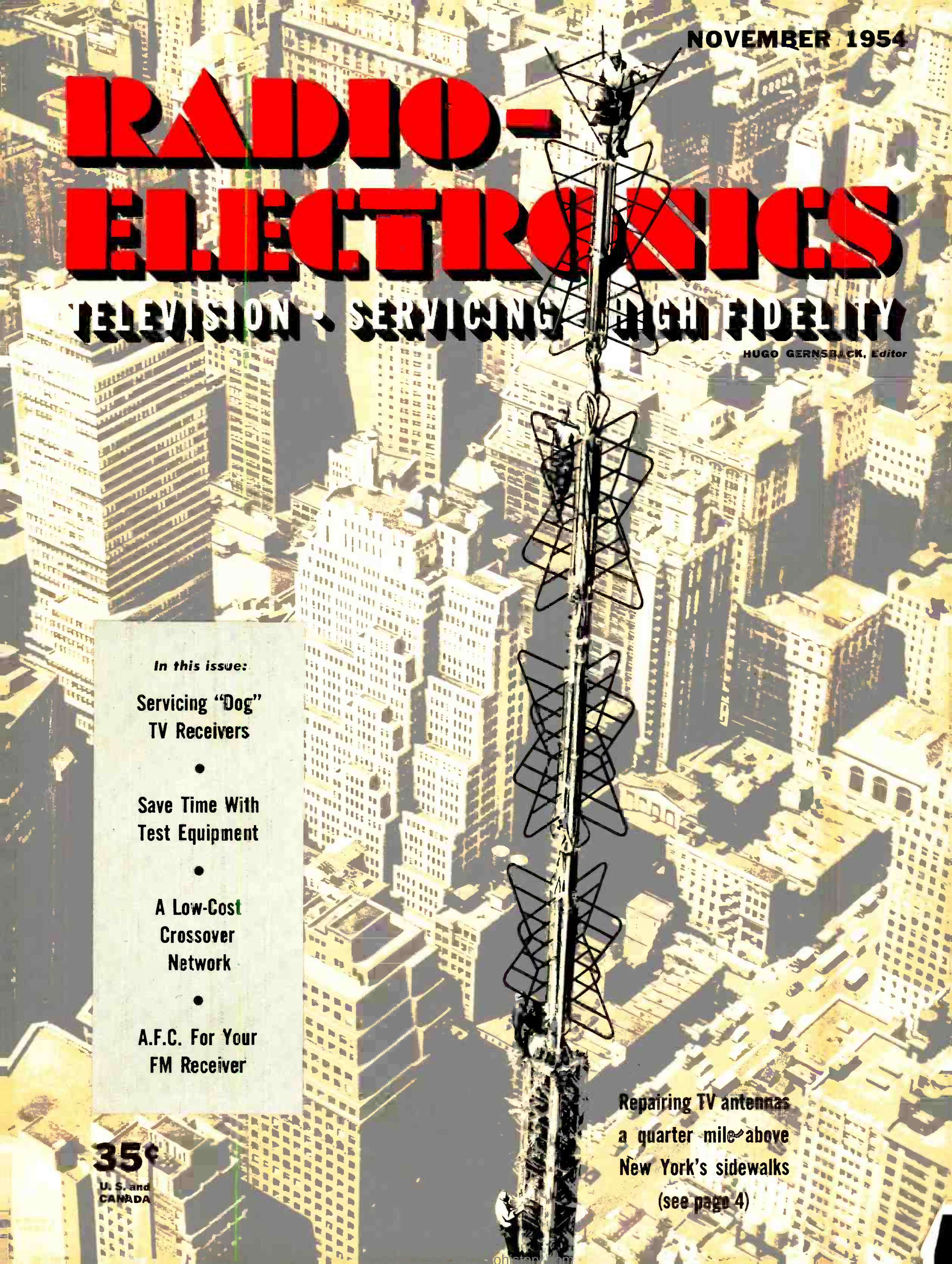
NOVEMBER 1954

RADIO-ELECTRONICS

TELEVISION • SERVICING • HIGH FIDELITY

HUGO GERNSBACK, Editor



In this issue:

Servicing "Dog" TV Receivers

•

Save Time With Test Equipment

•

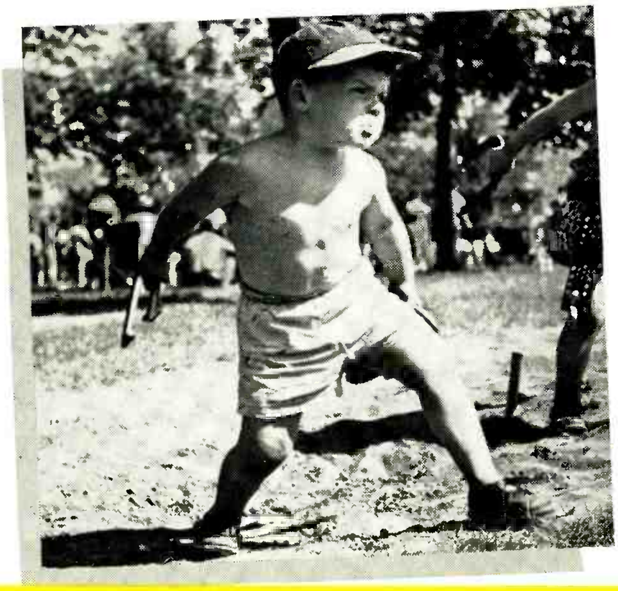
A Low-Cost Crossover Network

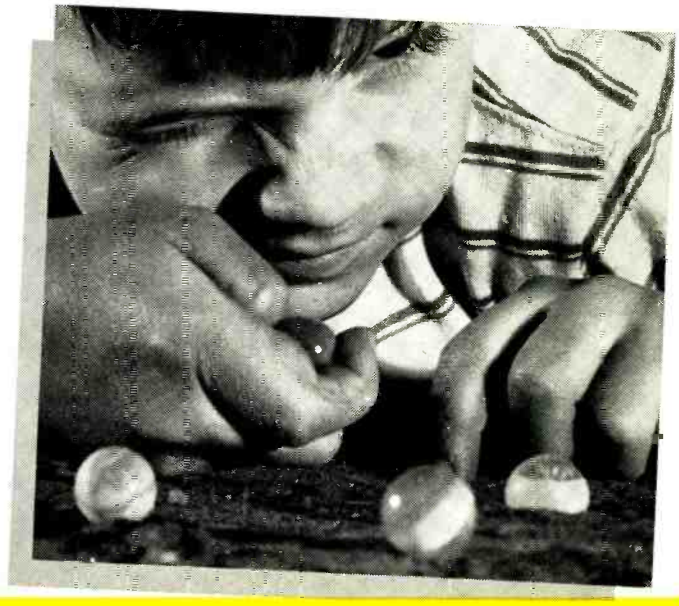
•

A.F.C. For Your FM Receiver

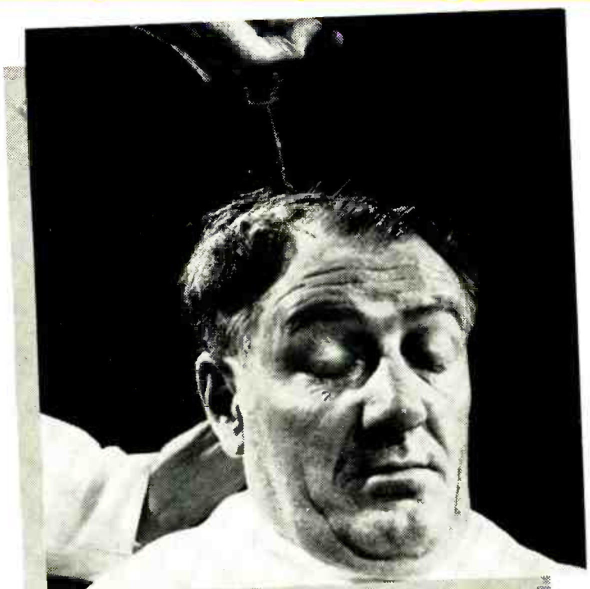
Repairing TV antennas a quarter mile above New York's sidewalks (see page 4)

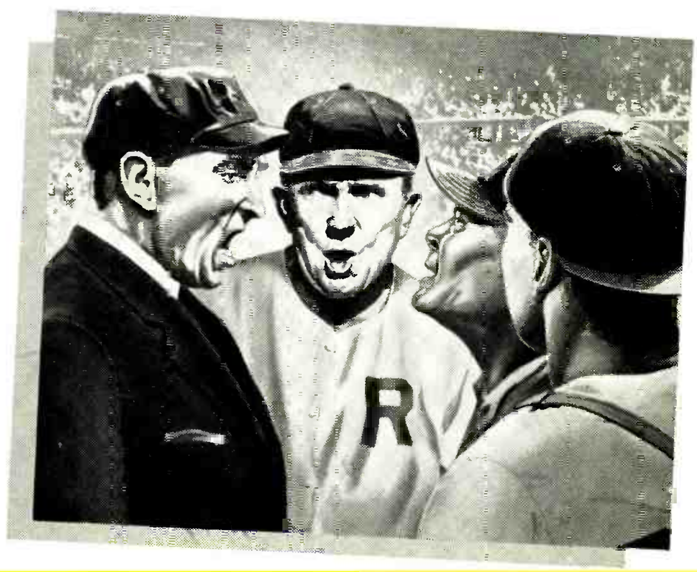
35¢ U. S. and CANADA





=SERIOUS SERVICEMEN= DRAW A BEAD ON QUALITY,=





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Installing front-end channel selector strips in modern UHF-VHF Television receivers and learning UHF servicing problems and their solution is part of the practice you get. To cash in on the coming color TV boom you'll need the kind of foundation in knowledge and experience this training gives.

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RADIO-ELECTRONICS

Formerly RADIO CRAFT • Incorporating SHORT WAVE CRAFT • TELEVISION NEWS • RADIO & TELEVISION*

ON THE COVER

Maintenance work high up on the Empire State Building's television antenna tower. The picture was rendered by a novel process by Martin J. Weber from an ordinary black-and-white photo by Ed Clarrity, which was separated photographically into the four line originals from which the plates for printing the cover were prepared.

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MEMBER Audit Bureau of Circulation — Vol. XXV, No. 11

Average Paid Circulation over 180,000

RADIO-ELECTRONICS, November 1954, Vol. XXV, No. 11. Published monthly at Mt. Morris, Illinois, by Gernsback Publications, Inc. Entered as Second Class matter June 23, 1954, at the Post Office at Mt. Morris, Ill.

EXECUTIVE, EDITORIAL and ADVERTISING OFFICES: Gernsback Publications, Inc., 25 West Broadway, New York 7, N. Y. Telephone REctor 2-8630. Hugo Gernsback, Chairman of the Board; M. Harvey Gernsback, President; G. Aliquo, Secretary.

SUBSCRIPTIONS: Address correspondence to Radio-Electronics, Subscription Dept., 404 N. Wesley Ave., Mt. Morris, Ill., or 25 West Broadway, New York 7, N. Y. When ordering a change please furnish an address stencil impression from a recent wrapper. Allow one month for change of address.

SUBSCRIPTION RATES: In U. S. and Canada, and in U. S. possessions, $3.50 for one year; $6.00 for two years; $8.00 for three years; single copies 35c. All other foreign countries $4.50 a year; $8.00 for two years; $11.00 for three years.

BRANCH ADVERTISING OFFICES: Chicago: 7522 North Sheridan Road, Tel. ROgers Park 4-8000. **Los Angeles**: Ralph W. Harker and Associates, 600 South New Hampshire, Tel. MAdison 6-1271. **San Francisco**: Ralph W. Harker and Associates, 582 Market St., Tel. GArfield 1-2481. **FOREIGN AGENTS**: Great Britain: Atlas Publishing and Distributing Co., Ltd., London E.C. 4. **Australia**: McGill's Agency, Melbourne. **France**: Brentano's, Paris 2e. **Belgium**: Agence et Messageries de la Presse, Brussels. **Holland**: Trilectron, Heemstede. **Greece**: International Book & News Agency, Athens. **So. Africa**: Central News Agency Ltd., Johannesburg; Capetown, Durban, Natal. Universal Book Agency, Johannesburg. **Middle East**: Steimatzky Middle East Agency, Jerusalem. **India**: Broadway News Centre, Dadar, Bombay #14. **Pakistan**: Paradise Book Stall, Karachi 3. **POSTMASTER**: If undeliverable send form 3578 to: RADIO-ELECTRONICS, 25 West Broadway, New York 7, N. Y.

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the Radio month

TELEVISION TELEPHONE was recently demonstrated at the Western Electronic Show in Los Angeles. When the telephone receiver is lifted from its hook, the caller's image appears simultaneously on one half of his screen and half the screen of the telephone at the other end of the circuit. Upon answering, the image of the called party is shown on the remaining half of each screen.

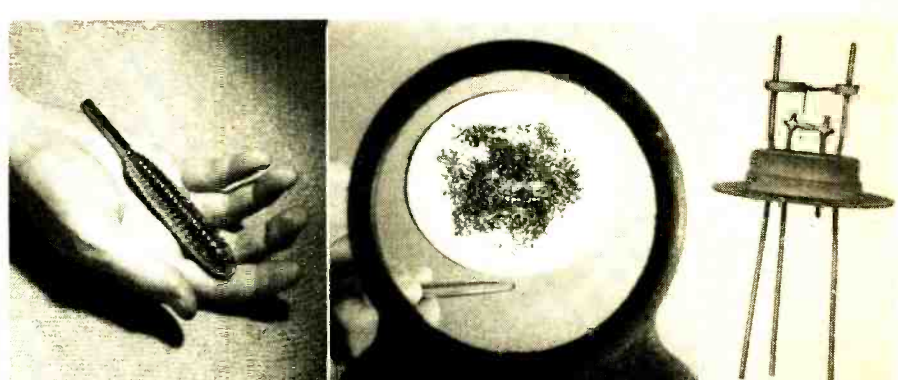
A simple adjustment enables either party to make the entire screen area available for a variety of uses, such as viewing signatures, documents, and miscellaneous articles.

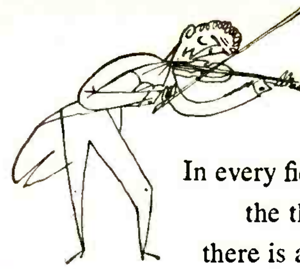
When the set is not in use as a TV telephone, the screen can be used for monitoring an industrial closed-loop television system, for receiving subscription television, or for taking programs from the air in the same manner as a standard television receiver. The system is made by Kay Lab, San Diego.

RATE-GROWN TRANSISTORS are scheduled for mass production by G.-E. Dr. W. R. G. Baker, G-E vice-president, said that the rate-grown process is the only one showing promise of large-scale transistor production at prices competitive with vacuum tubes. Present plans call for a multimillion volume of these transistor units within the next two years. Their availability and low price should result in widespread use.

The rate-grown process involves introducing special impurities and varying the heat controls during the crystal growing process. By this method, in only two hours, a large ingot is formed (see photo, left) containing as many

(*Continued on page* 10)





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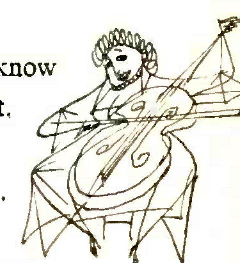

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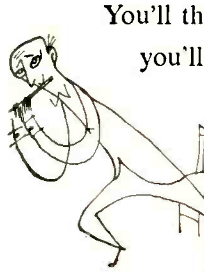

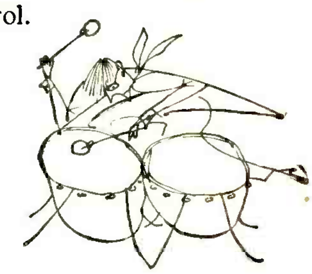

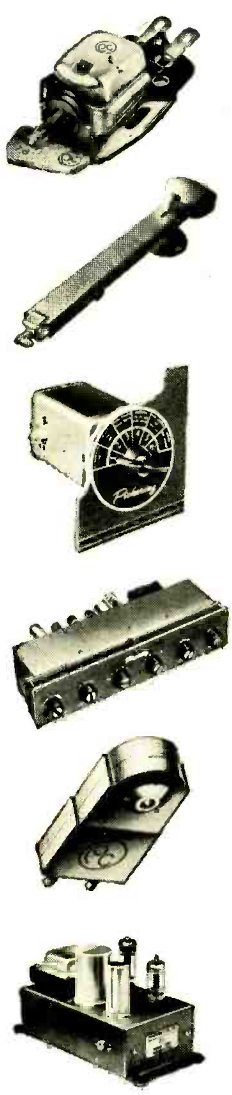

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as 100 wafer-thin layers of specially treated germanium. The ingot is then diced into thousands of very small bars (center). Each bar with leads attached becomes a transistor (right).

A feature of this process is that germanium growth can be varied so that transistors with optimum operating characteristics can be obtained at will.

TEN NEW TV STATIONS have gone on the air since our last report. These are:

KOVR	Stockton, Calif.	13
WJNO-TV	Palm Beach, Fla.	5
WINT	Waterloo—Ft. Wayne, Ind.	15
WTWO	Bangor, Me.	2
WMTW	Poland Spring, Me.	8
KSWM-TV	Joplin, Mo.	12
WCMB-TV	Harrisburg, Pa.	27
WUSN-TV	Charleston, S.C.	2
WMVT	Montpelier, Vt.	3
WCHS-TV	Charleston, W. Va.	8

One station, KTHE, Los Angeles, Calif., channel 28, has gone off the air.

CKLW-TV, Windsor, Ont., Canada, channel 9, has gone on the air.

The deletion of KMBC-TV, Kansas City, Mo., channel 9, from the TV station list in the September, 1954, issue was an error. KMBC-TV shared time with WHB-TV. WHB-TV ended operation. KMBC-TV is still on the air.

A SCHOLARSHIP, to be awarded annually to an engineering student who has demonstrated outstanding ability and potentialities in the field of radio-electronics, has been established by Hugo Gernsback, editor and publisher of RADIO-ELECTRONICS. The scholarship has been established at New York University, for students who have completed the junior year in the University's College of Engineering.

The scholarship fund will provide $1,000 annually to defray the tuition costs of the selected student.

Hugo Gernsback and Lawrence Wechsler

The scholarship fund is the outgrowth of an award made to Mr. Gernsback himself in 1953, when leaders of the electronics industry presented him with a handsome silver trophy in recognition of his "fifty years of devoted effort and contributions to the radio-electronic art." At that time he expressed a wish to establish a Hugo Gernsback

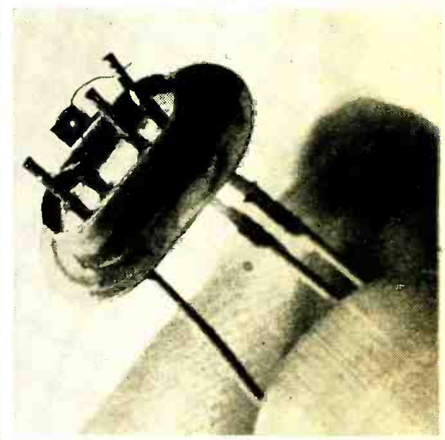
trophy as an annual award to the man making the year's outstanding contribution to the electronics industry.

Recognizing the crying need for top engineering talent in electronics today, Mr. Gernsback revised his original intention and decided instead to create a living trophy, dedicated to furthering the education of engineering students who have demonstrated potentialities of scientific leadership in the field of electronics.

The first award of this scholarship—for the academic year 1954-55—has been made to Lawrence Wechsler, of 110-45 71st Road, Forest Hills, N.Y. Selection of students will be made by a committee appointed by the University.

U.H.F. TRANSISTOR recently developed by Bell Labs operates at 440 mc, higher in frequency than any transistor yet known. The unit, called an "intrinsic-barrier" transistor, has a power gain of approximately 1,000 and operates effectively as a u.h.f. oscillator.

An intrinsically pure layer is added



to a basic p-n-p wafer, which acts as a "shock absorber" for high-voltage electrical charges. This chemically pure part of the germanium crystal remains neutral, while the three adjoining sections receive plus or minus charges.

The "intrinsic" region in the middle of the transistor permits the faster movement of positive charges, isolates the input and output areas, and reduces the stored energy to make functioning at the high frequencies possible.

FCC JURISDICTION over community TV was requested by the Fairmont Broadcasting Co., permit holder of station WJPB-TV, channel 35, Fairmont, W. Va. The request concerned specifically community TV distribution systems operating for a profit.

The company charged that many community systems are in direct competition to TV stations, inserting commercial advertisements in network programs picked up off the air, with or without the consent of stations. In other areas, systems are preparing to telecast live, local, sponsored programs over their closed circuits. These, it is claimed, will "constitute a serious economic threat to allocated and established TV stations." END

Correspondence

QUESTION BOX

Dear Editor:

Let me say that from my viewpoint you definitely should continue the Question Box.

Being behind the typewriter you have no way of knowing how it is being received on the reading end except by the number of questions that come in. Believe me, this is not a good basis. The questions you receive represent a cross-section of what every technician is thinking. And when you receive one question, your answer will benefit thousands of readers.

Your answer to the question concerning the modification of the Eico 425 scope was utilized by thousands of Eico users. You may have received only one letter but your reply to that one question answered innumerable unwritten ones.

No, you can't stop the Question Box, for it plays a very important part in the electronics field.

STEWART BABBITT, W6QHR
Bellflower, Calif.

ANOTHER IDEA

Dear Editor:

This is in reply to the article "A Superunusual Case" that appeared in the September issue of RADIO-ELECTRONICS. Not agreeing with Mr. Gnessin I suppose a guess of my own is in order, so here is what I think happened.

The picture became normal when the 6SN7 was first removed and would go out when the tube was reinstalled. Then, after all components in this stage were changed with a .05-μf capacitor inserted by mistake, the set worked with the tube in but not when the tube was removed.

This I would say was the normal condition. I do not believe it would have made any difference whether a .05- or .005-μf capacitor had been installed. It would have worked just the same.

Before the components were changed, I believe there was either excessive leakage across some terminal connections or coupling by some adjacent wiring or component that was not apparent to the eye. This condition was corrected subconsciously when all the components were replaced.

ALBERT J. PAUKSTITUS
Transmitter engineer
WWDC and WWDC-FM
Silver Spring, Md.

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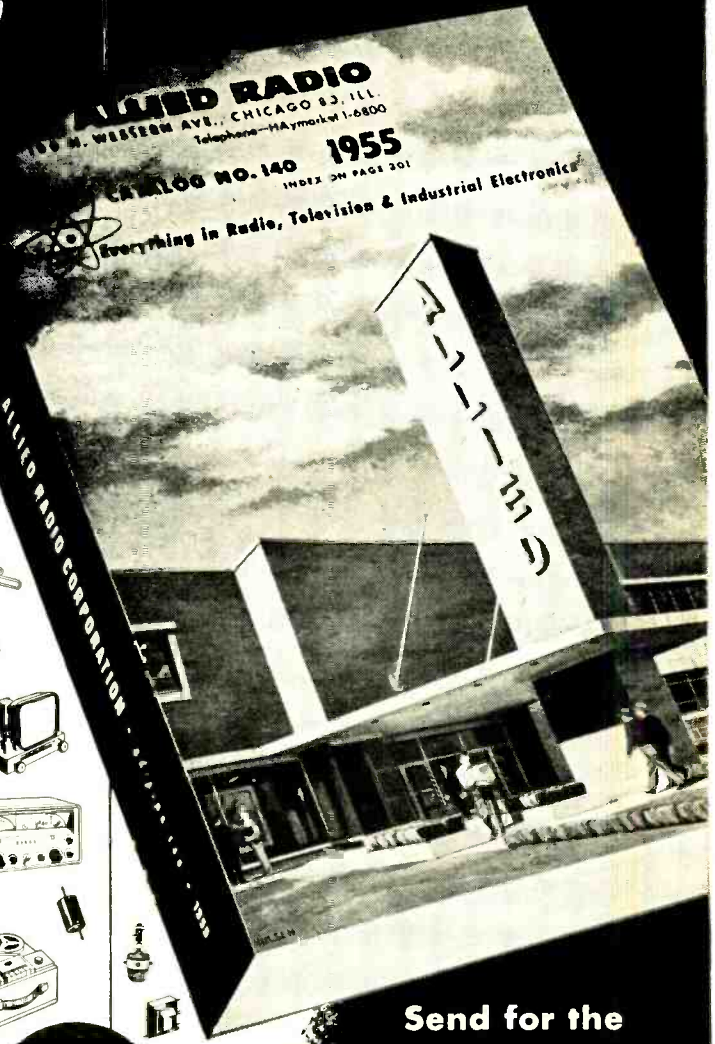

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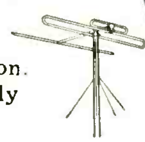

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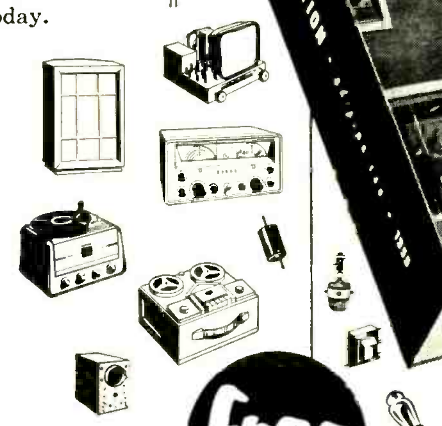

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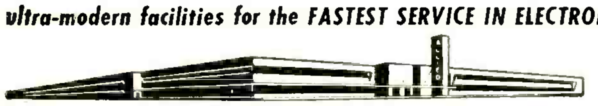

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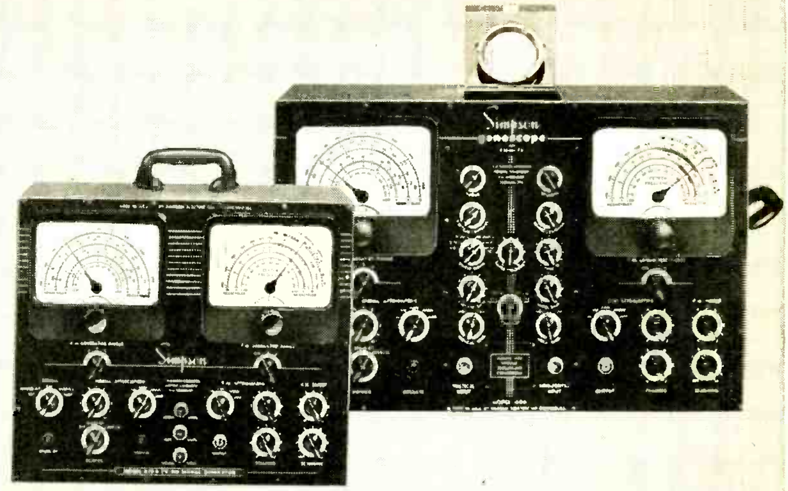

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In conjunction with either the Simpson Genescope or TV-FM Signal Generator, the new Chromatic Probe can align and test the chroma channel, I and Q channels, and color video amplifier in color TV receivers. What's more, it gives you two new black-and-white applications — direct video amplifier testing and stage-by-stage testing.

The new Simpson Chromatic Probe also has the widest frequency range of any equipment on the market — 8kc to 4.5 mc.
The new Simpson Chromatic Amplifier permits testing of low-gain video amplifiers in color television receivers, as well as other tests where a low-gain scope is being used.

With these low-cost accessories, the Simpson test equipment you bought for black-and-white TV will also meet your color requirements. Once again — in spite of rapid technological changes — your investment in Simpson equipment is protected.

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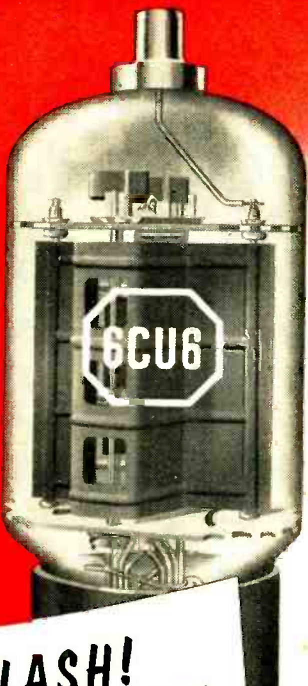

FLASH!

NEW CTS-RATED 12CU6 · 25CU6 . . . with all the 6CU6's features . . . at no extra cost . . . now available for series-string operation.

Combined data sheet for 6CU6, 12CU6, and 25CU6 free on request.

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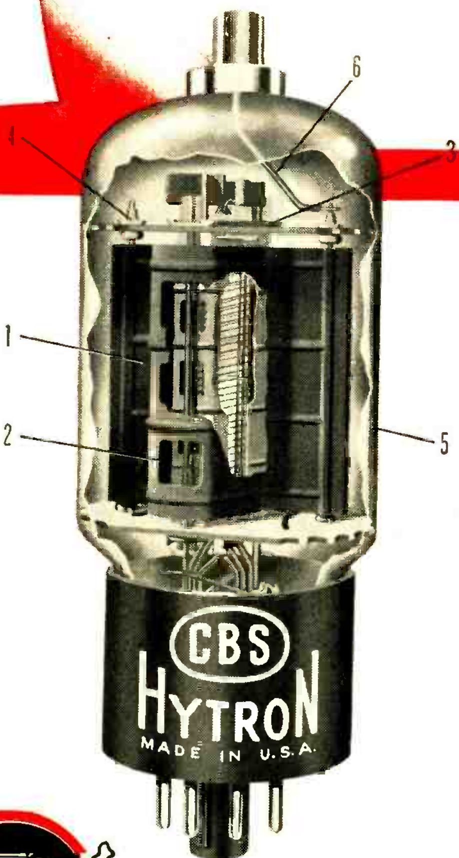
The 6BQ6GT is a good tube. (Heck, CBS-Hytron originated it.) But, it was designed for 10- and 12-inch TV sets. Today it carries the load in 21-inch sets. Furthermore, it must combat the accumulated dissipation caused by: 1. Line-voltage variations. 2. Faulty receiver adjustments. 3. Shifting values of components due to age and overload. Result: The 6BQ6GT is often operated above maximum ratings.

Obviously, a brand-new design . . . not just an improved 6BQ6GT . . . was needed. The husky CBS-Hytron 6CU6 (See Mechanical Features) is the answer: a premium-performance tube *at no extra cost.* CTS-Rated, it offers generous safety margins for plate dissipation . . . high-voltage insulation . . . and high-line protection. Note also the bar graph showing much larger plate and envelope areas of CBS-Hytron 6CU6.

In the 6CU6 . . . another CBS-Hytron first . . . high voltage and heat meet their match. You forget run-away plate current, high-voltage arc-overs, and shrinking TV pictures. You gain by longer life . . . minimized service . . . happier customers. Try the CBS-Hytron 6CU6 today.



