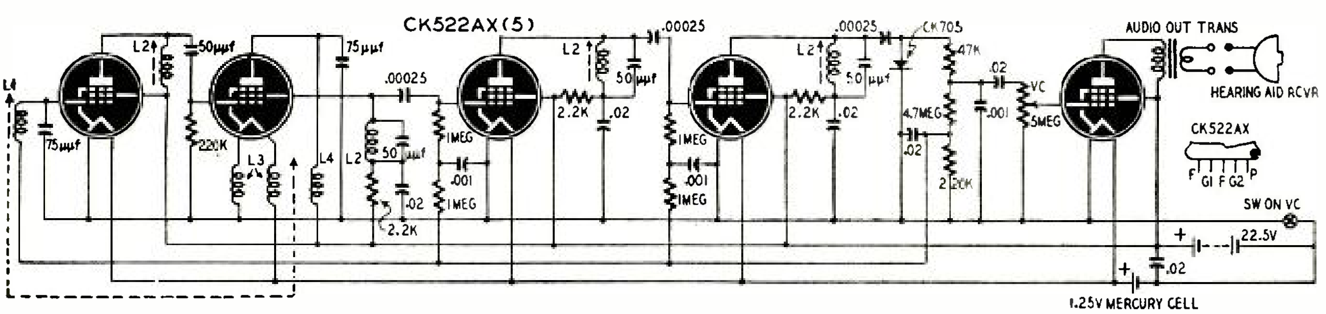


Fig. 1—Circuit of the receiver. It is a complete superheterodyne with a.v.c. and uses five subminiature pentode tubes.

coils is capacitive and bypasses the screen for r.f. signals. The r.f. coil L2 is also placed in a cup like that in which the i.f.'s are mounted.

The i.f. cans also hold the resistors and capacitors associated with them, thus tending to keep each stage in a shielded unit.

The output of the last i.f. stage is fed to a shunt-connected germanium diode detector of very small size such as Raytheon type CK705. The shunt type circuit is necessary to isolate the d.c. plate voltage from the detector. The diode second detector feeds a single a.f. stage which is transformer-coupled to a magnetic type hearing-aid earphone. The transformer for coupling the 50-ohm magnetic receiver to the output tube is wound on a core ¾ x 17/32 x 9/32 inches. The turns ratio is 5,000/100 so that the 50-ohm earphone appears as a plate load of approximately

$$\left(\frac{5{,}000}{100}\right)^2 \times 50 = 125{,}000 \text{ ohms}$$

Permeability tuning

The inductance of a coil due to the presence of an iron core is given by the equation:

$$L_1 = L_0 \left(\frac{a}{A}\right)(P-1) + 1$$

in which

a=cross sectional area of iron core,
A=cross sectional area of coil winding,
P=effective permeability of iron core,
L_0=inductance of coil without iron core,
L_1=inductance of coil with iron core.

The effective permeability of the core is a function of the ratio of length to diameter of the core and is best expressed in graphical form. Fig. 2 is a set of curves showing the relation between the effective permeability of cylindrical iron cores and the permeability of the core material itself. These curves were prepared by W. J. Polydoroff, a pioneer worker in the field of permeability tuning. Each of these curves shows the effective permeability as a function of the permeability of the core material for various ratios of core length to diameter, L/D. If the coil and core are not the same length, an additional correction factor is necessary. The true effective permeability is then $P_1 = P(L/l)^{1/3}$ in which L is the core length, and l is the coil length. This is the value of permeability to be used in the equation for L_1 if the coil and core lengths are unequal.

To cover the AM band of 550 kc to 1600 kc requires a tuning range of 1600/550=2.91. Since the resonant frequency of a tuned circuit varies inversely as the square root of the inductance, a change in inductance of $(2.91)^2$=8.5 is required to tune from 550 kc. to 1600 kc. Using a core 0.875 inch long and 0.200 inch in diameter gives

$$L/D = \frac{.875}{.2} = 4.37.$$

With this ratio of L/D and a material with a permeability of 30, Fig. 2 shows that an effective permeability of 11 can be obtained, thus giving a tuning range of 3.32. For an i.f. of 455 kc., the oscillator must then tune from 1005 kc to 2281 kc. a range of 2.26. This corresponds to an inductance change of approximately 5.11. To make the oscillator and r.f. stages track with the same core movement, several schemes can be used. The oscillator coil can be wound differently in shape or size, the iron core can be made a different size or shape, or an oscillator core of different permeability may be used. The latter method is used in this set. For the same L/D ratio of 4.37 and an inductance change of 5.11, Fig. 2 shows that a core with a permeability of about 6 is needed.

Since it is hard to get iron cores of specified permeability or to check the permeability of available cores, it may be easiest to wind two identical coils to cover the broadcast band, on the best core material available. Then turn or file down the oscillator core, checking frequently with a signal generator, till you have the correct range as given above.

The r.f. tuning coil consists of 200 turns of No. 36 enamelled wire wound on thin-walled bakelite tubing ⅞ inch long with an inside diameter of 0.200 inch. The oscillator coil is wound on a similar form. The plate winding has 210 turns of No. 38 enamelled wire wound next to the bakelite form. To obtain optimum coupling between the plate and cathode windings, a cathode winding consisting of a bifilar winding of 200 turns of No. 36 enamelled wire is wound over the plate winding. The three i.f. coils and the coil in the plate circuit of the r.f. stage are alike and consist of 300 turns of No. 32 enamelled wire wound on a 3/16 inch diameter form 1/4 inch long.

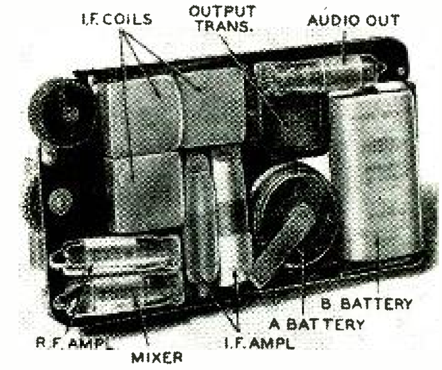
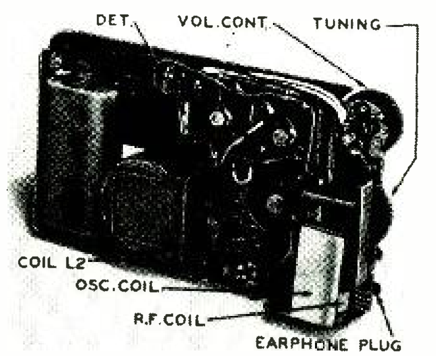


Photo of one side of the bakelite chassis showing how the tubes are mounted.



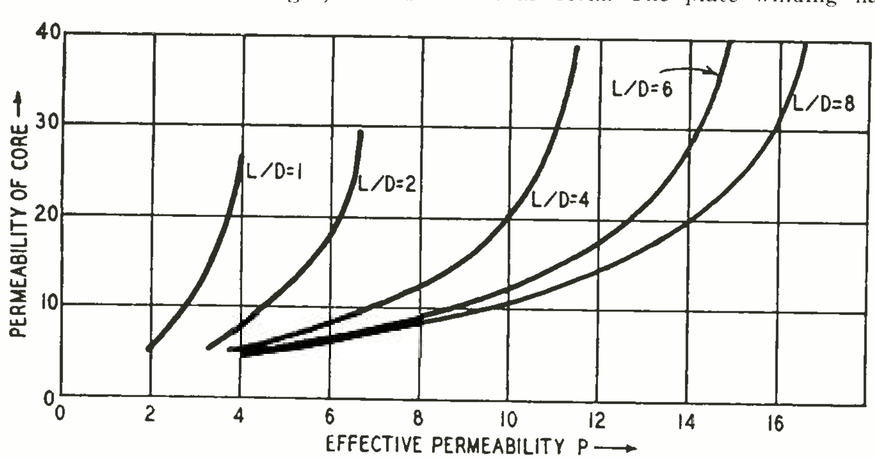
A view of the other side of the chassis which shows the slug tuning mechanism.

Output and fidelity

The power output of the audio stage is about 1 milliwatt, which is sufficient to drive the receiver to a sound level of 120 db above the normal threshold of hearing. The tiny hearing-aid earphone is so small that it may be nestled in the ear without an eartip or other means of support. For the best sound quality, a hearing-aid type molded earpiece should be used.

Some may object to the use of a receiver instead of a loudspeaker as an output device. A loudspeaker, in addition to being much larger in size, would also require more driving power and therefore, larger batteries, thus removing the set from the true pocket-size class.

Actually, a personal pocket radio should not use a loudspeaker, even if it were possible to do so. The advantage of not having one is that you can listen to programs of your own choosing without disturbing others. This is a real advantage in crowded places such as stadiums, etc. In addition, it is possible to get better audio fidelity than can be obtained with even a large loudspeaker.



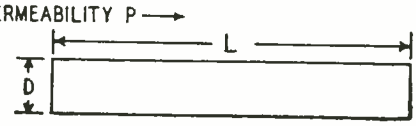


Fig 2—Curves of effective permeability versus core material permeability.

This is so because the receiver, working directly into the ear, radiates into a small closed cavity which provides a fairly efficient load for all frequencies. A loudspeaker radiates into a much larger space and is not efficiently loaded, especially at low frequencies.

The sensitivity and selectivity are good, and reception is reliable in all but the most unfavorable surroundngs.

Construction

Mechanically, the set is constructed of units which are mounted on a bakelite chassis. The two tuning coils are mounted side by side and fastened to the chassis with an adjustable bracket so that the coils can be accurately aligned with the tuning cores. The cores are mounted on a rack which is geared to the tuning knob. Each of the i.f. interstage coupling units is mounted in a metal box which fits into cutouts in the bakelite chassis. Battery contacts, transformer, volume control, and socket for the plug-in receiver cord are all fastened to the bakelite chassis which can be removed as a single unit from the plastic covering case.

Coil Winding Data for Receiver

Coil	Turns	Wire Size (AWG)	Length (inches)	Diameter (inches)
L1	200	36	7/8	0.225
L2	300	32	1/4	3/16
L3	200*	36	7/8	0.300
L4	210	38	7/8	0.225

*100 turns in each half
Use enamelled wire for all coils

The tube sockets are also set into the bakelite chassis and are held in place with cement. The tubes are inserted into the sockets and are bent over so they lie flat against the chassis. This must be done with care so that the glass around the tube leads does not crack.

The photographs indicate the layout of the little receiver. The batteries take up about a third of the space on the chassis, and the rest of the parts are laid out to avoid oscillation. All the wiring is point to point and is kept as simple as possible. This layout has proved excellent and should be followed.

The plastic case which houses the complete unit, including both of the batteries, is 4½ inches long, 2⅝ inches wide and 1 inch thick. The complete unit with batteries weighs 9 ounces. The controls, dial, and plug-in connection for the receiver cord are located at one end of the case for convenient operation while being carried in the pocket. The plastic case is in two sections, the lower section being removable to allow replacement of batteries.

Materials for receiver

Resistors: 3—2,200, 1—47,000, 2—220,000, ohms; 4—1, 1—4.7 megohms, 1/3 watt; 1— 5 megohms, hearing-aid type volume control.
Capacitors: 4—50, 2—75, 3—250 μμf, 3—.005, 6—.02 μf, ceramic.
Miscellaneous: 5—CK522AX tubes; 1—CK705 germanium diode; 1—hearing-aid type output transformer; 1—s.p.s.t. switch on volume control; 1—hearing-aid earphone; 1—1¼-volt mercury cell; 1—22½-volt B-battery; 1—socket for earphone cord; bakelite chassis, hookup wire, assorted hardware.
Note: use smallest sizes obtainable for all parts.

—end—

OPPORTUNITY AD-LETS

Advertisements in this section cost 35c a word for each insertion. Name, address and initials must be included at the above rate. Cash should accompany all classified advertisements unless placed by an accredited advertising agency. No advertisement for less than ten words accepted. Ten percent discount six issues, twenty percent for twelve issues. Objectionable or misleading advertisements not accepted. Advertisements for September, 1951 issue must reach us not later than July 21, 1951

Radio-Electronics, 25 W. Broadway, New York 7, N.Y.

U.H.F. IMPEDANCE BRIDGE

This instrument is a flexible and accurate impedance bridge for measurements at frequencies from 70 to 1,000 mc, an important range for TV and other services. Conductance and susceptance are directly indicated over a range 1 to 400 millimhos. This is equivalent to 1,000 to 2.5 ohms. Unlike conventional l.f. bridges, the calibration readings are independent of frequency, once a single adjustment is set. The instrument is manufactured by General Radio Co. and is known as type 1602-A admittance meter.

The bridge is a junction of five coax arms (Fig. 1). A u.h.f. generator is connected to the rear fitting. At the front is an outlet for a detector. This may be a converter and u.h.f. receiver combination. The other three arms are terminated in a standard conductance, a standard susceptance, and the unknown admittance. The conductance is a 50-ohm resistor. The susceptance is an adjustable stub which is set for one-eighth wavelength for each measurement. Therefore the standard conductance and susceptance are known at every frequency.

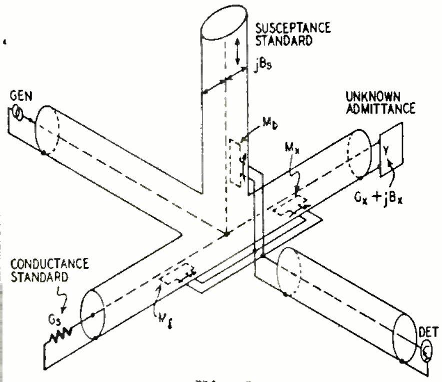


Fig. 1

The detector measures the sum of three induced voltages picked up by the three variable loops (Fig. 1). Each loop has a voltage which is proportional to its mutual inductance and to the current in the line. The right-hand loop picks up a voltage equal to M_xI_x which is proportional to M_x $(G_x + jB_x)$. M_x is set by a pointer which slides along the "multiplying factor" scale. Then it remains only to determine the unknown G_x and B_x.

