DECEMBER

Radio-Electronics

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HUGO GERNSBACK, Editor

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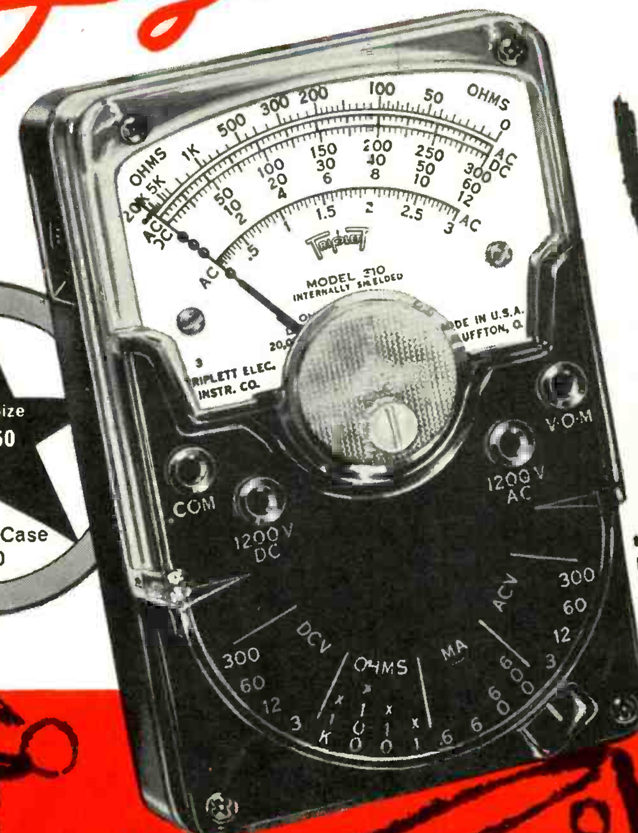

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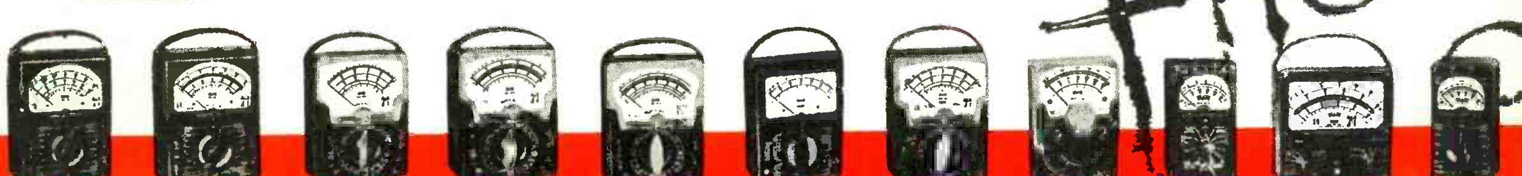

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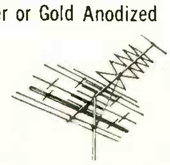

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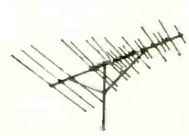

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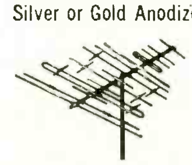

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DECEMBER, 1960

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ON THE COVER

(Story on page 36)

Troubleshooting with Trace reveals no voltage at the audio output transistor base—a good lead toward spotting the trouble in this transistor radio.

Color original by Philco

Radio-Electronics is indexed in *Applied Science & Technology Index* (Formerly *Industrial Arts Index*)

the departments

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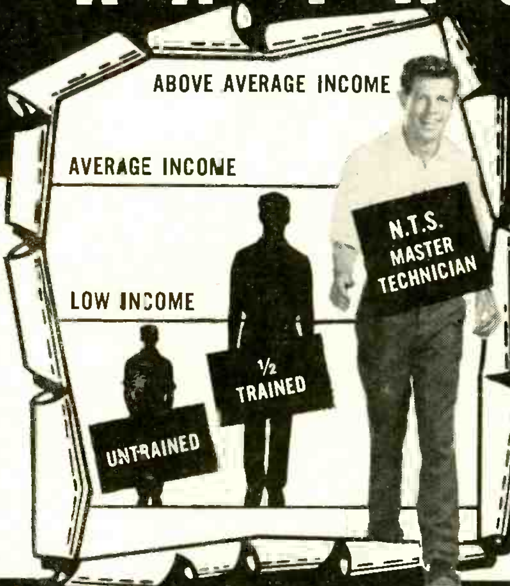

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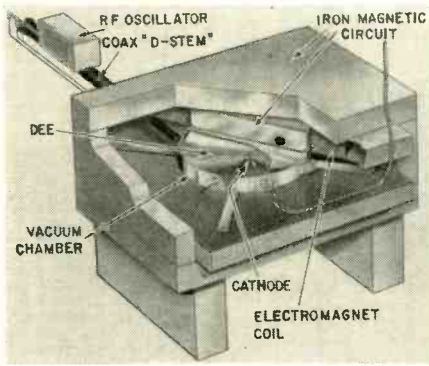
News Briefs

New Compact Cyclotron Is Office-Desk Size

A 2,000,000-volt cyclotron no larger than an office desk was presented to Pomona (Calif.) College by trustee Frank Seaver as part of the college's 73rd Founder's Day ceremony. It was built by Hughes Aircraft Co. The cyclotron speeds up charged particles in a pillbox-shaped chamber. The particles travel in circular paths and get two accelerating "kicks" on each revolution.

Technically, a cyclotron is a vacuum chamber containing two semicircular hollow metal accelerating electrodes called dees (one shown in drawing). Particles of hydrogen gas in the chamber are ionized by a hot filament near the center (at end of two-wire line). Dees are charged alternately positive and negative by the rf oscillator in the cage at upper left, which feeds dees through a large coax or dee-stem. Ions move toward the dee that is negative at the instant and are given a circular motion by the powerful electromagnetic field generated by the coils of ½-inch busbar above and below the chamber (top coil shown). The voltage and frequency are so chosen that, as the particle leaves one dee and enters the other, it finds a repellent positive charge behind it and an attractive negative one ahead



of it. Thus it travels in a spiral and keeps on gaining speed till it reaches the outside wall, where it escapes at atom-smashing velocity through an electronic gate into the target chamber.

This cyclotron can produce protons of 2,000,000 electron-volts or deutrons at 4 mev energy at currents up to 25 μamp. The accelerating voltage is 17.5 kv at 13.8 mc, and the magnetic field 9 kilogauss. Power consumed is 11 kva at 220 volts.

The cyclotron and auxiliary apparatus. The semi-circular chambers, or "dees", are in the huge iron-block electromagnet at right. The charged atom-smashing particles strike targets inserted at the right face of the block, not visible in the photograph. Viewers from left to right are—Dr. B. Wilson Lyon, president of Pomona College; Frank Seaver, college trustee who donated the machine, and Dr. Edward M. Fryer, acting chairman of the college's physics department.

Ball Lightning for Defense?

Electronic fireballs of highly concentrated charged particles (plasma) might be used to destroy missiles, physicists of the Armour Research Foundation believe. The balls would be kept active and be guided by a concentration of radar beams. Data on the subject is being studied by the Air Force, the foundation stated.

The work is based on speculation by Peter Kapitsa, the leading Russian nuclear scientist, who theorizes that a natural lightning ball is a mass of highly ionized plasma fed continuously from outside resonance absorption of intense radio waves. He believes that artificial lightning balls can be created by a powerful source of sustained radio waves focused into a small volume of space. Natural lightning balls are most often from 10 to 20 cm in diameter, which would indicate wavelengths between 35 and 70 cm, Dr. Kapitsa stated.

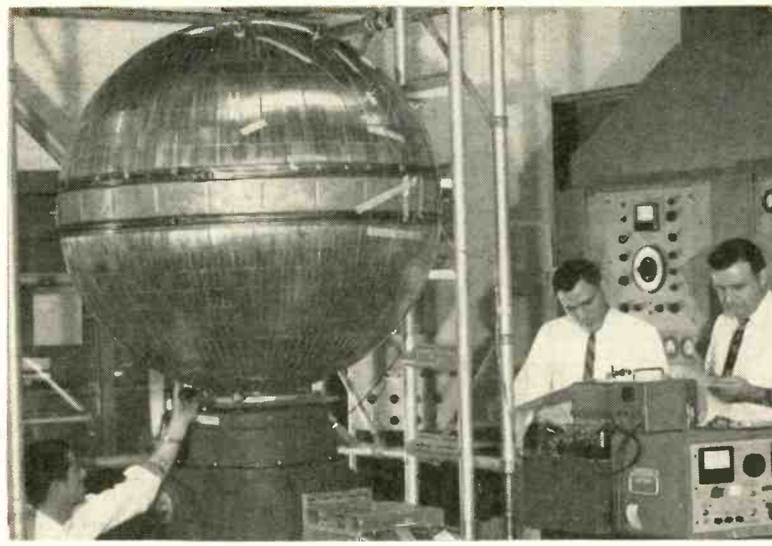
Courier Satellite Is World's First Space Station

A genuine radio station in space went into action with the launching of the Courier satellite. Intended to act chiefly as a delayed relay station, storing information sent to it for later release, it can, of course, act as a simultaneous relay as well.

The satellite system was conceived by the Army Signal Research and Development Laboratory at Fort Monmouth, N. J., under direction of the Advanced Research Projects Agency of the Department of Defense in Washington, D. C. The satellite itself was designed and developed in Palo Alto, Calif., at the Western Development Laboratories of Philco Corp., in accordance with specifications by the directing agencies.

The Courier has two complete radio systems. One, operating at vhf, is intended for tracking and locating; the other, in the microwave region, for actual communication.

The vhf transmitter sends a 50-mw signal. When orbiting, the transmitter is on for 1 second, then off for 9. The receiver follows with a 1-second listening period. When the satellite's signal is picked up by a ground station, a command signal is sent and it goes into continuous action, sending telemetered data as to the condition of the satellite and electrical equipment. At the same time, it turns on the microwave equipment. In all, 35 items are telemetered, ranging from battery voltage and signal strengths to satellite temperature. The telemetry information is sent by a 1.5-watt transmitter. There are two of these, to assure greater reliability. There



The satellite is checked for performance under simulated launching conditions.

are also two 50-mw "acquisition" transmitters.

The satellite has four 5-watt microwave transmitters. Two of them operate at a time, tuned to slightly different frequencies and connected to different antennas. Four receivers operate together. The signals received over the microwave link can be used to modulate the microwave transmitter, relaying the message to a second ground station, or can be stored. The satellite has five tape recorders to handle information from high-speed teletype machines or other sources. The information is transmitted backward on the rewind cycle of the tape, and is reversed again by being recorded and played back by a tape recorder at the ground station.

Power is supplied by the 19,000 solar cells that cover more than 70% of the total area of the sphere. The cells are hooked up in series-parallel to deliver 32 volts to a nickel–cadmium storage battery. Diodes between the batteries and the solar-cell network prevent reverse current. Diodes are also inserted between each 84-cell unit of the solar battery and the common bus, since cells on the dark side of the sphere can dissipate considerable leakage current.

BBB Cites Electronics Complaints

Third place in the national complaints-by-customers marathon went last year to the home electronic devices field, Kenneth B. Wilson of the National Better Business Bureau told the EIA service committee at its recent quarterly meeting. Leader of the pack was the home-improvement field, runner-up the major household appliance industry.

Service technicians will be pleased to hear that the larger number of consumer electronic complaints were directed at the manufacturer, and that many against the technician were based on customer misunderstanding of manufacturers' warranties.

Wilson offered the following suggestions to the manufacturers' service committee:

Ship only pretested products.

Educate the public to the nature and limits of warranties.

Limit ad claims to the product's field performance; step up replacement parts availability.

Keep the service industry better informed on products.

Recognize and correct "bugs" promptly.

New Maser Amplifies Light

A true amplifier of light was demonstrated by Bell Telephone Laboratories in early October. Unlike light intensifiers (sometimes called light amplifiers), the apparatus actually uses light to stimulate light, much in the manner of radio waves in a regenerative radio circuit.

A maser is a circuit in which radiation from atoms is stimulated. (Maser = Microwave Amplification by Stimulated Emission of Radiation.) In the optical maser, light is radiated as microwaves were in the earlier maser (RADIO-ELECTRONICS, June, 1955).

The optical maser depends upon the same principle as earlier ones, that atoms which absorb power from radiation are "excited" or raised to a higher energy level and then radiate energy if they drop back to their original level.

The optical maser is a rod of ruby, with chromium atoms introduced as controlled impurities. When excited by bright bluish light from a photoflash tube (see illustration), these chromium atoms are excited to a higher energy level, decaying back to the original level in two steps. The first of these steps is very rapid; the second a more stable condition from which the atoms, when they drop back to their original level, fluoresce or emit a deep red light.

The light emitted by the first few atoms stimulates others to emit. The ends of the ruby rod are silvered to act as reflectors so that, when a ray

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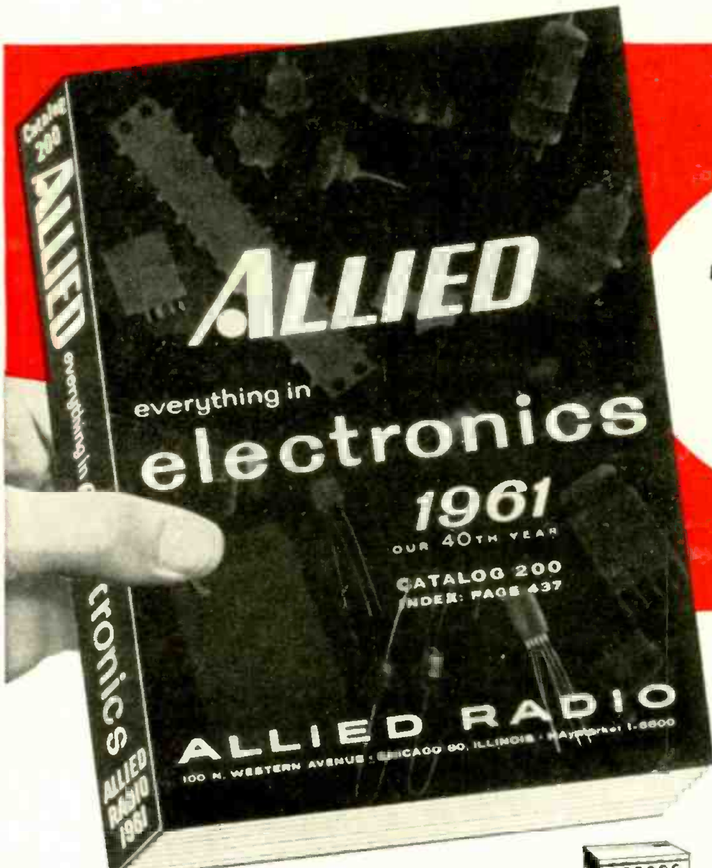

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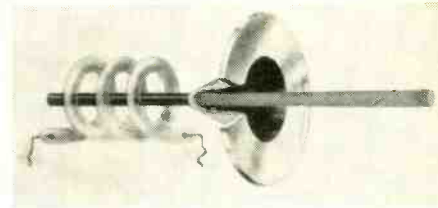


Heart of the light maser. In use, the instrument is sealed in a metal cylinder, of which the cone assembly here forms one end, to prevent light from escaping.

of light reaches one end, it is again sent down the rod, stimulating emission from other atoms. Thus an intense radiation is built up and continues as long as the outside source of "pumping" energy (the photoflash tube) continues to raise atoms to higher energy stages.

Obviously, the light which moves along the rod stimulates many other atoms to emit. Light from these atoms moves in the same direction as the stimulating light, so a very powerful beam is built up, becoming powerful enough to penetrate the thin silvering on the ends of the tube. This output can be used for signaling, in spectroscopy, or as a source of very narrow-frequency monochromatic light.

With the further development of the optical maser, it is expected that all the techniques of modulation and amplification used with lower frequencies can be applied to it. Thus the maser may extend the communications spectrum upward to an extent that will make our present ranges from the very low to the super-high frequencies an insignificant portion of the total spectrum.

Patents on the optical maser are held jointly by Professor Townes, inventor of the original maser, and A. L. Schawlow of Bell Laboratories.

Calendar of Events

EIA Winter Conference, Nov. 29–Dec. 1, Fairmont Hotel, San Francisco, Calif.

Third Annual Futuronics Exposition, Nov. 30–Dec. 2, Roosevelt Raceway Exhibit Hall, Westbury, N. Y.

Vehicular Communications Meeting, Dec. 1–2, Sheraton Hotel, Philadelphia, Pa.

EIA Conference on Maintainability of Electronic Equipment, Dec. 5–7, Grenada Hotel, San Antonio, Tex.

URSI-IRE Fall Meeting, Dec. 12–14, NBS Boulder Laboratories, Boulder, Colo.

Eastern Joint Computer Conference, Dec. 13–15, New Yorker Hotel and Manhattan Center, N.Y.

Symposium on Thermoelectric Energy Conversion, Jan. 8–12, Statler Hotel, Dallas, Tex.

National Symposium on Reliability & Quality Control, Jan. 9–11, Bellevue-Stratford Hotel, Philadelphia, Pa.

Symposium on Space Instrumentation, Jan. 16–17, Washington, D.C.

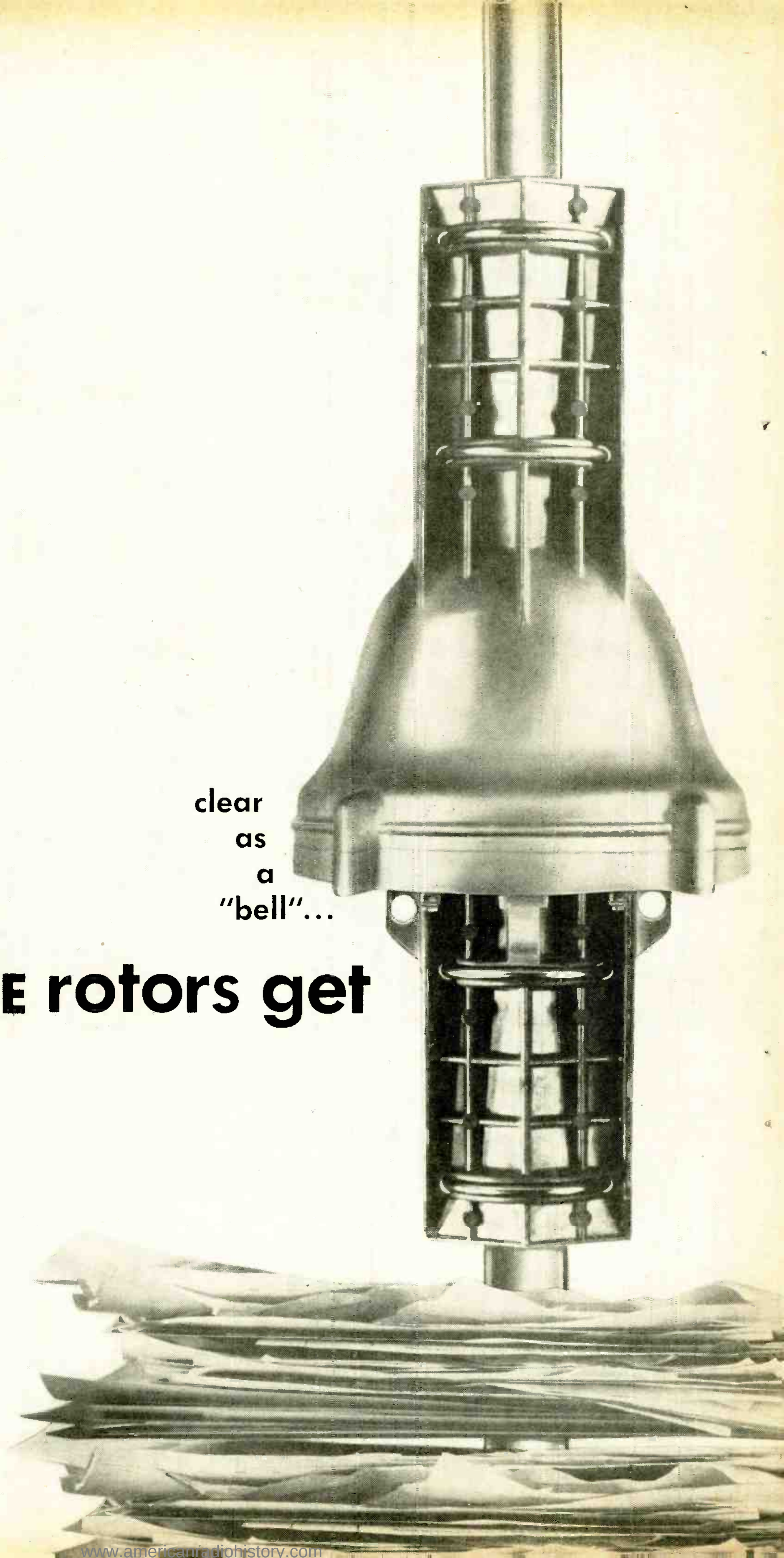
ERA Southwest Chapter Distributor.-Representative Manufacturer Conference, Jan. 29, McAllen, Tex.

Cleveland Electronics Conference, Jan. 31–Feb. 2, Cleveland Engineering and Scientific Center, Cleveland, Ohio.

Stereo at 100 Cycles, Says AES

Two papers read at the recent Audio Engineering Society Convention in New York City indicate that frequencies down to 100 cycles have a part in the stereo effect. One, by

(*Continued on page* 14)


clear
as
a
"bell"...
CDE rotors get

(*Continued from page* 10)

F. K. Harvey and M. R. Schroeder of Bell Labs stated that all listeners found a 500-cycle cutoff different from full-range stereo, and that less than 20% found a good spatial resemblance to full-range stereo. The RCA paper stated that some directional information in carried by frequencies from 100 cycles to 10 kc.

Post Office Goes Electronic

Electronics plays an important part in the new all-automated post office in Providence, R. I., which was dedicated on Oct. 20.

Electronic devices switch trays of incoming mail from one conveyor to another as directed by coded elements attached to the trays. A cancelling-facing machine checks the position of the stamp on each letter, passes it through the cancellor so that it arrives in the proper position,

and stacks the letters, now properly positioned, for transmission to the semi-automatic sorting machines.

Here the letters pass at the rate of 50 a minute before human coders, who press keys to assign the letter to any one of 300 destinations. The coded signals are recorded in the magnetic memory of the sorting machine, and the letter is directed down the correct conveyors to the 300 destination boxes.

The system was designed and developed by Intelex Corp., a subsidiary of ITT.

Mechanical automation backs up electronics at a number of points to make the whole operation of receiving, unloading, sorting and re-dispatching the mail automatic.

The project is expected, not only to be a super-efficient post office, but a means for testing other new postal machines and for gaining knowledge that may be applied to the United States postal system as a whole.

Underground TV

A TV camera was used by the Washington Gas Light Co. to inspect the gas mains under the route of the Presidential inaugural parade, to guard against any leaks. The camera was pulled through the 24-inch mains to spot cracks. Workmen above watched the screen, noted the position of bad sectors, and plugged the leaks with sealing fluid. END

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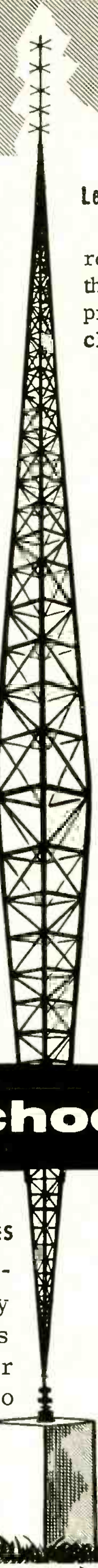

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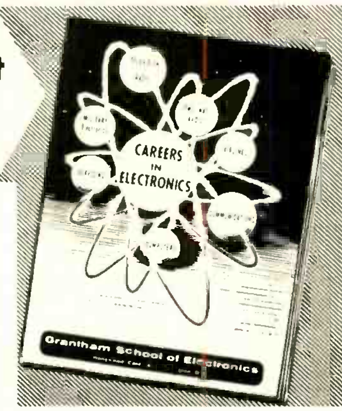

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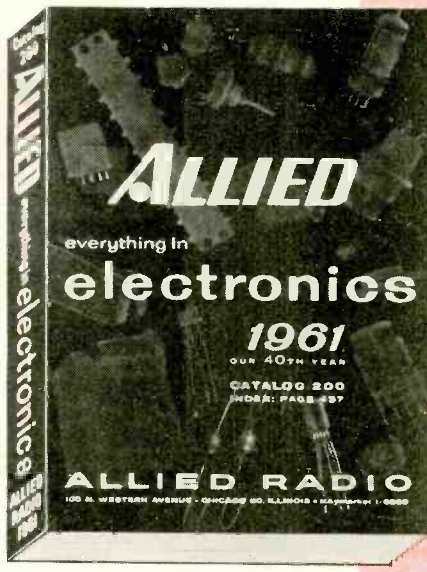

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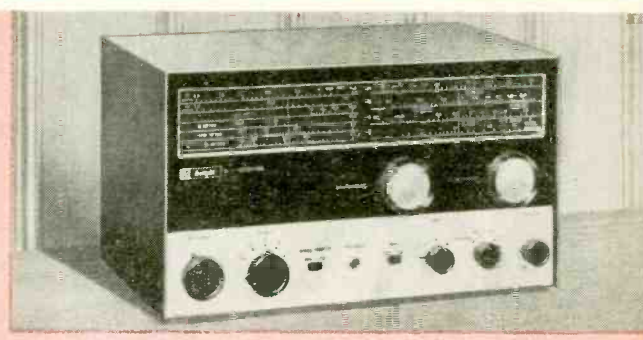

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Correspondence

HOW ABOUT A FUSE STORY

Dear Editor:

I would like to see an authoritative article about fuses printed in RADIO-ELECTRONICS.

As you know, fuses are rated both as to current and voltage. I became curious about the voltage angle and in an unorganized information sort of way learned that the voltage rating is on account of the explosion hazard.

The question came up because I wanted to fuse a 400-volt power supply. Due to unknowns in the picture, I developed a simple circuit breaker instead. But I was so surprised to learn of a fuse explosion hazard that I thought the whole subject might be explored by an article in RADIO-ELECTRONICS. JOSEPH H. SUTTON

Kansas City 13, Mo.

[We have just such a story scheduled for the near future, and a shorter treatment on page 99 of this issue.—*Editor*]

IDENTIFY CALIBRATION SIGNALS

Dear Editor:

I enjoyed the article "Identify Your Calibration Signals" in the September, 1960, issue. I have often had to identify my own calibration signals on my communications receiver. However, I use a simpler identification system than the one proposed in the article.

When there is some doubt as to whether a signal is the calibration oscillator signal or a strong unmodulated carrier, just turn off the calibration oscillator. If the signal stops, it came from your oscillator; if not, it is not from your oscillator.

Obviously, my method is far inferior to the one you suggest. However, you must admit that my method is less expensive. JAMES F. VAN DETTA

Schoharie, N. Y.

[We admit it is cheaper, but as you say—it isn't better.—*Editor*]

BUILDS PREAMP AFTER READING R-E

Dear Editor:

I have just completed building the preamp described in "Design Your Own Preamp," on page 61 of the May issue.

In my version I have changed the design for stereo, using four 7025 tubes —one section of each tube per channel. I used only RIAA equalization to reduce wiring problems and keep components to a minimum and because it is almost the only equalization needed today. Switching provides for stereo, stereo reverse, FM single channel, FM both channels, FM multiplex.

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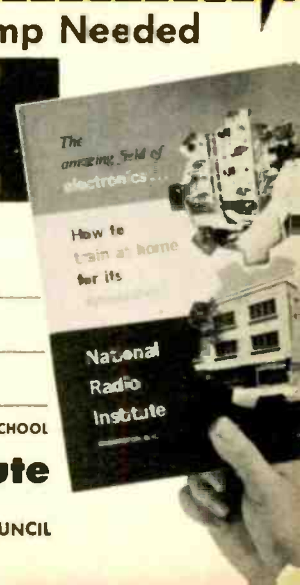

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W. R. WILLIAMS

Toronto, Canada

[We sent your letter to Mr. Crowhurst, who is favorably impressed. He suggests that, since his story was a design article only and as you have constructed a prototype, it might make a useful construction story. Do you feel like writing a story on it?—*Editor*]

MORE TRANSISTORS, PLEASE

Dear Editor:

Please print more data on transistors as they are introduced.

L. C. ERNST

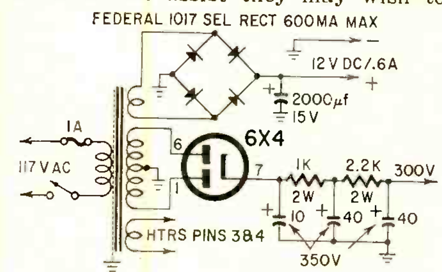
Ann Arbor, Mich.

[We list the most interesting new transistors in our monthly New Tubes and Semiconductors column. You'll find it listed on the contents page.—*Editor*]

PREAMP POWER SUPPLY

Dear Editor:

Many readers may want to build the preamp discussed in "Design Your Own Preamp," on page 61 of the May, 1960, issue. As an assist they may wish to



use the power supply shown here. It centers around a Webster Electric transformer No. 212-19764-97-0, which puts out 300 volts B-plus and 12.5 volts from its heater winding.

C. L. KING

Plainfield, Ill.

[Thanks for the circuit. All interested preamp builders please note.—*Editor*]

DISPLEASED

Dear Editor:

Please list me along with other readers who were disappointed with the statements of your Mr. Middleton regarding "Eggy." I noticed with pleasure that he went on in his article to use equations and information which were certainly not the work of the uneducated.

Mr. Middleton's attempted ridicule of anyone possessing an uncommon amount of knowledge is, however, surpassed by Mr. Jack Darr's efforts in the TV Service Clinic in the September issue. What does he mean by "even a 'PhD' can do it himself"? Is he one? If he were, he would be aware of how to write and punctuate the letters standing for the degree. Later he mentions quitting a training course in disgust since he disagreed with a statement made by the instructor. Why wasn't he teaching the course?

Of all magazines in which to find people and knowledge in general held

(*Continued on page* 24)

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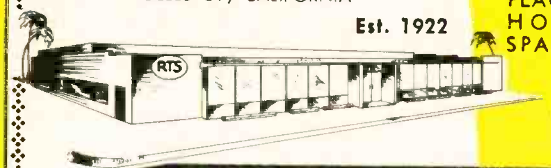

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(*Continued from page* 21)

up to ridicule, RADIO-ELECTRONICS with its excellent articles and scientifically brilliant editorials should be the last. As the editorial in this very issue (September) implies, this is the age of interstellar activities. It is not the era of Robert Fulton. H. L. COVER
Fredericksburg, Va.

MR. DARR'S REPLY

Dear Mr. Cover:

It seems to me that both Bob Middleton's article and my TV Clinic introduction did not present our point as clearly as they might have. What we were both trying to say, in different ways, was that TV technicians need *more* knowledge, certainly not less!

However, the point was, as both of us have said repeatedly, it is *not* necessary for a practicing TV technician to know how to *design* a TV set before he is able to service it. He must know the basic circuits, their commercial applications and the characteristics of all types of parts. But, as for the higher-level math needed in design work—it is not only unnecessary, but actually useless in service work.

The proficient service technician must have *both* a theoretical and a practical knowledge of TV circuitry! Either one alone is quite useless. I remember (another) college instructor, also with a PhD (plus a doctorate in math, too) and a complete knowledge of radio design theory, who was completely unable to locate an open filter capacitor in a little ac–dc radio! I showed him how; I was at his home to get some help in math. He not only laughed, but told the incident in class the next day!

So it depends upon the instructor. I am still in complete disagreement with the attitude of the highly educated gentleman mentioned in the column—that all a TV technician needs to know is how to clip out and replace parts. First, he must have enough knowledge of circuitry to *find* them!

JACK DARR

BOOKS DISTRIBUTED

Dear Editor:

After going through the replies to my letter, which appeared in the June issue of RADIO-ELECTRONICS, I have distributed the books among those who wrote. I wish to thank you and your staff for your co-operation. It has been more than I ever expected and I appreciate it more than words can say.

NAME WITHHELD

[*The kind donor was somewhat reluctant to describe her part in the distribution, so here is a brief summary.*

A total of 32 books was distributed among seven persons. The breakdown was made by the donor and took into consideration both the need of the recipient and the suitability of the subject matter of the books. Two persons receiving books were also presented 1-year subscriptions to RADIO-ELECTRONICS *by the donor.*

We have been delighted to cooperate on such a worthy project and are pleased to have been offered the opportunity.—Editor] END

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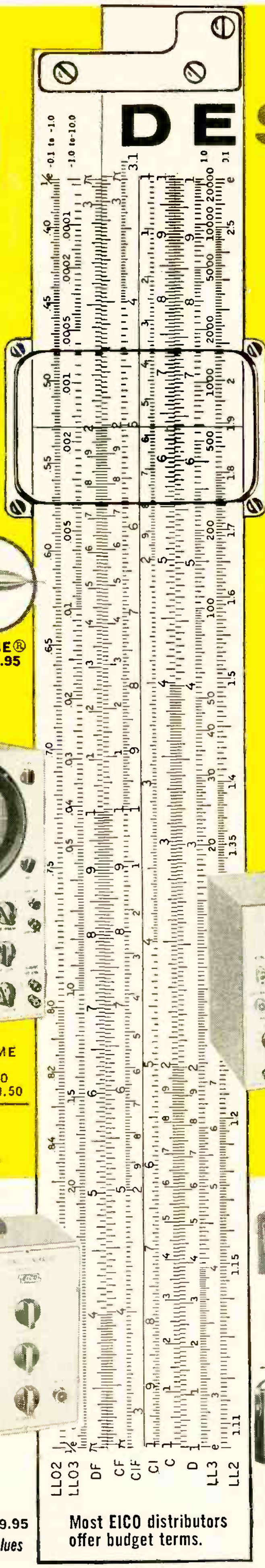

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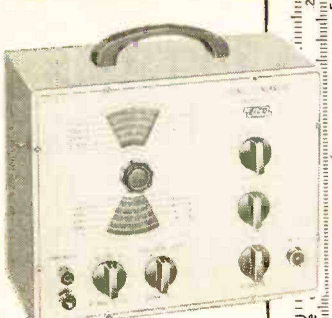

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HOW FAR AMPLIFICATION?

. . . *It Is Doubtful That Ultimate Amplification Is Possible Soon* . . .

WHEN Marconi in 1901 sent his historic letter S across the ocean, a distance over 2,000 miles, from Poldhu (England) to St. John's (Newfoundland), he used what was then considered a terrific amount of power (20 kilowatts) to do so. The reason: modern electric amplification was unknown. Hence his primitive auto-coherer (detector), even with a high antenna, was just sufficient to intercept the faint signals over the single 'phone he used at that time.

True electronic amplification was not possible till the advent of de Forest's vacuum tube and the principles of regeneration, superregeneration and amplification using a number of tubes in cascade, each step amplifying the original signal enormously.

Today's radio amateur can easily communicate with his friend at the antipodes with a transmitter that uses but a few dry cells and has a power output of only a few watts. To achieve this, the signal is amplified hundreds of millions of times at the receiver; yet only a minimum number of vacuum tubes or transistors are used.

Spectacular as these results are, amplification at present has its limitations. Vacuum tubes cannot be added indefinitely in cascade because the tube noises are amplified too, and very soon a point is reached where the inherent noises of the receiver overpower the signal.

A similar condition exists in transistor receivers to a lesser degree. Nevertheless, with each additional transistor the noise ratio increases, soon preventing further magnification of the original signal.

As time goes on, the obvious remedy seems to lie in the greater and ever greater sensitivity of the detectors used, as well as radically new amplifiers. It all started with Hertz' detector, a wire with a brass ball on each end and formed into a loop. You *saw* the result in the form of a tiny spark. Then came the Branley metal-filings coherer, followed by the Marconi hysteresis-iron-wire-band detector, later the crystal detector, then the vacuum tube, a while later the transistor. More recently new low-noise amplifiers, the *parametric amplifier* and the maser, have appeared. These produce very much less noise than do tube amplifiers, and hence can be used to amplify signals that would formerly have been lost in receiver noise. This covers the comparatively short time of some 60 years.

There would seem to be little doubt that as time goes on more and more sensitive detectors will be invented. Amplifiers too will be vastly improved. It appears certain that the amplifiers of 60 years hence will give many thousands of times greater amplification than those we have today. This despite the fact that scientists will tell you that you cannot drive amplification beyond a certain mathematical limit. Their ideas stem from the fact that even if you succeed in eliminating all the extraneous and inherent noises, you will then amplify the colliding electrons themselves. Very true. Nevertheless, remedies for such an eventuality will be found, probably in new applications of *cryo-electronics*, i.e., in hypercooled circuits, near absolute zero, coupled with atomic power that generates the necessary supply current. Incidentally, masers in use today already use cryo-electronics to reduce thermal noise to the minimum.

Why the race for superamplification? In military missile detection, in submarine detection, our present instrumentation is still, to put it bluntly, extremely crude. We have made only a start in this direction.

Further, we still struggle with atmospheric and ionospheric interference of radio waves; the quality of the signal is all too often not very good. This is particularly true in radio astronomy, where all signals must pierce our atmosphere. As we have mentioned before on this page, one remedy would consist of a lunar detecting center. Then the highly amplified, powerful signal could be sent to earth without difficulty.

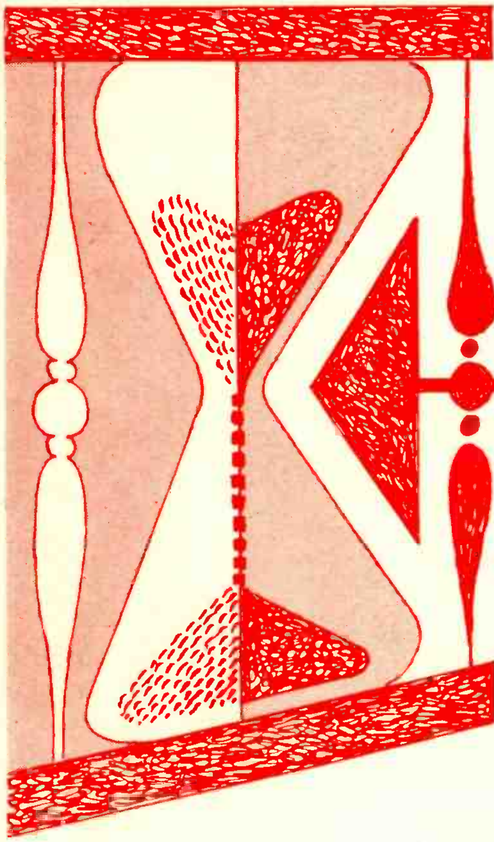
Despite atmospheric and ionospheric difficulties, we have been able to receive radio signals over immense distances. In 1950, Professor Lovell and his associates at England's Jodrell Bank radio observatory succeeded in registering radio signals from the Great Nebula in Andromeda (M31) 2,000,000 light-years distant! The frequency, incidentally, was 1.9 meters (158 mc). A light-year is the distance covered by light traveling at 186,285 miles per second during one year, or almost 6,000,000,000,000 (6 trillion) miles. Radio astronomers really should call the unit a *radio-year*, since they use radio waves, not light waves.

If Marconi's original letter-S signal had not been absorbed completely by the ionosphere, it would be speeding out into space now almost 60 light-years—or 60 radio-years. Later, also more powerful, short-wave signals are 35 radio-years out in space, winging through space to be intercepted by other civilizations, should they exist in a neighboring world. But as our galaxy measures more than 100,000 radio-years across, it may be many thousands of years before our radio emissions reach a radio-civilized planet of some galactic sun. Hence we cannot hope for an early answer or other communications from some other intelligent world which has known electronics for eons.

Furthermore, there is always the possibility that weak, attenuated signals from other worlds have reached the earth for ages. But we have not intercepted them because of our crude detectors and insufficient amplification.

It is one thing to intercept signals from a star naturally powered with billions of horsepower. It is quite another proposition to detect signals with a moderate power of 1,000 or 10,000 kilowatts that would originate from a planet inhabited by intelligent beings. Such signals would arrive on earth so attenuated that we would certainly not be able to intercept them for a long time, due to the present crude state of our electronic art. —*H.G.*

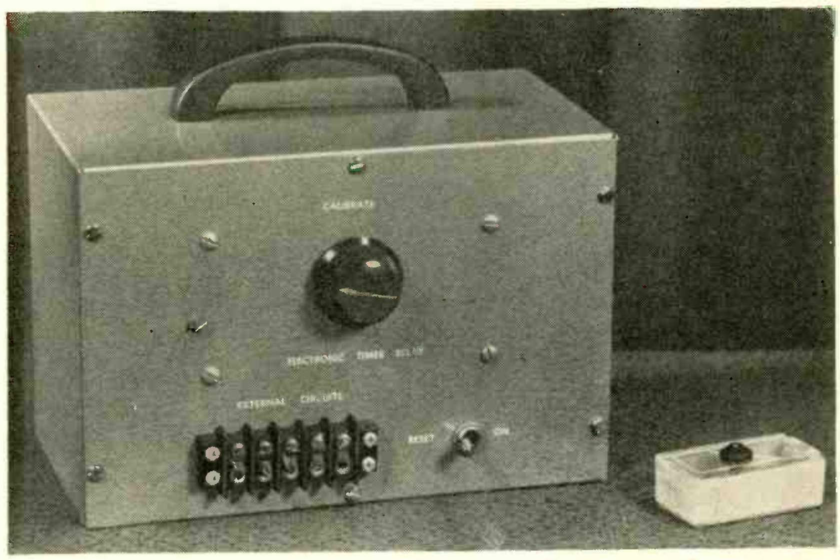
A very Merry Christmas to all our readers—The Editors



an integrating timer

It adds up light, temperature, pressure or humidity till the total keys a relay.

By JOHN POTTER SHIELDS



There are only two controls on the face of the instrument. Note the photocell at the right.

THIS electronic timer has been designed for use where the average timer is inadequate. It is battery-operated, freeing it from the power lines and, since no vacuum tubes are used, it is extremely rugged. Although the timer was originally developed as an electronic exposure timer, it can be used for practically any other timing operation including event timing, time delay and process control.

As mentioned above, this timer was originally designed to be used as an exposure timer. However, unlike the ordinary indicating exposure meter, this one "integrates" the total amount of light or other types of radiation received, and trips a relay when a predetermined amount has been received. By choosing the proper photoconductive cell, various types of radiation from infrared to X-rays will actuate the timer. One practical application is that of accurately controlling the exposure time of a photo enlarger. The tiny photocell is placed so it will receive the same amount of light from the enlarger as the unexposed print paper. Once the timer has been calibrated for the various kinds of papers to be used, it will automatically control the time of exposure, depending upon the density of the negative used and the enlarger lens opening. Since the unit is portable, it can be even taken out to the beach to monitor how long you sunbathe!

The timer is easy to build. It requires no special components, and current consumption is slight, making it economical to operate. The timing interval is from several seconds to about an hour.

How it works

Fig. 1 is the unit's circuit. The neon lamp, calibration control R1, photoconductive photocell V1, and R2 are

R1—pot, 5 megohms, linear taper
R2—1,000 ohms, ½ watt
R3—470 ohms, ½ watt
R4—100 ohms, ½ watt
R5—15,000 ohms, ½ watt
C1—40 μf, 150 volts (tantalum or standard electrolytic, depending on space requirements)
C2—0.5 μf, 200 volts
BATT 1, 2—67.5 volts (Burgess P45 or equivalent)
RY—dpdt, 2,500-ohm coil (Potter & Brumfield type LM-11 or equivalent)
S1—dpdt toggle
V1—CL-2 or CL-3, Clairex photoconductive cell
V2—2N332
Terminal strip, barrier type, 3 or more terminals
Neon lamp, NE-2
Case and chassis to suit
Miscellaneous hardware

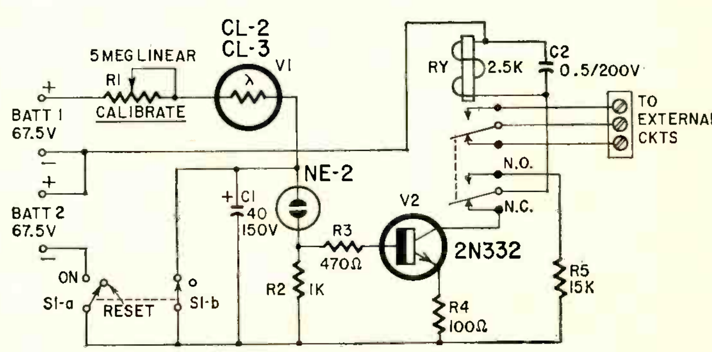
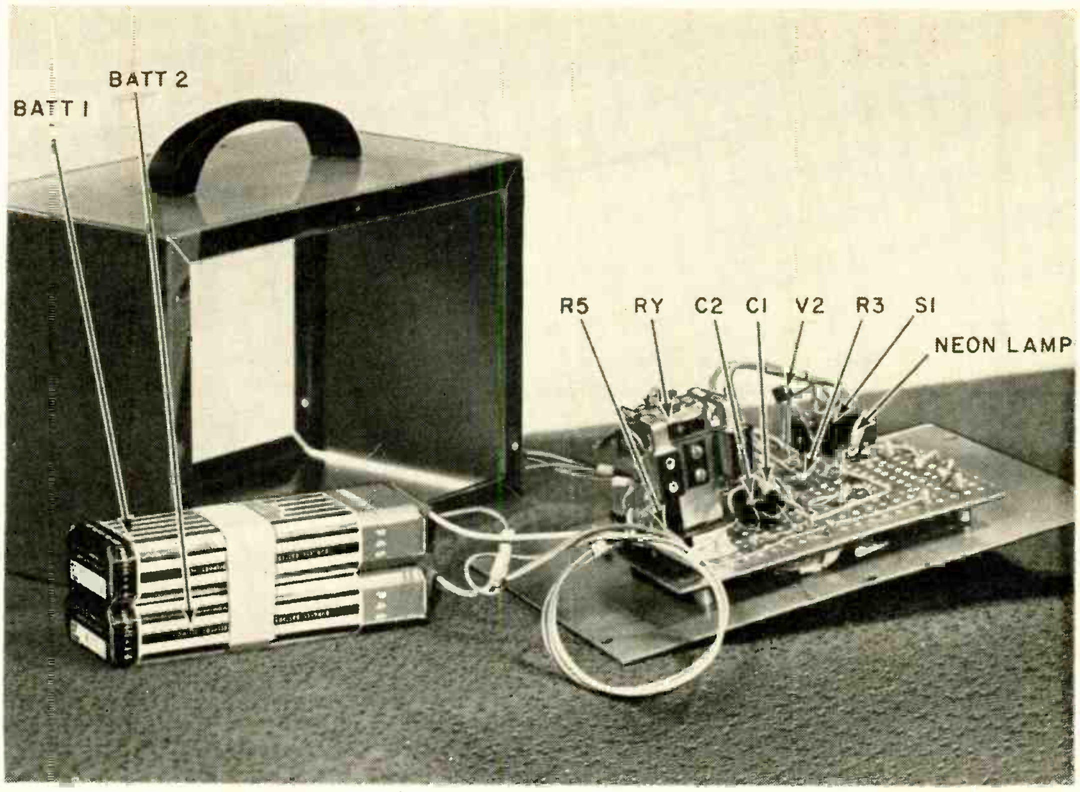


Fig. 1—Circuit of the timer.



Since parts layout is not critical, this is only one possible way of assembling the unit.

connected in series across the two 67.5-volt batteries. Capacitor C1 and reset switch S1-b are connected across the neon lamp. When the power switch S1-a is closed, current from the two batteries flows through R1 and V1, charging C1. The charging rate for C1 depends upon the setting of R1 and the resistance of V1, which will vary from many megohms in total darkness to a few thousand ohms in bright sunlight. Thus, the capacitor's charging depends on the internal resistance of V1, which in turn depends on the amount of radiation (light or otherwise) striking it.

When C1 charges enough to fire the neon lamp (around 75 volts), a brief positive-going pulse is developed across resistor R2. The pulse is applied, through isolating resistor R3, to V2's base. The pulse momentarily biases the transistor's base positive with respect to the emitter, causing a corresponding pulse of collector current to flow through the relay coil, energizing the relay. A dpdt relay is used, and one set of contacts is connected so that, once energized, the relay stays locked in until the power switch, which is ganged with the reset switch, is opened. Resistor R5 limits relay coil current when the relay armature is energized. If you want the relay to close only momentarily, wire it as shown in Fig. 2.

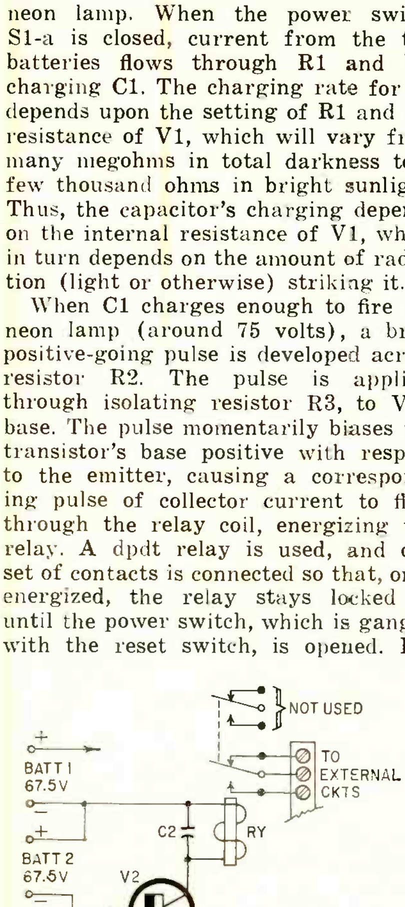


Fig. 2—Alternate circuit for momentary relay closing.

The timer circuit was assembled on a perforated phenolic-board chassis which is fitted into a metal cabinet. The photocell is mounted in a small metal box and connected to the main timer unit by a length of ordinary line cord. This is done so the photocell can be conveniently located in tight corners if necessary. A barrier type terminal strip is mounted on the front of the timer cabinet, and the photocell and second set of relay contacts are connected to it. The two batteries are held in place with simple sheet-metal straps. Decals dress up the units. Give them a coat of clear plastic spray after they are thoroughly dry. While a tantalum charging capacitor was used in the original model to save space, an ordinary tubular electrolytic will work just as well.

Calibration and operation

The timer must be calibrated before it is placed in operation. The simplest way to do so is to expose the photocell to the light source to be used and, with the unit operating, adjust the CALIBRATE control for the desired timing interval. This must be done with the photocell placed at its normal operating distance from the light source. If the cell is placed at a different distance from the light source, the timing interval will change because of the difference in light intensity.

If the timer is to be operated in applications involving extremely high illumination levels such as direct sunlight, place a filter over the photocell to get a reasonably long timing interval. If such a filter is not used, the photocell's resistance will be extremely low, and unreasonably large values for charging capacitors will be required for reasonable timing intervals. If desired, a variable aperture can be used in place of a filter. Generally speaking, the filter or aperture should keep the cell's internal resistance somewhere between 1 and 5 megohms when it is exposed to the light source.

If desired, replace the photocell with a fixed resistor and use the unit as a conventional electronic timer. Then the calibration consists of just setting the timing control for the desired timing interval.

A thermistor can be substituted for the photocell if a change in timing with a change in temperature is desired. In fact, any variable-resistance transducer —pressure, humidity, sound—can be used with this timer.

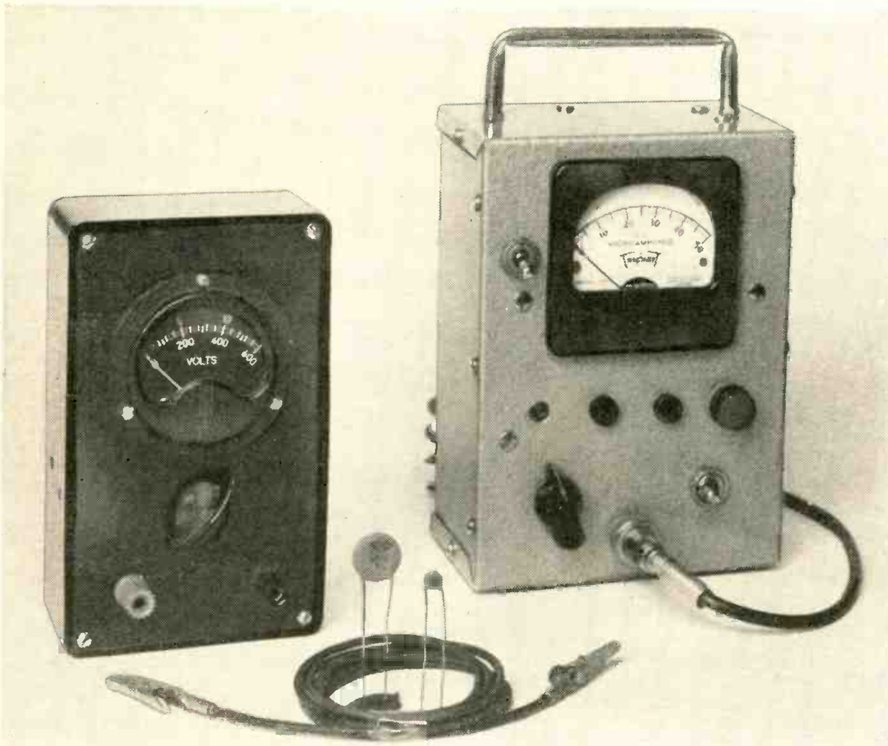
As mentioned before, this circuit is not critical with respect to components and a number of substitutions are possible. If desired, two 45-volt batteries can be used in place of the 67.5-volt units shown. Also, a p-n-p transistor such as the 2N398 can be used in place of the 2N332. All that is required is that the battery and charging capacitor C1's polarity be reversed; no other circuit changes are necessary. A different relay can be used as long as its sensitivity is equal or better than that of the one specified. (It may be necessary to change the value of R5 slightly, if a different relay is used. This resistor should be chosen so the relay just stays pulled in when it is energized. Too low a value of resistance will cause excessive current flow through the relay coil and reduce battery life.) Parts layout is not critical, and almost any desired layout and housing can be used.

Well, that's the story. Why don't you build one of these little timers? You'll be surprised at its many uses. END

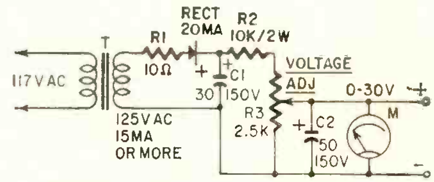
TAMING THE VIDEO IF SYSTEM

Speed up if troubleshooting with these tricks of the trade

By WAYNE LEMONS



Bias box (left), dc vtvm, clip leads and ceramic capacitors are all you need to tame the video if.