*Rated for Continuous Television Service

MECHANICAL FEATURES OF 6CU6

1. Heavier-gauge plate with large radiating fins.
2. Vents in beam plates and plate aligned for maximum radiation of heat from grids.
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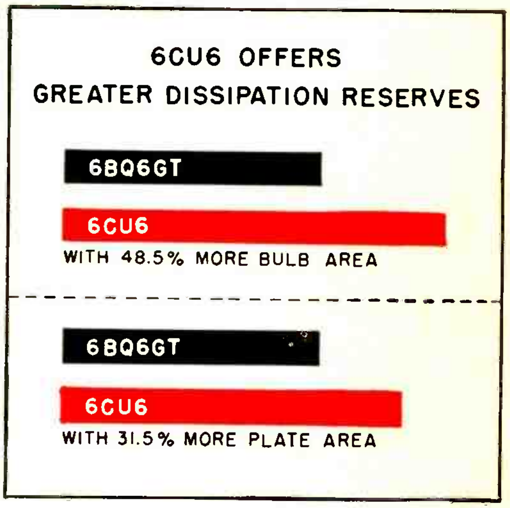

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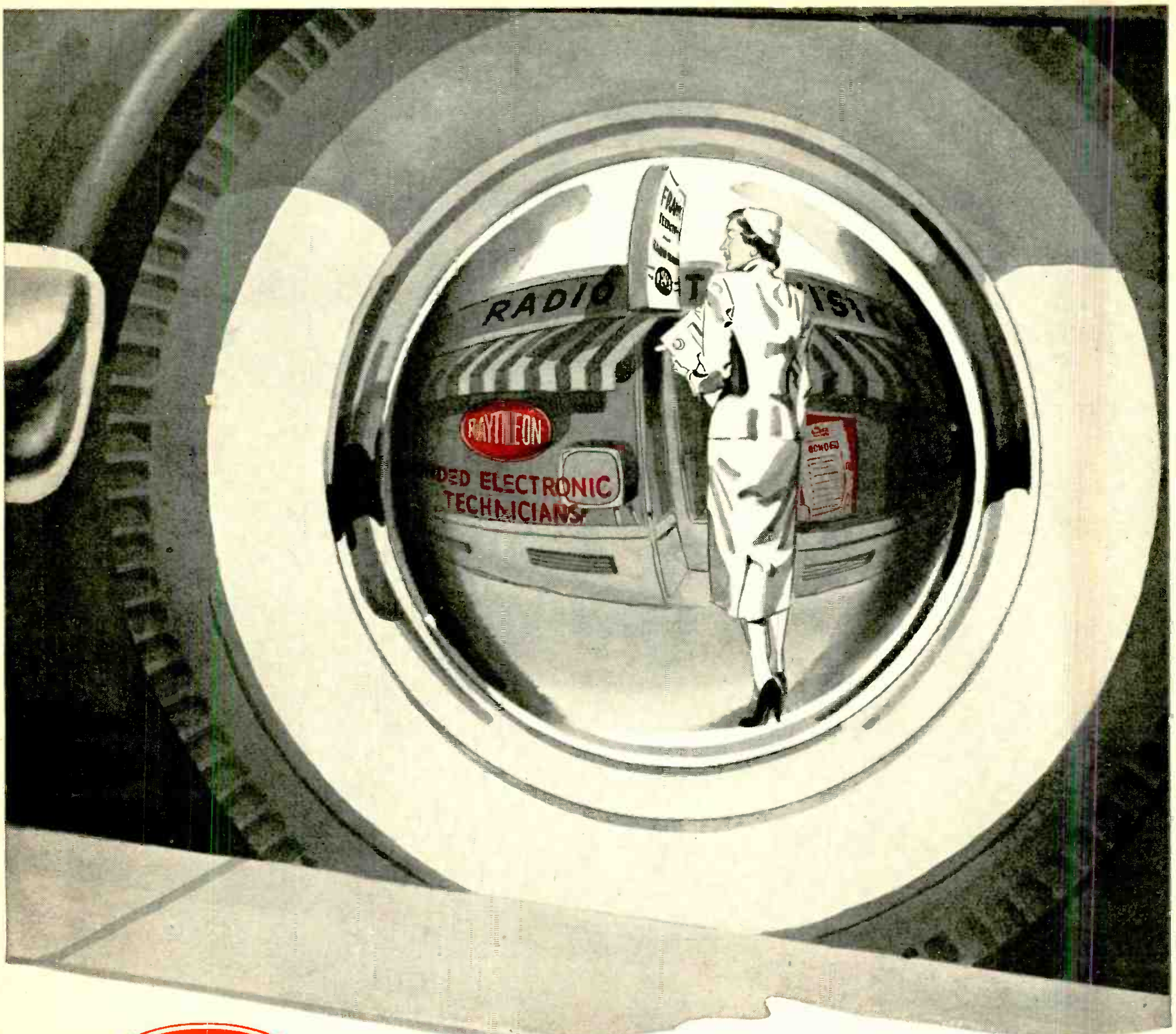

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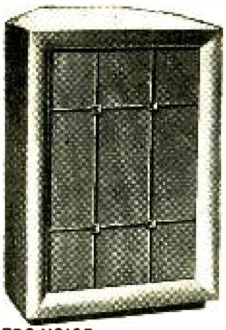

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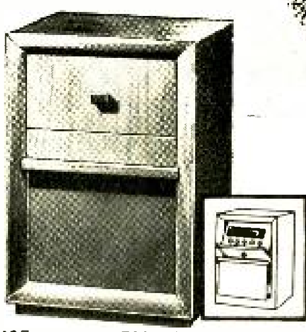

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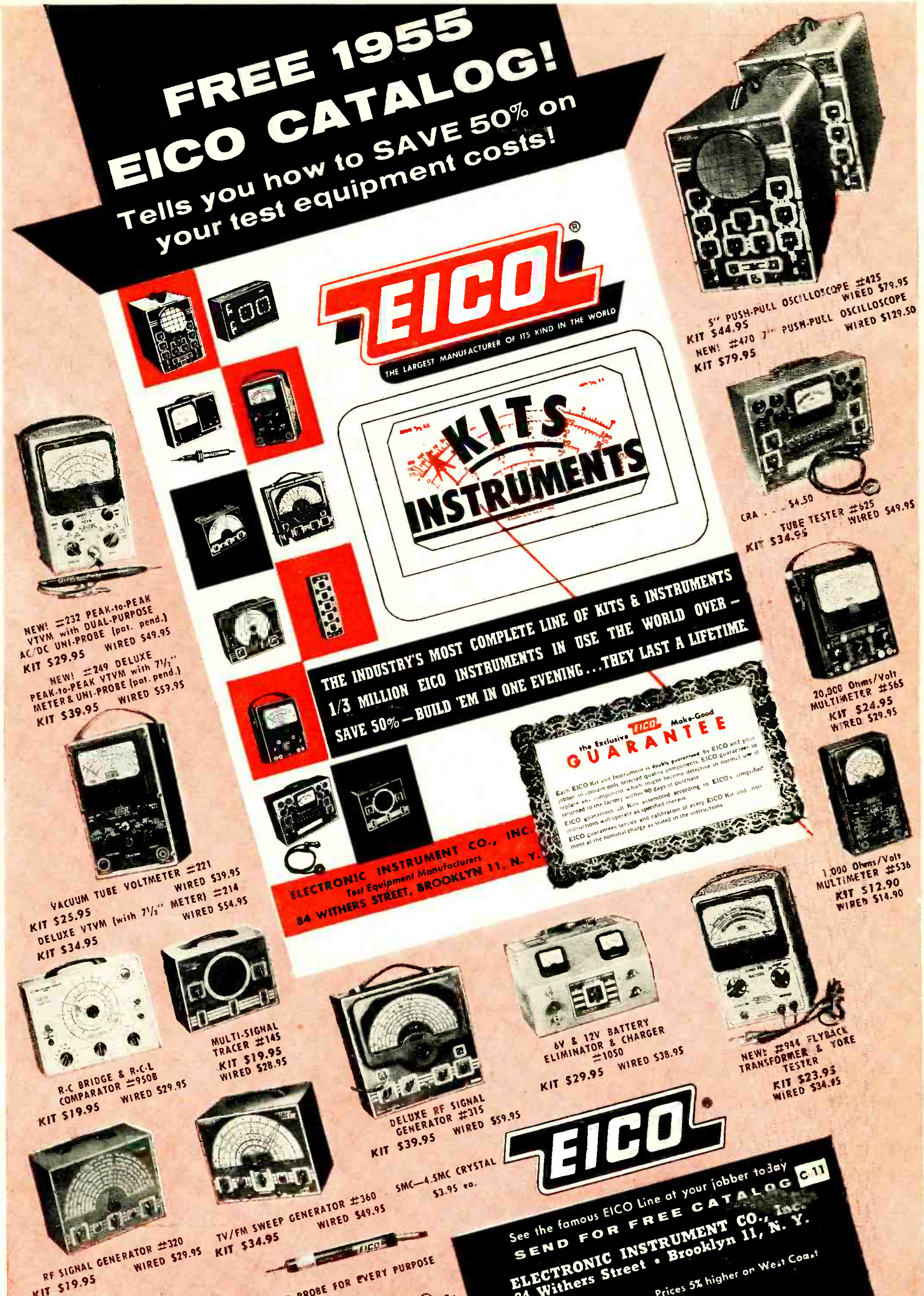

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RADIO-ELECTRONICS
Hugo Gernsback, Editor

HOT ELECTRONS—OR COLD?

....*New Means of Liberating Electrons in the Future*....

THE science of electronics began with a *released electron flow*, when Edison first noted an important phenomenon now known as the Edison effect. This revolutionary discovery occurred in 1883. Sealing a separate wire or plate into an electric light bulb, Edison noted that when the bulb was lit, an electrical current could be made to flow from the hot filament to the sealed-in cold plate. This despite the fact that there was no connection between the filament and the plate.

It was some years before scientists understood that what went on in the tube was a stream, or flow, of hot electrons from the filament to the cold plate, bridging the vacuum as if it were a good conductor.

Practically our entire science of radioelectronics—up to very recently—was built upon the hot-filament-to-cold-plate flow of *heat-generated* electrons. No practical electron tube for *general* radioelectronic purposes has been perfected that works in a cold state (Exceptions: specialized tubes such as certain rectifiers, photoelectric and multiplier tubes, etc.).

In the early days of wireless we used crystal detectors which worked quite well in the cold state without *heat-released* electrons. We may thus call them cold *quasi autoelectrons*, because they are practically self-releasing. Nevertheless, they require *some* energy to make them flow, even if the energy is exceedingly minute—as, for instance, radio-frequency currents collected from an aerial. Now the crystal detector becomes a rectifier and current flows through the earphones, bringing the distant broadcast music to us in the form of sound.

The modern, metamorphosed crystal—now known as a semiconductor and called a transistor—has caused a revolution in electronics, partly because it can oscillate just as can a vacuum tube, but more importantly, because it is an amplifier. Amplification is something the crystal diode never could achieve practically, though apparently it is about to make its debut as an amplifier. (page 94)

The transistor, in its many designs and types, functions with cold quasi autoelectrons and an exceedingly low energy input.

But marvelous device that it is, the transistor nevertheless is not the final word in electronics, for it still requires outside power to function.

The day is not too far distant when the atom will power the transistor and similar devices, *making them independent of outside energy in supplying current for the transformers, loudspeaker, picture tube, etc.*

As long ago as our October, 1945, issue, the writer, speaking of the future harnessing of the atom, said editorially: "From this it appears that such tiny, but powerful, generators will not contain moving parts in order to generate electricity." This idea was scoffed at for many years, but last September it was accepted as a coming reality by no less an authority than Eugene M. Zuckert, former chairman of the Atomic Energy Commission. In a talk in Boston before the Savings Bank Association of Massachusetts, he assured his listeners that conversion of atomic energy *directly* into electricity was no longer a dream.

For that matter, the atomic battery, recently demonstrated and fully described in these pages, proves that the generation of electrical power in small quantities, directly from the atom, can no longer be called visionary.

It is thus certain that in the foreseeable future the atom in some manner will be coupled to the transistor to power it. *Indeed, the radioactive element will be integrated into the transistor, making it a single component.* Incidentally, laboratory samples of such devices are already in existence—not perfected, but an excellent blueprint of what will be done in the future.

These *autotransistors*, atom-powered, require no batteries, no electric light circuits, indeed no outside source of current whatever. *The atom furnishes whatever electric energy* is required. Such an autotransistor becomes in effect a true autoelectric generator, liberating in itself any desired flow of electrons, within reason.

The cost of such an atom-powered autotransistor will be quite reasonable—cheaper, in due time, than the present-day vacuum tube. Vast research during the past few years, particularly in atomic by-products, assures this. Even today, a large list of atomic radioactive isotopes can be bought at reasonable cost, chiefly because so very little is required. To atom-power an autotransistor will require only a minute quantity of a particular radioactive isotope. Moreover, the half-life of many such promising isotopes runs from five to hundreds of years, hence the life of the average autotransistor will be measured in decades.

Will it not be dangerous to work with such atomic transistors? Can they be handled safely? Would they not endanger owners of future atom-powered radio and television receivers? The answer must be a reassuring "no." We already mentioned that only minute amounts of radioactive substances will be used. All such atomic components will be safely sealed in lead or other shielding devices, allowing no leakage of dangerous radiation. The service technician of the future will carry a Geiger counter, or its equivalent, routinely. He will periodically test all atomic components for leaks, eliminating those that are defective.

By eliminating a large number of present-day components, the circuitry of future receivers will be greatly reduced, too. The manufacture of such sets, using printed circuits and many printed components, will be much simplified. Automation of receivers will make their building cost low, too. Hence, servicing the future sets will be easier also, and far less costly than today. Utopia? No — merely good and intelligent applied science.

H.G.

Unusual TV Circuits

By ROBERT F. SCOTT
TECHNICAL EDITOR

Recent developments, circuit tricks, and modifications for improving TV performance

SOME of the latest TV receivers use triodes such as the 6C4 or half of a dual triode instead of a diode in the video detector and a.g.c. circuits. Fig. 1 shows the circuit used in the Arvin TE331 chassis. The video i.f. signal from the fourth picture i.f. amplifier is fed to the cathode of a triode (one half of a 12AU7). The grid acts as the anode of a diode detector.

The detected video signal appears across dectector load L1, R1, and L2 and is capacitance-coupled to the 6AC7 video amplifier. The grid and cathode are returned to a 2.4-volt point on voltage divider R5, R6.

The 12AU7 plate is the anode of the a.g.c. detector diode. The rectified voltage across R2, R3, and R4 is used as a.g.c. voltage. The portion of it that appears across R3 and R4 is applied to the first three video i.f. amplifier stages. Two levels of a.g.c. for the tuner are available at the LOCAL-DISTANCE switch.

The plate of the triode returns directly to ground through R2, R3, and R4 while the cathode is biased 2.4 volts positive. This bias prevents the a.g.c. detector from conducting until the i.f. signal voltage equals or exceeds 2.4.

The delay bias does not affect the operation of the video detector because the detector anode (the control grid) is also biased 2.4 volts positive.

The RCA video detector

At first glance the video detector circuit in the RCA KCS72D-1 and KCS72D-2 (Fig. 2) appears very similar to the circuit in Fig. 1. However, there is a decided difference between the two circuits. The video detector uses one half of a 12AU7 twin triode. The other half is the vertical sync separator. The video detector and sync separator halves of the tube must be shielded from each other to prevent interaction. Shielding can be obtained by grounding the plate of the detector. However, grounding the plate loads the detector circuit and reduces its efficiency.

RCA has worked out a novel scheme for isolating the two halves of the 12AU7 without loading the video detector. The plate of the video detector is grounded through a .01-μf capacitor (C1) and is connected to a negative voltage (the grid of the 6BQ6-GT horizontal output tube). The negative voltage prevents the plate from drawing current as it would if grounded directly. The 2.2-megohm resistor and .01-μf capacitor filter out the horizontal sweep voltage and prevent it from affecting the video and sync circuits.

Another unusual circuit feature of the RCA KCS72D chassis is in the low-voltage rectifier circuit (Fig. 3). A 5Y3-GT and 5U4-G are connected in parallel as full-wave rectifiers. The impedances of the two tubes are such that the current divides between them

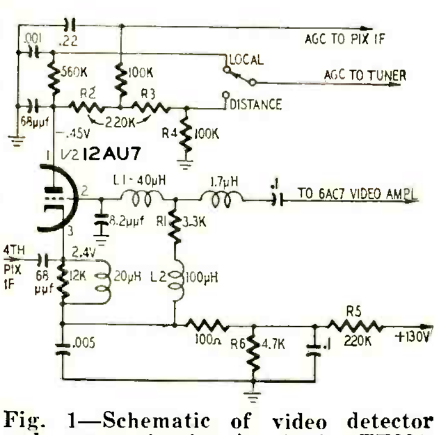


Fig. 1—Schematic of video detector and a.g.c. circuits in Arvin TE331.

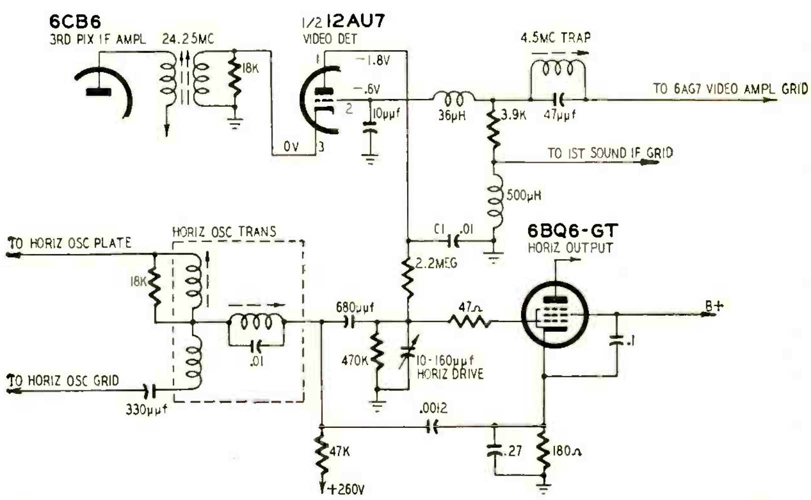


Fig. 2—Video detector and associated circuits in the RCA KCS72-D1,2.

with approximately two-thirds being carried by the 5U4-G and one-third by the 5Y3-GT.

Horizontal a.f.c. clamp

TV receivers that use Synchro-lock type a.f.c. circuits sometimes develop a hook at the top of the picture. This is often caused by vertical sync pulses leaking into the horizontal sync circuit and causing instantaneous changes in the error voltage developed by the horizontal discriminator. In the Video Products 630DX, K24C, and similar models, the diodes in the 6AT6 first a.f. amplifier are used to clamp the error voltage on the sync discriminator cathodes as shown in Fig. 4. Any increase in the error voltage due to vertical sync pulses causes the diodes to conduct and act to level out that voltage.

The 22,000-ohm resistor and 0.1-μf capacitor have a time constant that effectively smoothes out transient variations in the voltage on the discriminator cathodes.

Olympic video detector and a.g.c.

The video detector and first sound i.f. amplifier circuit in the Olympic TL-20 and TK-17 chassis (Fig. 5) is similar to that used in the Magnavox series 105 described in this column in the July, 1952, issue.

In both circuits, the grid and cathode of the 6BA6 act as a diode video detector. Unlike the Magnavox, which uses a keyed a.g.c. circuit, the Olympic system uses the d.c. component of the rectified video i.f. signal as a source of a.g.c. voltage. The d.c. voltage is tapped off the 5,600-ohm detector load resistor and fed to the a.g.c. line supplying the tuner and first and second video i.f. stages. The filter network for the a.g.c. line consists of a 1-megohm series resistor and a 0.1-μf smoothing capacitor connected from the a.g.c. line to ground.

Two-tube TV sound strip

The sound strip of the average TV set contains five separate tubes—some sets have seven or eight. The Westinghouse V-2227-1 TV chassis is unusual in that there are only two tubes in the sound circuit. A 6BK5 video amplifier (Fig. 6) is driven by direct coupling from the video detector. The sound take-off point is at the plate of the 6BK5 video amplifier. The 4.5-mc sound i.f. signal is fed from this point to the grid of the 6BN6 gated-beam FM detector. The output of the 6BN6 drives the 6BK5 a.f. output stage.

Hallicrafters' a.g.c. delay

Various methods of grading and delaying the application of a.g.c. voltage to cascode-type tuners were discussed in the July, 1953, and December, 1953, issues. Fig. 7 shows a somewhat different solution to the problem of supplying a.g.c. to cascode tuners. This is the circuit used in the Hallicrafters A1100D.

A 6AL5 is used as the video detector and a.g.c. rectifier. Diode V1-a is the video detector. The signal is fed to its cathode and the video signal is developed across the 3,300-ohm detector load resistor. The a.c. component of this signal is fed to the grid of the 6CB6 video output stage and the d.c. component is filtered and used as a.g.c. voltage for the first and second picture i.f. amplifiers. The negative voltage on the plate of V1-a averages only about 0.2 volt so this section of the 6AL5 conducts on all i.f. signals exceeding 0.2 volt peak.

A.g.c. voltage for the cascode tuner is developed by V1-b. This a.g.c. voltage is developed across R1 and is filtered by R2, R3, C1, and C2. With no signal input and all controls set for normal operation, there is a cutoff bias of approximately 5.6 volts between the plate and cathode of V1-b. This section does not conduct and develop tuner a.g.c. voltage until the picture i.f. signal exceeds the bias voltage. A positive voltage for the cathode of V1-b is obtained from a B plus voltage divider consisting of a 47,000-ohm resistor and the contrast control connected in series between the 125-volt line and ground.

When the contrast control is advanced for a weak signal, R4 is shorted out and positive bias is increased on the cathode. This increases the delay in production of tuner a.g.c. voltage and permits the tuner to operate at maximum gain.

On strong signals, the contrast control is rotated so that its arm moves toward ground. This action decreases the tuner a.g.c. delay bias on the cathode of V1-b and reduces the gain of the video amplifier by placing a larger portion of the contrast control in parallel with R4. END

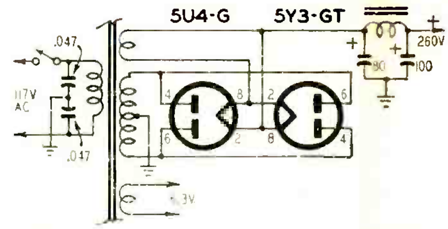


Fig. 3—RCA KCS72D power supply.

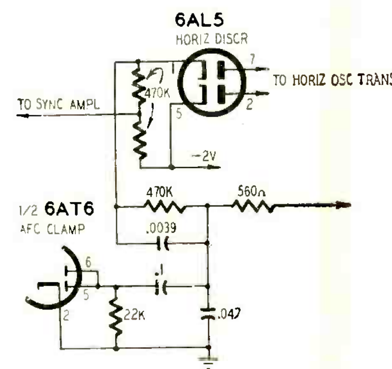


Fig. 4—Video Products' a.f.c. clamp.

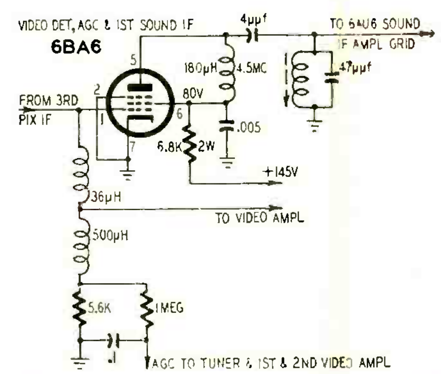


Fig. 5—Video detector and first audio amplifier in Olympic TL-20, TK-17.

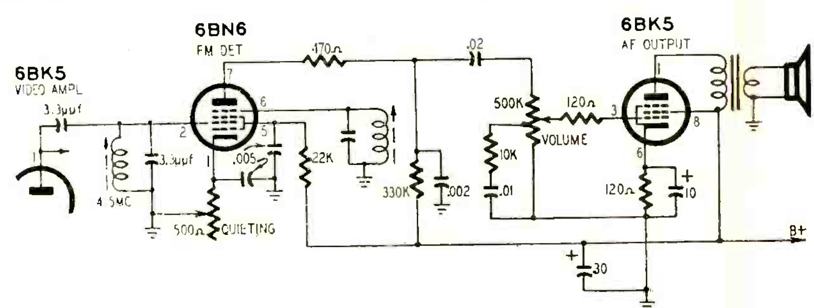


Fig. 6—Diagram of the audio section of the Westinghouse V-2227-1 chassis.

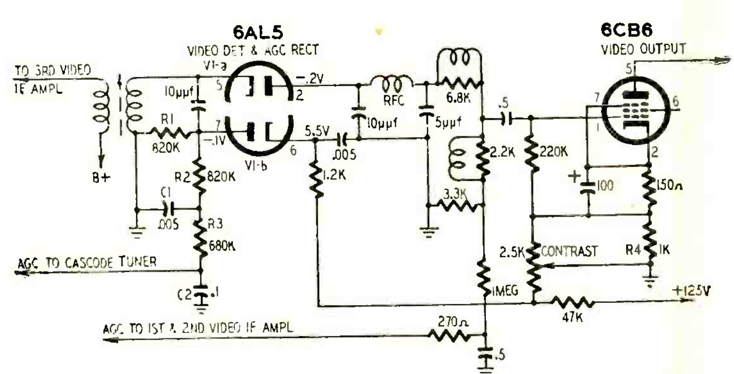
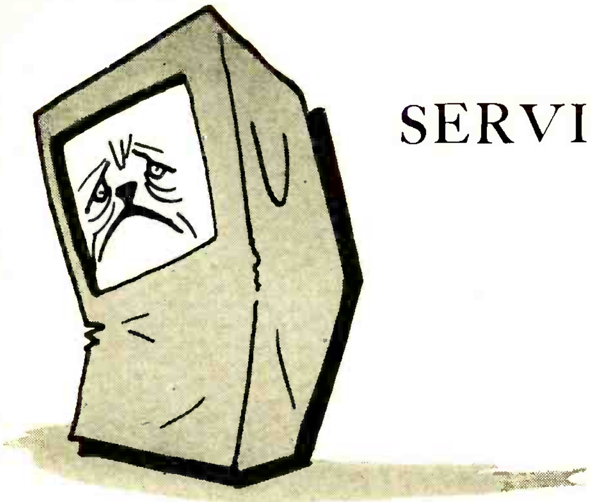


Fig. 7—Video detector and a.g.c. rectifier in the Hallicrafters A1100D.



SERVICING DOG RECEIVERS

Special techniques are required for trouble-shooting those really tough ones

By ROBERT G. MIDDLETON*

TELEVISION receivers that have been tackled and given up by several shops are called by various and often unprintable names. They finally acquire the title of *dog* after no one in the community has been able to restore the receiver to satisfactory operation. Some shops in metropolitan areas specialize in "dog" work; these shops, in general, are much better equipped than the usual service shop.

A dog job must be undertaken very seriously: there is a good chance that the technician will be stumped even when provided with more and better instruments than the shop which let out the job. The first step is to obtain a complete history of the trouble, since important clues are sometimes so obtained. For example, if the defect has developed gradually and is slowly becoming worse, the experienced technician may suspect a failing electrolytic capacitor in an out-of-the-way portion of the circuit because these often depreciate slowly.

For example, a receiver was brought in with a dark vertical bar down the center of the screen. It was reported that the trouble had developed gradually and was slowly getting worse. The service technician suspected that some electrolytic capacitor might be failing. Since the dark band appeared vertically on the screen, the spurious voltage causing the trouble must be originating in horizontal circuits. All d.c. voltages and resistances checked O.K.; the picture tube and yoke had already been replaced.

*Field engineer, Simpson Electric Co.

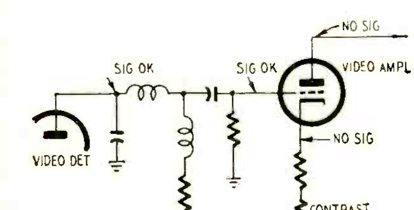


Fig. 1—Test points in video circuit.

The picture tube was grid-driven, and the cathode operated in the brightness circuit, powered from the booster circuit. After several false starts, a scope check was made at the cathode of the picture tube. The trouble became apparent as a substantial a.c. voltage at the horizontal frequency superimposed upon the d.c. voltage in the brightness circuit. Shunting a bypass capacitor from cathode to chassis removed the vertical bar. This, of course, was not a repair, but only a confirmation of the scope analysis.

The next step was to trace the spurious a.c. voltage with the scope back to its source, which proved to be a faulty electrolytic capacitor in the booster-decoupling circuit. Thus the preliminary theory, based on the history of the complaint, was correct. And served to make short work of what could have been a very difficult job, as the faulty capacitor was located in a somewhat inconspicuous part of the circuit. This job also served to emphasize the value of a scope to supplement the information provided by d.c. voltage and resistance measurements.

Of course, the history of the complaint often sheds no light on the trouble, and permits no theories to be formed. In such a case, work starts with a careful analysis of the symptoms. For example, a receiver was brought in with the complaint that the picture had suddenly disappeared, while the sound remained. No tube noise appeared on the screen of the picture tube when the contrast control was wide open, which indicated video-amplifier trouble, since the sound was taken off the picture-detector output. New tubes had been tried, and d.c. voltage and resistance measurements checked correctly.

To check the video-amplifier operation, a scope and low-capacitance probe were applied, starting with the output circuit of the picture detector (Fig. 1), at which point the video signal appeared normally. The video signal was present through the series peaking coil to the grid terminal of the video-amplifier tube socket. However, it stopped there; no signal could be found at the plate of the video amplifier or at the cathode (across the contrast control). This was a very unusual situation, and the first thought was that the heater was not energized. However, a check showed that the heater was operating normally. Another tube was tried, because occasionally even a new tube will be found defective. This was another bad guess.

After wasting a lot of time in idle speculation, it finally occurred to the service technician that a signal being present at the grid terminal of the socket was no assurance that the signal was also present at the grid terminal of the tube base. A scope check showed the suspicion to be correct—the socket was defective, and a new tube socket cleared up the trouble. This job also emphasized the value of a scope.

Correct measurement

The service technician must always "use his bean," and be on the alert for incorrectly made measurements. For example, a receiver was brought in with poor picture quality. The d.c. voltage measurements in the i.f. amplifier did not all check correctly. The service data called for 135 volts at the plate and 145 volts at the screen of an i.f. tube. The voltmeter indicated 145 volts at both plate and screen.

A look at the circuit arrangement (Fig. 2) made this situation a real puzzler, since the plate and screen were tied together through the coupling coil which had a very low resistance. Investigation revealed that the service data was wrong! The technician who compiled the service data had used a

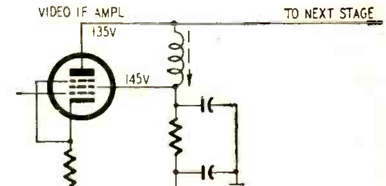


Fig. 2—Video i.f. amplifier stage.

20,000-ohms-per-volt meter to make these measurements. Lead resonance had caused the circuit to oscillate when making the plate-voltage measurements, reflecting circuit disturbances which worked out as a lower plate resistance in the tube and a lower apparent plate voltage. A v.t.v.m. avoids such difficulties, because the 1-megohm isolating resistor in the d.c. probe decouples the leads from the circuit.

Another practical example of incorrect measurement (or interpretation) occurred when servicing a receiver brought in with the complaint that the picture was too narrow. In a case like this, it is good practice to check first the drive at the grid of the horizontal-output tube. The drive was only 60% of the peak-to-peak voltage specified for the receiver, and the conclusion was drawn immediately that the trouble was probably in the horizontal-oscillator circuit and not in the horizontal sweep circuit. The d.c. voltage measurements showed low plate voltage at the horizontal oscillator. Some time was wasted checking the low-voltage power supply before discovering that the plate voltage was obtained from the booster circuit. Substitution of normal plate voltage to the horizontal oscillator by a pair of test leads from another chassis showed that the conclusion was true, and that the trouble was actually in the booster circuit. Replacement of a faulty booster capacitor restored normal operation.

Interconnected circuits of this type complicate servicing. Merely setting the receiver controls to the positions specified by the service data for voltage measurements may not be sufficient. It still may be impossible to make a correct measurement until the influence of other receiver sections, possibly faulty, is removed from the circuit.

Measurements may be made incorrectly for other reasons; for example, reading peak-to-peak voltages is sometimes confusing. Occasionally it is incorrectly assumed that a peak-to-peak voltage is equal to twice the peak voltage. That this is not true may be seen from Fig. 3. Unless symmetrical waveforms, such as sine waves (*a*), or square waves (*b*) are under measurement, the positive-peak voltage is not equal to the negative-peak voltage (*c*).