When the detector indicates balance, the M_x loop voltage is equal and opposite to the sum of the other two loop voltages. Equating resistive and reactive voltages, we find

$$M_xG_x + M_gG_s = 0$$
$$M_xB_x + M_bB_s = 0$$

As noted previously, G_s and B_s are fixed. The mutual inductances M_g and M_b are controlled by pointers sliding along the conductance and susceptance scales. Therefore the unknowns may be calculated or determined directly from the calibrated scales.

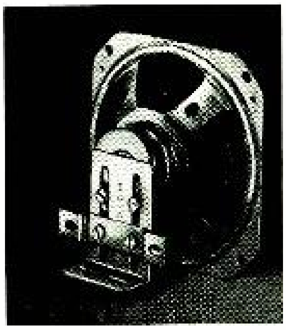
Besides measuring directly in terms of susceptance and conductance, the bridge can be used to match terminations. to lines, measure reflection coefficient, etc.

—end—

UNIVERSAL BRACKETS

Jensen Mfg. Co., 6601 So. Laramie, Chicago, Ill., announces a set of brackets for their Viking line of speaker models from 3½ inches to 6 inches in size.

The unit package is the Viking CTM Universal Bracket Set which is used in mounting speakers to the chassis in small radio repair work, and also provides transformer mounting facilities. A metal clamp strip with channels holds the speaker in position at any predetermined height above the chassis. The transformer mounting bracket



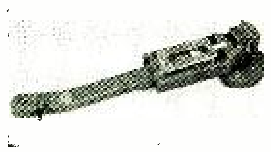
is a separate piece which can be attached several ways to solve most space problems. Included is an illustrated instruction sheet.

TRANSCRIPTION ARM

General Electric, Syracuse, N. Y., announces a professional tone arm, the FA-21-A, designed to mount the G-E variable-reluctance cartridge, RPX-050.

Minimum mass and friction is obtained by using magnesium alloys and cone type bearings. It is designed for lateral transcriptions, and will mount on machines whose dimension from the center of the turntable to the edge of the mounting surface is approximately 15 inches or less.

The stylus is located by an arrow on the arm so that it may be accurately positioned for playback of transcrip-



tons. Adjustable stylus pressure is provided by a precision spring loading system calibrated in ounces and grams.

SENSITIVE METER

Hickok Electrical Instrument Co., 10531 Dupont Ave., Cleveland, Ohio, has developed a high-sensitivity battery volt-ohm-milliammeter with a 5-inch meter and the following ranges: 20,000 ohms/volt d.c., 5,000 ohms/volt a.c. Volts a.c. and d.c.: 2.5, 10, 50, 250, 1,000, 5,000. Output volts: 2.5, 10, 50, 250, 1,000. Milliamperes, d.c.: 2.5, 10, 50,

250, 1,000. Microamperes, d.c.: 0 to 50. Amperes, d.c.: 0 to 10. Decibels: —30 to + 55 in five ranges. Ohms: 0 to 1,000, 5-ohm center scale, 0 to 10,000 50-ohm center scale, 0 to 1 meg., 5,000-ohm center scale, 0 to 100 meg., 500,000-ohm center scale.

The instrument weighs 2¾ pounds and measures 5¾ x 8¾ x 2½ inches. Test leads are furnished.

PLATE TRANSFORMERS

Standard Transformer Corp., 3580 N. Elston, Chicago, Ill., is marketing two new lines of plate transformers, the Stancor PT and PC series. These have insulated leads to provide protected routing to circuit; no exposed terminals; no difficult cutouts needed.

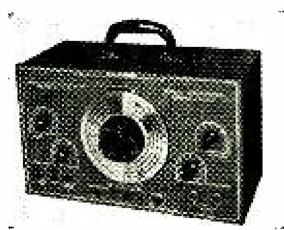
The PT mounting provides a direct

protected path to the anodes of rectifier tubes with heavily insulated high-voltage leads coming out of the top of the transformer. The primary is brought out the bottom for concealed subchassis wiring.

The PC mounting is for units requiring single-ended rectifiers where safety is achieved through all leads being brought out the bottom of the transformer for subchassis wiring.

SIGNAL GENERATOR

Radio City Products Co., Inc., 152 W. 25th St., New York City, is marketing a new wide-range model 706A signal generator which provides continuous coverage of 150 kc to 220 mc. There are eight ranges, including six on fundamental frequencies through 55 mc.



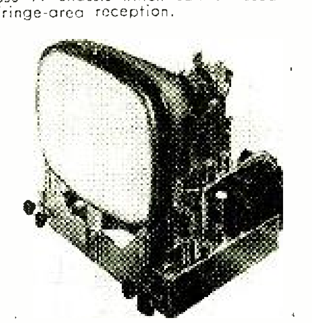
Accuracy is within 1%. Adjustment and recalibration is readily available by air trimmers.

Thorough shielding and stability of calibration is claimed. Modulation is at 400 cycles, with provision for external modulation and variable modulation percentage control.

Other features are high and low r.f. signal output, ladder type step attenuator and 6½-inch dial with vernier tuning.

DX 630 CHASSIS

Video Products Co., Red Bank, N. J., announces a modified version of its 630 TV chassis which can be used for fringe-area reception.



The Super-Video-630-DX contains circuit features which bring its sensitivity up to 4 µv, making it possible to receive good programs in many fringe locations without boosters or complex antenna systems.

T.V. ANTENNA SWITCH

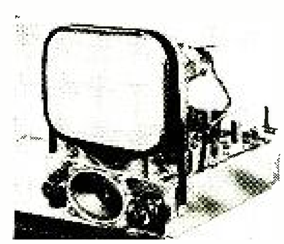
Mosely Electronics, Overland, Mo., announces a new 3-position TV antenna switch that can be mounted inside or on the back of the TV set. It is designed

to supply efficient switching facilities in any TV installation where up to three antennas are used and where installation of a flush type unit is not feasible.

The new unit has a special constant-impedance rotary switch with low-resistance silver-to-silver contacts on high-grade phenolic insulation enclosed in a molded plastic case. Switch positions are clearly marked on the face of the unit. Leads of standard 300-ohm transmission line provide easy connection to set and to three antenna lines. Mounting screws are furnished.

T.V. KIT

Tech-Master Products Co., 443 Broadway, New York, N. Y., has marketed



a budget-priced television kit accommodating up to 14-inch rectangular tubes. The kit features a.c.-d.c. operation, a hi-gain stagger-tuned i.f. system, new 12-channel turret type tuner, a.g.c. system, and 2-knob control providing automatically synchronized picture and sound.

The main chassis is completely "above ground" and convenient test points are located on top of the i.f. Synchro Strip for easy and efficient testing. No further i.f. alignment is necessary since the tuner and i.f. "Synchro Strip come prewired, tested, and aligned. Furnished complete with instructions, components, hardware, speaker, picture tube mounting brackets, and all tubes (less kine).

RECORD CHANGER

Webster-Chicago Co., 5610 Bloomingdale Ave., Chicago, Ill., is introducing its model 106 record changer to replace the model 356. It automatically plays all three speeds of records in all three sizes. No adapter is needed for the 7-inch records.

The velocity-trip mechanism provides jam-free change with minimum record wear. Other features include an automatic needle-set-down point, automatic stop, and muting switch.

All specifications given are obtained from manufacturers' data.

CORD SHORTENER

Coilzit Products, 25-57 Steinway St., Long Island City, N. Y. is marketing a cord shortener which eliminates the need for cutting and splicing. Surplus wire is wound about this device, and up to three feet of electric wire can be held safely.

SMALL MICROPHONE

Shure Bros. Inc., 225 W. Huron St., Chicago, Ill. announce a new small edition of the standard Unidyne dynamic microphone. The small version, model 556 is an ultra cardioid approximately one half the size of the

model 55 and retains all the important directional qualities.

A large air-gap clearance and rugged coil construction plus smooth frequency response and high efficiency are claimed by the manufacturer.

TV BOOSTER

Mark Simpson Mfg. Co., 32 28 49th St., Long Island City, N. Y., has developed a 2-stage booster for poor-reception areas. The Super Sky Chief Booster avoids over loading the TV set by providing a 2-knob control which makes it possible to vary the gain desired.

This booster has eight tuned circuits with uniform gain on channels 2 through 13. It has full 4.5 mc band-width.

Other features include a pilot light.

switch and receptacle for the TV receiver's a.c. plug. In the off position, the switch connects the TV receiver directly to the antenna.

PHONO EQUALIZER

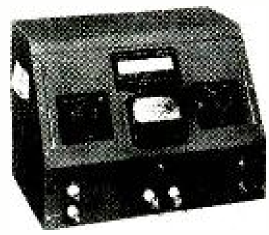
Radio Shack Corp., 167 Washington St., Boston, Mass., is marketing a playback equalizer type HL 1 6, for use with the G E variable reluctance cartridge.

It incorporates a 6-position switch which provides correction for the recording curves used by domestic and European manufacturers of 78, 45 and 33 1/3 r.p.m. records. It is inserted between the pickup and preamplifier. It is supplied complete with wire and plug.

RESISTANCE CHECKER

Clippard Instrument Lab., Inc., 1125 Bank St., Cincinnati, Ohio, announces a high-speed automatic resistance comparator capable of testing as many as 17 resistors per minute for grading or matching or checking factory output.

The PR-5 is housed in a steel cabinet and is completely self-contained. After warmup and zero adjustment, the standard resistor is connected to two terminals and resistors to be checked are placed across the "unknown" terminals.



The 4-inch Weston meter is graduated in percent, and is calibrated in 3 full scale ranges: —5 to +5%, —25 to +30%, and —50 to +100%. Accuracy is better than 1% over entire range from 100 ohms to 100 megohms.

MOISTURE METER

Weston Electrical Instrument Corp., Tagliabue Instruments Division, 614

Frelinghuysen Ave., Newark, N. J., is producing the Tag Moisturonic Moisture Meter, model 8008, for testing the moisture content of materials.

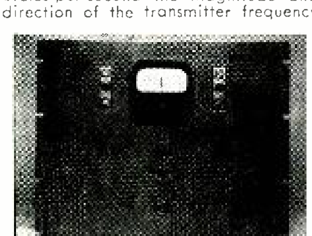
The instrument comes in two forms: one with a scale calibrated for use with lumber, wood, plaster, and wood products, and the other with linear graduations for manufacturers and processors to use in establishing calibration tables for other materials in which moisture content is an important problem.

The instrument can be used with any material capable of accommodating electrode probes. It is portable, with an over-all range of from 2,000 ohms to 20,000 megohms.

FREQUENCY MONITOR

Radio Corp. of America, Engineering Products Dept., Camden, N. J., announces an AM frequency monitor, RCA Type BW-11A, for use in broadcast stations.

The monitor will directly indicate in cycles-per-second the magnitude and direction of the transmitter frequency



deviation from its assigned channel in the range of 500-2,000 kc. It reveals deviation range (readable to 1 cycle) of plus or minus 30 cycles with an accuracy of plus or minus 10 parts per million. Stability is better than 1 part per million. A warning-lamp system indicates failure of either transmitter carrier or monitor crystal oscillator and other features.

ION-TRAP

Indiana Steel Products Co., Valparaiso, Ind., is marketing the E-ZEE-ON ion

trap which can be easily adjusted and which possesses a uniform field pattern.

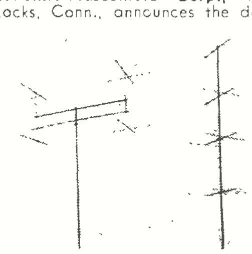
It is made of one piece of permanently magnetized Cunife and requires no manual clamping. It slips onto the tube neck and permits adjustment with one hand.

ELECTRIC KNIFE

Ungar Electric Tools Inc., 615 Ducommun St., Los Angeles, Cal., are marketing the 540 combination knife tip designed for cutting, stripping, and marking plastics and insulation materials. This brass tip is interchangeable with the other tips in the lightweight Ungar handle and cord set and threads onto the heating unit of the 776 Ungar.

DX ANTENNAS

LaPointe-Plascomold Corp., Windsor Locks, Conn., announces the develop-



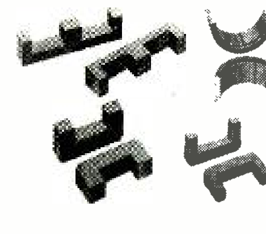
ment of two new methods of stacking the VEE-D-X JC Yagi. Special phasing harnesses are now being manufactured to convert the regular JC Yagi into a horizontal or vertical 4-stacked antenna.

These arrays are designed for long-distance, single-channel reception, with the vertical type recommended for flat terrain and the horizontal type for hilly and mountainous areas.

HI-PERM CERAMIC

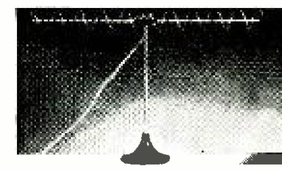
D. M. Steward Mfg. Co., Chattanooga, Tenn., announce production of Lavite ferrites, which combines high permeability with low electrical losses, permitting the reduction of size and weight in electrical products.

This ceramic compound is recommended for use in horizontal output transformer cores, permeability-tuning cores, and in printed circuits from 1 to 200 mc.