R1—10 ohms, ½ watt
R2—10,000 ohms, 2 watts
R3—pot, 2,500 ohms, 4 watts, linear taper
C1—30 μf, 150 volts electrolytic
C2—50 μf, 150 volts electrolytic
M—voltmeter, 0 to 30 volts
T—primary, 117 volts; secondary, 125v ac, 15 ma or more
RECT—20 ma or more, selenium
Case and binding posts

Fig. 1—Bias box schematic. Transformer may be salvaged from antenna booster.

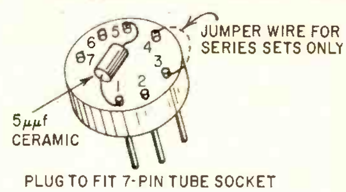


Fig. 2—Small ceramic capacitor mounted on plug completes stage jumper.

THE video if system can be exasperating when it doesn't function properly. It develops troubles that are hard to pin down to a particular stage or component. These problems are all the more difficult to solve because of the high-frequency signal paths involved.

These tricks of the trade that have been developed over the years will speed if troubleshooting procedure. They can help you turn a potential dog into an interesting challenge. They may be just what you need to cure that service headache "twice as fast!"

Test equipment

These tricks do not involve any expensive or complicated special test equipment. A jumper wire with an alligator clip on each end, a couple of ceramic capacitors, a vtvm and a bias box are all you need. See photo above.

If you don't already own a bias box, a schematic is shown in Fig. 1. Its design is quite flexible. About the only precaution necessary is that the output be isolated from the power line. A low-impedance output is necessary so that the bias box can take over the agc line by swamping out any other voltages developed on it. Use a low-resistance high-wattage pot for the VOLTAGE ADJ control. This will insure a low-impedance output, and any voltage on the agc line will not damage the control.

A meter across the bias box output is desirable. This will immediately indicate a shorted agc line. Almost any meter with reasonable accuracy is satisfactory.

Locating a dead stage

Sometimes it is pretty hard to track down the actual defective stage even though you know the if system is faulty.

Obviously, all voltages should be checked. Check plate and screen voltages and for low or high agc voltage at the if tube grid. Make sure the tube is the correct type. An incorrect tube type is commonly overlooked, and can make you feel like a fool when you do stumble onto it.

If no obvious faults are uncovered, we may suspect that the stage is not really defective at all. However, there are so many possible troubles that we can sometimes miss even the more obvious. How often have you wished that you could just substitute a stage for a suspected one? In the video if it's easy! How? Remove the if tube. Take a 5-μμf ceramic capacitor and solder it from the grid to the plate terminal on the tube *socket*. These are always pin Nos. 1 and 5 for seven-pin tubes. Leave the tube out and turn the set back on. If the stage is defective, you will now get picture and sound because all parts in the stage have been bypassed (with the possible exception of the coupling transformers). You can jump these also with a capacitance link if necessary.

Stage jumper

Fig. 2 shows a stage jumper using a miniature seven-pin plug and a 5-μμf capacitor soldered from pin Nos. 1 to 5. This will let you find a defective stage without pulling the chassis. It may also be used to check an rf stage. For series-heater sets, connect a jumper between pins 3 and 4. This will raise the voltage on the other heaters while you are testing, but the rise will be so slight as to be unimportant (for test purposes).

After finding the defective stage, you should have no trouble finding the defective part, using conventional methods.

Unfortunately, the stage jumper might be misleading if the set has agc troubles. The reason is that the gain of the system is lowered so that, if it had been overloading, it might operate OK when the stage jumper is used. (Of course, the cause of the overload should be found rather than just returning the set to the customer with the stage jumper installed!) But seriously, if the customer is in an extremely strong signal area and the agc in his set is inherently poor, the stage jumper might be the answer to a lot of problems.

Checking Tubes

Although checking tubes without a tube tester is not always the quickest way, it can be the most accurate.

You can become adept at checking emission and stage operation by just measuring the voltage drop across the cathode resistor. This voltage represents all the tube currents (except heater) in the stage. Cathode voltage, therefore, can tell quite a story—if you will let it.

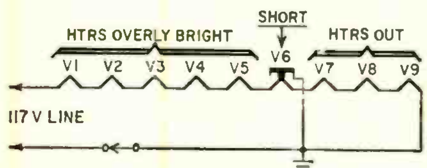


Fig. 3—Heater–cathode short in V6 extinguishes V7, 8 and 9, applies excessive heater voltage to other tubes in string.

For example, let's suppose you have little or no cathode voltage. The trouble could be a defective tube or it could be that the agc bias on the grid is excessive. To check tube emission, use a jumper wire between the grid and cathode. For most circuits, simply connect the grid to chassis. Usually the set contains two (or more) stages having identical cathode resistors, so you can compare one tube against another.

The big advantage of making the tube tests in this manner is that the tube is tested under actual operating (or nonoperating) conditions. No tube tester will exactly duplicate conditions found in a set. This method may also show up faults in the circuit such as an incorrect tube type, defective wiring, etc.

Heater–cathode shorts are easily isolated in parallel-heater sets. Clip the jumper wire from the cathode terminal of the tube socket to the chassis. If the hum bar in the picture disappears, you have isolated the defective tube. Sometimes this method will burn out the short in the tube and it will seem to operate normally. It is usually best, though, to replace the tube.

Heater–cathode shorts in series-heater sets nearly always either burn themselves out or else bypass the heater circuit so that some tubes will light (usually too brightly) and others will not. Tubes that do remain lit may be damaged by excessive heater voltages. A simplified schematic (Fig. 3) shows how this happens.

Checking for gas or grid leakage is a little more difficult but can be done. Disconnect the leads from the grid and cathode terminals of the tube socket. This leaves the tube grid and cathode floating. Now, using a vtvm, measure the voltage on the floating grid terminal (Fig. 4). Any tube with a positive grid voltage, though small, must be replaced.

Note that all elements in the tube except the control grid (and suppressor grid and heater, which are not important in this test) are at a relatively high positive voltage. Any leakage to the grid is therefore indicated as a positive voltage.

Stacked stages

A few manufacturers have used stacked video if stages—two tubes in series across the power supply. Fig. 5 is a schematic of a stacked stage similar to that used in some Zenith models. They can be tricky to troubleshoot. For example, if you have little or no plate or screen voltage on V1—the trouble is almost sure to be in tube (or stage) 2! This could be caused by a defective tube or by an open 56,000-ohm resistor from the B-plus line.

Note that this resistor sets the bias for V2's grid. This positive bias on the grid of V2 causes it to conduct. V2's cathode is in series with tube V1 and goes positive. This voltage is used as the plate and screen supply for V1. This circuit is similar to that used in cascode rf amplifiers.

Touchup

Touchup of the if stages is often frowned on by the so-called professionals, especially the text-book set. You will find from actual experience though, that touchup can be the lesser of many evils. It should be used only when it is apparent that no other method will produce the desired results. For instance, we don't recommend it when using a built-in antenna or rabbit ears. Moving the antenna can upset the overall response of the set and make touchup useless. If, however, an outside antenna is used, a touchup may mean the difference between a passable and a really good picture and sound.

Don't go hog wild, but if you have a sound buzz that is obviously caused by too much sound gain in the video if (and you can't eliminate it with adjustments in the sound if or agc system) moving one of the if slugs slightly may eliminate the buzz. Adjust for the best sound while watching the picture. You will usually find an adjustment that produces both good sound and picture. If a slight turn smears the picture, move the slug back and try turning it in the opposite direction.

Touchup can also improve picture detail. If the fine detail is hard to make out, a slight adjustment of one if slug may produce a crisp, clear picture (or you might need glasses).

Touchup may be required even after a sweep alignment of the video if. This need may be caused by either poor alignment equipment or improper technique. Next time try the touchup procedure *before* you align the set. You may get a world of improvement with just a "twist of the wrist!"

Re- and degeneration

Although regeneration and degeneration are exact opposites, they can be caused by the same component going bad. This depends entirely on stage design. An open bypass capacitor may cause a stage to oscillate (regeneration) or have low (even less than unity) gain (degeneration).

Regeneration symptoms take many forms but usually herringbone lines appear in the picture or (if severe) the picture may actually appear negative. Because regeneration can also affect many types of agc circuits and cause them to produce excessive voltage, the screen may be blank (raster but no picture).

Measure the voltage across the detector load resistor (Fig. 6). If the if system is oscillating, the drop will be several volts even though no station is tuned in.

A good method for isolating the os-

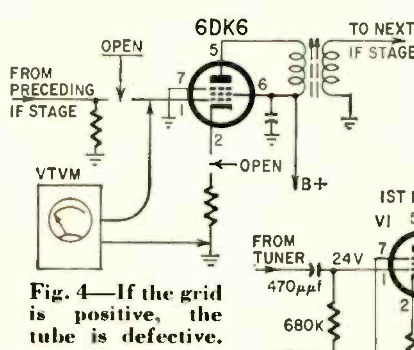


Fig. 4—If the grid is positive, the tube is defective.

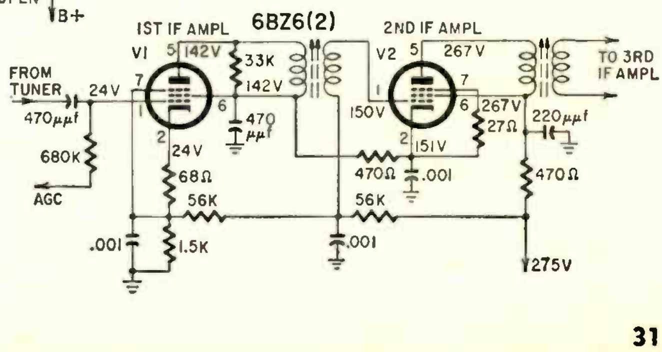


Fig. 5—In stacked-stage arrangement, one tube gets plate and screen voltages from cathode of second tube.

cillating stage is: beginning with the first if, pull the tube while watching the voltage across the detector load resistor. If the voltage drops to near zero when the tube is pulled, then either the stage is oscillating or is part of an oscillating network. If there is no voltage change, move on to the second stage, etc.

Once you have found the defective stage, check for missing tube shields, defective grounds, incorrect tube type, open suppressor-grid connection or open bypass capacitors. The capacitor giving the most trouble is the screen and plate decoupling bypass. This capacitor, when open, can also cause degeneration and washed-out pictures.

Improper alignment may cause regeneration but this is rare unless the set has been tampered with. So look for all other possibilities first.

The stage jumper described at the beginning of this article is ideal for spotting a case of severe degeneration. It may also be helpful in spotting a regenerative stage (and determining if other troubles exist).

Agc problems

Of all the difficulties encountered in the if system, perhaps none is more dreaded than an agc problem.

Here's what we feel to be the best approach. First, use a bias box to *make sure that you really have an agc problem.* A symptom that points to the agc system may be caused by something else entirely. The bias box, when connected to the agc line, will restore the picture at some voltage adjustment—if the trouble is caused by improper agc action.

The bias box will determine whether the fault is in the agc system. Tracking down the actual defective part is seldom so easy. But, at least we now know where to look.

There are many types of agc circuits. It would be impossible to discuss them all in this article. Usually, as with most

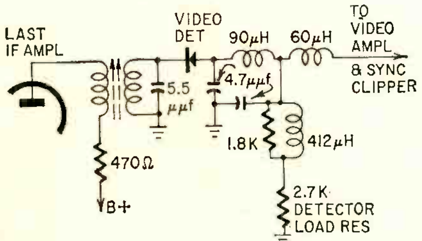


Fig. 6—Typical video-detector stage.

TV problems, trouble is caused by a component failure. In some cases though, perhaps only an adjustment is necessary.

Keyed agc circuits are usually more difficult to troubleshoot. A trick or two here is essential. First, if you find that you have little or no agc voltage, divide the circuit—find out in which direction the fault is.

Artificially "keying" the agc keyer tube is an easy way to divide the circuit. Use a jumper wire between the keyer tube grid and cathode. This will zero-bias the tube, and it will conduct, producing 15 to 50 volts negative on its plate *unless* something is wrong in the keyer circuit. If you get little or no negative voltage, it is likely that you have a defective keyer tube or wiring or that you are not getting the keying pulses from the horizontal sweep circuit.

If the keyer seems to operate correctly, the fault obviously is in the keyer biasing circuit. The keyer's grid-bias voltage is usually developed across a video plate-load resistor, but is sometimes developed by the first sync stage. Any fault in the keyer biasing stage will upset the keyer bias. Fig. 7 shows a typical biasing arrangement for a keyer tube.

A defective video-detector diode is a frequent cause of agc problems even though it may detect the signal properly. The diode should also be suspected if the agc is slow to "take hold" when changing channels.

Another thing to look for in the agc circuit is an open or partially open agc bypass filter. This can cause what appears to be a sync problem. An open bypass will nearly always cause critical vertical hold and may cause the picture to bend or tear. If this is suspected, bypass the agc line with a 2-μf filter capacitor while watching for improvement in the picture or sound.

Shorted bypasses sometimes occur. Often they are not suspected because the voltage on the agc line is normally low. (This is a common fault in RCA KCS47 series. When you have an agc problem with one of these, be sure to check for a shorted bypass.)

Too much agc voltage will lower gain in the video if stages and the tuner. Quite often a set may appear normal on a strong local station, but be completely insensitive to weaker stations. A meter on the agc line may indicate several volts negative. The most common cause for this condition is an open bucking or delay resistor. This resistor ranges in value from 4.7 to 22 megohms and is tied from the B-plus line to the agc line. Often it is tied only to the tuner agc but occasionally it is also tied to the video if agc. When this resistor opens, it allows the negative voltage on the agc line to rise above its normal value (go more negative) with resulting lower gain. So whenever there is no snow on an inactive channel, it is wise to check the agc voltage with your VTVM.

Don't overlook the possibility that a hidden agc control may be incorrectly adjusted. When working on any set, it is always wise to have a schematic of the set for reference.

Intermittents

An intermittent if system, as with any intermittent, can be vexing. Probably no procedure will work every time. Whatever the procedure, however, we must always make sure the trouble is duplicatable. By this we mean that you should be able to produce the symptom by *causing* the defect in the suspected circuit.

For example, if you suspect that a printed circuit is open at a certain point, make sure it is—by cutting across it (you're going to repair it anyway). When you deliberately open it this way, it should produce the symptom (that had previously been intermittent) on a steady basis. Only by making sure, in duplicating the fault, can you be really positive that you have corrected the intermittent.

Quite often you are tempted, when confronted with an intermittent printed circuit, simply to run a bead of solder over each conductor and heat each terminal, then hope for the best. This *may* do the trick, but you can't ever be

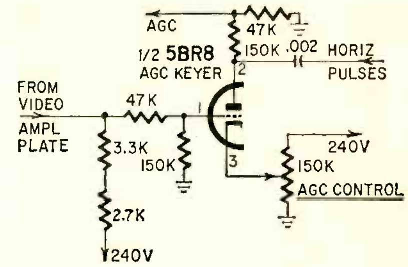


Fig. 7—Keyer tube in keyed agc circuit.

really sure and you get no sense of satisfaction from the job. There always is the nagging worry that something may have been overlooked.

One big source of intermittents is tube sockets. If they are the wafer type, they can be crimped from underneath (with the tube removed) so that a firmer connection is made to each pin. The molded type tube socket and the wafer type used with printed circuits usually cannot be repaired if they make poor connection to the tube pin—but something else can be done! Bend the tube pins out, then back in so they are slightly bowed (don't try this with an octal-based tube). This will insure a tight fit in the socket and just about eliminates any intermittent conditions from that source.

[Bending all the pins can be a bit tricky so this method works best when you know which pin is intermittent. Also, coating the intermittent pin with a light film of solder is a good expedient. In either case, be careful and don't crack the tube.—*Editor*]

The stage jumper described earlier is an excellent stage isolation device. It bypasses so many parts that it is practically foolproof. Slip it in the suspected stage in place of the tube. If the intermittent disappears, you have only to concentrate on that particular stage to find the trouble.

Summary

Finding needles in haystacks is difficult only when we must look through *all* the hay. If we could narrow down the location of the needle to a single cubic foot of hay in the haystack—finding it would be infinitely easier. So it is with TV troubleshooting. If we can confine our search for the defective part to a small portion of the TV receiver, we have the battle almost won. We hope this article may help to make it a little easier for you to pinpoint both defective stages and defective components in the if stages. END

Puzzled about OUTPUT TRANSFORMERS?

You can measure the turns ratio and power handling ability of that idle transformer and put it to use

By NORMAN H. CROWHURST

PEOPLE write to me for advice about output transformers. They want to know which one to get, or whether a certain transformer can be used in a particular way. They quote manufacturers' catalog numbers, or even send me sheets torn from catalogs. But my chances of answering these questions (with any authority) from catalog information stands only the slightest chance of being better than their own semi-educated guesses.

Then, of course, there's the case of the "unknown" transformer that's been lying on the shelf. Maybe it could be used for something, but how does one go about finding out its specifications? Or maybe the specification sheet reads 4,000 ohms center-tapped to 4, 8 and 16 ohms. Could this be used for an 8,000- (or 2,000-) ohm load?

First, it is practically impossible to tell from published specifications which is the better of two transformers *even for its own job*. What complicates matters here is the fact that no two manufacturers list the same data. Some list rated power, impedance and frequency response (even if it only says 20–20,000 cycles). Some state the permissible primary plate current, while others specify the permissible dc unbalance in the two halves of the primary. Some give dimensions, with or without a case, while others also include weight. From such diversified information how can anyone compare products of different manufacturers?

Transformer Power-Handling Capacity (Transformer saturates at 31 volts)

Secondary Impedance	Lowest frequency for listed output (cycles)			
(ohms)	20	30	40	60 ∿
8	13.3	30	53	120 watts
12	8.9	20	36	80 watts
16	6.7	15	26.7	60 watts

Chart for hypothetical transformer.

If rated power is given, it probably does not state the lowest frequency at which this power can be handled. One can only presume, with no guarantee of being correct, that the lowest figure quoted under frequency response (if this is given) is applicable. The impedance figure says what it was designed for, but not necessarily for what mode of operation. A transformer that works well with triodes or triode-strapped pentodes may not do so well with pentodes, *or vice versa*. Taps may be provided for "universal" application, but can these be used for Ultra-Linear? Frequency response is given, measured in a "standard" test circuit that represents no practical output arrangement.

So the more you know about transformers, the more you realize the specifications usually printed don't really tell you anything, except that the unit is designed for a specific purpose or as a replacement for some other type. The best answer is take one and measure it. But what simple measurements can we make to find out a transformer's capabilities?

Transformer characteristics

The first thing to find out about an unknown transformer is its ratio. Apply line voltage to its primary—this should be less than the plate-to-plate voltage it normally handles, so should not saturate it. Then measure both the primary voltage and the secondary voltage, with a suitable voltmeter (Fig. 1). Don't bother about loading it. The ratio between the voltages gives the turns ratio of the transformer, as close as your voltmeter can measure it.

Suppose the line voltage reads 115 and the secondary voltage 4.6. The overall ratio is $\frac{115}{4.6} = 25:1$. While you're at it, check that a center tap does divide the voltage equally. Don't rely, though, on its being exactly half—your voltmeter may not be that accurate. Rather check that the reading on each half is *the same*. Both halves may read 60 volts (or 55) although the total is 115. This is probably scale error on the meter. By the same token the actual ratio may be anywhere between, say, 22 to 1 and 27 to 1 for those readings. But loudspeaker impedances aren't so close that you need to be more critical.

Now you know the turns ratio is 25 to 1. The impedance ratio, or transformation, is this squared, or 625 to 1. It might be 10,000 to 16 ohms, 5,000 to 8 ohms, or something like that. Allowing for your voltmeter error, if the ratio is 22 to 1, the impedance ratio is 484 to 1. If it is 27 to 1, the impedance transforms 729 to 1. On this basis, an 8-ohm load would be transformed to something between 3,900 and 5,800 ohms—that's if it really *is* 8 ohms and if the transformer losses don't modify it slightly.

But now you know the ratio, what impedances was it *intended* for? That you may never know. More to the point is, what impedances can you *use* it for? One way to tackle this is to measure the winding resistances. *Then a simple approximate rule is to multiply the resistance of each winding by the expected power-handling capacity.*

Suppose you want to handle 20 watts and the primary resistance measures 300 ohms. The intended impedance *is probably around* 6,000 ohms. If the secondary resistance is 0.75 ohm, the same calculation would give its impedance as $20 \times 0.75 = 15$ ohms. But 6,000 to 15 is *not* 625 to 1. Does this prove your voltmeter readings were off? More likely the use of convenient wire sizes does not allow equal losses in both windings. If 15 ohms is correct, then the primary should be $15 \times 625 =$ 9,375 ohms. The ratio could have been intended for 7,500 to 12 ohms, splitting the difference. But this is only a rough guide.

The *thing* to recognize is that the resistance of the windings is your main loss, except at the low-frequency end. If each winding has a resistance 5% of its working impedance (or if your working impedance is 20 times the measured resistance of each winding), the transformer will work at 90% efficiency. If all winding resistances are then halved in proportion to their respective impedances, the efficiency rises to 95%.

Power measurements

To find the actual power-handling capacity, find out where the transformer saturates. To do this, you will need a 5,000-ohm 4-watt potentiometer as well as a scope. Connect as in Fig. 2. Now turn the pot up until the waveform goes distorted. Take a voltage reading at the point where it just departs from a sine wave. Add about 20%, and this is the voltage-handling capacity at 60 cycles.

Suppose you get 26 volts. Add 20%. This gives about 31 volts. If your secondary impedance is 16 ohms, the 60-cycle power rating is $\frac{E^2}{Z}$, or $\frac{31 \times 31}{16}$, or approximately 60 watts. If you use it for 8 ohms (in which case your efficiency will be lower), it will handle $\frac{31 \times 31}{8}$, or about 120 watts, at 60 cycles.

Presumably this is a high-fidelity transformer, in which case power is required to a frequency lower than 60 cycles. Just divide by the square of the ratio between the frequencies (for example, 60 cycles to 20 cycles or 3 to 1, square is 9). We have drawn up a little table (Page 33) for the rating of the imaginary transformer we just measured.

Now we can see the answer to the question about whether a transformer can be used for other impedances. Used for 10,000 ohms to 16 ohms, the winding resistances are about 5% each, primary and secondary, so the transformer is about 90% efficient and will handle 20 watts down to about 35 cycles (interpolating the lower line of the table). Used for 5,000 ohms to 8 ohms, the efficiency drops to 80%, but it will handle 20 watts down to about 25 cycles (interpolating second line).

Actually, using different impedances will also affect the high-frequency response. But to predict this you need to know more about how the transformer is wound—its winding sectionalizing—as well as the output circuit. However, we can lay down some ground rules.

Mode of operation

Starting with the impossible first:

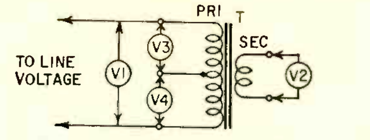


Fig. 1—Measure all the ac voltages indicated to determine the turns ratio.

pentodes in class B, or semi-class B (class AB), require very specially designed output transformers—don't try it with strangers! But pentodes in class A are a fairly safe bet with a simple inexpensive transformer, using little mixing. You can use feedback without too much likelihood of trouble. Such a transformer will show equal *voltages* on primary halves in the ratio test, but will *not* have equal resistance in each half.

With triodes, or triode-connected pentodes, you should look for a "better" transformer—one with more mixing or interleaving of the windings. One where the resistances of primary halves measure the same, as well as its ratio showing accurate center tap, is a good one to try.

If you want to try Ultra-Linear operation, my advice is to buy a transformer designed for it. But you can try a universal job, if you have one around. Use the outside ends for the plates. The square root of the nominal impedance ratio will give the percentage tapping for the screens. If the outside ends are nominally 14,000 ohms apart, the 4,000-ohm taps will be $\sqrt{\frac{4,000}{14,000}} = 0.535$, or 53.5%. That's the nearest you can come to 43%. Higher taps will represent higher percentages.

Another thing about these universal jobs: they are designed as a "replacement" item. Being a stop-gap measure, their performance is below the standard of items designed for a specific job. A really high-quality universal transformer can be made, but it is a laboratory item at a price that would put it out of the replacement market—or any commercial application.

Catalog specifications

So much for transformers you can take and measure. But many inquiries are concerned with possible alternatives to buy, and the only information available is that in the makers' catalogs.

If weight is quoted, this can give you some clue about low-frequency response, where the specification omits this information. A transformer with good low-frequency response and reasonable efficiency for its power rating will run between 2 and 3 watts per pound. So a 20-watt transformer will weigh between 6 and 10 pounds. These so-called "universal" jobs usually run 10 watts or more per pound, as do most kitchen radio outputs.

Nominal power is usually quoted, but since it does not say ". . . . watts at . . . cycles," the figure does not mean much. As the tabulation showed, a transformer that will give 20 watts at 30 cycles can handle 80 watts at 60 cycles. Specification of frequency response from 20 to 20,000 may or may not mean it will handle its rated power down to 20 cycles.

Incidentally, the type of output circuit can affect this too. Some circuits can supply quite a hunk of saturation current in the output transformer before distortion shows up, others cannot.

A few definitions

When you look at a catalog, you read everything pertinent if you really want to make a critical choice. Knowing this, catalog writers put in all kinds of flowery descriptions—"scientifically designed," "using the latest engineering principles," "applying improved techniques," etc. The implication drawn by the tyro is that a manufacturer who does any of these things has a better product than one who does not.

Unfortunately, *some* who make these

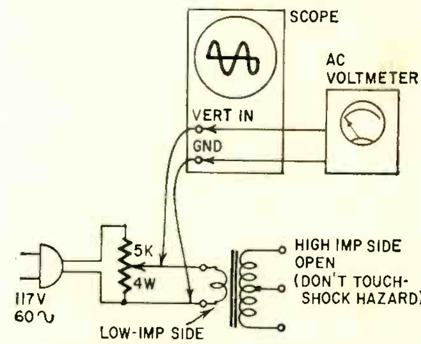


Fig. 2—An oscilloscope and ac voltmeter are used to determine the tranformer's power handling capacity.

claims apparently follow these definitions:

Scientifically Designed: A process consisting of buying a competitor's sample of a new line, pulling it apart, and making a "Chinese copy."

Latest Engineering Principles: The engineer bought a new slide-rule, so no longer counts on his thumbs. He has learned to use scales A, B, C and D and may some day learn what all those other scales are.

Improved Techniques: If the competitor used black paint, we dip it in shellac. This *may* make it more durable, but does not affect its performance.

It should not be inferred that all manufacturers use such methods, but I have been surprised to find how many do! A few years ago I wanted some special filter transformers made. I had worked out the necessary data; all I needed was someone to wind them. But this was unorthodox—"we don't work that way," "our engineering department does all our design work."

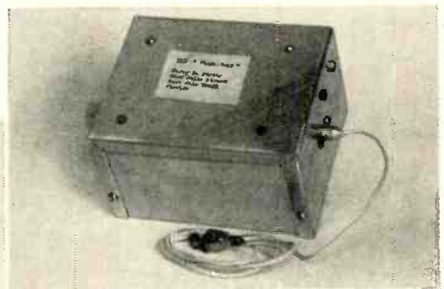
However, after one company had made them to my data, the rapidity with which other companies produced Chinese copies was surprising. My experience tells me, when a representative (styled a "sales engineer") gives me a pitch about his company's superior engineering facilities, to take it with "a grain of salt." A company that's really progressive, in transformers as with other things, is one that's first with really new lines. And don't always believe advertising that says "another first!." Watch to see who really is first.

END

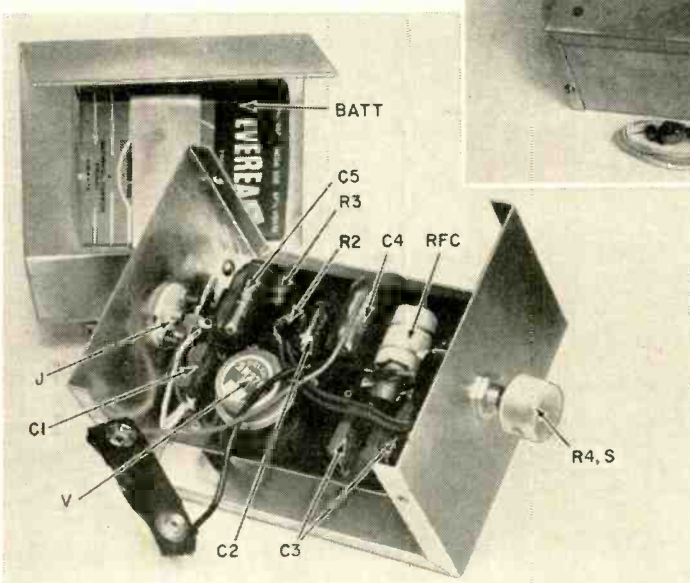
TRANSITONE LOCATES HIDDEN WIRING

Conduit imbedded in a concrete wall or buried underground can be traced easily with this simple instrument

By HARRY D. PARKER



Finished unit forms neat package.



Parts arrangement inside aluminum case.

MANY times a service technician has to know where wiring conduit is located. This is especially true when installing electronic equipment (sound systems, intercoms, fire and burglar alarms, etc.) in hotels, apartments, warehouses, factories, etc. The little transistor Transitone will find the conduit for you.

The unit consists of a tone-modulated transmitter and any portable broadcast radio. Here in the South, as in many other places, building regulations state that wiring conduit and plumbing must be buried in the concrete walls and floors. So when future installations or repairs have to be made, it is convenient to know where the conduit is. Just clip the Transitone's antenna to the case of an outlet box or a water pipe and with a transistor radio tuned to the transmitter frequency you can trace the tubing through the building. Chalk lines on the walls or flooring to indicate the tubing's position. Many other uses are obvious; such as locating buried wiring in outdoor stadiums, from house to garage and so on.

Circuit description

The transmitter consists of a simple rf oscillator and is self-modulated by the blocking action of C4 and R1 (see schematic). Varying C4's value changes the transmitted tone and the power output. R2 and R3 are base-bias resistors and C2 is the base rf bypass. Capacitor C3 is the feedback capacitor that starts and maintains oscillation. If it is too small, the circuit won't oscillate; if too large, you can't get the frequency high enough. Coil L and C1 act as a ringing circuit and determine the frequency. Changing either L or C1, or varying the value of R3 shifts the frequency. A small pot (R4) (about 25,000 ohms) may be used as a fine frequency control instead of L's adjustable core. Varying the supply voltage will also shift the frequency slightly. Capacitor C5 is an rf bypass across the power supply. The rf choke is a horizontal oscillator coil for a TV set and is part of the audio blocking network that includes C4 and R1.

A toggle or slide switch is inserted in one battery lead. If you use a control for R3, a switch could be included with it.

Notice the battery voltage. It is 67.5 volts. This may confuse you as most transistors are operated at 6 or 12 volts. This unit will oscillate at a lower voltage but it will not be tone-modulated. The Delco 2N278 transistor has a 50-volt collector rating, so with proper biasing the voltage may be raised to any level as long as the collector-to-emitter voltage does not exceed 50 and the collector power rating is not exceeded. The low current drawn by the unit (about 4 ma) is so slight that the transistor does not need any heat sink.

All components are mounted on a 3 x 4-inch phenolic board, and wiring is straightforward.

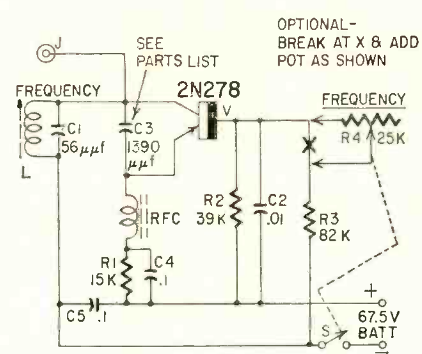
A 3 x 4 x 5-inch case houses the unit. A phono plug and jack with a clip lead is used for the output connection. Brass spacers ½ inch long are used to mount the phenolic chassis to the cabinet. A metal strap holds the battery in place and a standard snap-on battery terminal connects the battery into the circuit.

Now use it

The unit is tuned with L's slug or with R3. Use the slug to center the frequency on a quiet spot in the AM band and fine-tune with the pot. Don't vary R3 too much as it affects the base bias and may make the circuit stop oscillating.

The receiver is only a means of detection and any home portable set may be used or you may make one just for this purpose.

The transmitter, when connected to a pipe line, does not radiate very far into the surrounding air, only a few feet at best. So, no matter how much power is used, you are not breaking FCC requirements. But don't let this fool you either as the signal may be picked up several blocks away on the pipe line. It has proved ideal in large motels when we wanted to know where existing wiring was so as not to cut into it when cutting through walls during a TV antenna installation. END



Circuit of 1-transistor transmitter.

R1—15,000 ohms
R2—39,000 ohms
R3—82,000 ohms
R4—optional pot, 25,000 ohms with switch
All resistors ½-watt 10%
C1—56 μμf mica
C2—.01 μf, ceramic
C3—1390 μμf, .001 μf and 390 μμf in parallel
C4, 5—0.1 μf
BATT—67.5 volts
J—phono jack
L—ferrite antenna for broadcast band
RFC—horizontal oscillator coil, Thordarson HS-30 or equivalent
S—spst on R4 or separate toggle
V—2N278
Case—3 x 4 x 5 inches
Miscellaneous hardware

TRACE Simplifies Servicing

Easy to use aid that speeds transistor radio servicing may open the door to a new era in printed-circuit service techniques

By LARRY STECKLER
ASSOCIATE EDITOR

TRANSISTOR *R*adio *A*utomatic *C*ircuit *E*valuator (TRACE) is a group of five words that may spell out a new approach to servicing electronic devices that use printed circuits. In this first version, it is the work of a single manufacturer, and is adapted to transistor radios only. It could just as easily work for hi-fi amplifiers and preamps, TV sets or any other kind of electronic gear that incorporates printed circuits.

In its present form, TRACE consists of a folder containing nine plastic-coated cards—one for each transistor radio chassis in the 1960 Philco line. More will be issued as newer sets are made, and Philco is currently considering issuing TRACE boards for older sets.

A typical TRACE board is shown in Fig. 1. It is printed in four colors—black to indicate components and voltages; blue to show the rf signal path and rf generator setting; red for the if signal path and the proper generator setting, and green to indicate the audio signal path and generator setting.

Servicing is simply a matter of signal injection, a procedure familiar to all service technicians. Starting from the speaker, a signal generator is used to inject a signal into the receiver at the proper frequency. Then the technician works his way back through the receiver to the antenna. The trouble always lies between the last point where a signal is heard in the speaker and the first point at which it isn't. Naturally, the technician changes his generator settings as he works through the various types of circuits in the radio.

Using TRACE

This is a standard troubleshooting procedure and can be followed with or without TRACE. But by using a TRACE panel, the technician knows just where to apply his signal generator and doesn't have to keep referring back and forth between set, schematic and printed circuit to determine which point is which. He refers to the schematic only after the trouble is localized and when he has to replace a component. Now let's see how this works. The TRACE board shown in Fig. 1 matches the circuit shown in Fig. 2. Both are for the Philco model T-901 code 124. This is a nine-transistor set with a push-pull output stage.

So let's take a short walk over to Harry's Radio & TV Repair and see how he handles one of these sets. There's one on his bench—must have just come in. Harry's first step is to make some preliminary checks:

- Are the batteries good?
- Are the battery terminals corroded?
- Is the on–off switch OK?
- Does the tuning capacitor have any shorted plates?
- Is the printed-circuit board cracked?
- Is there an obvious open in the printed-circuit board?
- Is the antenna OK?
- Is the speaker working?

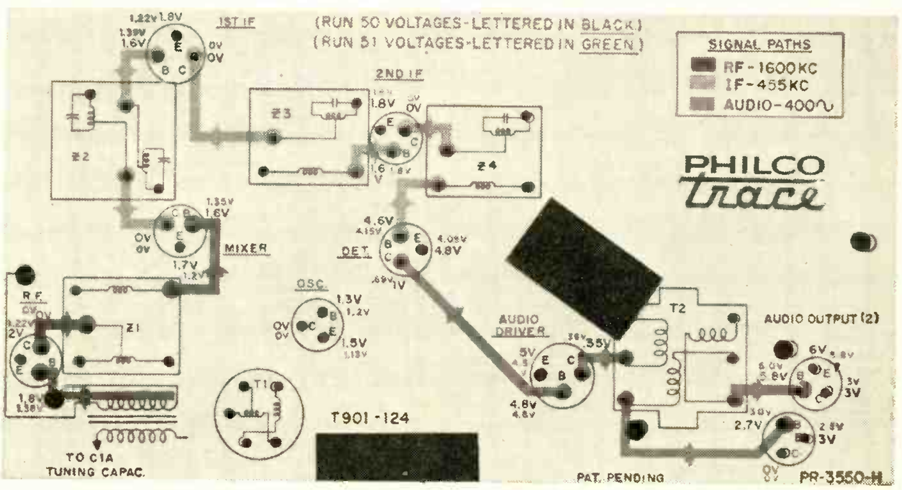


Fig. 1—Philco TRACE board for model T-901 code 124 transistor radio.

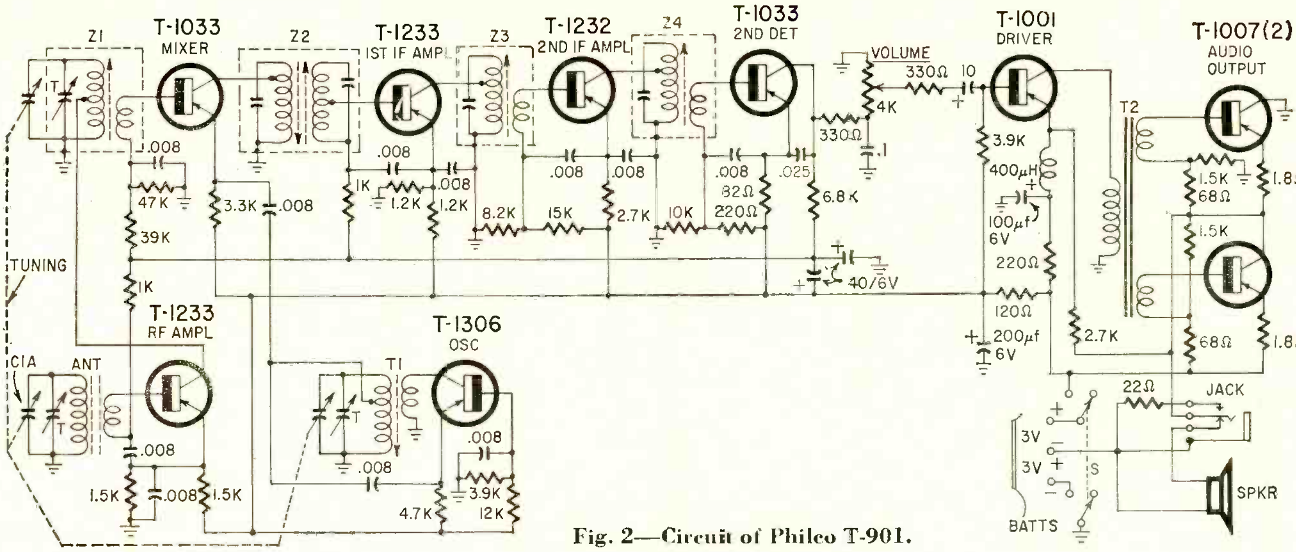


Fig. 2—Circuit of Philco T-901.

These may seem like foolish things to check, but Harry learned the hard way. He knows, now, that these checks can have him a lot of time later.

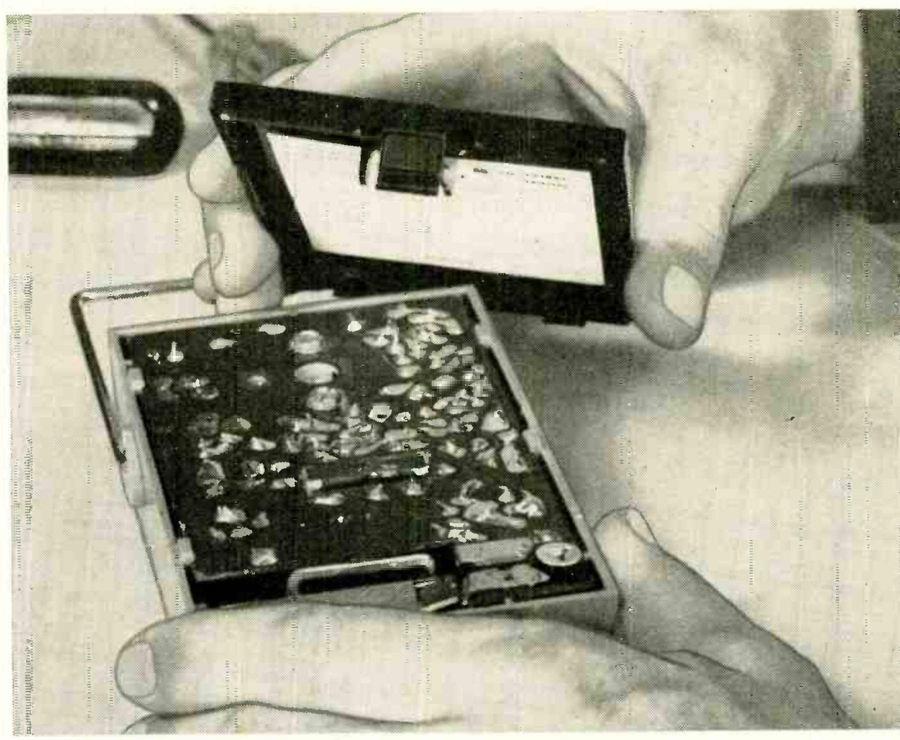
Harry will never forget the transistor portable that was brought in for motorboating. He spent quite a bit of time replacing the B-plus filter capacitor only to find it didn't help. Turned out that the set just needed new batteries. The old ones weakened enough to cause motorboating, but not enough to keep the set from operating.

After making these preliminary tests, it's time to go a little deeper. This is where the TRACE panel comes in. Harry picks the proper one out of his folder and fits it into place over the wiring side of the printed-circuit board. Then he sets his signal generator for a 400-cycle audio signal (as indicated on the TRACE panel) and starts signal injection at the end of the green line. First stop is at the bases of the output transistors. Good signal from the speaker. Then back to the audio driver transformer secondary and next the transformer primary.

If he gets no signal from the speaker when he applies one at the primary of the transformer and does get a signal when it is applied to the secondary, Harry knows that the transformer is bad and must be replaced. But if he does get a signal at the input of the transformer, he continues to the collector of the detector. Now he switches to the intermediate frequency (455 kc, modulated by 400-cycle audio, as indicated on the card). He applies this signal to the base of the detector stage and continues to work back toward the antenna.

At the collector of the first if amplifier he still gets a signal, but at the base of that transistor nothing happens. Before replacing the transistor, Harry pulls out his vtvm and checks voltages at the base, emitter and collector of the if transistor. These readings can tell him a great deal about what may be wrong with the circuit. For example:

- Higher than normal emitter voltage indicates an open transistor or an open or high resistance in the collector circuit.



On the service bench, the first step is to remove the back of the receiver, uncovering the printed circuit panel.

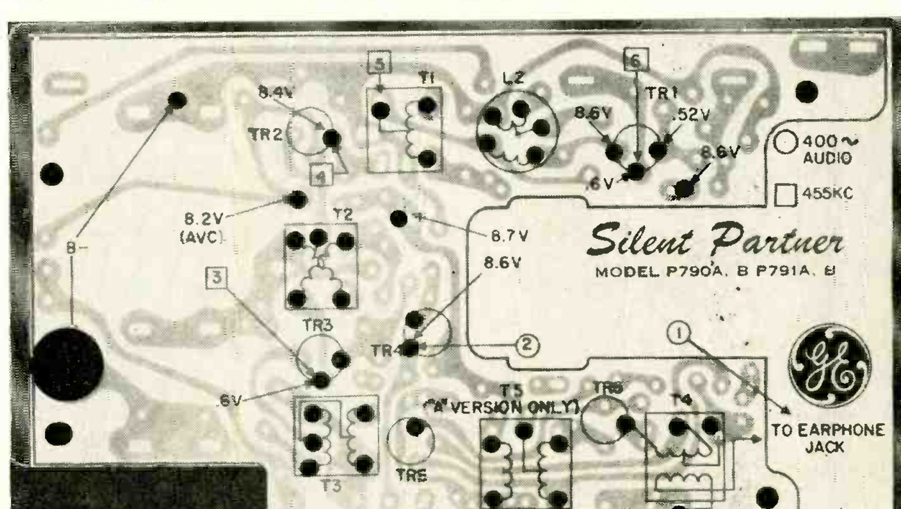
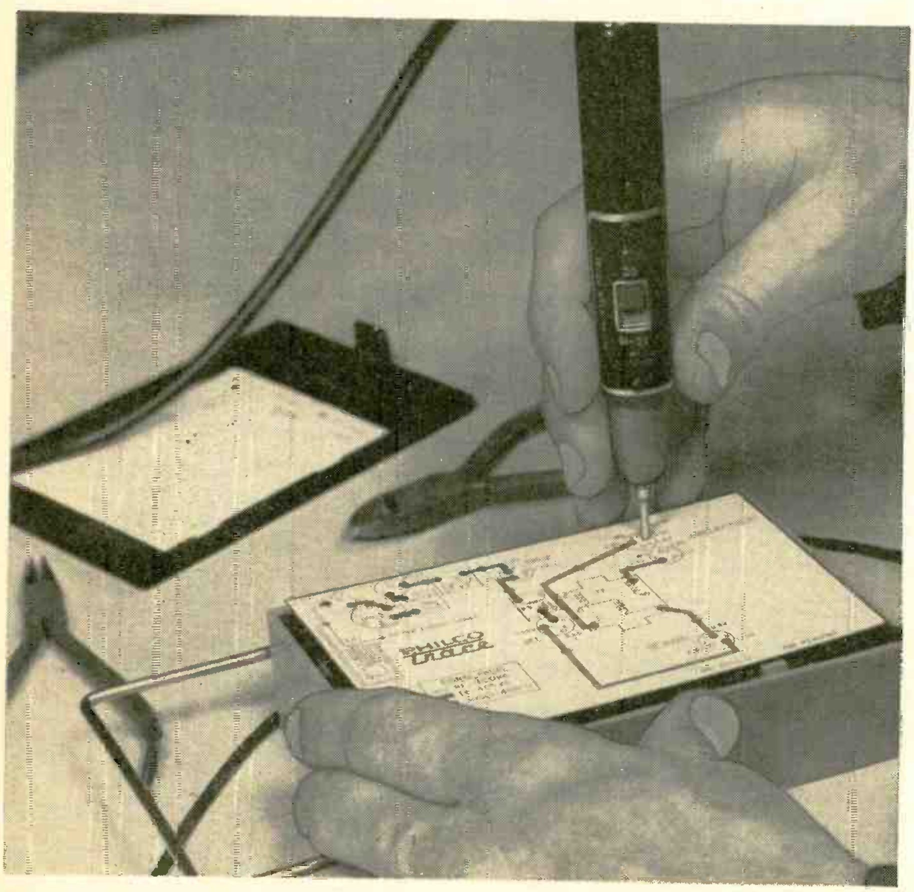


Fig. 3—The General Electric Silent Partner for model P790A.

The technician picks out the proper TRACE card for the receiver he is working on.



Vtvm measurements pinpoint the defect in the radio.

▶ A lower than normal emitter voltage reveals a shorted transistor or a low resistance in the base circuit.

▶ If the base voltage reads high, it shows a shorted transistor or an open or high resistance in the base circuit.

▶ Lower than normal base voltage could mean an open transistor or a short or low resistance in the base circuit.

▶ Higher than normal voltage at the collector usually means a shorted transistor or an open or high resistance in the collector circuit.

▶ A lower than normal collector voltage means an open transistor.

There is one thing to remember when checking voltages in transistor circuits: A high or low voltage does *not* mean 10 or 20 volts higher or lower than normal. A difference of only a few *tenths* of a volt is considered high or low and can keep a transistor set from working. After all, we are dealing with voltages that measure only between 0 and 6, and in many circuits never get higher than 1 or 2 volts. A few tenths of a volt is an appreciable portion of these small voltages. This means the technician must have a voltmeter he can trust, one that is accurate and is capable of measuring small voltages. The rule that a technician must be able to rely on his instruments is doubly valid in transistor work.

General service hints

TRACE or not, the usual general service rules still apply. Distorted sound usually means a bad speaker or output transistors. Motorboating, when not caused by weak batteries, is usually due to an open B-plus filter. Low sensitivity is often the result of trouble in the antenna, rf or if stages. No reception at the high end of the broadcast band calls for a check of alignment and the converter transistor. No reception at the low end of the band can be caused by a defective converter transistor or low supply voltage.

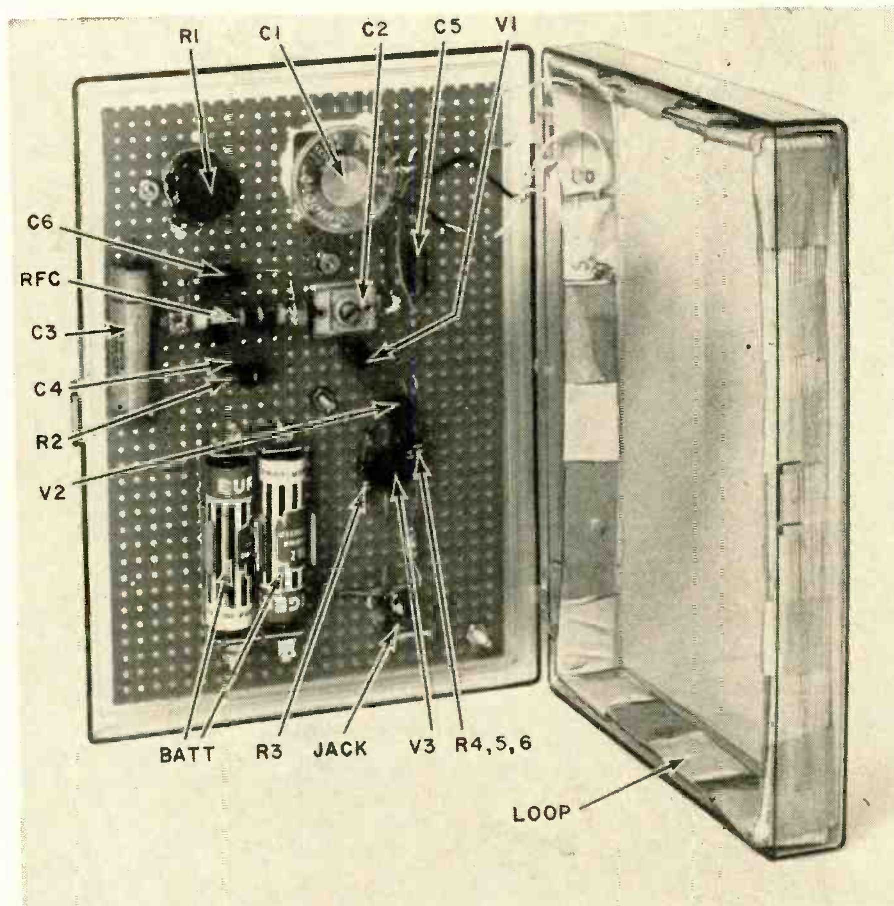
Some service technicians take a short cut to signal injection servicing. They start off by applying an if signal to the input of the detector. If they get a good signal from the speaker, they know that the whole audio section is good. Next they go to the mixer and apply a signal at the mixer base. Again either the whole if checks good or the trouble lies between the mixer and the detector. But whether you use the short cut or follow the time-tested technique of running through the whole set from speaker to antenna, TRACE will speed repair time and make it possible for you to give your customer a reasonable repair bill. Every hour of your time is worth at least $6, so if you save 15 minutes, you're ahead $2.

Other manufacturers are sure to follow with their versions of the TRACE board. One is already out. G-E is turning out a similar device called Silent Partner, a single-color card encased in laminated plastic (Fig. 3). Each card comes in its own envelope that has the set's schematic printed on the back. Only one card is out to date, but more are sure to follow. END

ULTRA-SENSITIVE 3-Transistor RADIO

Standard-size components and a large loop antenna give sensitivity and selectivity far above average 3-transistor set

By JOSEPH AMOROSE and EDWARD HOFFMEISTER



Lid-mounting parts makes set more accessible and separates it from antenna.

BACK in the early '50's, RADIO-ELECTRONICS printed an interesting original receiver circuit by Edwin Bohr. The set was a good performer; it had sensitivity, stability and other fine features. So intrigued were the authors by this circuit that they carried on experiments to simplify, sensitize and otherwise improve this novel hookup for several years. (Hoffmeister did the major part of the research.)

Primarily, the plan was to come up with a set that was unusually sensitive. It had to be selective, easy to make and tune, use few parts, be economical to operate and, last but not least, it had to be long-lived and troublefree. In striving for such an above-average receiver, we feel that we have achieved our aims.

The set shown is unusually sensitive. Selectivity is high enough to warrant vernier control. Although designed solely for headphone use, the rig will work a speaker on strong nearby stations. With a class-B audio stage added, this receiver has outperformed a well-known manufacturer's superhet rig. It got more stations, produced more volume. Tested in an all-metal car, housed in a metal garage, the receiver still brought in four of the local, louder stations, with "no strain, no pain." Since most Richmond stations are about 10 miles away and use only 5,000 watts input, receiver sensitivity must be considered very good. In the open, all eight locals could be tuned in with ease.

In St. Louis (Hoffmeister's home town), all 11 stations between 550 and 1600 kc were received clearly. The dx log there was impressive too. Regeneration is smooth, sure and noncritical. The most sensitive spot is easy to find and hold. There is no annoying, sudden "spilling over" into oscillation.

Since utmost sensitivity was desired, no attempt was made at miniaturization; full-size parts were used. Yet they fit comfortably, without crowding, in a 5½ x 7½-inch cabinet—overcoat-pocket size. This set makes an ideal bedside companion for the hospital patient who wants more variety in his radio fare than hospitals' "single-shot" systems provide. It has proved a natural for patients lolling around on the sunporches too.

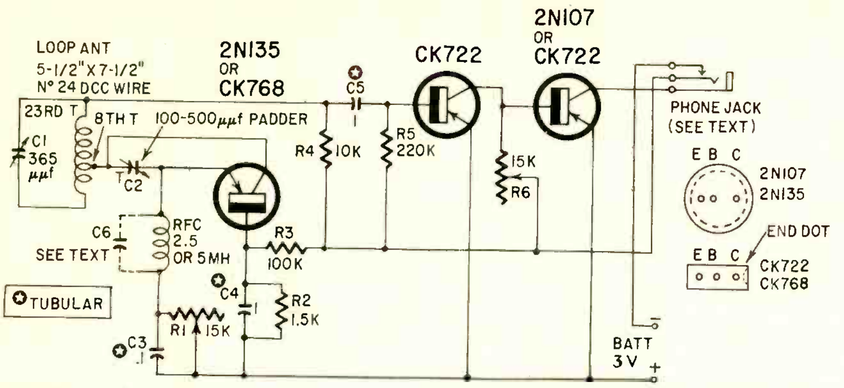
Construction

The schematic is self-explanatory and should be easy to follow. The loop antenna is a most important part of this set. Upon its proper impedance and the correct tuning of the associated circuits depends the high performance of the whole receiver. In strong-signal areas, a tapped Ferri-loop coil works well, but with lessened sensitivity.