To obtain a clear understanding of such measurements, the following points must be learned:

1. A sine wave is the element or "atom" of a.c. electricity—all non-sinusoidal waves can be broken down into a certain number of sine waves of various voltages, frequencies, and phases.
2. A sine wave has a positive-peak value which is equal to its negative-peak value, since the sine wave is a symmetrical waveform.
3. A sine wave has a definite relation to a d.c. voltage of the same value; this is called the r.m.s. or root-mean-square, or effective, value of the sine wave.
4. Before an r.m.s. voltage can be used to calibrate a scope, the r.m.s. value must be converted to the corresponding peak-to-peak value by multiplying by 2.83.
5. The multiplying factor of 2.83 applies only to sine waves; it does not apply to square waves, sawtooth waves, pulses, or rectifier waveforms.
6. Once a scope has been calibrated in terms of a peak-to-peak voltage on a sine-wave basis, the peak-to-peak calibration will apply to any waveform whatever.
7. The resting position of the scope beam indicates the zero-volt level. Positive-peak voltages are measured by counting squares of deflection above the zero-volt level; negative-peak voltages are measured by counting squares of deflection below the zero-volt level. The same calibration serves for peak voltage measurements as well as for peak-to-peak voltage measurements.
8. When a d.c. voltage is used for scope calibration, the d.c. value is equivalent to a peak-to-peak value. However, d.c. voltages are not indicated by an a.c. scope.
9. Unsymmetrical waveforms do not have equal positive and negative deflections with respect to the zero-volt line; however, the positive area of any waveform is always exactly equal to the negative area of the waveform, since there is just as much positive electricity in a waveform as there is negative electricity.
10. A d.c. scope is converted into an a.c. scope by a series blocking capacitor in the input circuit; a d.c. scope shows the d.c. voltage component value in addition to the a.c. waveform values.

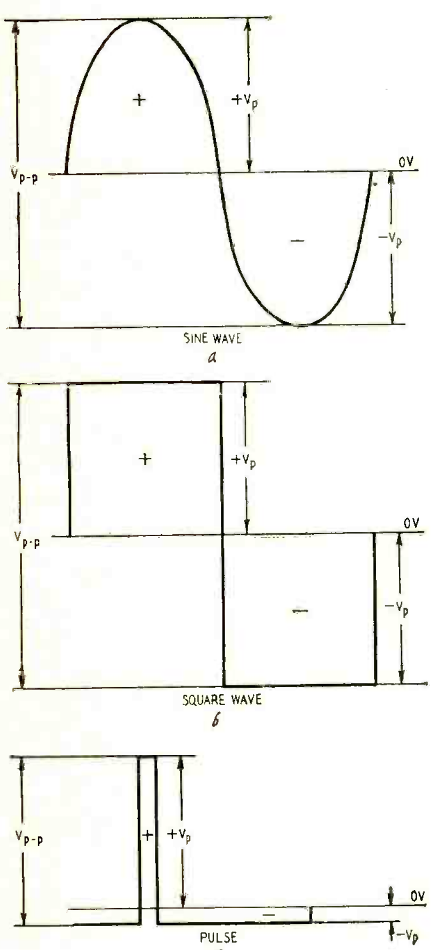


Fig. 3—Peak-to-peak calculations of frequently used television waveforms.

Measuring Instruments

Peak-to-peak voltages are best measured with a scope and low-capacitance probe. The probe (usually of the 10-to-1 variety) minimizes circuit loading and permits accurate measurements in sensitive circuits. When the scope provides for internal calibration, the 10-to-1 attenuation of the probe must be taken into account, and the nominal calibrating voltage must be divided by 0.1 in making the calibration. For example, if the scope is calibrated from a 6.3-volt r.m.s. sine-wave source, the 6.3 volts is first multiplied by 2.83 to obtain its peak-to-peak value of 17 volts. But if a 10-to-1 probe is used in making receiver tests, this 17 volts peak-to-peak is regarded as 1.7 volts peak-to-peak in calibrating the scope, thus taking into account the signal attenuation in the probe.

Standard voltmeters with peak-reading a.c. scales must not be used in making peak-to-peak measurements, since, as shown in Fig. 3, many waveforms do not provide equal values of positive and negative peaks. Likewise, a voltmeter with a half-wave rectifier probe cannot have a peak-to-peak scale, because full peak-to-peak information is not obtained by the probe. A suitable voltmeter must provide a voltage-doubler type probe (or built-in) rectifier, with a peak-to-peak indicating scale. Since the circuit loading of such an arrangement is much greater than that of a 10-to-1 scope probe, most service technicians prefer the use of the scope and probe.

It is sometimes supposed that a peak-to-peak measurement can be made by taking two measurements with a half-wave instrument, reversing the test leads for the second measurement, and adding (supposedly) the positive and negative peak values. Unfortunately, one of the measurements is almost certain to be in serious error because this method causes the "ground" terminal of the instrument to be applied to the "hot" side of the circuit for one of the measurements. As a result, the "hot" side of the circuit is partially shorted-out by the "ground" side of the instrument. On the other hand, a voltage-doubler type probe obtains both positive and negative peak voltages with the "hot" side of the instrument applied to the "hot" side of the circuit, and the peak-to-peak measurement can be made correctly. END

ZERO-REFERENCE and ALIGNMENT

Various problems involved in servicing with an oscilloscope

By The Engineering Staff, Scala Radio Co.

WHEN a response curve is displayed on the screen of a d.c. scope, the base line level is always "locked" at a position on the screen set by the operator. By adjusting the vertical centering control (vertical positioning control) of the scope, the operator chooses the zero-volt reference position. As tuned circuits are adjusted, the response curve will change in form, but the zero-volt reference level remains fixed on the scope screen.

Fig. 1 shows that, as a ratio-discriminator transformer is adjusted, the S curve may appear completely above or completely below the zero-volt level when the circuits are detuned; but when the circuits are in proper adjustment, the S curve appears symmetrical with respect to the zero-volt level. And if a d.c. scope is used in the alignment procedure, this zero-volt level does not shift on the screen as the adjustments are made to the ratio-discriminator transformer.

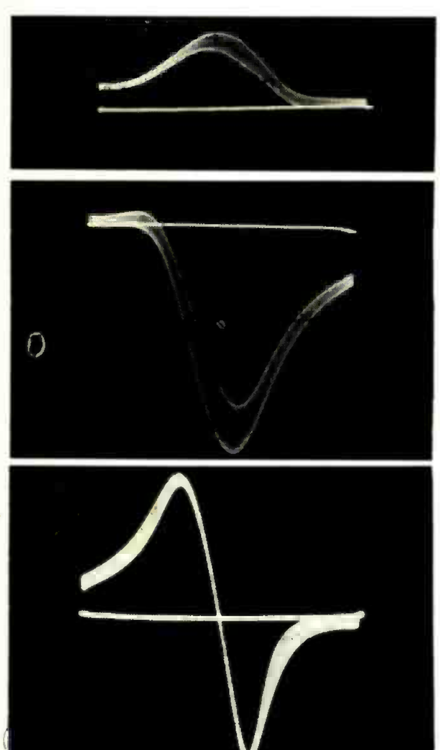


Fig. 1—S-curve variations as the ratio-discriminator transformer is adjusted.

However, when the zero-volt reference level is developed by a suitable blanking network in the sweep-generator circuits, the zero-volt level does not remain fixed in position on the scope screen—it will move up or down the screen as the tuned circuits are adjusted, and the shape of the response curve changes.

A clear distinction must be made between the zero-volt reference level on an a.c. scope and the resting position of the beam when no signal is applied. Unlike a d.c. scope, an a.c. scope displays the zero-volt reference level and the resting positions at different heights on the screen. Fig. 2 shows an i.f. response curve, with a zero-volt reference base line developed by the sweep generator, and the resting position of the beam, as displayed on the screen of an a.c. scope. The zero-volt reference level appears below the resting level of the trace. This is the essential distinction between displays on a.c. scopes and d.c. scopes.

The zero-volt reference level can be developed by the sweep generator in various ways. One of the simplest means of developing a zero-volt reference level is shown in Fig. 3. A pair of contacts in an automobile-radio vibrator rapidly short the input terminals of the scope during operation.

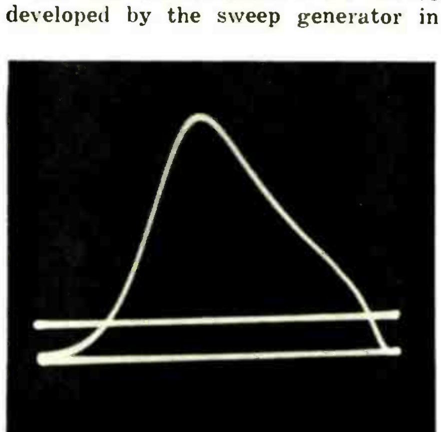


Fig. 2—No-signal position at different level than zero-volt reference line.

Shorting out the input signal to the scope at rapid intervals makes the beam fall to the zero-volt level many times during the forward sweep. The action is similar to that of an electronic switch, except that in this case the action is that of a mechanical switch.

When the zero-reference function is built into a sweep generator at the factory, a mechanical switch is not used—it is more convenient to design an electronic switch. The electronic switch is in fact a keying bias (square-wave voltage), that is applied to the grid of the swept oscillator in the generator. The keying bias changes from maximum to minimum voltage 60 times a second, to synchronize with the horizontal sweep rate in the scope. However, synchronism is not essential to satisfactory keying, so the random switching of the auto-radio vibrator will provide an entirely satisfactory display.

Landmarks

The technician should learn to look for various "landmarks" as soon as the receiver chassis is placed on the bench. Some of these are the peaking coils in the video-detector circuit, which are suitable points for scope connection in

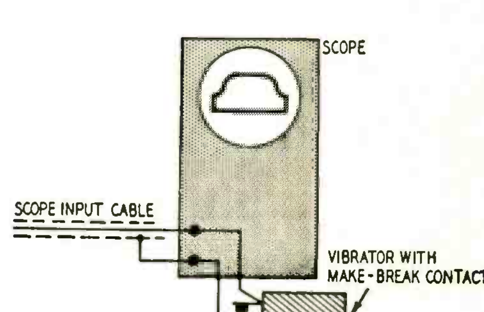


Fig. 3—Developing a zero-volt reference line for use with an a.c. scope.

i.f. alignment; and the mixer tube, a suitable point for capacitive injection of the sweep signal into the i.f. input circuit.

The a.g.c. bus, to which the d.c. returns are made from the grid circuits of the i.f. amplifier tubes, usually can be located without using a circuit diagram for the receiver. Most of the present-day tubes used in i.f. amplifiers have pin 1 as the control grid, and unless unfamiliar i.f. transformers are used in the receiver under test, it is easy to pick out the return point of the grid circuit, which identifies the a.g.c. bus. Fixed d.c. bias should be applied between the a.g.c. bus and chassis ground to stabilize i.f. amplifier operation during alignment and to set the gain at a suitable point.

When the front end is of a famliar type, the local-oscillator tube can be quickly located. In the majority of cases, the technician will reach for a dummy oscillator-mixer tube which he has made up.

The output of the video amplifier is usually easy to locate, also; it consists of the final pair of peaking coils in the signal-circuit line-up, and the output from this set of coils is fed to either the grid (green lead) or to the cathode (yellow lead) of the picture tube. Although the video amplifier is not always checked during an alignment job, complaints of poor picture quality are sometimes traced to this section.

Override bias battery

Receiver manufacturers usually state that override bias should be applied to the i.f. amplifier to stabilize the output and control the gain during alignment. This override bias is essential in the case of keyed a.g.c. systems, because the keyed a.g.c. circuit is normally operated by horizontal sync pulses having a frequency of 15,750 cycles. When a 60-cycle alignment voltage is applied, the a.g.c. circuit becomes unstable and the forward trace usually has a different shape from the return trace. However, when override bias from flashlight cells is applied to the grids of the i.f. amplifier tubes, the a.g.c. circuit is stabilized, and trace and retrace have the same shape.

Many technicians open the a.g.c. bus from its driving circuit for application of the override bias. This can be done, if desired, but it represents a waste of time, because the stabilization is not affected by opening or closing the circuit. The a.g.c. circuit has a high impedance, and when a low-impedance voltage source, such as flashlight cells, is shunted between the a.g.c. bus and chassis ground, the low-impedance source fixes the voltage in the circuit. Hence, disconnection of the a.g.c. bus is not required.

About −3 volts is generally used for override bias application, but, as will be discussed in future articles, special alignment jobs arise where a greater or a lesser value of override bias may be more suitable.

Transformer, or transformerless?

Some receivers are of the transformerless type. They may or may not have a hot chassis. The hot chassis types have one side connected to the power line. The possibility of having hot-chassis sets to work on makes a line-isolation transformer at the service bench essential, to avoid the possibility of shock, due to the operator touching the chassis while standing on a damp floor, touching a conduit, pipe, or other ground path.

Using a line-isolation transformer also protects the test equipment. Instrument cases are usually grounded to avoid minor shocks to the operator when he touches the metal portions of the equipment. Minor shocks result from the use of shunt capacitors in the line filters of the test instruments; these line-filter capacitors conduct a small current, sometimes sufficient to be felt by the operator. Hence it is common practice to ground the instrument cases.

Since instrument cases are grounded, connecting the instruments to a hot-chassis circuit can result either in blown fuses, or in burned-out components in the instruments. The line-isolation transformer prevents such damage.

Standing-wave distortion

Standing-wave distortion is a most troublesome alignment bug, especially when the technician is unaware of its basic cause. Standing-wave distortion shows up as a change in the shape of the response curve due to body capacitance in the vicinity of the instruments or the TV chassis, and appears as shown in Fig. 4.

There are at least two types of standing wave distortion. One occurs *inside* the sweep-output cable, the other occurs *outside* the sweep-output cable. Standing waves are generated inside the sweep-output cable when the cable is improperly terminated. The sweep-output cable is usually connected to a light load, such as a floating tube shield over the mixer tube. This floating tube shield represents a very light capacitive load at the end of the sweep-output cable, and does not provide the required termination (impedance match).

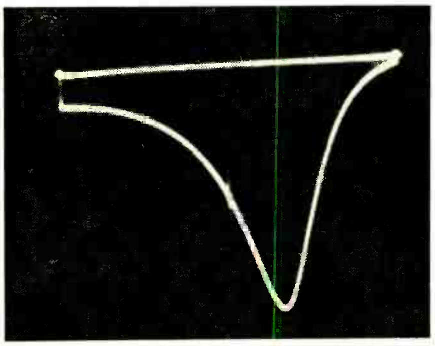
To terminate a sweep-output cable properly, it is usually necessary to shunt a 75-ohm carbon resistor across the end of the cable. The termination is sometimes provided by the manufacturer of the instrument. It is essential to use a carbon resistor for termination, because a wirewound resistor will have high inductive reactance at intermediate alignment frequencies, and will fail to provide a proper termination.

When a sweep-output cable is not terminated in its own characteristic impedance (usually 75 ohms), a peculiar situation results. Not all of the electric energy flowing down the cable is absorbed by the load. Some of the downcoming energy is reflected back up the cable again. This reflected energy interferes with the incoming energy at half-wave points, and as the generator sweeps through the frequency band, these interferences, sometimes called "hot" spots and "cold" spots, oscillate along the cable, back and forth, at a 60-cycle rate. The generator will then deliver a higher voltage to the load at one frequency, and a lower voltage at another.

The response curve is distorted by the abnormal voltages. But there is a distinguishing characteristic which is very important to the working technician—the curve shape changes when a terminating resistor is shunted across the end of the output cable, but the curve shape does not change when the technician moves about or touches the test instruments.

If the curve shape changes when a dial or cable is touched, standing-wave distortion is present as a result of sweep voltage on the outside of the instruments and cables. In some cases sweep voltage spreads out over the outside of the cable because of improper termination, but more often the sweep voltage spreads along the outside of the cable from the generator end. Faulty connectors, for example, are often responsible for sweep voltage leaking from the generator to the outside of the cable.

One of the standard methods for minimizing trouble from standing-wave voltages of this type is to ground all the test instruments together. A business-like way is to mount all the instruments in a rack-and-panel assembly, which can in turn be grounded to a water pipe. More often than not a water pipe will not be close at hand. In such an event use a heavy copper strap to connect all instrument cases and run the strap to a water pipe or a copper rod driven into the earth. Where possible, solder the copper strap to the instrument cases and, of course, to the grounded rod. END



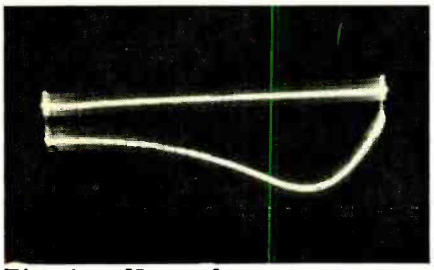


Fig. 4-a—Normal response curve. 4-b—Curve changes shape when sweep-generator tuning dial is touched.

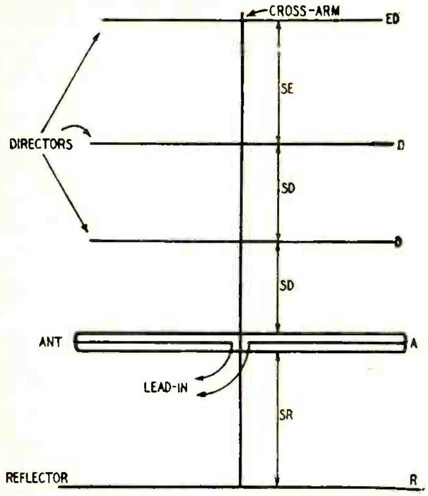


Fig. 1—A five-element Yagi antenna showing length of reflector and directors, and spacing between them.

ELEMENT SIZES for UHF ANTENNAS

By MATTHEW MANDL

THE antenna dimensions given in Table I can be used in constructing u.h.f. antennas such as the Yagi, the bowtie with reflector, and the bowtie with a flat screen or corner reflector. Since antennas have a slightly broader response at the ultra-high frequencies, and differences in element lengths are small, the table has been prepared in quarter-inch steps for the antenna elements. Thus the unnecessary fraction-of-an-inch measurements are minimized. In a number of instances a set of dimensions covers from two to five channels. As shown in Fig. 1, the lengths given in Table I apply to the total length of the antenna, director, reflectors, and spacings between.

Yagi antennas have high gain, and the 4- or 5-element types can be used over several adjacent channels. If greater gain is desired, 6- or 10-element Yagi antennas can be constructed. Generally, these will be useful only for the particular channel for which they are cut, and orientation will be very critical. The table can also be used for construction of broad-band u.h.f. Yagi antennas. The broad-band types, however, have less gain than a Yagi designed for a specific channel. (See "Broadband Yagi Antennas," page 45 of the September, 1953, issue of RADIO-ELECTRONICS.)

When constructing the u.h.f. Yagi, all directors except the last one should have the dimension shown in column D. Thus, if a Yagi has six directors, the first five (from the antenna) have the dimension given in column D for the channel desired, while the last director has the length given in column ED. The end director (ED) is also spaced from the last director by a greater distance than the others, as given in column SE.

For v.h.f., maximum gain is obtained when reflectors are spaced 0.15 wavelength from the antenna, while directors are spaced 0.1 wavelength. Since the same *diameter* elements are used for u.h.f. (one-quarter to one-half-inch stock), spacings given in Table I are somewhat greater to minimize capacitance effects between elements, and aid in keeping the antenna impedance up. An ordinary folded dipole will result in a greater impedance drop than the double-folded dipole shown in Fig. 1. Thus, the double-folded dipole is recommended, plus the use of one-quarter-inch diameter aluminum or copper tubing. Space the folded-dipole sections no farther apart than the diameter of the tubing used. The crossarm should be metal; it should interconnect the reflector, all directors, and the unbroken elements of the antenna. Make sure the elements are mounted *directly at their center*, within a quarter inch.

The bowtie antenna can pick up any u.h.f. channel if it is cut for the lowest channel to be received. Thus, a bowtie designed for channel 14 can pick up all the other channels if the signal strength of the stations is sufficient and the antenna is oriented correctly. The bowtie however does not have the gain of the Yagi. Dimensions given in Table I are used for the illustrations in Fig. 2. The bowtie can be mounted on an insulator, while the folded-dipole element of Fig. 1 is usually very rigid and an insulator is unnecessary. (Air is the best insulator, and does not accumulate the dirt, grit, and moisture which affect u.h.f. reception so much.)

When antennas are double-stacked, gain is increased approximately 3 db. Thus, a 4-element u.h.f. Yagi with a gain of 8 db can be stacked to give a gain of 11 db. If *four* such types are stacked, the gain will be 14 db. An 8-bay stack has a gain of 17 db. You must double the number of elements (bays) in an array to increase the gain 3 db. Stack the antennas at a distance equal to the antenna length (Column A).

Two Examples

We wish to construct a 6-element Yagi as shown in Fig. 1, with an additional director, to be used on channel 28. Table I indicates that the dimensions given for channels 27, 28, and 29 apply. Thus, the reflector is 10.5 inches, the radiator (A) is 10 inches, and the next three directors are 9.5 inches each. The last director is 8.5 inches. Spacing between the reflector and antenna is 4.75 inches, and between the first three directors, 4 inches. The spacing between the last two directors is 5.5 inches.

We wish to construct a bowtie with corner reflector, to cover channels 14, 26, and 30. The antenna is cut for the lowest channel and is 12 inches wide. Two screens are used to form the cor-

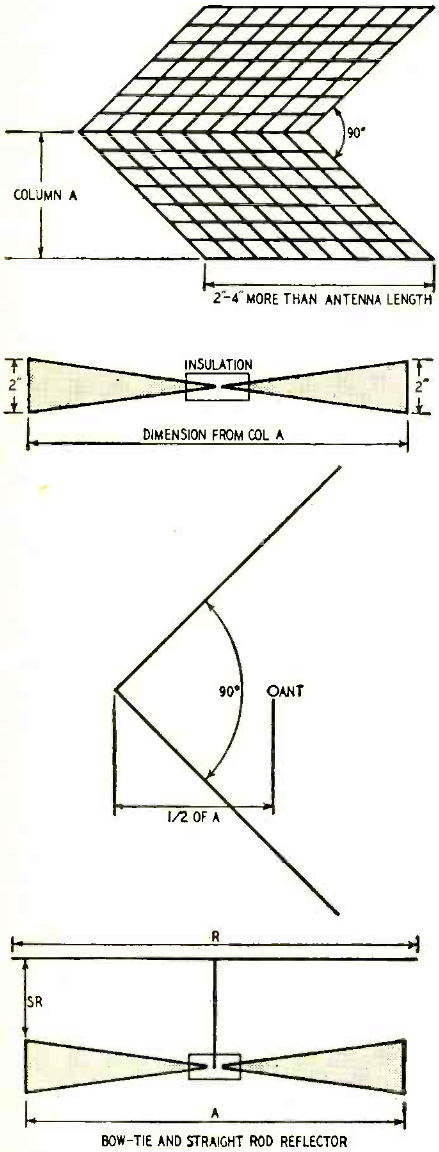


Fig. 2—Diagram indicates all dimensions of the bowtie antenna and screen and straight-rod reflectors.

ner reflector, each 12 by 16 inches wide. The bowtie is spaced 6 inches from the center of the screen.

TABLE I

Dimension in inches

Channel Numbers	R	A	D	ED	SR	SD	SE
14	12.5	12.0	11.5	11.0	6.0	5.0	7.0
15	12.25	11.75	11.25	10.25	5.75	4.75	6.75
16-17	12.0	11.5	11.0	10.0	5.5	4.5	6.5
18	11.75	11.25	10.75	9.75	5.25	4.5	6.25
19, 20	11.5	11.0	10.5	9.5	5.0	4.5	6.0
21, 22	11.25	10.75	10.25	9.25	5.0	4.5	6.0
23, 24, 25	11.0	10.5	10.0	9.0	5.0	4.0	6.0
26	10.75	10.25	9.75	8.75	5.0	4.0	6.0
27, 28, 29	10.5	10.0	9.5	8.5	4.75	4.0	5.5
30, 31	10.25	9.75	9.25	8.25	4.75	3.75	5.5
32, 33, 34	10.0	9.5	9.0	8.0	4.75	3.5	5.5
35, 36, 37	9.75	9.25	8.75	7.75	4.5	3.5	5.25
38, 39, 40	9.5	9.0	8.5	7.5	4.5	3.5	5.25
41, 42, 43	9.25	8.75	8.5	7.5	4.25	3.25	4.75
44, 45, 46	9.0	8.5	8.25	7.5	4.25	3.25	4.75
47, 48	8.75	8.25	8.0	7.25	4.0	3.25	4.5
49 to 53	8.5	8.0	7.75	7.25	4.0	3.0	4.5
54, 55, 56	8.25	7.75	7.5	7.0	3.5	3.0	4.0
57 to 61	8.0	7.5	7.25	6.75	3.5	3.0	4.0
62, 63, 64	7.75	7.25	7.0	6.5	3.5	2.75	4.0
65 to 70	7.25	7.0	6.75	6.25	3.5	2.75	4.0
71 to 75	7.25	6.75	6.5	6.25	3.25	2.5	3.75
76 to 81	7.0	6.5	6.25	6.0	3.25	2.5	3.75
82, 83	6.75	6.25	6.0	6.0	3.0	2.5	3.5

U.h.f. installation factors

1. Mount antenna at least six feet away from tin roofs, metal rain gutters, or other metallic objects.

2. Use high-grade, low-loss standoff insulators. Never tape the lead-in directly to the mast.

3. Use high-grade transmission line, such as the tubular two-wire line or the new u.h.f. open-wire line. Space well away from parallel-running rain pipes or metal conduit.

4. Use a short lead-in from the antenna to the receiver, and leave only enough slack behind the receiver so it can be moved for cleaning. Never leave a coil of lead-in lying behind the receiver.

5. If possible, explore the antenna mounting site by moving the antenna around to find an area where u.h.f. signals are highest.

6. If a tubular line is used, seal up the top to keep water out, and punch a few drain holes in the line where it enters the home.

7. If the station is over 25 miles away and is transmitting with low power, or if your converter or receiver is faulty, u.h.f. reception will suffer. Check these facts before condemning the antenna system.

8. Orient antenna carefully for best signal strength. This is particularly important with Yagi antennas.

9. For lasting results, the application of a clear plastic spray on the antenna and insulators will assure good performance.

10. In hilly terrain a slight upward tilt of Yagi or stacked antennas may increase signal strength.

11. Try a section of tin foil or aluminum foil 8 inches long, wrapped around the transmission line near the converter or receiver. This helps tune some frequencies better than others when slid up and down. (Not applicable to open-wire line.)

12. If u.h.f. stations seem to drift, check the crystal mixer in the converter, or check the local oscillator tube in the receiver. END

NEW TV REMOTE CONTROL

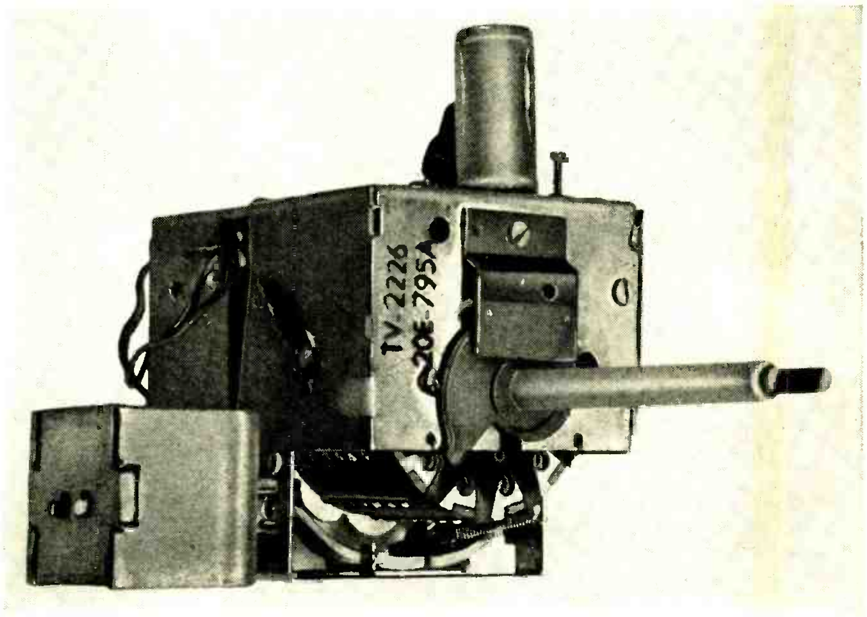
A new and low-cost approach to the problem of tuning a television receiver from a distance is the *Controlmaster*, which uses the stepping-relay principle. A ratchet-paw solenoid mounted on the tuner operates the cam ratchet usually located at the center of the tuner drum. The present model—made by the Mercury Marine Electric Co., San Francisco—is adapted to the widely used Standard Coil tuner.

Pressing the remote solenoid control button energizes the solenoid armature and moves the channel selector one notch.

The *Controlmaster* is mounted on the rear of the tuner where the dust cover is usually located—a new cover is furnished to replace it.

Besides the rachet-paw assembly, the control unit includes 25 feet of 8-conduit cable and a remote-control assembly consisting of an on-off switch, volume control, contrast button, and solenoid control button.

The new control is remarkably simple in design and apparently equally positive in operation.



THE CORE OF THE MATTER

In Buenos Aires (see photo) we have our servicing headaches as anywhere else. I recently went out on a routine service call involving a Zenith model 19K20. The owner complained that the horizontal sync was completely out.

The horizontal sweep circuit of this receiver uses the Gruen a.f.c. system which I have found to be extremely stable. The only control requiring adjustment is the iron core of the oscillator coil in the front of the set. It has a control knob with a stop that permits only one rotation of the core. If you take off the knob, the core can be rotated through several turns. This is done in cases where it is necessary to compensate for some change in operating conditions.

When I inspected the set the a.f.c. was working properly but the horizontal oscillator was away off its normal frequency.

I changed the 6NS7 horizontal oscillator and the 6AQ7 a.f.c. tube—no luck. I then pulled the chassis to check for a possible defective capacitor in the oscillator tank. I changed the suspected capacitors—still no luck. After making all the usual measurements without finding the trouble source, I was ready to tell the customer that it would be necessary to take the set to the shop for a more extensive checkover.

In moving the chassis, I saw a piece of iron core—a part of the horizontal coil's core that had broken off and fallen out. The remainder of the core was unable to bring the oscillator to its correct frequency. A drop of cement applied to the core fixed everything.

—*Egon Strauss*

COLOR TV CIRCUITS

Part VI—The three-gun picture tube and its control circuitry

By KEN KLEIDON* and PHIL STEINBERG*

THE first five articles of this series covered circuitry of color receivers using the three-gun color picture tube. It was pointed out that the majority of these circuits would also be found in the single-gun (Lawrence) tube receiver. A later installment will cover circuits required specifically for the single-gun tube receiver. This article will deal with the operation of a three-gun type picture tube.

To understand the operation of a three-gun color picture tube consider the tube as three separate picture tubes in one glass envelope. Each of the three separate picture tubes has an individual filament, cathode, control grid, accelerating anode (screen grid), focus anode, and phosphor-dot screen identical to a monochrome or black-and-white picture tube. The only difference between the three separate picture tubes is the color of the screen. One has a red phosphor-dot screen; the other two colors are blue and green, which comprise the three primary colors necessary to produce a color picture. The filaments are connected in parallel and the focus electrodes are tied together internally. Fig. 1 shows the essential elements and base connections of a three-gun picture tube.

Two components in a three-gun picture tube not found in a black-and-white tube are a shadow mask and a convergence electrode. These are required for mechanical reasons and to assure that the proper electron beam strikes the correct phosphor dot at the right time.