SPIRAL ANTENNA

Hi-Lo TV Antenna Co., 3540 N. Ravenswood Ave., Chicago, Ill., is distributing a spiral antenna 20 inches high and 32 inches wide. It is claimed that this design provides good reception of



signals received in areas of high interference. It can be tuned to high and low TV channels. A floor model with metal base is also manufactured.

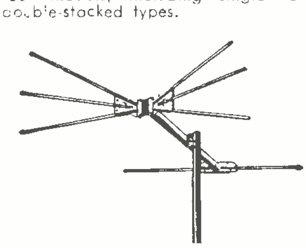
ALUMINUM TOWER

Alprodco, Inc., Kempton Ind., announces production of a large-diameter aluminum tower which can accommodate all popular rotators. A rotator adapter kit is available as an accessory, or an adaptor plate can be purchased separately.

The present model features an increase in strength of 22% over the previous model. Steps are now included as standard equipment.

CONICAL V BEAMS

Telrex Inc., Asbury Park, N. J., is distributing a low-cost Vanguard series of conical V-beams which incorporate the essential features of the standard Telrex models. This series is available in four models, including single- and double-stacked types.

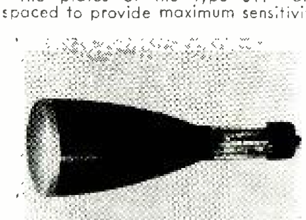


CATHODE-RAY TUBE

Allen B. Du Mont Laboratories, Inc., Instrument Division, 1000 Main Ave., Clifton, N. J. has a new type 5YP-cathode-ray tube, with a deflection factor of 12-Volts per inch deflection for each kv applied to anode No. 2.

It employs an intensifier for increased brightness and smaller spot size, and is useful in wide-band equipment or where high sensitivity is required at low and medium accelerating potentials.

The plates of the type 5YP- are spaced to provide maximum sensitivity



commensurate with distortion-free performance over three inches as the usable vertical scan of the tube.

Input capacitance to the vertical deflection plates is 1.7. $\mu\mu$f.

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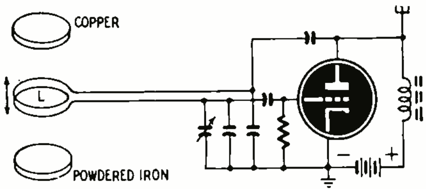
VARIABLE INDUCTANCE PICKUP

Patent No. 2,531,689
Henry L. Kalmus, Chicago, Ill.
(Assigned to Zenith Radio Corp.)

This phono pickup can be made light and compact. The accompanying illustration shows the principle of operation. A small coil L is fixed to the stylus. As the stylus vibrates it drives



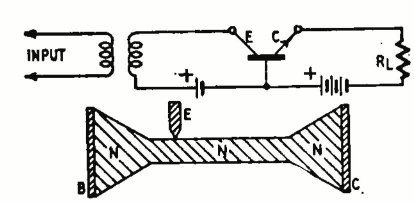
the coil alternately toward the copper disc and the powdered iron. The inductance of L is *decreased* when it approaches the copper, but motion toward the iron *increases* the inductance. These changes provide frequency modulation of the ultraudion oscillator.

The FM wave is transmitted by the antenna and may be intercepted with a nearby receiver. Any type of discriminator converts the wave to audio. The detector may be followed with a.f. amplifier stages to increase the power.

IMPROVED TRANSISTOR

Patent No. 2,502,479
Gerald L. Pearson, Millington and
William Shockley, Madison, N. J.
(assigned to Bell Telephone Labs, Inc.)

A transistor is made of a semiconductor such as germanium to which an "impurity" is added to control the flow of electric charges. When arsenic is added to germanium, it becomes an N-type semiconductor. This means that conduction takes place when the germanium is made *negative* with respect to a metal contacting it. When aluminum is added, the germanium becomes a P-type substance; that is, it conducts when it is *positive* with respect to a metal surface or point contact on it.



This invention relates to improvements over early transistors. The transistor made in accordance with this invention is shown in the figure. It is composed of a long, thin, N-type germanium crystal with enlarged ends. At each end is a metal surface, which may be a film of solder. A tungsten or phosphor bronze point contacts the thin portion.

Positive charges or "holes" flow from the emitter E into the N-type semiconductor. These move toward the negative collector C and away from the positive base B. The long, thin portion of the transistor increases the output impedance, a desirable feature. It also permits more intense internal fields to accelerate the holes, thus reducing heating and transit time effects. A large metal surface contact at C (instead of a point contact) decreases noise.

If desired, a P-type semiconductor stub may be used as emitter instead of the catwhisker. This also reduces noise.

3-DIMENSIONAL OSCILLOSCOPE VIEWING

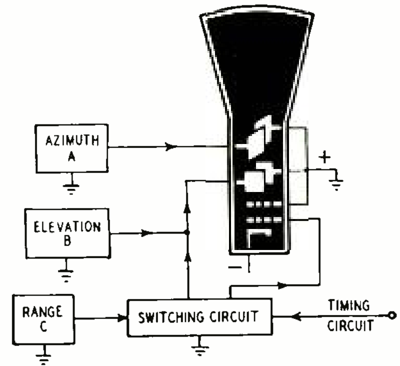
Patent No. 2,541,041
James L. Whittaker, Princeton, N. J.
(Assigned to Radio Corp. of America)

This oscilloscope measures 3 variables simultaneously. Horizontal and vertical positioning of the spot indicates 2 of the variables. The third is measured by the *apparent* distance of the spot from the observer. A stereoscopic method provides depth of vision for this purpose.

This invention may be used to find the azimuth, elevation, and range of a target. In the diagram shown, circuits *A* and *B* have outputs which vary with *azimuth* and *elevation*, respectively. *A* deflects the spot vertically while *B* controls it horizontally.

A third circuit *C* has an output which depends upon the *range* of the target. This voltage controls a switching circuit which deflects the beam to the right and the left alternately. The amount of deflection increases with range. Therefore for each target there is a pattern of 2 spots which appear alternately and whose separation increases with longer range.

Optical or mechanical arrangements may be used to provide stereoscopic viewing. While the spot is deflected to the right, only the right eye is permitted to see it. Then when the spot is in its other position, only the left eye is permitted to view it. When the switching is periodic and rapid there is a sensation of seeing only a single spot which is located some distance from the observer. As the



range increases, the deflection is greater and the spot seems further from the viewer.

To prevent confusion, the deflection trace is blanked out by a suitable voltage applied at the scope grid.

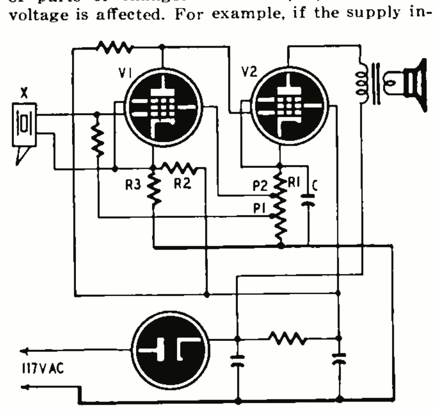
SELF-FOCUSING AMPLIFIER

Patent No. 2,538,488
Walter K. Volkers, Schnectady, N. Y.
(Assigned to Volkers & Schaffer, Inc.)

A direct-coupled amplifier passes low frequencies down to and including d.c. It therefore transmits undesirable drift and fluctuations due to random emission, supply voltage variations, etc. This interference is called defocusing, as it "blurs" the original signal. Defocusing may result in overloading, noise, and distortion. Several self-focusing methods are described here.

The figure shows a crystal phono pickup and a 2-stage d.c. amplifier. The control- and screen-grids of V1 are returned to taps P1, P2 on the cathode resistor R1. By choosing these taps correctly, drift is cancelled out by the negative feedback. The a.c. is bypassed through *C* and cannot be fed back.

The divider R2, R3 is another self-focusing arrangement. If the B-voltage varies due to aging of parts or changes in line input, the cathode voltage is affected. For example, if the supply in-



creases, so does the amplifier gain. However, the increased bias of V1 reduces its gain so there is no defocusing.

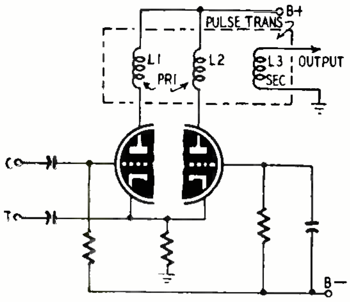
The pickup is shown connected to the cathode of V1 instead of ground. This is done to reduce hum. If it were connected between grid and ground as usual, any ripple across R3 would be impressed across the tube. With the connections that are shown, only a fraction of the ripple is present.

COINCIDENT CIRCUIT

Patent No. 2,538,500

Leon Bess, Boston, Mass.
(Assigned to United States of America as represented by the Secretary of the Navy)

Output is obtained from this circuit only when two simultaneous signals are fed to it. One signal (*T*) must be negative. The other (*C*) may be either negative or positive. *C* must appear simultaneously with *T* to produce output.



Ordinarily both triodes are blocked by the large cathode resistor. A negative *T* unblocks them. Due to symmetry, equal currents flow through L1 and L2. These are similar coils but oppositely wound, therefore no output is induced in L3. When a signal is applied at *C*, greater or less current flows through L1. This destroys the coil balance, permitting output to flow in L3. The phase of this current depends upon whether *C* is negative or positive.

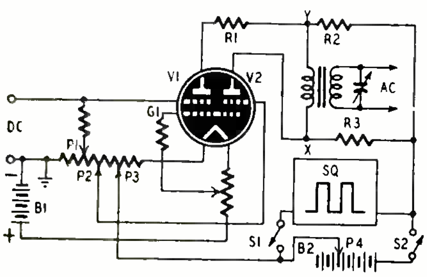
In a practical case *T* may be timing or sync pulses. The circuit does not operate unless *C* happens to coincide with a timing pulse. It cannot operate as a result of noise or interference between timing pulses. If the control pulses *C* are positive, they must be smaller than *T*.

D.C. TO A.C. CONVERTER

Patent No. 2,540,825

James M. Lafferty, Schenectady, N. Y.
(assigned to General Electric Co.)

A direct-coupled stage can amplify d.c. but its gain and stability are not as high as those of a conventional R-C coupled amplifier. It is often better to convert the d.c. signal to a.c. before amplifying. This invention discloses a combination of electrometer tube and square-wave supply. These amplify the d.c., then convert it to a.c. Then the a.c. may be amplified as desired.



The tube may be a G-E type 5675 "split" electrometer. It has two similar sections, V1, V2, with common filament and common space-charge grid G1. The tube is designed for low leakage between elements and to ground. It operates with very low voltages to minimize ionization and noise. G1 neutralizes the space charge around the filament, thus increasing the space current for a given low plate voltage.

The electrometer is in a bridge circuit. R2, R3 are arms of this bridge. The third is made up of V1 in series with R1. V2 is the fourth arm. Tube bias, space charge, and anode voltage are adjustable by means of P1, P2, P3, P4. These are set to balance the bridge with S1 open and S2 closed. Therefore, with zero d.c. signal, no potential difference appears between terminals *X*, *Y*.

Now the square-wave generator SQ is substituted for B2 by closing SW1 and opening SW2. It must have the same amplitude as the battery. With square-wave input, the bridge still remains balanced until a d.c. signal is fed to V1. This changes the resistance of V1 so a voltage appears between *X* and *Y*. This voltage is a square wave like SQ. The a.c. is induced into the secondary of the transformer which is tuned for maximum output. Stages of a.c. amplification can follow.

—end—

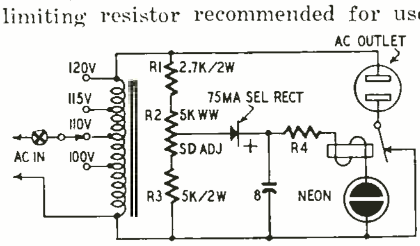
WHEN WRITING ADVERTISERS PLEASE MENTION RADIO-ELECTRONICS

HIGH-VOLTAGE CUT-OUT

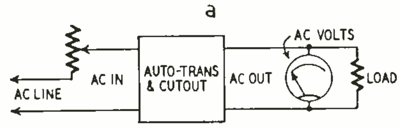
Autotransformers are often used to compensate for variations in line voltage. Some equipment such as a.c.-d.c. receivers are easily damaged when the line voltage rises above normal. Other types fail or work poorly when the voltage is too low.

Described in *Radio Constructor* (London, England), is a novel device which breaks the circuit to the equipment when the voltage rises above a predetermined level. The circuit is shown at *a* in the illustration. In the original circuit—designed for use on 220-volt lines—R1, R2, and R3 are 5,000, 10,000, and 10,000 ohms respectively. The bleeder current is 10 ma or more. The values on the diagram are for 117-volt lines.

A portion of the voltage across the bleeder is rectified and applied to a neon lamp through a limiting resistor R4 and the coil of a relay. When the voltage reaches a given level, the lamp ignites and draws enough current to cause the relay to pull in, thus breaking the supply line to the external appliance. Resistor R4 is the normal current-limiting resistor recommended for use



a



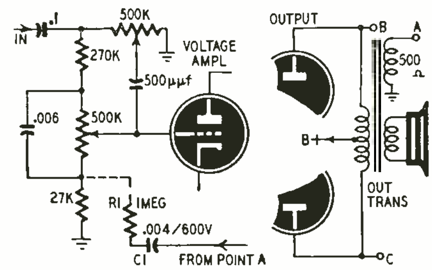
b

with neon lamps. Use the value specified for the lamp you select. The neon lamp can be replaced by 0B3 or 0C3 voltage-regulator tubes. In this case, R4 should limit the current to 30 ma for the 0B3 or 40 ma for the 0C3. The relay must pull in at a current within the range of the neon or voltage-regulator tube. The relay contacts must be heavy enough to handle the current drawn by the external circuit.