To wind the loop, make a 5½ x 7½-inch cardboard form. On it, wind 23 turns of No. 24 double-cotton-covered wire. Tap at the 8th turn. This lead goes to C2, the regenerative padder capacitor. *Wind the loop in solenoid fashion!* Jumble winding won't do; it requires more taps to cover the band. Pancake winding is OK if the proper inductance is approximated. Run the 23d turn to the stator of C1; the first turn goes to C1's rotor. (Reverse these two leads if hand-capacitance is noted. Also, try a .001-μf capacitor across the phone cords.)

BENCH TESTED

Tested in Brooklyn, this receiver picked up 12 stations. At a point a little over 20 miles from New York City, 7 stations were received with good listening volume. The set is remarkably free from the distortion and noise heard in many of the smaller regenerative sets with "miniaturized" antenna systems.



Schematic of the ultra-sensitive 3-transistor receiver.

R1—15,000-ohm pot
R2—1,500 ohms
R3—100,000 ohms
R4—10,000 ohms
R5—220,000 ohms
R6—15,000 ohms
C1—365-μμf variable
C2—100-500-μμf padder
C3—0.1-μf tubular
C4, C5—1-μf tubular
C6—See text
RFC—2.5 or 5 mh
J—Phone jack, see text
BATT—2 penlight cells
Case, wire, mounting board, miscellaneous hardware

This set is built in reverse; that is, the loop goes in the deep part of the cabinet, the parts assembly (mounted on a perforated board) goes in the lid. One or two screws through the lid hold the parts board down. This permits removing the entire parts assembly from the cabinet for experiments or changes. It also keeps the antenna away from the components, thus avoiding detuning effects and loss of signal strength.

To eliminate problems caused by capacitor aging and reforming, no electrolytics are used. Tubulars take their place with no noted loss of performance. Long life and troublefree performance are thus assured. The 0.1-μf capacitor C3 adds sensitivity. A 1-μf at C4 and C5 substitute for the electrolytics. Recommended RFC is 2.5 mh, though we have used 5 mh with good results. As the rf choke is made bigger, sensitivity increases, but so does regeneration. [In the set constructed by the RADIO-ELECTRONICS staff, shown in the photo, a small capacitor (C6) was placed across the choke to control regeneration. C6 will vary widely with different sets, and in many cases must be omitted, but in this particular receiver the best value was 33 μμf.—*Editors*]

The set will work well with a 1.5-volt dry cell but 3 volts of battery is best. Six volts will give more volume and sensitivity, but with it come increased regeneration and need of more careful tuning. In strong signal areas, hearing-aid type earphones work well. But let's face it, the volume they give does not approach that of a full-size standard 2,000-ohm headphone.

The best volume is produced by 24,000-ohm headphones. The impedance match is better and sensitivity is optimum with this value. [In the receiver shown in the photograph an earphone *was* used, with some probable sacrifice in sensitivity. The phone jack was used to turn the radio on and off. This unit is sold as a "subminiature jack—may be used for both open and closed circuits," and is adjusted so that it closes the battery contact when the plug is inserted.—*Editors*]

In strong-signal areas, R6 can be replaced with a 15,000–25,000-ohm potentiometer for volume control.

A word about transistors. Both the 2N135 and the CK768 types work excellently. The higher the cutoff frequency, the higher will be the set's sensitivity, the authors' tests showed. As old-timers know, transistors vary widely in performance, even among "identical" units. So try all the transistors you have on hand. Tune in a weak station—choose the best performer.

The set took about 4 hours to build. It can be made more compact, but the loop antenna should be at least 4 by 5 inches for good performance. Set values are not too critical, but keep leads short and direct. Do not overcrowd parts unduly. Use special transistor sockets (the authors don't believe in soldering their leads). Be sure to check and recheck wiring before trying out set. *That's a must!*

Aligning the set

Be sure the 8th turn goes to C2 and that the larger number of turns appears between C2 and the C1 stator. Then fully mesh C1's rotor until you get regeneration. Or, better still, tune in a local in the 550-kc region (if you have one), and adjust C1 and C2 until you can bring the station in clearly. Use as much C2 capacitance as you can. This is the low-frequency adjustment.

To adjust the high-frequency end, unmesh C1 rotor and tune in a local between 1500 and 1600 kc. If this station does not come in, adjust C2 slightly until it does. Now go back to the station in the 550-kc region. If it doesn't come in now, take one turn off the loop aerial at a time, *at the stator end of the coil,* until the station is received. When this is done, all stations between 550 and 1600 kc should come in easily. (Avoid ultra-small variable capacitors. Some of those tried wouldn't tune in the entire band.) That's about all there is to it. (All parts used in this set were obtained from Lafayette Radio, 165-08 Liberty Ave., Jamaica, N. Y.)

If you are a hobbyist weary of building miniature, museum-piece creations with less than optimum performance, and you want a private listening receiver which will give you optimum performance with a minimum of effort and expense, this project will interest you. Here is a radio which will give you the "mostest" for the "leastest." END

Preamp Input Circuit

Modern hi-fi equipment must provide inputs for AM radios, FM radios, record players and tape recorders. These inputs are usually selected by a switch which is connected to the various sources by shielded cables that are anywhere between 2 and 5 feet long and have a capacitance of 50–150 μμf. But a 150–μμf cable capacitance introduces a loss of 3 db at 20 kc when the output resistance of the unit feeding the cable reaches 50,000 ohms. A higher output impedance would increase signal loss further and curtail the audio quality.

A way around this problem is to use a plate follower so cable capacitance can be countered by placing the input resistor at the source end of the cable as described in *Wireless World* (June, 1959). The circuit is shown below. The charts show how much capacitance is now needed at a particular input to produce a 3-db drop at 20 kc for different values of R2. Obviously, lower capacitances are nothing to worry about. Of course proper gain must be maintained for the input circuit, so choose resistor values wisely. END

TABLE I
R2 = 2.2 MEGOHMS

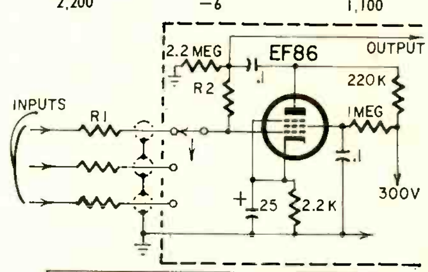
R1 (KΩ)	Gain (db)	Capacitance (μμf) for — 3db at 20 kc
47	31	750
100	26	690
220	19.5	650
470	13	630
1,000	6.5	610
2,200	0	600

TABLE II
R2 = 4.7 MEGOHMS

R1 (KΩ)	Gain (db)	Capacitance (μμf)
47	36	450
100	31.5	330
220	25.5	280
470	19.5	270
1,000	13.5	260
2,200	6.5	260
4,700	0	260
8,200	−5	260

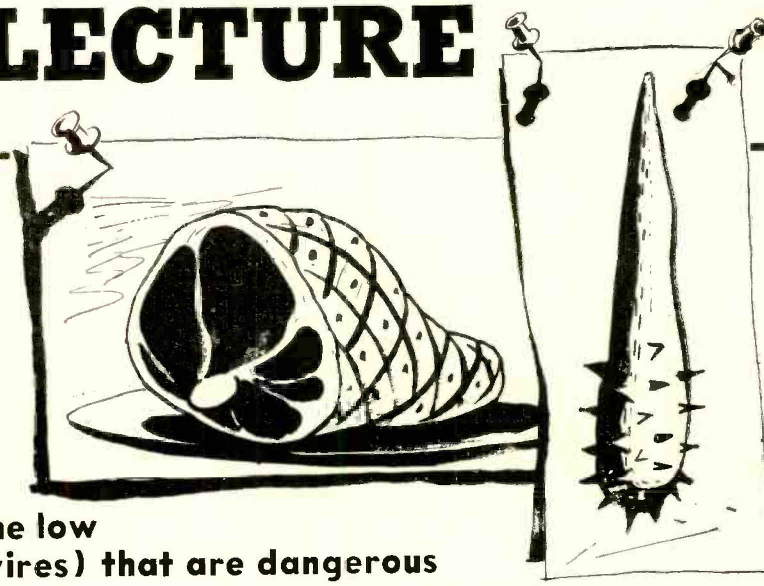
TABLE III
R2 = 1 MEGOHM

R1 (KΩ)	Gain (db)	Capacitance (μμf)
47	25	1,300
100	19.5	1,150
220	12.5	1,100
470	6	1,100
1,000	0	1,100
2,200	−6	1,100



GRID RESISTOR OF FOLLOWING STAGE 1 MEG

THE OLD TIMER GIVES A SAFETY LECTURE



It's the little (?) things (like the low voltage in a TV and exposed wires) that are dangerous

By JACK DARR

THE Old-Timer came in the back door of the shop, whistling "Colonel Bogey" very softly. He smiled as he heard loud voices from the small back room he had donated for the Ham Club the Young Ham had organized. The smile turned into a full-sized grin as he saw the new sign the Young Ham had made a few days before. It was simply two colored pictures clipped from magazines: a luscious ham and a fearsome looking spiked club, pasted to a board.

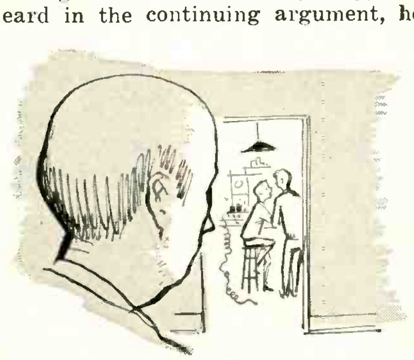
The voices rose as he neared the door. "No, Eddie, look here now! You're not getting any rf out into the load because you haven't got enough coupling! See? This coil has *got* to go over a little more!"

"Well, it's lighting th' light, ain't it?" said the other voice.

"Yes, but not near enough," said the first speaker, the Young Ham. "A little ol' yellow glow like that ain't 50 watts, is it? You oughta get a bright white on that bulb!"

The Old-Timer glanced through the doorway at the two boys. They were bent over a piece of equipment at the far end of the bench. The smile froze on his face as he saw the tangle of wires trailing down the bench. Quietly, unheard in the continuing argument, he

He reached for the master switch . . .



reached for the master switch he had insisted they install after they had left the lights on all night a few times. He snapped it off, which brought a simultaneous roar from both boys. "Hey! What'd you do *now?*" They looked up and saw him leaning against the side of the door. The look on his face brought them both upright with apprehension written on their faces.

Fireman's friend

"All right," said the Old-Timer grimly, pointing to the mess of wires on the bench. "What'd I tell you about that?"

"That" consisted of: (a) approximately 3 feet of slightly dilapidated line cord with a molded plug, connected to the ac outlet; (b) 6 feet of plastic-insulated bell wire connected to the other end of the line cord; followed by (c) 3 feet more of line cord terminating at the power transformer of the home-made power supply. All the connections were twisted (none too tightly) and all were completely innocent of tape or covering of any kind. From the output terminal board of the power supply, several similar leads went to the small transmitter the boys had been working on. These were also haywired (twisted to screws, twisted together, or simply twisted) and sans insulation or tape.

The Young Ham gulped and hung his head. The Old-Timer snorted and glared at him.

"Dang it all, now you know better'n that! I'll swear some people git up *bright* and early, looks like you just got up *early!* If I've told you once about them haywire hookups, I've told you a thousand times and this is the last one. From now on, use a little common sense around this stuff. I know I pay Dick a heck of a lot of money for fire insurance on this place, but I don't want none of it back. There's new line cord and stuff all over this place. Why didn't you use some of it?"

"Well, we were just trying it out," said the Young Ham sheepishly. "We didn't want to waste any new stuff on it until we knew whether it'd work."

"Look, Jughead," fumed the Old-Timer. "I don't care if it ain't for but 10 seconds. Don't *ever* let me catch you hookin' up a Fireman's Friend like that again! Why, a new plug and line cord wouldn't cost over 30 cents. My gosh, I'd rather *give* you th' stuff! Did I ever fuss at you guys about usin' stuff like that?"

"No," admitted the Young Ham, "but I've seen you usin' things like that in the shop. Hooking up record players an' things."

"Hah? Oh, you mean th' Fool-Killer? Come here just a dad-burned minute!" He chased them up the long hall ahead of him, into the service shop. He picked up a 5-foot piece of POSJ cord from a hook above the bench. One end was fitted with a bulky plug, the other terminated in two rubber-covered test clips. "Now, is this what you're talking about?"

"Yes," said the Young Ham, "and I've seen you use it a thousand times!"

"Well, Junior, there's a wee mite of difference," said the Old-Timer, shoving the plug under the boy's nose. "Look here. Do you notice anything unusual about that plug?"

"Yes," admitted the Young Ham, "it's a fusible plug."

"Well?" demanded the Old-Timer. "Doesn't that spell anything to you? There's a pair of nice little 2-amp fast-blow fuses in there, one on each side of the line. If I do get a short in anything, or let the clips touch accidentally, one of 'em pops out and everything's pretty safe—as far as the *fire hazard* is concerned. That ain't sayin' anything about th' shock hazard, though! You just gotta use a little *common sense* with it! Dang it, do you know how close Eddie's elbow was to one of them frazzly connections you had in there? About 2 inches! You were so busy arguin' about that transmitter you didn't even notice it. Those frazzlin' B-plus wires with about 500 volts on 'em weren't over a few inches away! Y'know, sometimes I wonder how you guys managed to get as old as you are."

"Aww, we were watching it," said the Young Ham.

"Junior!" said the Old-Timer, sternly. "You weren't watching *me*, and I stood there for a minute or so before I noticed what you were doing. Why, I saw both of you darn near get electrocuted three or four times! I was so scared that I like to never found that switch. Now you listen to me, young sprouts. From this moment on, *every* time you hook up anything like that around here, you take the proper precautions, and that means making sure that all your connections are safe, well insulated and tight! *Then*, you can go ahead and argue till you're blue in th' face about your loading procedure and you'll be safe. But, if I *ever* find another haywire hookup like that one around here, out you go, the whole gang of you, while you're still alive. Get me?"

The boys looked at the fire flashing from the Old-Timer's eyes and decided that he really meant what he was saying, so they surrendered gracefully. "OK, we'll be good, from now on," said the Young Ham. Eddie nodded agreement.

"You'd better be," said the Old-Timer, with a return of his normal good humor. "I'll be danged if I want to take the trouble to break in any more young squirts around here, to say nothin' of all th' money I'd have to spend for flowers. No, young fellers, I know that you guys feel like you know quite a bit about electricity and things, but that's the *one* thing you never ought to do in th' electronics business: get cocksure! Y' know, you can always tell th' difference between an old-timer and a new hand just fresh out of radio school: ask 'em both the same question. Th' young dude right out of school will pop right back at you with a positive answer; the more experienced man will always say: 'Well, I don't know right now. Let's check it and see!' Time you get to the point where you realize you don't actually know nothin' about this bewildering business, then you're gettin' to be a pretty good radio man!"

"I sure am thirsty," piped up the Young Ham, nudging Eddie, who dutifully echoed, "Me, too."

"All right, you human sponges, come on," growled the Old-Timer in mock anger. "Let's go gitta cuppa cawfee. But if you think you're gonna take my mind off the lecture you're gonna get, you're mistaken! You've both earned a good chewin' and you're gonna get it!" He led the way out the back door, down the alley and into the drugstore.

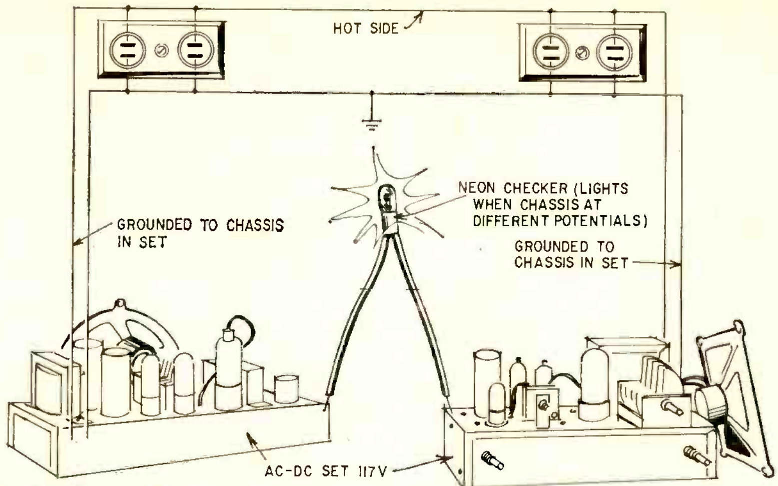


Fig. 1—A pair of ac–dc sets may have full line voltage between the chassis.

Ac–dc sets

"Speakin' of hot stuff, which you'd probably rather I wouldn't but I'm goin' to anyhow," said the Old-Timer, stirring briskly, "now you're gonna get the rest of that lecture you got comin'. Didn't I see you workin' on two ac–dc's at the same time on the radio end of th' bench?"

"Yes," replied the Young Ham. "One of 'em needed a filter capacitor and I was cooking the other one after I changed the rectifier, to see if there was any more trouble in it." He had a strange gleam in his eye, but the Old-Timer pursued the questioning, not noticing.

"Well and good," said the Old-Timer. "But I didn't tell you to work on *two* ac–dc's at the same time on the same end of the bench. Tell me, how's the ac line connected to an ac–dc set?"

"One side to the chassis?" asked the Young Ham innocently.

"Yep. Now, if you got two chassis with this kind of line connections, both of 'em out of th' box with the chassis exposed, what's the ac potential between them?"

"Zero," said the Young Ham quietly, sipping his coffee. The gleam brightened.

"Zero?" The Old-Timer's left eyebrow shot up, a trick he had practiced for many a year.

"Zero!" repeated the Young Ham firmly. "Nyaaa! You were going to catch me, weren't you? I actually remembered what you told me about that. So, I checked between the two chassis with the little neon checker (Fig. 1) and turned the plug around on one of 'em! Zero voltage! Also made sure both chassis were on the ground side of the line.

"Well, I'll be cow-kicked!" said the Old-Timer, shaking his head in amazement. "You got me, f'ar and squ'ar! I'll swear, I thought that had gone in one ear and right out the other in that nonresonant cavity you use for a head! My, my! I just can't git over it." He shook his head solemnly. "Congratulations, young feller. Just for that, I'll buy th' coffee!"

"You might not have known it, but you were going to anyhow." The Young Ham grinned. "I'm broke."

"This is unusual?" said the Old-Timer. "Well, sir, I'm glad you thought of that, though. It's sure a good habit when you're workin' around stuff like that. You know how *I* found out about it, don't you?"

"Yes, *sir!*" said the Young Ham. "And you got *reminded* of it just last week, when I had that portable sitting on my end of the bench, and you backed into it while you were moving that ac–dc TV set! Goodness, such language!"

"Well, I was mostly mad at myself," admitted the Old-Timer. "Us old fools ought to remember them things automatically, and we do, most of th' time, but we still git caught now and then. That's just th' reason I yowl at you guys so much about bein' careful with electricity. Workin' with it all th' time, you're gonna get a plenty of shocks accidentally, even with good habits. There's only one way to stay alive in this business, and that's to be careful, dern careful! And that's somethin' else you've got to do for yourself. There sure ain't nobody goin' to do it *for* you!"

"'Nother thing, while you're workin'

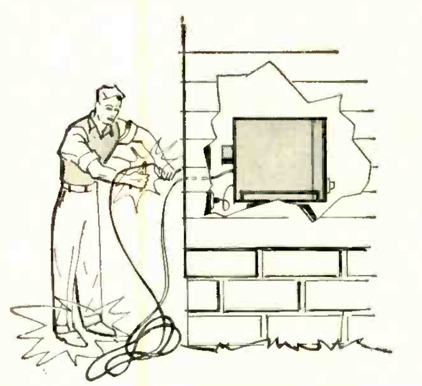


Fig. 2—Never touch an "outside antenna" lead of a radio or TV when standing on the ground unless the set's plug is *out of the socket*.

with a transmitter like you were a while ago. Don't ever let anybody else handle the key. You do it yourself! If you're the one makin' the adjustments, you do th' keyin'; it's a heck of a lot safer! I 'member once durin' th' War, while I was with the Air Force. Three or four of us was arguin' about a transmitter, just exactly like you were just now. All of a sudden one feller keyed the thing to illustrate a point he was tryin' to make. Only trouble, I happened to be leanin' on the final plate caps with my elbow!"

"What happened?" asked the Young Ham. "Did it hurt you much?"

"Well, not too much, but I'll tell you one thing. I was the only man that left the ground that day on that field without takeoff clearance from th' tower! I got darn near as much altitude as some of the kay-dets! Th' moral of that is: if someone is workin' on a piece of equipment, stay clear of it. If you're workin 'on it, make *everybody else* stay clear and always look to see that everything's safe before you mash that button. Saves a lot of trouble!"

The Old-Timer paid for the coffee, as usual, and they trooped out the back door and across the alley to the shop. Lighting his pipe, he perched on the end of the bench and continued the discussion.

"Y'know, there's lots of what you might call 'everyday' hazards that we run into that we don't really pay enough attention to. F'rinstance, even you know enough not to go outdoors, stand on the ground, and try to hang up an antenna wire that's already tied to an ac–dc radio in th' house (Fig. 2). You'd be surprised how many folks don't, though! Way I look at it, that oughta be part of our job; to kinda warn the customers about such hazards."

"Yeah," agreed the Young Ham, "I've heard you tell lots of 'em about that kind of stuff. I hope they paid attention to it."

"So do I, Junior," said the Old-Timer soberly. "If all th' techs would take a little time to warn their customers about some of the hazards, maybe we wouldn't be hearin' about so many people gettin' electrocuted by touchin' a TV set and stuff at the same time. While we're on th' subject, that's one thing I want you to promise me you'll always remember to do: never let a set git out of here in such a shape that it could hurt anybody. I'm pretty proud of you so far. You've been dern good about it. Keep it up."

"You mean like always putting the backs back on little ac–dc radios and checking the line cords for bare wires, and so on?" asked the Young Ham.

"That's it," said the Old-Timer. "And if the radios *should* have a metal cabinet, be dern sure that the chassis *is* isolated from that cabinet, like it ought to be. Remember the little set we found with the chassis shorted to the cabinet 'cause some kid had poked a metal bobby pin into it? And, most especially, watch out for these metal-cased portable TV's with the hot chassis. Pretty near all of 'em are provided with some kind of insulation between chassis and cabinet, but be awful careful to check those insulators. I've found several of 'em chewed out and shorted: found one set shorted to the case cause some sloppy-joe had dribbled a big hunk of solder down the chassis!"

"Yeah, I've found them myself," agreed the Young Ham.

"Tell you one more," said the Old-Timer, relighting his pipe. "You know the little isolating networks in the antenna connection? Couple of little capacitors in series? I found one only day 'fore yesterday, where some jerk had shorted those out! Don't know who did it, but they were shorted out beautifully. Tied a piece of wire across 'em! I do know what the result was: he managed to burn out the balun coil on th' tuner doin' it! It was one of those stinkers, too. I had the heck of a time gettin' it back in that tight place. Wish they'd put 'em on the outside!"

"That would make life too easy!" opined the Young Ham.

"I could stand a little of that," said the Old-Timer. "T'ain't too easy as it is. No kiddin', though, that's something *you* want to watch out for. You can git th' infernal waddin' knocked out of you if you happen to get hold of the lead-in with one hand and touch the chassis with the other! Don't ask me how I found *that* one out, either. I remember once I was squattin' down behind a TV set and got between antenna and chassis: I bounced off, hit th' wall and bounced right back onto th' TV set again, which promptly bounced me right back to th' wall, and so on! I'll tell you, when I finally stopped bouncin', I felt like the oldest punching bag in Johannsen's gym!"

"I'd like to have seen that!" The Young Ham laughed. "I'll bet you were mad!"

"Yep," said the Old-Timer ruefully. "Like before, I was mad at myself for bein' so careless, and that's the worst kind! Seriously, though, you wanna watch out for that kind of stuff. I was readin' an article in a science magazine a while ago, and the doctor who wrote it told how much current it took to be fatal. Guess how much it was."

"Golly, I don't know. Quite a bit?"

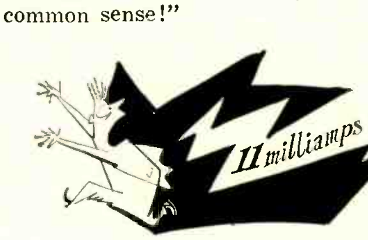
"Nope," said the Old-Timer, soberly. "Eleven milliamperes! That ain't much, is it? A 50L6 draws a heck of a lot more'n that: so, always remember that figure! If you get caught by an electric current so that that amount of current flows through your heart, you're off the air for good. So, that's one of the reasons for this old sayin' about 'one hand in your pocket.' Although a shock any place is bad, I believe it's worse if you get it from 'hand to hand,' you might say, so that the current path is through your chest. You can git pretty bad shocked say from fingertip to elbow, and although it'll hurt like fury, it wouldn't be as bad as if it was from arm to arm.

"That's the reason I always wear thick rubber-soled shoes, and keep 'em dry whenever I'm foolin' around anything. Long as you ain't grounded, you ain't in near as much danger.

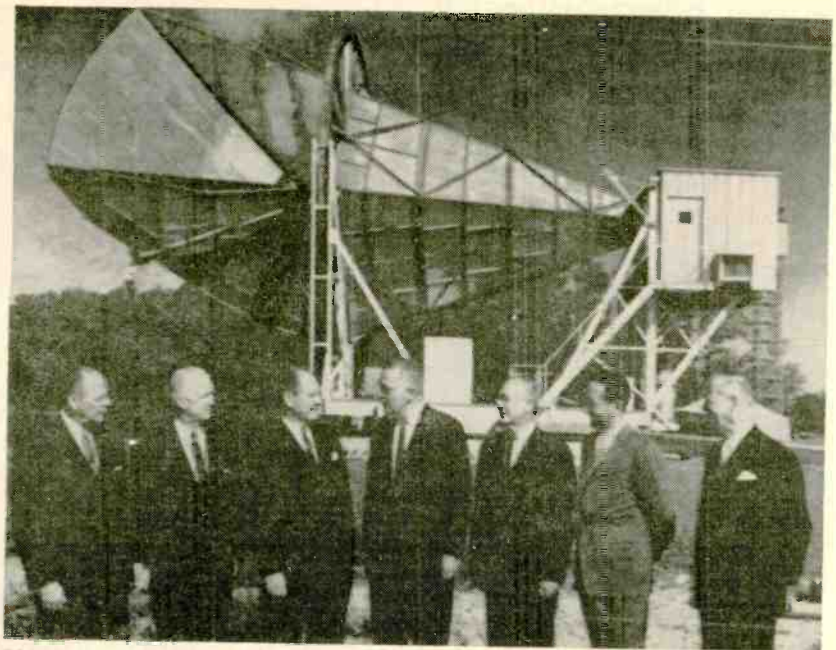
"I might give you another word on th' matter, too. You notice everybody seems to be pretty scared of the high voltage in a TV set, even lots of guys who should know better. Well, that stuff isn't near as dangerous as th' 300 volts or so in what we laughingly refer to as the 'low-voltage supply.' Actually, th' low-voltage'll kill you a lot quicker'n th' high voltage. Best way, of course, is to keep off of both of 'em!"

"Right," assented the Young Ham.

"Well, sir, I'll give you one last word, while I'm at it: you seen a darn good example of it this morning, right here. Regardless of how much you know about electricity, and how skillful you are, a well insulated and properly installed circuit won't bite you. So, the best thing for any of us to do is use the most useful remedy—good old common sense!" END

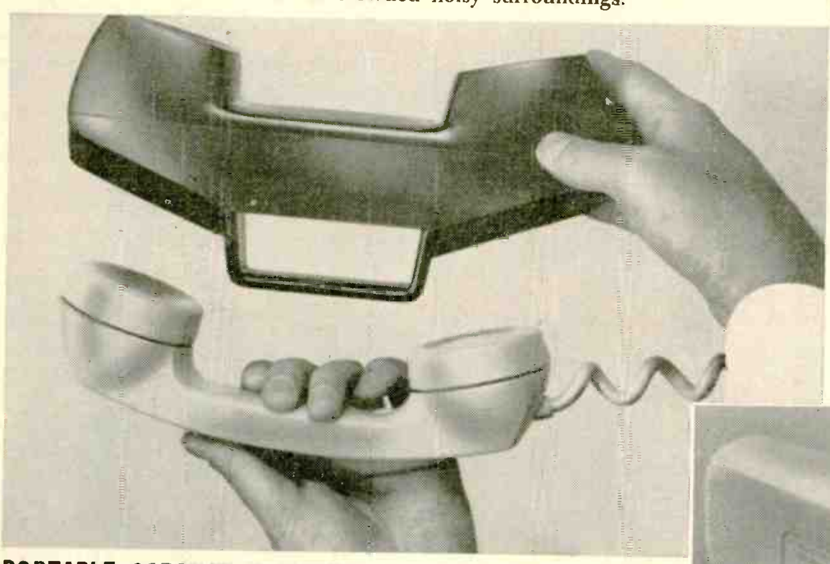


WHAT'S NEW



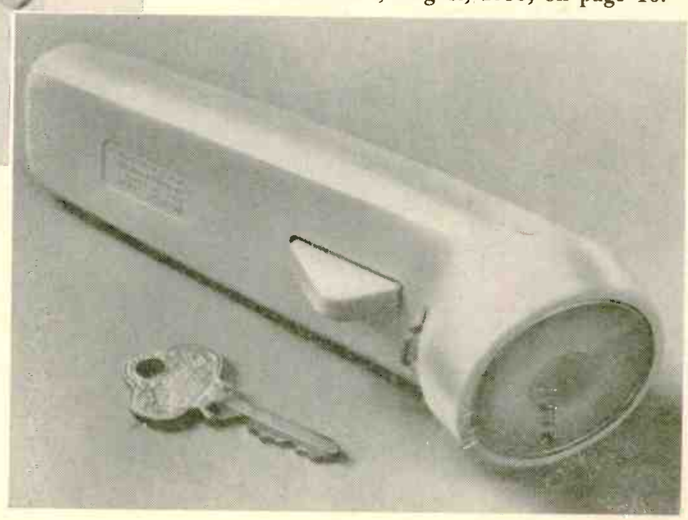
PICTURE BOUNCED OFF ECHO I satellite shows FCC members and NASA administrator. The photo, taken at Bell Telephone Labs in Holmdel, N. J., was transmitted by land line to the Naval Research Laboratory at Stump Neck, Md., and then bounced off the Echo I satellite back to Holmdel. The horn antenna in the background was used to receive the picture. People in the photo are (from left to right): FCC Commissioners John S. Cross and Rosel H. Hyde; Dr. T. Keith Glennan of NASA; Frederick W. Ford, FCC chairman; and Commissioners Robert T. Bartley, Robert E. Lee and T. A. M. Craven.

STEREO RECORD DEMONSTRATOR consists of a stereo amplifier, stereo headphones and a manual turntable and arm with a stereo cartridge. Made by Sargent-Rayment, Oakland, Calif., the unit is used to demonstrate stereo records in crowded noisy surroundings.



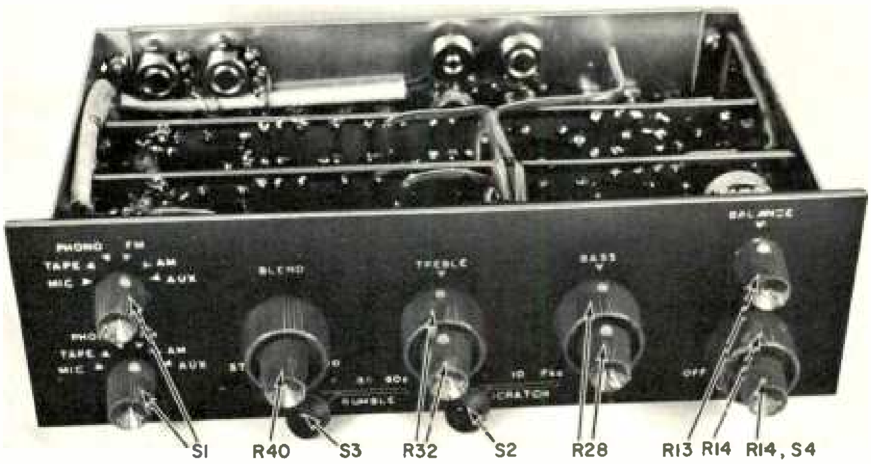
PORTABLE SCRAMBLER PHONE insures telephone privacy. Device fits over standard phone, uses 10 transistors to transform ordinary speech into incoherent gibberish. The gibberish is transmitted over the regular phone circuit and only a second scrambler unit will translate it back into normal speech. Developed by the Delcon Corp., Palo Alto, Calif., the units are coded at the factory with one of several basic codes and must be used in pairs—one at each end of the phone line.

ARTIFICIAL LARYNX includes a control that allows the user to vary the pitch of his voice, producing more natural inflection and emphasis. Earlier models gave a stiff mechanical quality to the voice. Transistorized unit developed by Bell Laboratories will be sold by American Telephone and Telegraph at manufacturer's cost on a first-come first-served basis. The larynx was described, with a schematic, in RADIO-ELECTRONICS, August, 1959, on page 10.



ALL-TRANSISTOR STEREO PREAMP YOU CAN BUILD

Two printed-circuit boards make this unit a comparatively easy construction project and low-cost transistors keep the price down



Front-panel layout of the preamp.

Underchassis view of preamp. Angle brackets fasten the circuit boards to ends of chassis frame.

Once again RADIO-ELECTRONICS is pleased to announce that the printed-circuit boards used in this article can be purchased. The price is $1.50 each, postpaid (get only one if you want a monaural all-transistor preamp). They are available from RADIO-ELECTRONICS, 154 W. 14 St., New York 11, N. Y., or direct from Electro-Technik Co., 19456 Meyers Road, Detroit 35, Mich.

By DANIEL MEYER*

THIS all-transistor stereo preamp was designed to replace a monophonic preamp that has been in service for some 5 years. I decided to use a transistor preamp for stereo because of the advantages a transistor circuit could provide. Transistors are quieter than tubes in low-level stages if used properly. They are smaller and need less power, which means less heat, and heat can be a problem in a stereo installation. Their size makes possible a small, compact preamp. These factors, and the challenge of building something new and different, led to the construction of this preamp when I converted to stereo.

The controls and features included meet my needs. If you have different tastes in controls, simply change the circuit slightly to get what you want.

The input selectors (Fig. 1) are somewhat unusual—there is a separate switch for each channel. This in combination with the BLEND control makes a very flexible input switching arrangement. With the more usual arrangement—a selector and a mode switch—a separate position is needed on the selector switch for each possible combination of inputs. If you start adding up the possible combinations such as AM–FM, FM–FM, TV–AM, TV–FM, etc., and then consider that we could also have a reverse condition for each, the reason for the system becomes obvious. With this arrangement the only thing not possible is reversing the two channels when both are on the same input. While this is not usually necessary it could be easily done with a dpdt switch (Fig. 2).

In the PHONO position, each preamp is compensated to match the RIAA recording curve. No provision was made on the original unit to change this since the RIAA has been standard for

*Research engineer, Southwest Research Institute, San Antonio, Tex.

electronically speaking–

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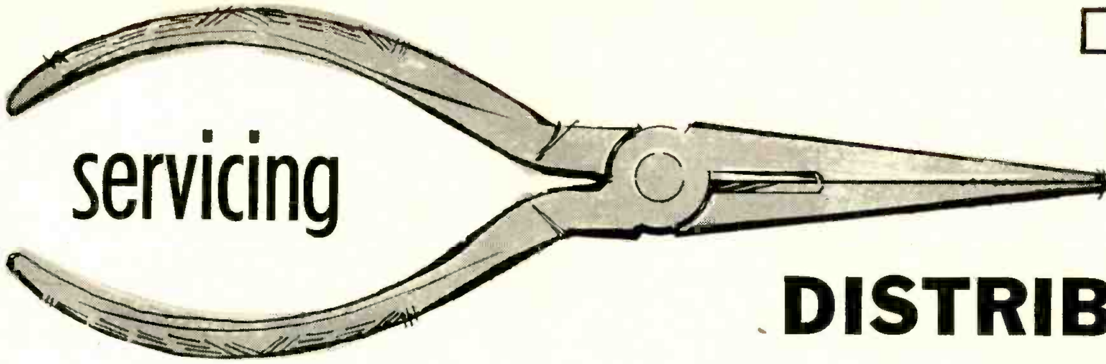


servicing TV DISTRIBUTION SYSTEMS

Part II—System defects: How to troubleshoot and find their causes

By JACK BEEVER *

THE first part of this series discussed types of distribution systems and some of the requirments of each. Now let's get down to the defects that may show up in these systems and see what causes them.

When faced with a defective system, the first thing to do is *think!* Don't just start testing here and there. Get an idea of the general layout. If possible, get a plan of cable layout and the equipment specifications. You will need one additional service instrument, a direct-reading field-strength meter, preferably one that will read the video and audio TV carriers separately.

Remember first that the average TV set owner who is connected to a TV distribution system always calls the system servicing people before he calls his TV technician—he hopes that the trouble lies in the system since service would then cost him nothing. The system technician should check, perhaps by telephone, with other people in the building to see if their sets are also out. Check apartments on each side and above and below, unless you know the wiring pattern of the building. If other sets are out or functioning improperly, then the trouble must be tracked down in the system. Listed below are a series of symptoms, their causes and cures.

No pictures on any channel all over the building. Usually an amplifier or the power supply of a strip head end is out. Check for a bad tube, blown fuses etc. Don't forget to check the ac power lines. If these are OK, the output line may accidentally have been cut somewhere between the amplifier output and the first splitter in the system (if it were elsewhere, there would be pictures in part of the system). Structural failure of the antenna system may be the cause.

No pictures on one channel, others OK all over. In a strip type head end, one amplifier or the associated antenna or preamplifier is out.

Snowy picture on one or more, but not all, channels at the ends (farthest points from the head end) of the system. In a strip head end, this usually means defective tubes in the amplifier of the channels involved. It may be a broken antenna connection or an antenna slewed on its mast (or corroded). The snow is an indication of too little signal to the TV receiver and signals are usually lowest at the system extremities.

In broad-band systems, this is usually caused by antenna difficulties, most often misorientation.

Snowy pictures on all sets, but head-end sets are getting high signal voltages. This is an indication that the amplifier is still operating, but is getting too low signals from the antennas. This results in a bad (low) signal-to-noise ratio at the amplifier input. When such a situation exists, no matter how much the signals are amplified (beyond this point) the pictures will still be snowy.

If the system has worked well in the past, the trouble is quite likely low antenna signals. In general, amplifiers should have signals of over 1,000 μv at their inputs. Preamplifiers should have a minimum of 150 to 200 μv for good crisp pictures.

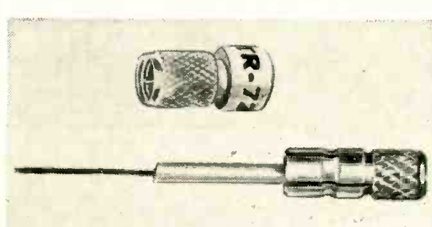
All sets on the system show one or two horizontal black bars, with shaded edges, moving or stationary. This is hum modulation and can be caused by a heater–cathode short in a tube or by defective filter capacitors in an amplifier. It will not be caused by anything past the amplifiers—ac on the system wiring will not cause it. If found on a strip type system, it will usually appear on only one channel if caused by a heater–cathode short. In the broad-band system, it may appear on all channels or just the channels of one band, depending on the circuitry of the particular amplifier. Usually, a dried-out or open filter capacitor puts the symptom on all channels.

A heavy, black vertical bar is seen moving across the screen, sweeping back and forth irregularly. This is "windshield-wiper" effect, properly called cross-modulation. In a strip type system, it means that a powerful signal is overdriving the amplifier or preamplifier of a weaker channel. The highest-power portions of this unwanted signal are the blanking pulses and are seen on the desired signal as an overlaid, unsynchronized pattern. The remedy is to trap out the undesired signal *before* it enters the amplifier—it cannot be taken out afterward.

In a broad-band system, the undesired signal is easy to identify. It will be the channel which *does not* have the symptom. This signal must be reduced. Bear in mind that broad-band amplifiers are actually double amplifiers. If channels 2, 4 and 8 are being used and 4 has the windshield-wiper pattern, channel 2 will be the offender. Channel 8 is in the high-band amplifier and could not normally overdrive the channel 4 in the low-band section.

In extremely severe cases, it is possible for a low-band section to be overdriven by a high-channel signal or vice versa, but it generally requires signals in excess of 100,000 μv.

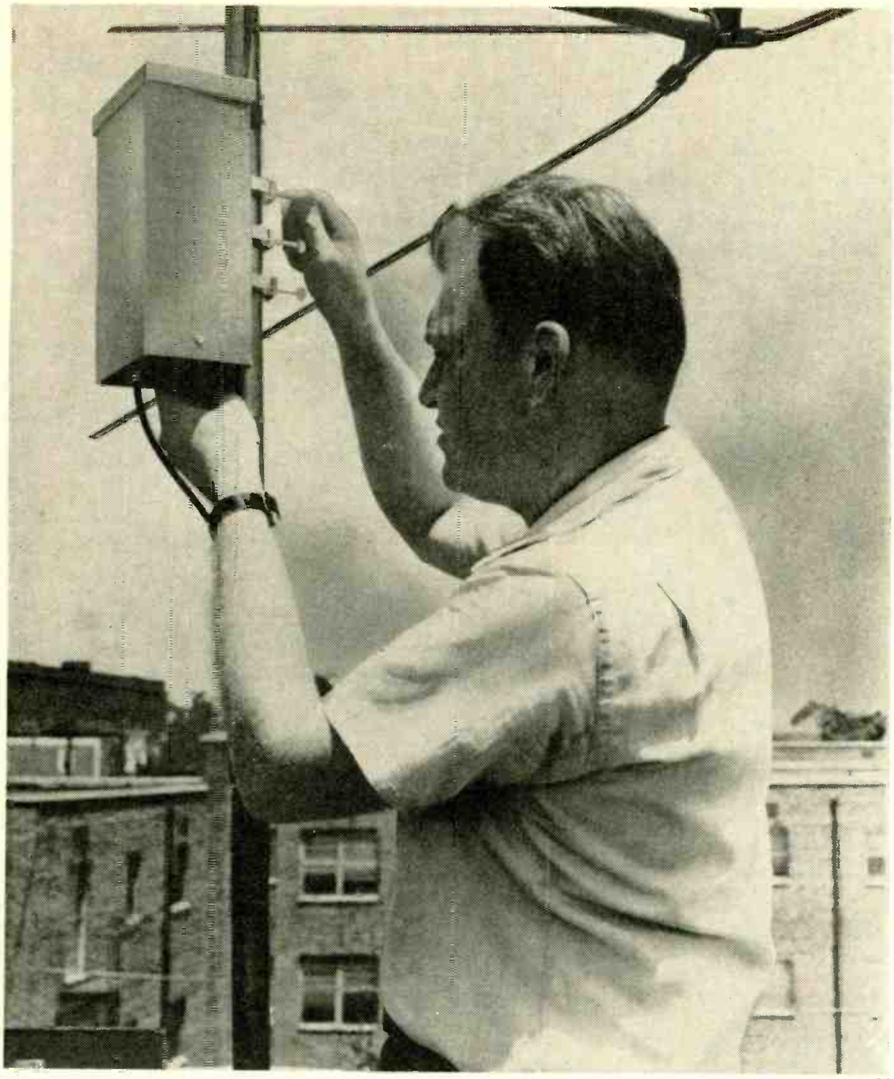
A percentage, or all, of the sets on a system show vertical instability and are very touchy about vertical hold control setting. This is also a symptom of overdriving and is called sync clipping. When an amplifier is overloaded, it tends to clip off the high points of the signal. This reduces the sync pulse size. Many sets will then synchronize to the



Jerrold

Terminating resistors for 72-ohm lines.

★Applications engineer, Jerrold Electronics Corp.



Jerrold

Technician replacing mast-mounted preamplifier

leading edge of the blanking pulse and lose interlace. They may show vertical jitter as they alternate between the weakened sync pulse and the leading edge of the blanking pulse. In a strip type head end, this will usually occur on one channel. The remedy is to reduce the signal level to the overdriven amplifier.

In the broad-band types, it may be necessary to "pad down" (attenuate) all signals or reorient the antenna to get satisfactory results.

Sync buzz in sound on all sets, and the audio carrier reads much lower than the video carrier. A defective antenna can sometimes cause this, but it usually is amplifier misalignment. Before doing anything else, check the signals from the antenna. If audio signals here are about even with the video signals or a little less (as is normal), the trouble lies in the amplifiers. Read the output levels of the preamplifier or amplifier to pin down where the trouble starts.

When found, change tubes from a known good set and reread the signals. If the trouble does not disappear, the amplifier is out of alignment. *Don't* grab an alignment tool. These amplifiers are much more difficult to align than a TV set, and the proper equipment is needed. Unless you have the proper sweep oscillators, delay lines, attenuators and detectors, don't touch; return it to the manufacturer.

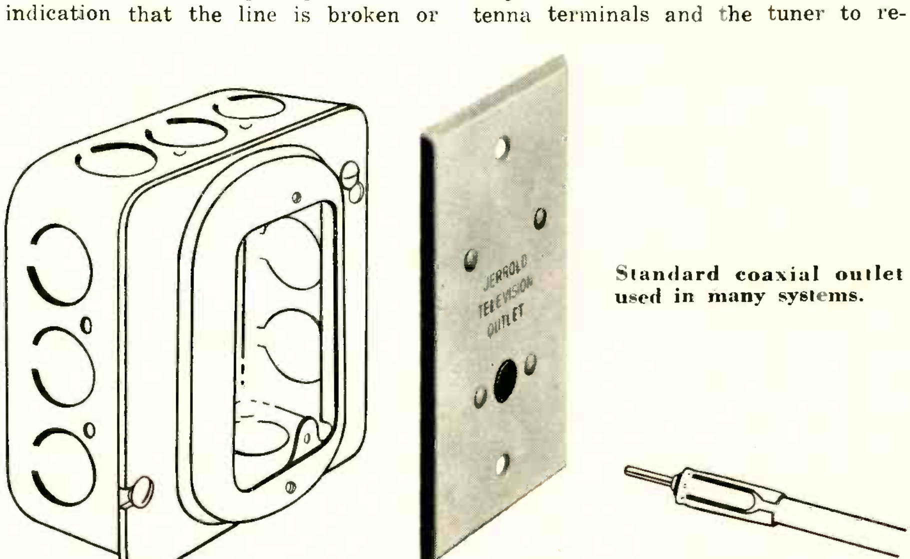
Along a feeder line, sets have strong but slightly smeared pictures, up to a point on the line. Beyond this point, pictures are weaker and ghosty. This is an indication that the line is broken or shorted between that last strong picture and the first weak one. Remember that a break and a short are the same to a coaxial cable and that neither stops signals entirely. A considerable amount of energy will get past the interruption. The easiest technique is to open the suspected outlet and check with an ohmmeter for continuity through the terminating resistor. Readings of 80 to 120 ohms are normal; less than 75 indicates a short.

Pictures along a line are smeary. Some sets have weak signals on one channel, but other sets on either side of the outlet may have higher signals. Close examination of pictures near the head end will usually show a close trailing ghost. The symptom indicates a poor or bad termination. An open or shorted terminating resistor or a short or open near the end of the feeder cable can cause this. The ghost is due to reflection from the unterminated line end, which also produces standing waves on the line, resulting in alternately weak and strong signals.

Leading ghosts (to the left of the main image) are seen on the local channel(s). This is caused by direct pickup of the local signal. The set is getting one signal from the system (delayed by the amplifier and cable) and is picking up a second undelayed signal directly from the station. Therefore, we have two images on the screen.

The remedy is to change the ratio between the direct-pickup signal and the system signal in favor of the system signal. Since we cannot change the strength of the direct-pickup signal in the vicinity of the set, two courses are open to us. The first is to increase the level of the system signal. Increase the output of the head end as much as possible. If this is not sufficient, it may be helpful to install higher-powered amplifiers.

The second way is to reduce the amount of set pickup. Coaxial cable from the tap to the set (which may require changing the tap to one with a coaxial output) will reduce pickup considerably. Shielded ribbon type line may be installed between the set's antenna terminals and the tuner to re-



Standard coaxial outlet used in many systems.

duce pickup on this section of exposed line.

If these remedies fail, a final but more expensive recourse is left. Convert the local channel to an unused, nonadjacent channel before inserting it into the system. Crystal-controlled converters are available for this purpose. As an example, suppose the channels in use are 3, 5 and 10, and there is too much direct pickup on channel 3. Channel 3 may be converted to channel 7, 8, 12 or 13. Channels 2, 4, 6, 9 and 11 cannot be used because they are adjacent to 3, 5 and 8. This could result in adjacent-channel interference (herringbone patterns).

Pictures flash or streak when trucks go by or elevators are operated. This trouble is usually just what it appears to be—a loose connection somewhere. Before pulling wires, however, check all tubes and antenna connections. Pound or shake the antenna mast while an assistant watches a TV set. Don't trust a signal-strength meter for this since the needle cannot move fast enough to indicate a loose connection. If these measures fail, jiggle all cable connections and check them for corrosion or oxidation. *Carefully check ground leads* to the amplifier chassis—these can raise the devil due to ground currents.

Keep in mind that the trouble is not necessarily in the system—the vibration of elevators or trucks going by may cause an arc in a loose power connection somewhere near the antenna. If this is the trouble, you have to locate it and inform the building superintendent. Usually, this effect will be more pronounced on distant channels and less noticeable or absent on the local station.

General notes

When an obscure trouble exists, a good procedure is to "strip down" the system. This is a process in which a television receiver is used to check all stages of the system. Start with the antenna leads (everything else disconnected), insert the preamplifiers, then the amplifiers, etc. The cable system is broken down into sections by removing all but one branch of the wiring from the splitters and terminating (connecting terminating resistors) to all unused "spigots" (coaxial connectors). Each leg can then be checked separately.

Finally, season all work with large doses of common sense. Good luck! END

Problems for Imports

Sales of imported TV and stereo sets are prevented in some parts of the US by lack of UL approval. Certain states and cities ban the sale of nonapproved devices.

A set is normally inspected at the factory (using the manufacturer's test equipment) when there is an Underwriters Laboratories branch nearby. Where Japanese imports are concerned (a UL branch has not yet been set up), the importer may have the sets inspected in this country as long as he makes any necessary design changes.

STEREO PA AT NEWPORT

By JACK ALLISON

ALTHOUGH the 1960 Newport Jazz Festival was wound up at the halfway point through no fault of its own, the first half of the show was covered as completely as possible by electronic means.

While the musicians performed on stage, behind the scene 30 engineers and technicians were busy at their jobs, making the coverage a 100% affair.

As the sound went into the six mikes on stage, it was being picked up on three-track and two-track Ampex equipment by Vanguard Records. Some of the material will be released by Vanguard; other tapes will be sold to the company that has a particular performer under contract, such as RCA Epic and Columbia. From Vanguard, a composite monaural signal was fed to the Voice of America facilities nearby.

A similar signal was simultaneously picked up on the audio track of the Videotape recorder Sports Network Inc. had brought along. SNI had three cameras covering the action. Their work is under contract to the US Information Agency and the tapes they have made are in demand by all the foreign TV networks. It seems that jazz is one of America's most easily assimilated exports.

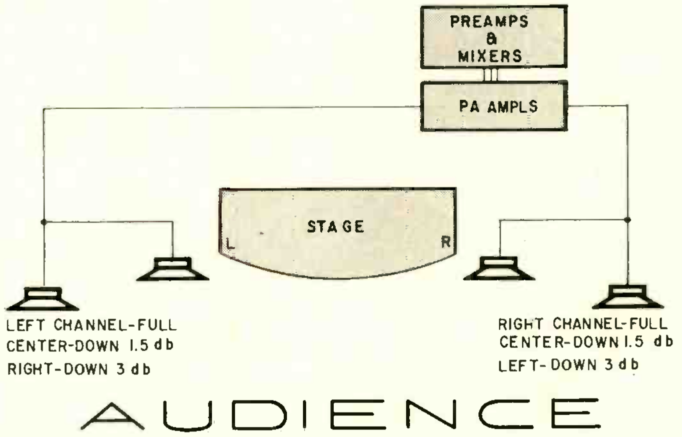
A third mono signal was taken from the Vanguard truck by the CBS Radio Network. They had Mitch Miller narrate the programs on the spot and were able to broadcast a complete hour-long program, commercials and all, from Newport over special lines the telephone company had installed.

Of particular interest was the PA system. Few critics failed to mention the excellent sound at the festival.

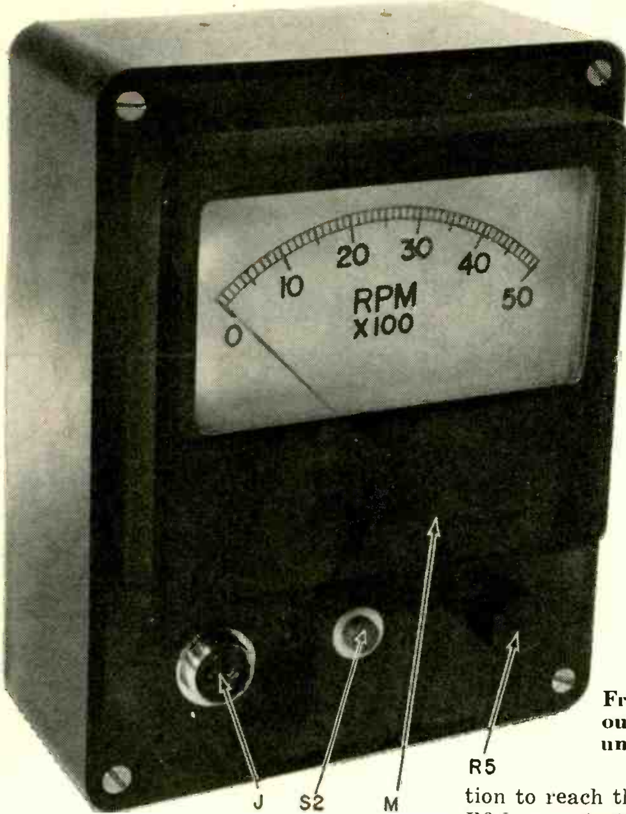
The three channels picked up by Vanguard were fed into two three-channel high-fidelity mixers so that, as you faced the preamp–mixers, the controls on each unit rode gain on left, center and right channels. Each preamp fed a 200-watt McIntosh commercial high-fidelity amplifier capable of over 500 watts peak. In turn, each amplifier was connected so that one half or side of the audience was covered by it.