Most black-and-white picture tubes require an ion-trap magnet. It must sometimes be adjusted during installation. A color picture tube does not require an ion-trap magnet. Instead, it has a purity coil which must also be adjusted. The purity coil is located behind the deflection yoke (Fig. 2). Its function is to align the three electron guns by an electromagnetic field so that the beam from each gun strikes only its own phosphor dots. A pure red field is desired when only the red gun is operating and pure blue only when the blue gun is operating. The electron beam from the red gun must strike only red phosphor dots, electrons from the green gun must strike only green dots, and blue phosphor dots must be illuminated only by the electron stream from the blue gun.

The deflection yoke on a color picture tube performs the same function as on a black-and-white tube. The only other new components for a color tube are the convergence magnets. Three are provided (one for each gun). Their action is to deflect their respective beams so they converge at the same hole in the shadow mask. Then each beam strikes only its own proper phosphor dot at the correct time, thus preventing color fringing. (See Fig. 3.)

Only one brightness control is necessary for a black-and-white picture tube. A three-gun color tube has an individual brightness control for the blue and green guns and a master brightness control which affects the brightness of all three guns. This is shown in Fig. 4-a. An individual red brightness control is not needed as the red phosphor is the least efficient of the three. The blue and green brightness controls are adjusted to obtain a balance using red as a reference.

In black-and-white receiver design the accelerating anode or screen grid voltage is fixed at a predetermined level. Due to nonuniformities and varying cutoff characteristics of each gun, individual screen controls are necessary for a three-gun picture tube. Also required are a high-potential focus and convergence electrode voltage. Corresponding controls are provided. These controls are shown in Figs. 4-b and 4-c, respectively.

Since the face plate on which the red, blue, and green phosphor dots are deposited is flat (in the RCA 15-inch tube, for example), the distance that the three electron beams travel to reach the center or an edge of the tube varies. If there was no compensation for this variation, both the focus and convergence would change and present an unsatisfactory color picture. For this reason both the focus and convergence potentials are varied by a parabolic waveform obtained from the horizontal and vertical deflection circuits to compensate for the distance changes in electron beam travel. The parabolic waveforms vary the focus and converge potentials so as to provide correct convergence and focus over the entire viewing screen.

Figs. 5-a and 5-b illustrate the parabolic waveforms usually obtained from the cathodes of the horizontal and vertical output tubes after they are applied to wave-shaping networks and amplifiers. Fig. 5-c shows the combined waveforms which are applied to the focus and convergence electrodes. Amplitude, phasing, and wave-shaping controls are provided to adjust the parabolic waveforms to the proper size and shape to correct for mechanical deficiencies of the three-gun color picture tube. The d.c. convergence and focus controls are usually referred to as static controls and the controls which affect the parabolic waveforms are referred to as dynamic controls.

The set-up or installation adjustments of a color picture tube are identical to a black-and-white tube in that the same controls must be adjusted in basically the same manner. The vertical size, linearity and centering, horizontal size, drive, linearity and centering as well as the hold controls, etc., must be properly adjusted before the controls

*Raytheon Manufacturing Company, Television and Radio Division.

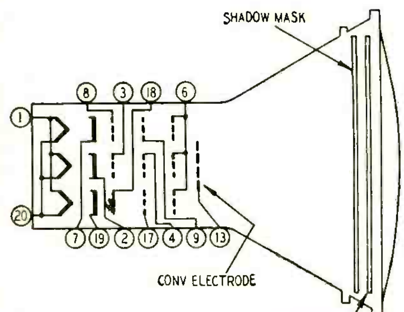


Fig. 1—The three-gun picture tube.

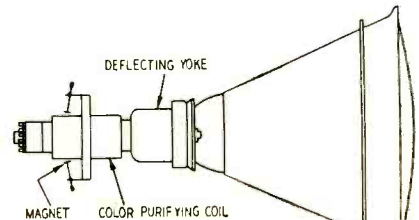


Fig. 2—Location of the purity coil.

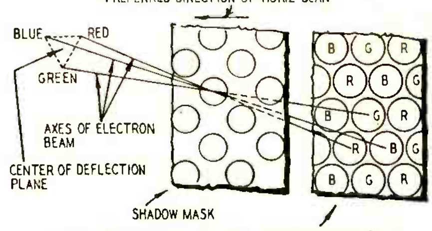


Fig. 3—Proper convergence action.

typical of a color tube are attempted. Then the first step would be to adjust for color purity.

Purity Adjustments

1. Turn contrast control to minimum.
2. Turn blue and green screen controls to minimum. Turn red screen control to maximum.
3. Adjust master brightness control for average brightness.
4. Position yoke for small red field raster in center of screen.
5. Adjust purity coil positioning and current control for pure red field.
6. Repeat steps 4 and 5.
7. Check purity of blue and green fields and compromise the settings of the purity adjustment, if necessary, to secure best red, blue, and green fields.

Convergence Adjustments

1. Connect dot generator to receiver.
2. Turn horizontal and vertical convergence amplitude controls to minimum.
3. Turn d.c. convergence control to minimum.
4. Adjust screen controls for equal size color dots.
5. Adjust convergence magnets for equal spacing between color dots at center of tube. Must form an equilateral triangle.
6. Adjust d.c. convergence control until color dots at center of tube come together and form a white dot. Readjust convergence magnets if necessary.
7. Adjust horizontal convergence phase and amplitude controls until center horizontal line converges.
8. Adjust vertical convergence shaping and amplitude controls until center vertical line converges.
9. Repeat steps 6, 7, and 8 until only white dots appear over entire face of tube.

The dot generator recommended for the convergence adjustment is not an absolute requirement as a cross-bar generator will serve equally as well.

Color Balance

1. Turn the chroma and contrast controls to minimum.
2. Adjust master brightness control for high brightness.
3. Adjust red, blue, and green screen controls for a light gray or a low-brightness white picture.
4. Turn contrast control to its center adjustment position.
5. Adjust the blue and green video gain controls for a satisfactory black-and-white picture.
6. Adjust master brightness control for a low-brightness-level picture.
7. Adjust blue and green brightness controls for a satisfactory picture.
8. Turn master brightness and contrast controls from maximum to minimum and observe picture. If a change of picture color is noticed, repeat procedure.

The above adjustment procedures are not presented to be used as a step-by-step adjustment method but only as a general outline to give service technicians who are unfamiliar with or who have never attempted color picture tube adjustments an idea of the procedure to be followed. The manufacturer's service literature should be consulted, the specified equipment used, and the procedures outlined should be carefully followed. See also RADIO-ELECTRONICS, May 1954 issue on P. 35.

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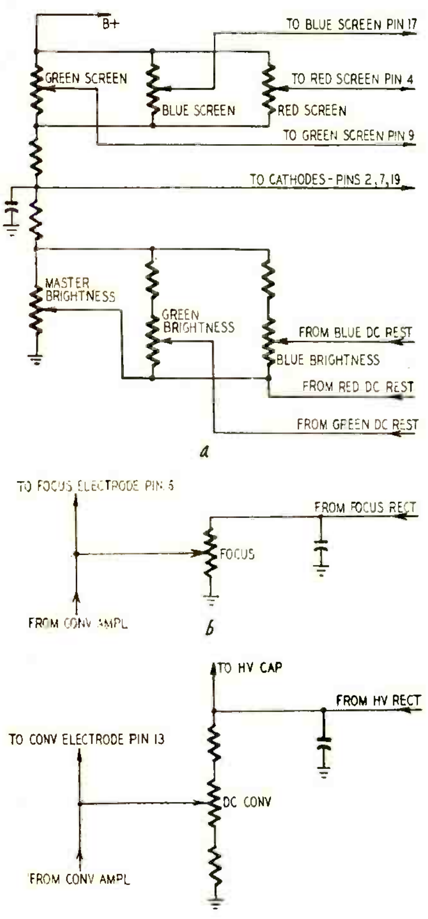


Fig. 4—Various circuits necessary for three-gun color tube operation.

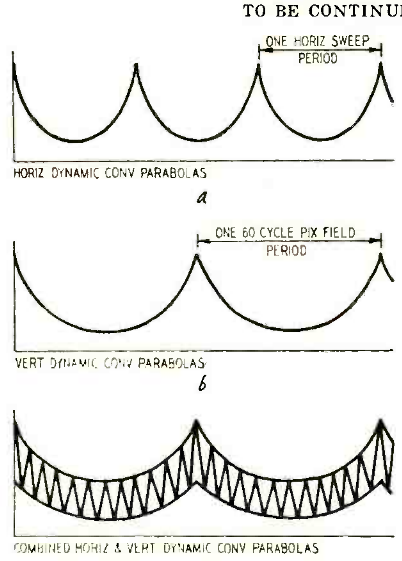


Fig. 5—Waveforms that are applied to the focus and convergence electrodes.

MECHANICAL BUGS ARE DEADLIEST

By MILTON LOWENS

PROBABLY it could never happen again but . . .

I remember the set well—it was a Du Mont RA-110A—not only because of its weight, which was considerable, but because of the trouble it gave me. The complaint was routine: no pix, no sound, raster O.K. I considered the facts on my way over and wondered how long it would take to fix the set. I made a small bet with myself that I would hit the bad tube in the tuner on the first try. It couldn't be the r.f. amplifier (some sound usually gets through), so it would be either the mixer or the oscillator. I hoped it would be the mixer—the list price of the 6AK5 is higher than that of the 6AB4 and I could use the money.

I lost my bet. I didn't hit the tube on the first try, nor the second, nor the third. The set was lively enough. Auto ignition noise came roaring through. Scraping the antenna leads on their terminals gave plenty of noise and flashes on the picture tube. Tuner trouble, I decided. That's when I found out the weight of the chassis. The nice old widow looked sympathetic as I staggered out.

I should have used my signal generator once I got the set on the bench, but I was sure I knew what the trouble was—one of the sliders was not touching the ends of one of the coils—or the trolley was off the wire. I had heard of these Inductuner troubles although I never had tried to fix one. I was not so sure I could. Unpleasant visions arose involving a big bill for a replacement tuner and the sad face of the nice old widow who obviously was not too well fixed.

First thing to do though was to see just what had failed. This meant removing the aluminum cover over the coils. Why is it that so many otherwise well-engineered sets make things so tough for the service technician? Did *you* ever try to get one of these covers off without taking the whole tuner out of the chassis? Well, I did what I had seen plenty of evidence of others having done: I removed the accessible top screws and pried the cover high enough to peek in.

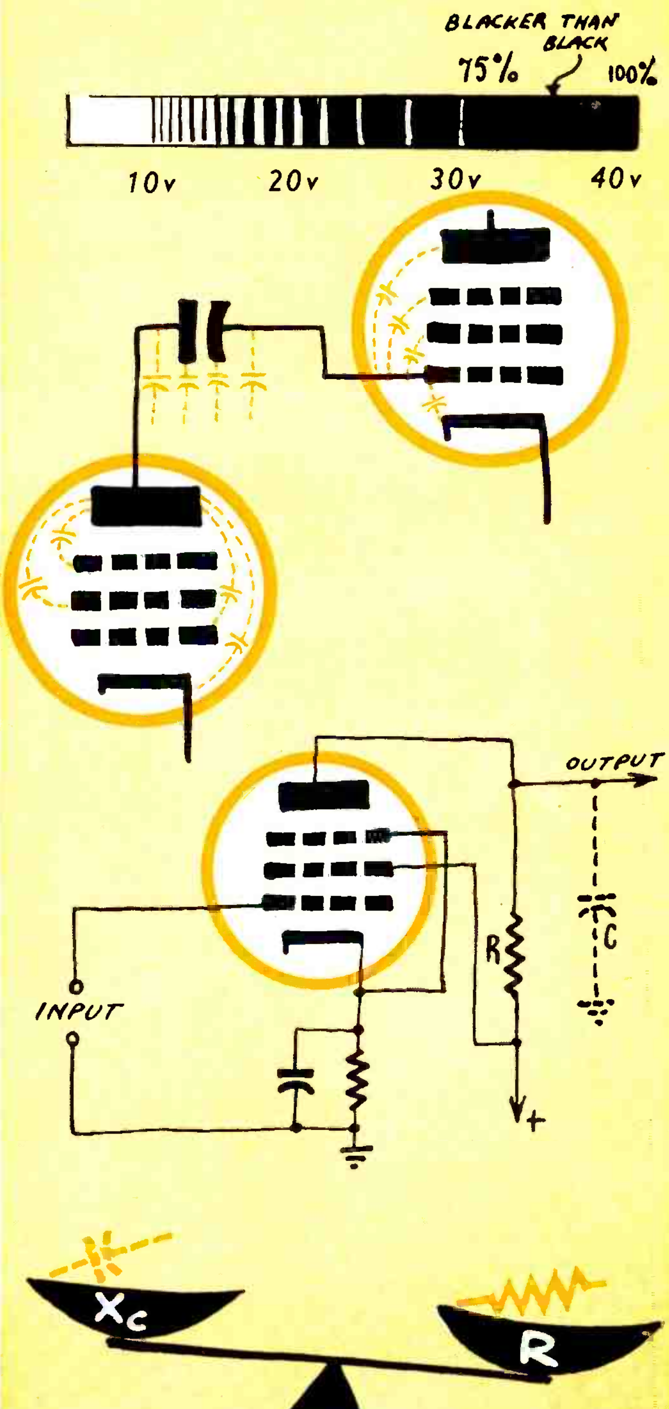
Everything looked fine. All voltages, measured from above with the tubes out of the sockets, were normal. In disgust I twirled the tuning knob to hear the sound of the many gears in the special dial. Everything turned nicely *except the concealed shaft in the tuner* on which the coils were mounted. The trouble? *Both* Allen-head setscrews on the dial drive collar were loose and the coils stopped at a dead spot!

I happily tightened the setscrews and returned the receiver to its original condition. I had learned a lesson—a television set is an electrical device but it is made of mechanical parts. END

TELEVISION... it's a cinch

By E. AISBERG

Thirteenth conversation, second half: Parasitic capacitances; value of load resistors; high-frequency compensation.



Video is not audio

WILL—Now that we've finally got our video frequency clear of its carrier, all we have to do is amplify it. That shouldn't be too much different from amplifying the audio frequencies in a radio receiver, except for the wider frequency band you have to amplify. And with the frequencies 'way up in the megacycles, I suppose you have to be pretty careful of stray wiring capacitances?

KEN—That's for sure! But that's not the only difference between a.f. and v.f. Fortunately, some of the differences are in our favor and make our problems easier instead of harder. For instance, we need only a *voltage* to control the picture tube's electron beam at the output of our amplifier, rather than *power* to operate a speaker.

WILL—So we have to put out volts instead of watts? Fine—voltages are easier to calculate! And what are the other differences between a.f. and v.f.?

KEN—Another important difference is that we don't need nearly as much gain as the average audio amplifier. To vary the brilliance of the spot from a good white to a good black needs only 20 to 30 volts. You usually get about a volt at the detector output. Therefore—in spite of the things that tend to cut down the gain in a video amplifier—one stage is enough in most cases. A few models do have two video stages, though.

WILL—And the "things that tend to cut down the gain" are tied up with the high frequencies and problems of stray capacitances?

KEN—You've guessed it! The video amplifier uses the old reliable resistance-coupling system. And—right across the coupling resistor, which is R in this diagram—you have a capacitance that may run up to 30 $\mu\mu$f.

WILL—I see. And that capacitance is made up—I suppose—from the capacitance between the plate and the various other electrodes in the tube, plus the wiring capacitances?

KEN—Pretty good! All you've left out is the input capacitance of the following tube—between the grid and cathode of the picture tube, or (if you are feeding into the second of two video stages) the grid and cathode of the following amplifier.

WILL—H'm-m, with all these parasitic capacitances, the reactance at 4 mc would be less than a couple of thousand ohms. That means if we use a 100,000-ohm load resistor, same as in radio—all the higher frequencies would be shorted around it, and the high-frequency gain would be zero. So we lose all the highs—I mean detail—on our image.

KEN—Fine. You've analyzed the causes of the trouble, so you shouldn't have much trouble supplying a remedy?

WILL—Well, I suppose we'll just have to throw away some more efficiency. So, we'll have to cut the load resistor down to a value that's comparable to the reactance of C at the highest frequencies the amplifier will have to handle. But—if we cut R down to 2,000 ohms or so the gain will be pretty low. With such a low resistance, we're going to need a lot of plate current to get any gain at all! So our tube will have to be a pretty powerful one. . . .

KEN—You're right all the way! As with the r.f. and i.f. amplifiers, we need a tube with high transconductance. The gain is—under these conditions—practically equal to the product of the transconductance and output impedance of the amplifier.

WILL—Then TV is based on waste all the way down the line! We invent remarkable special tubes, then use them at a fraction of their possible amplification, damp our tuned circuits, cut down our load resistors . . . ! What a life! !

KEN—Don't worry, Will. The main thing is to get enough signal at the output. In spite of all the inefficiency and low gain we usually manage to do that.

Improving the response curve

WILL—I'm thinking along radio lines, as usual. So I wonder why we can't help out our high-frequency response with some kind of "treble boost" that will accentuate the higher frequencies?

KEN—A good question! And the answer is—they *do* use such a "boost" on all receivers. The job is done with small inductors, placed either in series or parallel with the parasitic capacitance, or in both positions. In *parallel* compensation, the winding L1 is placed in series with the load resistor R, as you see. When the value is correct, the response in the high-frequency direction is considerably improved.

WILL—I suppose L1—together with the stray, or parasitic, capacitance—is tuned to the high frequencies you want to reinforce. Then its impedance increases a lot at those frequencies and is added to load resistance R, so the apparent plate load (and therefore the stage gain) will be higher over a small range of frequencies in the upper video range?

KEN—That's just about it. In fact, it's even a bit better, for L1 neutralizes the effect of the parasitic capacitance and to some extent therefore increases the plate load over the whole range of frequencies. And we can get the same result—or even a little better one—by *series peaking*. A winding L2 is placed in the output circuit of the stage in such a way as to divide into two parts (C2 and C3) the parasitic capacitance. In some cases L2 may be shunted across the resistor of the same order of resistance as R. The coil is often wound right on the resistor.

WILL—The circuit looks like a low-pass filter.

KEN—That's just what it is, but it has a very high cutoff point. But to be really valuable as a filter, the capacitances C2 and C3 should be in a certain ratio. And of course—with these wild capacitances—it's pretty hard to be sure of anything. . . .

WILL—Didn't you say a while ago that we could combine both types of compensating circuits in a single video amplifier stage?

KEN—I did. And a combination of series and parallel peaking really does do the work! It gives you an excellent response curve, and permits an increase of gain by further increasing the value of R. But all the elements must be carefully calculated and precisely adjusted.

WILL—Effective, eh? Can you use these circuits on two-stage video amplifiers, too?

KEN—Of course. But isn't it getting a bit late? Suppose we continue our studies some other time.

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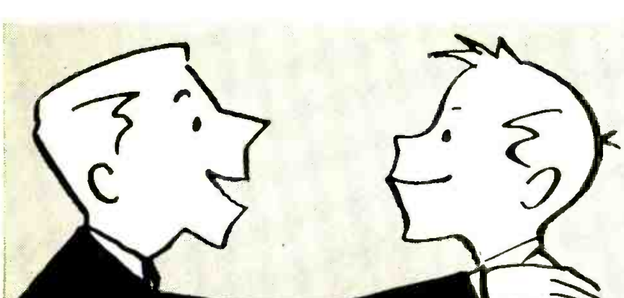
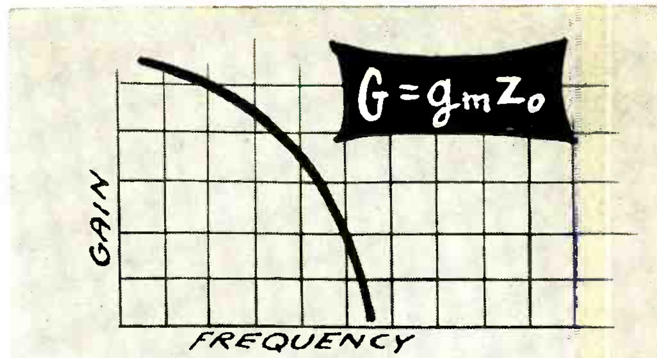
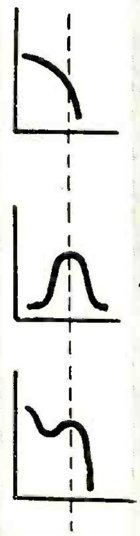
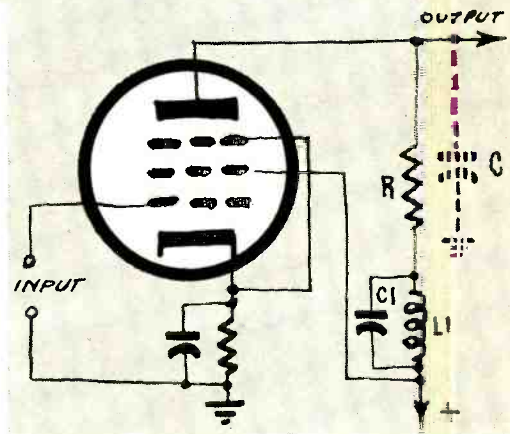
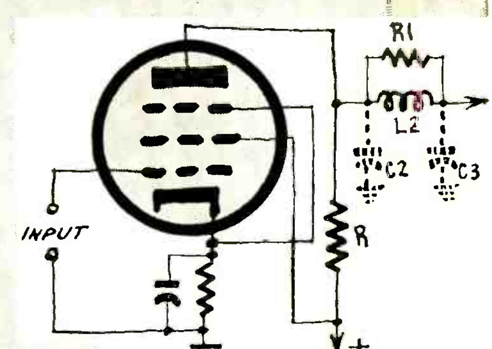
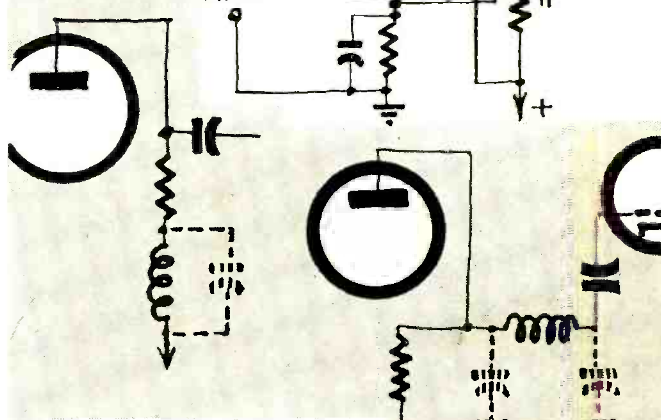


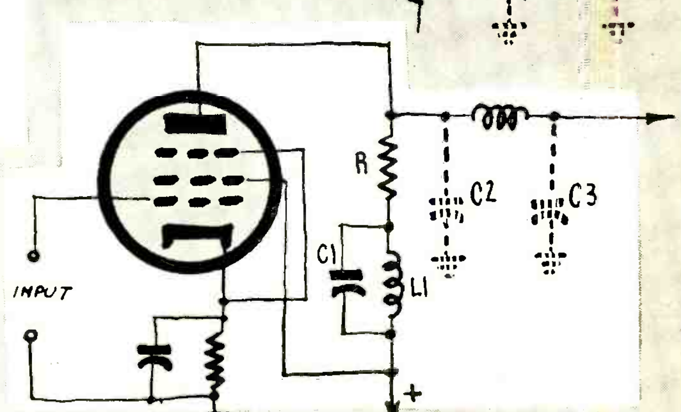


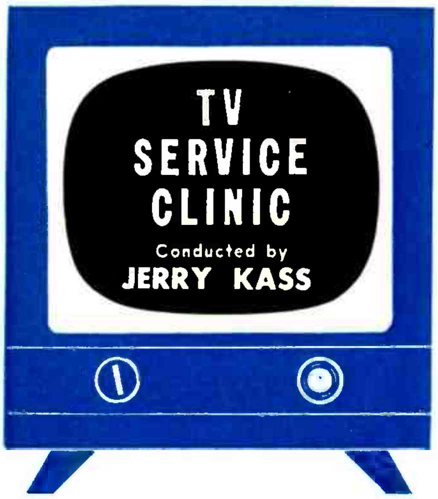












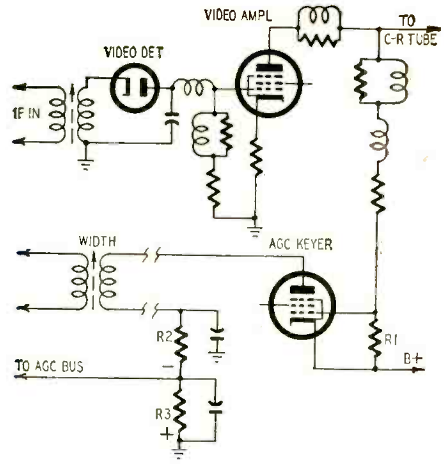


Fig. 1—Basic keyed a.g.c. circuit.

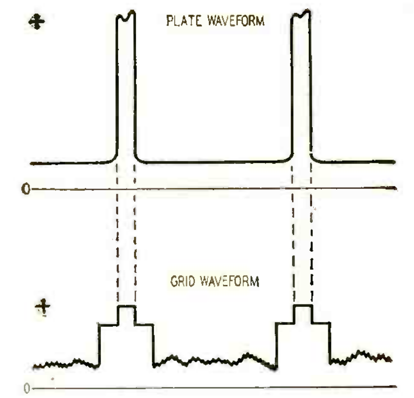


Fig. 2—Waveforms on the a.g.c. keyer.

THE purpose of a.g.c. in a TV receiver is to vary the gain of the r.f. and video i.f. amplifiers to maintain a constant signal level at the input to the video amplifier. By feeding the rectified i.f. signal into a special circuit that develops a negative bias voltage in proportion to the strength of the signal, and then feeding this negative voltage to the grids of the r.f. and video i.f. amplifiers, a constant-amplitude signal can be obtained.

Under normal conditions, a simple a.g.c. circuit will provide satisfactory operation—under difficult conditions, it falls short. The standard a.g.c. circuit is a slow-moving affair. It must rectify the video i.f. signal and filter it to obtain a d.c. voltage. Because of the relatively long vertical pulses, the a.g.c. filter must be capable of smoothing out signal components as low as 60 cycles. Such a circuit would obviously not follow a signal rapidly varying in strength.

The principal enemy of the simple a.g.c. circuit is noise—especially in areas where the signal-to-noise ratio is low. Noise usually appears as sharply peaked impulses that are amplified and rectified along with the signal. A prolonged noise condition acts the same to a simple a.g.c. circuit as an increase in signal strength and will therefore increase the negative a.g.c. bias and further weaken a usually already weak signal. Another troublemaker is airplane flutter, a series of increases and decreases in signal strength caused by signal reflections from an airplane in flight. Since this can occur at a frequency of over 100 cycles, most simple a.g.c. circuits cannot smooth out this variation and the result is a continuous overload and fading on the picture screen.

The solution might seem to be faster-acting a.g.c. filter circuits. However, among other problems, a fast-acting filter circuit could not filter out the broad vertical pulse—the pulse would appear as an increase in signal strength, increasing the a.g.c. bias and decreasing the amplitude of the sync pulse, making synchronization difficult.

The solution to these problems lies in a fast-acting a.g.c. circuit known as keyed a.g.c. In this system the a.g.c. bias will be determined not by the entire signal, but only by the horizontal sync pulses in the complete video signal. Any noise occurring between pulses will have no effect on the a.g.c. bias, and noise occurring during the pulse will have little effect because the pulse represents the maximum transmitter signal strength. The a.g.c. action can be made very fast because the vertical pulse will not appear as a wide pulse to the keyed tube. Fig. 1 shows a basic keyed a.g.c. circuit.

Keyed a.g.c.

Most commonly, a pentode such as the 6AU6 is used as the keyer tube. Its control grid is fed the composite video signal with positive-going sync from the video amplifier. In addition, to maintain the d.c. component of the signal, the control grid is direct-coupled to the plate of the video amplifier. The cathode is connected to some point slightly more positive than the control grid to make the grid slightly negative with respect to the cathode. This is frequently done simply by connecting these elements across part of the video amplifier plate-load resistance. The voltage drop across this resistor (R1) is such that the tube is held at cutoff except when a positive horizontal sync pulse appears at the grid.

The plate is at ground potential except at those times (15,750 cycles per second) when it is fed a positive pulse of approximately 300 to 500 volts from the horizontal output circuit—usually from a winding on the width coil. Since the plate-voltage pulses on the keyer tube are in sync with the positive-going horizontal sync pulses on the control grid, they appear simultaneously (Fig. 2) and the keyer tube conducts (is "keyed"). The plate current flow of the keyer develops a negative voltage across load resistors R2 and R3. This voltage, directly proportional to the sync-pulse amplitude, is fed to the a.g.c. controlled r.f. and i.f. stages. Only the 15,750-cycle horizontal frequency need be filtered so the a.g.c. can have a much shorter time constant than simpler types. This fast action permits the circuit to follow and compensate for rapid changes in signal strength.

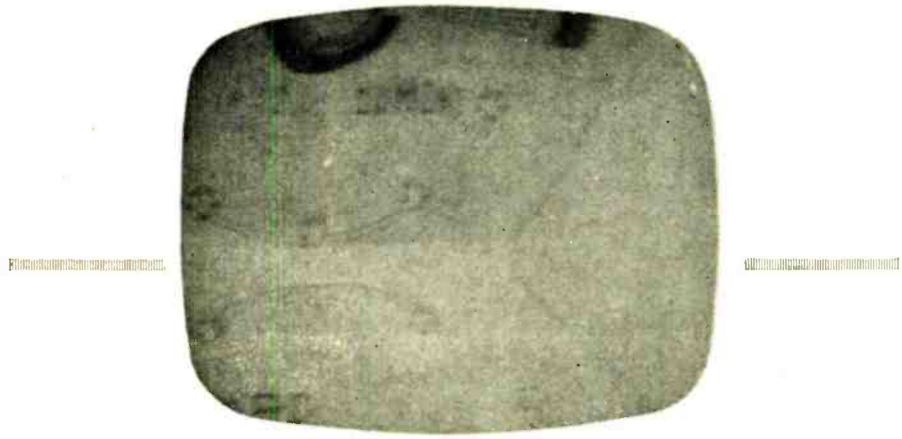
The value of the plate keying pulse is not critical. Since a pentode is used as the keyed a.g.c. tube, a great amount of amplification is obtained. And as in all pentodes, plate current being fairly independent of plate voltage, the a.g.c. bias is controlled entirely by the peak amplitude of the horizontal sync pulses applied to the control grid of the keyer tube. The sync pulse is used for this purpose because, whereas the video modulation continually varies, the sync pulses are transmitted at a constant amplitude. Only a change in signal strength would vary the amplitude of the sync pulses.

Trouble-shooting

The complexity of servicing a keyed a.g.c. circuit can be seen from the number of other circuits involved. Aside from the keyer circuit, there is the video amplifier feeding the grid-cathode circuit, the horizontal output circuit feeding the keyer plate, and the various r.f. and i.f. circuits being fed a negative bias from the keyer output.

As an example, it might seem that one of the essentials of proper keyed a.g.c. action, that of simultaneous positive grid and plate voltages, would be automatic. Yet, if the horizontal oscillator is out of sync, the horizontal plate pulse will not occur at the right time, and proper a.g.c. voltage will not be developed. The same trouble can occur with a poorly operating a.f.c. circuit, since this circuit has considerable control over the horizontal oscillator.

As a rule, a poorly operating keyed a.g.c. circuit will produce too much or not enough a.g.c. voltage. As a result, the following defects are most commonly seen: excessive, insufficient, or varying contrast; snow; airplane flutter; poor horizontal and vertical hold; poor noise immunity, and picture overload.



Courtesy Du Mont

Fig. 3—Poor contrast, snow, and poor sync may result from excessive bias.