To calibrate the unit, use the setup shown at *b*. If the equipment is to operate at 110 volts, set the tap on the transformer and the variable resistor in series with the line so approximately 115 volts is applied to the load. Slowly advance R2 until the neon lamp or voltage-regulator tube fires and opens the relay contacts. Check the setting by turning off the unit to extinguish the lamp, then vary the input voltage between 110 and 120 volts to make sure that the relay always opens as soon as the voltage exceeds 110.

MORE BASS BOOST

Variable bass-boost circuits like that shown in the diagram are widely used in amplifiers and receivers. They usually work well at high volume but are unsatisfactory when the volume is turned down. Additional bass boost can be provided by adding R1 and C1 in an inverse feedback network. Connect the free end of C1 to point A, one side of the 500-ohm winding on the output transformer. If the amplifier oscillates, reverse the connections to this winding. If the transformer has no 500-ohm winding, connect the feedback loop to either of the output plates at B or C. Using either of these connections is



likely to increase the hum level, particularly if the power supply is not highly filtered. Therefore, it may be necessary to install additional filter capacitors and decoupling resistors in the circuit. R1 may be made variable and a switch may be installed to open the loop when maximum output from the amplifier is desired.—*M. Ort*

REMOTE ANTENNA DIRECTOR

A remote direction indicator for rotatable shortwave, FM, and TV antennas was described in *Ohmite Ham News*. An Ohmite type RB-2 direction-indicating potentiometer is installed at the antenna with its shaft connected to the rotating portion of the antenna mast through a 1-to-1 drive mechanism. It is connected to the control box at the receiving position through 3-wire cable. The control switch may be a double-pole unit which has one of its poles connected to control the motor of the rotator.

The meter scale should be calibrated in compass points as shown in the

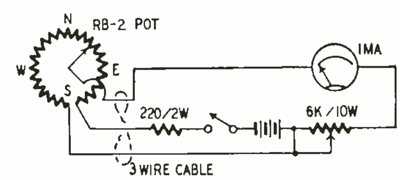
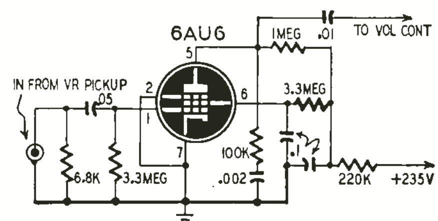


diagram. South is at the ends of the scale and north is in the center. West and east are one-quarter and three-quarter scale, respectively.

PHONOGRAPH PREAMPLIFIER

Most preamplifier-equalizers for G-E variable-reluctance pickups use the now familiar circuit with the triode sections of a 6SC7 connected in cascade. A 6AU6 pentode is used as a phono preamplifier in the G-E model 752 and 753 receivers. This circuit is shown in the diagram.



AUTOMATIC ANTENNA MATCH

Tuned loops, open and shorted stubs, Q-bars, and delta- and T-match systems have been devised for matching transmission lines to antennas to provide a low standing-wave ratio. With these systems, the frequency range is limited to narrow bands and the antenna cannot be operated efficiently on harmonics without making adjustments on the matching system.

This system is devised to match almost any balanced line to antennas having high or very low radiation resistances. It is suitable for feeding rhombics, V-beams, folded dipoles, all-channel TV antennas, stacked arrays, and many other types of antennas requiring 2-wire feed lines. An antenna cut for 80 meters will work equally well on 40, 20, and other harmonics. The only difference is in the radiation patterns.

Two methods of applying the automatic match are shown in Fig. 1. D1 is equal to the spacing between conductors of the transmission line, and D2 is just enough spacing to prevent voltage breakdown. In receiving and low-power transmitting antennas, D2 may be the insulation of two wires taped together. For transmitters of 500 or 1,000 watts, D2 may be approximately 3/8 inch. We have used 72-ohm coaxial cable for the quarter-wave section. The inner conductors were connected to the antenna and the outer conductors connected to the transmission line. In this case, D2 is the spacing between the conductors of the coax, and D1 is adjusted so the outer conductors present the same impedance as the transmission line. In other tests, the matching section consists of No. 12 wires taped together with 3/4-inch spacing between pairs to match 300-ohm ribbon. For other open-wire lines, the matching sections should be made of wire having the same diameter and spacing as the transmission line.

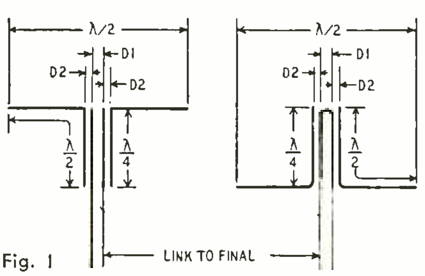


Fig. 1

This system has been used to feed antennas having up to six reflectors. The only necessary adjustment was trimming the radiator and matching section. Rhombic and V-beam antennas are matched by cutting two legs long enough to include an additional one-quart " wavelength at the lowest usable frequency.

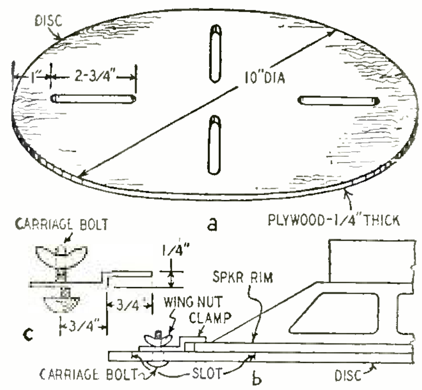
The standing wave ratio of an antenna cut for 200 mc dropped from 3:1 at 150 mc to 1:1 at 200, then rose slowly to only 1.6:1 at 250 mc. This shows clearly that antennas cut for the lowest frequency can be used at considerably higher frequencies.—*A. L. Munzig*

—end—

PROTECTING SPEAKER CONES

Most service technicians have accidentally punctured a speaker cone at one time or another while working on a set or carting it to or from the shop. Although such accidents are rare, there is always a chance that it will happen on your next servicing job. A simple protective cover will prevent this and make it less likely to drop bits of solder, metal filings, and dirt between the voice coil and pole piece.

For speakers from 4 to 8 inches in diameter, cut a 10-inch disc from ¼-inch plywood or similar material. Draw two lines at right angles through the center. With these lines as centers, begin 1 inch from the rim and cut four slots 2¾ inches long as at *a* in the figure. They should be just wide enough to pass the square shank on the head of a small carriage bolt. When you finish the slots the disc will look like a lathe faceplate. Make four clamps from strap iron (see *b* in the drawing) and drill holes to pass the shafts of the bolts.



The disc is fastened to the front of the speaker by four small Z-shaped clamps slipped over the shafts of the bolts and held against the rim of the speaker with the wing nuts. The slots grip the shanks of the bolts and prevent them from turning while the nuts are being tightened. (see drawing at *c*.)

For speakers ranging between 8 and 15 inches in diameter, cut the disc at least 17 inches in diameter. The slots should be approximately 4¾ inches long and should start about ¾ inch from the rim.—*Francis Robbins*

BUILT-IN ANTENNA FOR FM

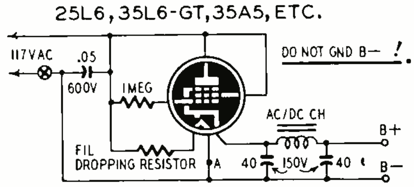
To install a built-in antenna on FM receivers and tuners simply replace the standard line cord with a flexible, rubber-covered, three-wire cord. Connect two of the conductors to the power supply and line plug. One end of the third wire connects to the antenna terminal, and the other end is cut to approximately 6 feet and taped.

If a three-conductor cable is not available, take a 6-foot length of insulated wire and tape it to the power cord with cellophane tape.

The third wire has some direct pickup plus additional pickup through capacitive coupling to the line. The system is used by some commercial receivers. This type of antenna can be used with AM sets as well, if the signals override the static on the line.—*Arthur Trauffer*

B-SUPPLY USES OLD TUBES

The next time you start to hook up an experimental power supply and find that you don't have a suitable rectifier, look around and see if you can find a 25L6, 35L6-GT, 50B5, or similar output tube that is weak or not being used.



The circuit shows how these tubes can be connected as half-wave rectifiers. The filament-dropping resistor should be selected to supply the correct voltage to the heater or heaters. Other tubes can be connected in series and inserted at *A* on the diagram.—*M. G. Williams*

BRUSH FOR SPEAKER CEMENT

Some makes of speaker cement do not have a brush or applicator built into the bottle cap. Consequently, the brush always gets hard and must be discarded. I prevent this by drilling the bottle cap to pass the handle of a small metal-handled glue brush. The handle is then soldered solidly to the cap with an air-tight joint. The tip of the brush will not harden because it is immersed in cement when not in use.—*Manuel E. Silva*

TRANSMITTING-TUBE CHECK

You can tell when your transmitting tubes are going sour if you will make a note of the plate-current readings of new tubes for a given load and plate voltage with the transmitter operating normally. When a tube starts to lose emission, the plate current will begin to drop off from its former fixed value and its output will be less. Class B modulators are checked by watching for a decrease in the static plate current. A gassy tube will cause a higher-than-normal plate-current reading.—*Norris C. McKamey*

LONGER LIFE FOR METERS

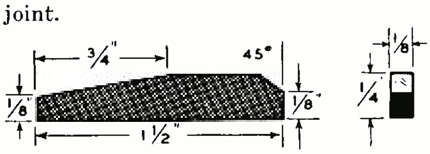
The life and accuracy of the sensitive movement of a 20,000-ohms-per-volt multimeter can be prolonged by keeping the function switch set to A.C. VOLTS whenever the meter is being carried on outside jobs. Setting the meter to read a.c. voltage damps the meter movement by shunting it with the low resistance of the instrument rectifier. This damping action greatly reduces pivot wear caused by bouncing while in transit. This fact can be verified by setting the meter to DC VOLTS and giving it a quick jerk. The meter will swing wildly upscale. Try an a.c. range and note how much the needle is damped.

The meter can also be protected against vibration and sudden jolts by setting the function switch to a high current range. This damps the movement by loading it with the current shunts. This method is not recommended. The meter will burn out if you forget to switch the meter before measuring voltage.—*Milton Kalashian, W1NXT*

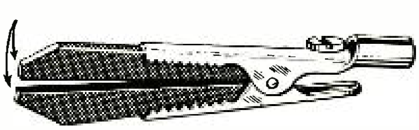
THERMAL SHUNT

While studying the effect of heat on the value of resistors and other components used in electronic equipment, the Telecommunication Research Establishment, a branch of Britain's Ministry of Supply, found that small composition resistors can be ruined by heat when using standard soldering techniques. The heat from the soldering iron may cause the value of the resistor to increase or decrease by 20% or more. *The body temperature of the resistor should be restricted to* 100° C *and preferably* 50° C *if permanent change in the initial value is to be avoided.* In most cases, the temperature rise does not reach the critical value when the length of lead between the body and soldered joint is at least ½ inch.

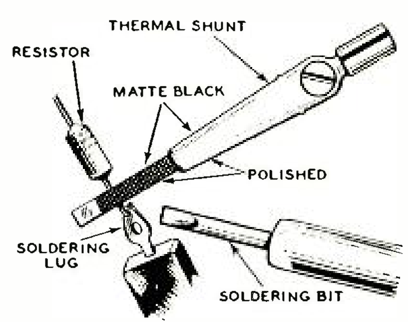
Leads ½ inch long are prohibitive in most miniature apparatus, so a *thermal shunt* was developed to dissipate the unwanted heat and prevent it from reaching the body of the component. The shunt consists of a crocodile clip with copper bars ⅛ inch thick, ¼ inch wide, and 1½ inches long sweated to its jaws. The shunt is clamped to the resistor lead so it is at least 1/16 inch from the body of the resistor and from the soldering lug. It should be left in this position for at least 15 seconds after the iron is removed from the joint.



COPPER BARS SOLDERED INTO JAWS OF CLIP



(a) SHUNT DIMENSIONS AND CONSTRUCTION.



(b) SOLDERING SET-UP USING THE SHUNT.

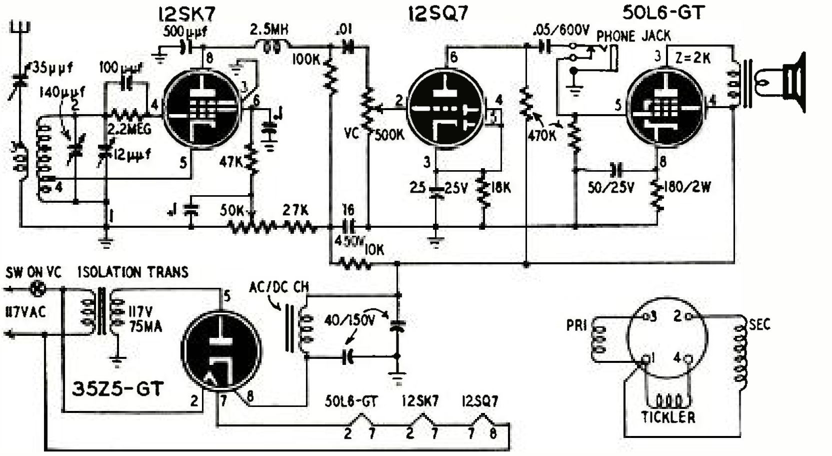
The construction of the shunt is shown at *a* and method of using it is shown at *b* in the drawings. The surface next to the resistor should be finished with a flat black paint. The opposite side should be polished so heat will be radiated away from the resistor.