If the left channel were fed directly to the left speakers, and the right the right, this would mean that those sitting near a speaker would get only half a channel of music, hardly a fair situation. To correct this, both halves of the signal were fed to all speakers, but on the left side the right signal was cut down 3 db and on the right side just the opposite was done. The center or solo signal was fed, slightly reduced, equally to both sides. Listeners at the sides near the front heard a complete signal. However, the vast majority near the center and back of the audience obtained the stereo illusion which made the music seem to come right from the stage, and the speakers themselves drew no attention.

The Newport Jazz Festival was a spectacular show, musically and electronically. END



How the speakers were fed to give the stereo illusion.



Front panel layout of all three units is identical

IGNITION-OPERATED TACHOMETERS

Three types of tachometers that will measure engine rpm of almost every type of gasoline engine—lawn mower to automobile

By ALEX M. SCHOTZ*

THERE are many types of electronic tachometers, each designed for a specific purpose. Two of the three units described in this article can be used on either 2- or 4-cycle engines with battery or magneto ignition (on engines with up to eight cylinders). The third one is a battery ignition-operated tachometer only.

The spark plugs fire on every stroke in a 2-cycle engine, and on every other stroke in a 4-cycle engine. Therefore, each revolution, one pulse is produced at the primary of the ignition coil for each cylinder in a 2-cycle engine, and one pulse for every other revolution per cylinder in a 4-cycle engine. The pulse width varies with the dwell time of the ignition points and the engine speed.

The first instrument is a combination electronic–electromechanical tachometer (Fig. 1). Its input is connected between the hot side of the ignition breaker points and ground. When used with a battery-ignition engine, the input leads must match ignition polarity. The pulse received from the primary of the ignition-coil circuit is fed through a low-pass filter composed of R1, R2, C1 and C2 that is designed to eliminate counting extraneous and breaker-point-bounce pulses. The desired pulses, from the low-pass filter, are coupled through dc blocking capacitor C3 to the base of transistor V. Also connected to the base of V is D1's anode. The diode clamps the pulses, allowing only the negative portion to reach the base of the transistor. R3 is a protective resistor for the diode. Transistor V operates as a switch and is turned on by the negative pulse, is off between pulses and allows current to flow through the relay coil with the pulses. D2 is placed across the relay coil to prevent negative peaks which might otherwise damage the transistor. The contact arm of the millisecond relay swings between the Zener-regulated voltage supply and the meter. When it is connected to the supply, capacitor C5 is charged. Resistor R7 limits charging current and later discharges the capacitor through the meter circuit. The average or dc value of these discharges is determined by the frequency of the discharges multiplied by the capacitance and voltage (I = F × C × E). If the capacitance is in microfarads, current will be in microamps.

To calibrate the instrument, apply the secondary voltage of a 6.3-volt filament transformer to the input. Then adjust potentiometer R5 so the meter indicates the proper rpm for the amount of pulses received at 60 pulses per second (see calibration chart, below.)

CALIBRATION CHART (ADJUST R5)

PULSES PER REV	METER READS
1	3,600
2	1,800
3	1,200
4	900

In many magneto-operated ignitions there are separate coils for individual cylinders or pairs of cylinders. When the tachometer is operated, this must be considered when figuring the pulses received.

The condition of the instrument's battery is shown when S2 is depressed, the meter reading voltage. Current drain is less than 50 ma, and the instrument is accurate within 2%. The frequency limit is set by the type of millisecond relay, dwell time of the ignition points and engine rpm.

Electronic tachometer

The second instrument is an all-elec-

R1, 2—1,000 ohms
R3, 7—10 ohms
R4—270 ohms
R5—pot, 500 ohms, 2 watts, linear taper
R6—74,000 ohms, 2% (73,200 and 806 ohms, 1%, in series)
All resistors ½-watt 10% unless noted
C1—0.25 μf, 400 volts, paper
C2, 5—0.5 μf, 200 volts, paper
C3—100 μf, 25 volts, electrolytic
C4, 6—25 μf, 25 volts, electrolytic
BATT—13 volts (2—6.5-volt mercury batteries in series) (Mallory TR-135R or equivalent)
D1—1N68-A
D2—1N68
D3—1N707, Zener diode, 6.2—8 volts, 5 ma (Hughes or equivalent)
J—2 contact input receptacle
M—0-200 μa, 4-inch rectangular (Simpson Model 29 or equivalent 1,000-ohm meter)
RY—millisecond type, 6-volt 150-ohm coil (Stevens-Arnold type 173 or equivalent)
S1—spst toggle
S2—spdt pushbutton, spring return
V—2N188-A
Case, bakelite, 6¾ x 5¼ x 2¼ inches
Panel, bakelite, 6½ x 5 inches
Miscellaneous hardware

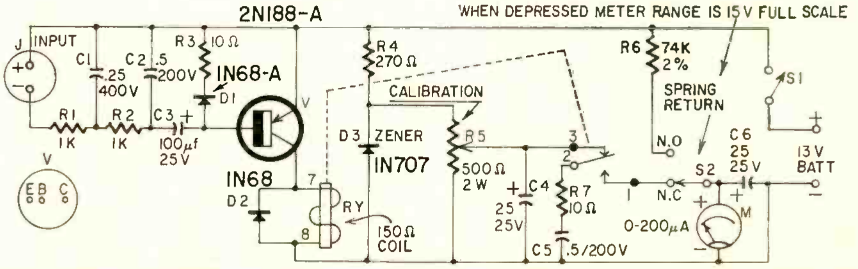
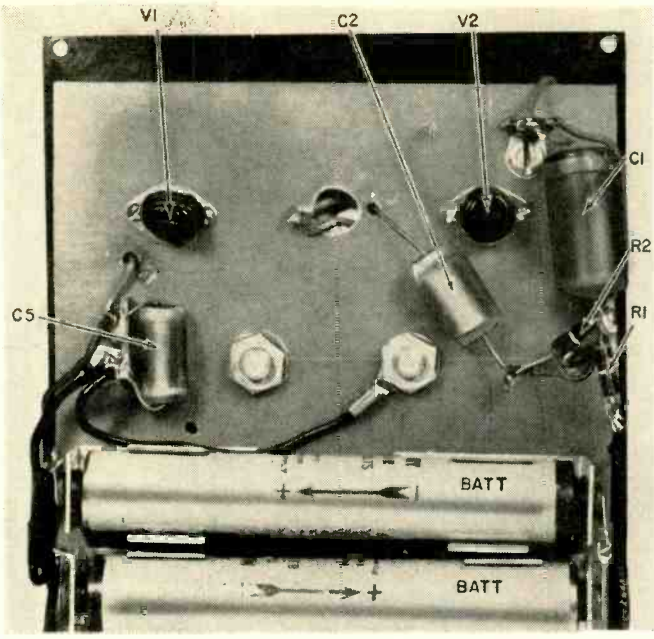
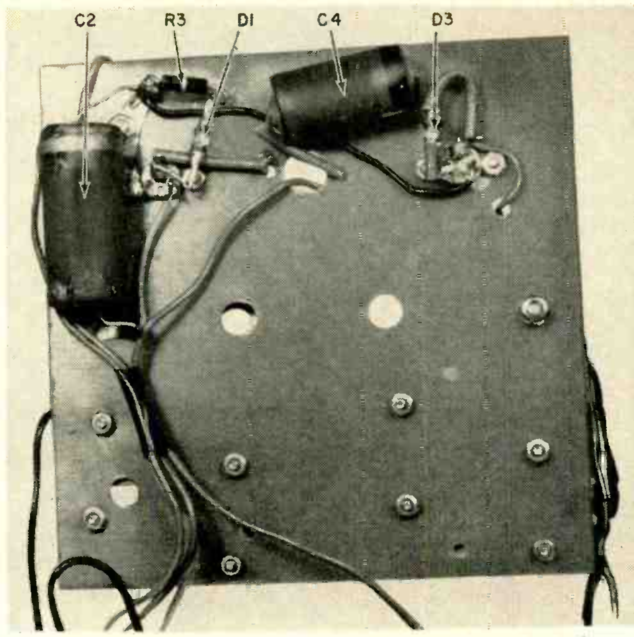


Fig. 1—Electromechanical tachometer for magneto- or battery-ignition engines.

*Outboard Marine Research Center, Milwaukee, Wis.



Inside all-electronic unit of Fig. 2. Note transistors.



Rest of components are on this side of chassis board.

tronic tachometer that can be used on battery- or magneto-ignition engines (Fig. 2). The input circuit is the same as for the first one.

A negative pulse is fed to the base of transistor V1, making it conduct. Between pulses, V1 is cutoff. Through voltage dropping resistor R4, Zener diode D2 swings between its maximum rated voltage when V1 is conducting and zero volts when V1 is not conducting. The pulse coming from D2 has a definite amplitude and is fed to potentiometer R5, which acts as a pulse amplitude control. This pulse is then fed to C4, giving it a charge with every pulse.

C4 is part of a transistor pump circuit that was described in *Wireless World*, March 1958 ("Unusual Transistor Circuits," page 107, by P. L. Burton and J. Willis). V2, D3 and C5 are all part of this circuit which discharges through the meter. The amount of current supplied to the meter from C4, the calibration, and the rest of the circuit are the same as Fig. 1. Again the instrument's accuracy is well within 2%, but it draws less than 30 ma from the power supply.

R1, 2—1,000 ohms
R3—10 ohms
R4—270 ohms
R5—pot, 500 ohms, 2 watts, linear taper
R6—74,000 ohms, 2% (73,200 and 806 ohms, 1% in series)
All resistors ½-watt 10% unless noted
C1—0.25 µf, 400 volts, paper
C2, 4—0.5 µf, 200 volts, paper
C3—100 µf, 25 volts, electrolytic
C5—25 µf, 25 volts, electrolytic
BATT—13 volts (2—6.5-volt mercury batteries in series) (Mallory TR-135R or equivalent)
D1—1N68-A
D2—1N707, Zener diode, 6.2—8 volts, 5 ma (Hughes or equivalent)
D3—1N68
J—2-contact input receptacle
M—0-200 µa, 4-inch rectangular (Simpson Model 29 or equivalent 1,000-ohm meter)
S1—spst toggle
S2—spst pushbutton, spring return
V1—2N188-A
V2—2N293
Case, bakelite, 6¾ x 5¼ x 2¼ inches
Panel, bakelite, 6½ x 5 inches
Miscellaneous hardware

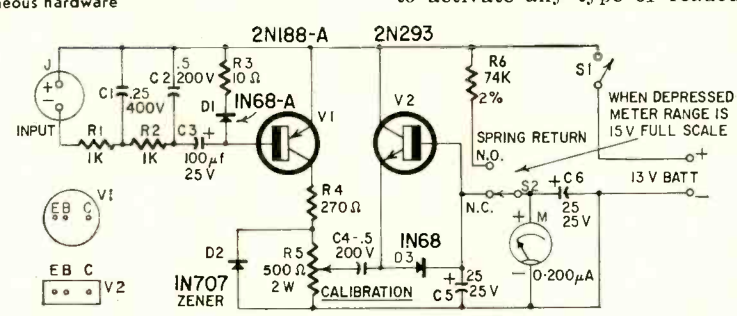


Fig. 2—All-electronic tachometer for magneto- or battery-ignition engines

Battery-ignition unit

The third instrument is fundamentally electromechanical and can be used only with battery-ignition engines (Fig. 3). The input is in parallel with the breaker points with the proper polarity to ground. When checking a 12-volt system, leave S open. For 6 volts, close the switch. The 6-volt millisecond relay coil is energized every time the breaker points open and is de-energized when they close. When the relay is energized, C1 is charged through R4 from the Zener-diode regulated source. The charge on C is then applied to the meter circuit, as previously discussed. Calibration is also the same as in the other two tachometers described. Accuracy of this circuit is about 3%.

There are many possible variations of these tachometer circuits. The meter can be replaced by a resistor and a dc voltage proportional to the frequency which will appear across it can be used to activate any type of readout device or to control another circuit. Or you can use the electronic tachometer with a magnetic pickup setup to count the teeth in a gear or flywheel. The only requisite for a magnetic pickup is that the gear or flywheel be made of a magnetic material. The low-pass filter and clamping diode circuit can then be removed and the pulse fed through a capacitor directly to the base of V1. Bias the transistor so that center voltage appears at V1's collector. Then as the negative portion of the pulse is fed to V1's base from the magnetic pickup, the transistor will conduct and be cut off during the positive half of the pulse. The type and the placement of the pickup must provide sufficient voltage to make V1 conduct and cut off, or another stage of amplification will have to be added. Capacitor C4 should then be calculated for the frequency range of the pulses that will be received from the magnetic pickup at the gear's maximum speed so it provides sufficient current to the meter or indicating device. END

R1—150 ohms, 1 watt, 10%
R2—100 ohms, 1 watt, 10%
R3—pot, 500 ohms, 2 watts, linear taper
R4—10 ohms, ½ watt, 10%
C—1 µf, 200 volts, paper
D—1N705, Zener diode, 4.3—5.4 volts, 5 ma (Hughes or equivalent)
J—2-contact input receptacle
M—0-200 µa, 4-inch rectangular (Simpson Model 29 or equivalent)
RY—millisecond type, 6-volt 150-ohm coil (Stevens-Arnold type 178 or equivalent)
S—spst toggle
Case, bakelite, 6¾ x 5¼ x 2¼ inches
Panel, bakelite, 6½ x 5 inches
Miscellaneous hardware

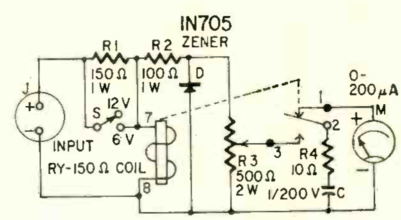
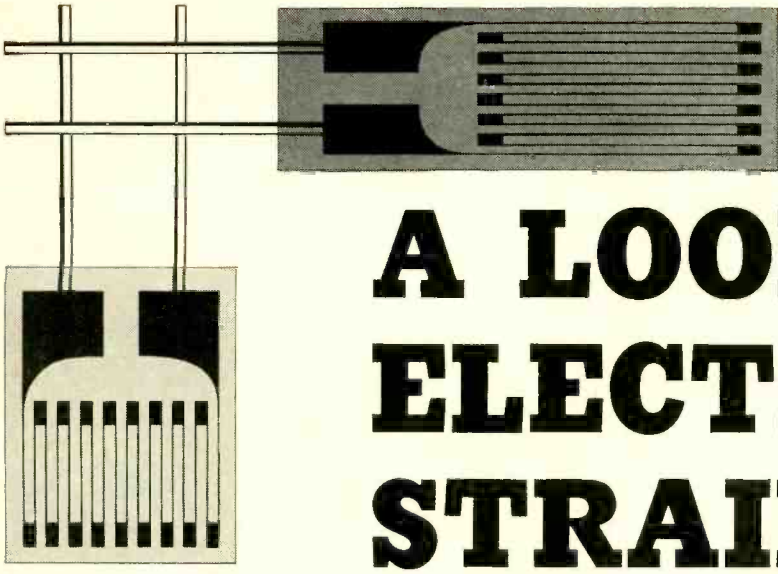


Fig. 3—Simple electromechanical unit checks battery-ignition engines.



A LOOK at the ELECTRONIC STRAIN GAUGE

Strain gauges make it possible to measure the distortion of a steel beam or measure fluid pressure

By ARTHUR S. KRAMER

IF you wonder why strain and stress measurements are important, take a look at some pictures or drawings of old-style rotating machinery. The reason why such massive heavy parts were used is simply that designers of those days had no convenient and accurate method to measure dynamic and static stresses. Cut-and-try methods were used, together with a multiplying "safety factor" of 4 or 5. The result was a large, heavy machine, costly in material and upkeep.

Contrast this picture with today's requirements for aircraft design, where maximum strength per pound of material is required. Other applications where strain measurements are of great importance are in concrete-highway and steel-bridge design. Several applications will be described and pictured further on in the article.

Early types

Before electronic strain gauges were invented, several ingenious mechanical and optical types were used. One used a pen to record strains on a moving chart. Another, for measuring stress conditions in concrete structures, was equipped with a writing stylus at the end of a long lever arm. A third mechanical type measured and recorded the stresses on a drum. All purely mechanical and optical types have one major disadvantage: they cannot be used in telemetering. This makes them of little use for flight testing of experimental aircraft, missiles and space vehicles.

One of the very first applications of the electronic strain gauge was in Los Angeles in 1931. A crude type was built and used in the Big Tujunga Arch dam project. Basically, it consisted of a framework of two unglazed porcelain plates grooved to accommodate three coils of steel wire. Although it was fairly accurate, it was big clumsy and relatively insensitive.

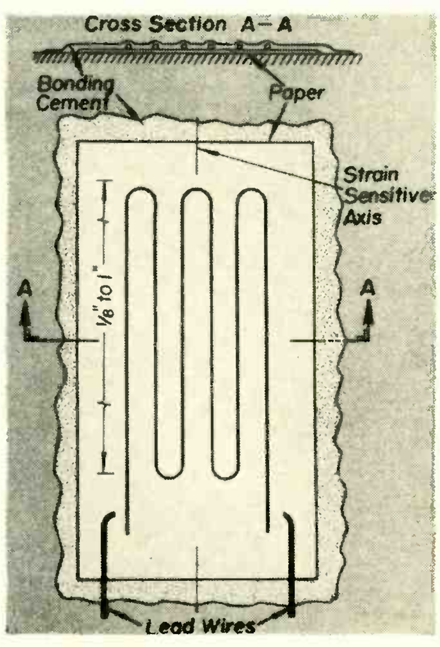
Another early type was magnetic rather than electrical, and was arranged in an ac bridge circuit. The air gap of the strain-gauge head varied according to the strain in the tested specimen, and unbalanced the bridge.

The modern resistance-wire strain gauge (invented almost simultaneously by Simmons and Ruge in 1938) is a transducer which transforms a strain in a tested specimen into a change of electrical resistance. If the gauge is one of four resistors connected as a Wheatstone bridge, a strain will unbalance the bridge. This is the way in which most resistance-wire gauge circuits function. The essential parts of a simple system consist of the gauge cemented to the specimen, three other resistors (possibly dummy gauges), an energy source such as a battery and an indicating meter.

Baldwin acquired the original inventions (wire-resistance strain gauge) by Simmons and Ruge and began to manufacture them as SR-4 (Simmons-Ruge) gauges. Early SR-4 gauges consisted of a simple grid of 1-mil wire looped back and forth and cemented to a sheet of thin paper. Short copper lead wires were provided. In use, the paper was cemented to the desired spot on the specimen and the gauge was oriented in the direction in which the strain was to be measured.

Modern types

Modern strain gauges are made in several forms. One of the most common is the bonded-wire type as shown in Fig. 1. A piece of fine resistance wire is looped back and forth and connected



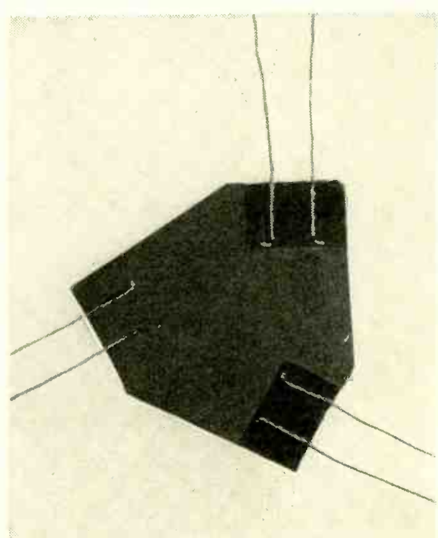


Fig. 2—Rosette gauge with three elements.

Fig. 1—Bonded-wire strain gauge.

by leads to the external measuring circuit. A cross-section shows how the wire is bonded to the paper with cement. When gauges of this type are made with Karma wire, (a special alloy usable up to 900°F) they are suitable for use in high-temperature applications.

A variation of this type is the multiple-grid or *rosette*. It consists of several gauges mounted with their major axes at various angles to one another and is used for measuring multidirectional strains at one point on the specimen (Fig. 2).

Consolidated Electrodynamics Corp. produces a chamber type of unbonded strain-gauge pressure pickup (Fig. 3). It is claimed that this transducer retains its accuracy at pressures up to 10,000 pounds per square inch. A spring type sensing element with four active arms is used. Pressure against the diaphragm displaces the sensing element, changing the resistance of the active arms and causing an output proportional to the applied pressure.

An important sort, with a growing list of applications, is the etched-foil gauge (Fig. 4). These are produced from an extremely thin foil sheet by photo-etching techniques and have no

Fig. 3—Chamber type pressure pickup by Consolidated Electrodynamics Corp.

critical internal joints. They are rugged and stable and are easily fitted to sharply curved surfaces. It is possible to stack them in rosette form.

Polyphase Instrument Co. (Bridgeport, Pa.) has developed a "load-sensitive bolt." This permits direct measurement of the actual bolt load. The bolt is threaded right into the structure under test. Tension or compression is sensed by special resistance type strain gauges potted axially at the center of the screw (bolt or rod) (Fig. 5).

The vibrating-wire kind of strain gauges uses different principles. The resonant frequency of a taut steel wire varies with the tension. A wire is rigidly anchored in a frame which, in turn, is securely fastened to the specimen. In use, the wire is "plucked" by an electromagnet, which then picks up the vibrations as stress is applied to the

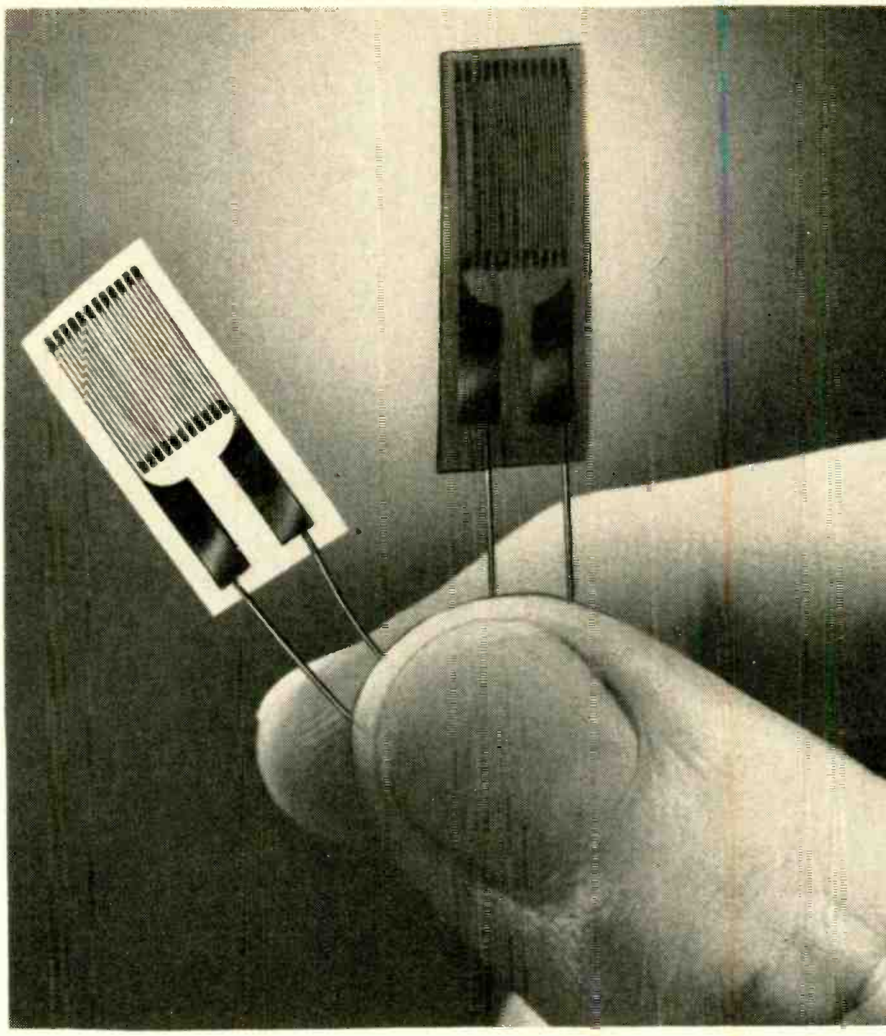


Fig. 4—Etched-foil gauges are more flexible than bonded-wire types.

specimen. The frequency is measured and, from previous calibration, the strain and stress are determined. This type is fairly common in England for measurements on concrete highways.

The Baldwin SR-4 fluid pressure cell illustrated in Fig. 6 consists of a pressure-sensitive metal tube to which bonded-wire strain gauges are attached. Changes in fluid pressure result in minute deformations of the tube with resultant changes in strain-gauge resistance. These changes will show on the external meter.

Stress and strain

In any discussion of strain gauges, *stress* and *strain* are frequently mentioned. Stress is the force exerted upon an object or body which deforms it. Strain is the total change in any linear dimension of a body (because of external stress). *Unit strain* is the total change of any given dimension (of the stressed body) divided by the original (unstressed) dimension. Strain gauges usually measure unit strain in micro-inches per inch.

A 17th-century English physicist, Robert Hooke, formulated a law relating stress and strain. Simply stated, Hooke's law is "stress is proportional to strain." Algebraically, it is expressed as: $E = \beta/\lambda$ where β = stress, λ = strain and E = modulus of elasticity (Young's modulus).

Proper use of strain gauges makes determining the average stress intensity

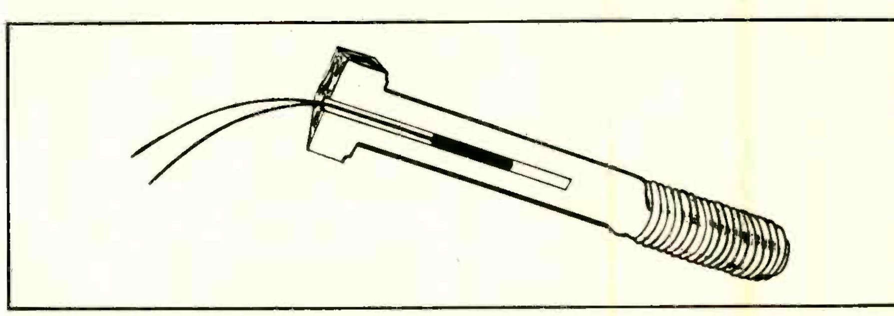


Fig. 5—Strain gauge imbedded in a bolt allows its stress to be measured.

Fig. 6—The Baldwin SR-4 fluid pressure cell.

at some point in a specimen quite easy. Just measure the strain at the point and multiply it by the modulus of elasticity. As an example, suppose a strain-gauge circuit indicates a strain of 2,000 microinches per inch ($2,000 \times 10^{-6}$ in/in). If the sample's modulus is 17.2×10^{6} pounds per square inch (17.2×10^{6} lb/in^2), stress is $E = (17.2 \times 10^{6} \text{ lb/in}^2)(2,000 \times 10^{-6} \text{ in/in}) = 34.400 \text{ lb/in}^2$. This is the way in which strain-gauge readings are used to determine stress at one point (or many) in a specimen.

Gauge factor

Strain-gauge factor (or simply *gauge factor*) is a very important quantity. This is the ratio of unit change of gauge resistance to unit strain. As a formula,

$$F = \frac{\Delta R/R}{\Delta L/L}$$

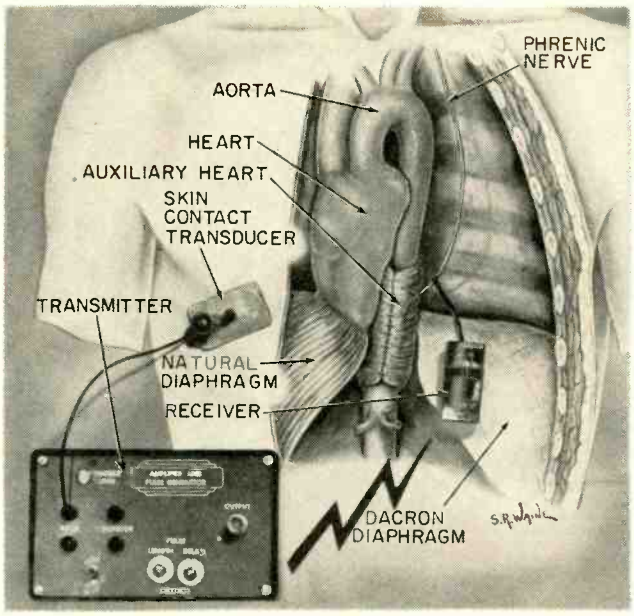
where R = original resistance of the gauge wire,
L = the original length of the gauge wire,
ΔR = the small change in resistance which takes place as the gauge is strained,
ΔL = the small change in length which takes place as the gauge is strained.

Various wire materials have different gauge factors. For nichrome, F is +2; for manganin, +0.47; for platinum, +4.8, and for nickel, −12.1. The gauge factor is equivalent to the sensitivity of the gauge. Other factors being equal, the material with the greatest gauge factor would usually be picked for a given application.

Strain gauges are used to weigh heavy loads, determine the strain on a gun barrel, measure torque, measure the thrust of a jet engine, etc. A future article will show some of these uses and discuss measuring circuits.

The author wishes to express his thanks to Mr. T. L. Gaffney of Baldwin-Lima-Hamilton Corp., Waltham, Mass., who contributed much useful technical information and the photos of Figs. 1, 2, 4 and 6. END

ELECTRONIC "AUXILIARY HEART"



The artificial heart is a section of the diaphragm wrapped around the large artery. Its assistance to the real heart can be decisive in some cases.

Fig. 1—Block diagram of transmitter.

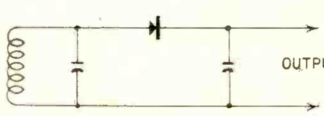


Fig. 2—Simplified schematic of receiver.

An electronically actuated heart "booster" can take over as much as 25% of the work of an impaired natural heart.

Developed by Dr. Adrian Kantrowitz, director of cardiovascular surgery, and Dr. William M. P. McKinnon, research fellow, at Maimonides Hospital in Brooklyn, N. Y., the electronic "second heart" has been used successfully in animals.

The rather crude diagrammatic representation shows how the electronic heart would be applied to human beings. The auxiliary heart actually is formed from a section of the diaphragm, which is replaced by the sheet of Dacron fabric. The diaphragm section retains its original blood supply and its connection with the phrenic nerve. The auxiliary heart is wrapped around the aorta (the large artery that carries blood to the body).

The skin-contact transducer picks up the natural heartbeat. It is translated into an rf pulse in the transmitter (Fig. 1). The pulses are transmitted to the Lucite-encased receiver (Fig. 2) embedded in the body. The receiver emits a faint electrical impulse which stimulates the phrenic nerve and causes the muscle to contract.

A relay system in the transmitter makes it possible to cause the auxiliary heart to beat alternately with the natural heart, if desired. Researchers currently are exploring methods to shield the receiver against random radio waves. END

MODERN PICTURE-TUBE testers

This article will clear up some of the confusion surrounding the terms "open, reactivate and rejuvenate" as applied to TV picture tubes

By WILLIAM KELVIN

Chief engineer, Mercury Electronics Corp., Mineola, N.Y.

IF you've been in the TV service business for a few years, you have probably run into at least one case where you were willing to bet a month's income that the picture tube was bad. All the symptoms were there (uncontrollable brightness, bad focus, barely discernible video, but good sync and plenty of high voltage). Later you were glad you didn't make the bet out loud because you would have lost it to a shorted video coupling capacitor! This has happened to plenty of competent men who did not use a good picture-tube tester. Even sadder is the case of those who confidently installed a new picture tube in the home, with the customer watching!

Today, the well-equipped service technician must be able to identify a bad cathode-ray tube every time. And, just as important as being able to convince the set owner that his "big tube" is bad, the technician must also convince himself.

A professional picture-tube tester must:

- Check heater continuity
- Check picture-tube output or "quality"
- Check life expectancy
- Reactivate low-emission cathodes
- Check for interelement shorts
- Repair interelement shorts
- Check for opens
- Reweld opens

No instrument can repair all bad tubes, but a good one can tell the service technician when a tube is repairable and when it is not. And it can guide him in using his judgment on those inevitable borderline cases.

Heater continuity

All popular CRT testers use a neon indicator for this test. Fig. 1 is a typical heater continuity circuit (in simplified form). The tube heater is put in series with a neon lamp, a current-limiting network and a 117-volt portion of the transformer secondary. Usually, if the heater shows no continuity, the picture tube must be replaced. Rewelding a CRT heater is not practical for reasons mentioned later.

Picture-tube quality

Since picture quality is directly related to cathode emission, emission measurement is known as a quality check. Practically all picture-tube testers use the emission-check principle that has been used for decades to test receiving tubes.

Fig. 2 shows a simplified circuit of the most widely used method for checking picture-tube cathode emission. In this circuit, the screen grid is tied to the control grid. Resistance R limits cathode current to a maximum of 5 ma. This is a heavier drain on the CRT than would be put on it by a TV set, but not enough to damage the emitting surface. Many engineers favor this design because the slight overload on the cathode shows up a weak-emitting condition at once. In this way, a BAD quality reading is obtained for tubes with nearly exhausted cathodes. Many of these nearly dead tubes still show a dull raster that gives a poor although usable picture. The BAD reading warns the technician that the tube will shortly be needing reactivation, if not replacement.

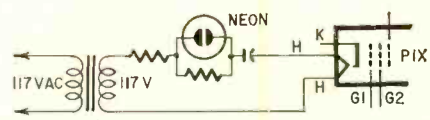


Fig. 1—Basic circuit used to check heater continuity.

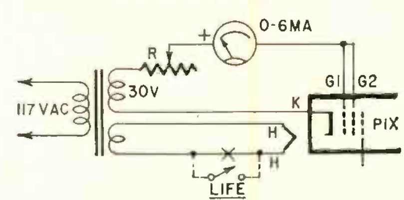


Fig. 2—Circuit used to measure cathode emission and life expectancy.

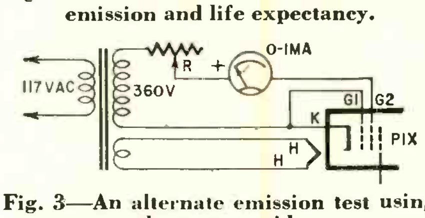


Fig. 3—An alternate emission test using the screen grid.

Another method of checking emission is shown in Fig. 3. This circuit is less common but is favored by some designers because the test voltage is applied between screen grid and cathode, thus more closely approximating beam current. Notice that over 10 times as much test voltage is required. The maximum cathode current drawn by this method is 1 ma.

As an addition to the emission test, a few picture-tube testers provide an extra—a means for measuring the CRT cutoff voltage. This adds to the cost of the instrument and is omitted by most designers because this characteristic of a cathode-ray tube is actually of more interest to the tube manufacturer than to the service technician or set owner. It is a measure of the contrast ratio that the tube will show on its screen. Referring to Fig. 4, the CUTOFF control applies increasing negative bias to the picture-tube grid (or increasing positive bias to the cathode) as it is advanced. The less bias needed to cut off the cathode current, the greater is the tube's contrast ratio. Thus a high cutoff voltage would seem to indicate a

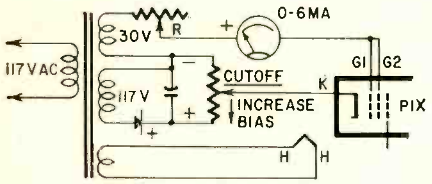


Fig. 4—Emission test circuit with cutoff voltage measurement feature.

bad tube because it means low contrast ratio. However, this does not necessarily follow because high-cutoff-voltage tubes can still show good contrast ratio if cathode emission is high.

Life expectancy

A means of checking the life expectancy of a CRT is found in all but the lowest-price instruments. As a service technician, you must have been asked by many customers: "How long do you think my picture tube will last?" With a life expectancy test, you can give a reliable answer.

All manufacturers who include such a test use a method like that illustrated in Fig. 2. The quality reading is noted and then the heater circuit is opened with the LIFE switch. The cathode cools causing emission to fall off. A "countdown" of the number of seconds it takes for the current to fall to zero measures the life expectancy of the tube, since it is directly related to the amount of emitting material on the cathode.

The question of gas content arises here, since gas in a CRT will shorten its life. The gas particles ionize within the tube leading to the familiar negative-picture effect. A gassy tube must be replaced once this effect has become severe.

Cathode reactivation

The term "reactivation" is frequently misunderstood or misapplied. It is also called "rejuvenation". Both terms seem valid because it may be said that after *reactivating* an inactive cathode, the tube has been *rejuvenated*, since it performs like a youngster once more! The successful repair of shorted or open elements in a CRT is definitely a case of reactivation, since the tube was certainly out of action before the repair. For consistency, the word *reactivate* will be used here to denote any kind of an operation performed to cure an ailing picture tube.

The best known reactivator for weak emission is the common brightener. Professional tube testers always contain a built-in brightener, or booster, in addition to their other features. The circuit shown in Fig. 5 illustrates the most widely used method of boost re-

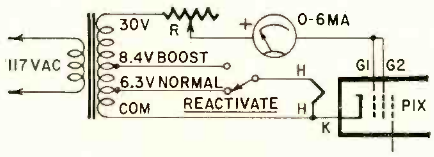


Fig. 5—Boost reactivation raises tube's heater voltage somewhat.

activation with an additional feature that the manufacturer calls "Watch It Reactivate." This consists of boosting the heater voltage while reading the emission. The service technician can see whether or not the picture tube responds to reactivation. When this is done in the home, the TV set owner also can see the results obtained with his tube.

As shown in the full schematic of Fig. 6, the latest picture-tube tester design has provision for picture tubes with the new heater ratings of 2.35, 2.68 and 8.4 volts. Some designers call for a 1- to 2-minute period of overheating the cathode before measuring emission. One manufacturer provides a double boost, but most reactivators have a boost voltage approximately 30% above normal. This limit avoids any danger of heater burnout.

A more powerful method of emission reactivation is called "sweeping" the cathode or "shot" reactivation. The service technician will find this provided in all the medium- and higher-priced instruments. Basically, a high voltage is applied to the CRT signal grid (for a short period of time) and

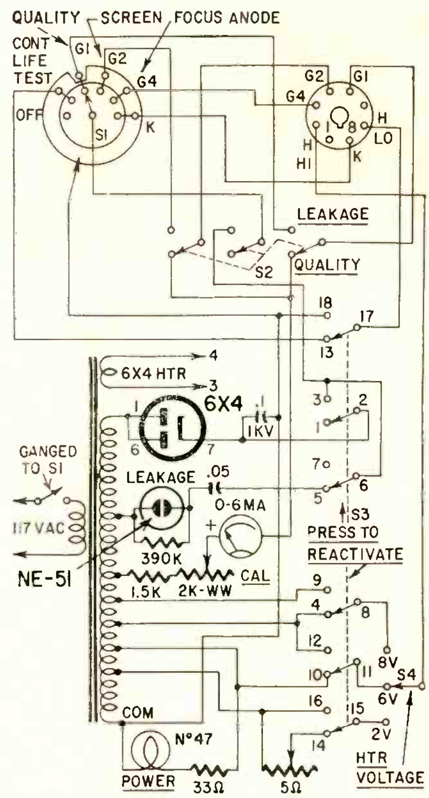


Fig. 6—Schematic of Mercury 800 CRT tester.

Mercury 800 CRT tester.

Superior Instruments model 83-A.

B & K 440 Cathode Rejuvenator Tester.

Anchor Products T-470 CRT tester.

draws a *momentary* emission current of very high density. This knocks contamination from the cathode surface and allows emission to return to normal.

The high voltage used for shot reactivation varies from 200 to 1,000. Fig. 7 shows a 1,000-volt shot reactivation circuit. Note that the applied voltage is

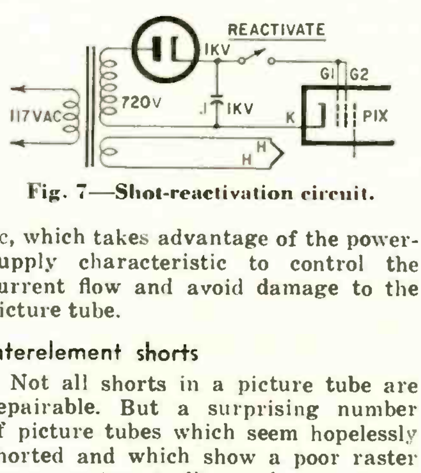


Fig. 7—Shot-reactivation circuit.

dc, which takes advantage of the power-supply characteristic to control the current flow and avoid damage to the picture tube.

Interelement shorts

Not all shorts in a picture tube are repairable. But a surprising number of picture tubes which seem hopelessly shorted and which show a poor raster (or no raster at all) can be completely cleared of shorts and restored to useful life.

Fig. 8 shows a type of short that can be repaired. It is caused by a bit of metallic dust getting between two elements in the CRT gun. Fig. 9 shows a short that usually cannot be repaired. This is a structural defect that

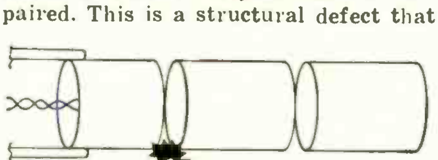


Fig. 8—A metallic flake can short two elements together.

might be a fault of manufacture or caused by excess heat of operation. Note that the CRT gun elements are warped and touching each other.

To check for a short, we need an indicating device and a means of isolating the shorted element. A neon lamp is invariably used as the indicating device. All popular CRT checkers use one of two methods to isolate the shorted element.

The first method—preferred by the majority of manufacturers — uses a switch. Each position is labeled with the name of the element to which it is connected. If the neon lamp lights when the switch is turned to any one position, one of the shorted elements is positively identified (Fig. 10). Switch section A contacts all but one element and connects them through the neon-indicator network to one side of a transformer winding. Section B of the switch con-

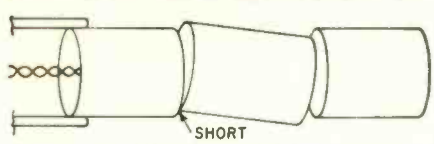


Fig. 9—A short caused by structural deformation.

nects the isolated element to the other side of the transformer winding. Thus, a short between the isolated element and any of the other elements causes the neon lamp to glow.

The second method (Fig. 11) employs several indicator lamps. Here each element is isolated by a lamp except for the cathode. An advantage of this method is that no switch is necessary. To identify the shorted elements, however, it is necessary to interpret the various combinations in which the four lamps can glow.

Repairing interelement shorts

To repair a short, a momentary high current must be passed through the shorted path (in an action similar to shot reactivation as described above). The intense heat of the high current burns up the loose material lodged between the elements and thus clears the short. In the circuit of Fig. 12, a switch similar to that of Fig. 10 allows you to apply the repair voltage to any one element. This method can clear a cathode-to-heater short, a feature not provided by some instruments. Danger of heater burn-out is avoided by separating the heater- and repair-current paths.

Ac may also be used for repairs. One early manufacturer of CRT testers used a high-voltage rf supply called a Sparker. Repair circuits have proved to be a very popular feature and are found in nearly all instruments.

Open elements

Technicians often misunderstand the term "open element" in a picture tube. In particular, a cathode whose emitting surface has become dead is often referred to as an open cathode. It is not open unless there is an actual break in the wire leading from the base pin. Such breaks do occur and can sometimes be seen inside the tube neck (Fig. 13). However, whether the failure of the element to pass current is due to a lack of emitting material or due to a break, the treatment is the same and is covered in the various instruction manuals under the heading of Welding. A simple test for an open is to tap the neck of a CRT which shows no raster at any brightness level. If the screen lights up momentarily at each tap, an element (usually the cathode) is intermittently open and it is worth try-

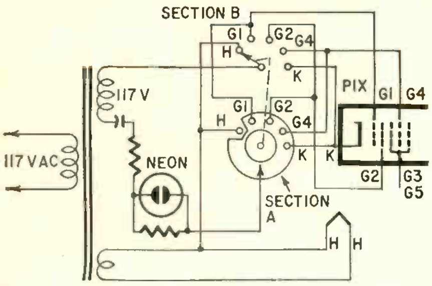


Fig. 10—Double-section switch allows identification of shorted elements.

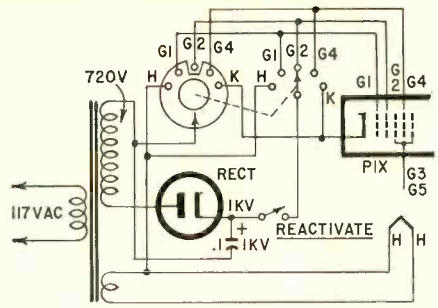


Fig. 12—A high-voltage pulse may be used to burn out certain shorts.

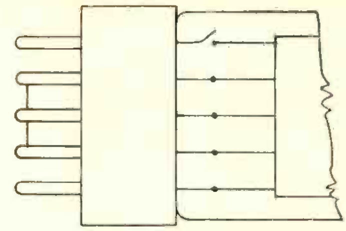


Fig. 13—A visible open in a CRT neck.

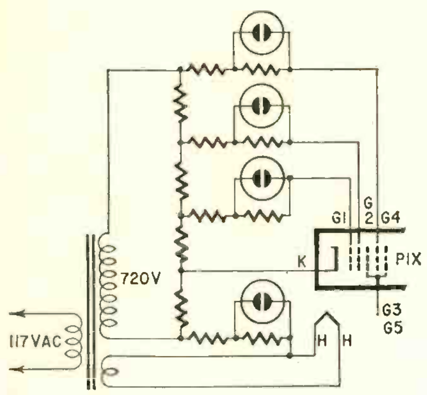


Fig. 11—A short check that requires no switch.

ing to reweld it. In Fig. 13 the break where the gun element will be welded to the base pin can be seen.

Rewelding opens

Spot welding in industry is bonding two metals by the heat of an electric current or arc passed between them. An open element in a CRT is welded in the same way. The welding technique is modified for picture tubes, to accommodate the relatively large gap presented by an open element. The CRT tester must force an arc to cross the gap. This requires high voltage. Even so, unless the ends of the element are very close or touching they cannot be welded.

Technicians who use reactivators with a welding feature tap on the CRT neck while applying the high voltage. The tapping jiggles the broken ends. When they brush against each other, the arc completes the weld. This can be done by the circuit that is used to repair shorts, shown in Fig. 12. For welding, the high voltage is applied continuously until an arc is struck, rather than momentarily as when repairing of an interelement short.

Rewelding CRT elements is completely successful in less than half the attempts. But those welds which hold enable the picture tube to perform as well as ever once more.

A note about open heaters: In general, you cannot successfully reweld them. The heater is a high-current element, passing 600 ma in most picture tubes, as compared with only 2 ma for the cathode. This heavy current will heat up and open any weld which has appreciable resistance. Also, the filament expands and shrinks when the TV set is turned on and off. This will open the weld unless it is perfect. Most technicians prefer to recommend CRT replacement when they diagnose an open heater.

Adapters

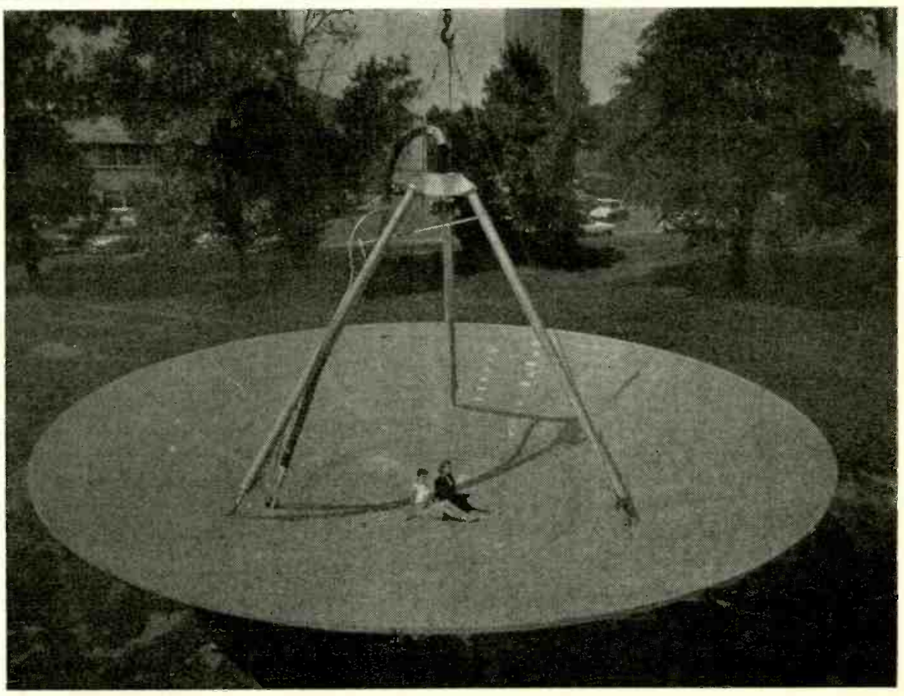
All manufacturers of CRT testers provide for testing the small-based 110° picture tubes, and most also accommodate color picture tubes. This is done by adding cables or by supplying adapter caps for use with the standard socket on the existing cable. In the model designed by the author, shown in one of the photographs, a Multi-Head solves this problem. The Multi-Head is seen in the compartment at the left side of the instrument case. It is a single cable terminating in a head that contains all four socket types in use today. A COLOR-GUN switch is also included in the head. Fig. 6 is a complete schematic of this instrument (which will check the newer 2- and 8.4-volt types).

A check with various cathode-ray manufacturers shows that no new bases are planned at present. However, adapters can be made for any new bases. The test procedure will not change because the emission characteristics of all picture tubes are very similar.

Today's technician must be armed with something more than a "brightener" in his caddy if he expects to win enough customer confidence to get his share of the picture-tube repair and replacement business. And brother, it's a big business! If you don't think so, just do some figuring. There are 60,000,000 sets in the country, average picture-tube life is 3 to 4 years and the retail price of replacement picture tubes averages over $30 apiece. The annual gross is over a *half-billion dollars* and still growing! END

THREE DISHES

The two prettier ones are sitting in the center of a 40-foot parabolic antenna at ITT Labs, Nutley, N. J. The big one, when mounted, will enable scientists to pick up radio signals bounced off the moon or man-made satellites.



TV Service CLINIC

conducted by

JACK DARR

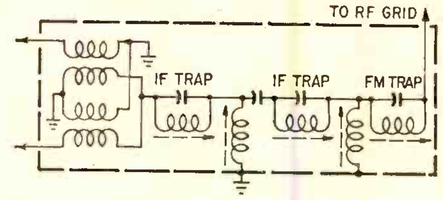


Fig. 3—Antenna matching unit used in better TV receivers.

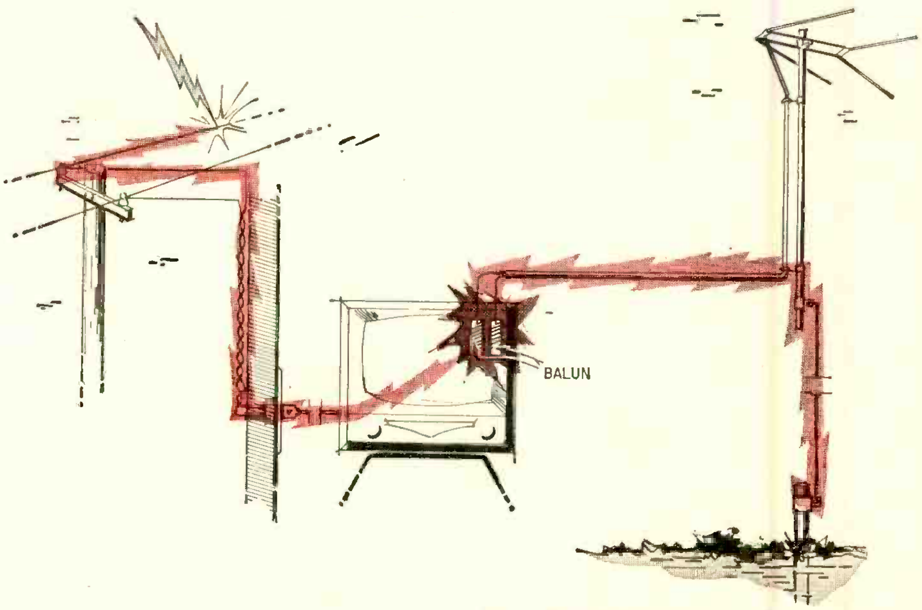


Fig. 4—Lightning off power line can affect set. Lightning passes through line bypass capacitors to chassis, through chassis to grounded end of balun, from balun up lead-in to antenna, then down mast to ground. In hot-chassis receiver lightning goes directly to bottom of balun.

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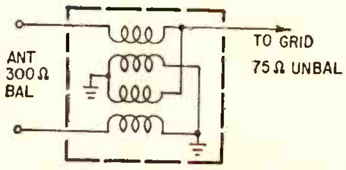

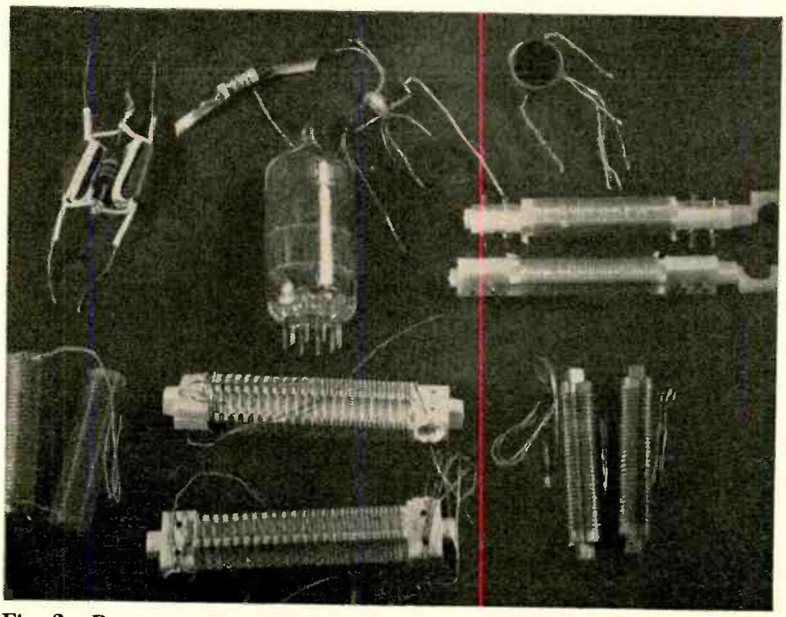

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(*Continued on p.* 68)

(*Continued from page* 63)

We once pulled a coil which was apparently undamaged on the outside, only to find every turn blown open on the back side!