A common cause of overload is keyer-tube failure. The heater may be open, cathode emission low, the a.g.c. winding on the width coil open, or some other defect may lower the a.g.c. voltage. This will frequently cause the overloading of an i.f. or video amplifier tube and cause the screen to go blank or a negative picture to appear. If the overload takes place before the sync take-off, it will also result in poor horizontal and vertical synchronization. When replacing a width coil be careful of the polarity of the windings—incorrect polarity will also cause a negative picture.

Another cause of overload is the improper adjustment of the a.g.c. control. If readjustment does not help, place a potentiometer across a 9-volt battery, connect the center arm to the a.g.c. line, and use this as the negative a.g.c. bias. Some receivers have convenient test points, others require that the a.g.c. line be opened and still others that the keyer tube be removed. Set the potentiometer for the manufacturer's recommended bias voltage and observe receiver operation under proper bias voltage. If a scope can be used to observe the keyer grid, plate, and filter waveforms, troubleshooting will be that much quicker. If the trouble is due to a circuit defect in the a.g.c. line, setting the proper bias voltage should clear the picture. If trouble persists despite normal a.g.c. bias, it is usually safe to turn your attention to another circuit. Before applying battery bias, be sure the a.g.c. line is not short-circuited to ground.

Much the same procedure can be used to check excessive bias that causes snow and poor contrast, and poor sync stability. (See Fig. 3.) This could be caused by a decrease in the keyer bias causing excessive plate current flow in the keyer. This is often caused by a low-emission video amplifier resulting in too small a voltage drop across the keyer input resistor R1. This resistor is a critical factor in proper a.g.c. action. If it varies in value, it will cause considerable changes in bias voltage. Equally critical is the plate current flow through this resistor. Both should be checked carefully.

The keyed a.g.c. circuit is a frequent cause of poor interlace. A defective filtering component will allow horizontal sync pulses to appear on the a.g.c. line where there should be only d.c. This upsets normal vertical synchronization and destroys proper interlace. Trouble of this nature can usually be checked by placing a scope on the a.g.c. line.

In cases of fading, always check for components that are varying in value.

Tuner alignment

I was recently called upon to service a General Electric receiver having a model U.H.F.-70 tuner. Besides a position for continuous tuning, this unit has two fixed u.h.f. positions. I tried to adjust these positions without success. According to the manufacturer's instructions it is necessary to turn the oscillator and r.f. cores a given number of turns from some starting point. Since other technicians had previously adjusted this tuner, I have no idea of what position the cores are in and therefore cannot adjust them. The continuous tuning on this u.h.f. unit works perfectly, so I am sure that the only thing wrong is the fixed-channel adjustments. Is there any way I can correct this condition?—G. L. C., Springfield, Ill.

Although the original "count" has been lost there is an alternate procedure for aligning this unit. Set the u.h.f. selector to one of the fixed positions and turn the u.h.f. oscillator tuning core counterclockwise until the slotted end of the core is flush with the first turn of the *coil*.

Be sure the core is flush with the first turn and not the coil form. If the core is unscrewed too far, it will be difficult to start into the coil again without cross-threading.

From this starting point, slowly turn the oscillator tuning core clockwise into the coil until a u.h.f. picture and sound signal are received. While turning the oscillator core clockwise into the coil several minor responses as well as two strong picture responses will be noticed. Use the first strong response received while turning the core clockwise from its starting point. While turning, be careful not to exert heavy pressure on the core—the coil damages easily.

Now adjust the r.f. tuning core for maximum picture signal. Then readjust the oscillator core so that the fine-tuning control on the TV receiver will permit tuning in audio bars. Be sure you can tune away from any adjacent-channel interference.

Picture and sound loss

I am servicing a Meck receiver that apparently has a bad tuner. I get a raster but no picture or sound. I would like information on replacing the existing tuner with the Standard cascode tuner. There is no model number on this receiver, but the circuit checks with the Meck XQA.—H. S., Cleveland, Ohio

You mention that the tuner is bad but do not state how you came to this conclusion. If this receiver is similar to the XQA model, it is an intercarrier receiver and the sound take-off is at the video amplifier. The lack of picture and sound (with the raster present) could be caused by a defective tube or circuit in the tuner, the video i.f. amplifiers, the video detector or the video amplifier. Thus, your idea of replacing the tuner to correct this trouble may not be the solution. If a defective tube or part exists in the video i.f. stages or the detector or video amplifier, the new tuner would be of no help.

The Standard Coil cascode tuner is supplied with complete schematic and installation instructions. You can find additional information on cascode tuners in previous issues of RADIO-ELECTRONICS: January, 1953, page 49; September, 1953, page 58; and January, 1954, page 43.

Arcing in picture tube

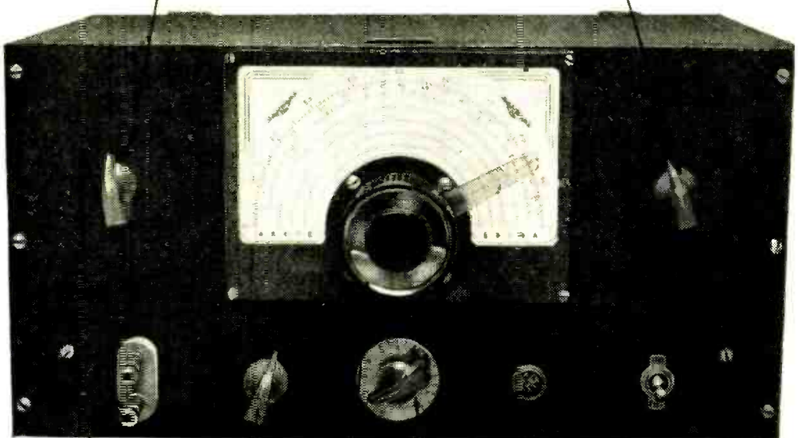
I recently got a brand new Stromberg-Carlson TV receiver. During the first week or so of operation there was considerable arcing in the neck of the picture tube, a 21FP4A. The receiver is model 421. I checked all voltages applied to the tube and found them to be of proper value. The odd thing about the arcing was that it interfered very little with the picture. I carefully checked all components in the various circuits feeding the picture tube elements and found them all in good condition. Now after a couple of weeks, the arcing has stopped. The picture is fine but I wonder if anything has been damaged that will show up at some later date.—S. M., Buffalo, N.Y.

The arcing in the 21FP4A during the first week of operation is due to the presence of loose particles in the neck of the tube. They work their way into the gun structure and cause the arcing. When these particles are burned out, the arcing stops. This will rarely cause permanent damage. END

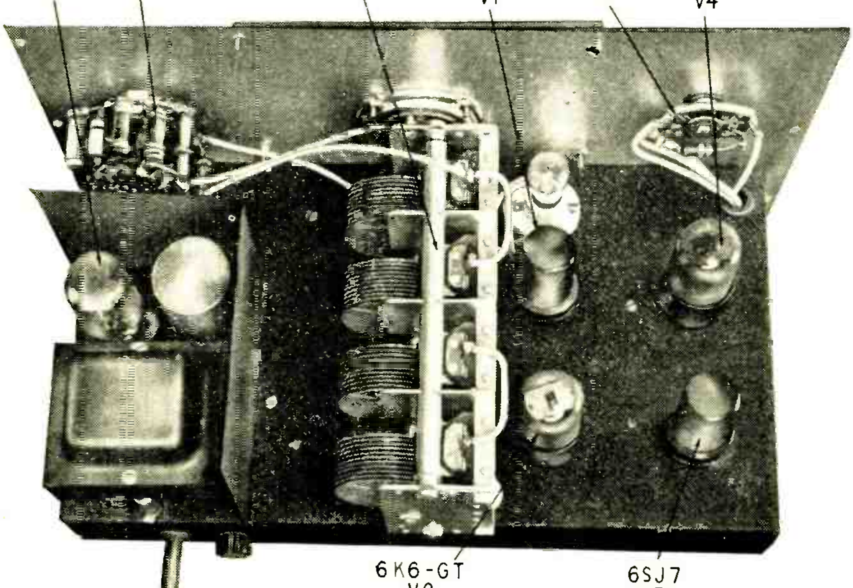
sine-wave square-wave generator

Instrument features a wide frequency range and extremely stable output

By FRANK J. DiELSI



This instrument produces both sine and square waves, and has a frequency range from 20 to 200,000 cycles.



Top view of the sine-wave and square-wave generator. The frequency-determining resistors are on bandswitch.

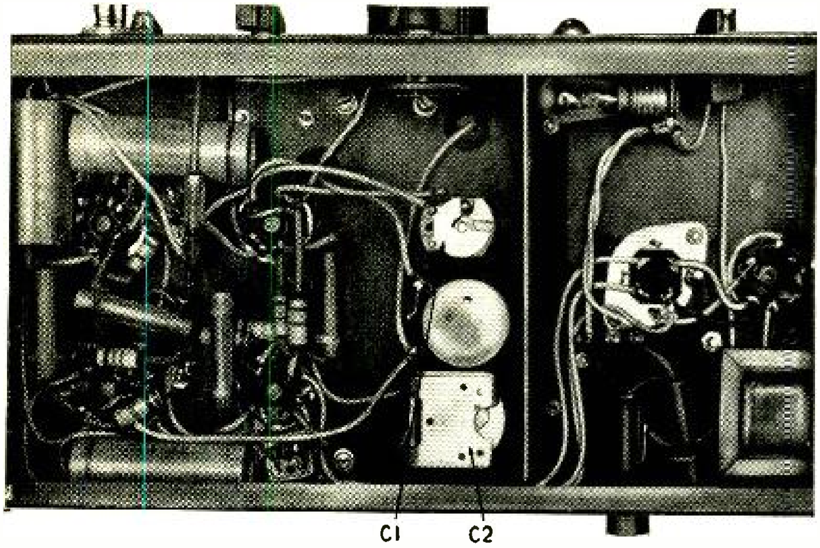
THE generator described in this article is a versatile and dependable instrument that can be used for testing audio amplifiers, video amplifiers and sweep circuits as well as in many other applications. Although compact and inexpensive, it has a stable output within ±0.43 db over its wide range with sine- and square-wave output at either low or high impedance. The sine-wave output—in four bands of 20-200, 200-2,000, 2,000-20,000 and 20,000-200,000 cycles — has less than 0.8% distortion. The low-impedance sine-wave output is 5 volts; the high-impedance 21 volts. The square wave has a rise time of less than 2 microseconds in the three ranges of 20-200, 200-2,000 and 2,000-20,000 cycles. The peak-to-peak square-wave amplitude is 23 volts at low impedance and 92 volts at high impedance.

Circuit

The oscillator is a two-stage wide-band amplifier using a 6SJ7 (V1) and a 6K6-GT (V2) with the output coupled through a modified Wein bridge to the input. The frequency-determining arms of the bridge (in band 1 position) consist of R2 in series with two of the parallel sections of a 4-gang tuning capacitor, and R1 shunted across the other two sections. A 4-gang broadcast tuning capacitor with 440 μμf per section is used to get 880 μμf in each variable arm of the bridge, thus obtaining plenty of overlap on all bands.

To prevent distortion and unstable output the oscillation amplitude is controlled by the negative feedback arms of the bridge consisting of R3 and the 3-watt 120-volt lamp. This lamp in the cathode return of V1 serves as a bias resistance that increases very rapidly with a small increase in oscillation amplitude, thus increasing the inverse feedback and maintaining the output essentially constant.

The output of the oscillator is coupled to a two-stage amplifier consisting of a 6SJ7 (V3) and a triode-connected 6K6-GT (V4). This amplifier isolates the oscillator section from the load. For square-wave output, S2 removes the inverse feedback to V3 and also shorts out its cathode bias resistor, causing it to clip the sine wave of the oscillator section and produce a very steep-sided and flat-topped square



Underchassis view. Note shield between the power supply and signal circuits.

wave. The response of V3 is greatly improved by omitting the screen bypass capacitor.

A high- or low-impedance output may be selected with S3. The high-impedance output is taken across the 2,500-ohm plate load resistor of V4. For low-impedance output V4 is used as a cathode follower, with an output impedance of 340 ohms. When used as a cathode follower, the plate load resistor of V4 is not shunted-out since this would remove the inverse feedback to V3 and cause overloading and excessive distortion of the sine-wave output. Resistor R4 is included in the circuit to reduce the sudden surge of charging current of C4 when switching from low to high impedance with square-wave output. A 500-μf cathode capacitor (C3) with a reactance of only 15 ohms at 20 cycles and a 40-μf plate coupling capacitor with a reactance of 190 ohms at 20 cycles are used to pass the low frequencies.

Construction

The instrument is enclosed in a 7 x 12 x 8-inch cabinet. The layout of the components can be seen in the photographs and is not too critical except that the power supply—including the a.c. switch, fuse, pilot light, and filament wiring—should be shielded. The 4-gang tuning capacitor must be insulated from the chassis and panel.

The band-determining resistors are mounted directly on the lugs of the 2-pole 4-position bandswitch.

Parts for generator

Resistors: 2—10,000, 2—100,000, 2—510,000, 2—1 megohm, 2—10 megohms, ½ watt; 2—510, 1—3,300, 1—4,700, 1—10,000, 2—51,000, 1watt; 1—4,700, 2—10,000, 1—27,000, 2—51,000, 2—100,000, 2 watts; 1—2,500, 1—10,000, 10 watts; 1—5,000, 1—10,000, potentiometer.

Capacitors: 1—50 μμf, 1—.002 μf, mica or ceramic; 2—0.5 μf, paper, 400 volts; 1—20-20-20-20 μf, 2—40 μf, 450 volts, electrolytic; 1—500 μf, 25 volts, electrolytic; 1—100 μμf, 1—400 μμf, 1—4-gang 440-μμf-per-section, variable.

Miscellaneous: 2—6SJ7, 2—6K6-GT, 1—6X5-GT, tubes; 1—power transformer, 600 volts ct @ 30 ma, 6.3 volts @ 2 amps; 1—filter choke, 30 h @ 30 ma; 1—3-watt 120-volt G-E lamp (type S-6); 1—socket for lamp; 5—sockets for tubes; 1—pilot light and holder; 1—1-amp fuse and holder; 1—2-pole 4-position switch; 1—s.p.d.t. switch; 1—d.p.d.t. switch; 1—s.p.s.t. switch; 1—line cord; 1—output jack; 1—chassis; 1—cabinet; 1—dial face (National SCN or equivalent).

On the front panel a National type SCN dial is used for the tuning control. In the lower left corner of the panel next to the output terminals is sine-square switch S2. Output control R5 is directly below the tuning knob. Output impedance switch S3 is to the left of the main dial and bandswitch S1 is at the right.

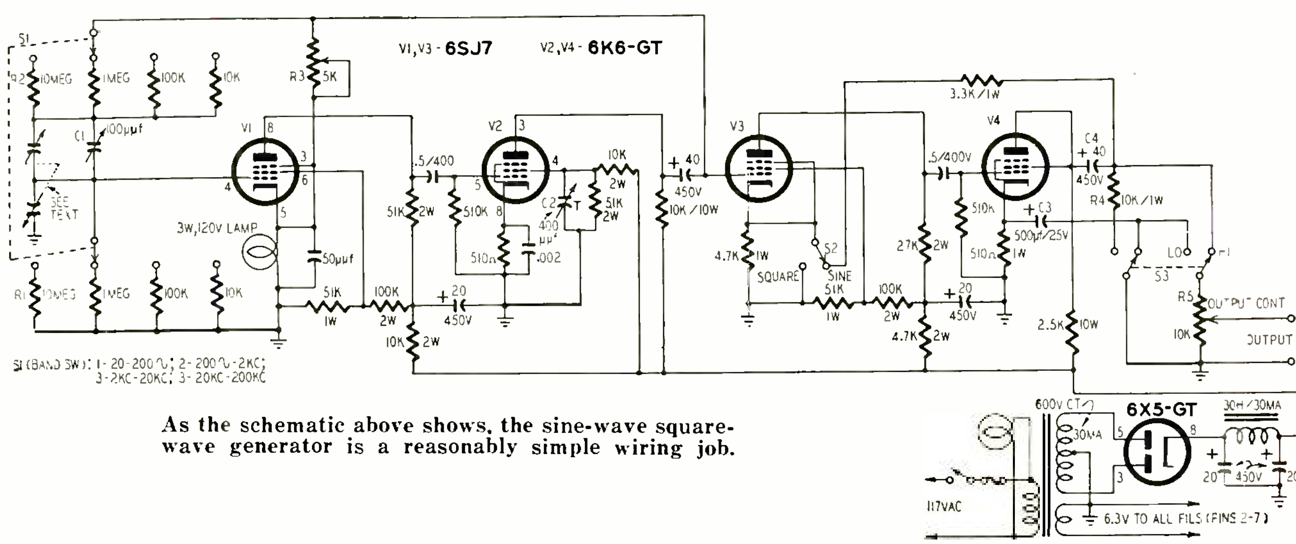
Calibration

The instrument should be enclosed in the cabinet before attempting any adjustment because the large frame of the tuning capacitor is at grid potential and will pick up any stray fields in the room.

If the band-determining resistors are selected within 1% accuracy, the dial needs to be calibrated on only one band since all the other bands have the same 10–1 ratio frequency calibration. If extreme accuracy is not essential, the exact resistances are less important than matching the corresponding pairs such as R1 and R2. The resistors may be selected from 10% tolerance stock and matched with a good ohmmeter.

Adjust trimmer C1 for uniform output over the 20–200-cycle band with feedback control R3 set as low as possible without causing loss of oscillation. If R3 is set too high, excessive sine-wave distortion will result. Trimmer C1 is used to balance out the frame-to-ground capacitance of the tuning capacitor which is across the other arm of the bridge. If constant output cannot be obtained, another 3-watt 120-volt lamp should be tried.

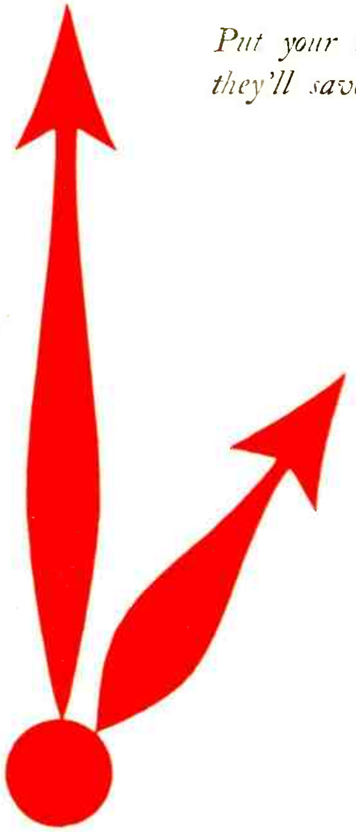
Variable screen bypass capacitor C2 can usually be set at approximately half capacitance (200 $\mu\mu f$). If difficulty is experienced with the dial-calibration tracking of the higher-frequency bands 3 and 4 as against 1 and 2, C2 can be adjusted to make bands 3 and 4 fall in line. This capacitor compensates for the high-frequency phase shift caused by tube and stray capacitances. After C1 and C2 have been adjusted, the generator may be calibrated by comparing its frequency with the power-line frequency or other standards on an oscilloscope. END

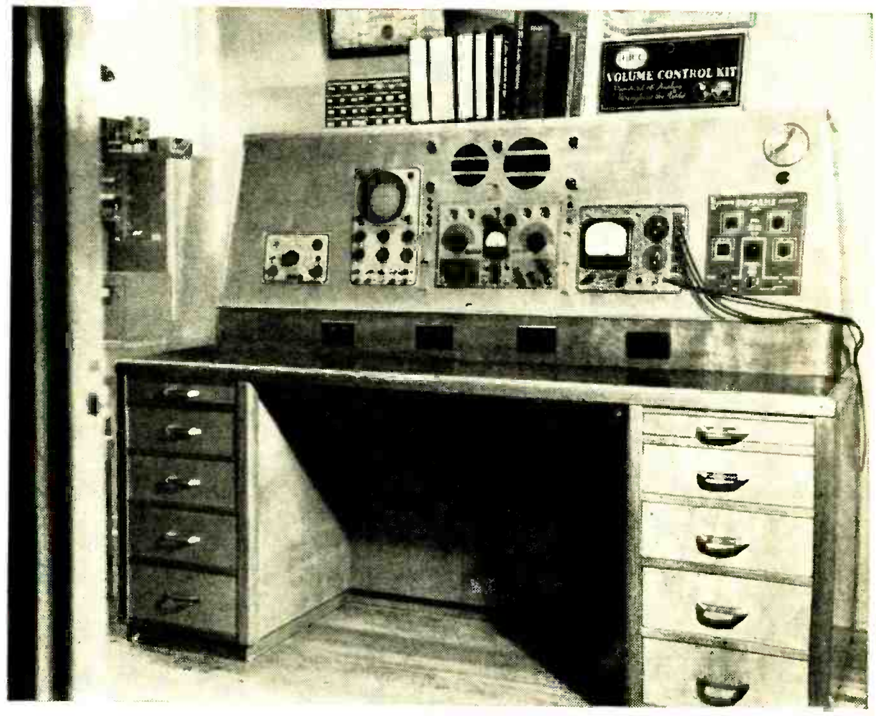


As the schematic above shows, the sine-wave square-wave generator is a reasonably simple wiring job.

SAVE TIME with TEST EQUIPMENT

Put your instruments to work— they'll save you time and money





By EDWARD M. NOLL

A well planned service bench assists the technician in the use of equipment.

MANY a technician has learned to manipulate oscilloscope controls with great skill the first day the unit was placed in front of him, but one year later he knows no more about how to use this scope than he did the first day. At the same time an apparently awkward beginner who perhaps required days before he could adjust a scope properly has become a marvel by continuous practice.

All of us feel awkward, slow, and at times skeptical when we put a new piece of test equipment into operation. We do not always recognize that skill, speed and effectivness grow with time and practice. Like a beginner on skates, you are slow and wobbly—but that doesn't mean you can't become a fast, successful operator. In any technical field, it isn't how quickly you learn that matters, but how persistently you grow into the skill, care and speed that marks the master.

Let us assume that to acquire skill we must try to make extensive use of our test equipment. Locate the equipment properly because *how often you apply test equipment depends on how convenient it is to use*. Certainly, if the test unit is hidden in a closet or on a shelf a few feet overhead, it will not be used frequently.

The bench arrangement should be such that all equipment is close at hand without interfering with work on a chassis. It should be placed at the rear or side of the bench work area so that the leads are always convenient for speedy attachment to a chassis. The equipment should not, of course, be so positioned that it can get in the way and make the actual bench work awkward. No matter what the arrangement, it must be so planned as to keep the test equipment out of the way but still convenient to use.

A common complaint of the technician regarding the use of test equipment is that it takes so long to connect and disconnect. This is not the fault of the equipment *but the fault of the bench arrangement*. A bench should be planned so that within 5 minutes after placing a chassis on it, the equipment can be connected and ready to use. If it requires 15 to 30 minutes to put your test equipment into operation, your arrangement is inefficient.

Applications

There are applications for test equipment in every section of a television receiver. It is our responsibility to learn these applications and how we can use the equipment to speed adjustment, alignment and repair work, and thus render a better caliber of service.

Successful use of test equipment is a function of three factors—what can be done with test equipment, how to do it, and what precautions to take in doing it.

Of the many uses for test equipment in the repair and adjustment of a tuner, the three basic ones are:

1. Measurement of supply voltage points.
2. Measurement of local oscillator grid voltage, and test for mixer grid injection.
3. Response curve of tuner.

In most tuners it is simple to locate the supply voltage sources. When the tuner remains inoperative after tube substitutions, check all supply voltage points with a v.t.v.m. The next step, if these voltages are normal, is to connect the v.t.v.m. to the grid of the local oscillator to see if proper negative voltage is developed, indicating oscillation. In some cases the oscillator is functioning but no excitation reaches the mixer, so the v.t.v.m. can also be attached to the mixer grid to determine if proper oscillator injection exists.

The response curve of a tuner tells all about its operation. The effect of tube replacement in terms of sensitivity and frequency response can be easily seen. If the bench arrangement has been planned properly it should require only a few minutes to obtain the tuner response curve. Once the curve can be seen, the choice of tube replacement becomes definite. For example, if the local oscillator is weak on the high band and a new tube is substituted, there will be an immediate increase in the amplitude of the tuner response curve. Likewise, the replacement of the r.f. amplifier or mixer tube will influence the response curve and show up a weak tube—with more certainty than any tube checker or picture observation.

Watching the response curve during tube replacement not only indicates the tuner sensitivity but also any change in bandwidth and its influence on frequency response and interference rejection. The response curve on each channel should be watched carefully as tuner changes are made. This applies particularly in a fringe area where there is adjacent-channel interference or impulse noise disturbances because the response curve shows the tuner's ability to reject interference without affecting the resolution of the picture.

The TV tuner is a compromise device because it must function on so many channels spread over a wide frequency range. Consequently, we do not obtain an ideal response on each channel and there are certain departures from the ideal pattern (Fig. 1). In observing the response pattern on any given

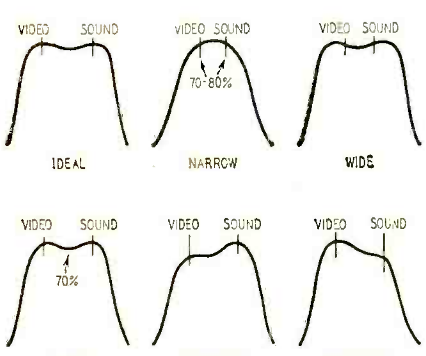


Fig. 1—TV tuner response limits. The curves are drawn to different scales, the distance between the two vertical markers being 4.5 mc in all the cases.

channel, be certain that the response departures do not exceed the specified limits of the tuner. In fact, slight touch-up of the alignment adjustments on the tuner can help to favor a particular channel. When the signal is weak or accompanied by a great deal of interference, it is advisable to use as narrow a pattern as possible without disturbing the frequency response.

Test equipment precautions

It is necessary to consider two factors very carefully, if test equipment is to be of any use to you. First—is the alignment equipment functioning properly, and second—is it connected correctly? If these two points are overlooked, use of the equipment may be a waste of time, or worse.

To obtain the response pattern indicated as typical by the manufacturer of a given receiver it is, in most all cases, necessary to connect the alignment equipment and tuner in exactly the manner recommended in the service notes. Failure to do so may cause the equipment setup itself to distort the pattern. If an attempt is made to obtain a correct pattern, it will be impossible to do so or a poor alignment will result that can hurt receiver performance.

The sweep signal generator should be linear in two ways to obtain a good response pattern—the amplitude of the output over the swept range and the frequency deviation on each of the given channels. This linearity should exist over the entire range of output levels from strong signal to weak signal. Oscilloscope sensitivity should be such that when a sweep signal output comparable in strength to a received TV signal is applied, a usable deflection is obtained. Signal level and a.g.c. bias affect tuner performance, and it is always preferable to align a tuner at the approximate signal levels of your area.

A most important consideration in sweep alignment, and one taken far too lightly, is marker accuracy. Although it is possible to obtain a response pattern with the shape and amplitude indicated by the manufacturer, it is to no avail if it is shifted in frequency even a small amount. In fact, just a slight shift in the channel 3 response pattern (Fig. 2) because of inaccurate picture and sound carrier markers can cause the pattern to shift into the channel 2 or channel 4 spectrum. For example, if the pattern shift is on the high side of correct frequency, it means that we emphasize adjacent-channel interference from the picture carrier of the next highest channel and, at the same time, reduce the sensitivity of the tuner to the desired picture carrier frequency. An error of just half a megacycle could be detrimental. Thus for tuner alignment in fringe areas and areas troubled by adjacent-channel interference it is important to have accurate markers—either crystal-controlled markers or a marker generator that is calibrated with a crystal source.

U.h.f. devices

There are a number of applications for test equipment in the adjustment or repair of u.h.f. converters. In the newer u.h.f. units special test points are often included to permit attachment of a v.t.v.m. or sensitive current meter.

Key considerations in the efficient operation of a u.h.f. converter are proper local oscillator strength, proper crystal current, and proper oscillator injection. These three conditions can be checked with a v.t.v.m. For example, with the v.t.v.m. connected at the crystal-current test point, the operation of the converter can be predicted

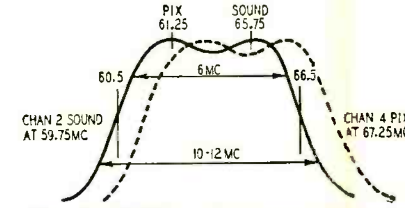


Fig. 2—Shift in the tuner response.

and the results of any changes observed. The crystal current is a function of the three factors mentioned—a low crystal current indicates a defective crystal, a weak local oscillator tube, or improper local oscillator injection. With the meter connected to the test point the crystal mixer can be replaced to check if normal crystal current returns. If the current reading is still low, the local oscillator tube should be replaced to check if it is weak. With the crystal current still low make certain that the crystal injection control, if present, has been set properly. When low crystal current still persists, there may be a defect in the local oscillator circuit. To check the local oscillator tube, connect the v.t.v.m. to the grid of the oscillator (to check strength of oscillation) and other supply voltage points to locate a possible defect.

Another consideration in a continuous tuning type u.h.f. converter is proper tracking over the entire u.h.f. band. Often tracking has to be adjusted when the local oscillator tube or crystal mixer is replaced. A simple method of checking the tracking of a u.h.f. converter is to connect a signal source to the input of the converter and a conventional v.h.f. field-intensity meter to the output circuit (Fig. 3). The v.h.f. field-intensity meter serves as a very sensitive output indicator and can be used to measure the weak u.h.f. harmonics of a standard v.h.f. signal source.

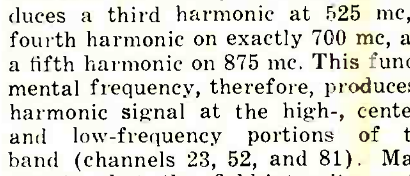


Fig. 3—Checking converter tracking.

If the v.h.f. fundamental signal source is set exactly on 175 mc, it produces a third harmonic at 525 mc, a fourth harmonic on exactly 700 mc, and a fifth harmonic on 875 mc. This fundamental frequency, therefore, produces a harmonic signal at the high-, center-, and low-frequency portions of the band (channels 23, 52, and 81). Make certain that the field-intensity meter reading is not the result of a harmonic of the v.h.f. local oscillator of the field-intensity meter itself. If the field-intensity meter is actually recording one of the harmonics of the v.h.f. signal source, the meter reading will fall away when the signal source is switched off temporarily.

Some manufacturers have been presenting sweep alignment data for their u.h.f. units. At present, service-type u.h.f. test equipment is not available but in a short time it is likely to become plentiful. There are a number of restrictions imposed on test equipment for u.h.f. alignment. The crystal mixer of the usual u.h.f. unit has a loss instead of a gain as compared to a vacuum-tube mixer. Thus the actual sweep indication is rather weak when the applied sweep signal is made comparable to a received signal amplitude-wise. As a result, the scope sensitivity must be high, and it is highly possible a special preamplifier will be constructed in the form of a probe to permit a good visual indication from

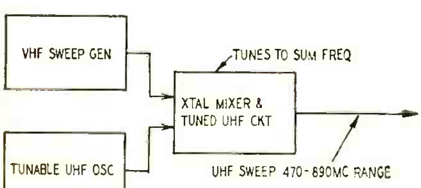


Fig. 4—Indirect u.h.f. sweep generator.

the very weak sweep signal that must be rectified to obtain the response pattern.