This will be found to be a useful device to have around the shop or laboratory. With the trend today to smaller components, the need for direct applications of small amounts of heat is becoming more important. Not only resistors, but miniature capacitors require careful handling.

—end—

SENSITIVE 4-TUBE REGENERATIVE RECEIVER

? *I would like to see a diagram of a 4-tube short-wave regenerative receiver using any of the following tubes: 12SA7, 12SQ7, 6K6, 35Z5-GT, and 50L6-GT. Please show how my 4-prong coils (see inset) can be used in the circuit which you prepare. I want to use a pair of crystal phones, so include a means of silencing the speaker when the phones are plugged in.—E. S., Toronto, Ont.*



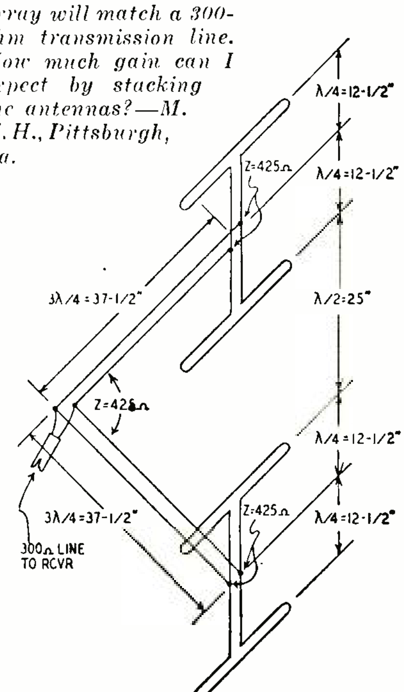
A. The circuit of a sensitive regenerative set is shown in the diagram. The tube heaters are connected in series across the a.c. line. The B-supply is taken from the secondary of a small isolation transformer. If this type of transformer is not available, you can use two 6.3-volt, 2-ampere filament transformers connected back-to-back.

The size of the detector grid-leak and the number of turns on the tickler or feedback winding determine the case with which the detector goes in and out of oscillation as the regeneration control is varied. The direction in which the feedback winding is wound determines whether the set will oscillate or not. If the circuit does not oscillate with your coils, transpose the connections between the ends of the tickler and pins 1 and 4 on the coil form. Try different values of resistance for the oscillator grid-leak and use the value that provides the smoothest control over regeneration.

The performance of the set can be slightly improved by shunting the 100,000-ohm plate resistor with an audio choke of 300 henries or more. Use an audio transformer with primary and secondary connected in series (in the direction giving best results) for this choke, if you have one on hand.

STACKING TELEVISION ANTENNAS

? *I have four 300-ohm Yagi antennas which are cut for channel 13. Please show how I can stack these so that the array will match a 300-ohm transmission line. How much gain can I expect by stacking the antennas?—M. H. H., Pittsburgh, Pa.*



A. With correct interbay spacing and a perfect match to the transmission line, a 4-bay stacked antenna will have a theoretical gain of approximately 6 db over that of one of the antenna sections used alone. This assumes that the signal strikes all the antennas equally with respect to phase and amplitude. Therefore, the maximum gain is possible only when the signal is free from multipath reflections. Location in this case is important.

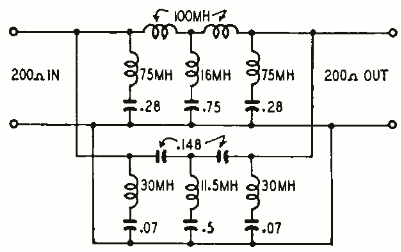
Stack the antennas one-half wavelength apart and connect them in pairs with 425-ohm matching sections as shown in the diagram. The centers of the matching sections connect to two ¾-wavelength 425-ohm sections which are connected in parallel across the 300-ohm lead-in. The 425-ohm matching sections may be ¼-inch tubing spaced 4½ inches or No. 12 wire spaced 1½ inches.

This stacking arrangement can be used for TV antennas cut to other frequencies and having different impedances. The length of the matching sections and the interbay spacing *in wavelengths* will remain constant. The spacing and size of the conductors used in the matching sections are determined by the impedances of the line and antennas.

BAND-REJECTION FILTER

? *Please print a circuit of a filter network which will attenuate by 3 db or more all signals between 880 and 3,400 cycles. This filter is to be used in a 200-ohm audio line.—M. T., Peru, Ind.*

A. A band-rejection filter having the characteristics you want would be diffi-



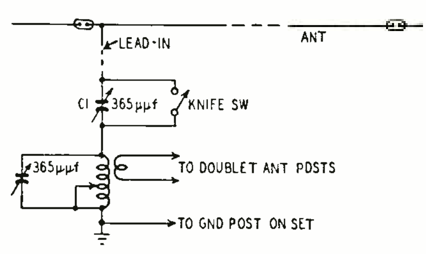
cult to design and construct, so we have prepared this circuit which should do the job for you. It consists of a three-section high-pass filter network cutting off at 3,400 cycles paralleled by a three-section low-pass filter cutting off at 880 cycles. Both of the filter units being designed for 400-ohm lines, there will be a slight mismatch in each. The existing mismatch should not be great enough to affect the performance of the circuit as a whole.

It is recommended that the high- and low-pass filters be shielded from each other. The shunt inductors should be mounted so their axes are at right angles to each other.

ANTENNA TUNING COUPLER

? *I use a 300-foot long-wire antenna for broadcast and international short-wave reception. I would like to have details on constructing a coupler for tuning the antenna system for optimum performance on any frequency and coupling it to a receiver which has terminals for a doublet antenna.—G. T., Little Rock, Ark.*

A. The diagram shows a tuner that should do much to improve the perform-



ance of your antenna. Two 365-μμf capacitors are used. C1 is in series with the antenna and effectively shortens it. The parallel-tuned circuit has the effect of lengthening the antenna. The coil consists of approximately 30 turns of No. 12 or 14 bare wire on a 2½-inch form. The turns should be spaced the diameter of the wire. A small clip should be provided for shorting out turns when necessary. The pickup loop is 3 turns of No. 18 hookup interwound with the turns at the antenna end of the large coil.

Remember, however, that short-wave station signals are often weak. In some cases it might be advisable to use special directional antennas.

ELIMINATING NECK SHADOW

? *I am having trouble eliminating shadows on the left and lower right sides of the 12LP4 picture tube in my TV set. I've tried replacing the 6BG6-G and 5V4-G damper tube, but new tubes don't remove the shadow. Can you help me to correct this condition?—N. LaS., Torrington, Conn.*

A. The dark areas or shadows on your picture are probably neck shadows caused by obstruction of the electron beam before it reaches the sides of the screen. This condition exists when the deflection yoke or focus coil is too far back on the neck of the tube. It may also occur when the neck of the tube is not centered in the focus coil. Make sure that the neck of the tube is horizontal and parallel to the chassis and that it is centered in the deflection yoke and focus coil. Try moving the focus and deflection coils as far forward as possible. Transpose the leads to the focus coil. Reversing these leads will reverse the relative operation of the centering adjustment screws but will not affect the operation of the set. Misadjustment of the ion trap magnet may cause the trouble, too.

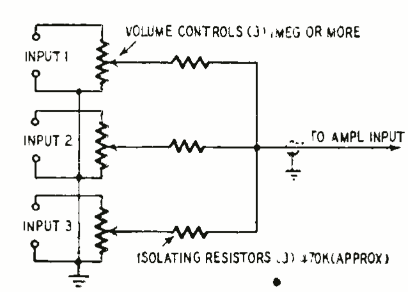
Sometimes small shadow areas can be eliminated by moving the picture slightly off center and advancing the width control. This does not remove the shadow, but hides it behind the mask.

Neck shadow also has been traced to a distorted picture tube in which the axis of the neck is not in line with the axis of the bulb. Close examination will show the neck to be slightly off center or to be cocked off at an angle. Rotating the tube in its mount will often remove shadows which will not respond to more conventional treatment.

PHONO MIXER PANEL

? *Please print a diagram of a non-electronic mixing and volume-control panel for use with three phonograph pickups, without interaction.—P. C., Haverford, Pa.*

A. Interaction between the controls can be minimized by connecting isolat-

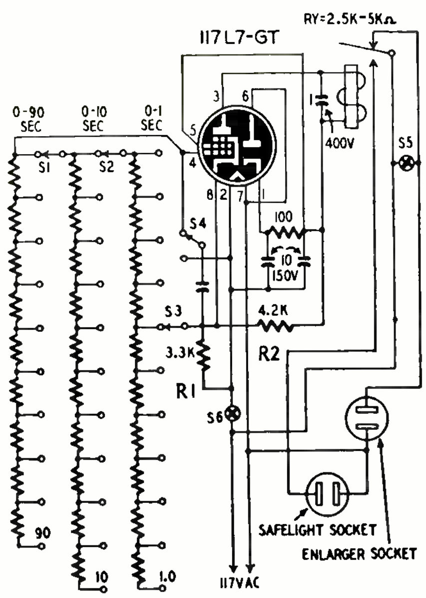


ing resistors in series with the arm of each control as shown in the diagram. The value of each isolating resistor should be approximately one-half the resistance of each control. Use the smallest value which will prevent interaction. This setup can be used for an indefinite number of controls. The only disadvantage is that the signal input may drop and a tone-control effect is noticed if several controls are simultaneously set at zero.

PHOTO TIMER

? *I would like to have a diagram of a photo timer having three controls for setting the timed interval from 0.1 second to 100 seconds. If possible, please design the circuit around a 117L7-GT and a 2,500-ohm plate relay.—H. W. H., Irwin, Pa.*

A. This circuit will time intervals from 0.1 second to 101 seconds in decade



S1-EACH RES=2.2MEG; S2-EACH RES=220K; S3-EACH RES=22K; S4-SPDT SPRING RETURN TIMER SW; S5-FOCUS SW; S6-POWER SW

steps of 0.1 second. For high accuracy, the resistors in the timing circuit should be matched pairs of 5% or better.

Calibrate the timer on the 0–100-second range using a stop watch for measurements. If the timed interval is too long increase R1 and decrease R2 slightly. If it is too short, make R1 larger and R2 smaller. Slight changes in calibration can be made by varying the tension on the relay spring. Remember that absolute accuracy of timing (if required) depends on stable line voltage regulation.

TRANSFORMER SPECS

? *Please give specifications on the output transformer used in the sound alarm described on page 31, October, 1950, issue.—E. H., Columbus O.*

A. Any plate-to-voice coil output transformer will do the job. However, it is advisable to use one having a primary impedance of 20,000 ohms or more. Your best bet will be to use a standard intercom *input* transformer which may have a secondary impedance of 38,400 ohms or higher.

Many constructors use standard output transformers connected in reverse when small PM speakers are used as microphones. Pickup improves in almost all cases where the output transformer is replaced with a standard intercom input transformer. It should be remembered that specialized input transformers are so designed as to give maximum transfer of energy with minimum pickup of noise and hum. Also, various input impedances can be matched more readily.

—end—

THE FUND TOPS $8,000.

HELP - FREDDIE-WALK FUND

It has been a source of great gratification to us to note that the Freddie Fund with this month has reached $8,176.78.

Little three-year-old Freddie, as our readers know by this time, is the completely legless and armless son of Herschel Thomason, Arkansas radio technician.

Freddie still has to make constant trips to the North where his doctors are fitting him with the necessary appliances so in time he will be able to walk and use artificial legs and arms. The case is greatly complicated by the fact that Freddie has not a vestige of either arms or legs and there are no stumps on which to fit appliances. In time he will have to use his body muscles to obtain articulation for the artificial arms and legs.

The FAMILY CIRCLE Magazine. which also became interested in Freddie's case, continues to be high on the list of contributions which we report below:

FAMILY CIRCLE magazine contributions.

Balance as of April 19, 1951	$253.95
A Prayerful Mother—New Hartford, N. Y.	2.00
Susan R. Baker—New Castle, Ill.	5.00
Mr. & Mrs. William F. Barnes—Chicago, Ill.	5.00
Lucy B. Blaich—Los Angeles, Cal.	3.50
Mr. and Mrs. J. L. Boyd—Charlotte, N. C.	6.00
Mr. & Mrs. James Brightwell—Belpoint W. Va.	1.00
Mrs. C. Portland, Oregon	2.00
Mrs. John M. Clausen—Rainier, Oregon	1.00
Eleanor Clementi—Pueblo, Colo.	1.00
Mrs. Jean R. Duff—Peekskill, N. Y.	5.00
Mrs. Gladys A. Donnelly—East Orange, N. J.	10.00
Mrs. George Eshelman—Quarryville, Pa.	2.00
Mrs. Charles J. Fabso—Cincinnati, Ohio	1.00
Mrs. F. Faider—Brooklyn, N. Y.	2.00
Mrs. F. Goucet—Philadelphia, Pa.	.50
Mrs. Charles D. Grafton—Philadelphia, Pa.	2.00
Elizabeth J. Griffin & Tris—Cheyenne, Wyo.	2.00
Mrs. A. Grow—Trail, Oregon	1.00
Catherine T. Haley—Chicago, Ill.	1.00
Mrs. W. E. Hyatt—Glendale, Cal.	10.00
Mr. & Mrs. Fred E. Jenni—Horicon, Wisc.	5.00
Sara Joyner—Richmond, Va.	1.00
Mr. & Mrs. Chester R. Kennedy—Pittsburgh, Pa.	10.00
Mrs. E. F. Kennedy—Philadelphia, Pa.	1.00
Mrs. E. F. Kalacny—Englewood, Colo.	2.00
Ruth Lapo—Syracuse, N. Y.	2.00
Jean McDowell—Philadelphia, Pa.	1.00
Mrs. George D. Manderbach—Wyomissing, Pa.	1.00
Mrs. D. Newton—El Cajon, Cal.	1.00
Mr. & Mrs. S. Wm. Pattis—Chicago, Ill.	6.00
Ardelle Quinn & Mother—Glendale, Calif.	1.00
Roger & Carole Rapp—St. Louis, Mo.	1.00
Nettie Rickert—Bellmore, N. Y.	3.00
Donald L. Sandberg and Family—Long Beach, Calif.	5.00
Mrs. E. K. Schoen—Phoenix, Ariz.	2.00
Rachel Schwartz—Brooklyn, N. Y.	1.00
Mrs. S. Smith—Burlington, Vt.	1.00
Mrs. Barbara J. Triche—El Segundo, Calif.	5.00
Mrs. E. Wesley—Oakland, Calif.	5.00
Mrs. L. L. Whitehead—Washington, D. C.	2.00
Mr. & Mrs. L. F. Williams—Chapel Hill, N. C.	6.00
Mary Witkowski—Painesville, Ohio	1.00
FAMILY CIRCLE contributions received up to May 18, 1951	$379.95

We are also pleased to report the following collection made:

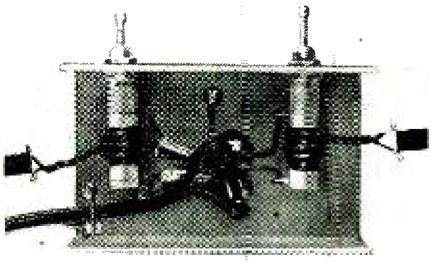
$5.00 contributed by the Yadkin Valley Radio Club of North Wilkesboro, N. C. through the efforts of Robert M. Harvey.