Standard replacements are available —Fig. 2 shows a typical service-shop stock. The coils shown will replace 95% of the input coils in modern tuners. It takes a long thin soldering iron, a very long-nosed pair of tweezers and infinite patience to replace some of them, but it has to be done!

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In a Packard-Bell 2111-2 TV, the picture is good but sound is fuzzy on channels 7, 9 and 11. Channels 4 and 5 are normal or nearly so. I've tested the tubes in the tuner and video if without results.—T. R. W., Seattle, Wash.

I believe I'd check the tubes in the sound if and the ratio detector by substitution before I did anything else. If this doesn't help, alignment of the audio section is a must.

You can align the sound if's by using a station signal, if you have a good strong one nearby. Connect the dc probe of a vtvm to the junction of the 22,000-ohm resistor and .02-μf capacitor between the 6AL5 and the 6AV6 first af amplifier (point A in Fig. 5). Now, tune in the best picture on the set, and set the vtvm for about a midscale reading; this should be only a few volts, and will be negative. Next, tune the sound if coil in the grid circuit of the 6AG5 for maximum. Now tune the primary of the ratio-detector transformer for maximum—you'll have to trace this one, but it's usually the bottom slug on the transformer. Tune all these for maximum reading.

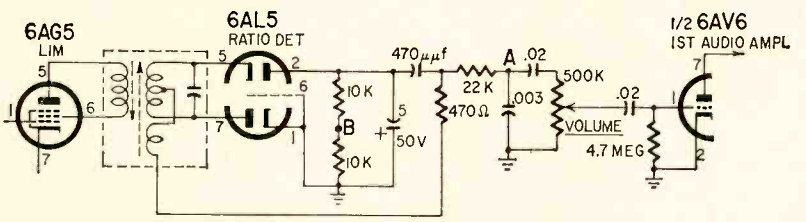

Fig. 5—Partial schematic of Packard-Bell 2111-2 audio section.

Move the vtvm to the junction of the two 10,000-ohm resistors between pins 1 and 2 of the 6AL5 (point B). Adjust the secondary of the ratio-detector transformer for zero voltage at this point. You should have equal and opposite swings as the adjustment is varied about zero. In other words, if it swings 4 volts positive, it should swing 4 volts negative.

After this adjustment the sound should clear up if all parts are all right. If it is still fuzzy, replace the 5-μf electrolytic capacitor across the two 10,000-ohm resistors as this is a frequent cause of this kind of trouble. In fact, it might be a good idea to try this first, before you do the alignment. Might save a lot of time!

Metal to glass

My distributor says that I can replace the 21MP4 (metal-coned) picture tube in a Silvertone 25WG-3075 with a glass tube, using a conversion kit. What electrical modifications would have to be made in the chassis and what type of tube would be the best replacement?—G. McK., Menasha, Wis.

Your distributor is right. Because of the ever-present shock hazard of the metal-coned tubes, it is a good idea to replace them with glass equivalents (when they need replacing). Using the conversion kit, it is not difficult to mount a glass tube in place of the metal type.

The 21YP4-A is electrically interchangeable with the 21MP4 and no modifications are required. The only difference lies in the fact that the glass tube is about ¾ inch longer than the metal one. This may require that the yoke bracket be set back slightly and you may have to cut a small hole in the "cup" on the back (if the original tube was too close).

Horizontal roll

A Motorola TS-425 TV came into the shop for horizontal rolling. Replacing several capacitors and a resistor eliminated the rolling. It now has a phasing ghost about a third of the way across the screen from the left side. It also has a slight jitter. I've tested all components, replaced the dual diode in the afc and all other components in the horizontal circuits. All tubes have been replaced, including the damper and high-voltage rectifier.—W. H. R., Braddock, Pa.

Like yourself, I would have replaced that afc diode first! This cures most of these complaints. Since it didn't, there may be something else wrong in that circuit.

The first thing to do here is run a very careful alignment of the horizontal oscillator. In this series, the horizontal hold control should have a normal range of about 30°. If it doesn't, it needs adjustment.

Ground the horizontal afc, from pin 4 of the test receptacle on the chassis (Fig. 6). Connect a 0.1-μf capacitor between 2 and 5 on this socket to short out the ringing coil. Now adjust the horizontal hold control until the picture stands still or as near to still as you can get it—it will drift from side to side. Now leaving the controls where they are, take the capacitor jumper off the ringing coil and adjust the slug for a locked-in picture. After the picture locks in, keep on turning the slug until it falls out again. Now, turn it back and leave it halfway between the two points.

If this process does not stop the trouble, try changing those diodes again just for luck! Incidentally, these diodes are the type connected with both diodes "looking the same way" (Fig. 6). Be sure that you have the right type, and also be sure that the *polarity* is right! Reversing the diode could cause trouble!

No magnet

A set brought in the other day had been converted to use a 21CQP4 tube. It has a single ion-trap magnet on the neck. I cannot get the picture bright enough and it is out of position, too. Neck shadows are always bad. Do you think the magnet is not strong enough, or what?—E. J. B., Hatfield, Ark.

Someone may be playing a prank on you. The 21CQP4 tube does not use an ion-trap magnet at all! This is a straight-gun type of tube, with electrostatic focusing. The surprising thing is that you got *any* picture on the screen with an ion-trap magnet of any strength at all on the neck. It looks as if the beam bender must be fairly weak.

Take the ion-trap magnet off and be sure that the picture-positioning magnets (the two thin metal rings with tabs) *have* been installed on the back cover of the yoke. Since this was a conversion job, whoever did it may not have installed them. They are necessary to get the picture placed properly on the screen with this type of tube.

Horizontal sync trouble

I am having trouble in the horizontal sync circuit of a G-E 21T14 TV. I originally had a shorted capacitor in the screen circuit of the horizontal output tube. I replaced it and the resistor, and brought the picture back in. When I put the chassis back in the cabinet and had everything connected and adjusted, I could not get the horizontal sync to lock in as it should. A large vertical black streak on the right side of the screen pulls to the left. When it moves, the picture tears up. I can just barely touch the horizontal hold. It stays locked in for 1 to 5 minutes, then tears again. —J. T. D., Babson Park, Fla.

The "large black streak" you see on

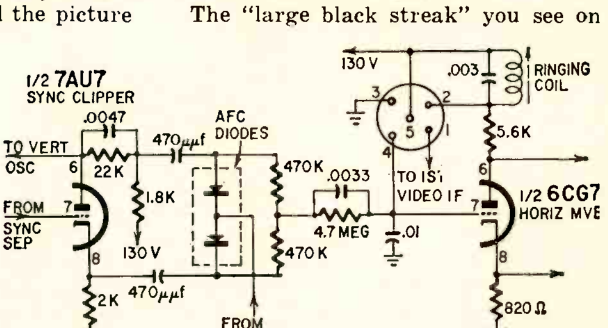

Fig. 6—Part of the horizontal sync and sweep circuits of a Motorola TS-425.

TV Service CLINIC

conducted by

JACK DARR

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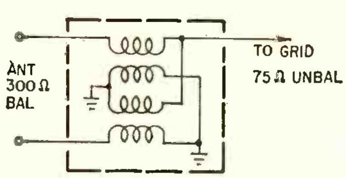

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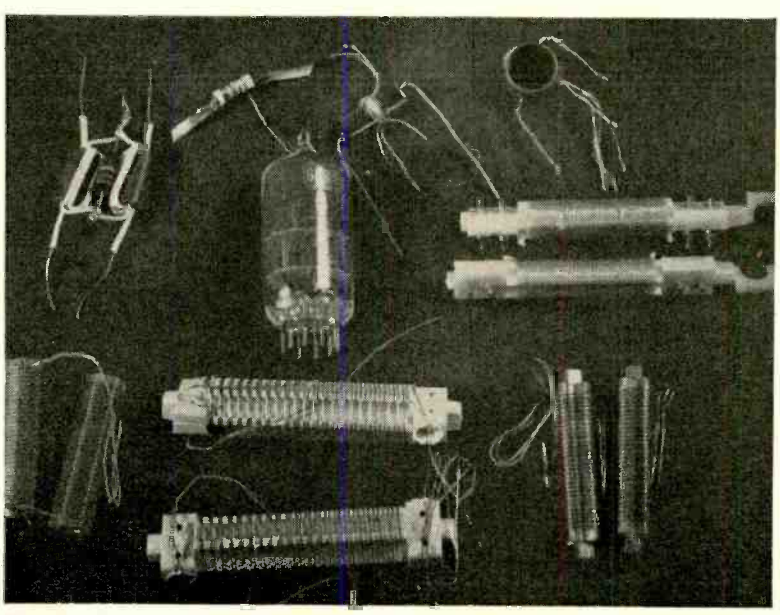

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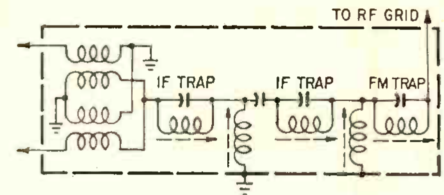
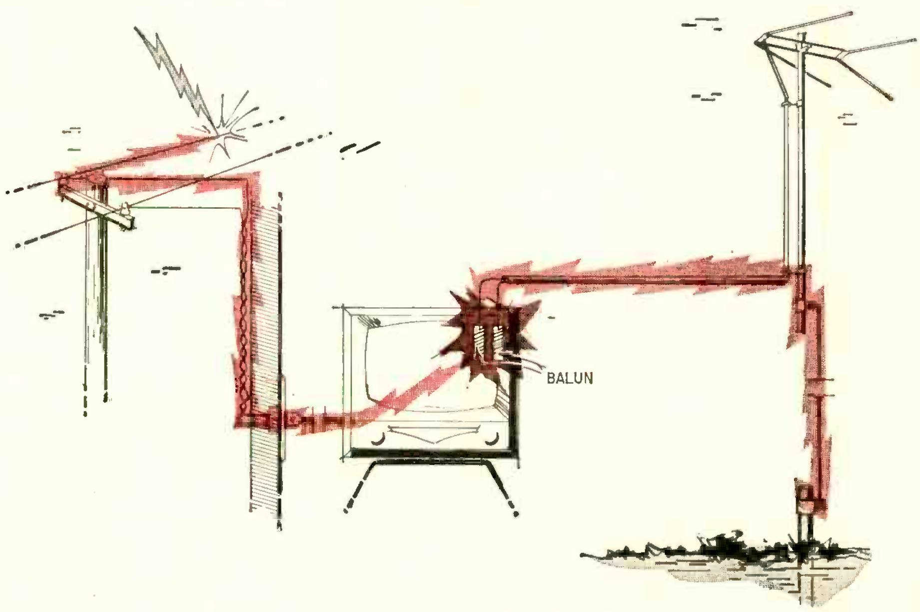


Fig. 3—Antenna matching unit used in better TV receivers.



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(*Continued on p.* 68)

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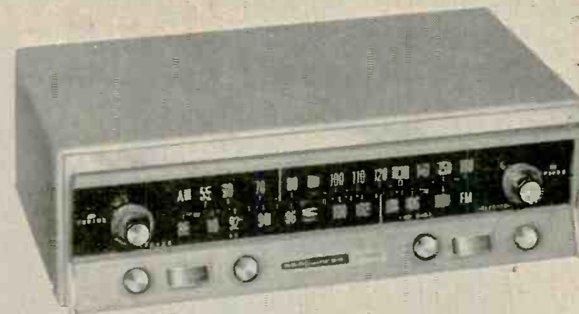

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Model AA-100 (kit) . . . .$8.50 dn. **$84.95**
Model AAW-100 (wired) . . .$14.50 dn. **$144.95**

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Its "bookshelf" size belying its gigantic capabilities, this amazing unit outperforms speakers 4-times its size. A 10" acoustic suspension woofer and two "dispersed-array" cone tweeters deliver high-fidelity tone with fantastic brilliance over the entire range of 30-15,000 cps. ± 5 db. Preassembled cabinet in choice of finishes or unfinished woods. Measures 24" L x 11½" D x 13½" H. 28 lbs.

Model AS-10M or **W** (mag. or wal.) . . .$6.50 dn. **$64.95**
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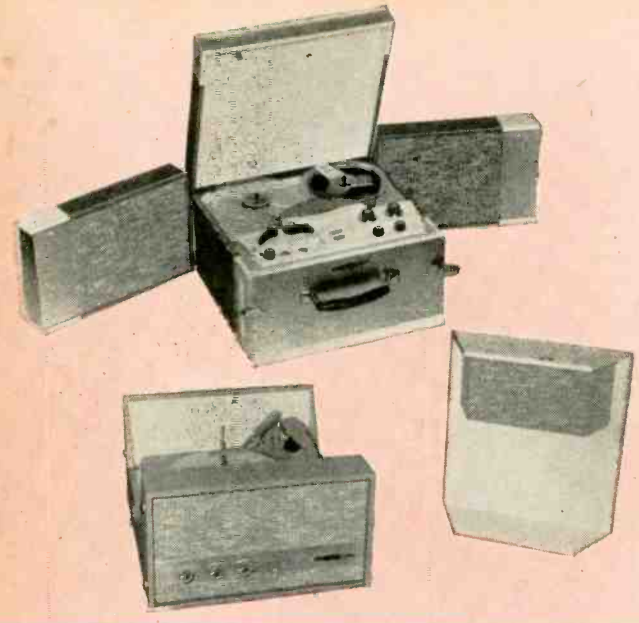

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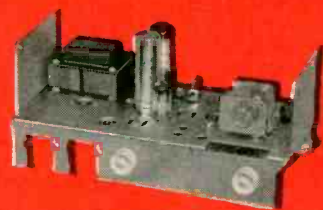
Model GD-10...$7.00 dn., $7.00 mo. **$69.95**



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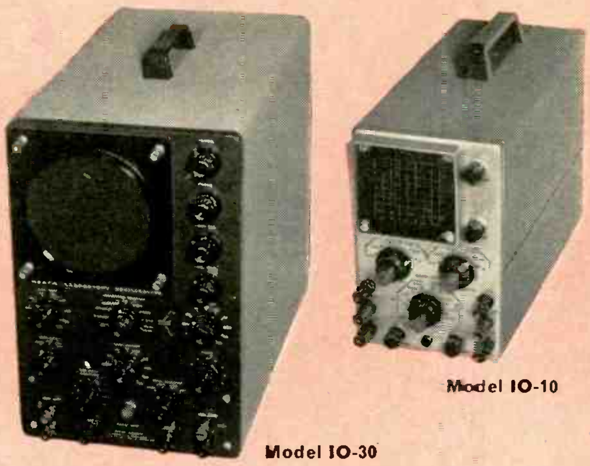

Model IO-10

Model IO-30

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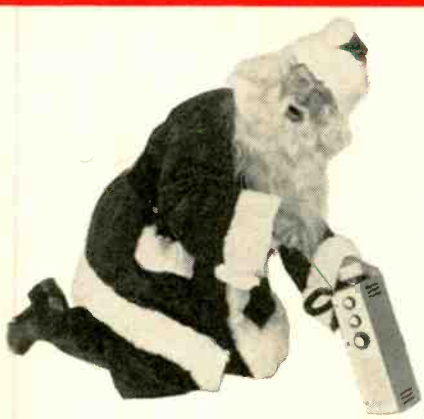

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(*Continued from page* 63)

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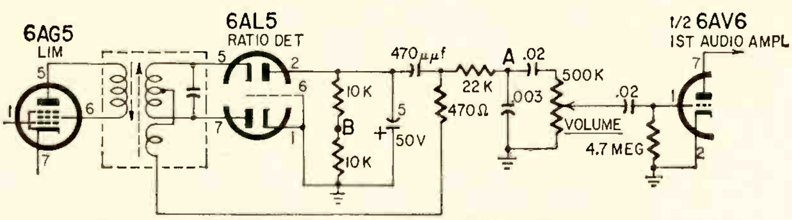

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The 21YP4-A is electrically interchangeable with the 21MP4 and no modifications are required. The only difference lies in the fact that the glass tube is about ¾ inch longer than the metal one. This may require that the yoke bracket be set back slightly and you may have to cut a small hole in the "cup" on the back (if the original tube was too close).

Horizontal roll

A Motorola TS-425 TV came into the shop for horizontal rolling. Replacing several capacitors and a resistor eliminated the rolling. It now has a phasing ghost about a third of the way across the screen from the left side. It also has a slight jitter. I've tested all components, replaced the dual diode in the afc and all other components in the horizontal circuits. All tubes have been replaced, including the damper and high-voltage rectifier.—W. H. R., Braddock, Pa.

Like yourself, I would have replaced that afc diode first! This cures most of these complaints. Since it didn't, there may be something else wrong in that circuit.

The first thing to do here is run a very careful alignment of the horizontal oscillator. In this series, the horizontal hold control should have a normal range of about 30°. If it doesn't, it needs adjustment.

Ground the horizontal afc, from pin 4 of the test receptacle on the chassis (Fig. 6). Connect a 0.1-μf capacitor between 2 and 5 on this socket to short out the ringing coil. Now adjust the horizontal hold control until the picture stands still or as near to still as you can get it—it will drift from side to side. Now leaving the controls where they are, take the capacitor jumper off the ringing coil and adjust the slug for a locked-in picture. After the picture locks in, keep on turning the slug until it falls out again. Now, turn it back and leave it halfway between the two points.

If this process does not stop the trouble, try changing those diodes again just for luck! Incidentally, these diodes are the type connected with both diodes "looking the same way" (Fig. 6). Be sure that you have the right type, and also be sure that the *polarity* is right! Reversing the diode could cause trouble!

No magnet

A set brought in the other day had been converted to use a 21CQP4 tube. It has a single ion-trap magnet on the neck. I cannot get the picture bright enough and it is out of position, too. Neck shadows are always bad. Do you think the magnet is not strong enough, or what?—E. J. B., Hatfield, Ark.

Someone may be playing a prank on you. The 21CQP4 tube does not use an ion-trap magnet at all! This is a straight-gun type of tube, with electrostatic focusing. The surprising thing is that you got *any* picture on the screen with an ion-trap magnet of any strength at all on the neck. It looks as if the beam bender must be fairly weak.

Take the ion-trap magnet off and be sure that the picture-positioning magnets (the two thin metal rings with tabs) *have* been installed on the back cover of the yoke. Since this was a conversion job, whoever did it may not have installed them. They are necessary to get the picture placed properly on the screen with this type of tube.

Horizontal sync trouble

I am having trouble in the horizontal sync circuit of a G-E 21T14 TV. I originally had a shorted capacitor in the screen circuit of the horizontal output tube. I replaced it and the resistor, and brought the picture back in. When I put the chassis back in the cabinet and had everything connected and adjusted, I could not get the horizontal sync to lock in as it should. A large vertical black streak on the right side of the screen pulls to the left. When it moves, the picture tears up. I can just barely touch the horizontal hold. It stays locked in for 1 to 5 minutes, then tears again. —J. T. D., Babson Park, Fla.

The "large black streak" you see on

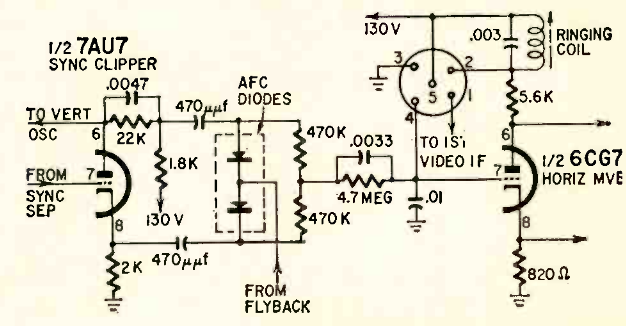


Fig. 6—Part of the horizontal sync and sweep circuits of a Motorola TS-425.

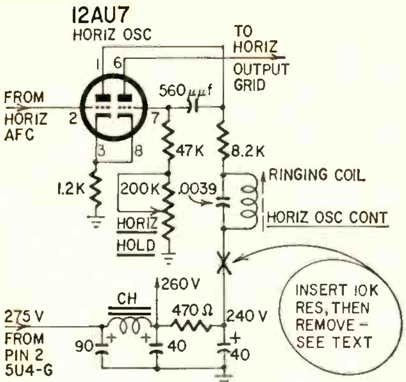


Fig. 7—470-ohm resistor in power supply may be a sleeper, a component that failed when a capacitor in the horizontal oscillator went.

the screen is obviously the horizontal blanking bar between frames. It is pulling in on you because of some trouble in the horizontal afc circuit or possibly in the oscillator itself.

This is not an uncommon trouble, but it can be annoying. I'd change the 12AT7 horizontal phase detector tube first, if you haven't already done so, then the 12AU7 horizontal oscillator. And don't get them mixed up, as this can lead to some strange and wonderful results! I know!

Next, run a complete realignment on the horizontal oscillator. Short out the ringing coil, set the hold control for a stationary picture, then open the short on the coil and adjust the slug for the most stationary picture. You'll have to add about 10,000 ohms temporarily between the ringing coil and B-plus to get the oscillator to work, as the original resistor here has a value of only 8,200 ohms.

There is one more good possibility. Check the operating voltages on the oscillator stage. When that capacitor went out, it may have burned up the 470-ohm resistor in the power supply, between the 240- and 260-volt lines. It is connected from the output of the filter choke to the 40-μf electrolytic (Fig. 7).

There is a modification on this series too. If the set has the 220,000-ohm resistor shunted across the horizontal hold control, cut it out. This will increase the horizontal hold range quite a bit.

Slow agc

I am presently working on a Capehart model 3011M TV. It does fine, except that the agc is too slow. I have to readjust it every time channels are changed. Can I change this to keyed agc?—M. J. B., Southington, Conn.

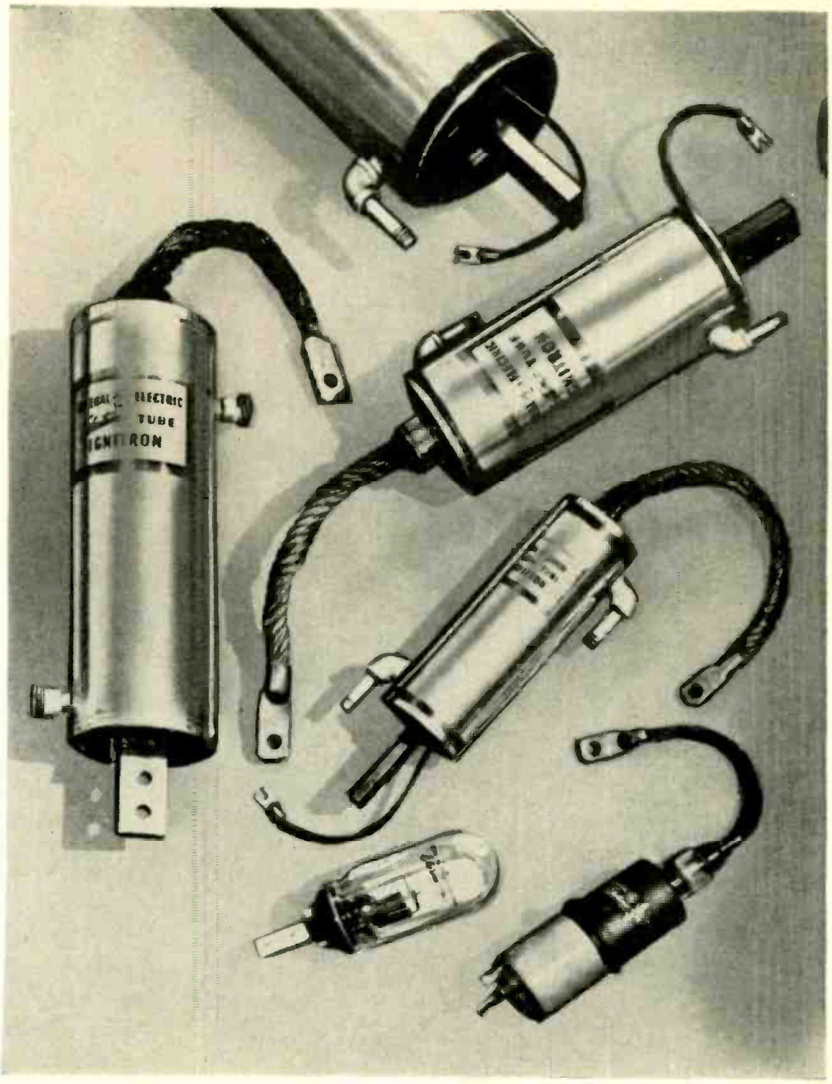
Check the 10-μf filter on the agc amplifier plate, also all resistors and capacitors in the agc network. Also check the diode clamp which is a part of the 6AV6 af amplifier. Leakage here can cause trouble.

You might reduce the time constant somewhat by using smaller agc bypasses. It would be a pretty rough job to attempt to install keyed agc in this set! END

BE CAREFUL WITH IGNITRONS

By ALLAN H. LYTEL

Although they look and are rugged, ignitrons are not immune to abuse. Take care of them, and they'll work for you!



Ignitrons come in all sizes

IGNITRONS are powerful gas-filled rectifiers whose cathodes are pools of mercury. They come in a variety of sizes (see photo) and can carry up to tens of thousands of amperes in various industrial applications. The ignitron is no ordinary mercury-vapor rectifier. Its secret is in the little third electrode, the ignitor, from which the tube gets its name. By applying a positive voltage to this third element, an arc which ionizes the mercury can be struck. The mercury ions aid the flow of electron current from the cathode (a pool of liquid mercury) to the anode, as long as the output current remains above a threshhold level.

Since the ignitor can be pulsed to start the arc at any part of the positive alternation, the tube can supply current for a full half-cycle or only a very small portion of a cycle, as desired. It becomes an efficient current regulator as well as rectifier. In fact, in some applications, the rectifying action is ignored. Two tubes are used back to back, so that output current flows on both halves of the cycle. The combination can then be used to supply any desired amount of current, from almost zero to the maximum available in the circuit.

When the direction of current changes, the arc goes out and remains out through the nonconducting half of the cycle. Thus the possibility of arc-back is cut down as compared with tubes that are filled with ionized gas throughout the cycle.

Fig. 1 shows the construction of a typical ignitron. Note that it has an additional anode. The reason is that if the current to the main anode drops too low, the arc goes out. With the auxiliary anode, a small current flows until the anode goes negative keeping the arc alive.

Because ignitrons are powerful, rugged tubes that can handle up to tens of thousands of amperes, there is sometimes a tendency to treat them as if they could not be damaged. They can be ruined by abuse or improper operation, and reasonable care in using them will pay off in long life and reliable performance.

A typical use is in welding control (Fig. 2). Here we see the back-to-back action, giving output on both halves of the cycle. The ignitor excitation is usually taken from the anode voltage in resistance welding equipment. A rectifier (here, a thyratron) is connected between the anode and the ignitor to prevent reverse ignitor current. Where a thyratron is used the grid of this thyratron is used to determine the welding cycle (the portion of the

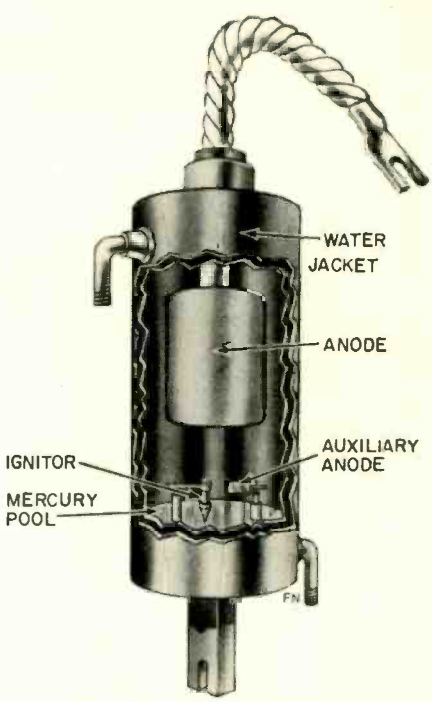


Fig. 1—An ignitron, showing all parts. Some types add other features, such as de-ionizing grids and splash baffles.

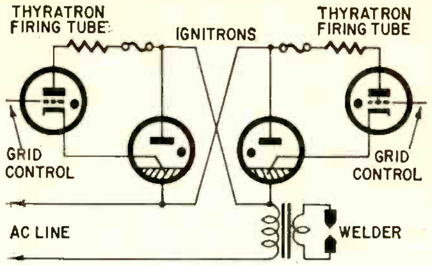


Fig. 2—Typical welder-control circuit. In this hookup, the ignitrons supply controlled ac rather than dc.

positive alternation during which the tube connects). In some installations, a relay in the rectifier circuit will determine the firing point in the welding cycle. A fuse and a resistor are used to limit the ignitor current to its maximum rated value.

Industrial rectifiers (as in Fig. 3) have the ignitor circuit separated from the anode circuit. One part of a three-phase rectifier is shown.

Storage precautions

Ignitrons require care in storage. Their stainless-steel construction protects them from physical damage during normal handling and storing. But it is necessary to take precautions to prevent the mercury in the tube from being deposited on the anode or glass seal. Any mercury droplets deposited on the glass seal or the anode can cause arc-backs which can damage the tube. For this reason ignitrons should be stored in the vertical position as shown in Fig. 4. By accident a tube may be placed on its side, causing the mercury to run from its normal position. If this happens, shake it from side to side to bring any drops of mercury to the bottom. Several tubes, depending on specific needs, may be kept on "replacement standby" to prevent operational delays. This is done by keeping their tops slightly above room temperature with a heat source such as a 100-watt lamp in a reflective enclosure (Fig. 5). Only the top of the tube is heated, removing any deposited mercury from the seal or anode.

Installation precautions

Protect the tubes from vibration and

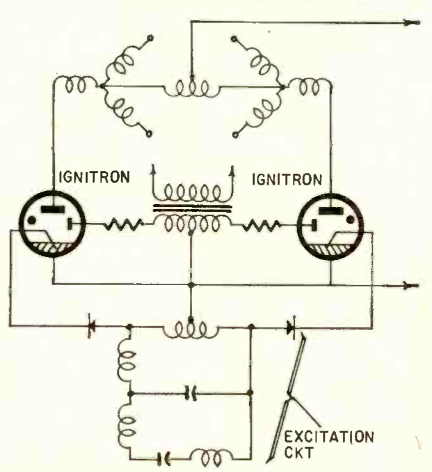


Fig. 3—Industrial rectification circuit, with auxiliary anodes and separate excitation circuit for ignitor firing.

Fig. 4—How an ignitron is shipped.

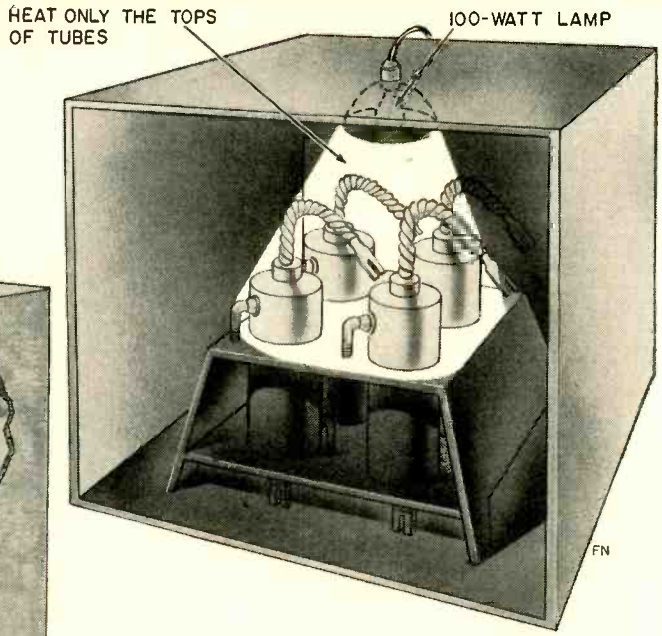


Fig. 5—Taking care of standby tubes.

shock. Although they are metal, they require care and protection against mercury splashes onto the anode or tube walls. Voltage surges should be kept off the tube as much as possible, since voltage surges may cause arcing within the tube.

Keep terminals clean and securely fastened to the mounting brackets.

Shield tubes from nearby high-frequency fields, which sometimes initiate arcs within the tube. Also, shield them from magnetic fields, which may cause the arc to form on the tube side walls. The tubes are usually sufficiently shielded by the metal panel enclosures. However, high-frequency lines and conductors carrying large currents should still be kept away from the panels.

When replacing a faulty ignitron tube in the panel be sure to check the rectifiers in the ignitor circuit. They may have caused the original failure by applying negative voltages to the ignitor.

Cooling the ignitron

Specific design-temperature limits and the heavy current flow make temperature control important. Temperature is controlled by the amount of water flowing through the water jacket. Measureing the water temperature at the outlet indicates the actual ignitron temperature. These tubes will often overheat if the water is turned off when the anode power is removed. To avoid this, the water flow should be maintained for the time indicated by the manufacturer. (It may run up to an hour for some ignitrons.)

Cooling-water temperatures and flow rates are always specified by the manufacturer. Both minimum and maximum inlet temperatures are usually given. For normal service conditions, a better working minimum is a point approximately midway between the rated minimum and maximum values. If an ignitron is operated for long periods near the rated minimum temperature, certain load conditions can cause high-voltage surges in the tube. These surges will in turn cause breakdowns in the associated equipment unless it is adequately protected. Outlet water temperature depends upon the peak inverse voltage, which is the voltage in the nonconducting direction.

Servicing

Ignitron failures or improper and sporadic tube operation can usually be traced to one of three basic conditions:

- Inadequate flow of cooling water
- Failure of the rectifiers which block ignitor current flow
- Operating the tubes outside of their published ratings

These cause other conditions that lead to tube failure or irregular operation, as shown in the chart.

Ignitor wetting is a special problem in these tubes. In proper or normal operation the mercury in an ignitron is uncontaminated. The mercury does not wet the ignitor. The ignitor is composed of a number of crystals touching the mercury but not wetted by it. When a voltage is impressed between the ignitor and the mercury, a cathode spot occurs at the juncture between the crystal and the mercury due to high voltage gradients. As long as this cathode spot forms on the mercury, the ignitor is unchanged and should last for years.

If the mercury becomes impure it attaches itself to the ignitor. Under this condition, the crystal-to-mercury junctures become short-circuited. This results in sporadic tube operation or complete failure of the ignitor to initiate the arc.

Inadequate water flow will cause tube overheating. As stated, the water flow should be continued after the tube anode power is removed. This cools the tube before shutdown. Excessive tube temperatures will result from improper cooling (see chart). This can result in holes burned through the tube walls or in igntron wetting.

If the water jacket becomes clogged, it will have to be cleaned. This is a critical process, in which powerful acids are used. A person qualified to work with acids, preferably a chemist, should handle this job. Follow manufacturer's directions exactly. An excellent set of instructions can be found in General Electric's handbook, *Instructions for Handling, Servicing, Installing G-E Ignitrons*. This booklet is the source material for most of the information in this article, as well as the illustrations, and can be obtained from the Electronic Components Div., Power Tube Dept., General Electric Co., Schenectady, N.Y.

Tube ratings are given by the manufacturer and are the basis for operating the tube properly. Ratings are maximum and are not to be exceeded if proper tube operation is expected.

Blocking rectifiers are important. Their failure can destroy the ignitor and the tube. Note in the chart that the rectifier failure can cause lack of firing control or even complete breakdown.

Testing the ignitron

Fig. 6 shows the method of testing for ignitor wetting. First remove the ignitron from the socket after all power has been disconnected from the equipment. Support the tube vertically on a table and connect an ohmmeter between ignitor and cathode. The cathode connection can be made to any portion of the tube jacket or to the cathode terminal. Tilt the tube slowly back and forth to change the depth of immersion of the ignitor in the mercury.

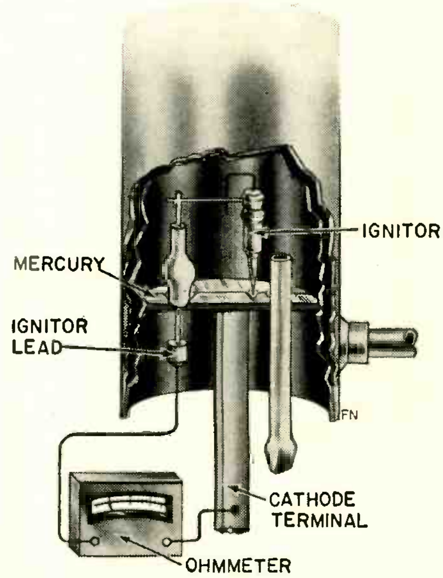
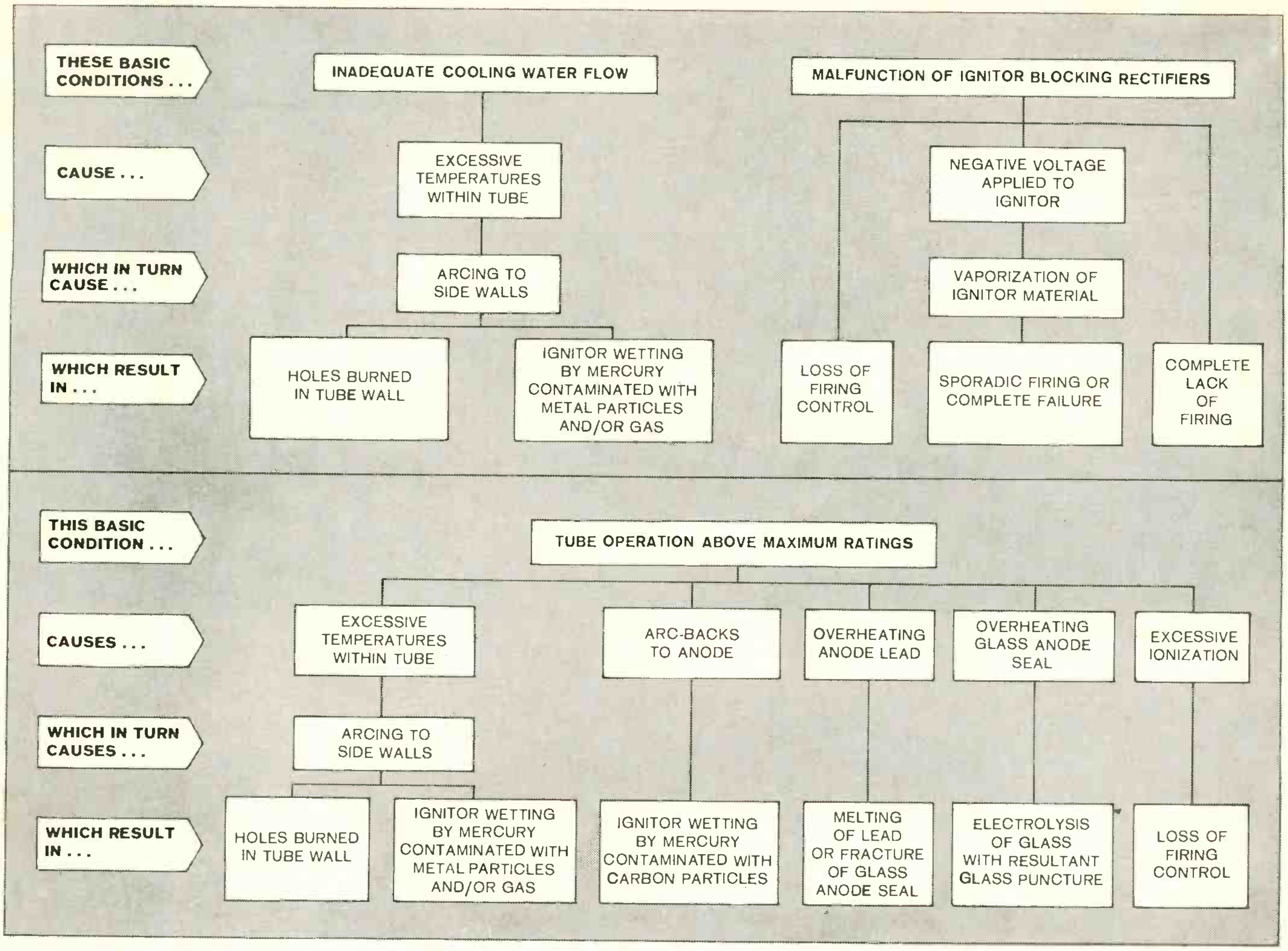


Fig. 6—Checking for ignitor wetting.

The ignitor resistance varies approximately uniformly on a good tube until



Causes and Symptoms of Ignitron Troubles

either the ignitor is completely out of the mercury or the mercury completely covers the lead. If the resistance remains constant through a considerable arc as the tube is tilted, a portion of the ignitor is wetted.

The technician would be well advised to test several tubes, including new ones, to gain experience and ability to detect ignitor wetting.

If the tests show that the ignitor is

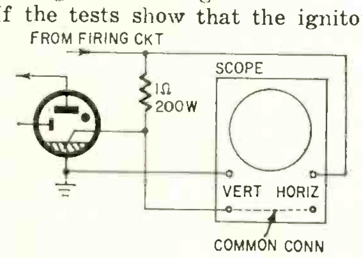


Fig. 7—How equipment is connected for checking ignitor firing characteristics.

wet, the tube may still operate satisfactorily for a time, however, but sporadic operation or complete tube failure will result eventually.

Wet ignitors indicate that the tubes have been operated at too high temperatures. Determine and correct the cause.

Ignitor characteristics can be determined with an oscilloscope as shown in Fig. 7. Connect a 1-ohm resistor with a power rating of 200 watts (noninductive) in series with the ignitor lead as indicated. One vertical (V) input is tied to ground; the other vertical lead is to the ignitor. This same point is connected to one of the horizontal (H) inputs. Voltage across the 1-ohm load is fed to the other horizontal input.

A straight line at an angle with the horizontal appears on the scope. The angle depends upon the dynamic resistance of the particular ignitor being measured and on the relative gain of the vertical and horizontal amplifiers.

Since there is considerable variation in the voltage and current values from cycle to cycle, watch for the maximum values displayed over about 1 minute and record these maximum deflections. The data should be taken under both light-load and full-load conditions.

After taking a number of readings,

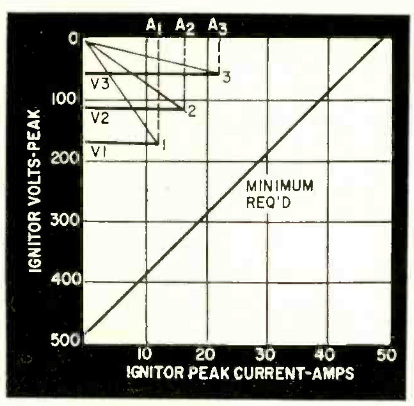


Fig. 8—Ignitor firing characteristics are plotted on a sheet like this one.

the peak voltage and current can be established. If the resistor is exactly 1 ohm, the voltage across it is equal to the current. V1 is maximum voltage; A3 is maximum current. The points 1 (V1, A1) and 3 (V3, A3) are both plotted on the ignitor volt-ampere requirement sheet. All points plotted for a good ignitor, at both low and high loads within the tube rating, will lie to the left of (and above) the line marked **minimum** required in Fig. 8. If the ignitor passes this test and the test for mercury wetting of ignitors, it may be considered satisfactory. The minimum required ignitor characteristics are given by the manufacturer for each tube.

To test for gas, leave the tube out of service for a week. Hook it up with cathode and anode in series with the secondary of an oil-burner or other transformer with about a 12-kv output. Insert two 50,000-ohm, 100-watt resistors in circuit to limit current, and put a 2-watt neon lamp across one of them. Use a variable autotransformer between primary and line and advance the control till the lamp lights steadily. Then check the time till the lamp goes out (clean-up time). If this is less than 30 seconds, the tube is probably good. If a little more, it can be used for continuous, but not intermittent service. If the clean-up time is several minutes, the tube is unusable, and should be returned to the manufacturer if still within warranty. END

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the REMO NEMO

By HAROLD REED

Designed for handling remote pickups from the studio, this little unit has many applications in various types of distant monitoring or control

THE purpose of the Remo-Nemo is is to provide for remote control of remote (or nemo) pickups of program material for radio broadcasting. The device, of course, is not limited to just this application.

I have observed in numerous instances, that radio-station plans for remote pickups of local events and entertainment are discarded when the cost of engineering personnel overtime and transportation are estimated, in addition to telephone-line charges. This is especially true when the intended pickup would be a daily feature and particularly so if the station is operating under the terms of a union contract.

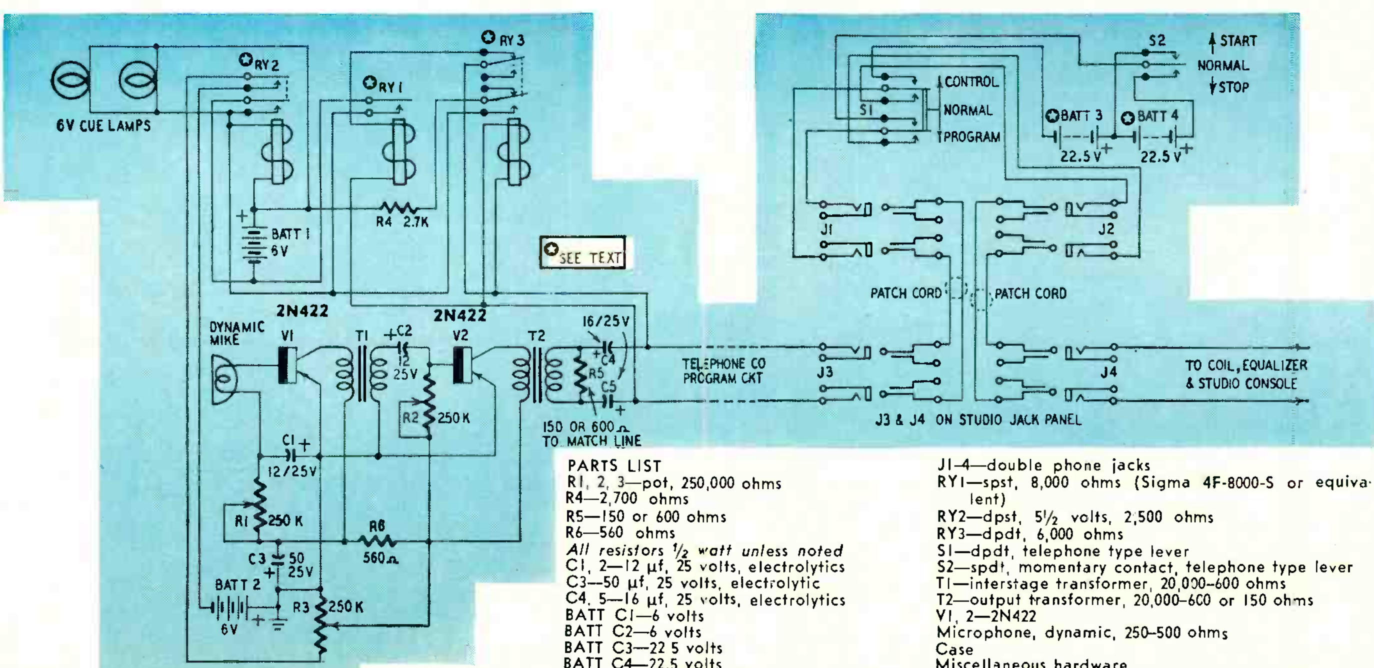
The Remo-Nemo is intended primarily for single-channel program use although, with proper input impedance matching, additional microphones could be used. There would, of course, be no individual control over each microphone. However, the majority of the average radio station's local remote pickups are the type that can be handled satisfactorily with a single microphone. It is always preferable to assign a radio technician to the type of program pickup requiring elaborate engineering setups.

Radio broadcasting stations have resorted to different means in an attempt to overcome this situation. Standard remote equipment has been installed at the remote points and set in advance, making it necessary for an announcer to throw only one switch to feed a program to the station control room. In some cases, when the announcements are made at the studios, the individual or one of a group of those comprising the program may place the equipment in operation.

The disadvantages in the above methods are many. In the first place, most union contracts would prohibit this procedure: all station equipment must be operated by a technician of the station. Expensive remote apparatus is tied up at each pickup point, regardless of the simplicity of the program. This costly equipment is also subject to thievery and vandalism. It requires either 117-volt ac power or a supply consisting of an expensive group of batteries.

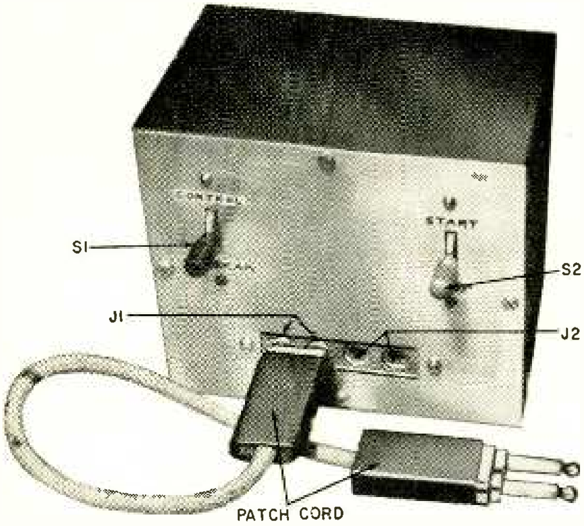
The Remo-Nemo can be built into a small metal box. It can be self-powered with self-contained, inexpensive batteries, and with no external controls to be manipulated at the remote point. The unit can be installed in some location not easily accessible to the public. Only two external connections are required: microphone input and output to the telephone company program line. These connections may be made inside the box so they cannot be tampered with. The box can be locked if desired.

Very little maintenance is required to keep this device in operation and the cost of each unit is such that a station may keep several available for

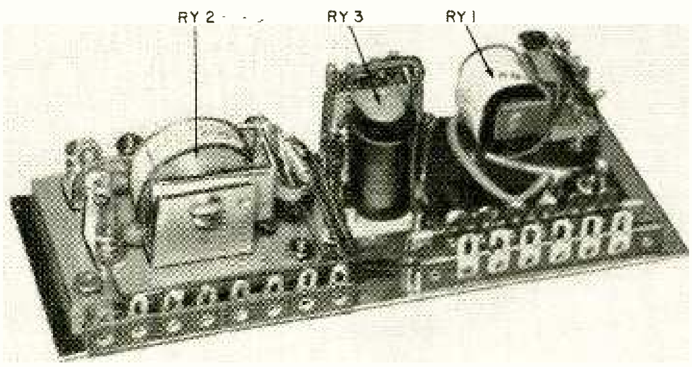


PARTS LIST
R1, 2, 3—pot, 250,000 ohms
R4—2,700 ohms
R5—150 or 600 ohms
R6—560 ohms
All resistors ½ watt unless noted
C1, 2—12 µf, 25 volts, electrolytics
C3—50 µf, 25 volts, electrolytic
C4, 5—16 µf, 25 volts, electrolytics
BATT C1—6 volts
BATT C2—6 volts
BATT C3—22.5 volts
BATT C4—22.5 volts
J1-4—double phone jacks
RY1—spst, 8,000 ohms (Sigma 4F-8000-S or equivalent)
RY2—dpst, 5½ volts, 2,500 ohms
RY3—dpdt, 6,000 ohms
S1—dpdt, telephone type lever
S2—spdt, momentary contact, telephone type lever
T1—interstage transformer, 20,000–600 ohms
T2—output transformer, 20,000–600 or 150 ohms
V1, 2—2N422
Microphone, dynamic, 250–500 ohms
Case
Miscellaneous hardware

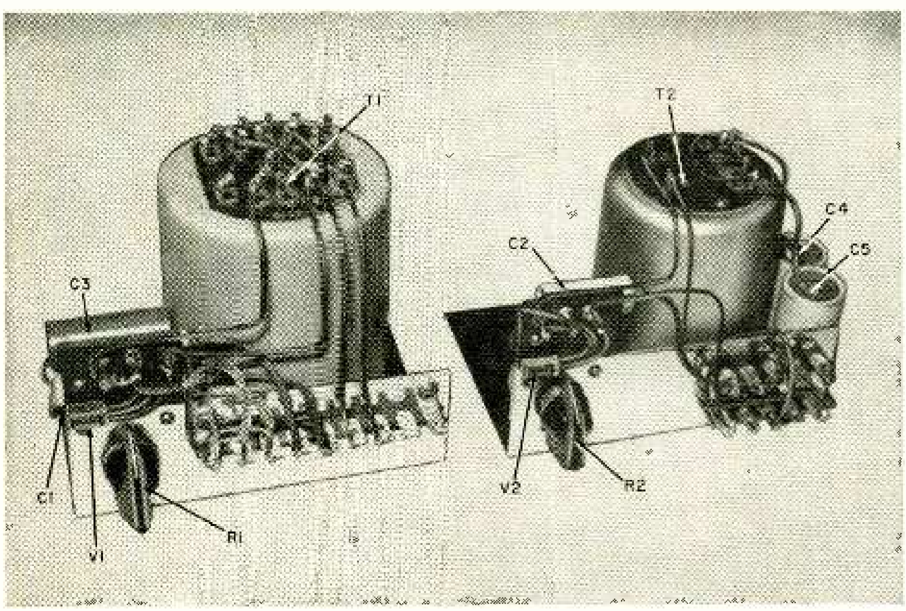
Fig. 1—Circuit of remote pickup and studio control unit.



Completed control unit for the studio.



Relay strip controls remote operation.



Two-stage transistor amplifier uses broadcast line bridging coils.

field work. In fact, in some instances, the cost in overtime paid for several remote pickups may very well be as great as the cost of one of these units.

Circuit design

The Remo-Nemo is designed around the 2N422, a p-n-p junction transistor. The 2N422 should provide a power gain of 30 db per stage. The diagram shows the circuit of a two-stage common-emitter amplifier. A dynamic microphone of 250–500-ohm impedance is connected directly to the input, between base and emitter. Microphones of other impedances may be used with a proper impedance-matching transformer. The secondary of transformer T2 (Fig. 1) is connected to the program line. This output winding may be 150 or 600 ohms as required.

Variable controls R1, R2 and R3 are adjusted to obtain the greatest possible gain, with acceptable values of noise and distortion levels. These variable controls used in the experimental model may be replaced with fixed resistances after optimum values have been determined. The best values for these resistances in tests made with the other components as used in the experimental model were: R1—100,000 ohms, R2—250,000 ohms and R3—200,000 ohms. Because of the common battery supply a filter composed of R6 and C3 is necessary to prevent the amplifier from breaking into oscillation.

The CK722 can be used, and were in fact the original complement of the equipment. With these, the battery voltage (BATT 2) is 15. Different CK722 transistors were tried. With these, gains of between 25 and 31 db per stage were possible. In the two-stage amplifier (see diag.), an overall gain of 55 db was realized with acceptable values of noise and distortion levels. These measurements were made with a collector voltage of -9, collector current of 2 ma, and base current 50 μa. The input fed to the first stage for these tests was a 400-cycle signal from a General Radio Co. audio oscillator, attenuated to a level of −65 db. Noise level in the amplifier, below the signal input level, was −40 db. In the experimental unit these tests were made without special care in shielding and grounding and I believe that lower noise levels may be obtained.