A recent method of u.h.f. sweep generation uses an indirect approach (Fig. 4). In this system the actual frequency deviation occurs in the v.h.f. range (can be a present v.h.f. sweep oscillator) and is mixed with a single-frequency, tunable oscillator set in the u.h.f. range. The sum frequency is utilized at the output of the mixer (generally a crystal mixer) to produce the u.h.f. sweep signal. Thus a single-frequency, but variable u.h.f. oscillator plus a crystal mixer stage can be constructed into a unit that operates in conjunction with a present v.h.f. sweep generator to form a u.h.f. sweep signal at its output.

Video i.f. response

There are four important reasons for using sweep alignment equipment when making any changes in the i.f. system of a television receiver:

1. A proper video i.f. response curve is necessary to minimize intercarrier disturbances.

2. With many new v.h.f. stations, higher-powered transmitters, and more sensitive receivers, adjacent-channel interference has become a problem in many areas. A proper video i.f. response curve is necessary to have maximum rejection at the adjacent-channel picture and sound carrier frequencies.

3. Circuit changes and even tube replacements can influence the video response curve and alter the picture quality in terms of resolution and development of i.f. transients.

4. The presence of color television receivers will impose stricter requirements on alignment and all of us must become familiar with critical alignment techniques and future refinements. Slight departure in i.f. response can cause phase shift over the video-frequency spectrum that would go unnoticed on monochrome but will have a decided influence on the color picture. In fact, special circuits are planned for the video amplifier of a color receiver to correct for any departures in phase between various frequency components of the video signal. However, the correction can restore proper response for limited departures only in earlier stages. Likewise an improper response can cause the loss of color information and the color synchronization signal because they are positioned at the high-frequency end of the video range.

A set in the shop should always be checked in terms of the response of the tuner and video i.f. section. If the picture on a particular model appears a bit smeary, do not always jump to the conclusion that it is a matter of design. Often it is just a slight defect in alignment because of resonant-circuit drift or a tube has degraded in performance enough to hurt picture resolution without giving the customer any indication of loss in sensitivity (because of a.g.c. action). Remember it is a credit to your organization if you can take a receiver back to a customer and have him remark, "I've never seen the picture so clear before."

For video i.f. alignment, too, the need for accurate markers is becoming increasingly important. The video i.f. range is approximately twice as high in frequency as in earlier receivers and,

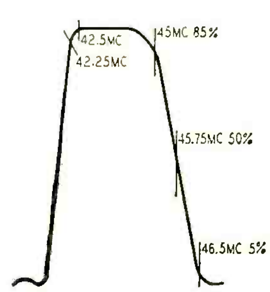


Fig. 5—Calibrated response curve.

consequently, the calibration of a marker generator is a more trying problem for the test equipment manufacturer. In the first place it is a higher frequency and more difficult to obtain even with the same percentage drift. In addition, the absolute permissible drift is the same as for the previously much lower i.f. Thus to maintain this absolute limit on drift the actual percentage of drift is less at the higher frequency.

Some method of crystal calibration of your marker generator is almost a necessity if you are to align and check alignment with accuracy. The importance of accurate alignment megacycle-wise is apparent from the actual response curves and their calibration as recommended by manufacturers (Fig. 5). The location of the picture carrier on the response curve has much to do with the resolution (particularly low-frequency response) and the stability of the picture in fringe areas or under severe noise conditions. The proper location of the sound carrier on the response curve determines how free of intercarrier buzz you can hold the receiver. The location of the adjacent-channel picture and the sound i.f. is important so receivers can be least sensitive to adjacent-channel interference. The over-all smoothness (freedom from humps and ridges) and the over-all bandwidth of the curve determines the resolution and freedom from transients.

In the usual stagger-tuned i.f. amplifier the individual resonant circuits are peaked using a v.t.v.m. at the video detector and a single-frequency generator at the input circuit. In a typical receiver (an RCA receiver's response curves are shown in Fig. 5) it is necessary to set the single-frequency generator on these various frequencies: 39.25, 41.25, 47.25, 43.7, 45.5, and 41.8 mc.

Tell me, can you set your signal generator dial on 43.7 mc accurately? Do you feel certain that if you can set it there that you obtain this frequency instead of 44 or 43 mc? *Crystal checkpoints should be a part of all marker generators.*

Sound i.f. section

A sweep generator, oscilloscope, and 4.5-mc crystal marker source are preferred alignment and repair equipment for the sound i.f. section. Again, this method presents conclusive evidence of sound-strip performance in terms of gain, frequency response, noise rejection, and intercarrier buzz rejection. The trend toward higher-fidelity audio systems in the television receiver places increasing importance on sound-drift performance in avoiding raspy sound and high background levels.

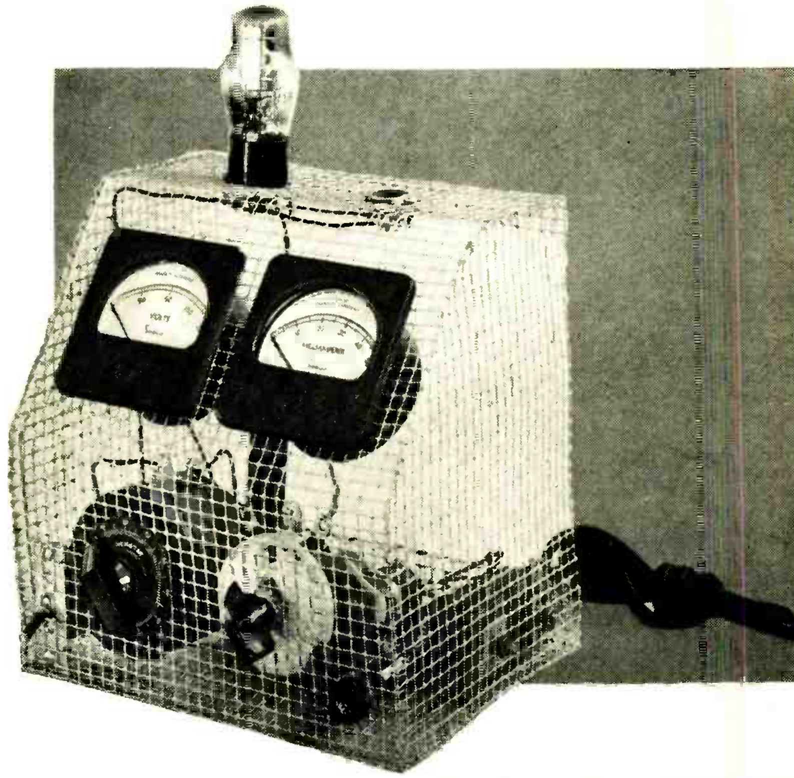
Though at times not as effective, a signal generator and v.t.v.m. can also be used to adjust the sound i.f. section. If other than a crystal-controlled 4.5-mc signal source is used, be certain to set the frequency as close to 4.5 mc as possible. Once set, do not move off this frequency until alignment is complete. For peak signal and minimum background noise the frequency demodulator, limiter, and i.f. amplifier center frequencies must be the same. This means there is highest gain and maximum noise rejection about the center frequency of the FM signal applied to the frequency demodulator.

Many receivers now in operation and many that have been repaired are not operating with the very best picture and maximum interference rejection. It is the use of test equipment that permits service far above average and, with an efficient bench arrangement, you will spend no more time per set than using a less critical repair technique. END

Something new and different in the way of tube checkers

VR TUBE TESTER

By JOSEPH F. SODARO



For illustrative purposes, the VR tester is built on hardware cloth.

IT is often necessary to measure the operating conditions of a voltage regulator tube, especially when a circuit defect has caused excessive current flow through it. These measurements include determination of the striking or starting voltage as well as operating voltage across the tube, within the control current range.

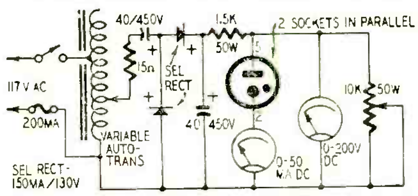


Fig. 1—Schematic of VR tube tester.

The electrical characteristics of interest for the six popular types of VR tubes are listed in the table. The starting voltage is the voltage required to cause the tube to ionize. If this value is higher than normal, the source voltage may fail to reach the required value. As a result, the tube will not ionize, and the voltage source will not be regulated.

Once ionized, the tube will pass more or less current as the input voltage is increased or decreased, but the *voltage* across it remains constant. Similarly, tube voltage is constant as load current is increased or decreased. The VR tube *current* changes to accommodate load current change. Under normal operation a VR tube will regulate from the minimum to the maximum of its current rating, providing a wide range of voltage stabilization.

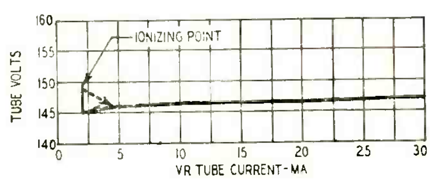


Fig. 2—Action of VR tube current.

The VR tube tester is designed to measure starting voltage and current, operating voltage, the current range over which the operating voltage is constant, and extinguishing current.

Manufacturers' data indicate that the supply voltage to the VR tube should be at least 30 volts higher than the average d.c. starting voltage to insure reliable starting throughout the normal tube life. Failure of a VR tube to regulate may be caused by too low a supply voltage, too much series resistance, or excessive load current.

Circuit of the checker

The tester circuit shown in Fig. 1 provides a variable source voltage for the tube under test to simulate line-voltage changes. It also provides a variable load to simulate load changes. Input voltage is adjusted by a small variable autotransformer, the output of which is rectified and filtered in a voltage-doubler circuit using selenium rectifiers. The variable load is a 50-watt rheostat capable of handling 70 milliamperes. The voltmeter and milliammeter have an accuracy of 2%.

A voltage doubler is used instead of

ELECTRICAL CHARACTERISTICS OF VR TUBES

Tube	Approx. starting volts D.C.	Min. Tube ma	Max. Tube ma	Approx. oper. volts	socket
0A3/VR75	100	5	40	75	Octal
0B3/VR90	125	10	30	90	Octal
0C3/VR105	115-135	5	40	105-108	Octal
0B2	115	5	30	105-108	Min.
0A2	155-156	5	30	150-151	Min.
0D3/VR150	160-180	5	40	150-153	Octal

Parts for VR tube tester

1—15-ohm, ½-watt, resistor; 1—1,500-ohm, 50-watt, resistor; 1—10,000-ohm, 50-watt, rheostat; 1—variable autotransformer, 165 volt-amperes (Powerstat, Superior Electric type 10 or equivalent); 2—40-µf, 450-volt, capacitors (electrolytic); 2—selenium rectifiers, 150 ma, 130 volts; 1—200-ma fuse, and holder; 1—milliammeter, 0-50 d.c.; 1—voltmeter, 0-200 d.c.; 1—s.p.s.t. switch; 1—octal tube socket; 1—miniature tube socket; 1—chassis (see text).

a simpler half-wave circuit, to provide for testing 150-volt tubes. At a load current of 150 milliamperes—the current limit for the rectifiers—the output from this supply exceeds 200 volts. The circuit is fused for 200 milliamperes. The maximum load current obtainable when the load is short-circuited is 150 milliamperes for normal a.c. line voltage. Tube sockets to accommodate the VR tubes are wired in parallel, but of course only one tube can be tested at a time.

Construction details

Hardware-cloth chassis construction was used for simplicity and to show internal construction of the prototype. Dimensions of the prototype are: 8 inches wide, 6 inches deep at the base, 8 inches high at the rear and 3 inches deep on top. The lower portion of the front panel is 4 inches high, and the slanting panel is 5 inches in length.

The line switch, fuse holder, Powerstat (autotransformer), and load resistor are mounted on the lower front panel. Both meters are mounted on the slanting panel. The tube sockets, located on the top are octal and 7-pin miniature types.

The rectifiers are all mounted on the right side of the chassis, and the filter capacitors are mounted on the bottom. The a.c. line enters from the rear and is brought to the fuse holder and a tie-point.

Operation

To operate the VR tube tester turn the autotransformer control to zero and the load rheostat to maximum resistance. Put the VR tube to be tested in the socket, and turn the power on. Slowly advance the autotransformer control while observing the voltage and current to the tube. The striking voltage for a good tube is reached at a value higher than the operating voltage shown in the table. At this point the tube ionizes, voltage drops to the operating value, and tube current increases to approximately 5 ma.

Continue to increase input voltage until maximum tube current is reached. Throughout this input voltage change, the tube voltage must remain constant to indicate satisfactory operation. The operating voltages in the table are approximate. As a result, this measurement may vary from tube to tube. In most applications the operating voltage is not critical provided the voltage is constant both for input and for load changes.

Next, increase load current by decreasing the rheostat resistance. As the load takes current from the tube, output voltage should remain constant until the minimum ionization current for the tube is reached. The tube will lose control as ionization ceases and the tube voltage will decrease. The data from the test of an 0D3/VR150 is shown in Fig. 2. As the supply voltage was increased to 146 volts, the tube current rose to 2 ma and remained constant until the voltage increased to 149 volts. At this point the tube ionized completely, the tube voltage dropped to 146 volts and tube current increased to 4.5 milliamperes. This portion of the curve is shown dashed because the changes occurred instantaneously, and data could not be taken between these points. From 4.5 to 30 milliamperes the tube voltage increased gradually to 147 volts.

As load current increased, tube current decreased along the same curve with tube voltage decreasing to 146 volts at 4.5 milliamperes. A further increase in load current caused the tube voltage to decrease gradually as the tube was extinguished. This action is shown by the lower left-hand portion of the curve.

This VR tube tester will be of great value to the technician working with regulated power-supply circuits. END

Compensated Headphone Circuit

By GEORGE D. PHILPOTT

WHEN connecting a headphone jack to the secondary of an output transformer, it is common to load the transformer with a resistor across the terminals of the jack. By connecting a moving-coil load to the jack, in place of the resistor, headphone fidelity can be improved.

A speaker voice coil when moving and cutting lines of force reflects counter-e.m.f. back to the transformer —and to any reactive unit (headphones) on the line.

To visualize this counter-e.m.f., consider negative feedback such as exists when a voltage is fed to a point 180° out of phase with it. In effect, this is just about what goes on in the output circuit of an audio amplifier when voice-coil movement—and counter movement—reflects self-generated currents back to the output stage. The "damping factor" of the amplifier output tube enters the counter-e.m.f. picture—with regard to harmonic and subharmonic tendencies of the stage. Voice-coil counter-e.m.f. affects a changing plate impedance by varying the primary inductance of the output transformer, giving a hint of why a nonlinear plate load might offer better harmonic cancellation than a linear (resistor) load.

In other words, a moving-coil impedance used across the terminals of low-impedance headphones, such as Signal Corps HS-33, or Army-Navy type ANB-H-1's, tends to bring out the lows, lowers harmonic distortion by improving the damping factor of the output tube, and in general allows for more pleasing tone reproduction.

As shown in Fig. 1, a small PM speaker that has been replaced because of a defective cone, but which has magnet and voice coil intact, can be used for constructing a moving-coil load for your headphone hookup.

Remove the damaged cone, using speaker solvent or a razor blade. Leave the small strips of cone supporting the voice-coil leads. With tinsnips, cut off the outer cone support, as shown. This leaves you the voice coil, magnet, and spider (centering) assembly. Make sure that the voice coil is in good shape —not rubbing the pole piece, open, or with the windings loose. Mount the assembly, preferably inside the receiver cabinet, and run leads from there directly to the headphone jack (Mallory A-3-A or equivalent), connecting as shown in Fig. 2.

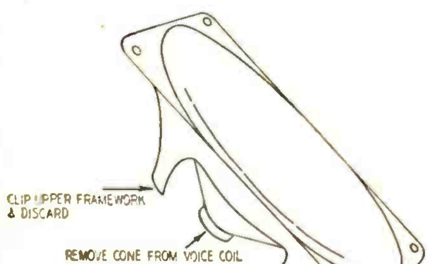


Fig. 1—Mechanical details of the unit.

High-impedance headphones may be used across the low-impedance secondary of the output transformer, but more satisfactory results are obtained when they are connected in place of the output transformer's primary winding or across it.

When connecting *any* headphone on the plate side of the output stage, it is advisable to change the plate bypass capacitor, or at least make sure that it can withstand a voltage surge of 600 or higher. These capacitors were not calculated to stand the unusual peak voltage imposed on them by circuit making and breaking. They have a nasty habit of shorting out soon after the initial jack installation—usually when phones are being plugged in or withdrawn from the jack. A 1,600-volt capacitor did a beautiful job. END

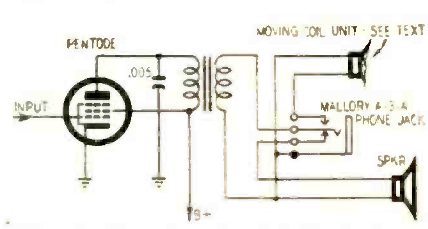
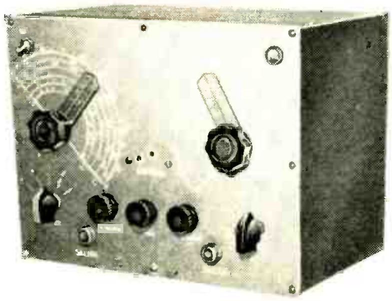


Fig. 2—How the circuit is hooked up.

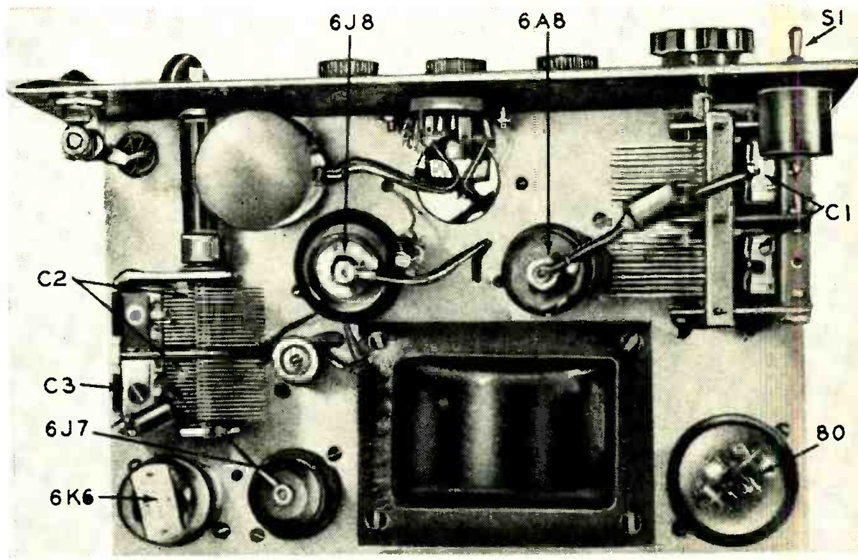
Inexpensive instrument has many applications



At left—The finished generator. Decals and lacquer give it a professional appearance. Below—Top view of the equipment gives a good idea of the layout.

SIGNAL GENERATOR

By A. J. GALOFRE



CONSIDERING the many applications of this multipurpose signal generator, its components are simple and its cost is indeed low. Its value also lies in the combining of many test functions in one instrument, which saves both space and time.

The signal generator was primarily designed for the alignment of stagger-tuned video i.f. amplifiers where closely separated signals are needed (the 630 requires 21.8, 25.3, 22.5, 25.2, and 23.4 mc).

Instruments sufficiently accurate to provide these small frequency differences are usually beyond the average technician's pocketbook. In this multipurpose signal generator the r.f. and crystal oscillator signals are mixed and provide a continuous tone with crystal accuracy.

A block diagram of the a.f.-r.f. signal generator is shown in Fig. 1. An interesting circuit feature is found in the 6J8 where a common grid connects the crystal oscillator with the 6A8 oscillator circuit. The complete schematic diagram is shown in Fig. 2. Switches S1 and S2 control the functioning of r.f. and a.f. oscillators. Removing the crystal will of course prevent the crystal oscillator from functioning.

The r.f. signal generator uses a 6A8 operating as a transitron oscillator. It furnishes a stable frequency at high output. A single set of coils are all that is needed, and bands are changed with

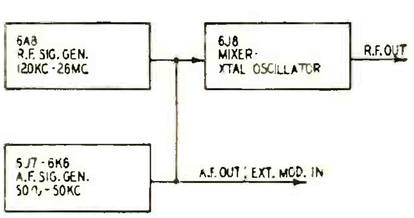


Fig. 1—Block diagram of the generator.

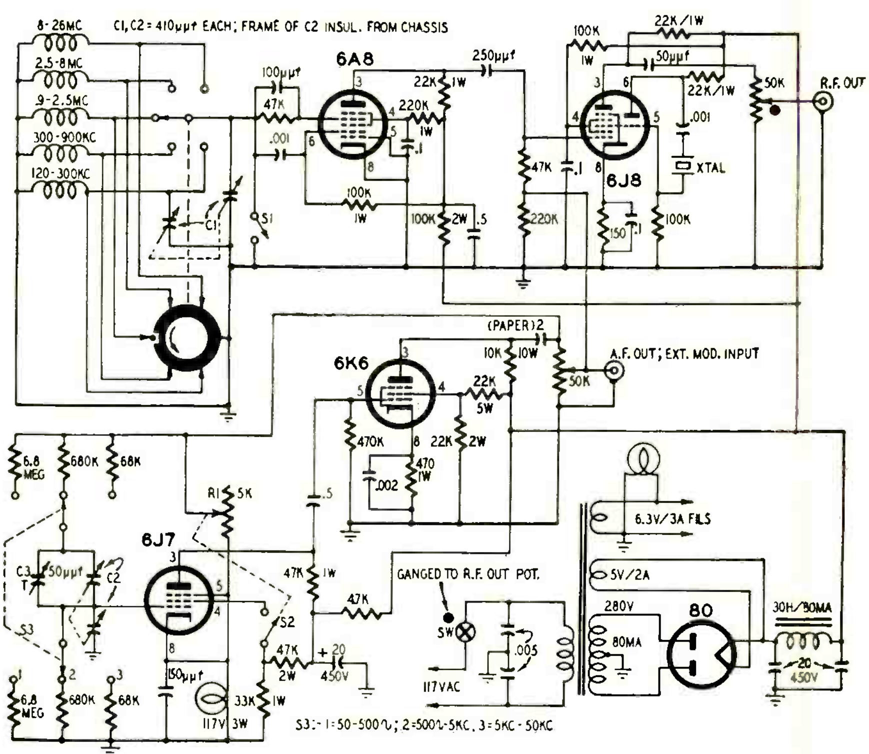


Fig. 2—Schematic diagram of the multipurpose a.f.-r.f. signal generator.

a 1-gang, 5-position selector switch.

When the crystal is removed from its socket the 6A8 r.f. signal is fed to the r.f. output terminal, with or without modulation, and the instrument is used as a standard signal generator.

The crystal oscillator uses a Pierce type circuit and works as well with crystals of 7 and 14 mc. I have not tried it at other frequencies, but I believe it is flexible enough to cover a wide range of frequencies. Closing switch S1 permits the instrument to operate as an independent crystal oscillator, with or without modulation.

The a.f. signal generator provides three bands: 50 to 500 cycles, 500 to 5,000 cycles, and 5,000 to 50,000 cycles. The three bands provide a sufficient range for radio and TV servicing. As a TV bar generator the instrument will supply frequencies of 600 and 157,500 cycles, providing 10 horizontal and vertical bars. Resistor R1 is variable from the front panel and is used to control the a.f. wave shape. For stable oscillation, R1 is adjusted for maximum feedback.

Operation

The r.f. and crystal signals are used together to obtain highly accurate signals for the alignment of video i.f. amplifiers. To illustrate, suppose we want to obtain a signal of 23.4 mc. We make the following adjustments:

Crystal oscillator	14.0 mc
R.f. generator	9.4 mc
Sum	23.4 mc

Assuming the crystal frequency to be highly accurate, any possible error is limited to a deviation of the 9.4 mc signal. Any error is bound to be less than if the r.f. generator was tuned directly to 23.4 mc.

If greater accuracy is desired, the following combination might be used:

Crystal oscillator	14.0 mc
R.f. generator	2.3 mc
Difference	11.7 mc
Second harmonic	23.4 mc

In this case, we may assume the 23.4 mc to be completely accurate. Let us suppose that the error in the 2.3 mc is 2% or .046 mc. Multiplying this by 2 because we are dealing with the second harmonic, we obtain .092 mc, an error of only .004% of the desired frequency, 23.4 mc.

Occasionally it is difficult to pick out the desired harmonic. To solve this problem, the i.f. amplifier to be used should first be roughly adjusted with the i.f. signal taken directly from the r.f. oscillator with the crystal out of the circuit. The instrument also will supply markers for sweep-generator alignment.

I constructed this instrument, as much as possible, out of spare parts in my workshop. It is built in a 6 x 9 x 11-inch case. This proved to be a little small, so I advise using a case at least 20% larger. I used decals for the panel printing, and added a thick layer of transparent lacquer to get a commercial appearance. I have used this signal generator for some time, and am highly satisfied with it. END

Parts far signal generatar

Resistors: 1—150, 1—4,700, 2—47,000, 2—68,000, 1—100,000, 1—220,000, 1—470,000, 2—680,000, 2—6.8 megohms, ½ watt; 1—470, 2—22,000, 1—33,000, 1—47,000, 2—100,000, 1—220,000, 1 watt; 1—22,000, 1—47,000, 1—100,000, 2 watt; 1—22,000, 5 watt; 1—10,000, 10 watt; 1—5,000 (with on-off switch), 1—50,000, 1—50,000 (with on-off switch), potentiometers.

Capacitors: 1—50 μμf, 1—100 μμf, 1—150 μμf, 1—250 μμf, 500 volts, ceramic; 2—.001 μf, 1—.002 μf, 2—.005 μf, 3—0.1 μf, 2—0.5 μf, 1—2.0 μf, 400 volts, paper; 1—20-20-20 μf, 450 volts, electrolytic; 1—50 μμf, trimmer; 2—15 to 467 μμf, 2-gang variable (1 with insulated rotors).

Miscellaneous: 1—6A8-GT, 1—6J8-G, 1—6J7, 1—6K6-GT, 180, tubes; 1—power transformer, 560 volts c.t. at 80 ma, 6.3 volts at 3 amps, 5 volts at 2 amps; 1—filter choke, 30 henries at 80 ma; crystals; 1—lamp, 117 volts, 3 watts; 1—chassis and cabinet; coils covering 120 kc to 26 mc; sockets for tubes and crystal; 1—s.p.s.t. switch; 1—pilot light and assembly; 1—1-gang, 5-position switch.

NEON-LAMP TEST SET

THE neon lamp is versatile and inexpensive. It can regulate and indicate voltages, it can oscillate and can show the presence of light, X-rays, and other radiations. This circuit (Fig. 1 from U.S. Patent No. 2,682,636 issued to Jerome Brewer of Kansas City, Mo.) combines many useful functions of a neon lamp into a single instrument, simple enough to be used as a classroom demonstrator of electronic principles.

The line voltage (d.c. or a.c.) is applied as shown. This voltage is stabilized by a pair of 150,000-ohm resistors and neon lamp LM1. The regulated output is available at the VOLTAGE OUTPUT terminals.

Lamp LM2 is fed by two voltages in series. One is the drop across R2. This should be approximately 50-60 volts and is insufficient to ignite the lamp. This constant voltage should be measured with a v.t.v.m. as it must be known accurately. The other voltage is E2. As R4 is increased, a point is reached at which LM2 ignites. (On a.c., both plates of the lamp glow; on d.c. only one.) At this instant the voltage across LM2 is approximately 65 volts a.c. or 80 volts d.c., the ignition potential of a neon lamp. (For highest accuracy, the *exact* ignition value for LM2 may be measured.) If the drop across R2 is known, so is E2.

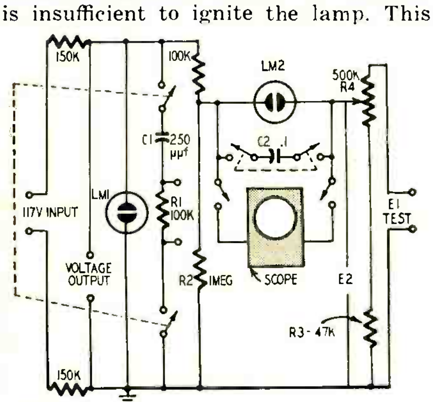


Fig. 1—Versatile neon lamp circuit.

Potentiometer R4 can be calibrated to indicate values of E1 at the TEST terminals for any setting at which LM2 begins to glow. This can be done by applying known values for E1, adjusting R4, and watching LM2 for glow.

This voltage measurement consumes no power from E1, because LM2 passes no current until the correct setting of R4 is reached. After this, LM2 glows and conducts — this does not matter. The measurement has been completed.

If E1 is a.c. and has the same frequency as the line, it should be connected in phase with the line. Thus the two voltages add across LM2. In any case, when LM2 flashes, it indicates the *peak sum* of these voltages.

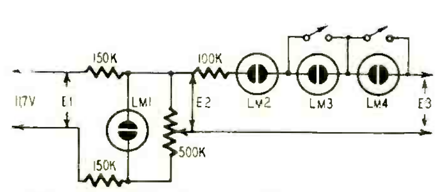


Fig. 2—Adaption of Fig. 1 patent.

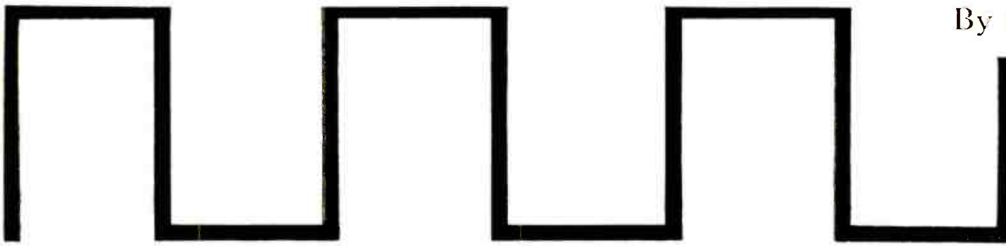
The circuit becomes an oscillator when 100 volts d.c. is applied at E1, the line disconnected, and C2 is switched in. A sawtooth wave is generated. The frequency depends upon values of C2, R2, and R3, as well as the lower portion of R4 which varies the frequency. The wave may be inspected, or the frequency measured, by switching in an oscilloscope.

With the power line connected as shown and 30 volts d.c. fed in at E1, radiation may be detected. If R4 is set so that LM2 is just below the ignition point, when light, X-rays or radioactive excitation falls on LM2, it breaks down.

The circuit in Fig. 2 illustrates an invention (patent No. 2,682,637) that is a division of the patent previously described, and is base on it. Line voltage E1 is regulated by LM1. A fraction of it (E2) is delivered by the potentiometer. If E2 is in phase with unknown voltage E3, these will add across the neon lamps.

To measure an unknown voltage between 10 and 80 (E3), only one neon lamp is needed — LM3 and LM4 are shorted out. When LM2 glows, the voltage across it is 65 volts a.c. or 80 volts d.c. If E2 is known (from the potentiometer calibration), so is E3.

To measure higher voltage, other lamps are switched in. Each lamp represents an additional 65 volts a.c. or 80 volts d.c. END



SQUARE WAVES : $1.00

By DON KETCHUM*

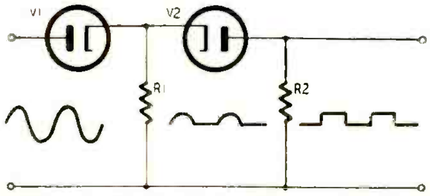


Fig. 1—Basic diode clipper circuit.

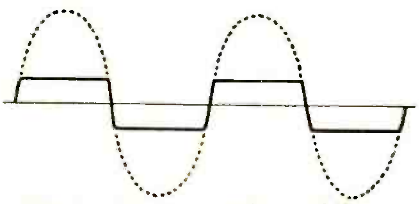


Fig. 2—Output waveform of Fig. 1.