RADIO-ELECTRONICS CONTRIBUTIONS

Balance as of April 19, 1951	$7,691.83
A Friend—Dayton, Ohio	4.00
A Friend—Mingo Junction, Ohio	1.00
Fred A. Anderson—Wilmington, Dela	1.00
Anonymous—Oakland, Calif.	1.00
Anonymous—Wallingford, Conn.	1.00
Anonymous—Chicago, Ill.	.50
Anonymous—Lake Odessa, Mich	2.00
Anonymous—Lake Odessa, Mich	2.00
Anonymous—St. Louis, Mo	1.00
Anonymous—Hysham, Mont.	1.00
Anonymous—Gilead, Nebr.	1.00
Anonymous—Manchester, N. H	1.00
Anonymous—Bernardsville, N. J	1.00
Anonymous—Lanikai, Hawaii	1.00
P. Blum—Newark, N. J	1.00
E. F. Bowman—St. Louis, Mo	1.00
George Cheakas—Dallas, Tex	1.00
Addie Lee Domangue—Houma, La	5.00
H. W. Fisk—San Francisco, Calif	2.00
Alexis Hebert—Southbridge, Mass	1.00
Sigmund S. Kahn, M.D.—Brooklyn, N. Y	5.00
Anthony Kalwaxczyk—Dudley, Mass	1.00
Saul Kozuck—Orange, N. J	2.00
Frederick M. Levin—Philadelphia, Pa	1.00
Fred Lynn—Brooklyn, N. Y	3.00
H. D. McBride—Los Angeles, Calif	1.00
Wm. F. McGowan—Alameda, Calif	10.00
Floyd A. Marsellos—Houston, Tex	5.00
J. A. Mencos—Tiquisati, Guatemala, C. A.	1.00
Joseph M. Morrone—Philadelphia, Pa	5.00
Geo. W. Oleson—San Jose, Calif	2.50
Walter O. Paquette—Southbridge, Mass	1.00
James H. Parsons—Charleston, W. Va	10.00
Joseph Piliero—Maspeth, N. Y	5.00
A. V. Predki—Detroit, Mich	2.00
George Roberts—Willow Grove, Pa	2.00
D. R. Scroggin—Lake Forest, Ill	3.00
Theo. L. Seybold—Washington, D. C	1.00
John Sohanchak—Camden, N. J	5.00
Stanley Sekal—Utica, N. Y	2.00
Max B. Stern—Salt Lake City, Utah	1.00
John Tensen—Gothenburg, Sweden	1.00
Doug Wilson, W9GWE—Fort Wayne, Ind	1.00
Yadkin Valley Radio Club—No. Wilkesboro, N. C.	5.00
RADIO-ELECTRONICS contributions	$7,796.83
FAMILY CIRCLE contributions	379.95
Total received to May 18, 1951	$8,176.78

MORE ON DOC GAINES' BOOSTER

The coil data was inadvertently omitted from the article "Home Built Booster Increases TV Range" in the June issue. Herewith the necessary data, as well as a photo of the booster which arrived too late to be published with the article.



Since layout is often as important as circuit at very high frequencies, the photo may be helpful to constructors. The bottom of the tube socket is seen in the center of the chassis, and the two tuning slugs project from the front when the unit is turned upright.

Coil Data For Booster

Channel	Coil	Turns	Length (inches)	Remarks
2 to 4	L2 and L3 L1 and L4	11 3	11/16 11/16	Insulated from L1 or L4 Wound over L2 or L3
5 and 6	L2 and L3 L1 and L4	7 3	11/16 11/16	Insulated from L1 or L4 Wound over L2 or L3
7 to 13	L2 and L3 L1 and L4	3 1	11/16	Insulated from L1 or L4 Centered on L2 or L3
	L5		1¼	Closewound on ¼ in. dia. form. No. 22 enamelled wire

Use No. 19 enamelled wire, coil form Millen 69045 or equivalent for L1, L2, L3 and L4.

Radio Thirty-Five Years Ago
In Gernsback Publications

HUGO GERNSBACK
Founder

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some of the larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

JULY, 1917 ELECTRICAL EXPERIMENTER

Testing Radio Units with Dummy Antenna, by Frank C. Perkins
A Human Radio Outfit
How the Government Seals Radio Apparatus
How Radio Brought the News to the Farm
Wireless on the American Submarine Chasers, by Samuel Cohen
Light-Weight Radio Transmitter and Receiver
Amateur and Experimental Radio Research, by Raymond Francis Yates
Wireless Telephone Hook-up

ELECTRONIC LITERATURE

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. All literature offers void after six months.

BUSINESS GUIDES AND FORMS

A new 4-page catalog lists items designed to simplify billing and filing, and to enable the service technician to provide faster and more efficient service. Among the items listed are TV service contract forms, job tickets, radio and TV service record forms, and *Radio Service Standard Rate Book*, designed to assist the technician to prepare a fair bill for services and material in the shortest possible time.

The catalog is available from Oelrich Publications, 4135 N. Lawler Ave., Chicago 41, Ill. Gratis.

SELENIUM RECTIFIER CATALOG

A new illustrated catalog describes the Seletron line of miniature selenium rectifiers as well as a selected group of high-current units. The catalog also illustrates some typical circuit applications of selenium rectifiers.

Available from Sales Department, Seletron Division, Radio Receptor Co., Inc., 251 W. 19th St., New York 11, N. Y. Gratis.

TRAINING-AIDS BROCHURE

Sylvania is distributing a brochure listing their wall charts, lesson folders, TV servicing booklets, color-code and radio symbol charts, and tube manuals.

Available from Sylvania Electric Products Inc., Emporium, Pa. Gratis.

INDEX TO SUPREME MANUALS

The new *Complete Index to Most-Often-Needed Radio and Television Servicing Information* is a cross reference to the contents of all the volumes in the Most-Often-Needed diagram series published by Supreme Publications.

Available from Supreme Publications, 3727 W. 13th St., Chicago 23, Ill. Gratis. Send 3¢ stamp for postage.

TV ANTENNA GUIDE

"TV 'Tenna Tips" is a pocket-size reference manual containing useful data on TV antennas, installation problems, dimensions of antenna elements, channel frequencies, and answers to a number of questions most often asked by TV service technicians.

Available from Snyder Mfg. Co., 22nd and Ontario Sts., Philadelphia 40, Pa. Gratis.

QUARTZ CRYSTALS CATALOG

Catalog No. 51 issued by The James Knights Co. is a 5-page illustrated brochure describing the JK line of quartz crystals and crystal ovens. Crystals for oscillators, filters, and transducers are available in the frequency range between 3 kc and 100 mc.

Available from The James Knights Co., Sandwich, Ill. Gratis.

TV ANTENNA CATALOG

The new VEE-D-X catalog No. 51 includes technical information on their complete line of television receiving antennas and accessories such as towers, switch boxes, lightning arresters, and various types of antenna installation hardware.

Available from LaPointe-Plascomold Corporation, Windsor Locks, Conn. Gratis.

TV TRANSFORMER CATALOG

The 1951 edition of Stancor's TV transformer catalog and replacement guide contains 36 pages of information relating to replacements for power, audio, blocking-oscillator, and deflection transformers, filter chokes, deflection yokes, and focus coils for over 900 TV models and chassis made by 71 manufacturers. Also listed are mechanical and electrical specifications on 75 Stancor transformers and related components for TV replacements and conversions.

Available from Standard Transformer Corp., 3580 Elston Ave., Chicago 18, Ill. Gratis.

STAMPED CIRCUITS BOOKLET

A 16-page illustrated booklet, "Electronic Circuit Production by Die Stamping Explained," describes a die-stamping process used for mass-producing electronic and electrical circuits. Also available is a 20-page catalog listing and illustrating terminal strips, connectors, plugs, pin-board assemblies, and special sockets for various types of electron tubes.

Available from Franklin Airloop Corp., 43-20 34th St., Long Island City 1, N. Y. Gratis to interested parties upon request.

TV ANTENNA CATALOG

The Brach line of TV antennas, antenna couplers, matching transformers, and lightning arresters and other accessories are described and illustrated in catalog 51-T. This catalog is constructed like a standard manila folder to simplify filing, and is punched to receive additional inserts.

Available from Brach Mfg. Corp., 200 Central Ave., Newark 4, N. J. Gratis.

—end—

Suggested by Richard H. Rogers

I think I must have hit the jackpot. It's been going for 3 days

Television is moving fast—Keep up with it in
RADIO-ELECTRONICS

DU MONT-WU COALITION

All sections of the service industry have reacted vigorously to the proposed Du Mont-Western Union coalition in television servicing (RADIO-ELECTRONICS, June, page 12). General opinion is that in the long run, service by over-large organizations will prove uneconomical, but that many independent organizations will be ruined while the proposition is being proved.

Television Contractors Association of Philadelphia has presented probably the best reasoned-out reaction to the plan. In a release from their executive secretary, Paul V. Forte, reporting on a recent meeting of the organization, it was made clear that the members believed:

"That there was nothing illegal or illegitimate in the Du Mont-Western Union arrangement" . . . but Du Mont was probably acting in disregard for the best interests of television; and that the arrangement" foreshadowed the disintegration of many service contracting businesses across the country," if and when the intentions of Western Union to operate on a national basis were realized.

In view of the fact that "this is a free country and anyone can go into business if he has the money . . . ," TCA could see no sense in issuing probably fruitless resolutions of condemnation, but felt that it was the duty of the service industry to obtain full information on the proposed action, so that the various sections of the industry could take whatever actions might be deemed useful to protect the future of the independent service contractor.

To this end, 20,000 copies of a news story and editorial in the association's publication, *The TV Tuner*, have been printed for wide distribution throughout the service and related fields. Interested parties may obtain copies from Paul V. Forte, Executive Secretary, TCA, 158 North 20th St., Phila., Pa.

MORE LEGISLATION

Two more states, Wisconsin and New Jersey, have come out with bills designed to affect television and radio servicing. At the time of writing, both bills had been referred to committee.

The Wisconsin law proposes setting up a Board of Examiners in radio and television. All persons desiring to engage in "radio and television electronics" for profit or compensation must obtain a certificate of registration which is obtained by paying a $25 examination fee and passing an examination in theory, practical knowledge, and skill in the manipulation of equipment and tools. Apparently the term "radio and television electronics" means radio and television servicing to the legislators of Wisconsin, as the registration does not apply to dealers.

Attempts to practice without the certificate would be punishable with a maximum penalty of $100 fine plus three months' imprisonment.

The New Jersey bill, like a number of others recently introduced, seeks to provide that funds paid in advance for

OUR AUGUST ISSUE

Big-tube conversions for existing television receivers will be featured in several articles in the August issue of RADIO-ELECTRONICS. This is an issue that no television repair technician can afford to miss. Reserve your copy now!

television servicing be placed in a trust fund and that monthly withdrawals shall be equivalent to the proportion one month bears to the time of the contract. The preamble states that this has become necessary because "numerous persons have paid in advance sums of money for service contracts and thereafter have failed to receive said service due to the financial failure of the service organizations, resulting in financial loss to the inhabitants of this State . . . the unscrupulous tactics of such organizations tend to harm ethical businessmen and to discredit the television industry generally."

PIX TUBE WARRANTY

Warranty problems on picture tubes are likely to produce more than the average number of warranty headaches for the television service contractor due to the slow movement of television sets in late spring. Picture-tube makers since late last year have cut down their warranty from one year to six months, and the result is that some replacement tubes may be out of warranty before they are sold.

General Electric and Ken-Rad have met the situation by arranging that picture tubes sold through their franchised distributors and dealers have warranty protection for six months *from date of purchase by the actual consumer.*

That the matter is an important one may be gathered from dealers who estimate that from 1 to 15% of their television picture tubes show defects within the first 90 days. After that, the number of defects drops to a figure that can be ignored.