An oscilloscope connected at the amplifier's output gave evidence of a good sine wave under the above conditions of operation. Attempts to obtain greater gain, by increasing or decreasing the operating values of the circuit, resulted in flattening the sine-wave peaks. A scope also indicates objectionable distortion when the level of the 400-cycle audio input signal is increased. Frequency response is shown by the graph of Fig. 2.

An amplifier used for this purpose should be capable of providing approximately 0-db level to the program line. A two- or three-stage amplifier may be required, depending upon the output of the microphone used. The photographs show two separate stages. For

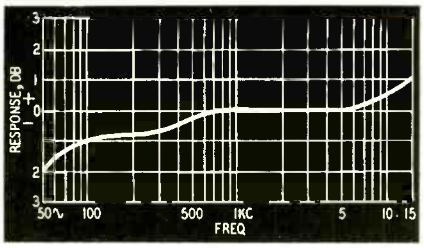


Fig. 2—Response curve of amplifier.

experimental reasons each stage was constructed individually so it could be tested separately and so that additional stages could be added to the first stage as required. As you can see, no attempt was made at miniaturization. Components on hand were used and the transistors are dwarfed to the extreme by the relatively large size of the transformers which are the usual high-quality bridging to 600-ohm coils normally used in radio broadcasting station service. The equipment can be miniaturized by employing minute transformers, such as the UTC A-25, the UTC Ouncer O-9 or the Microtran Co.'s transistor transformers designed for audio-frequency transistor circuitry. In this manner the remote unit would be reduced to a very small package.

The Remo-Nemo requires only one telephone-line pair which is used for program transmission, control circuit and cue line. This line is the standard, unequalized type circuit supplied by the phone company. Most radio broadcasting stations use this type of line, providing their own equalization.

Three inexpensive relays are used in the control-cue system. During program time the line must be free of battery potentials and appreciable loading by apparatus not associated with program transmission. Two of the three relays are continuously across the line but, because of their high coil resistance with respect to the low impedance of the line, they have a negligible effect on the program circuit. Fig. 1 also gives the wiring diagram of the relays and a photograph shows the relay strip. Only RY2 is in operation for the full time that the program is in progress. The relays in this experimental model were those that happened to be on hand. Other relay combinations operating at other voltages may, of course, be utilized.

Using the unit

When it is time for the program to begin, the operator at the studio control point throws S1 (Fig. 1) to CONTROL. S2 is momentarily placed in the START position. S1 is then pushed to PROGRAM.

When the operator places S2 in the START position, the low dc potential of BATT 3 is placed across the line and operates RY1 at the remote point (see Fig. 1). When RY1 closes, voltage from BATT 1 is applied to RY2. When RY2 closes, it completes the circuit between BATT 1 and the coil of RY2, holding the relay closed after S2 is released and RY1 opens. RY2 also closes the circuit of the battery supply to the transistor amplifier and lights the "on the air" cue. Two lamps are connected in parallel to guard against failure.

At the end of the program S1 is thrown to CONTROL and S2 is momentarily placed in the STOP position. This places BATT 3 and 4 in series across the line. This higher voltage closes RY3 which places a resistance across the coil of RY2, causing it to open, thus removing BATT 1, opening of BATT 2 supply and extinguishing the cue lights. RY1 will not operate on this higher voltage as its coil is in series with a pair of contacts on RY3 which open when the higher potential is applied.

The starting and stopping control potentials of BATT 3 and BATT 4 must not be applied while the line is patched to the input of the control room program console. This is prevented by S1, which makes it impossible to apply dc control voltages while the line is terminated to the input to the line coil or console.

BATT 3 and 4 may be single batteries with the correct voltage taps. This reduces the number of batteries required for the complete system to two. A single 45-volt B-battery was used for BATT 3 and 4, using the 22.5-volt tap as BATT 3. RY1, with a coil of 8,000-ohm resistance, operated on the 22.5 volts, while relay RY3, with a coil of 6,000 ohms, pulled in when the 45 volts were applied across the line. The required battery control voltage will vary according to the coil resistance of the relays and the relay adjustments as well as the resistance of the telephone company's program line, which is dependent on its length. Using higher battery voltages and variable controls average potentials suitable for all encountered local line lengths may be arrived at.

The low-resistance winding of the transistor amplifier output transformer is isolated from the program line, as far as dc control voltage is concerned, by two 16-μf capacitors. I found that these capacitors had negligible effect on the frequency characteristics of the line. In fact, frequency measurements made with and without the capacitors in the circuit gave the same results throughout the range from 50 to 10,000 cycles with the exception of a 1-db drop at 50 cycles with the capacitors in the line.

The control equipment at the studio may be mounted in a small box, including input and output jacks, or arranged on a standard relay rack panel. The installation should be made near the jack panel on which the remote lines are terminated so that patching may be effected between any line, the control equipment and the program console input. A photograph shows this control unit for the studio control room.

As the device is simple and straightforward, working with low dc voltages and low current drain and using no tubes to contribute to failure, it should operate for long periods of time with little maintenance. END

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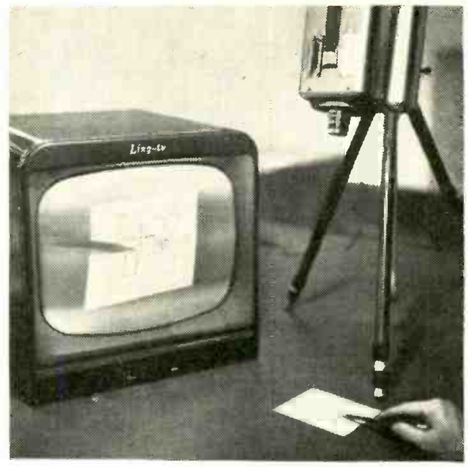


4

ELECTRONIC classroom

AN electronic teaching and testing laboratory using teaching machines and designed to take the guesswork out of teaching has been developed and installed by the New York Institute of Technology. It uses a combination of electronic intercommunication, closed-circuit TV, record players, tape recorders and telemetry devices to supplement and supplant standard teaching aids.

In the class, each student receives the lesson to be learned in small steps. Necessary diagrams are on preprinted cards. The student also has a programmed workbook and a special stylus for answering examination questions. The earpiece and miniaturized transmitter he uses are his private property. This portion of the course can also be recorded as shown in Photo 1 or be on tape, TV film, etc.

After going over the lesson material the student is tested for an understanding of the content and then for application of the theory and problem solution. He indicates his test answers with an answer stylus that simultaneously perforates a permanent examination record card; surrounds the perforated mark with a color indicating the correctness of his choice; registers his score on an indicator at the teacher's desk; and lights a lamp on his own desk to indicate right or wrong. If the student has picked the wrong answer he is directed to alternate data in a reference workbook or is connected to an equivalent source of data.

A student having trouble can contact the instructor through an intercommunication system (Photo 2). Also, the instructor can speak to a student if his telemetered data shows such a step to be necessary. The telemetry indicator appears at the far right in Photo 3 and records the number of correct answers for each student. When asking a question the student uses a mike that has a miniature acoustic chamber which eliminates the need for booths and insures privacy. The mike doubles as a receiver when the instructor speaks to the student.

The instructor can answer a student's question by referring to the diagram the student is using or by using other material transmitted to the student from a TV camera at the instructor's desk (see Photo 4). The teacher can also call on a central TV studio to televise a TV film or other visual material or for an answer from another teacher.

The student follows this instruction on a TV monitor at his desk. If desirable, the instructor can switch a number of students into the circuit to hold a joint discussion.

By following a carefully programmed set of directions the student continues the steps he has taken in the electronics classroom to allow optimum conditions for efficient learning. END

NEW at the NEW YORK Hi-Fi SHOW

The recent High Fidelity Music Show saw new developments in tuners, phonographs and pickups, amplifiers and speakers.

The upside-down record player operating. Empire's Gale Guterman is varying the stylus angle by a very simple means.

THE most spectacular sight at the High Fidelity Music Show held in New York City early in September was a record player operating upside down in one of the demonstration rooms. The Empire arm, which was doing the playing, operates on a principle used by few other arms. It is balanced perfectly, then pressure is applied with a spring to obtain the correct tracking force.

The Empire record player on which it was used is a three-speed type *without speed-changing mechanism*. It is belt-driven. The motor, mounted at one corner of the case, swings on a hinge so that a spring maintains belt tension. The shaft, like that of many record changers, is stepped at the end (Fig. 1). To change speed, one simply removes the protective case from the motor and moves the belt up or down to the step that gives the correct speed. Thus speed is changed *manually*, not mechanically.

The three stepped shaft sections are crowned slightly, and a knurled adjustment screw that cants the motor a little causes the belt to ride up or down a small amount. This slows the turntable down or speeds it up as the belt moves to a point of greater or smaller shaft diameter, giving a very fine speed correction.

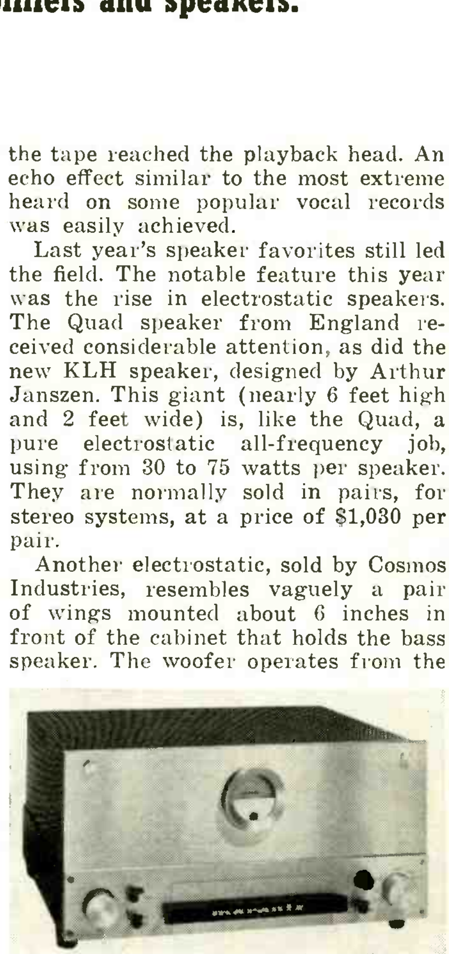
Another record player—exhibited by Rek-O-Kut—had an automatic shutoff guaranteed not to affect tracking. ESL (Electrosonic Laboratories) also showed a new improvement in pickup arms—an elliptical ring under the arm support that made it possible to adjust exactly the amount of overhang.

A German company, Korting, demonstrated a tape recorder with *reverberation*. Two small heads picked up the signal after the tape had come from the recording head and re-recorded it along with the original signal before the tape reached the playback head. An echo effect similar to the most extreme heard on some popular vocal records was easily achieved.

Fig. 1—Mechanism of new Empire record player.

Last year's speaker favorites still led the field. The notable feature this year was the rise in electrostatic speakers. The Quad speaker from England received considerable attention, as did the new KLH speaker, designed by Arthur Janszen. This giant (nearly 6 feet high and 2 feet wide) is, like the Quad, a pure electrostatic all-frequency job, using from 30 to 75 watts per speaker. They are normally sold in pairs, for stereo systems, at a price of $1,030 per pair.

Another electrostatic, sold by Cosmos Industries, resembles vaguely a pair of wings mounted about 6 inches in front of the cabinet that holds the bass speaker. The woofer operates from the



The Marantz 9A, showing bias meter.

low end of the spectrum to 600 cycles, and the electrostatic units take over from there to beyond audibility.

A growing tendency toward bias indicators was noted. Used for some time on the Marantz they appeared on two others this year. Bogen showed an amplifier that was in effect a whole music distribution system. Two input selector switches are used instead of the usual one. Thus each channel of the stereo amplifier can be used for a separate unit—channel 1 could be tuned to TV sound and channel 2 to FM for example. A set of illuminated indicators shows exactly what is being piped into each channel at all times. Four switches on the output control local and remote speakers, so that a stereo program may be reproduced on local or remote, or both, or two separate programs can be played on the desired speakers. Thus it is possible to feed FM to a speaker in an upstairs room and at the same time play 45's for a playroom in the basement. Speaker switching is shown in Fig. 2.

The increasing strength of FM was shown by a number of FM kits. One of these was by H. H. Scott, a newcomer in the kit field. Another, the Dynatuner, was offered by Dynaco and is that company's first kit outside the audio amplifier field.

Another new component was the reverberation unit, now popular in packaged audio. These were offered by Fisher and Sherwood.

The contest between live players and recorded music—often a feature of audio demonstrations—appeared at this show, this time with a slightly new motive. The Fine Arts Quartet (Everest Records and Concertape artists) played alternately and simultaneously with a pair of Dynakit amplifiers and AR-3 speakers. In the words of the sponsors—Acoustic Research and Dynaco—this was done, not to show again that recording can be indistinguishable from a live program, but to "demonstrate that stereo high fidelity can be a transparent medium for re-creating a musical program rather than a means for creating a 'new' sound." Some special efforts were necessary to prove the point—for example, studio reverberation was eliminated by recording outdoors, as seen in one of the photos. END

The Bogen RP-40. Unit consists of AM-FM stereo tuner, stereo preamp and dual power amplifiers. The amplifier system is also available without the tuner.

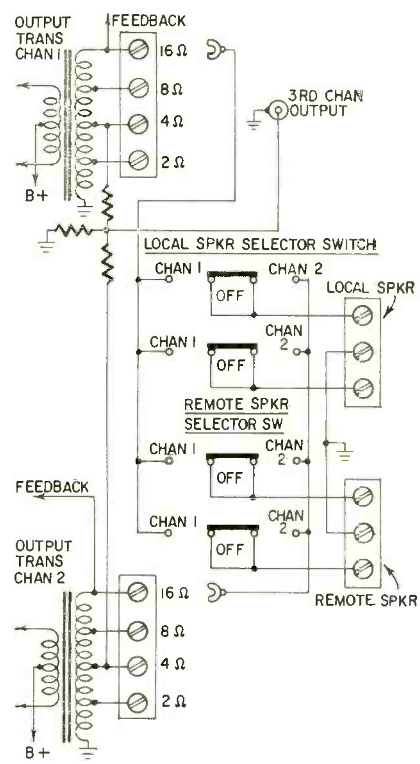


Fig. 2—Output circuitry of Bogen RP-40 home music center.

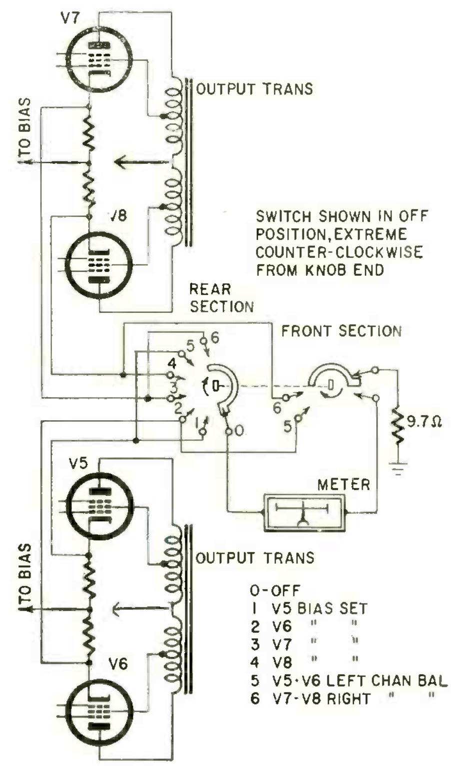


Fig. 3—Bias and balance metering in Acresound 120. In first 4 positions, meter is connected between each cathode and ground in turn. In positions 5 and 6 it is between the cathodes in each pair and shows balance by zero indication.

Recording sessions for the Dynaco-Acoustic Research project were held outdoors to reduce reverberations to zero.

The Fine Arts Quartet playing in cooperation with their own recording, as reproduced through the speakers in the rear.

Model TW-11—Tube Tester
Total Price $47.50
Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary.

SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER

★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Subminars, Proximity fuse types, etc.
★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.
★ The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.
★ Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE

SEPARATE SCALE FOR LOW-CURRENT TUBES: Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

The Model TW-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a handsome portable saddle-stitched Texon Case. Only **$47.50**

Model 83—C.R.T. Tube Tester
Total Price $38.50
Terms: $8.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

SUPERIOR'S NEW MODEL 83

C.R.T. TESTER

TESTS AND REJUVENATES ALL PICTURE TUBES

ALL BLACK AND WHITE TUBES

From 50 degree to 110 degree types —from 8" to 30" types.

ALL COLOR TUBES

Test ALL picture tubes—in the carton—out of the carton—in the set!

● Model 83 is not simply a rehashed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes.
● Model 83 provides separate filament operating voltages for the older 6.3 types and the newer 8.4 types.
● Model 83 employs a 4" air-damped meter with quality and calibrated scales.
● Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.

● Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition.
● Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a selective low voltage uniformly to assure increased life with no danger of cathode damage.

Model 83 comes housed in handsome portable Saddle Stitched Texon case—complete with sockets for all black and white tubes and all color tubes. Only. . . **$38.50**

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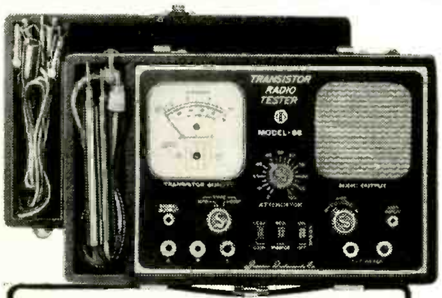

Model 88 — Transistor Radio Tester and Dynamic Transistor Tester. Total Price . . . $38.50
— Terms: $8.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

The Model 88 is perhaps as important a development as was the invention of the transistor itself, for during the past 5 years, millions of transistor radios and other transistor operated devices have been imported and produced in this country with no *adequate* provision for servicing this ever increasing output.

The Model 88 was designed specifically to test all transistors, transistor radios, transistor recorders, and other transistor devices *under dynamic conditions.*

AS A TRANSISTOR TESTER

The Model 88 will test all transistors including NPN and PNP, silicon, germanium and the new gallium arsinide types, **without referring to characteristic data sheets.** The time-saving advantage of this technique is self evident. A further benefit of this service is that it will enable you to test new transistors as they are released!
The Model 88 will measure the two most important transistor characteristics needed for transistor servicing, leakage and gain (beta).

AS A TRANSISTOR RADIO TESTER

The Model 88 provides a new simplified rapid procedure — a technique developed specifically for transistor radios and other transistor devices.
An R.F. Signal source, modulated by an audio tone is injected into the transistor receiver from the antenna through the R.F. stage, past the mixer into the I.F. Amplifier and detector stages and on to the audio amplifier. This injected signal is then followed and traced through the receiver by means of a built-in High Gain Transistorized Signal Tracer until the cause of trouble whether it be a transistor, some other component or even a break in the printed circuit is located and pin-pointed.

Model 88 comes housed in a handsome portable case. Complete with a set of Clip-On Cables for Transistor Testing, an R.F. Diode Probe for R.F. and I.F. tracing; an Audio Probe for Amplifier Tracing and a Signal Injector Cable. Complete—nothing else to buy! Only............................ **$38.50**

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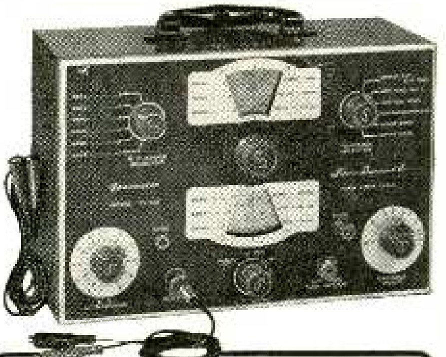

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- R.F. Signal Generator for F.M.
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- Cross Hatch Generator
- Color Dot Pattern Generator
- Marker Generator

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Model TV-50A—Genometer. Total price—$47.50—Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary!

R. F. SIGNAL GENERATOR: The Model TV-50A Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Model TV-50A Genometer provides a variable 300 cycle to 20,000 cycle peak wave audio signal.

BAR GENERATOR: The Model TV-50A projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

CROSS HATCH GENERATOR: The Model TV-50A Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

DOT PATTERN GENERATOR (FOR COLOR TV) Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

MARKER GENERATOR: The Model TV-50A includes all the most frequently needed marker points. The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc. (3579 Kc. is the color burst frequency).

THE MODEL TV-50A comes absolutely complete with shielded leads and operating instructions.

$47.50 NET

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Compare it to any peak-to-peak V.T.V.M. made by any other manufacturer at any price

- Model 77 completely wired and calibrated with accessories (including probe, test leads and portable carrying case) sells for only $42.50.
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- Model 77 uses new improved SICO printed circuitry.
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- Model 77 meter is virtually burn-out proof. The sensitive 400 microampere meter is isolated from the measuring circuit by a balanced push-pull amplifier.
- Model 77 uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.

AS A DC VOLTMETER: The Model 77 is indispensable in Hi-Fi Amplifier servicing and a must for Black and White and color TV Receiver servicing where circuit loading cannot be tolerated.

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SPECIFICATIONS

• **DC VOLTS**—0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. • **AC VOLTS (RMS)**—0 to 3/15/75/150/300/750/1,500 volts. • **AC VOLTS** (Peak to Peak)—0 to 8/40/200/400/800/2,000 volts. • **ELECTRONIC OHMMETER**—0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms • **DECIBELS**—10 db to + 18 db, + 10 db to + 38 db + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v).

• **ZERO CENTER METER**—For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Model 77—VACUUM TUBE VOLTMETER ...Total Price $42.50—Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary!

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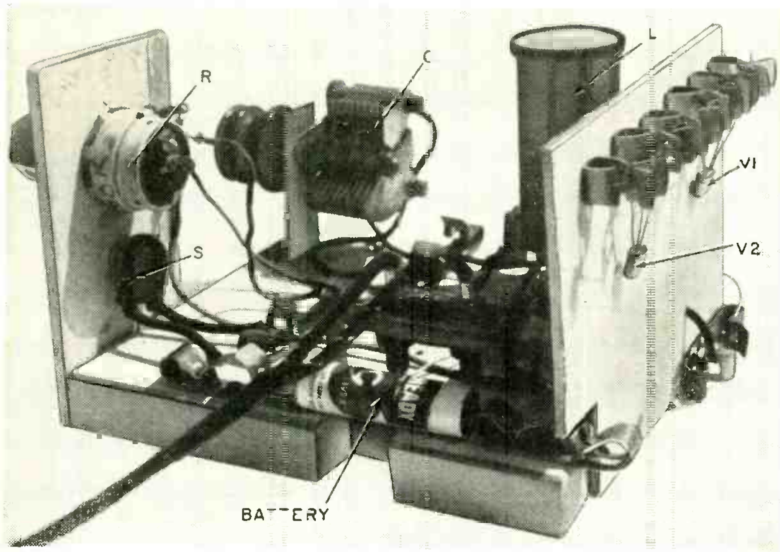
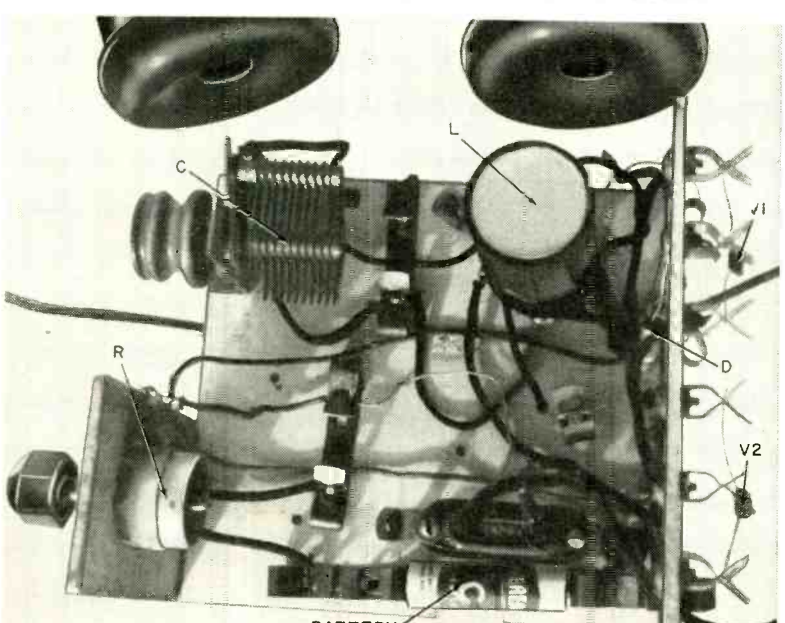


One view of transistor unit. Note that transistors are fastened to Fahnstock clips for easy mounting.

Top view of completed receiver.



By ANTHONY P. CIARDI

THIS transistor circuit will not be found in any transistor handbook but, for simplicity, results, and unexplored possibilities, it is hard to beat. It closely follows direct-coupling techniques used with vacuum tubes.

Designed for headphone use and powered by a 1.5-volt penlight cell, it is the utmost in economy and its volume is excellent for such a small array of parts and low battery voltage. While I did not attempt to miniaturize the unit, the few parts can be assembled into a very compact amplifier.

As I have been a direct-coupling enthusiast for many years, using tube amplifiers, I was determined to try my luck with transistors. However, I soon discovered that transistors do not follow tube techniques, except in a general way.

As the first step in building an experimental transistor radio receiver, using a direct-coupled amplifier, I reviewed present direct-coupling techniques and discovered that all existing circuits had their own particular shortcomings. There were multiple battery arrangements, use of complementary transistors, use of similar transistors in low-gain circuits. But, none had the simplicity, gain and exact configuration I desired and finally developed. My goal was a single-battery power supply at a low voltage, and two common-emitter stages to deliver the greatest voltage and power gain.

Fig. 1 shows the circuit I started with. It was attractive because large input signals could be handled before peak clipping set in and it has a voltage gain of 50 with a 1.5-volt battery. Values for R_b and R_L are selected to suit individual transistors, but in the final circuit a single potentiometer takes their place. This permits the use of any low-power transistor and gives the best compromise between voltage gain, noise and minimum distortion.

To my circuit of Fig. 1, I added another stage, just like the first, which is powered by the same battery. The final version (see Fig. 2) was the result.

The two fixed resistors R_b and R_L in Fig. 1 are replaced by a 500,000-ohm potentiometer (R, Fig. 2) which in effect becomes a split resistor. Approximately half of R is used to supply V1's base bias and the other half for V1's output load. The variable feature sets the values required for the proper operating points of the transistor. Potentiometer R must be large enough so the operating position of its arm will fall toward a center setting, giving a large-enough range to provide adequate biasing plus output load resistance.

The R_L section of R is the output load resistance for V1 and the R_b section is the base-biasing portion. For V2 the R_L section of V1 acts as the base-biasing resistor while the output load is a pair of headphones, output

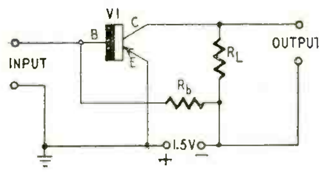


Fig. 1—This single-stage circuit was the starting point.

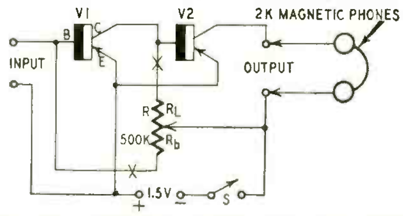
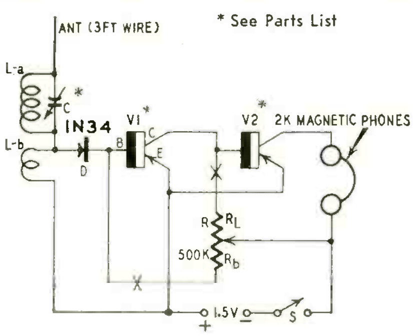


Fig. 2—Another stage, V2, has been added, and resistors R_L and R_b have been replaced by potentiometer R.

transformer or other suitable device. Thus the R_L portion of R is common to both transistors and is both the output-load resistor of one and at the same time the base-biasing resistor of the other. This follows vacuum-tube procedure as the interstage coupling resistor is common to both output and input circuits.

A crystal diode detector, variable capacitor, antenna coil and antenna were attached to the amplifier's input



R—pot, 500,000 ohms, linear
C—variable capacitor, 100 or 140 $\mu\mu$f
D—1N34 or equivalent
L—broadcast coil set, tuned to 190–550 meters (ICA 1473 or equivalent)
S—spst
V1, 2—any inexpensive p-n-p audio transistors, CK722, 2N107, 2N238
Headphones
Battery, 1.5-volt penlight cell
Chassis
Knobs
Miscellaneous hardware

Fig. 3—The detector circuit has been added and a simple headphone radio is the result.

as in Fig. 3, to make a simple but usable radio receiver. I use a short antenna—a longer one will be better in weak-signal areas. Of course, the output from a phono cartridge, crystal microphone or other high-impedance high-output source can be fed to the amplifier's input.

Just one word of caution: 1,000-ohm ½-watt resistors should be inserted at points X of Figs. 2 and 3 to prevent the transistors from being damaged by excess current.

I am pleased with my results and the layout of my breadboard setup is shown in the photos. I'm sure you'll like it too. END

T V QUIZ

By BOB ELDRIDGE

HERE are a few practical questions to test your powers of deduction. Each of the faults described has occurred in actual operation, and enough information is given to let you make an accurate diagnosis.

Voltage measurements have been taken with a vtvm.

For cases 1 through 4 refer to Fig. 1, which shows the sync phase inverter, phase detector and horizontal oscillator stages of an orthodox TV set.

Case 1

There is no raster. Pulling the 6AL5 causes the raster to appear, but the 6AL5 checks OK. A scope check at pin 7 of the 6AL5 shows high amplitude spikes at this point instead of the normal sawtooth waveform. *What is the fault?*

Case 2

There is no raster. If the 6AL5 is pulled, there is still no raster. A voltage check on the 6SN7-GT reveals the following:

Pin	*Volts*
1	100
2	100
3	25
4	−4
5	150
6	25

These voltages are the same whether the 6AL5 is in or not. The 6SN7-GT checks normal. *What is it?*

Case 3

There is no raster. If the 6AL5 is pulled, there is still no raster. A voltage check on the 6SN7-GT reveals the following:

Pin	*Volts*
1	0
2	240
3	11
4	150
5	70
6	11

The voltages are the same whether the 6AL5 is in or not. The 6SN7-GT checks OK. *What is it?*

Case 4

There is no raster. A measurement at the grid of the 6BQ6-GT shows −25 volts, but a scope check at the same point shows the frequency of oscillation to be about 5,000 cycles. The 6AL5 is pulled and left out—no change. The ringing coil is shorted with a jumper wire—no change. The 6SN7-GT checks OK. Voltages at the 6SN7-GT socket are all normal. Capacitors C61 and C64 are checked and found OK. If R90 (15,000 ohms) is shorted out, the raster appears, with a white overdrive line on it. *What is it?*

(For the next three cases, refer to Fig. 2.)

Case 5

There is no raster. High voltage at the second-anode cavity of the picture tube is normal. The following voltages are measured at the picture-tube socket, with the picture tube connected.

Pin	*Volts*
2	0
10	450
11	100, brightness control at "min"
	90, brightness control at "max"

The socket is removed from the picture tube and each voltage checks the same as before. It is noted that the voltage on pin 11 varies with movement of the contrast control. *What is it?*

Case 6

Agc action is too much delayed. Tuner and if strip have zero bias even with a medium strong signal. It is noticed that, although the alignment has been checked and found normal, there is poor resolution of fine detail in the picture. A check of voltages on the 6CS6 shows:

Pin	*Volts*
1	110 (normal is 130)
2/7	145 (normal)
6	300 (normal)

Resistor R28 (180,000 ohms is checked and found OK. *What is it?*

Case 7

There is a dim raster at "max" position of brightness control. At all other positions the screen is black. High voltage at the second-anode cavity of the picture tube is normal. The following voltages are measured at the picture tube socket connector:

Pin	*Volts*
2	0
10	450
11	130, brightness control at "min"
	40, brightness control at "max"

The connector socket is removed from the picture tube, and the voltage on pin 11 is now found to be:

Pin 11—130 volts at "min" of brightness control
0 volts at "max" of brightness control

The picture tube is checked and found to be normal. *What is it?* END

(Answers are on the opposite page. The honor system applies!)

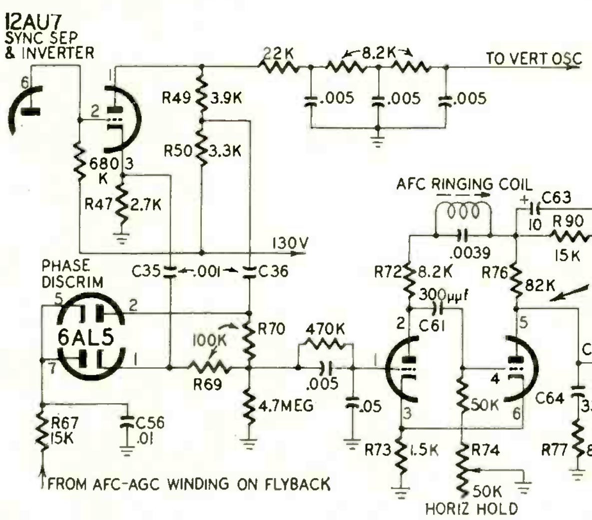


Fig. 1—This partial circuit, showing a TV receiver's sync phase inverter, phase detector and horizontal oscillator stages is used for cases 1, 2, 3 and 4.

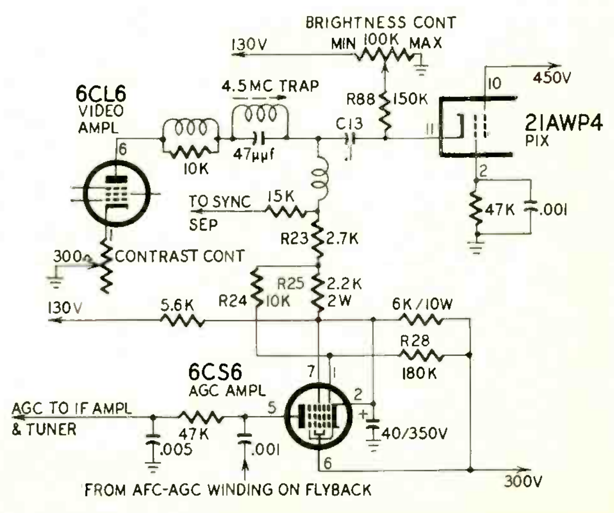


Fig. 2—For cases 5, 6 and 7, use this diagram of the agc, video output and C-R tube circuits.

Case 1
C56, a .01-μf capacitor, is open. This capacitor normally forms a sawtooth. In its absence, the uninhibited spikes coming from the flyback cause heavy conduction in the phase detector. The resulting high dc bias produced on the oscillator's control grid pushes the oscillator way off frequency. Note the fault only appears when the 6AL5 is plugged in. *Score 5*

Case 2
Leakage or short in C36, a .001-μf capacitor. If C35 was the culprit, positive voltage on the grid of the 6SN7-GT could not be as high as 100 because the leakage would have been from the voltage developed across R47 in the cathode of the phase inverter. *Score 5*

If you said "leakage across the 6SN7-GT socket," *score 2*. This is possible but not very likely.

Case 3
Leakage or short in C61, a 300-$\mu\mu f$ capacitor. The tube having been eliminated, this is the only possible cause of positive voltage appearing on the grid. *Score 5*

Case 4
C63, a 10-μf electrolytic, is open, raising the impedance of the oscillator plate circuits. Shorting out R90 (15,000 ohms) connects the main B-plus line filters, forming a low-impedance path to ground. *Score 20*

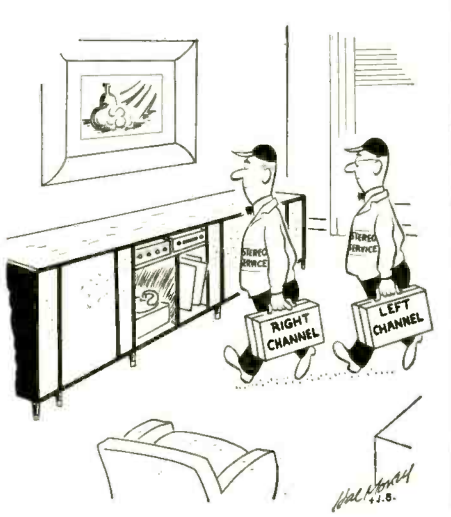
Case 5
C13, a 0.1-μf capacitor, is shorted, putting a permanent positive bias on the picture-tube cathode. The change in voltage which occurs with contrast control variation is caused by a change in potential drop across the video amplifier plate load resistance, due to changes in conduction through the video amplifier tube. *Score 10*

Case 6
R25, a 2,200-ohm resistor, is high. The voltage drop across this resistor establishes the bias between grid and cathode of the 6CS6, and this sets the keying level. *Score 20*

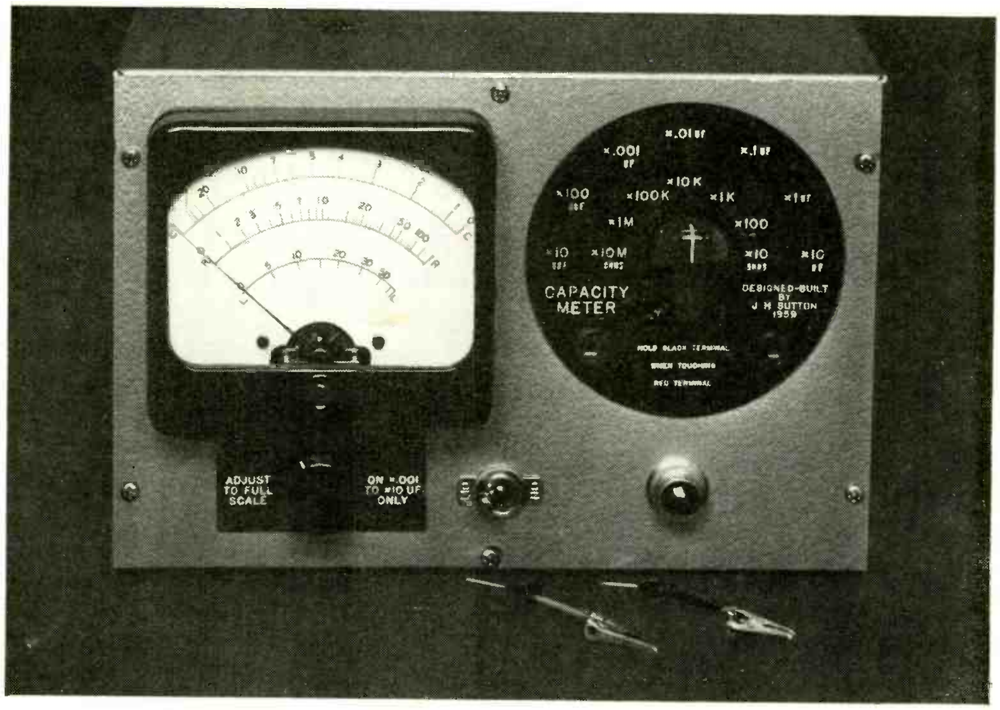
If you said "R24 is high," *score 5*. This is less likely, and you have overlooked the clue about the picture detail. High-frequency response suffers if the plate load resistance is too high.

Case 7
R88, a 150,000-ohm resistor, is high. This acts as a self-bias cathode resistor, automatically biasing the picture tube back when beam current flows. When checking the voltages at the socket with the picture tube disconnected, there is very little voltage drop across R88 because of the high input resistance of the vtvm. *Score 15*

Well, how did you fare? This quiz was for kicks, not for job ratings! But if you scored more than 60 you can hold your head high. If you made less than 50, you are out of practice, very tired, or need to get down to it and study!



CAPACITANCE METER



Front view of meter. Plugs and clips connect component to be measured to meter.

This one-tube unit measures capacitance, resistance and inductance

By J. H. SUTTON

THIS capacitance meter covers the unusually wide range of 1 $\mu\mu$f to 500 μf. Accuracy for nonelectrolytics is as good as that obtained on a high-grade impedance bridge (electrolytics may be measured approximately). Hand-capacitance does not affect readings, and there is no shock hazard (the maximum test voltage is only 6.3 ac). Warmup time is rapid, less than a minute.

The basic circuit is very simple (Fig. 1-a). But to measure the voltage across the capacitor accurately, the voltmeter must have practically infinite impedance. Hence we add an ordinary cathode-follower stage (Fig. 1-b) whose input impedance is almost open-circuit.

In this circuit, the voltmeter could be a good ac vtvm. A voltmeter with a lower input impedance will distort the cathode follower output. But good ac vtvms are scarce. Most show large errors on low ac ranges. Because of this, we replace the voltmeter in Fig. 1-b with a good linear amplifier and then read this amplified output on a vtvm, vom or, as in my pictured instrument, on a 1-ma meter. The complete schematic is shown in Fig. 2.

Construction

Construction layout is noncritical, ex-

The instrument measures capacitance from 1 $\mu\mu$f to 50 μf. Can operate with a low-priced 1-ma meter.

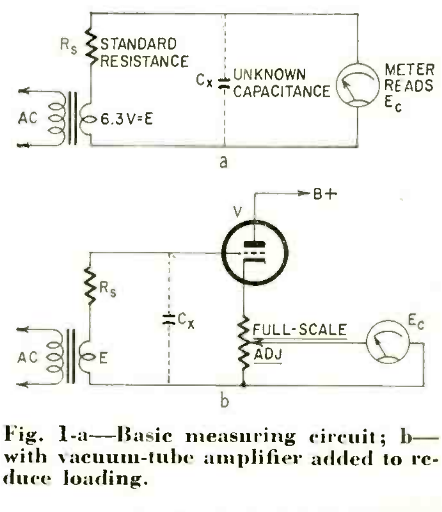


Fig. 1-a—Basic measuring circuit; b—with vacuum-tube amplifier added to reduce loading.

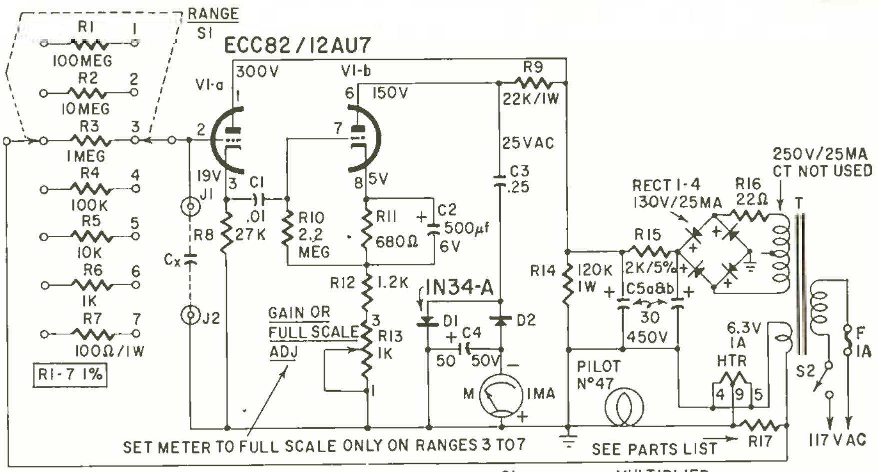


Fig. 2—Schematic of meter.

S1 RANGE	MULTIPLIER CAPACITANCE	MULTIPLIER RESISTANCE
1	X 10µµf	X10MEG
2	X 100µµf	X1MEG
3	X.001µf	X100K
4	X.01µf	X10K
5	X.1µf	X1K
6	X1µf	X100Ω
7	X10µf	X10Ω

R1—100 megohms, 1%, see text
R2—10 megohms, 1%, see text
R3—1 megohm, 1%
R4—100,000 ohms, 1%
R5—10,000 ohms, 1%
R6—1,000 ohms, 1%
R7—100 ohms, 1 watt, 1%
R8—27,000 ohms
R9—22,000 ohms, 1 watt
R10—2.2 megohms
R11—680 ohms
R12—1,200 ohms
R13—pot, 1,000 ohms, linear taper
R14—120,000 ohms, 1 watt
R15—2,000 ohms, 5%
R16—22 ohms
R17—adjust for 6.3 volts across 12AU7

all resistors ½ watt, 10% unless noted

C1—0.01 µf, 600 volts, disc ceramic.
C2—500 µf, 6 volts, electrolytic
C3—0.25 µf, 400 volts
C4—50 µf, 50 volts, electrolytic
C5—30, 30 µf, 450 volts, electrolytic
J1, 2—sockets for ⅛-inch plug, 1 red, 1 black, (Amphenol 78-1M or equivalent)
V1—12AU7
RECT 1, 2, 3, 4—selenium rectifiers, 130 volts, 25 ma or higher
D1, 2—1N34
S1—2-pole, 7 position rotary, Steatite insulation (Centralab PA 2004 or equivalent)
S2—spst toggle
M—1-ma meter, see text for scale
T—power transformer, 250 volts, 25 ma, (ct not used); 6.3 volts, 1 ampere (Stancor PS8416 or equivalent)
F—1-ampere fuse and holder
Pilot lamp, No. 47 and socket
Cabinet, 9 x 6 x 5 inches, aluminum
Chassis, aluminum
Miscellaneous hardware: knobs, tube socket, line cord, rubber feet, terminal strips, etc.

TABLE I
Calibration Points

R_s = 1,000 ohms: Meter reading	Capacitance in µf	R_s = 10 ohms: Meter reading	Resistance in ohms
1.000	0.0	1.000	infinite
0.998	0.2	0.952	200
0.989	0.4	0.938	150
0.975	0.6	0.909	100
0.958	0.8	0.900	90
		0.889	80
0.936	1.0	0.875	70
0.911	1.2	0.857	60
0.884	1.4	0.833	50
0.856	1.6	0.818	45
0.828	1.8		
		0.800	40
0.799	2.0	0.778	35
0.770	2.2	0.750	30
0.742	2.4	0.737	28
0.714	2.6	0.722	26
0.688	2.8	0.706	24
		0.688	22
0.662	3.0	0.667	20
0.639	3.2		
0.615	3.4	0.655	19
0.593	3.6	0.643	18
0.572	3.8	0.630	17
		0.615	16
0.553	4.0	0.600	15
0.534	4.2	0.593	14
0.516	4.4	0.555	13
0.500	4.6	0.545	12
0.484	4.8	0.524	11
		0.500	10
0.469	5.0		
0.454	5.2	0.487	9.5
0.441	5.4	0.474	9.0
0.428	5.6	0.455	8.5
0.416	5.8	0.446*	8.0*
		0.412	7.0
0.404	6.0	0.375	6.0
0.378	6.5	0.333	5.0
0.354	7.0	0.286	4.0
0.333	7.5	0.231	3.0
0.315	8.0	0.167	2.0
0.298	8.5	0.091	1.0
0.283	9.0	0.000	0.0
0.269	9.5		
0.256	10		
0.216	12		
0.186	14		
0.164	16		
0.146	18		
0.132	20		
0.088	30		
0.066	40		
0.053	50		
0.027	100		
0.000	infinite		

*from here down, divisions between points are practically linear.

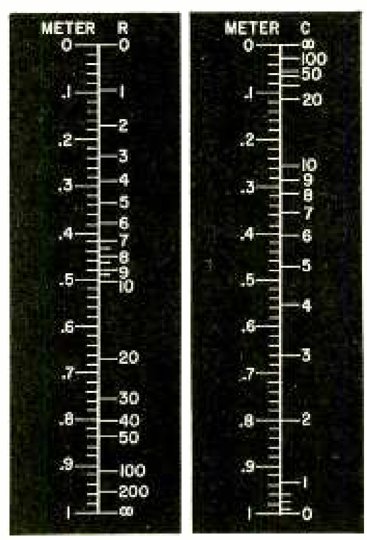


Fig. 3-a—Meter-current and capacitance scales (R_s = 1,000 ohms); b—meter-current and resistance scales (R_s = 10 ohms).

cept that input grid leads should be short to obtain low distributed capacitance. The switch should be steatite, double-deck for ease of resistor mounting. The test jacks are high-dielectric Amphenol sockets 78-1M. Residual capacitance of the instrument is only 15 µµf, about half that normal to a commercial product.

Your vtvm or vom, provided it has nearly linear response, will make a quite satisfactory indicating meter for this device. Using the scale in Fig. 3, voltage readings can be quickly translated into capacitance. Also, ac resistance can be similarly translated. Or, if your ohms scale mid-point is 10, ac resistance can be read directly.

The meter scale of my instrument is home-made and hand-drawn. But this requires some experience plus either a linear calibrating meter or a precision potentiometer. A similar dial can be purchased through your dealer from the Triplett Electrical Instrument Co. (Bluffton, Ohio) for a very few dollars plus cost of the meter. Supply Table I data to them interpreted in ma.

A 1-ma meter is used for two reasons. First, the accuracy of meter readings tends to increase as the meter current increases (i.e. as the sensitivity decreases). Second, a current as heavy as possible through the rectifiers improves their response linearity. My meter actually has a 40-µa movement with sensitivity reduced to 400 µa by heavy springs. It is then shunted with a 10% carbon resistor so that full-scale deflection requires about 1 ma. If a vtvm or vom is used as the indicating meter, shunt the terminals and possibly increase series capacitance (C3) until roughly 1 ma is required for full-scale deflection.

Capacitance ranges

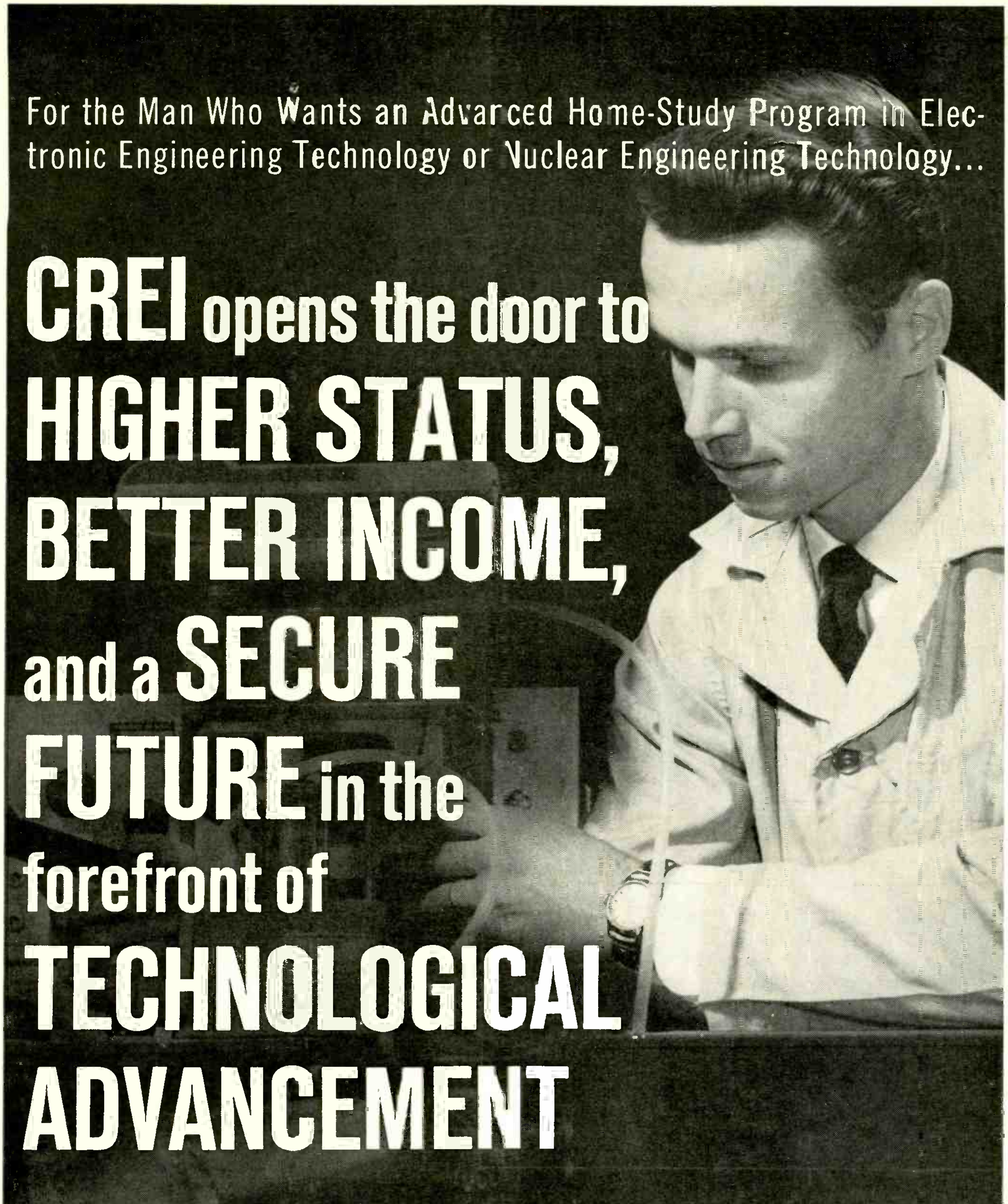
The ranges of the instrument are:

Range	Scale Multiplier	Measures Capacitance	Scale Multiplier	Measures Resistance
1	×10 µµf	0–500 µµf	×10 megohms	see text
2	×100 µµf	0–5,000 µµf	×1 megohm	0–200 megohms
3	×.001 µf	0–0.05 µf	×100,000 ohms	0–20 megohms
4	×.01 µf	0–0 5 µf	×10,000 ohms	0–2 megohms
5	×.1 µf	0–5 µf	×1,000 ohms	0–200,000 ohms
6	×1 µf	0–50 µf	×100 ohms	0–20,000 ohms
7	×10 µf	0–500 µf	×10 ohms	0–2,000 ohms

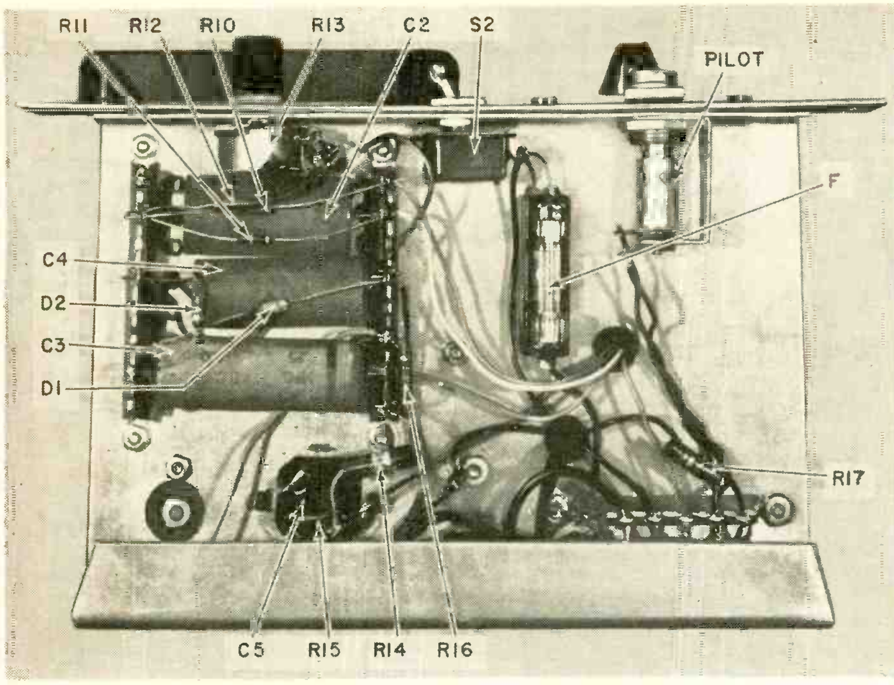
By assigning range 1 to the extreme counterclockwise switch position, the range knob and the meter needle will move in the same direction. Precision resistors were purchased for R3 to R7. R1 and R2, were built up from 10% carbons using the instrument itself.