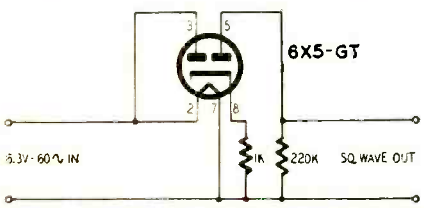


Fig. 3—Generator circuit using 6X5-GT.

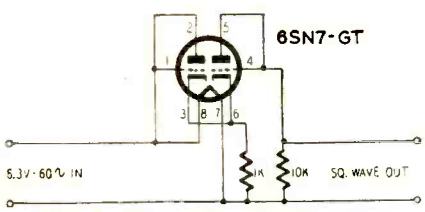


Fig. 4—Generator circuit using 6SN7-GT.

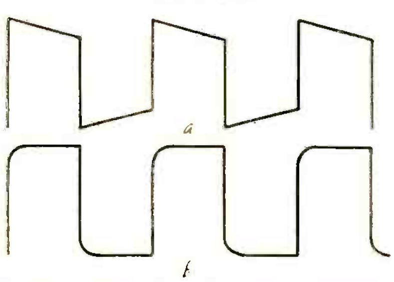


Fig. 5-a—Poor low-frequency response; 5-b—poor high-frequency response.

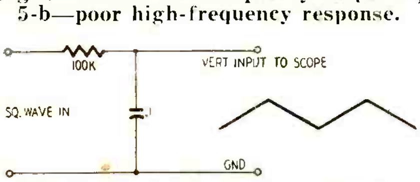


Fig. 6—Basic integrating network.

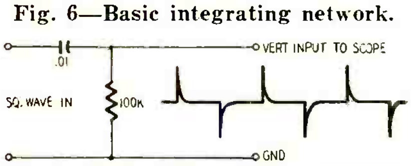


Fig. 7—Basic differentiating network.

FEW service shops have a square-wave generator, possibly because of its high cost and infrequent use. Yet a simple square-wave generator may be built very cheaply—for $1.00 or so if the junk box contributes. It is good enough not only to demonstrate some basic concepts of circuit theory but also may be valuable for checking the frequency and phase response of amplifiers.

This particular device is really not a generator at all, but a dual clipper. It consists of two diodes that clip off the positive and negative peaks of a sine wave, leaving a remarkably true square wave. As shown in Fig. 1, a sine wave applied across the input terminals will allow V1 to conduct on positive half-cycles, resulting in the waveform shown across R1, the negative half-cycle being cut off. This waveform is then applied to V2 which will conduct only on the negative half-cycle, cutting off the positive portion of the sine wave. At first thought it may appear that if both half-cycles were cut off, the output would be zero or just a straight line; but a diode will conduct slightly with zero volt on the plate. (By actual measurement on a 6X5-GT a current of about 0.4 ma was observed.) This means that not quite all of each half-cycle was cut off; the result, the square wave shown in Fig. 2 appears across R2. (We didn't believe this either, but it works!—*Editor)*

With 6.3 volts r.m.s. input (about 18 volts peak-to-peak) a square wave measuring about 0.3 volt peak-to-peak is obtained. This means that about 59/60 of each half-cycle is cut off, leaving a square wave with almost vertical sides.

The actual circuit of our 60-cycle square-wave generator is shown in Fig. 3. It uses a 6X5-GT. A 6SN7-GT may be used as shown in Fig. 4. Both work equally well. All that is needed is a 6.3-volt 60-cycle source that furnishes both the heater power and the sine wave.

Using square waves

Square waves have a distinct advantage over sine waves in testing amplifiers for phase and frequency response. To pass a square wave with very little distortion the amplifier must have constant gain over a band of frequencies from less than 1/10th of to over 21 times the square-wave frequency. Both audio and video amplifiers can be checked by using square waves of the proper frequencies. If the amplifier has poor low-frequency response, the flat tops of the square wave will be tilted (Fig. 5-a). If the high-frequency response is poor, the leading corners of the square wave will be rounded (Fig. 5-b). This can be demonstrated by connecting the output of a square-wave generator to the vertical input of an oscilloscope. With the square wave appearing on the oscilloscope, connect a .05-μf capacitor across the output of the square-wave generator, and the waveform will appear as in Fig. 5-b, showing loss of high frequencies. To obtain the waveform of Fig. 5-a, remove the shunt capacitor and connect a .005-μf capacitor in series with the lead from the square-wave generator to the vertical input of the oscilloscope. This results in low-frequency loss.

TV sync circuits

Sync pulses in television work are forms of square or rectangular waves. The horizontal and vertical pulses are separated by resistor-capacitor networks called differentiating and integrating circuits. The principles involved can be demonstrated easily. The circuit shown in Fig. 6 is an integrating network and responds to the horizontal or flat portion of a square wave—the part where the voltage is constant. This circuit gives a triangular wave shape.

If a square wave is applied to a differentiating network (Fig. 7), the output consists of short pulses produced by a change in voltage. The pulses are the vertical sides of the square wave. The polarity of the pulses depends on whether they are formed by a leading or lagging edge of the square wave.

Many electronic circuits operate on the principle of resistor-capacitor response to voltage changes. A better understanding of these principles can be obtained by building the simple circuits shown and observing the waveforms that can be produced.

*Instructor, American TV Labs of California, Hollywood, Calif.

References

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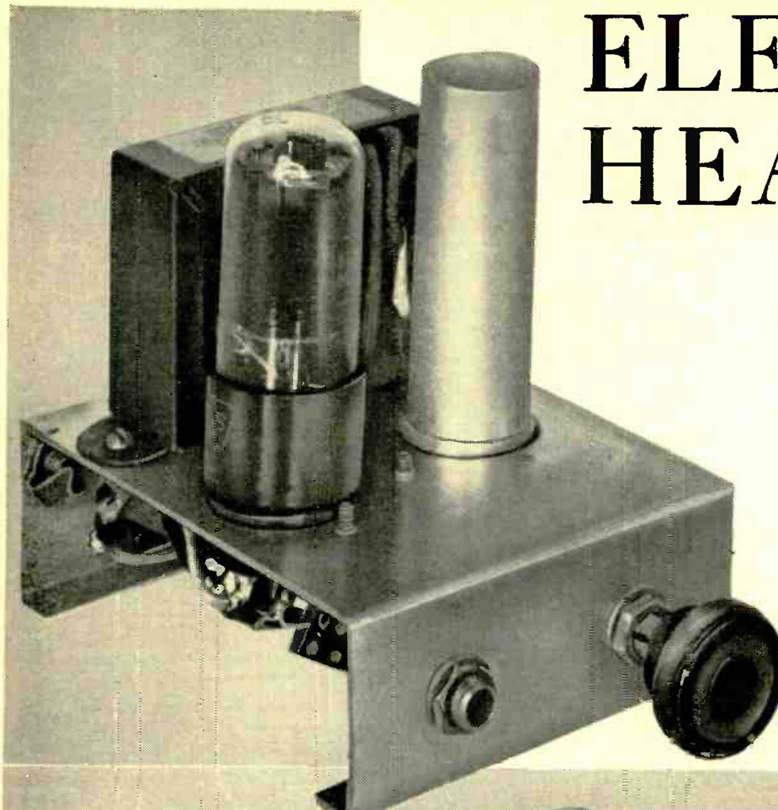
Basic Electronic Test Instruments by Rufus P. Turner. Pages 219-222.

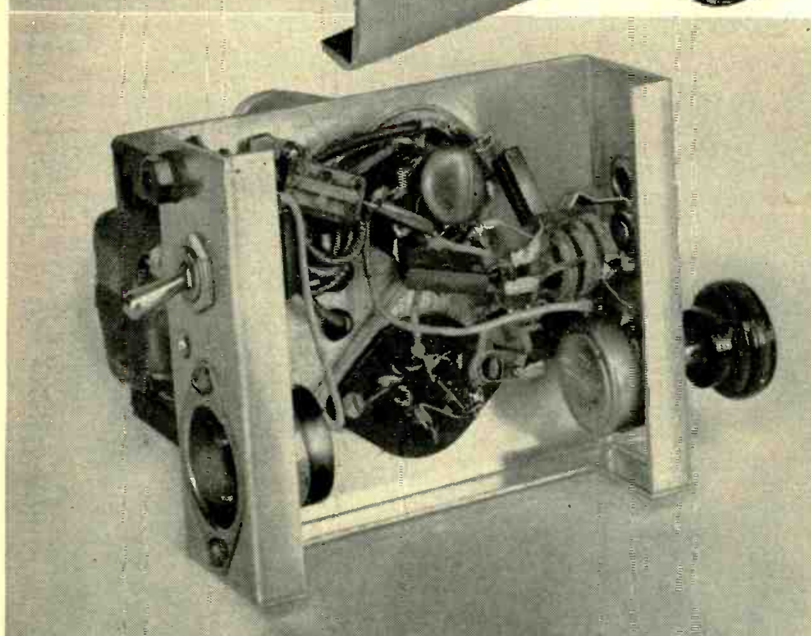
END

ELECTRONIC HEADPHONE



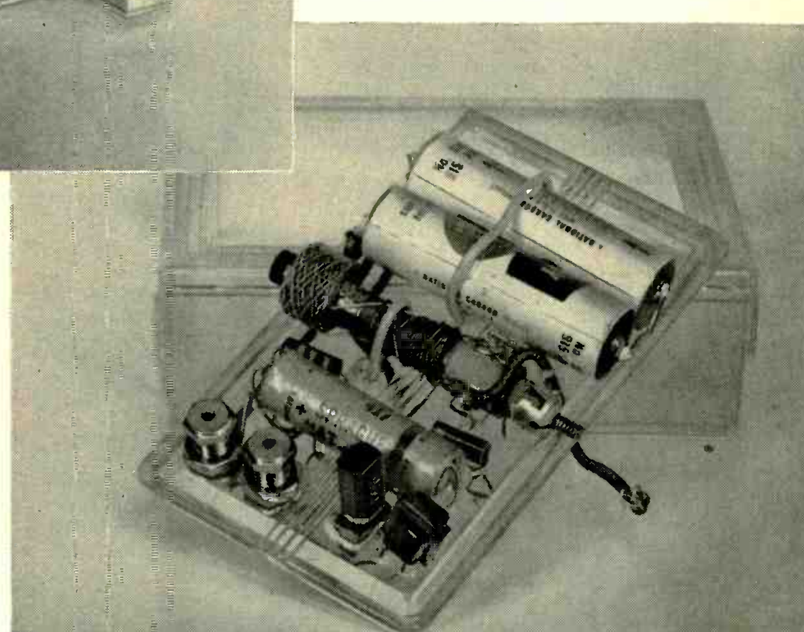
Baby tending and actor cueing are but two of many uses for this vest-pocket transistor receiver and midget transmitter

By JOHN A. IRWIN and I. QUEEN



THERE are times when some way of transmitting a radio signal a short distance to a small or inconspicuous receiver may be very useful. The first application that comes to mind is a cueing or prompting device for actors. Such apparatus (which can be very costly) is often used by magicians or "mentalists."

In the home such equipment may be used to hear radio or phonograph music without disturbing other persons in a room. (True, the listener could wear headphones, but they would limit his movements and the long leads would be



Top, the one-tube transmitter—unit tunes between 1.5 and 1.8 mc. Center, underchassis view of transmitter. A single 117L7 is used. Right, the receiver, containing a single audio frequency stage.

a safety hazard.) In some cases this transmitter-receiver combination might even be used as a radio "nurse," with the advantage that the mother could move from room to room without getting out of the "nurse's" range.

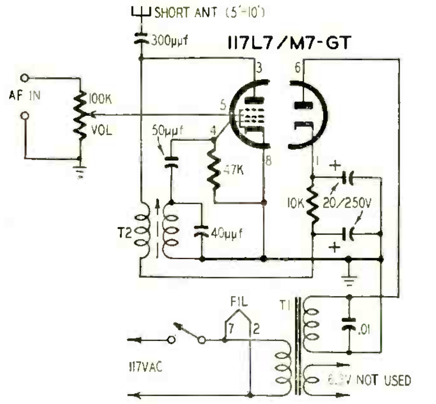


Fig. 1—One-tube transmitter. Isolation transformer reduces shock hazard.

A 117L7 tube (actually called a 117L7/M7-GT) makes a fine oscillator for the transmitting end. Its filament requires 117 volts which may be supplied directly from the line, avoiding the need for a 6.3-volt transformer. This tube has, in one envelope, a diode and a pentode. The diode is used as line rectifier (Fig. 1). The pentode is the oscillator tuned to the high end of the broadcast band or slightly above. The oscillator will work without isolation transformer T1, but its use is definitely recommended. It prevents a shock hazard when the chassis (or any other normally grounded point) is touched. The transformer may be any small unit delivering up to 150 volts at a few milliamperes.

The pentode screen is not returned to B plus as might be expected, but to ground. It is varied about 1 volt above and below ground potential by the modulation input.

Typical modulation sources are: speaker voice coil (working out of a radio, phono, or tape machine amplifier), FM or AM tuner, crystal pickup, high output mike. In any case the signal amplitude should be about 1 volt or more.

The oscillator tunes between 1.5 and 1.8 mc. The iron core of oscillator coil T2 controls the frequency. Adjust it while listening in on a near-by broadcast or all-wave receiver. Any unoccupied channel is recommended. Use as short an antenna as possible for the receiver used. If the antenna is too long, you may create radio interference over a wide area. With a 5-foot antenna on an ordinary home-type radio receiver, you should be able to hear the oscillator signal 20 or 30 feet away.

A simple portable receiver is shown in Fig. 2. It is a crystal set followed by an audio-frequency stage. The detector is a CK707; it was found more efficient than the usual 1N34. The amplifier uses a CK722 junction transistor, although a CK721 provides still more gain. Two penlight cells power the transistor.

With this receiver, signals are audible several feet from the oscillator. Thus if the "transmitting antenna" is strung across the ceiling of a small room, the signals will be heard over most of it. A small antenna, perhaps a foot or two, may be added at the receiver if necessary. Of course the *Superloop* (at the receiver) should be tuned to the same frequency as the oscillator. Adjust the iron core of the *Superloop* for maximum output.

The receiver uses such tiny components that the chief problem is mounting them. In the photo shown, parts are mounted on a plastic sheet. Leads are passed through small holes drilled in the plastic. Thus the parts are held in place by their own leads. All soldering is done under the plastic sheet. If desired, each part may be held in place with polystyrene cement. When completed, the plastic subchassis is put inside a plastic box to protect it. This may be a cigarette case, for example, which can be carried in a shirt pocket.

The *Superloop* is an antenna coil now available in most radio stores. It has an adjustable iron core. The tap is not used here. The coupling transformer is manufactured by Gramer. It is a tiny unit only 11/32 x ⅜ x ⅜ inch and weighs only a fraction of an ounce.

If your oscillator uses an antenna from 5 to 8 feet long, this receiver will pick up its signals 3 or 4 feet away. With an antenna 15 feet long, the effective range is nearly doubled, and so on. The length of antenna you

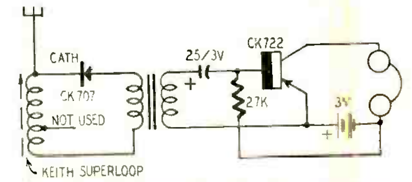


Fig. 2—Schematic of the receiver.

may use depends upon your location. If you live in an apartment house, your antenna must be a very short wire. Otherwise you may hear from your neighbors or even the FCC.

Parts list for transmitter

1—10,000 ohm, 1—47,000 ohm, ½ watt, resistor; 1—100,000-ohm potentiometer; 1—40 μμf, 1—50 μμf, 1—300 μμf, mica, 400 volts, capacitor; 1—.01 μf, paper or ceramic, capacitor; 1—20-20 μf, 250 volts, electrolytic. 1—117L7-GT tube; 1—octal socket; 1—slug-tuned broadcast oscillator transformer; 1—power transformer, 150-volt secondary @ 15 ma (or more); 1—s.p.s.t. switch; 1—phone jack; 1—pin jack.

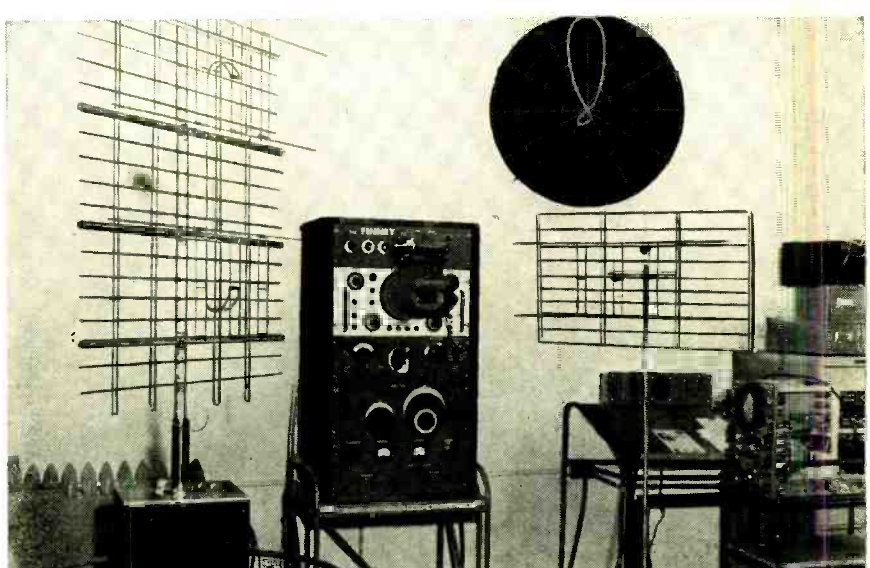
Parts list for receiver

1—27,000-ohm, ½ watt, resistor; 1—25 μf, 3 volts, electrolytic; 1—Keith *Superloop* antenna coil; 1—CK707 crystal; 1—a.f. coupling transformer, 20,000 to 1,000 ohms (Gramer); 1—CK722 transistor and socket; 2—penlight cells; 1—plastic sheet and box; 2—jacks for phones.

If a more powerful receiver is needed, try a superhet tuner. (See "A More Compact Battery Portable," September, 1954, page 90). The speaker and output transformer are not needed here, and one audio stage may be sufficient.

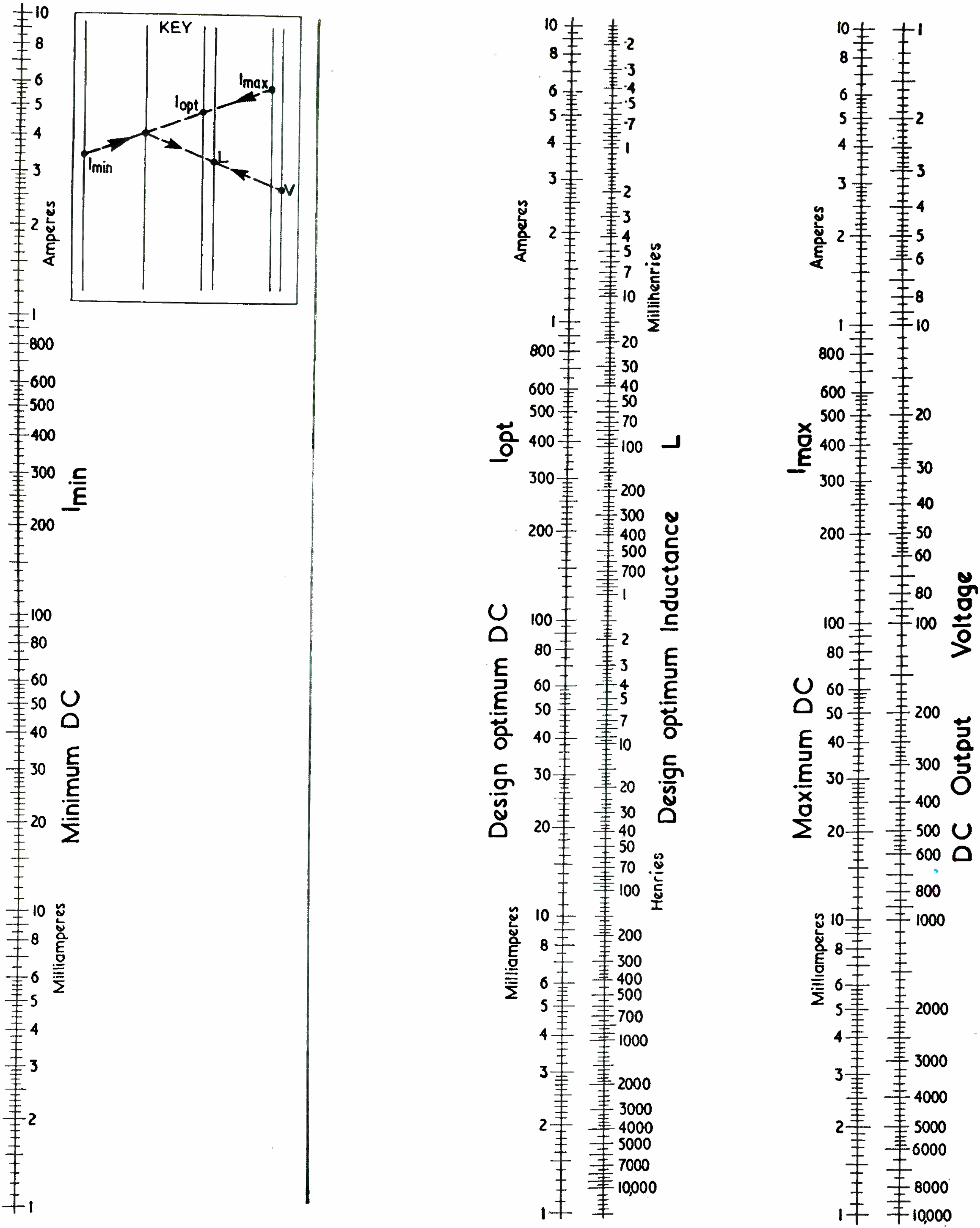
Such a portable set may be built within a space 3 x 3 x 2 inches or less. It will pick up signals from the oscillator up to 20 feet away when a short transmitter antenna is used. END

FINNEY ANTENNA-SCOPE



To speed up the time-consuming point-by-point method of plotting an antenna pattern, an antenna-pattern plotting and gain measurement instrument, the *Antenna-Scope*, has been designed by the Finney Co.

The *Antenna-Scope* displays on the screen of a polar oscilloscope the true voltage field pattern of any antenna being tested. The speed at which this pattern is traced is limited only by the antenna rotation rate. Antenna speeds of 30 to 60 r.p.m. are used and a complete field pattern is plotted in 1 to 2 seconds. The *Antenna-Scope* provides full coverage through the 50- to 1,000-mc range.



Design chart for calculating the optimum value of a swinging choke for a given range of B supply current swing.

SWINGING CHOKES AND POWER-SUPPLY REGULATION

Long used in transmitting circuits, the swinging choke is valuable in some types of audio power supplies. Fundamentals and design factors are discussed here

By NORMAN H. CROWHURST

MANY modern audio output circuits are operated class AB, causing large fluctuations in plate current. Two 6V6 tubes operated under recommended push-pull conditions, for example, swing from a total cathode current of 73 ma at zero signal to 105 ma at full output, a rise of over 40%. In normal power supply circuits such a rise in load current would result in an appreciable drop in d.c. supply voltage. This drop would reduce the available maximum output, and possibly introduce distortion (the bias becomes incorrect for the changed B voltage). So it is obviously desirable that the power supply be well regulated.

Some output-stage designs using transmitter type triodes or large output pentodes connected as triodes, biased for class-B operation, demand even greater relative changes in current between zero-signal and full-output conditions.

The voltage drop as the load current is increased is due to two effects: the voltage drop in transformer windings,

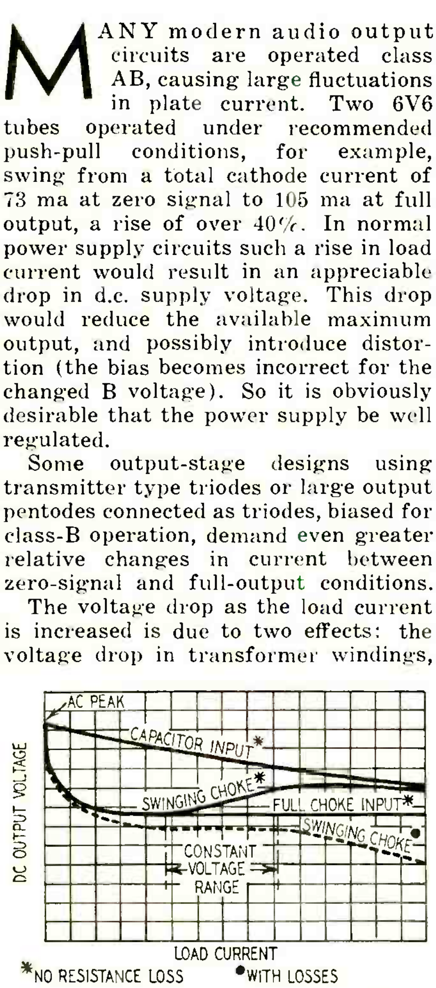


Fig. 1—Power supply characteristics.

chokes, and across the rectifier, and the inherent characteristic of the filter circuit that follows the rectifier.

The latter factor is not always appreciated. Fig. 1 includes a typical curve for the d.c. output voltage with a capacitor input (reservoir) type filter and an assumed loss, due to the various voltage drops listed above, of zero. However generous are the proportions of the transformer, rectifier and choke, the voltage characteristic of such a circuit cannot be better than this curve.

To offset these various sources of voltage drop as load current is increased, the swinging-choke type of filter is sometimes used when the current taken by the output tubes varies with signal. Fig. 2 shows a simple rectifier, choke, and filter capacitor arrangement for this circuit. Fig. 3 shows how the waveforms change to produce a rising output voltage characteristic in a theoretical resistanceless circuit designed for this purpose.

In Fig. 3-a the inductance of the choke is large enough to smooth out fluctuations in the output current from the rectifier to a considerable extent; so the choke current has a steady value with a slight ripple imposed on it. The output voltage from the choke has very little ripple at all due to the further smoothing effect of the filter capacitor. As the rectifier is conducting all the time, the output voltage is the average value of the voltage at the input to the choke, neglecting the effect of resistance drops. So the output voltage from a choke filter is 0.637 times the peak value of input voltage (or 0.9 times the r.m.s. value of the peak input voltage).

Fig. 3-b shows the waveforms as saturation begins. The positive current swing becomes very peaky due to saturation; the negative excursion becomes flatter, making the waveform asymmetrical. The effect on the output voltage is a tendency to rise to a higher point on the input waveform, as the positive-going pulses begin to make the filter capacitor act as a true reservoir. (The vertical lines in the current waveforms indicate the points where the current in the choke changes over from one plate of the rectifier to the other. At no point, however, does the current actually fall to zero during this time—it merely changes rapidly from one plate to the other.)

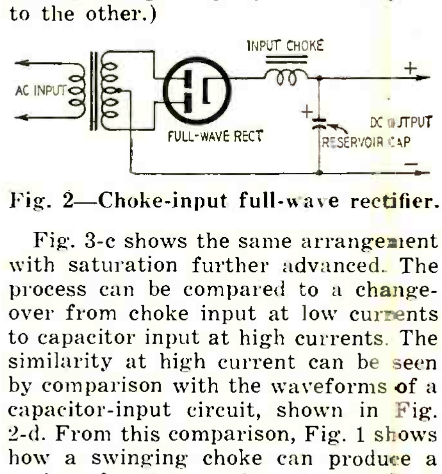


Fig. 2—Choke-input full-wave rectifier.

Fig. 3-c shows the same arrangement with saturation further advanced. The process can be compared to a changeover from choke input at low currents to capacitor input at high currents. The similarity at high current can be seen by comparison with the waveforms of a capacitor-input circuit, shown in Fig. 2-d. From this comparison, Fig. 1 shows how a swinging choke can produce a region of constant voltage output from the power supply. A filter using a nonsaturating, resistanceless choke (assuming no losses elsewhere) would pro-

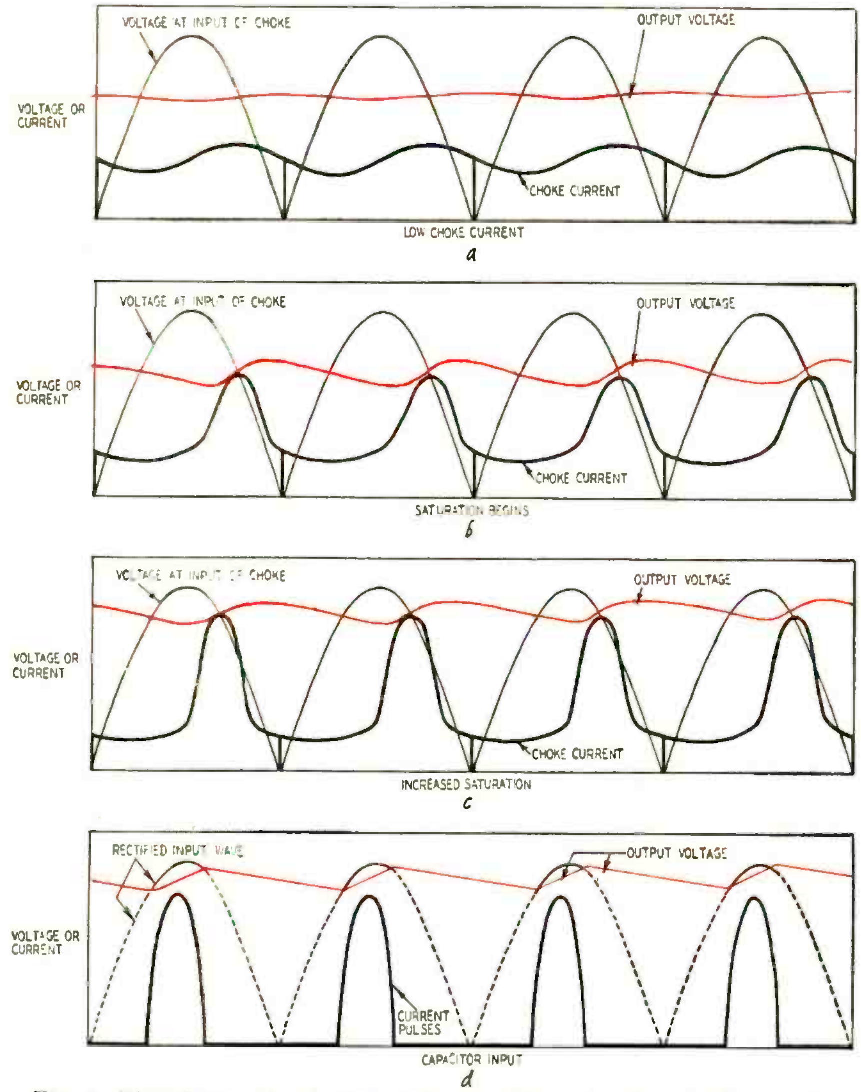


Fig. 3—Waveforms of swinging-choke operation at various load currents.

duce a level output at 0.637 of the peak a.c. input, for current values above the point where the inductance is large enough to prevent the filter capacitor from acting partially as a reservoir. (The reservoir action accounts for the upward sweep of the curve toward zero current.)

A swinging choke with no resistance losses would produce a characteristic following the full choke curve up to the point where saturation begins to set in. At this point it will begin to rise toward the capacitor input characteristic (if the same capacitor value is used in both cases). The dotted curve in Fig. 1 shows the final result when the effects of losses due to resistance in the plate transformer, choke, and rectifier are taken into account. These losses produce a voltage drop from the ideal curve directly proportional to current, but one in which the d.c. output voltage becomes virtually constant over a certain range, as shown.