LARGER INVENTORY

Joint recommendation of the Radio and Television Manufacturers' Association and the Better Business Bureaus that television contractors keep larger stocks of parts in order to render prompter service met with a sharp reaction from parts of the service industry.

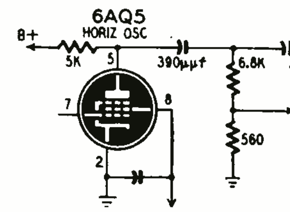
In a letter addressed to Robert C. Sprague as RTMA board chairman, Frank Moch, president of the National Alliance of Television and Electronic Service Associations, points out that the recommendation is out of order because "it does not take into consideration the fact that the TV manufacturer and distributor, and not the service contractor, have accepted fees to guarantee the replacement of parts."

NEW COUPON SERVICE PLAN

Pay-by-the-call television service contracts are being issued by a Brooklyn concern. The plan calls for payment by the customer of fees ranging from $45 for a 10-inch receiver to $85 for a 20-inch job. A number of coupons are given the customer, ranging from five for the lowest-priced contracts to nine for the most expensive. He surrenders one coupon for each call and can turn the unused balance in for refund at the end of the year. —end—

WESTINGHOUSE H-196

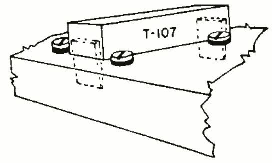
An elliptical shadow which produced an eclipse-like effect on the lower left side of the TV picture was finally



traced to failure of the 390-µµf capacitor at the plate of the 6AQ5 horizontal oscillator tube. The position of this capacitor is shown in the diagram. Be sure to check the 6,800-ohm, ½-watt resistor, as it may have been damaged. —*Frank Jusaites*

CROSLEY TV SETS

Horizontal sweep sing in the 10-401, 10-404, 10-412, and 10-418 can be caused by the bracket of the horizontal output transformer vibrating at a subharmonic of the 15,750-cycle horizontal sweep frequency. Transformers in later sets do not cause this trouble because their cores and brackets have been dipped in wax.



This trouble can be corrected by inserting small wedges between each end of the transformer and the chassis as shown.—*Crosley Service Dept.*

HALLICRAFTERS SX-42

Reception was normal on all bands except the 55–108 megacycle band. The trouble was traced to resistor R-6, a 2,200-ohm, ½-watt unit which is used only on the highest band. Replacing the unit with a similar ½-watt unit corrected the trouble for a few weeks. Replacing it with a 2-watt resistor eliminated a recurrence of the trouble.

The tuning meter read normal on FM. The lowest no-signal reading was S-8 for AM reception on all bands. All components in the tuning meter circuit checked good. The 6AG5's in the r.f. stages checked good on a mutual conductance tube tester. Finally, we substituted several 6AG5's and found two which brought the no-signal reading down to S-0. Apparently, many tubes which checked good on the tester lacked sufficient emission to bring the meter to zero in the bridge circuit.—*Robert H. Marshall*

LOW PICTURE BRIGHTNESS

When low picture brightness is not caused by a defect in the receiver, check the position of the ion trap. If adjusting the trap does not correct the trouble, possibly metal filings may be short-circuiting the magnets. Remove filings with a magnetized screwdriver.

If there is no evidence of a magnetic short circuit, the magnets may be weak. Try a new ion trap.—*John T. Bailey*

GENERAL ELECTRIC 810

A white vertical bar, shaped like a half moon and approximately 1 inch wide, appeared on the screen after the set had operated normally for 15 or 20 minutes. After the shadow appeared, plate and screen voltages on the 6BG6-G were low and anode voltage dropped to 3,000. We noticed that the blue fluorescence disappeared from the 6BG6-G at the moment that the voltages dropped. The trouble cleared up when the horizontal output transformer was replaced. By applying heat externally to the old transformer, we found that the primary would open when the unit approached normal operating temperature. The transformer cooled so rapidly that the high-resistance open circuit could not be detected.—*T. R. Odenath*

CURE FOR SYNC BUZZ

Sync buzz may be annoying when the contrast control is turned a little above normal on Motorola sets using TS-14B, TS-23B, TS-52B, and similar chassis. This trouble can be cleared up by making a minor change in the biasing arrangement for the video amplifier. Disconnect the lower end of the 1-meg-ohm grid resistor from the arm of the contrast control and connect it to the cathode of the audio amplifier. By providing a cleaner source of bias for the video amplifier, this circuit modification minimizes sync buzz.—*Edward Tanrath*

RCA 9T240 AND OTHERS

The symptom was a raster but no sound or picture. All common causes of this trouble were investigated without finding the fault. The trouble was caused by an open heater in the first video amplifier section of the 12AU7. Failure in this section of the tube causes the bias on the a.g.c. line to cut off the common audio-video i.f. amplifier stages, thus killing the sound as well as the picture. This trouble can appear in other RCA sets which have the same video amplifier and a.g.c. biasing arrangement.—*James J. McNamara*

WESTINGHOUSE CHASSIS V-2150-176

To reduce horizontal wobble under strong-signal conditions and to increase the contrast range, decrease the value of resistor R437 (between pins 6 and 7 of the 6AU6 a.g.c. tube) from 5,600 to 3,300 ohms.

To improve horizontal linearity, replace the 680-μμf horizontal discharge capacitor C427 with a 330-μμf unit.

These changes have been made in late runs of the V-2150-176 chassis used in models H-619T12 and H-619-T12U.—*Westinghouse Service Notes*

HICKOK 534 TUBE TESTER

If the meter pointer swings wildly when a tube is inserted in the rectifier sockets for checking, look for the trouble in the 150-ohm wire-wound resistor in series with button P-3 and one side of the power transformer secondary. This is a current-limiting resistor. Probably it is shorted.—*Wilbur J. Hantz*

—end—

Dr. Oliver E. Buckley, former president of Bell Telephone Laboratories, was appointed chairman of the newly created Science Advisory Committee of the OFFICE OF DEFENSE MOBILIZATION by President Truman. Dr. Buckley will continue his association with BELL LABORATORIES as chairman of the board. Dr. Mervin J. Kelly, former executive vice-president, was elected president to succeed Dr. Buckley.


Dr. O. E. Buckley

Bill C. Scales was named general sales manager of the Cathode-ray Tube Division of ALLEN B. DU MONT LABORATORIES, INC., Clifton, N. J., according to an announcement by Irving G. Rosenberg, general manager of the division. Mr. Scales has been with Du Mont since September, 1949. His most recent position was southwestern regional sales manager for the Receiver Sales Division.


Bill C. Scales

Robert E. Burrows joined THOMAS ELECTRONICS, INC., Passaic, N. J., cathode-ray tube manufacturer, as general sales manager. Mr. Burrows has had 22 years experience in the radio, appliance, and television fields. He was associated with such companies as General Electric Supply, Westinghouse Electric Supply, and Meissner Manufacturing Division of Maguire Industries.


Robert E. Burrows

Emil J. Maginot was appointed manager of advertising for CORNELL-DUBILIER ELECTRIC CORPORATION, South Plainfield, N. J. Mr. Maginot has been associated with the electronics industry for over 25 years. For more than nine years he held sales and advertising executive positions with the National Union Radio Corporation.


Emil J. Maginot

William H. Rous, sales manager of the AMERICAN PHENOLIC CORP., Chicago, was elected a vice-president of the company. Mr. Rous began his association with the company as assistant to the president, Arthur J. Schmitt.


William H. Rous

See Ad—Page 78

Personnel notes

. . . Don G. Mitchell, president of SYLVANIA ELECTRIC PRODUCTS, INC., accepted the 1950 Howard G. Ford Award for his company's achievements in sales growth in 1950. The award was made by the Sales Managers' Association of Philadelphia.

. . . W. H. (Terry) Dunning, formerly a member of the advertising staff of the General Electric Company in Syracuse, N. Y., joined P. R. MALLORY & COMPANY, Indianapolis, Ind., as advertising manager.

. . . William "Bill" Slawson joined JOHN F. RIDER PUBLISHER, INC., New York City, as general sales manager. He was formerly distributor sales manager of Federal Telephone and Radio Corporation.

. . . Richard H. Dorf, formerly an associate editor of RADIO-ELECTRONICS magazine, was appointed Electronics Project Engineer of the Brach Manufacturing Division of the GENERAL BRONZE CORPORATION, Newark, N. J.

. . . William J. Nezerka, vice-president and general sales manager of THE TURNER COMPANY, died recently in his home in Cedar Rapids, Iowa.

. . . Louis C. Kunz was appointed product manager for cathode-ray tubes in the Tube Divisions of GENERAL ELECTRIC. He was formerly section engineer on cathode-ray tubes in Syracuse.

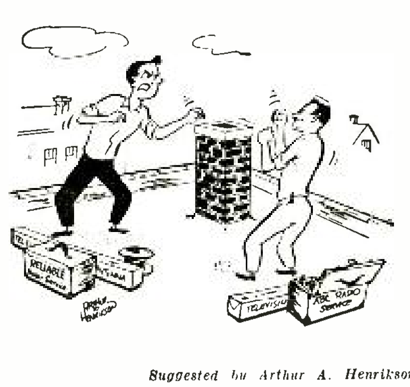
. . . Dr. Adolph H. Rosenthal, formerly director of physics, was elected vice-president and director of research and development of FREED RADIO CORPORATION, New York City.

. . . Joseph Y. Resnick, formerly general manager, was elected chairman of the board of the CHANNEL MASTER CORPORATION, Ellenville, N. Y. Harry Resnick was named president and general manager. Harold Harris was elected vice-president in charge of sales and engineering, and Judge Louis E. Berger was elected to the Board of Directors.

. . . David DeWitt was appointed vice-president in charge of research for the RADIO RECEPTOR COMPANY, INC., Brooklyn, N. Y. Devereaux Martin was named assistant to the president, and Allan Easton manager of communications engineering.

. . . Raymond W. Andrews, former merchandising manager of the Radio Tube & Television Picture Tube Divisions of SYLVANIA ELECTRIC PRODUCTS, INC., was promoted to manager of factory sales.

—end—



Suggested by Arthur A. Henrikson

A TASTE FOR SERVICING

Dear Editor:

I read with pleasure your article, "Five Service Aids," by Jesse Dilson, in the March issue. I have gone Mr. Dilson one further and have used my tongue as a test instrument several times. While visiting a friend's home, he dug up a little a.c.-d.c. set. If nothing lit it was a good bet that there was an open filament. But the only test equipment available would be a flashlight cell.

By placing one terminal of the battery to one of the filament prongs of the tube, and then bridging from the other battery terminal to the other filament prong, it is easy to tell if the filament is open. The tongue is very sensitive, and there is a distinct tickling sensation if the filament is O.K.

L. Esle Bond

Buckhannon, W. Va.

ERROR ON OUR PART

Dear Editor:

On page 12 of your April issue you have an item about Maddida which contains some misstatements.

Maddida was invented, designed, constructed and sold by Northrup Aircraft. Inc., of Hawthorne, Cal., and our part was limited entirely to a purchase of the first production model. Credit should be given to the Navy for its contribution to the purchase of this machine.

Robert R. Williamson
Stevens Institute of Technology
Hoboken, N. J.

CORRECTION

There is an error in the miscellaneous-notes column of the picture-tube replacement table on page 38 of the May, 1951, issue. Notes *a* (no exterior coating), *b* (triode gun), and *c* (2.5-volt heater) are shown opposite the 12LP4. These notes apply only to the 12CP4. The space opposite the 12LP4 should be blank. The 12TP4 does not have an exterior conductive coating so the letter *a* should be opposite it in the right-hand column.

Deflection angles were omitted from three of the column headings. Deflection angles for the 16-inch metal round tubes are in the right-hand column. The 17-inch glass rectangular tubes have a 70-degree diagonal or 65-degree horizontal deflection angle. The 19-inch glass round tubes have a 66-degree deflection angle.

The 19-inch metal round tube (19AP4-A, B-C-D) was not listed because there is no direct replacement for it.

We thank Pat Neels, of New York, N. Y. for these corrections.

NOTICE TO VETERANS

Veterans, the deadline for entering or re-entering training under the G.I. Bill of Rights is rapidly approaching. World War II veterans discharged prior to July 25, 1947, who plan to enter or resume training must do so before July 25, 1951, or they will lose their educational benefits. Veterans discharged after July 25, 1947, have four years from the date of discharge to begin training.

—end—

PRACTICAL WIRELESS ENCYCLOPAEDIA, by F. J. Camm. Published by George Newnes Ltd., London, England. 5¾ x 9 inches, 372 pages. Price 21 shillings.

This encyclopedia is a comprehensive collection of words, terms, phrases, and formulas commonly employed in radio, television, electronics, and allied fields. It is illustrated with schematic and pictorial diagrams, drawings, tables, and graphs where necessary.

Some American readers would probably have trouble finding or understanding some terms in the encyclopedia because of differences in American and British terminology. For example, there is no definition of a storage battery as such, but almost 20 full pages and 27 illustrations are devoted to the *accumulator* which is the British equivalent.—*RFS*

APPLIED ELECTRONICS ANNUAL, 1951. edited by R. B. Blaise. Published by British-Continental Trade Press, Ltd.. 222 Strand, London, England. 7¾ x 9¾ inches. Price $8.00.

This useful manual contains a number of interesting articles which cover the practical applications of electronics. Each of the articles was written by an expert in his field, and together, survey the industry. "Marine Electronic Equipment," "Printed Circuits" and "Television in Britain" are articles which will be enlightening to the American reader.

In addition to the twenty-four articles, there are a number of directory services which, although they could be more complete, are valuable. These include a directory of the radio and electronics industry which lists the manufacturers of radio and electronic apparatus throughout the world.