Inherent capacitance will be registered on ranges 1 and 2 and must be subtracted from readings on these ranges. Due to this residual capacitance, resistance readings on range 1 (and 2) do not appear accurate above mid-scale (or about 100 megohms). Moreover, since the input grid is considerably above ground on ranges 1 and 2, one hand must be touching the ground terminal whenever the other

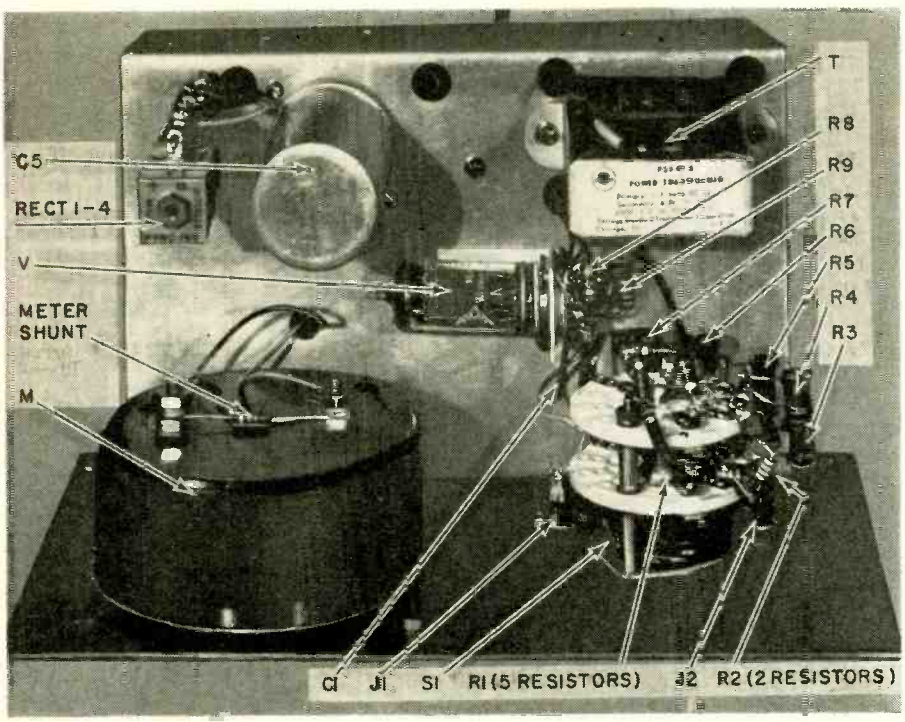
(Continued on page 96)



The world of science is the world of the future. There is no career more stimulating, challenging, or rewarding than that of working with topflight scientists and engineers to develop deep space probes and orbital satellite systems . . . package nuclear power reactors to provide economical, long-lasting power anywhere in the world . . . electronics and radioisotopes for use in medicine, agriculture and industry . . . missile systems for the Armed Forces . . . computers and data processing systems which will become accepted necessities by finance, industry and government . . . to develop a thousand and one concepts that will make our world a better and safer place for all. You can have a career—or speed up your present career—in one or more of these areas if you are eligible to enroll in a CREI home-study program . . . a program recognized everywhere as excellent insurance for a secure future, high professional stature, and better income.



Underchassis view. Terminal strips allow neater, easier wiring.



Top view of chassis. Rectifiers are mounted in a stack.

terminal is touched, to prevent needle slamming (from stray ac input). Since inherent capacitance is noted on only the first two ranges, the full-scale adjustment (by R13) should be made on any of the other ranges. This adjustment will hold for all ranges. Normal line-voltage variations affect this setting to only a minor extent.

Electrolytics

Ranges 5 to 7 can be used to measure electrolytic capacitance, provided the effect of power factor is noted. The master will see the power-factor resistance (say R_c) simply as a decrease of capacitive reactance, so that the indicated electrolytic capacitance will be greater than the true capacitance (X_C). However, this discrepancy diminishes progressively to the left of mid-scale. For example, a 17-μf electrolytic with 40% power factor is indicated 17 μf on the × 1 μf range, and 24 μf on the × 10 μf range. Again, an 8-μf capacitor with a 5% power factor measures 8 μf on the × 1 μf range, and 10 μf on the × 10 μf range.

The power factor of nonelectrolytics is normally neglected but would be similarly indicated. For example, to an .012-μf mica, power factors of 5%, 10% and 15% were added successively. These additions went unnoticed on the × .001 μf range; but on the × .01 μf range, the readings became .013, .014, and .015.

The formula giving capacitance in terms of relative voltage is presented in an appendix. The calculation result is shown in Table I and Fig. 3. The table of resistance value (also in terms of relative voltage) is suitable for calibrating the meter scale.

Inductance

The dial of my meter shows an inductance scale. The inductance-scale multiplier is not engraved on the range selector because I am uncertain of its accuracy. Inductance is related to capacitance, on the meter scale, by an extremely simple formula:

$$\text{Inductance (in henries)} = \frac{7}{\text{capacitance reading (in } \mu\text{f)}}$$

The 7 is an approximation, the full value being 7.036, derived as follows: The relative voltage across a pure inductive reactance X_L will be the same as across a pure capacitive reactance. Hence on the meter $X_L = X_C$. Then by substitution:

$$2\pi fL \text{ (henries)} = \frac{1}{2\pi fC \text{ (farads)}}$$

which simplifies to the above formula when $f = 60$ cycles. Thus, inductance to 1 henry would be measured on range 7 and up to 1,000 henries on range 4. This would limit measurements to large iron-cored inductors, such as audio and power supply chokes.

Concerning choke ratings, the Stancor (Chicago Standard Transformer Corp.) catalog states the following:

"Inductance varies with the amount of dc flowing thru the coil. . . . Filter chokes are rated at 10 volts, 60 cycles, with maximum dc in winding. . . . Audio chokes are rated at 2 volts, 200 cycles, with maximum dc in winding. Tolerance of minus 15% to plus 50% is maintained on all ratings."

In view of this wide rating tolerance, perhaps the following capacitance meter measurements, on four chokes I have, are not too bad:

Type and rating	Range 4	Range 5	Range 6
power, 10 h, 300 ohms	—	7.5 h	5.9 h
power, 10 h, 300 ohms	—	16 h	9 h
power, 2 h, 150 ohms	—	2.35 h	2.25 h
audio, 25 h, 660 ohms	24 h	35 h	—

One might assume, as for electrolytics, that the lowest-range reading is to be accepted; but here the second choke is a notable exception, unless its rating is in error. Measuring this choke's value by the voltmeter–ammeter method, with 10 volts ac but no dc in the winding, indicated that the rating might indeed be in error (measured 22 h, "high" readings being the rule by this method).

Available literature does not detail manufacturers' methods of rating chokes. The resonance method often cited in the literature (RADIO-ELECTRONICS, June, 1956, page 112) is more than likely incorrect.

Other measurement methods

As far as I have read (see bibliography), the various types of capacitance-measuring devices are never compared in the literature. In fact, most texts are blissfully unaware of accurate methods other than by bridge. Yet this comparative information is

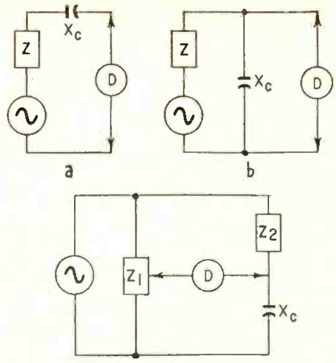


Fig. 4—Basic measuring circuits using: a—detector in series; b—detector in parallel, and c—bridge.

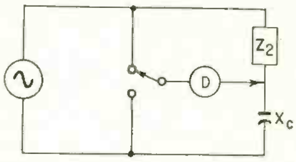


Fig. 5—Special bridge circuit using a spdt switch.

helpful to the technician, so that he may select the method best suited to his use.

Only three capacitance-measurement methods appear possible, depending on the position of the detector (meter, electron-ray tube, etc.) in the circuit (Fig. 4). They are: series detection, parallel detection and bridge detection. Additional configurations do not appear possible, except for interchange or elaboration of the elements.

In a special case of the bridge (Fig. 5) Z_1 becomes an infinite-impedance (an open switch) and D, instead of being a null detector, is a meter to equalize the voltages across Z_2, X_c. If D is a negligible load, we can say that Z_2 (usually a variable resistor) equals X_c.

All three are represented in construction articles published by RADIO-ELECTRONICS since January, 1955 (as far back as my files go). Table II lists pertinent data on these and on the Heathkit CM-1 (series detector) and the Knight-kit capacitor checker (bridge).

In the series-detector design, the oscillator voltage must be high if the frequency is low (if the voltage is not high, the range is limited). Calibration procedure is always empirical because the detector impedance is effectively a part of Z. By "empirical" I mean, to quote construction articles, "pick up a couple of dozen good fixed capacitors" and "mark the meter reading with the capacitor's value." The Heathkit CM-1 is supplied with four precision capacitors and, because circuit response is linear, readings should be accurate.

In the parallel-detection system, the oscillator voltage can be low without sacrificing measurement range. The oscillator and detector impedance must be included in Z.

The null-detection bridge can be made the most accurate of all measurement methods. Moreover, only this type can measure the power factor apart from the capacitance. There are, however, disadvantages. At mid- to high-range

TABLE II—Previously Published Data on Capacitance Meters

Reference	Oscillator Frequency	Oscillator Volts	Measurement range	Detector	Calibration Procedure
Series detection					
Sept. '58, p. 109	60	125	1,000 μμf to 10 μf	1-ma meter	empirical
Apr. '59, p. 39	60	270 max.	250 μμf to 10 μf	ac vom	"
Aug. '59, p. 88	60	6.3	250 μμf to 0.5 μf	dc vtvm	"
Heath CM-1	—	low	1 μμf to 0.1 μf	50-μa meter	"
Parallel detection					
March '57, p. 95	1 mc	0.13	12 μμf to 300 μμf	50-μa meter	component
the present article	60	6.3	1 μμf to 500 μf	1-ma meter	"
Bridge detection					
March '55, p. 106	audio	low	not stated	headphones	component
July '55, p. 40	1,000	—	not stated	"	"
Feb. '57, p. 60	audio	low	10 μμf to 1 μf	"	"
Aug. '58, p. 80	60	200	10 μμf to 1 μf	vtvm	"
Knight-checker	60	60	10 μμf to 1,000 μf	electron-ray tube	"

audio frequencies, measuring components must be shielded or accuracy will suffer. Also, the detector is practically limited to headphones, a disadvantage in noisy surroundings. At 60 cycles, components can be unshielded. A visual detector is practically universal, although there are complaints that the electron-ray tube is not completely satisfactory (RADIO-ELECTRONICS, January, 1956, page 180). To cover a wide measurement range, the oscillator voltage must be relatively high. Sometimes this voltage is higher than should be impressed on low-voltage low-capacitance electrolytics. For example, if the oscillator voltage is 60 in series with the usual 2-μf standard, then 10 volts of raw ac will be impressed on a 10-μf electrolytic. This may damage a 25- or 50-volt bypass capacitor, and almost certainly will damage 6- to 15-volt transistor types.

Because of the above, I decided to construct a parallel-detection instrument. For speed of measurement, a definite meter reading is preferred to hunting for a null indication. END

Bibliography

Kinnard, *Applied Electrical Measurements*, Wiley, N.Y. 1956, Part I, Section 4.

Frank, *Electrical Measurement Analyses*, McGraw-Hill, N.Y., 1959, Chapter 8.

Smith & Wiedenbeck, *Electrical Measurements*, McGraw-Hill, N.Y., 1959.

Golding, *Electrical Measurements & Measuring Instruments*, Pitman, London, 1955, Chapter 6.

Terman & Petit, *Electronic Measurments*, McGraw-Hill, N.Y., 1952, Chapter 3.

Banner, *Electronic Measuring Instruments*, Chapman & Hall, London, 1958, Chapter 7.

Buckingham & Price, *Principles of Electrical Measurements*, English University Press, London, 1955, Chapters 5, 8.

American Radio Relay League, *Radio Amateur's Handbook*, West Hartford, Conn., 1959 edition, page 525.

Henney, *Radio Engineering Handbook*, McGraw-Hill, N.Y., 1959, Chapters 4, 14.

Terman, *Radio Engineers Handbook*, McGraw-Hill, N.Y., 1943, Sections 2, 13.

Orr, *Radio Handbook*, Editors & Engineers, Ltd., Summerland, Calif., 1956 edition, pp 684–9.

Scroggie, *Radio Laboratory Handbook*, Wireless World, London, 1954, Chapter 9.

Appendix: Capacitance Calculation

Input current (I) flows through the standard resistance (R_s) and through the unknown capacitive reactance (X_c) in series, so:

$$(R_s^2 + X_c^2)^{1/2} I = E \text{ (input voltage)}$$

In R_s we include the *ac* resistance of the input transformer which, in practice, is negligible compared to the minimum measuring resistance used, 100 ohms. The detector measures the voltage E_c across X_c, so the relation of E_c to E is:

$$\frac{X_c I}{(R_s^2 + X_c^2)^{1/2} I} = \frac{E_c}{E}$$

Solving for E_c and converting X_c to C_x:

$$\frac{E}{\left(\frac{R_s^2}{X_c^2} + 1\right)^{1/2}} = \frac{E}{(4\pi^2 f^2 R_s^2 C_x^2 + 1)^{1/2}} = E_c$$

From this we calculate E_c by assigning scale values to C_x: power of 10 values to R_s and to E, a nominal full-scale meter value, say 1. E_c will then be given in terms of a 0-to-1 meter scale. So if a 0-to-10 scale is used, multiply the tabular values by 10. For a 0-to-12 scale, multiply the values by 12, etc. Table I was calculated using a five-place logarithm table. The resistance formula and data are derived in a similar fashion.

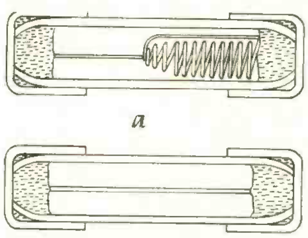
"Of course, technically, I'll have to charge you for a house call."

WATCH THAT FUSE REPLACEMENT

The fuse that fits isn't always the right one!

By JAMES W. ESSEX

THE mushrooming growth of electrical apparatus has helped the lowly fuse rival the vacuum tube in abundance and variety. There are sizes and shapes to fit any application—from circuits requiring slow-blow types for electric motors to vibrationproof fuses (see diagram) for aircraft and mobile equipment. All come in a wide variety of amperage ratings from the 1/500-amp 8AG fuse designed to protect sensitive instruments to the 9AG with its 50-amp rating for Diesel trucks. All serve the needs of industry (and the home). What would our costly circuits be worth (even home TV's) if a malfunction of one part could destroy many others? Fortunately, with the aid of the fuse, we can buy protection for a few pennies.



a

b

An anti-vibration fuse (a) and a standard type (b).

But there are limitations. Failing to note a few important facts about fuses can negate their usefulness and practically eliminate their money-saving potential. The electric windshield wipers on a friend's car failed one winter day. He tried to get things going again by inserting another fuse. He didn't bother to observe the markings on the one he took out. The one he put in was chosen merely because "it fitted." It blew. Angry, he wrapped cigarette foil around it and tried again. That fixed it. Everything was fine until a severe snowstorm caused the wipers to bind momentarily. He had no protection. The electric motor burned out. Cost—$4.75 plus labor. Choosing the correct fuse in the first place would have been less costly. Moral: do not chose a fuse replacement by size alone.

In our plant, we make fire engines, and fuses play an important part in the intricate lighting network of a truck. Where time is sometimes short, choosing the wrong fuse can be a serious mistake. Our wiring networks feed flashing lights, signal warning lights, compartment lights for night operation, and panel lights.

Three of the fuses (to give only one example) are the same physical size but have amperage ratings of 5, 20 and 30. Think what could happen if a 5-amp fuse were inserted in a 30-amp circuit or vice versa because someone chose a fuse by size alone. In one case, the circuit would not stand up. In the other, there would be no protection.

Auto manufacturers have made every effort to guard against over- or underfusing by adopting a system in which fuse lengths correspond to amperage ratings. The shorter the fuse, the lower the amperage-carrying capacity. The longer the fuse, the greater the current capacity. But they have been victims of progress, just as the changing designs in automobiles keep new cars old. According to Mr. A. M. Kalata of Littelfuse Inc. of Des Plaines, Ill., it is an inheritance of the past which progress has outdated. He says, "When the fuse industry first went into the manufacturing of fuses, they were primarily for the automotive trade. The Society of Automotive Engineers started a particular new line with the thought in mind that each amperage would have a different physical length. But the line got too big. Consequently, they reverted to the commercial standard field or nomenclature, as we know it." To name a few, there are 1AG, 3AG, 4AG, etc. The old SFE line (which is still the prefix for the automotive fuses) is still with us. For example, you'll still find SFE 20 and SFE 14 fuses widely used in autos to protect car radios. Others, like the SFE 6 and SFE 9, are used for headlight circuits.

How do the newer fuses—1AG, 3AG, etc.—differ from the old? First, the SFE line maintains the standard that fuse length corresponds to amperage. The new fuses, like the 1AG and 3AG, have a standard length for each type regardless of amperage. Thus, you can get a 3AG fuse which is 1¼ inches long in any amperage from 5 to 30, while only the 20-amp SFE has the same length. If you want a 30-amp fuse in the SFE series, length would jump to 1 7/16 inches.

The variety of fuses in the one-length type continue on into the 4AG, 5AG and on through 9AG types. Each group has its own particular use. Each group has a particular length.

When replacing a fuse, note the nomenclature stamped on the barrel and put in a similar one. Don't use a fuse just because it fits. For a rough guide in choosing fuses for original equipment follow these steps:

Determine the physical dimensions of the fuse to be used. Then choose a fuse that has the current-carrying capacity the circuit calls for. If you are working with a circuit in which momentary surges occur but you don't want to sacrifice protection by going higher in fusing, choose a slow-blow fuse, which has a high time lag. It can withstand heavy surges yet blow quickly on shorts.

I've often seen technicians confused by the voltage ratings marked on some fuses—32 volts or 250 volts, for example. This simply means that the 32-volt fuse can be used in any circuit up to 32 volts. Or a 250-volt fuse can be used in any circuit up to 250 volts. If your application calls for 32 volts and the fuse you get is marked with the proper amperage, but 250 volts, it will work satisfactorily, but it may cost a little more. END

COMPARISON OF FUSES

Current Rating (amperes)		Length (inches)
3AG	SFE	SFE*
—	4	5/8
5	—	
—	6	3/4
7½	—	
—	9	7/8
10	—	
—	14	1 1/16
15	—	
20	20	1¼
25	—	
30	30	1 7/16

*All 3AG fuses are ¼ inch in diameter and 1¼ inches long

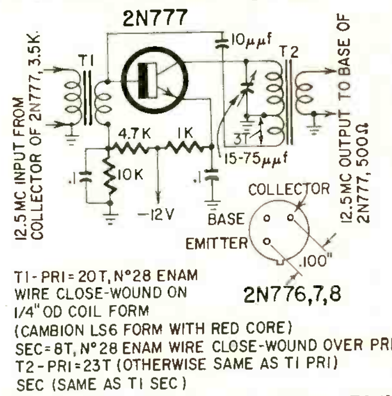
A listing of two series of 32-volt fuses. Note that the 3AG types are all ¼ inch in diameter and 1¼ inches long. The length of SFE automotive fuses changes in relation to current rating, making it impossible to put too large a fuse in a circuit.

NEW TUBES and SEMI-CONDUCTORS

A VERY DIVERSE group of products were released this month. There are 12.5-mc amplifier transistors, Zener diodes, 150-watt power transistors, and a set of tubes for ac–dc radios.

2N776, -777, -778

A family of silicon surface-alloy diffused-base transistors for 12.5-mc amplifier applications. The transistors feature a typical power gain of 25 db at 12.5 mc. Each transistor has a different beta range, making it possible to use these transistors in both narrow and wide-band video amplifiers.



Maximum ratings of these Philco transistors are:

V_{CBO}	20
V_{CEO}	15
V_{EBO}	2
I_C (ma)	100
P_{total} (mw)	150

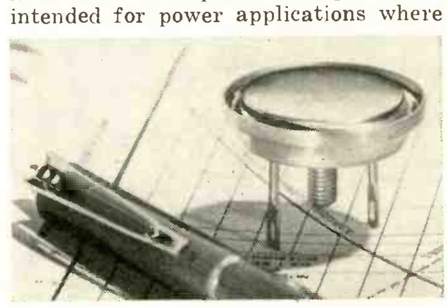
Beta gain characteristics are:

2N776	6–18
2N777	11–36
2N778	28–90

The diagram shows a typical single-stage 12.5 mc amplifier using the 2N777.

2N174, 2N1100, 2N1358

Three "doorknob" transistors that have a 150-watt power rating. All are intended for power applications where



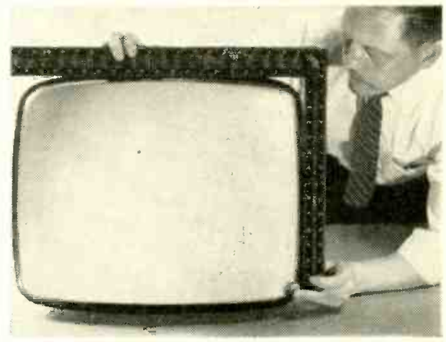
a beta gain of 25–50 at a 5-amp collector current are needed.

Maximum ratings of these Motorola transistors are:

	2N174	-1100	-1358
V_{CB}	80	100	80
V_{EBO}	60	80	60
I_E (amps)	15	15	15
I_B (amps)	4	4	4

Squarer square corners

Nearly square corners on new 19- and 23-inch picture tubes have expanded the useful viewing area to more than 95% of the area needed to display all picture information transmitted. Although the tubes are almost identical

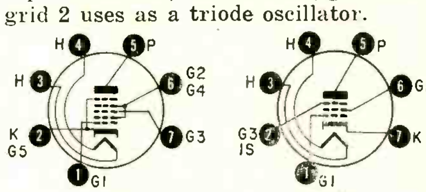


in height and width to typical 17- and 21-inch versions, they have 11% more screen area (17 square inches) than conventional 17-inch tubes and 8% more area (20 square inches) than 21-inch tubes. A look at the 23-inch Westinghouse 23FP4 shows just how square the corners are getting.

18FX6, 18FW6, 18FY6, 34GD5, 36AM3-A

Here are five tubes that can make up the tube complement of an ac–dc AM radio. All are 7-pin miniatures and all have 100-ma heaters. A complete AM radio using these tubes would have a power consumption of about 20 watts.

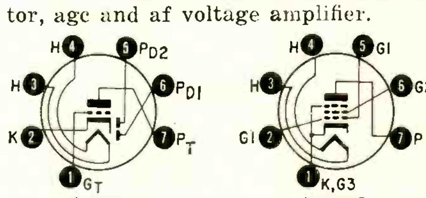
The 18FX6 is a pentagrid converter intended for use with grid 3 as signal input electrode; and cathode, grid 1 and grid 2 uses as a triode oscillator.



18FX6 18FW6

The 18FW6, a remote-cutoff pentode for use as an rf or if amplifier tube, has a 4,400-μmho transconductance at 11-ma plate current.

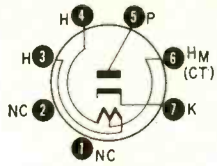
The 18FY6 is a twin-diode, high-mu triode intended for use as an AM detector, agc and af voltage amplifier.



18FY6 34GD5

The 34GD5 is a beam power tube designed for the output stages of small ac–dc radios with 110-volts on the plate, it can deliver 1.4 watts of audio.

The 36AM3 is a half-wave rectifier.

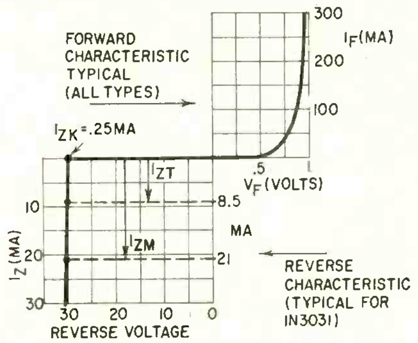


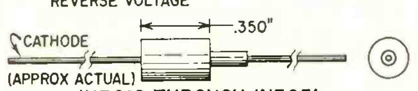
36AM3-A

Together, these 5 tubes become an AM ac–dc radio team.

IN3016 through IN3051

A series of Zener diodes rated at 1 watt range from a 6.8- to a 12-volt unit. Silicon, diffused-junction types with sharp zener knee; 5%, 10% or 20% tolerances, as desired.





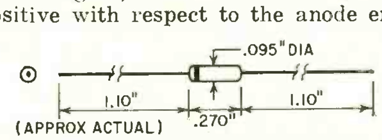
IN3016 THROUGH IN3051

Ratings of some of these Motorola units are:

	Zener Voltage	Max dc Zener Current (ma)
IN3016	6.8	100
IN3020	10	65
IN3024	15	42
IN3028	22	29
IN3032	33	20
IN3036	47	13
IN3040	68	9
IN3044	100	6
IN3048	150	3.7
IN3051	200	3

¼M2.4AZ through ¼M6.8AZ

A series of ¼-watt Zener diodes for use as constant-voltage references for 2.4- through 6.8-volt applications. The units in 5%, 10% or 20% tolerances. The cathode end is indicated by a color band. When the diode is operated in the Zener region, the cathode end will be positive with respect to the anode end.



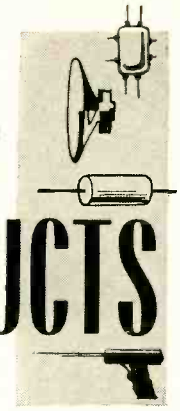
1/4M2.4AZ THROUGH 1/4M6.8AZ

Electrical characteristics of these Motorola units are:

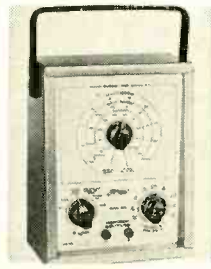
Type	Zener Voltage	Max Zener Imped (ohms)	Max Zener Current (ma)
¼M2.4AZ	2.4	60	70
¼M2.7AZ	2.7	60	65
¼M3.0AZ	3.0	55	60
¼M3.3AZ	3.3	55	55
¼M3.6AZ	3.6	50	52
¼M3.9AZ	3.9	50	49
¼M4.3AZ	4.3	45	46
¼M4.7AZ	4.7	35	42
¼M5.1AZ	5.1	25	39
¼M5.6AZ	5.6	20	36
¼M6.2AZ	6.2	15	33
¼M6.8AZ	6.8	10	30

END

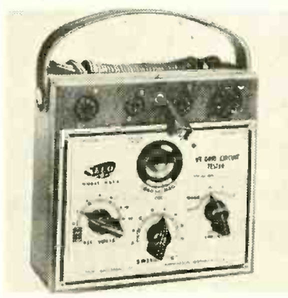
new PRODUCTS



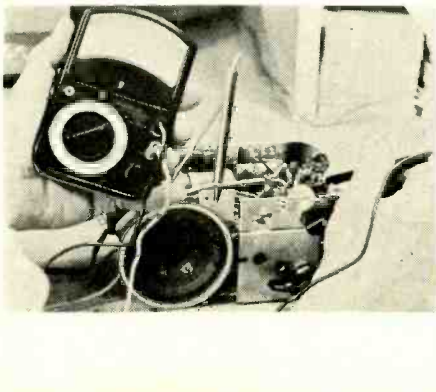
COMPONENT SUBSTITUTER, *model 500*. Substitutes 20 values of resistors from 33 ohms to 10 megohms, 10 values of capacitors from .0001 to 0.5 μf, 10 values of electrolytics from 4 to 330 μf, power rectifiers up to 55 ma, crystal diodes. Continuously variable power resistance up to 5,000 ohms, and bias voltages up to 15 volts either polarity. Hammertone-finish steel case, carrying handle folds back to tilt instrument when in use. — **Mercury Electronics** Corp., 77 Searing Ave., Mineola, N. Y.



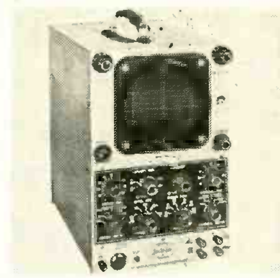
GRID-CIRCUIT TESTER, *GCT-9*, for all TV tube types. 6AF6 eye indicator. Checks grid emission, leakage, cathode continuity and interelement shorts. Metal case with exposed panel (GCT-9S) or portable carrying case (GCT-9W). 6½ x 6½ x 2½ inches.—**Seco Electronics, Inc.**, 5015 Penn Ave. S., Minneapolis, Minn.



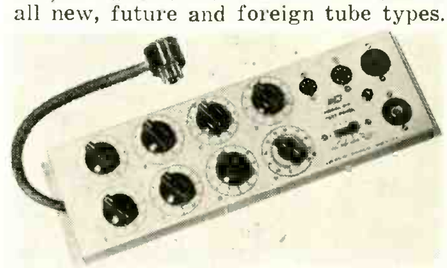
POCKET METER. Serves as ohmmeter, decibel meter, dc micro- or milliammeter, and dc and ac rms voltmeter. Also reads inductance, capacitance and relative signal output. Pair of test prods. 6 x 4 inches.—**Audiotex Mfg. Co., Div. of Textron Electronics, Inc.**, 400 S. Wyman St., Rockford, Ill.



LABORATORY SCOPE, *model 600*. Wide-band or high-sensitivity operation. Regulated power supply. Sweep-frequency pulse output on panel terminal. Wide-band vertical amplifier, flat within 1 db from less than 20 cycles to 4.9 mc. 2-range vertical sensitivity from 20 mv/inch. Uniform horizontal amplifier response within 2 db from less than 20 cycles to 200 kc. Linear sawtooth sweep, 10 cycles to 100 kc. Input calibration voltage 10 volts peak to peak. Camera studs for mounting standard 5-inch scope camera. Accessory probes available. 15 x 9⅛ x 13 inches.—**Jackson Electrical Instrument Co.**, 124 McDonough St., Dayton, Ohio.



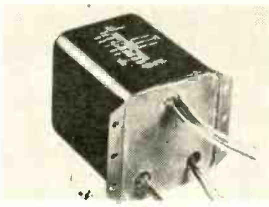
TEST PANEL, *models 610-500, 610-550, 610-650*. To add to manufacturer's 500, 550 and 650 tube testers for use on all new, future and foreign tube types. Completely wired.—**B&K Manufacturing Co.**, 1801 W. Belle Plaine, Chicago 13, Ill.



RESISTOR–CAPACITOR TESTER, *model 311*. Lab-type bridge circuit. 4 capacitance ranges from 10 μμf to 1,500 μf. 4 resistance ranges from 1 ohm to

150 megohms. Fully variable dc voltage up to 450. 1% precision resistors. 5% capacitors. 6E5 null indicator tube. Kit or assembled.—**National Radio Institute**, 3939 Wisconsin Ave., Washington 16, D. C. Request *Circular SD151*.

OUTPUT TRANSFORMERS, 65-watt high-fidelity, *BO-15* (shown). Use with 6550, EL34 or KT88's for 40- or 60-watt hi-fi amplifier with tertiary feedback construction. Total harmonic distortion less than ± 1 db 20 to 10,000

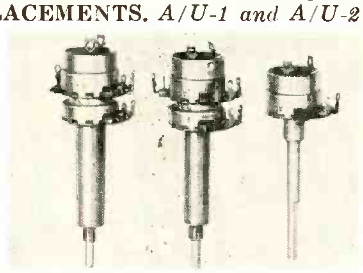


cycles; 1 db 20 to 20,000 cycles power response. Request *Bulletin CT-47*. *VO-110, VO-111* and *VO-112:* Isolation types with turns ratios of 16:1, 18:1 and 8:1. 18,000-, 20,000- and 7,000-ohm primary impedance. *OV-113:* autoformer type with turns ratio of 15:1 and 13,000-ohm primary impedance. Request *Bulletin 571*. — **Chicago Standard Transformer Corp.**, 3501 Addison, Chicago 18, Ill.

AXIAL LEAD RESISTORS. 3-, 5-, 7-, 10-, 15- and 20-watt. Resistance range from 0.24 to 6,200 ohms. Standard tolerances of ±5% and ±10%.

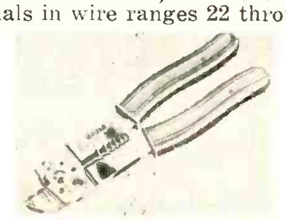
Fireproof. Heavy-duty precision crimp termination.—**International Resistance Co.**, 401 N. Broad St., Philadelphia 8, Pa.

AUTO-RADIO-CONTROL REPLACEMENTS. *A/U-1 and A/U-2* for



Automatic Universal radios used in 31 lines of foreign autos; *A/U-3* for 1957, 1958 and 1959 Fords.—**Centralab Div. of Globe-Union, Inc.**, 900 E. Keefe Ave., Milwaukee 1, Wis.

CRIMPING TOOL, *CT-3050*. Crimps terminals in wire ranges 22 through 10.



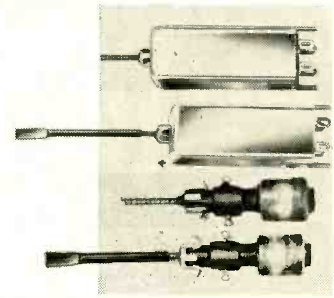
Cuts and strips wire. Shears bolts and screws.—**Waldom Electronics, Inc.**, 4625 W. 53rd St., Chicago 32, Ill.

ATR TUBE PROTECTOR. Use with

Please mention RADIO-ELECTRONICS when answering advertisements

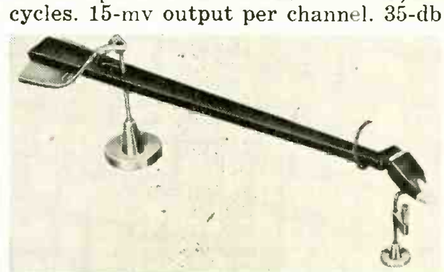
any equipment having 100 to 300-watt input. Golden - brown hammerloid - finished metal case.—**American Television & Radio Co.**, St. Paul 1, Minn.

REPAIR SHAFTS for repair without coil replacement. Coils with broken



studs on top in photo, repaired studs below. 6 sizes.—**Superex Electronics Corp.**, 4 Radford Pl., Yonkers, N. Y.

TONE ARM, *Unipoise model 198* with integrated Stereo Fluxvalve cartridge. Flat response within 2 db 20 to 15,000 cycles. 15-mv output per channel. 35-db



channel separation. 2 to 5 grams tracking force. Mounts on 15½ x 15½-inch motorboard. 6 oz.—**Pickering & Co., Inc.**, Sunnyside Blvd., Plainview, N. Y.

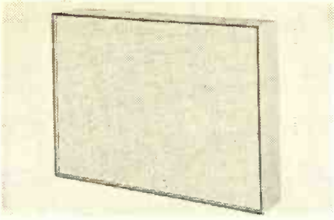
REVERBERATION COMPONENT, *Reverbatron*. Combination reverberation and echo unit. Compatible with basic

amplifiers. Electronics portion selects function and percentage intensity. Mechanical portion uses 2 delay lines of discrete pitch driven by 2 ferrite rotors controlled by electronic part.—**Sargent-Rayment Co.**, 4926 E. 12th St., Oakland 1, Calif.

PROJECTOR, cone type, *DC-5*. 5-inch-diameter cone speaker. Low-frequency response to 120 cycles. Bracket

swivels horizontally or vertically. Adapter strap for electrical fitting or direct wall or ceiling mounting. 7-inch bell diameter; 14-inch overall length.—**Atlas Sound Corp.**, 1449 39th St. Brooklyn 18, N. Y.

EXTENSION SPEAKER SYSTEM, wall mounting, *PT-2*. 3 inches deep. 6 x 9-inch inverted woofer, 3 x 5 inch tweeter, bass relief port. 8-watt power handling. 8-ohm impedance. Use as second speaker in monaural or stereo sys-



tem. Blonde or mahogany.—**Utah Radio & Electronic Corp.**, 1124 E. Franklin St., Huntington, Ind.

SPEAKER ENCLOSURE, *model 8*. Accommodates 12-inch speaker, adapter for 8-inch. Factory-installed acoustic damping material. Unfinished birch

veneer, full-face grille cloth, 5-inch flared legs. 18 x 29½ x 17 inches.—**Homewood Industries**, 26 Court St., Brooklyn 1, N. Y.

BOOKSHELF LOUDSPEAKER, *L-1*. Mounts vertically or horizontally. 50 to

14,000 cycles. Speaker impedance 4–8 ohms. Handles 16 watts. Unfinished walnut ready to oil. 15¼ x 9¼ x 8½ inches.—**Paco**, 70-31 84th St., Glendale 27, N. Y.

TURNTABLE AND ARM, *Troubadour*. 3-speed mono–stereo. Satin gold

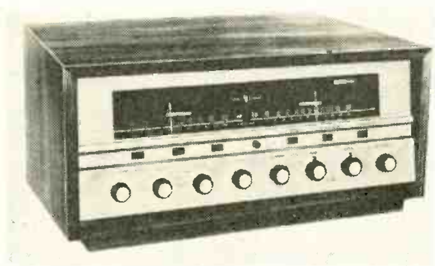
or chrome finish. Matching walnut base. —**Dyna-Empire, Inc.**, 1075 Stewart Ave., Garden City, N. Y.

TAPE TRANSPORT, *Collaro Studio*. 3-speed. 3-motor. 1⅞, 3¾ and 7½ ips. ¼-track stereo–monaural recording and

reproduction. Up to 7-inch reels.—**Rock-**

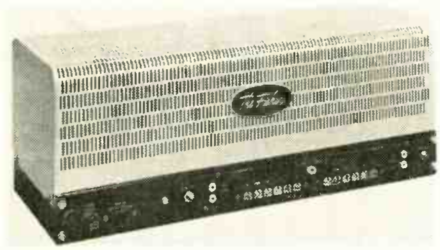
bar Corp., 650 Halstead Ave., Mamaroneck, N. Y.

STEREO AM-FM RECEIVER, *Festival II, model TA 260.* 18 to 40,000 cycles. 60-watt stereo amplifier (120-watt peaks). Separate AM and FM sections. Dual preamp. 2 magnetic inputs. Headphone receptacle. Third-channel amplifier output. Brushed gold and charcoal



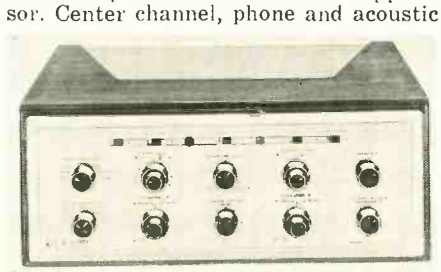
brown.—**Harman-Kardon, Inc.**, Ames Court, Plainview, N. Y.

STEREO AMPLIFIER, *SA-300-B.* 45 watts music power per channel. 35 watts per channel rms. Connections for 4-, 8- and 16-ohm speakers. Terminals for adding resistor to match speaker's recommended damping factor. Center channel



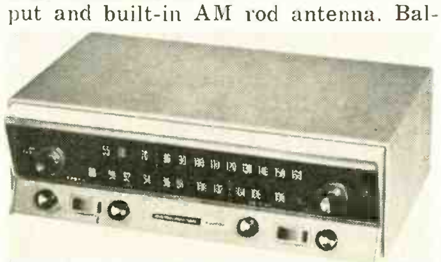
output jack for connection of third amplifier and speaker to unit. Two input jacks for each channel, with uniform frequency and controlled frequency response when using electrostatic speakers. Brushed-brass, slotted cage 16⅝ x 7¼ x 6⅛ inches. 32 lbs.—**Fisher Radio Corp.**, 21-21 44th Dr., Long Island City 1, N. Y.

STEREO AMPLIFIER *model 272.* 88 watts output. Binaural rumble suppressor. Center channel, phone and acoustic



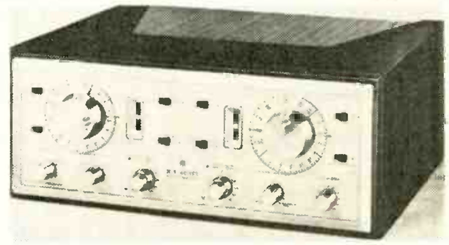
level controls. 14-lb output transformers with EL34 output tubes. 47 lbs total weight.—**H. H. Scott, Inc.**, Dept. P, 111 Powdermill Road, Maynard, Mass.

STEREO TUNER KIT, *AJ-30.* 3 printed-circuit boards. Wired, prealigned 3-tube tuned cascode FM tuning unit. Pre-aligned if transformers and coils. Balanced 300-ohm FM antenna input and built-in AM rod antenna. Bal-



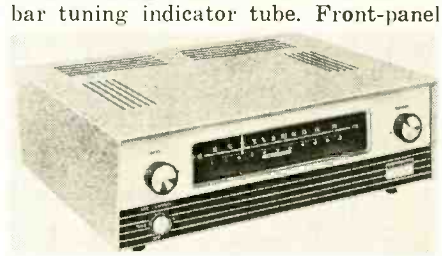
anced push-pull germanium diode detector. Delayed, amplified avc. Luggage-tan vinyl covering over all-steel cabinet with polished anodized aluminum trim.—**Heath Co.**, Benton Harbor, Mich.

STEREO TUNER/AMPLIFIER COMBINATION, *399.* 2 preamplifiers



and 2 20-watt power amplifiers, AM and FM tuners on one copper-bonded aluminum chassis.—**H. H. Scott, Inc.**, Dept. P, 111 Powdermill Rd., Maynard, Mass.

FM TUNER KIT, *KT-650.* Low-noise front end with triode mixer plus double-tuned dual limiters and wide-band Foster-Seeley discriminator. Sensitivity 2 μv for 30-db quieting. Plate-follower outputs for use up to 50 feet from amplifier. ±½-db from 15 to 35,000 cycles with standard 75-sec de-emphasis network. Variable afc control. Electronic bar tuning indicator tube. Front-panel

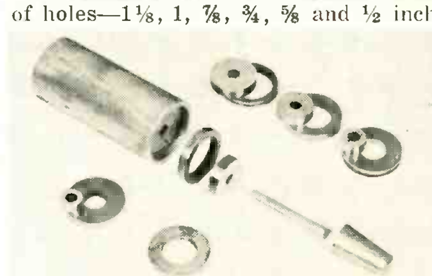


tuner level control. 14 x 5⅛ x 11 inches. —**Lafayette Radio**, 165-08 Liberty Ave., Jamaica 33, N. Y.

FM TUNER KIT, *Dynatuner.* Etched-circuit design. Sensitivity 4 μv. Broad-

band, bridge-balanced discriminator. Less than 0.25% IM distortion. Planetary drive system for tuning capacitor. —**Dynaco, Inc.**, 3912 Powelton Ave., Philadelphia 4, Pa.

CHASSIS PUNCH SET makes 6 sizes of holes—1⅛, 1, ⅞, ¾, ⅝ and ½ inch.



Drill ¼-inch pilot hole, insert pilot rod, assemble punch, hit it with hammer and get smooth hole that needs no filing.—**Punches**, Box 415, Toledo 1, Ohio. END

All specifications are from manufacturers' data.

the only one of its kind!

NOW . . . THE *First* ANALYZER DESIGNED EXCLUSIVELY FOR TESTING TRANSISTOR CIRCUIT CAPACITORS!

SPRAGUE MODEL TCA-1 TRANSFARAD*

THERE'S NOTHING LIKE IT ON THE MARKET ANYWHERE . . . AT ANY PRICE!

Here, for the first time, is a precision-made instrument which is specifically designed to *safely* test low-voltage aluminum and tantalum electrolytic capacitors, film and paper capacitors, and ceramic capacitors. *No laboratory or shop working with transistor circuit capacitors can afford to be without one!*

CAPACITANCE BRIDGE: $1\mu\mu f$ to 2,000 $\mu\mu f$ in five overlapping ranges, with laboratory accuracy.

INSULATION RESISTANCE: 50 megohms to 20,000 megohms. Only 25v d-c is applied, permitting measurements on low-voltage ceramic, paper, mica, and film capacitors. For ceramics rated below 25 volts, IR may be calculated from leakage current measurements at exact rated voltage.

POWER FACTOR: Measured by Wien Bridge from 0 to 50%.

LEAKAGE CURRENT: $0.6\mu a$ to $600\mu a$ in 7 ranges. Measured directly on meter at exact rated d-c voltage of capacitor. No guessing on eye-width or counting lamp blinks!

A-C BRIDGE VOLTAGE: Only 0.5v is applied to the bridge. The voltage across the capacitor is less than this applied voltage, the amplitude depending upon capacitance being measured. No danger of overheating and ruining even a 1-volt electrolytic or a 3-volt ceramic.

POLARIZING VOLTAGE: Continuously adjustable, 0 to 150v.

STABILITY: Dual regulation of the power supply assures short-time reliability, while specially processed etched circuits and complete encapsulation of the critical meter amplifier insure long-time stability.

MAGIC-EYE TUBE: Simplifies bridge balancing for capacitance and power factor measurements.

HIGH GAIN AMPLIFIER: Sensitivity control for magic-eye null detector permits accurate measurements of small capacitances.

CAPACITANCE DIAL: Latest design jet black dial with brilliant white calibrations for quick, accurate readings from any position.

BINDING POSTS: Shielded for protection against pick-up of strays, assuring greater accuracy during low-capacitance measurements. 5-way connection feature for use with all types of test leads.

SAFETY DEVICES: Automatic discharge of capacitor after testing. Three-wire line cord grounds instrument case.

OPERATING PROCEDURES: Easy-to-follow operating procedures clearly shown on pull-out slide at base of instrument. Always handy for ready reference.

MODERN CASE: Handsome grey Hammerloid finish on heavy-gage steel. Measures 8⅞" high, 14⅝" wide, 9½" deep. Weighs only 21 pounds.

See the remarkable new TCA-1 TRANSFARAD at your Sprague distributor or write for descriptive folder M-792a to Sprague Products Company, 81 Marshall Street, North Adams, Massachusetts.

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world's largest capacitor manufacturer

TECHNICIANS' NEWS

N. Y. PICTURE-TUBE LAW

A new state law that went into effect Oct. 1, 1960, makes the service technician responsible for picture tubes being correctly marked to show whether a tube is new, rebuilt or what. Sale of an unmarked or falsely marked tube and carton is a violation of the law.

The new law requires:

Only tubes using all new parts and new glass can be represented directly or indirectly as new.

The picture tube and its carton must be labeled to show the true quality or condition of the tube.

The marking on the tube may be removed only by the purchaser after the tube has been purchased.

TV technicians must furnish a written statement to the customer stating the true quality or condition of the tube furnished to the customer, even though the tube is marked as required by law.

ANTI-LICENSING SUIT

A group of 12 service dealers and four employees of service dealers have filed a suit against the new Kansas City, Mo., TV servicing licensing law. They claim that the new ordinance is unconstitutional.

Those who brought the suit to court say that law deprives service dealers of their liberty and property without due process of law and denies them equal protection of the law. They go on to point out that the ordinance does not require a license for persons who service other appliances and consumer products. The complaint also charges that the licensing board, which is made up with a majority of service dealers, has the power to prevent potential competitors from getting a license, thus keeping them from becoming competitors.

MEETING OF MINDS

Mauro E. Schifino, president of the National Distributors Association, and Frank J. Moch, executive director of the National Alliance of Television & Electronic Service Associations, met in Chicago for an informal discussion. They exchanged views on common problems and expect the exchange "to go a long way toward contributing to the welfare and achieving the mutual objectives of all segments of the industry."

Also at the meeting were Col. Gail S. Carter, executive vice president of NEDA; Lewis G. Groebe of Sherwood and Groebe as legal council, and S. I. Neiman of the Electronics Information Bureau as public relations consultant.

Schifino and Moch said, "We concluded that the most effective and direct method of arriving at a clear understanding of each other's problems was to hold this informal talk, following which we could make concrete suggestions to all interested sections of the industry which may enlarge the scope of such talks and formalize them into larger and more comprehensive meetings." They added that a plan for such meetings will be presented to the industry after each has had an opportunity to report to his respective organization.

TECHNICAL TRAINING SESSIONS

Again this year, Westinghouse is holding technical training sessions for television service technicians, on their 1961 line of TV receivers. Sessions will be conducted by distributor specialists trained by the Television–Radio div. service department.

These sessions are open to all service technicians, and they are advised to get in touch with their nearest Westinghouse distributor to get full information on meetings to be held in their area.

At the end of the session, each technician will be given a *Service Training Manual* and a *1961 Pocket Master*—a compact reference source that includes schematics and service data for TV, hi-fi and radio.

PROFITS IN INDUSTRIAL SERVICE

An important sidelight of the annual convention of the National Alliance of Television & Electronic Service Associations is the way in which industrial electronic service was pushed.

Robert B. Sampson of RCA's Tube Div. told TV service technicians to get out of their radio–TV straightjacket and make more money, implying that it is time that the TV technician branch out into the industrial field where there is distinct shortage of qualified men.

BOOST FOR LICENSING

Currently, the North Carolina Federation of Electronic Associations is licensing qualified members. To aid this program, the North Carolina Department of Instruction has agreed to help the federation. Classes will be conducted under the supervision of the local school system and will be open only to those who are employed as full-time service technicians. The classes are intended to give the service technician the opportunity to qualify himself for the federation license.

THOUGHTS FOR SET DISTRIBUTORS

Why not set up a "will call" department for those professional people who value their time and want to restore your brand of set for the owners as quickly as possible at the lowest cost? Why penalize them by wasting their time while your parts men handle the service and the public who don't know what they really want?

Why don't you realize you have far more to gain than lose by getting out of retail service? You have no legitimate excuse to be in that field, and you are, in many cases, in unfair competition with your dealers and the sincere professional service people.

Why not set up a sensible "warranty part" exchange setup, that does not eventually in most cases cost the purchaser of your brand far more than the value of the parts?

Why not give a special discount to those in the trade who order parts by proper part number to expedite handling?—(From *The Word* published for TESA—Chicago.)

WANT SERVICE LICENSE BILL

Harrisburg, Pa., was the scene of a meeting by the Federation of Radio-Television Service Associations, called to complete plans for promoting the electronics service license bill which comes before the 1961 Pennsylvania legislature.

All factions of the service industry were invited to attend and discuss the issues of captive and factory service, do-it-yourself tube testers, bait and unethical advertising, and wholesale–retail sales by parts distributors.

CORRESPONDENCE COURSE

Electronic technicians who are interested in getting an FCC communications license will be interested in a new home-study course being offered by Raytheon. It consists of 24 lessons intended to give the technician enough technical background to enable him to pass FCC examinations for communications licenses. After obtaining such a license, the technician can service Citizens and commercial radio transmitters.

Those applying for the course will be given a preliminary test to determine whether they have the background to enable them to complete the course.

IMPORTS CUTTING INCOME

Low cost of electronic imports has cut into the technician's income, according to David Krantz, active for many years in service associations. Mr. Krantz said, "the most damaging blow to the growth of independent service" has been the tremendous number of imported radios on the market and their prices. A major portion of a recent meeting of the Television Service Association of Delaware Valley was spent in trying to work out a solution.

Many technicians are complaining that customers are abandoning defective radios in service shops or letting them "rot" at home and replacing them with a newer model, since repairs based on American replacement parts and American wage scales would be impractical. The customer has been taught to look for price as the major selling point, not quality.

Mr. Krantz went on to say: "What we fear more than anything else, however, is that American manufacturers are going to have to produce more and more cheap radio and TV sets to compete effectively."

"If this condition arises, the entire independent service industry may become something of the past. We see thoughts in this direction in the way more and more manufacturers are sounding out independent shops to do factory work."

Mr. Krantz said that much of the imported equipment, including radios, television and tape recorders, is tinier than ours and requires more work, time and finer tools. "Coupled with the high cost of American labor, it becomes economically unsound for customers to have the sets repaired. It's cheaper to replace them."

AGAINST CAPTIVE SERVICE

Sell yourself and your service! Refuse to be new-set salesmen! Advise your customers to have their old sets repaired and not to purchase new ones! These are the recommendations the Television Service Association of Delaware Valley is making in its monthly publication, as a part of its fight against captive service.

The association goes on to point out that is only through the combined efforts of all independent service dealers that captive service can be stopped.

LICENSING FOR LOUISIANA

State Bill HB761 now enables all electronic technicians, including those in rural areas and towns under 20,000, to become eligible to operate under the Louisiana TV license law. Until now, only technicians in towns with a population of more than 20,000 were affected.

The bill was apparently supported by almost all groups. This is how it went in the State Legislature:

House committee—passed unanimously

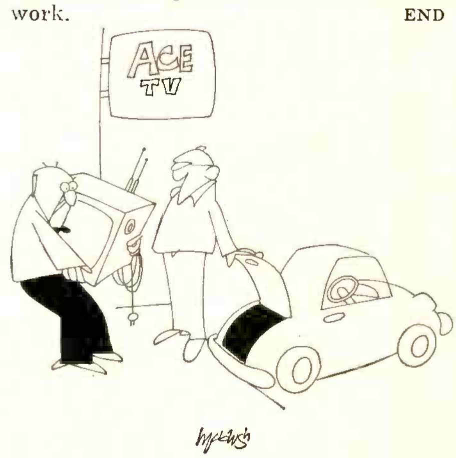
House floor vote—61 to 25

Senate committee—passed unanimously

Senate floor vote—35 to 1

SERVICE GROUP ISSUES LICENSES

To identify qualified service technicians and dealers, the Federation of Radio & Television Associations of Pennsylvania is issuing its own licenses to qualified shops and technicians. The licenses are framed certificates that bear the association's seal and are intended to identify to the public those technicians and shops that are both reputable and qualified to do TV service work. END



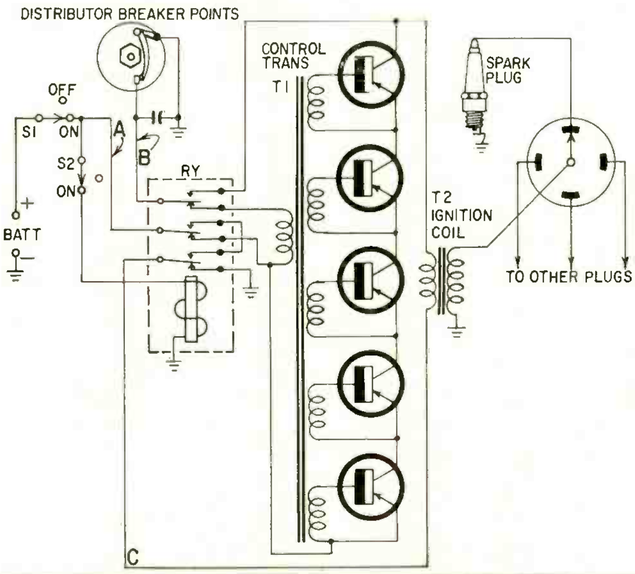
new PATENTS

TRANSISTORIZED IGNITION SYSTEM

Patent No. 2,941,119

Gerald M. Ford, Kokomo, Ind. (Assigned to General Motors Corp., Detroit)

This ignition system permits higher stepup of voltage and minimizes burning of spark-plug electrodes by breaking the current in a low-voltage circuit.



S1 is the battery switch. S2 is turned ON for transistorized ignition and OFF for conventional operation. With S2 on, relay RY is energized to attract (downward) its three-gang armature. Current flows through line A, primary of control transformer T1, line B, distributor and ground. The distributor cam makes and breaks the current to induce a high voltage in the secondary of T1. At some critical moment, this biases all transistors to conduction. When the voltage collapses, the transistors are blocked again.

During conduction, the current can be traced through line A, the transistors, primary of ignition transformer T2, line C and ground. A high voltage appears at the spark plug due to induction.

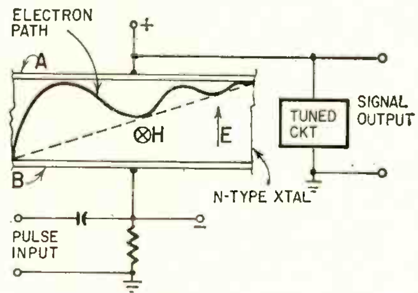
With S2 off, the system becomes a conventional one. RY releases its armature. The only current path is now through line A, line C, primary of T2, distributor and ground.

MICROWAVE OSCILLATOR

Patent No. 2,944,167

Herbert F. Matare, West End, N. J. (Assigned to Sylvania Electric Prod., Inc., Wilmington, Del.)

This oscillator performs at frequencies as high as 24,000 mc. It consists of an N-type crystal at a very low temperature. An electric field E—developed between plates A and B secured to the crystal—and magnetic field H are applied at right angles. See the diagram. E is upward, H is into plane of paper.



A pulse injects electrons into the semiconductor. These tend to move toward the positive E terminal, as well as to move in clockwise circles around H. A typical electron will miss the upper plate because of its curved path. E slows it down and finally reverses its direction. Again the electron accelerates and travels clockwise.

The electron gives up energy during acceleration, absorbs energy during deceleration. This energy is transferred to a resonant circuit or cavity tuned to the proper frequency. If a cavity is used, it must be insulated to avoid shorting E. Mica spacers may be used to separate the E terminals from the cavity walls.

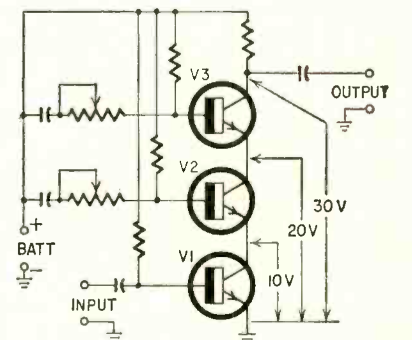
SERIES TRANSISTOR AMPLIFIER

Patent No. 2,943,267

Dominick Randise, Ozone Park, N. Y. (Assigned to Sperry Rand Corp., Great Neck, N. Y.

Transistors connected in series can handle output voltages too high for a single transistor. Thus, if each can carry 10 volts safely, then a series of three can handle a maximum of 30 volts.

V1 is shown as a common-emitter stage. The



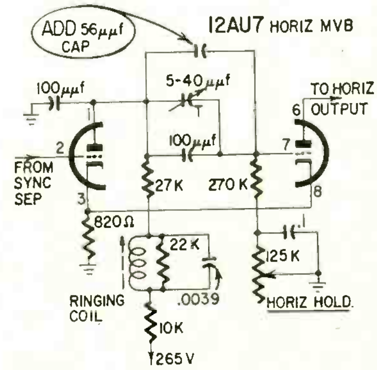
others are common-base. Load current flows through them all in series. Knowing the beta of a transistor and its collector flow, its base current and dropping resistor may be calculated.

The input signal should be sufficient to drive V1 to maximum output, in this case 10 volts. V2 should have a gain such that 10 volts between emitter and ground produces 20 volts between collector and ground. A base R-C network controls the gain of this stage. V3 also has a gain-controlling network. END

Technotes

WESTINGHOUSE MODEL H736T17

The complaint was poor horizontal stability varying with the different channels.



We tried adjusting the trimmer capacitor in the multivibrator. Sync improved as it was tightened but we were not able to get enough capacitance variation. So we changed the total capacitance by shunting the trimmer with a 56-μμf ceramic disc capacitor. Then we readjusted the trimmer for best sync on all stations.—*Jack Roberts*

CAR RADIO TROUBLE

Recently I encountered a number of auto radios with power supply trouble only during humid weather. Inspec-

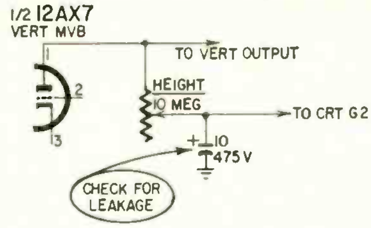
See Page 75

tion revealed arcing at the base of the vibrator socket, caused by accumulations of dirt and grime. To correct the difficulty and prevent callbacks, I cleaned the bottom of the vibrator socket and sprayed on a coat of anti-corona dope. —*John A. Comstock*

ZENITH MODEL 2229

Trouble: Unstable sync, waveforms near normal.

Check the boost-voltage filter capacitor (10-μf 475-volt



unit off the arm of the height control). May be leaky, feeding pulse into sync circuit, cancelling sync at vertical oscillator.—*William Porter*

SAVE YOKE COILS

Sometimes the inside of a yoke or even a focus coil sticks to the neck of the picture tube. This would never happen, if a coating of light grease were applied to the inside of the coils. The grease forms a film between the coil and the neck of the picture tube and keeps it from sticking.—*A. von Zook*

RCA T100

Complaint: Buzz in sound when picture control is set for best picture. When agc control is set for no buzz, sound is too weak.

Cure: Adjust agc for normal picture or turn it all the way up. Then adjust the bottom slug in the sound discriminator transformer for minimum or no buzz. Agc control can then be operated at any setting without buzz in sound. Align entire sound section for maximum output.—*Harry C. Keller*

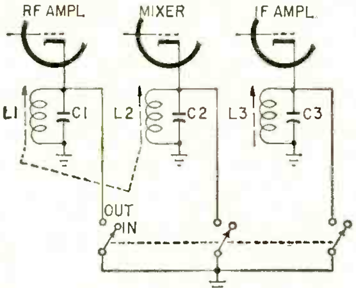
END

See Page 76

NOTEWORTHY CIRCUITS

NOVEL BCI TRAP

I live about a half block from KFSG, operating on 1150 kc. BCI is so severe that I can't use my radio. A few days ago, I salvaged a two-section permeability tuner from a discarded trf set and connected the coils as interference traps in the cathode returns of the rf amplifier and mixer of an old Hoffman receiver (see diagram). When the tuner's circuits, L1–C1 and L2–C2, were adjusted to 1150 kc, I received several



stations without interference. I plan to connect a similar trap (L3–C3) in the if circuit and tune it to the interference if caused by stations on channels adjacent to the one being tuned in. This circuit will have to be retuned for each station received, so I'll probably try an old bfo transformer.—*Nate Silverman*

[If cathode bias is used on any of the stages being trapped, connect the trap (L1–C1, etc.) between the cathode and the bias network.—*Editor*]

RE: NIGHT SWITCH FOR HI-FI

The article "Night Switch for Hi-Fi" in the May, 1959, issue reminded me of a simple modification that I made in my phonograph which featured a SIESTA switch—the ac input to the amplifier was controlled by the automatic shutoff switch on the changer. I don't like this feature as originally installed because by the time that you can get a new stack of records on the changer, the amplifier's tubes are cold. When you start the changer, the arm drops on the record before the tubes have a chance to warm up and you are cheated out of the first few seconds of play.

The diagram (Fig. 1) shows the hookup. When the dpdt switch is in the SIESTA position, one side of the amplifier's power line is completed through the shutoff switch on the changer. After the last record, the switch opens and cuts off the changer and amplifier. The next day, just throw the switch to NORMAL to turn on the amplifier.

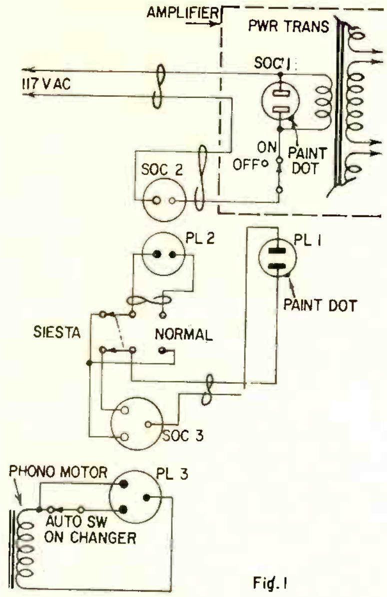


Fig. 1

SOC 1 is an ac receptacle mounted on the back skirt of the amplifier chassis. It and its mating plug PL 1 should be polarized types or must be polarized with dabs of paint. Connectors SOC 2 and PL 2 disconnect the amplifier from the switching circuit. Use a

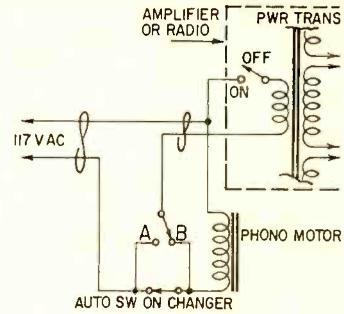


Fig.2

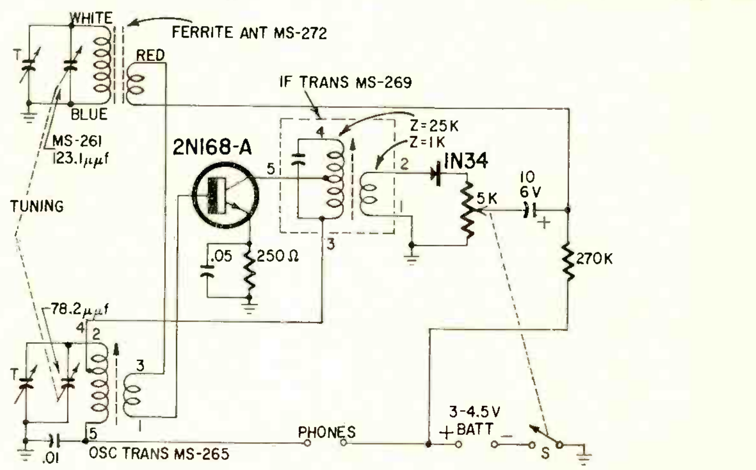
shorting plug in SOC 2 to restore the amplifier to normal use or when servicing. Connectors SOC 3 and PL 3 are for disconnecting the changer for servicing.—*C. L. Van Liew*

The Night Switch in the May issue is a good circuit but it may be difficult for a layman to wire without a technician's help. My circuit (Fig. 2) is simpler and does not require a relay or neon lamp. With the switch in position A, the changer's shutoff switch is bypassed and the amplifier or radio is turned on and off with its own switch. Position B shunts the radio or amplifier's ac input across the phono motor so it is switched off after the last record has played.—*M. H. Gurbaxani*

ONE-TRANSISTOR SUPERHETERODYNE

This circuit was put together just to see if it would work. Selectivity was good, but the set wasn't any better on sensitivity than a well designed one-

bringing this wire out and rewinding the secondary to make two separate windings. Of course, if you can get a ferrite-core antenna that already has



transistor circuit, but it was a superhet and as simple as one could be.

The ferrite-core loop antenna is modified by unwinding the secondary and breaking the connection where it joins the ground end of the primary,

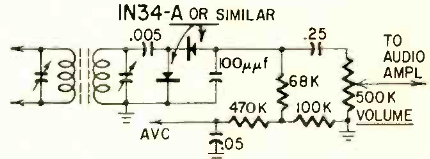
separate primary and secondary windings, you save yourself a job.

The set overloads on two locals, but a resistor from ground end of loop to the chassis, 10,000 to 40,000 ohms, may help.—*W. G. Eslick*

AM DETECTOR IMPROVEMENT

By changing the connection of the volume control in Leonard E. Geisler's article "Rejuvenation for the AM Detector" (October, 1959), the circuit can be improved. The way it is now arranged, the volume control is floating. If it is connected as shown here, it will act in a much more positive fashion.

Also note the changed capacitor and resistor values. They will help give improved avc action in small superheterodyne sets.

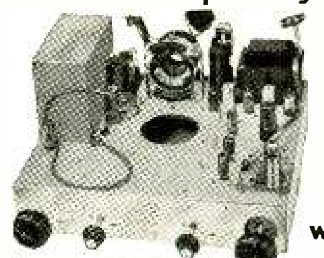


Using this detector, you can change the 12SQ7 to a 12SN7 and get an extra if or af stage. If you don't like the 12SN7, try a 12SC7 or a 12AX7.—*Leslie A. Moss*

END

DX-16 Super Deluxe TV KIT

70° or 90° — operating all 17", 21", 24" and 27" PICTURE TUBES



Dimensions 17½" W x 16" D
Shipping weight 40 lbs.

- ★ Produces a 16-Tube Chassis with 30-Tube performance.
- ★ Latest Intercarrier Circuitry and Multi-section Tubes.
- ★ Standard Neutrode Tuner for Selectivity & Fine Definition.
- ★ All Video and I.F. Coils factory pre-aligned and tuned.
- ★ Large 250ma Power Transformer for dependable service.
- ★ 12" Speaker or Twin-cone 6" x 9" Speaker.

Includes ***LIFE-SIZE*** step-by-step Building Instructions
Most Up-To-Date and Practical Course in Television

COMPLETE KIT with SET of WESTINGHOUSE TUBES $93.49

4—6CB6, 6U8, 6T8, 6C4, 12BH7, 6SN7, 6BQ6, 6W4, 6K6, 1X2B, 5U4. 6BN4, 6GC8, incl. in the Tuner (less CRT)

Also sold on **EASY-PAYMENT-PLAN** Buy LIFE-SIZE Instructions—$2.49—and buy Parts as you build.

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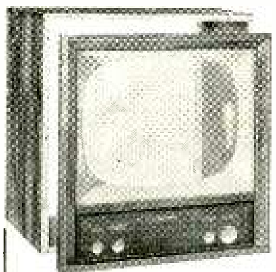

Comparable to the type that Top Mfrs. use on high priced TV sets.

CABINET KIT with 90% of the job done, includes—
FRONT SECTION in Solid Mahogany, Walnut or Blond Korina. **TOP, SIDES, BACK, MASK, SAFETY GLASS, ETC.**
And EASY-TO-FOLLOW ASSEMBLY INSTRUCTIONS

Front, Top and Sides supplied in a beautiful Piano Finish ● Knob panel undrilled ● For matching Mask specify type or number of CRT used. Same price—Mahogany, Walnut or Blond. (Shipping weight 36 lbs.)

21" CABINET KIT 26"H, 25"W, 22"D $26.97

23" TV Cabinet Kit . . $28.47   24" or 27" TV Cabinet Kit . . $38.47   24" or 27" Front Panel Assembly . . $24.97

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LATEST #630 CIRCUITRY   *WORLD'S MOST POWERFUL TV CHASSIS*
COMPLETE ready to play – Including Tubes, 12" Speaker, Knobs, Etc. (less CRT)
90° TV Chassis $175.85 ● 110° TV Chassis $182.60   Brochure on request

TUBULAR CONDENSERS—85°C TOP QUALITY—Equally as good for Radio or TV work

.0047-400v, .01-400v, .02-400v, .047-400v, .001-600v, .0047-600v, .01-600v, .02-600v, .03-600v 5¢ ea.
.1-400v, .25-400v, .47-400v, .047-600v, .1-600v, .25-600v, .001-1000v, .0047-1000v, .01-1000v, 8¢ ea.
.039-1000v, .047-1000v, .1-1000v, .007-1600v, .03-1600v, .05-1600v, .005-3000v, .001-6000v, 14¢ ea.

ELECTROLYTIC CONDENSERS—85°C 1-50v, 1-150v, 2-350v, 25-50v, 8-150v 19¢ ea.

20/20-150v, 50/30-150v, 40-150v, 10-450v, 20-450v, 30-450v, 40-450v, 60-450v, 80-450v......34¢ ea.

CARBON RESISTORS—Regular factory stock in Stackpole, Speer, etc.

½ WATT 10% 10, 39, 47, 100, 120, 150, 270, 330, 390, 470, 560, 680, 820, 1k, 1800Ω.... 2¢ ea.
½ WATT 10% 2700, 3300, 3900, 4700, 5600, 6800, 8200, 10k, 15k, 18k, 22k, 27k, 33kΩ.... 2¢ ea.
½ WATT 10% 39k, 47k, 50k, 56k, 68k, 82k, 100k, 120k, 150k, 180k, 220k, 270k, 330kΩ.... 2¢ ea.
½ WATT 10% 390k, 470k, 560k, 680k, 820k,Ω 1, 1.2, 1.5, 2.2, 6.8, 10, 15 MEGΩ...... 2¢ ea.
1 WATT 10% 3.3, 10, 39, 100, 120, 150, 330, 470, 560, 680, 820, 1k, 1800, 2700, 4700Ω.. 3¢ ea.
1 WATT 10% 6800, 10k, 15k, 18k, 22k, 27k, 33k, 39k, 47k, 68k, 82k, 100k, 150k, 470k, 680kΩ 3¢ ea.
2 WATT 10% 18, 22, 82, 100, 180, 2200, 3900, 4700, 6800, 8200, 18k, 22k, 100k, 470kΩ.... 4¢ ea.

WIREWOUND RESISTORS 5-5w, 16-10w, 20-10w, 47-5w, 100-5w, 140-5w, 220-5w. 9¢ ea.

280-10w, 390-5w, 470-5w, 500-10w, 680-10w, 820-5w, 1K-5w, 1K-10w, 1500-5w, 2K-10w.... 9¢ ea.
2500-5w, 3K-10w, 4700-5w, 5K-10w, 6K-10w, 7K-10w, 8200-5w, 10K-5w, 15K-5w, 22.5K-12w... 9¢ ea.

CERAMIC CONDENSERS 1, 2, 3, 5, 6, 10, 22, 25, 47, 50, 51, 56, 82, 100, 120, 150 mmf .. 3¢ ea.
CERAMIC CONDENSERS 220, 250, 270, 330, 470, 1k, 1200, 1500, 2k, 5k, 6800, 10k mmf . 3¢ ea.

MICA CONDENSERS 5, 25, 50, 60, 68, 75, 100, 120, 150, 220, 270, 330, 470, 510 mmf .. 3¢ ea.
MICA CONDENSERS 560, 680, 820, 1k, 1500, 2k, 2500, 3300, 4700, 6k, 6800, 8k, 10k mmf 3¢ ea.

- ☐ 1 – 5" PM SPEAKER alnico #5 magnet........$1
- ☐ 1 – 4" PM SPEAKER alnico #5 magnet........$1
- ☐ 1 – 3" PM SPEAKER alnico #5 magnet........$1
- ☐ 1 – 3½" TWEETER SPEAKER for HI-FI......$1
- ☐ 4 – AUDIO OUTPUT TRANS. 50L6 type......$1
- ☐ 3 – AUDIO OUTPUT TRANS. 6K6 or 6V6 type.$1
- ☐ 3 – I.F. COIL TRANSFORMERS 456 kc......$1
- ☐ 3 – I.F. COIL TRANSFORMERS 10.7 mc. FM .$1
- ☐ 3 – I.F. COIL TRANSFORMERS 262 kc (auto). .$1
- ☐ 40 – ASST. PRECISION RESISTORS best sizes ..$1
- ☐ 5 – SELENIUM RECTIFIERS 65ma list $1.50 ea. $1
- ☐ 4 – SELENIUM RECTIFIERS 75ma...........$1
- ☐ 3 – SELENIUM RECTIFIERS 150 ma.........$1
- ☐ 3 – SELENIUM RECTIFIERS 250ma..........$1
- ☐ 2 – SELENIUM RECTIFIERS 300ma..........$1
- ☐ 2 – SELENIUM RECTIFIERS 1—450ma 1—65 ma.$1
- ☐ 10 – TV CARTWHEEL CONDENSERS 10kv...$1
- ☐ 3 – TV CARTWHEEL CONDENSERS 20kv....$1
- ☐ 2 – TV CARTWHEEL CONDENSERS 30kv....$1
- ☐ 1 – TV RATIO DETECTOR COIL 4.5mc.....$1
- ☐ 1 – TV RATIO DETECTOR COIL 10.7mc.....$1
- ☐ 1 – TV SOUND I.F. COIL 4.5mc..........$1
- ☐ 3 – HV RECTIFIER SOCKETS 1B3 m'nted....$1
- ☐ 3 – HV RECTIFIER SOCKETS 1X2 m'nted....$1

10-TUBES #1U4..$1

- ☐ 2 – SILICON RECTIFIERS 500ma...........$1
- ☐ 1 – SILICON RECTIFIER 750ma............$1
- ☐ 1 – LB. SPOOL ROSIN CORE SOLDER......$1
- ☐ 4 – 50' SPOOLS HOOK-UP WIRE 4 colors....$1
- ☐ 10 – 6' ELECTRIC LINE CORDS with plugs...$1
- ☐ 5 – TV CHEATER CORDS with both plugs....$1
- ☐ 5 – TV CRT. SOCKETS with 18" leads.......$1
- ☐ 5 – HI-VOLT. ANODE LEADS with 18" leads..$1
- ☐ 50 – STRIPS ASST. SPAGHETTI best sizes ..$1
- ☐ 100 – ASST. RUBBER GROMMETS best sizes $1
- ☐ 100' – TWIN LEAD-IN WIRE 300Ω heavy duty $1
- ☐ 50' – FLAT 4-CONDUCT. WIRE many purposes $1
- ☐ 25' – INSULATED SHIELDED WIRE........$1
- ☐ 32' – TEST PROD WIRE deluxe (red or black)..$1
- ☐ 1 – $7 INDOOR TV ANTENNA hi-gain 3 section $1
- ☐ 20 – ASST. TV KNOBS, ESCUTCHEONS, Etc.$1
- ☐ 1 – RCA 70° FLYBACK TRANS. #75240....$1
- ☐ 1 – TV VERT. OUTPUT TRANS. 10 to 1 ratio..$1
- ☐ 15 – ASST. TV COILS sync. peaking, width, etc. $1
- ☐ 15 – ASST. STANDARD TUNER VHF STRIPS.$1
- ☐ 6 – ASST. STANDARD TUNER UHF STRIPS..$1

"ONE DOLLAR" Buys

As much as $15 worth — Everything Brand New and sold to you with a money back guarantee.

DEDUCT 10% ON ANY ORDER OF $10 OR OVER

(ON DOLLAR BUYS)

Plus a FREE SURPRISE PACKAGE

- ☐ 100 – ASST. ½ WATT RESISTORS some 5% .$1
- ☐ 70 – ASSORTED 1 WATT RESISTORS $1
- ☐ 35 – ASSORTED 2 WATT RESISTORS $1
- ☐ 50 – ASST. TUBULAR CONDENSERS $1
- ☐ 50 – ASSORTED FUSES popular sizes.........$1
- ☐ 75 – 220K ½ WATT RESISTORS 10%......$1
- ☐ 75 – 470KΩ ½ WATT RESISTORS 10% $1
- ☐ 5 – DIODE CRYSTALS 2—IN21 2—IN22 1—IN64 $1
- ☐ 3 – DIODE CRYSTALS 1—IN60 1—IN64 1—IN69.$1
- ☐ 4 – DIODE CRYSTALS IN34A...............$1
- ☐ 100 – ASST. CERAMIC CONDENSERS......$1
- ☐ 10 – ASST. WIREW'ND RES. 5, 10, 20 watt ..$1
- ☐ 100 – MICA CONDENSERS 10000mmf-500v ..$1
- ☐ 10 – HV TUBULAR CONDENSERS .005-6000v .$1
- ☐ 35 – ASST. DISC CERAMICS best numbers....$1
- ☐ 50 – ASST. MICA CONDENSERS some in 5% .$1
- ☐ 6 – ASST. SLIDE SWITCHES spst, dpdt, etc....$1
- ☐ 4 – BAKELITE KNIFE SWITCHES dpdt $1
- ☐ 3 – ASST. TOGGLE SWITCHES spst, dpdt, etc.$1
- ☐ 15 – ASST. ROTARY SWITCHES $15 worth...$1
- ☐ 100' – FINEST NYLON DIAL CORD best size ..$1
- ☐ 200 – SELF TAPPING SCREWS #8 x ½".....$1
- ☐ 35 – ASST. RADIO KNOBS screw and push-on ..$1
- ☐ 100 – ASSORTED KNOB SET-SCREWS $1
- ☐ 25 – ASSORTED CLOCK RADIO KNOBS $1
- ☐ 600 – ASST. H'DWARE screws, nuts, rivets, etc.$1
- ☐ 35 – ASST. SOCKETS octal, noval and miniature .$1
- ☐ 25 – ASST. PRINTED CIRCUIT SOCKETS ...$1
- ☐ 10 – ASST. VOLUME CONTROLS less switch...$1
- ☐ 5 – ASST. VOLUME CONTROLS with switch...$1
- ☐ 20 – ASST. PILOT LIGHTS popular types......$1
- ☐ 10 – PILOT LIGHT SKTS. bayonet type, wired..$1
- ☐ 50 – ASST. TERMINAL STRIPS 1, 2, 3, 4 lug .$1
- ☐ 10 – ASST. RADIO ELECTRO. CONDENSERS.$1
- ☐ 5 – ASST. TV ELECTROLYTIC CONDENSERS.$1
- ☐ 25 – ASST. MICA TRIMMER CONDENSERS..$1
- ☐ 15 – TUBULAR CONDENSERS .47-400v $1
- ☐ 15 – TUBULAR CONDENSERS .25-600v.......$1
- ☐ 6 – TV ION TRAPS standard for all CRT's.....$1
- ☐ 15 – TUBULAR CONDENSERS .047-600v.....$1
- ☐ 2 – ELECTROLYTIC COND. 40/40-450v........$1
- ☐ 3 – ELECTROLYTIC COND. 50/30-150v........$1
- ☐ 25 – ASST. PEAKING COILS popular types ...$1
- ☐ 1 – ELECTRIC PHONO MOTOR 78rpm 110v. .$1
- ☐ 10 – WIREWOUND RESISTORS 20 ohm—4W ...$1
- ☐ 300 – ASST. ½W RESISTORS short leads.....$1
- ☐ 4 – TV CENTERING RINGS $1
- ☐ 35 – DISC. CERAMIC CONDENSERS 5000mmf. $1
- ☐ 25 – ASST. RADIO DIAL POINTERS $1
- ☐ 8 – ASST. LUCITE CASES handy for parts.....$1
- ☐ 100 – MICA CONDENSERS 820 mmf-500v.....$1
- ☐ 3 – ASST. SIZES RADIO CHASSIS PANS...$1
- ☐ 3 – VARIABLE CONDENSERS super 420/162mfd. $1
- ☐ 4 – OVAL LOOP ANTENNAS ass't hi-gain types $1
- ☐ 3 – LOOPSTICK ANT. new ferrite adjustable...$1
- ☐ 3 – ½ MEG VOLUME CONTROLS with switch. $1
- ☐ 5 – 50K VOLUME CONTROLS less switch.....$1
- ☐ 5 – ASST. 4 WATT WIREWOUND CONTROLS $1
- ☐ 5 – ½ MEG VOLUME CONTROLS less switch .$1
- ☐ 5 – 1 or 2 MEG VOLUME CONTROLS 1/switch .$1
- ☐ 100 – VOLUME CONTROL HEX NUTS $1
- ☐ 10 – SURE GRIP ALLIGATOR CLIPS $1
- ☐ 1 – GOLD GRILLE CLOTH 14"x14" or 12"x18". $1
- ☐ 5 – SETS SPEAKER PLUGS wired $1
- ☐ 10 – SETS PHONO PLUGS and PIN JACKS..$1
- ☐ 2 – $2.50 SAPPHIRE NEEDLES 4000 playings $1
- ☐ 35 – MICA COND. 20–50 mmf & 15–68 mmf $1
- ☐ 35 – MICA COND. 20–100 mmf & 15–270 mmf.....$1
- ☐ 35 – MICA COND. 20–470 mmf & 15–680 mmf.....$1
- ☐ 35 – MICA COND. 20–820 mmf & 15–1000 mmf $1
- ☐ 35 – MICA COND. 20–2200 mmf & 15–2400 mmf....$1
- ☐ 35 – MICA COND. 20–6800 mmf & 15–10000 mmf ...$1
- ☐ 35 – CERAMIC COND. 20–5 mmf & 15–10 mmf...$1
- ☐ 35 – CERAMIC COND. 20–25 mmf & 15–47 mmf...$1
- ☐ 35 – CERAMIC COND. 20–56 mmf & 15–82 mmf...$1
- ☐ 35 – CERAMIC COND. 20–100 mmf & 15–150 mmf .$1
- ☐ 35 – CERAMIC COND. 20–270 mmf & 15–470 mmf .$1
- ☐ 35 – CERAMIC COND. 20–1000 mmf & 15–1500 mmf $1
- ☐ 35 – CERAMIC COND. 20–200 mmf & 15–5000 mmf $1
- ☐ 4 – KENRAD TUBES #6SH7 ....$1
- ☐ 2 – TOP NAME #6SQ7 TUBES...............$1
- ☐ 2 – TOP BRAND TUBES #35W4.............$1

TOP NAME TUBES OZ4, 1B3, 1X2B, 5U4, 6AC7, 6AX4, 6CB6, 6J6, 6K6, 6U8, 6V6, 6SN7, 6X8, 12AU7, 12AX7, 50L6 ....Each $1

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- ☐ 3 – TV ALIGNMENT TOOLS assortment #2...$1
- ☐ 3 – TV ALIGNMENT TOOLS assortment #3...$1
- ☐ 3 – TV ALIGNMENT TOOLS assortment #4...$1
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EACH ALIGNMENT TOOL is different and valued at over $1

HANDY WAY TO ORDER—Simply tear out advertisement and pencil mark items wanted (X in square is sufficient); enclose with money order or check. You will receive a new copy of this ad for re-orders.

ON SMALL ORDERS—Include stamps for postage, excess will be refunded. Larger orders shipped express collect.

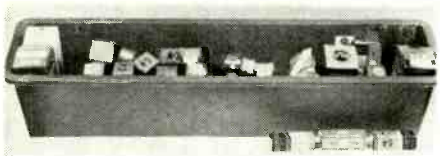
BROOKS RADIO & TV CORP., 84 Vesey St., Dept. A, New York 7, N.Y.

TELEPHONE COrtland 7-2359

TRY THIS ONE

TUBE CARRIER

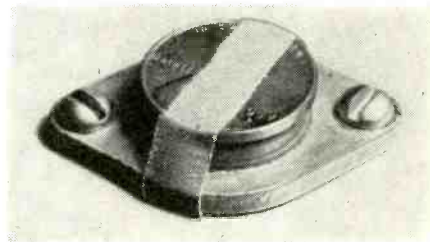
Plastic flower boxes are available in various sizes, and may be used as lightweight durable carriers for shop equipment. Tubes which are kept on hand



for use as trial tests may be handily stored and transported to and from the test bench in such a box. The box in the photo is about 28½ inches long and 6½ inches wide at the top and about 6 inches deep.—*H. Leeper*

EXTRA HEAT SINK FOR POWER TRANSISTORS

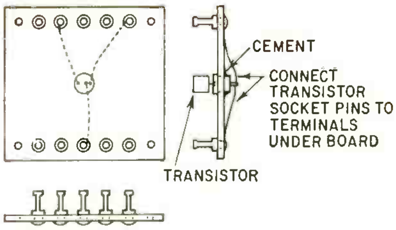
The popular types of power transistors have metal cases and are intended



to be bolted to a metal chassis or other sheet of metal, which acts as a heat sink to absorb some of the transistor heat. However, there is no provision for drawing off heat from the top of the transistor. I figured it would be a good idea to tape a copper coin or iron washer to the top of the transistor as a secondary heat sink. Thus the transistor is provided with heat sinks on the top and bottom at the same time to insure cooler operation. — *Art Trauffer*

TRANSISTOR SOCKET MOUNT

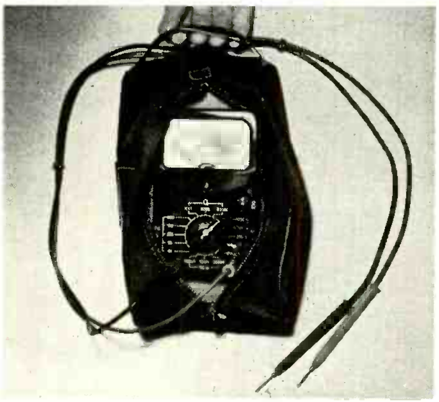
A mount for transistor sockets will simplify many experimental transistor circuit layouts. Such a unit can be made from a CTC or similar terminal board. Drill a hole in the center of the board. Put the socket in the hole and cement



it in place. Then connect the socket pins to the board terminals. The extra board terminals make convenient tie points for associated components.—*Sherwood M. Kidder*

VOM IN A SHAVING BAG

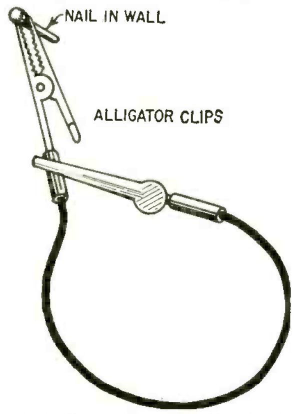
Whenever a service technician is called to repair a set in the customer's home, his reputation is hanging in the balance. The appearance of his test equipment can leave either a good or bad impression on the customer, depending on shape it's in. Obviously a



vtvm or vom with a cracked meter face or a badly scratched case isn't going to leave as good an impression as one having a new appearance. To keep your vom or vtvm looking new, store it in a travel type shaving bag. You'll find there's generally plenty of space in the bag for test leads and that you don't actually have to remove the meter from the bag to use it. The convenient handle makes it easy to carry too.—*Charles A. Cunningham*

KEEP JUMPERS UNTANGLED

Almost every service technician uses jumpers, and they are usually all tangled up when not in use. An easy way to keep this from happening is to



hook one clip on the other before hanging up the jumper. Now any number of jumpers can be hung on the same nail with little chance of entanglement.—*Joseph Amorose*

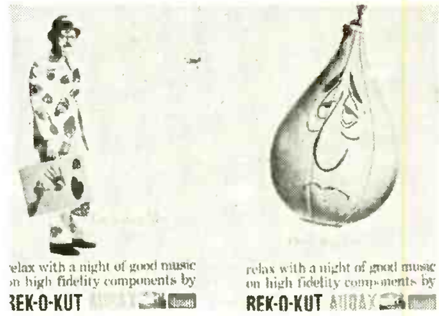
END

BUSINESS and PEOPLE

Electronic Instrument Co., Long Island City, N. Y., outlined plans for a stepped-up winter advertising and public relations campaign for its Eico hi-fi kits and equipment at a sales representative meeting at its plant. Eico

president, Harry R. Ashley (right); executive vice president, Phil Portnoy (standing left), are shown explaining the new panel designed for Eico stereo tuners and amplifiers to the company's sales representatives.

Rek-O-Kut Co., Corona, N. Y., and its subsidiary, Audax Div., are using a series of off-beat posters displayed on



Long Island RR stations to promote sales of its hi-fi components. The campaign ties in with local dealers by imprinting their names in local trading areas.

Pyramid Electric Co., Darlington, S. C., designed a new Whirl-O-Mat capacitor dispenser for its parts distributors. The company is also packaging its mylar-paper Gold-Dip capacitors in a plastic jewel box which may be reused for small parts storage.

Jensen Industries, Forest Park, Ill., is in full swing on a Give a Diamond for Christmas promotion featuring its

diamond needle in a gift package in an effort to stimulate Christmas sales.

Sencore, Addison, Ill., is continuing its series of coast-to-coast service technicians' clinics. Ed Flaxman, Sencore vice president—(fourth from left, front

row), and representative Mark Markman (seventh from left), are shown leading the discussion at Mobile TV Service Lab, Compton, Calif.

Fidelitone, Inc., Chicago, Ill., has launched a nation-wide advertising

campaign on its Pyramid diamond needles in trade and consumer magazines.

R. F. Meinicke was appointed vice president–sales of Amphenol Distributor Div., Amphenol-Borg Electronics Corp., Broadview, Ill. He joined the company in 1949 and was sales manager of the division immediately prior to his promotion.

Robert G. Lynch is now equipment sales manager for Sylvania Electronic Tubes Div., New York, N. Y. He was manager of industrial equipment sales.

Lloyd R. Day was promoted to the newly created position of manager of new business development, RCA Electron Tube Div., Harrison, N. J. He was planning manager.

David Hughes, former director of marketing of Hickok Electrical Instrument Co., Cleveland, was named vice president and general manager of the Meter and Controls Div. which will have the responsibility for the development and sales of meters and controls to the original equipment market. **Frank H. Sawonik,** former vice president, government sales, is now vice president and sales manager of the Industrial Instrument and Government Div. Both divisions were newly set up by the company. **P. H. Neville,** president of Leece-Neville Co., was appointed a director of Hickok.

Jacob H. Ruiter, Jr., joined the Weston Instruments Div. of Daystrom, Inc., Murray Hill, N. J., as manager of sales promotion. He comes from Allen B. DuMont Laboratories where he had been technical advertising manager and public relations manager.

L. H. Niemann was promoted to director of government relations for CBS Electronics with headquarters in Washington, D. C. He was previously semiconductor sales manager.

Joseph W. Yuhas is now manager of the Distributor Div. of Pyramid Electric Co., Darlington, S. C. He joined the company in February of this year from Astron Corp.

Harry P. Hancock, Jr., (left) was promoted to industrial relations manager of the Raytheon receiving tube plant in Quincy, Mass. Prior to the

promotion, he served as wage and salary administrator for the Industrial Components Div. **Arthur W. Randall** joined Raytheon as Chicago district manager for the Distributor Products Div. He came to Raytheon from General Electric where he was a district representative for housewares and radio receivers.

Julian King Sprague, president and director of Sprague Electric Co. and a director of Sprague Products Co., died of a heart attack at his ranch in Presidio, Tex., at the age of 57. END

new 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. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

ELECTRONICS CATALOG *No. 71, for* industry, defense and broadcast. Mail order and direct sales. 448 illustrated pages.—**Newark Electronics Corp.**, 223 W. Madison St., Chicago 6, Ill.

ACOUSTICAL CABINETRY *Bulletin R-16* describes and illustrates equipment, speaker and record cabinets in console and chairside types for separate or combined use in high-fidelity stereo and mono music systems.—**Rockford Special Furniture Co.**, 1803 W. Belle Plaine, Chicago 13, Ill.

PLANNING A STEREO HI-FI SYSTEM is studied in *Tech-Specs*. With an eye on the audiophile's space problems, the pocket-size booklet coordinates hi-fi components to the enclosure or cabinet and facilitates balanced selection with a special planning chart and complete technical specifications of manufacturer's cartridges.—**Dept. PR6, Pickering and Co., Inc.**, Sunnyside Blvd., Plainview, N. Y.

AUDIO TAPE RECORDER DIRECTORY *60-61* supplies such quick facts as model, price, frequency response and other technical data for magnetic tape recorders, audio accessories, tape and related items, manufacturers and their complete addresses. 27 pages profusely illustrated in black-and-white and color. —**Audio Devices, Inc.**, 444 Madison Ave., New York 22, N. Y. 10¢ mailing charge.

YOKE AND FLYBACK BULLETIN, *No. YFX*, available to service technicians for simplification of replacement problems. Index cross-references manufacturer's equivalents for other brands of replacement yokes and flyback transformers. — **Chicago Standard Transformer Corp.**, 3501 W. Addison St., Chicago 18, Ill.

SEMICONDUCTOR PRODUCTS BROCHURE charts germanium power, audio, switching, silicon and germanium mesa transistors, silicon rectifiers and Zener diodes, and key specifications such as breakdown voltage, current capacity, operating temperatures and power dissipation of manufacturer's industrial and military semiconductor line.—Technical Information Center, Motorola Semiconductor Products, Inc., 5005 E. McDowell Rd., Phoenix, Ariz.

SILICON RECTIFIER SHORT FORM CATALOG quotes from technical bulletins for various models of silicon rectifiers. Diagrams, charts and graphs give absolute maximum ratings (60 cycles) and operating characteristics. Interesting USA map on back of book highlights area sales reps. — **Standard Rectifier Corp.**, 620 E. Dyer Rd., Santa Ana, Calif.

STEREO monthly report in manufacturer's *Newsletter* describes new products, projects under development and available literature on the subjects. —**Harman-Kardon, Inc.**, Plainview, N.Y.

STEREO "BALANCE KIT," *Do It Yourself*, demonstrates scientific principle of balance in all planes. Center of mass of piece of cardboard can be located for balance identical to that of a transcription arm and its pivot at center of its mass. — **Audio Empire**, 1075 Stewart Ave., Garden City, N. Y.

WIRES AND CABLES in a variety of of types, including transmission and open line wire, rotor, coaxial and intercommunication cables, plastic molded products, accessories and tools are graphically illustrated in *Catalog b-22*. —**Saxton Products, Inc.**, 4320 Park Ave., Bronx 57, N. Y.

SOUND SYSTEMS FOR SCHOOLS itemizes and illustrates communication facilities available as production items or for integration into custom adapted program.—**DuKane Corp.**, St. Charles, Ill.

POWER SUPPLIES for utility, industrial, military and electronics applications are explained in *Bulletin GED-4184*. Discusses new line of 30 standard units with 25% fewer components and with protective circuit. Photos and charts outline specifications. — **General Electric Co.**, Schenectady 5, N. Y.

CONTROL COMPONENTS GUIDE includes military telemetering pressure and displacement position transducers, high accuracy and voltage pressure transmitters among manufacturer's products. Complete specifications and illustrations.—**International Resistance Co.**, 401 N. Broad St., Philadelphia 8, Pa.

1960 SHORT FORM CATALOG contains representative items from manufacturer's line of oscilloscopes, oscillators, generators, voltmeters, milliameters, electronic counters, measuring and monitoring equipment and wideband amplifiers. Also lists sales reps and instrument repair stations for North America and overseas on back page.—**Hewlett-Packard Co.**, 1501 Page Mill Rd., Palo Alto, Calif.

RELAYS, sensitive, power, antenna, micro-miniature, hermetically sealed, telephone and multi-pole sensitive types, and their complete electrical operating characteristics, diagrams and prices, in *Catalog No. 60-8*.—**Kurman Electric Co.**, 191 Newel St., Brooklyn 22, N. Y.

CIRCUIT BREAKER CATALOG gives

brief description, technical data and additional design requirement information on manufacturer's products in addition to ample photos and schematics. —Wood Electric Co., Inc., 244 Broad St., Lynn, Mass.

1961 CATALOG presents latest miniature-transformer information, diagrams and detailed specifications. Includes also special transformers manufactured per customer needs; electronic, electrical, aircraft and missile application transformers meeting MIL-T-27A and other military requirements. —Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N. Y. END

50 Years Ago

In Gernsback Publications

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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 larger libraries still have copies of Modern Electrics on file for interested readers.

In December, 1910, *Modern Electrics*

Wireless On Airships, by A. C. Marlowe.
A Selenium Alarm.
A Universal Wireless Testing Set, by William Dubilier.
How to Find the Required Capacity of Transmitting Condensers, by I. H. Glickman.
Rotary Spark Gap.
Construction of a Sensitive Wireless Detector, by William H. Taber.
New Military Quenched Spark Set, by Oliver A. DeCelle.
How to Make An Oscillation Transformer, by Ralph Weddel.
Construction of a Rotary Spark Gap, by Hallam Anderson.
A Circular Potentiometer, by Fannon Beauchamp.
Unique Potentiometer, by R. E. Baker.
Wireless Institute, by A. C. Austin, Jr.

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, JULY 2, 1946 AND JUNE 11, 1960 (74 STAT. 208) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF RADIO-ELECTRONICS, published monthly at Mount Morris, Ill., for Oct. 1, 1960.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Hugo Gernsback, 154 W. 14 St., New York 11, N. Y.; Editor, Hugo Gernsback, 154 W. 14 St., New York 11, N. Y.; Managing Editor, Fred Shunaman, 154 W. 14 St., New York 11, N. Y.; Business manager (none).

2. The owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual member, must be given.) Gernsback Publications, Inc., 154 W. 14 St., New York 11, N. Y.; Hugo Gernsback, 154 W. 14 St., New York 11, N. Y.; M. Harvey Gernsback, 154 W. 14 St., New York 11, N. Y.

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5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required by the act of June 11, 1960 to be included in all statements regardless of frequency of issue.) 165,401.

H. Gernsback, Publisher

Sworn to and subscribed before me this 14th day of October, 1960.

[SEAL] Joane Dodge, Notary Public

(My commission expires March 30, 1962.)

new BOOKS

CLASS "D" CITIZENS BAND RADIO CALL BOOK, supplement to Vol. 2, No. 1, 1960. International Crystal Mfg. Co., Inc., 18 N. Lee, Oklahoma City, Okla. 9 x 11 in. 230 pp. $3.95.

The great increase in licensees in this band has made it necessary to publish this supplement. These new calls were issued between Jan. 1 and July 1. Actually 40,000 new calls are listed here, about twice the total issued before Jan. 1. All 24 districts are represented.

101 MORE WAYS TO USE YOUR SCOPE IN TV, by Robert G. Middleton. Howard W. Sams & Co. Inc., 1720 E. 38 St., Indianapolis 6, Ind. 5½ x 8½ in. 160 pp. $2.50.

This book discusses 101 ways to test equipment, rf and if amplifiers, video amplifiers, agc, sync separators and sweep circuits with a scope. For each test the equipment needed, connections required, test procedures and an analysis of the result of the test are given. In this way, the technician and experimenter can become more proficient in the use of his oscilloscope.—*LS*

MOTOROLA POWER TRANSISTOR HANDBOOK (1st edition). Motorola Semiconductor Products, 5005 E. McDowell, Phoenix, Ariz. 5½ x 8½ in. 205 pp. $2.

This manual features theory, design and application. Beginning with the basic principles and characteristics of semiconductors, it explains their ratings, thermal effects, breakdown and other parameters. Diagrams, nomograms, schematics and equations show how to design amplifiers, switches, ignition systems and other circuits for which power transistors are useful. Among special applications discussed are electronic filters, regulators, inverters and TV deflection. A handy reference for engineers and technicians.—*IQ*

ELECTRONICS FOR THE BEGINNER, by J. A. Stanley. Howard W. Sams & Co. Inc., 1720 E. 38 St., Indianapolis 6, Ind., 5½ x 8¾ in. 192 pp. $3.95.

This book plus a little assistance may start a 12-year-old on a career in electronics. Hand it to someone older, and you've given him a new hobby. For young or old, this little book is packed with information—starting with a brief introduction, a few hints on soldering and a number of interesting construction projects ranging from a 1-hour radio through home broadcasters and a stereo amplifier. All units are built with transistors and use low-voltage batteries, making them safe same even for the youngest youngster. —*LS*

INSTALLING HI-FI SYSTEMS, by Jeff Markell and Jay Stanton. Gernsback Library, Inc., 154 W. 14 St., New York 11, N.Y. 5½ x 8½ in. 224 pp. $3.20.

There are so many "angles" to hi-fi

that it does not seem possible to cover them all clearly in a single volume. Yet these two professionals have done just that. They discuss the planning and techniques of monaural and stereo components, systems, interconnections, acoustics, noise problems, etc. The esthetic viewpoint is well represented. The reader learns the elements of design, color, styling, size and shape. Photos and diagrams illustrate the text.

The book is written for the hi-fi fan as well as the professional installer. Cabinet construction, finish and repair are described. One chapter is devoted to legal considerations including the basic facts of business life, codes, liabilities, etc.

Before you undertake building into, drilling or wiring a wall, you should consult the final chapter. It discusses and illustrates the masonry construction, wood frames and steelwork that make up walls, windows and doors.

MASERS, by Gordon Troup. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 4 x 6½ in. 168 pp. $2.75.

The maser has but a few outstanding features compared with other types of amplifiers and oscillators. However, low noise and precision frequency make it unbeatable for applications such as long-range radar, radio astronomy, microwave spectroscopy and time measurement.

The author approaches his subject by way of quantum mechanics and thermodynamics. He discusses excitation methods and derives equations pertaining to gain, bandwidth and noise. He reviews experimental results obtained by scientists and indicates the work still to be done.—*IQ*

MAGNETIC AMPLIFIERS, by Paul Mali. John F. Rider Publisher, Inc., 116 W. 14th St., New York 11, N.Y. 5½ x 8½ in. 101 pp. $2.45.

This book discusses basic principles of magnetic circuits as well as magnetic amplifiers. Clearly written and containing many illustrations, it explains the various types of devices and shows how they are used to control, switch, compute and memorize. A good first book on the subject for technicians and students. END

"They all broke down at the same time"

The January issue of Radio-Electronics will be on sale Dec. 15. Order your copy from your dealer now.

1960 ANNUAL INDEX

Vol. XXXI, January-December, 1960 — RADIO-ELECTRONICS

KEY TO SYMBOLS AND ABBREVIATIONS

* Construction Articles

† Section of Full-length article

CI	Television Clinic
Corr	Correction
Corres	Correspondence
NB	News Briefs
NC	Noteworthy Circuits
Pat	New Patents
Tech	Technotes
TTO	Try This One
WN	What's New

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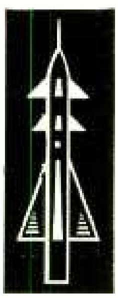

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(Continued on page 138)

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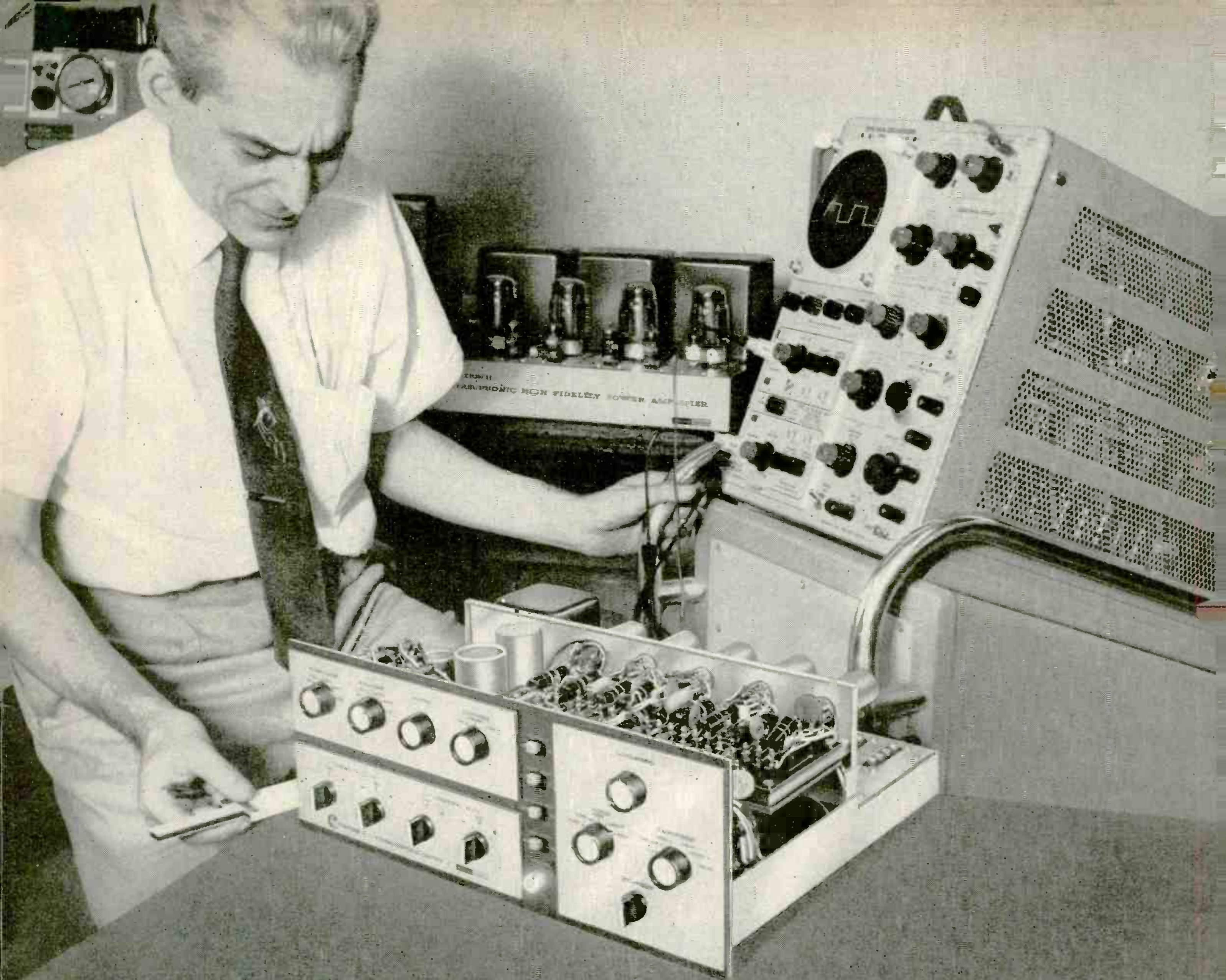
ADVERTISING INDEX

Radio-Electronics does not assume responsibility for any errors appearing in the index below.

SCHOOL DIRECTORY PAGE 133

[This ANNUAL INDEX is another service to readers. "One-side copy," it is planned to be cut out for convenience in use.
Key to symbols on page 130.]



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