COLOR TELEVISION NOTEBOOK, by Edward M. Noll. Published by the Paul H. Wendel Publishing Co. for Television Technicians Lecture Bureau, P.O. Box 1321, Indianapolis, Indiana. 8½ x 11 inches, 45 pages. Price $1.00.

A complete explanation of the principles of color television, with detailed descriptions of the CBS and RCA systems and a shorter discussion of the CTI method. The special features and advantages of each are impartially analyzed and information on receiver adaption and special circuits (crispening, color phasing) is given.

ELECTRONIC SHORTCUTS FOR HOBBYISTS. Sylvania Electric Products Inc., Electronics Division, 1740 Broadway, New York 19, N. Y. 6 x 9 inches, [illegible]3 pages. Price, $.25.

This booklet contains 24 crystal diode circuits expressly chosen for their general interest to experimenters and hobbyists. For example, an interval timer, a crystal-powered photo-electric relay, a radio-operated garage door opener, a light-duty electroplater and others are included. The descriptions of construction and operation are straightforward, and the illustrations and diagrams clear. Ratings and characteristics of Sylvania germanium diodes are appended in a 2-page table.

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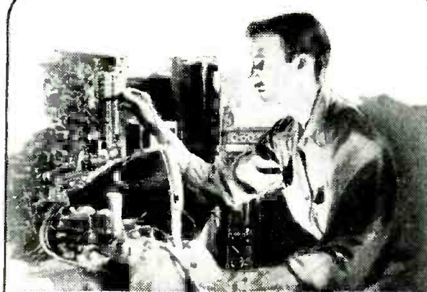

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WAVE MECHANICS (second edition) by J. Frenkel. Published by Dover Publications Inc., 1780 Broadway, New York, N. Y., 5¾ x 8¼ inches, 309 pages, 1950, vol. 1. Price $3.50.

The first volume of a projected three-volume series, this book covers elementary quantum statistics, wave mechanics, light, and matter. The author combines the chronological development of wave theory with critical analysis of the problems encountered by Newton, Schroedinger, Fermi, and other investigators.

This is a good primer for the person who is interested in an analysis of wave mechanics and modern physics, but higher math is essential.

ALTERNATING-CURRENT CIRCUITS (third edition) by Russell Kerchner and George Corcoran. Published by John Wiley & Sons, Inc., New York, N. Y. 6¼ x 9¼ inches, 598 pages. Price $5.50.

This book covers the theory and practice of a.c. circuits. It presupposses knowledge of integral and differential calculus on the reader's part. Energy measurement in polyphase circuits, electric filter theory, and power-system short-circuit calculations are among the topics covered. End-of-chapter problems with some answers are included.

THEORY AND DESIGN OF TELEVISION RECEIVERS, by Sid Deutsch. Published by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 6 x 9 inches, 536 pages, 1951. Price $6.50.

This is a text, written on the engineering level, which can appeal to the service technician as well as the student. The author has combined lucid description of TV circuit behavior with direct, full presentation of theory—no simple feat. Although mathematics is not avoided it is used judiciously.

One of the more interesting parts of the book is the antenna and r.f. chapter. It is complete and varied, including a description and analysis of airplane disturbance and interference effects, with a chart on fading plotted against relative airplane distance.

The service technician and advanced amateur will profit from the chapters on servicing and fundamentals. A complete list of questions for students is provided at the end of each chapter.

A complete index and list of tables, as well as detailed table of contents is included. There are numerous illustrations.

SEMI-CONDUCTORS, by D. A. Wright. Published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York, N. Y. 4½ x 6¾ inches, 130 pages, 1950. Price $1.75.

This book gives an elementary account of the properties of semiconductors, and covers the theory of electron flow in them or across the boundary between them.

It brings the reader up to date in this new field of electron physics and presents material otherwise found only in periodical literature.

—end—

TV CONVERSIONS

This important subject will be covered in a number of articles and features in the August issue of RADIO-ELECTRONICS. Fundamentals, techniques, and pitfalls will all be covered by experienced and authoritative authors. Information on replacement components will be tabulated. Reserve your copy now!

ADVERTISING INDEX

Radio-Electronics does not assume responsibility for any errors appearing in the above index.

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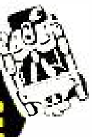
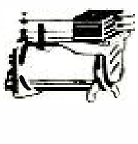
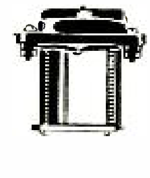
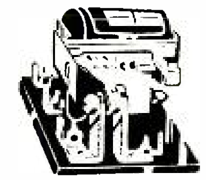

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R-161	6	10	2B&1A	1.10
R-100	24	600	2A&1C	2.45
R-289	40	3300	5A	2.20
R-518	85/125	6500	1C	3.60
R-266	150	6500	1A	2.45
R-633	180/350	10.000	1C&5Amps.	2.90
R-664	110*	...	2B&1A/Oct.Skt.	2.45
R-684	115*	...	1C	2.45
R-264	220*	...	1B	2.45
R-564	220*	...	1B&3A	2.45
R-667	6	.75	1B/10Amps.1A/3Amps.	1.45
R-632	6	12	5A&1C	1.25
R-154	6/12	200	1A	1.50
R-517	12	250	2A	1.50
R-777	12/24	70	1A&1B	1.50
R-578	24/48	2500	1B&1A	1.30
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R-565	150	7000	1A&2B	2.45
R-545	110/250	7000	1C	2.45
R-124	300	12.000	1A	1.55
R-511	24	200	W/Micro N.O.	3.05
R-160	6	12	3C&3A	1.30
R-591	6	40	1B&1C	1.35
R-592	12	160	1B&2C	1.35
R-155	12	100	4A&4B	1.45
R-520	200/300	14.000	2C	3.45
R-159	6	50	2A	1.35
R-158	6	50	4A	1.35
R-576	12	200	2A	1.35
R-153	12	200	1C&1A	1.55

SHORT TELEPHONE RELAYS

Stk. No.	Voltage	Ohmage	Contacts	Unit Price
R-635	12	100	1C&1A	$1.35
R-648	12	170	1E	1.35
R-826	12	150	2C. 1B	1.55
R-770	24	150	1A/10Amps.	1.45
R-538	24	180	2A	1.55
R-771	24	200	1A/10Amps.	1.45
R-603	18/24	400	2A	1.55
R-575	24	500	2C	2.40
R-764	48	1000	2C&2A	1.85
R-563	60/120	7500	1A	1.70
R-801	115*	...	None	1.45
R-213	5/8*	...	2A	3.10
R-690	115*	...	2C	2.45
R-589	12	125	2A	1.30
R-113	12	150	4A	1.55
R-689	12/24	255	1C	1.55
R-799	24	500	None	1.00
R-114	24	500	4A	1.60
R-115	24	500	1C	1.70
R-110	24/32	3500	1C	1.70
R-121	150	5000	2A&1C	2.05
R-634	150/250	6000	1A&1B	2.45
R-800	12	150	2C&1A	1.55
R-537	12/24	150	2C&1B	1.55
R-750	24	400	1A	1.60

SLOW ACTING

Stk. No.	Voltage	Ohmage	Contacts	Unit Price
R-547	24	200	1C–Slow Bk.	$1.80
R-548	48	1000	1B–Slow Mk.	2.00
R-128	50	2100	1C–Slow Bk.	2.80
R-525	12/24	200	1C/10Amps.S.Mk.	1.55
R-794	12	3 Coils. 16 Ohms ea.	3B&3A/15Amps.S.Mk.	3.35

CONTACTORS

Stk. No.	Voltage	Ohmage	Contacts	Unit Price
R-188	24	200	1A/75Amps.	$3.70
R-183	24	60	1A/50Amps.	3.45
R-187	24	100	1A/50Amps.	3.70
R-554	24	85	2A/100Amps.	5.90
R-788	100*	...	3B&2A	5.45
R-682	115*	35	5A/10Amps.	6.10
R-767	24*	20	2A/10Amps.	3.70
R-180	12	25	1A/50Amps.	4.05
R-657	24	50	4A/100Amps.	6.95
R-265	24	60	1A/100Amps.	3.45
R-535	24	70	1A/100Amps.	4.80
R-556	24	70	1A/100Amps.	4.80
R-557	24	100	1A/50Amps.	3.85
R-178	24	100	1A/100Amps.	4.80
R-727	10	20	1A/20Amps.	1.85
R-608	24	125	1A/200Amps.	2.80
R-184	28	50	1A/100Amps.	4.90
R-719	24	10	1A/200Amps.	4.90
R-182	28	80	1A/25Amps.	2.40
R-244	75*	265	1A/20Amps.	2.20
R-659	12	7.2	2A/20Amps.	1.70
R-681	12/15	16	2A/15Amps.	1.55
R-552	24	70	4A/50Amps.	5.35
R-185	24	100	1A/50Amps.	3.45
R-186	24	132	1A/50Amps.	4.35
R-817	24	150	1A/50Amps.	3.45
R-534	14	45	1A/30Amps.	2.05
R-223	28	150	1A/40Amps./48 VDC	1.70
R-680	6	3	1A/50Amps.	3.90
R-677	6	3.5	1A/50Amps.	3.90
R-532	6	15	1A/50Amps.	3.90
R-676	12	16	1A/50Amps. 1AUX/25A	3.90
R-678	12	18	1A/50Amps.	3.90
R-656	12	100	1A/100Amps.	2.60
R-553	24	55	1A/5Amps.	4.05
R-679	24	80	1A/50Amps.	3.90
R-610	24	80	1A Dbl.Bk.	2.05
R-555	24-	100	1A/50Amps.	4.80
R-533	24	150	1A/50Amps.	4.05
R-717	24	200	1A/50Amps.	3.45
R-703	12	20	2A/25Amps.	2.80
R-748	24	60	1A/30Amps.	2.45
R-655	24	80	1A/50Amps.	6.05
R-654	24	150	2A/40Amps.	2.40
R-742	24†	70	1A/25Amps.	3.05

ROTARY RELAYS

Stk. No.	Voltage	Ohmage	Contacts	Unit Price
R-709	6/8	1	12 Pos.3 Wafer	$3.90
R-197	9/16	70	2C	1.45
R-713	9/14	125	1C&1A	2.05
R-198	9/14	125	3B.3A.1C	2.05
R-616	28	7	5B&1A	1.90
R-712	24	200	2B	2.05
R-711	24	200	2C&1B	2.05
R-573	28	200	1C&1B	2.05
R-284	28	200	4C&1B	1.45
R-200	24/32	275	3C&1B	2.05
R-766	24	230	12 Pos.8 Deck	4.90
R-809	28	7	1B&12 Pos.W/ 7" Shaft for Wafers	2.45

W-E- TYPE "E" RELAYS

Stk. No.	Voltage	Ohmage	Contacts	Unit Price
R-736	18/24	600	3C	$1.50
R-585	12	650	2C	1.30
R-287	12/24	650	2C	1.30
R-164	24/32	1000	1A	1.50
R-646	24/48	1300	1B	1.50

DIFFERENTIAL RELAYS

Stk. No.	Voltage	Ohmage	Contacts	Unit Price
R-208	120	2000	2C/3Amps.	$2.45
R-209	220/250	8000	1C/3Amps.	3.10

SEALED RELAYS

Stk. No.	Voltage	Ohmage	Contacts	Unit Price
R-658	6	35	2C/Octal Plug	$3.45
R-125	24	300	2C/Octal Plug	3.45
R-261	12/24	1900	1C/5 Pin Plug	3.75
R-673	48/150	7500	1C/5Amps.	2.80

VOLTAGE REGULATORS

Stk. No.	Voltage	Ohmage	Contacts	Unit Price
R-745	6	2	1A/10Amps.	$1.05
R-780	24	350	1C/6Amps.	1.05
R-509	6/12	35	1B/2Amps.	1.05

SPECIAL RELAYS

Stk. No.	Voltage	Ohmage	Contacts	Unit Price
R-503	12/32	100	3A.2C	$2 80
R-749	600	...	Max.28Amps.	7.45
R-804	550*	...	1B/38Amps.	4 35
R-250	115*	...	Adj.Cir.Bk.–.04–.16A	17 50
R-579	220*	...	1B	8.70
R-294	27.5	200	1B	5.35
R-686	115*	...	2C	6 10
R-246	115*	...	1B	11.20
R-246A	115*	...	1A	11.20
R-611	24*	...	1A/30Amps.	5 35
R-283	12	125	1C/10Amps.	1.25
R-614	18/24	60	1A/15Amps.	4 35
R-262	..	200	1C	4.70
R-245	12	25	4" Micalex Lever	1.20
R-527	6/12	50/50	In Series	1.20
R-544	12/24	60/60	1C	2.05
R-255	...	...	1A	1.20
R-669	75*	400 Cycle	1B,1A	1.20
R-660	6	...	3/8" Stroke	1.20

* AC   † AC/DC

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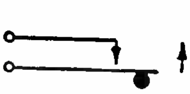
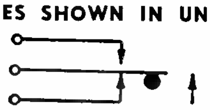
BASIC CONTACT ASSEMBLIES SHOWN IN UNOPERATED NORMAL POSITION

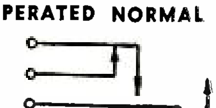


Form A—"Make" (Single Throw, Normally Open)

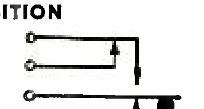
Form B—"Break" (Single-Throw, Normally Closed)



Form C—"Break-Make" (Double-Throw)



Form D—"Make-Before-Break"



Form E—"Break-Make-Before-Break"

WRITE FOR WELLS CATALOG

TELEPHONE **SEeley 8-4143**

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