The whole action is rather complicated, and a completely satisfactory mathematical analysis of its behavior has never been published. At one time it was assumed that the inductance of the choke had a constant value throughout each rectification cycle. The output voltage of such an arrangement was then analyzed as the inductance was varied. The curves of Fig. 3 show that the assumption of constant inductance during a cycle is not strictly true. Using

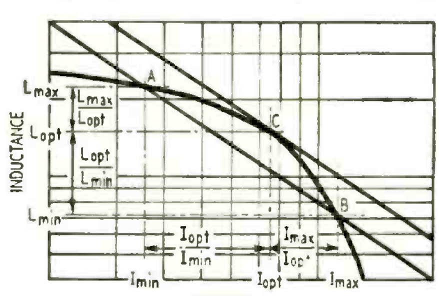


Fig. 4—Choke inductance-current characteristics drawn on log-log scale.

this principle as a basis, an ideal swinging choke would have an inductance that reduced in inverse proportion to increasing load current, as represented by the straight line joining AB in Fig. 4.

Investigation of a variety of iron-cored inductances with direct current flowing showed that the curve of inductance against current, as represented by ACB in Fig. 4, has inherent relations that never depart very far from the proportions shown. A logarithmic scale is used, so the distance between two points on the curve represents the *ratio* between the currents or inductances at those points, rather than the *difference* between them.

The inherent ratio of these proportions is incorporated into the design chart, so the optimum inductance value at a current, represented by point C, that bears a definite relationship to the minimum and maximum currents, represented by points A and B, can always be calculated from knowledge of the circuit requirements.

In practice, although the theory remains somewhat doubtful, this method of calculation has proved useful in preparing a chart for finding a choke with the right characteristic for a job. The quantities required for the chart are the maximum and minimum currents and the d.c. output voltage, using full-wave rectification at a supply frequency of 50 or 60 cycles. Using a straightedge as shown in the key on the chart gives us the inductance and current rating for a choke, having its optimum value at the current rating specified.

To give an example of the chart's use, suppose that the two 6V6's mentioned at the beginning of this article are used in an amplifier where the total B supply current consumption at zero signal is 100 ma, rising to 135 ma at full output. The chart shows that the design figure should be a little over 120 ma, and with a supply voltage of 285, as recommended by the tube manufacturers, the inductance required is about 3.8 h. In practice a 4-h 120-ma choke would serve this purpose well.

A small practical point for amplifiers using choke-input filters: a ticky kind of hum, similar to static hum, is sometimes heard. This is due to the sudden current change-over in the rectifier circuit, referred to earlier, which can produce by induction extremely sharp pulses in various parts of the circuit. To overcome this, a simple method is to use a small capacitor at the input end of the swinging choke (Fig. 5). Its value must be small enough not to interfere with the choke action appreciably at low currents, but large enough

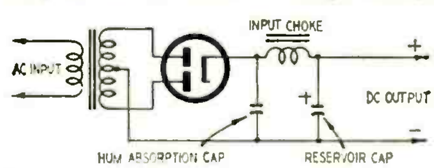


Fig. 5—Adding a small input capacitor.

to smooth off the sharp negative-going points of the voltage waveform at the input to the choke. This avoids the suddenness of transition from one plate to the other in the rectifier. Suitable values for this input capacitor are from 0.1 to 0.5 μf, depending upon its application. It should have a generous voltage rating because of the relatively large ripple current it will carry. END

ADDING AFC TO YOUR FM TUNER

By A. RINGEL* and E. R. GUNNY*

A DRAWBACK of the average FM home receiver is drift during the warmup period. Even though, percentagewise, the change is remarkably small for a commercial receiver, it is great enough to cause most users to condemn the unit as unsatisfactory because the sound becomes mushy in a short time after being set on a station. Some receivers are available with automatic frequency control. This feature eliminates the usual tuning difficulties, but makes the FM receiver too expensive ever to become as popular as the a.c.-d.c. table radios.

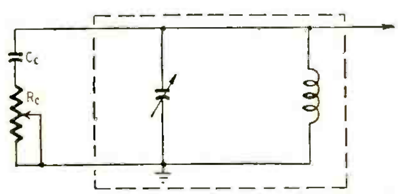


Fig. 1—The equivalent a.f.c. circuit.

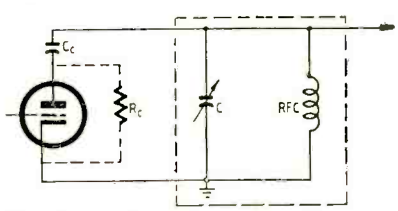


Fig. 2—Resistor is replaced by tube.

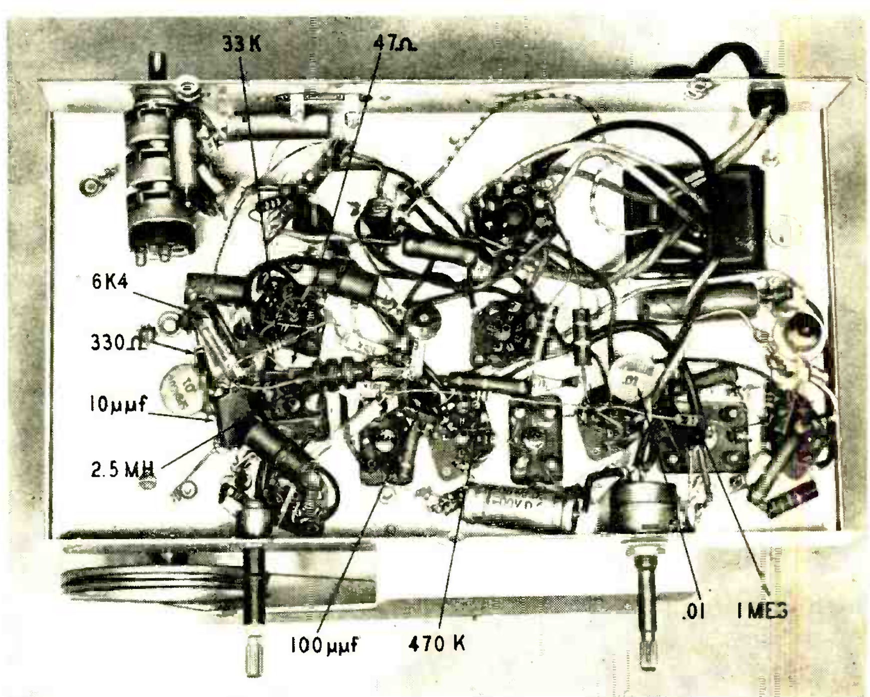
This article describes a simple but effective a.f.c. circuit that can be added to any FM receiver with a few parts and without any need for special test equipment.

Any FM receiver, whether it uses a discriminator or ratio dectector, produces at the audio end a d.c. voltage proportional in amplitude and phase to differences in frequency between the desired and the actual center frequencies. We shall call this the tuning error. When the oscillator drifts above the correct frequency, the d.c. voltage at the discriminator swings from zero volt to some positive value. Below the correct frequency, the d.c. voltage is negative. When the set is correctly tuned, the discriminator voltage is zero.

To correct for oscillator drift and to make tuning less critical, means must be provided to vary electrically the oscillator frequency in response to the d.c. voltage of the discriminator.

Fig. 1 shows the equivalent a.f.c. circuit. By varying R_c, a control resistance, effective capacitance of the main tuning capacitor and auxiliary capacitor C_c can be changed. This results in a change in oscillator frequency. Control resistor R_c can be the plate resistance of a triode shown in Fig. 2, the resistance of which varies as a function of the grid voltage. When the grid becomes more positive, the plate resistance of the triode decreases. The lower resistance increases the shunting effect of C_c, lowering the oscillator frequency. The operation is reversed when the grid becomes negative, raising the oscillator frequency. The control voltage available at the discriminator is of the proper polarity to be used directly on the grid of the tube.

When any change occurs that tends to increase frequency, a positive voltage is produced. It lowers the plate resistance of the triode, which adds capacitance and lowers the oscillator fre-



Underchassis view of tuner showing components added for a.f.c. operation.

*HUGHES AIRCRAFT COMPANY
Culver City, Calif.

quency until the discriminator voltage is zero. The effectiveness of this circuit is determined solely by the transconductance of the control tube used. The higher the transconductance, the better

Parts for a.f.c. circuit
Resistors: 1—47, 1—330, 1—33,000, 1—470,000, 1—1 megohm, ½ watt.
Capacitors: 1—10 μμf, 1—100 μμf, 200 volts, mica; 1—.01 μf, 200 volts, mica.
Miscellaneous: 1—choke, 2.5 mh; 1—6K4 subminiature tube and socket.

the control. Some satisfactory control tubes are the 6C4, ½ 12AT7, ½ 12AU7, ½ 6J6, and subminiature type 6K4, used in the unit in Fig. 3-a. The diagrams at *b* and *c* in Fig. 3 show the d.c. take-off points in typical ratio-detector and discriminator circuits.

The choke maintains the plate at an appropriate r.f. high impedance above B plus, which is equivalent to r.f. ground. The resistors and capacitors in the grid circuit serve as a low-pass filter. Mount the tube as close as possible to the oscillator tube socket. Plate and cathode leads should be short and direct. While the grid wiring of the 6K4 is not critical, it should be run so as to avoid hum pickup from the 60-cycle line.

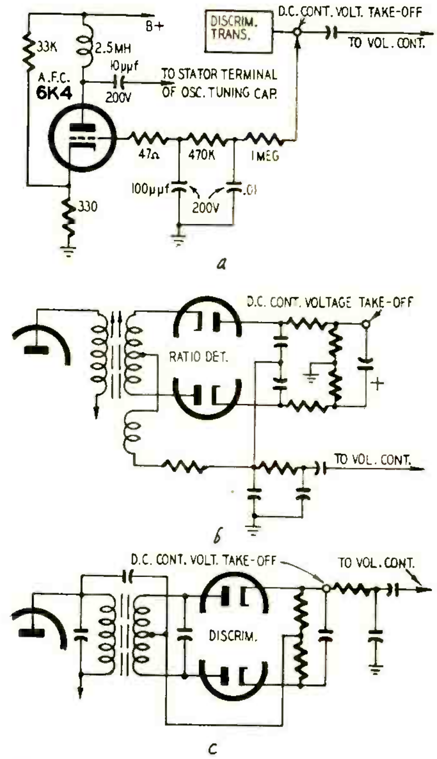


Fig. 3-a—Schematic of a.f.c. circuit; 3-b, c—typical circuit applications.

After completing the wiring, tune the receiver to a strong station. When the tubes have warmed up, reduce the oscillator trimmer until the station can be tuned in at exactly the dial setting at which it had been received before the a.f.c. was added. Adding a switch to disconnect the a.f.c. line from the d.c. take-off and connecting it to ground (Fig. 3-a) will simplify tuning in weak stations close to strong ones.

In a.c.-d.c. FM receivers with the filaments in series, another tube can usually be added. In sets having a 50-volt output tube, it can be replaced by a 35-volt tube. A 150-ma, 12-volt triode or control tube can be added in the filament string without any further changes. Some receivers already use a 35-volt output tube and usually have a resistor in series with the filaments. Whatever the value of this resistor, it must be reduced by 84 ohms, so that another 12-volt tube may be added to the string.

While a.f.c. may seem an unnecessary refinement to some, it is subconsciously annoying to all of us to have to retune after warmup, and persons unfamiliar with radio may attribute the effects of drift to FM in general, and abandon it for the more familiar and comfortable AM band. END

PUNCH PRESS CONTROL CIRCUIT

By WALTER T. STEVENSON

MANY of the older punch presses in use today are activated by a positive-action sliding-pin clutch controlled by a hand lever or a foot treadle. If the treadle is held down a trifle too long the punch makes more than one stroke and damages the dies or material and also may endanger the operator.

Double strokes and their damaging and hazardous effects can be prevented by disconnecting the mechanical linkage between the treadle and the clutch dog and by operating the clutch dog with a solenoid coupled to an electronic control circuit. Closing the control switch instantly engages the clutch and automatically releases it after the time interval required for safe and efficient operation of the press.

The operation of the electronic circuit is based on the time constant of a resistance and capacitance in series as in Fig. 1. When the switch is closed, the capacitor begins to charge through the relay coil. The charging current is limited only by the d.c. resistance of the coil and the back e.m.f. induced

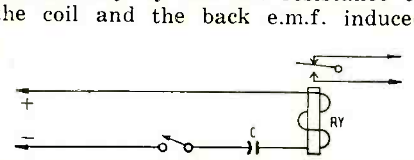


Fig. 1—The fundamental circuit. The relay coil serves as the resistance.

in it. The charging current flowing through the relay coil closes the contacts and holds them closed until the capacitor has charged.

Fig. 2 shows the complete circuit of the punch press control unit. When

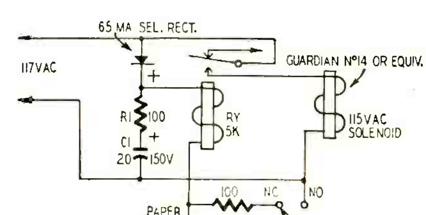


Fig. 2—The completed circuit. Relay at right operates the press mechanism.

the s.p.d.t. switch is closed, C2 begins to charge and pulls in the relay contacts. The contacts open when the charging current drops below the hold-in level of the relay. The time that the contacts remain closed is determined by the capacitance of C2 and the resistance of the relay coil. Adjust the value of C2 so the relay contacts open to de-energize the solenoid and release the clutch dog at the correct instant. A 4-μf capacitor is satisfactory for C2 in most applications.

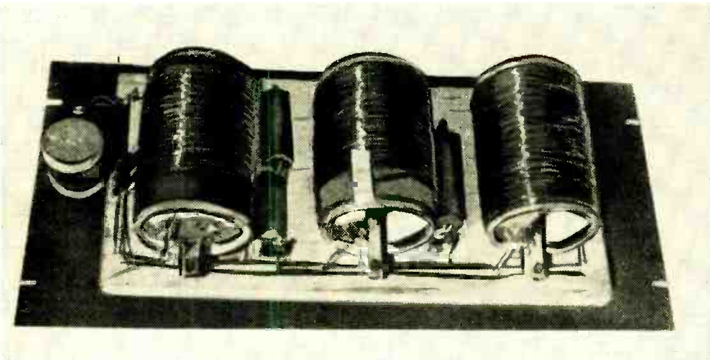
When the switch is released, C2 discharges through R2 so the punch will be free to operate the next time the switch is pressed.

C1 is the filter or storage capacitor and R1 is a protective resistor to limit the charging current to prevent damaging the selenium rectifier. It and R2, which slows down the discharge of C2 and thus prevents burning out the switch contact, may be ½-watt units, since they are on intermittent duty. C2 should be a paper type. It may be built up of smaller units and varied in capacitance till it provides sufficient "dwell" for proper solenoid operation. Cl is an ordinary electrolytic capacitor.

To hook up the device, remove the mechanical linkage between the clutch dog and the treadle. Mount the solenoid as close as practical to the clutch dog and couple to it. Adjust spring tension, stroke, and linkage for proper operation. The lower the mechanical mass of the setup, the more precise will be the action. Each press has its own peculiarities and must be treated as an individual problem.

The control switch, a snap-action type, should be fitted with a cord and polarized plug and may be mounted for either treadle or knee operation. The parts layout is not important but you must take care to avoid all grounds, because all lines are hot to ground. END

Crossover network—breadboard style.



By JAMES P. ROGERS*

A few simple components and a little work will improve the quality of any good audio amplifier

A LOW-COST CROSSOVER NETWORK

THIS entire crossover network can be built for about $6—even less if some of the parts come from the experimenter's junk box.

The purpose of a crossover network is to separate the bass and treble notes and feed them to individual speakers whose resonance falls within that band of frequencies. Even in my own rig, which uses identical speakers, the improvement is tremendous because neither speaker is required to respond to the entire audio range. Design a filter circuit that rapidly attenuates all frequencies above a certain point, and another that attenuates all frequencies below a certain point. Plot their characteristics on a graph. There will be a point at which the two curves coincide. This point is the crossover frequency. In my home-built network 1,000 cycles was arbitrarily chosen as a base from which to begin calculations.

By combining two filter circuits as shown in Fig. 1, a network[1] can be produced to perform to the satisfaction of even the most critical listener.

In calculating the values of L and C, you must know the impedance of the speakers, the crossover frequency desired, and the size of the coil forms you wish to use.

In the following calculations speakers are 8 ohms each, and cleanser cans of the Bab-O or Kitchen Kleanser type were used for coil forms.

Calculations

For the purpose of explaining the calculations we will assume you will use the same values and materials as in my original model. Later the information will be translated into terms of wire turns. For now, let us consider the formulas for the values of L and C:

$$L1 = \frac{R_o}{6.28\,f_c} \qquad C1 = \frac{1}{6.28\,f_c\,R_o}$$

$$L3 = \frac{R_o}{12.56\,f_c} \qquad C2 = \frac{2}{6.28\,f_c\,R_o}$$

$$L4 = (1+m)\frac{R_o}{6.28\,f_c}$$

$$C5 = \left(\frac{1}{1+m}\right)\left(\frac{1}{6.28\,f_c\,R_o}\right)$$

where L is in henries, C is in farads, R_o is speaker impedance, f_c is crossover frequency, and m is the design constant equal to 0.6. (The numbering of coils and capacitors follows Terman—cited above—and is used here for the convenience of readers who are able to refer to the *Radio Engineer's Handbook.*)

By substituting the given values of crossover frequency, speaker impedance, and design constant for the unknowns it is possible to find the exact values of inductance and capacitance needed.

$$L1 = \frac{8}{6.28 \times 1{,}000} \qquad L1 = \frac{8}{6{,}280}$$

$$L1 = 0.00127 \text{ henry}$$
or
$$1{,}270 \text{ microhenries}$$

$$L3 = \frac{8}{12{,}560}$$

$$L3 = 0.000637 \text{ henry}$$
or
$$637 \text{ microhenries}$$

$$L4 = (1+0.6)\frac{8}{6{,}280}$$

$$L4 = \left(\frac{1.6}{1}\right)\left(\frac{8}{6{,}280}\right)$$

$$L4 = \frac{12.8}{6{,}280}$$

$$L4 = 0.002038 \text{ henry}$$
or
$$2{,}038 \text{ microhenries}$$

$$C1 = \frac{1}{6{,}280 \times 8} \qquad C1 = \frac{1}{50{,}240}$$

$$C1 = 0.0000199 \text{ farad}$$
or
$$19.9 \text{ microfarads}$$

$$C2 = \frac{2}{6{,}280 \times 8} \qquad C2 = \frac{2}{50{,}240}$$

$$C2 = 0.0000398 \text{ farad}$$
or
$$39.8 \text{ microfarads}$$

$$C5 = \left(\frac{1}{1.6}\right)\left(\frac{1}{50{,}240}\right) \qquad C5 = \frac{1}{80{,}384}$$

$$C5 = 0.0000124 \text{ farad}$$
or
$$12.4 \text{ microfarads}$$

Having found the values of L and C for the network, it is next necessary to determine the number of turns of wire that will produce the required inductance. The formula[2] for this is:

$$N = \sqrt{\frac{3a+9b}{0.2a^2} \times L}$$

where N is the number of turns of wire, a is the diameter of the winding in inches, b is the length of the winding in inches, and L is the inductance in microhenries.

I chose cleanser cans as coil forms because they were available and inexpensive. These dimensions provide the values for *a* and *b* in the formula—*a* is equal to 3, and *b* to 5. Note that since the formula calls for the inductance in microhenries, the values in henries arrived at earlier must be converted.

This crossover network is much larger than commercially available units and could no doubt be reworked for greater compactness.

It performed so well, however, that no modifications were deemed necessary. Space was not considered important although wire size was—to reduce losses—so No. 18 wire was used. This seemed especially important since the amplifier that the network is used with employs a pair of 807's with a plate voltage of 450.

*Engineering Dept. WLW-A, Atlanta, Ga.

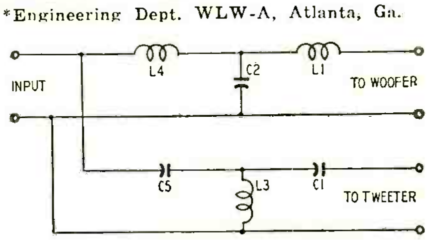


Fig. 1—A simple two-filter network.

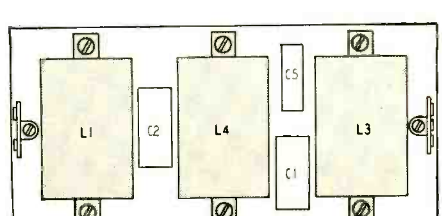


Fig. 2—Arrangements of components.

From the information we now have we can compute the required number of wire turns for our coils.

L1

$$N = \sqrt{\frac{9+45}{1.8} \times 1{,}270} \qquad N = 195$$

L3

$$N = \sqrt{\frac{9+45}{1.8} \times 637} \qquad N = 138$$

L4

$$N = \sqrt{\frac{9+45}{1.8} \times 2{,}038} \qquad N = 247$$

Construction

Drive a nail through a piece of wood, and drop the wire spool over the nail. Wind the wire by hand from the spool onto the cleanser can. In starting the winding, pierce a small hole in the fiber side at the end of the can containing the pouring perforations. Pass 6 or 8 inches of the wire through the hole in the fiber. Then feed it through one of the perforations in the metal end.

As the first layer of the winding is completed, carefully wind a layer of friction tape around the coil. This provides insulation between the layers and also holds the first layer in place while the second is being wound.

(Note that the inductance formula is not entirely correct for a bank winding. However, it worked out approximately for the author, who checked his crossover point with an audio oscillator—a frequency record could be used—and a vacuum-tube voltmeter. Variation in the inductance would result in slight differences in the crossover point and impedance, neither of which are particularly critical.—*Editor*)

When the required number of turns is reached, pierce a second hole in the fiber side of the cleanser can and feed another 6 or 8 inches of the wire through the fiber and then through another perforation in the metal end. Solder a 2-connector terminal strip to the metal end and cut the two protruding wires to the correct length for securing to the terminals. Before the wires are soldered, slip a piece of spaghetti over each to protect it from the sharp edges of the metal top.

After the coil is complete give it a good coating of varnish or coil dope to protect the insulation and prevent loosening of the turns. (Removing the metal ends of the can in no way changed the characteristics of the network.)

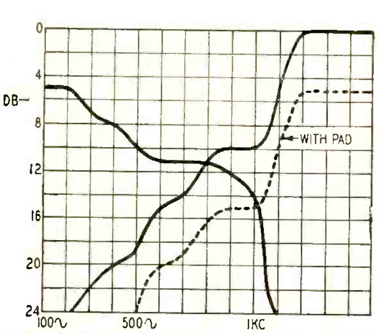


Fig. 3—Characteristics of the network with and without attenuating pad.

The network is laid out breadboard fashion with the components arranged as in Fig. 2. The base is a piece of 5-ply wood measuring 7 x 14½ x ¾ inches. Each coil is fastened to the base by ½ x ½-inch wood strips 6⅝ inches long. The strips are passed through the coil form from end to end and held in place by wood screws.

The three capacitors are mounted between the coils, using single-connector terminal strips. A 2-connector terminal is used at one end of the base for the input and a 3-connector terminal at the other end as the output.

All that remains is to connect the various components with suitable hookup wire.

There are two optional features. The unit may be mounted on a standard panel for rack mounting, as I did, or it may be placed inside the speaker cabinet. The second feature is a pad at the output of the high-frequency network. Because of the extremely low reactance of the low-frequency speaker voice coil from 10 cycles to roll-off, there is a 5-db loss, causing an unbalance between the highs and lows. The result is a crossover at about 800 rather than the calculated 1,000 cycles. To conteract this a 500-ohm T-pad was inserted between the output of the high-frequency section and its speaker, and the highs attenuated 5 db. Crossover then occurs at 1,000 cycles. Theoretically, I suppose a 4-ohm pad should have been used, but I did not have one, and the high resistance did not seem to disturb anything. (Still another use for the pad is to compensate for different room acoustics and listener preferences.)

Parts for crossover network

1—12 μf, 1—20 μf, 1—40 μf, 450 volts, electrolytic capacitors; 3—cleanser cans; 4—2-connector terminal strip; 5—1-connector terminal strip; 1—3-connector terminal strip; 2½ pounds—No. 18 enamel wire; 1—7 x 14½ x ¾-inch board; 6—1½-inch wood screws; 7—¼-inch wood screws; hook up wire.

Fig. 3 shows graphically—if you'll pardon the expression—the characteristics of the network both with and without the attenuating pad.

With or without the pad this economical network will improve the performance of any sound system and can be constructed in a spare evening. END

References

[1]*Radio Engineer's Handbook*, Terman, page 249.

[2]*The Radio Amateur's Handbook*, 30th Edition, page 27.

CIRCULAR EXPONENTIAL HORN

A new sound reproducing system, the Radial Exponential Transducer, has been demonstrated at the Buhl Planetarium, Pittsburgh. Designed by engineer Anthony Doschek, the system is primarily intended for high-fidelity speech and music reproduction in commercial and industrial applications.

The acoustical principle involved is similar to that of the exponential horn except that transformation of the acoustic energy takes place via an exponentially expanding, ring-shaped air load rather than the conventional columnar load. The exponential curve is generated by a very rigid circular structure, critically spaced and bolted to the plane of either a floor, wall or ceiling. The "mouth" of the transducer is actually a slot turned back on itself through a full circle of rotation, thereby radiating sound uniformly over the entire listening area. Five speakers are used to achieve smooth response from below 20 cycles to beyond the limit of audibility.

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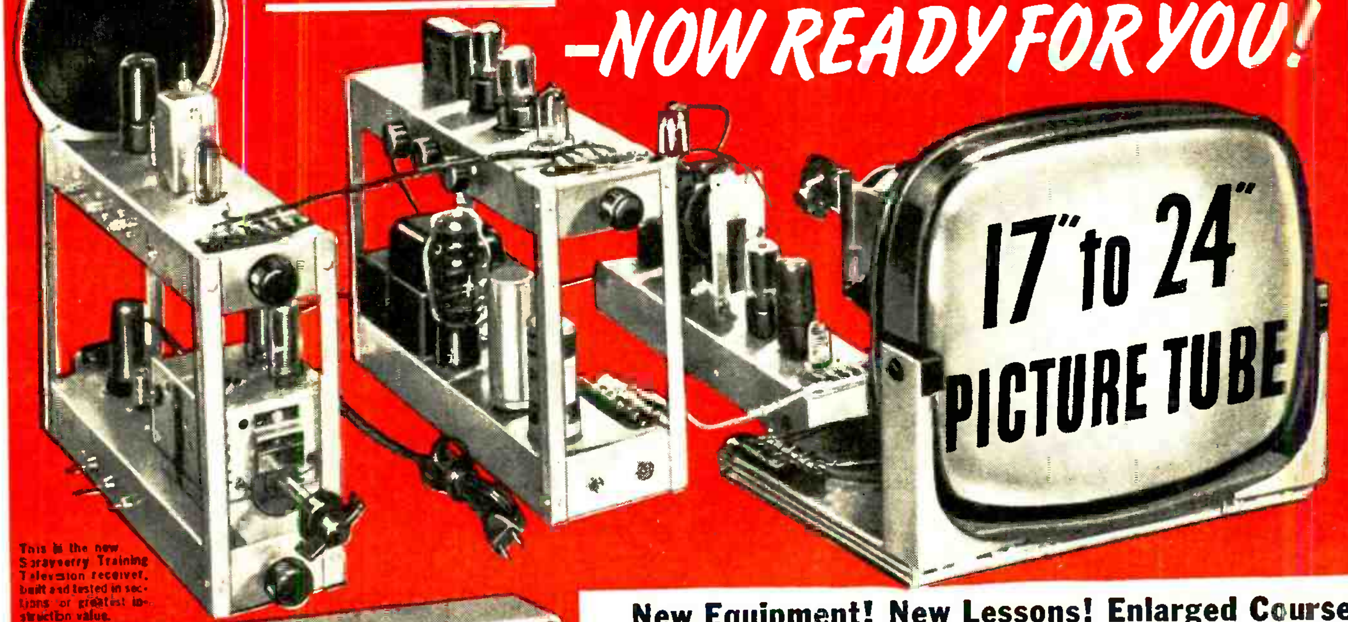
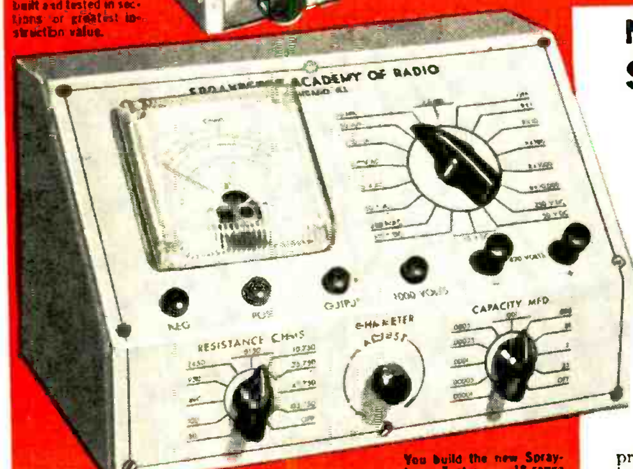


This is the new Sprayberry Training Television receiver, built and tested in sections for greatest instruction value.



These photos show only a small part of the training equipment I send my students.

You build the new Sprayberry Tester . . . 18-range Volt-Ohm-Milliammeter readings plus output meter and condenser and resistor substitution selector.

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SERVICING HIGH-FIDELITY EQUIPMENT

Part IX—Equalization and frequency response

By JOSEPH MARSHALL

THE playback equalization of a hi-fi system may change with time and correction may become necessary. The simplest and most frequent cause of a shift in playback characteristics is a worn stylus. The translation loss at high frequencies increases rapidly as flats are formed on the needle. Long before a needle becomes dangerous to records, its ability to trace the frequencies above 7,000 cycles deteriorates enough to reduce output above this region by as much as 6 db. The simplest and best check for this is the translation-loss test on the Cook series 10LP record.

The simplest and quickest way to check equalization is with the Clarkstan 102M sweep-frequency test record and a scope. This disc is recorded with LP pre-emphasis. Played back with a good LP equalizer it will produce a reasonably flat trace. Played back with old AES, new RIAA standard, or other equalizers, the trace will show variations from flatness on both ends. The rise at the high-frequency end for the new RIAA standard will be about 2 or 3 db, and for the old AES about 4 or 5 db at 10,000 cycles.

If you have any difficulty obtaining or maintaining synchronization with the sweep record, it is an almost certain sign that wow is excessive. While using the sweep record, watch for signs of distortion, resonances, and poor transient response. If your scope is sensitive enough, it is best to connect it directly to the output of the preamp so that troubles caused by following portions of the system are eliminated. Distortion is evidenced by a doubling of the trace at the high-frequency end and by a sharpening of the wave shape at low frequencies into a triangular, rather than sine-wave, form. Resonances are indicated by bulges at the resonant frequencies or band of frequencies. Transient response can be checked by watching the very beginning of the trace. If the system reacts to the synchronizing pulse by producing echoes or hangover, the initial portion of the trace will be followed by a weaving curve rather than a smooth one. Some of these effects are indicated in the drawings of Fig. 1.

If a scope has a sweep magnifying circuit, it is possible to examine the trace minutely from beginning to end and the exact point at which any distortion occurs—as well as its nature—is much more easily determined. A study of the leaflet which comes with the Clarkstan record, and some experience, will soon make you familiar with the various patterns and their significance.

A more exact, though more tedious, method of checking equalization is using a steady-state test-frequency record and an output indicator. When the budget for test records is limited, the Cook series 10 is probably the most useful single record because it permits the greatest variety of tests. It is also the only one which covers the complete audio range from 20 to 20,000 cycles and is, therefore, the only one which offers a measure of the response of those very high quality pickups which go beyond 10 or 12 kc. A useful procedure with this record is this:

1. Play side B with the equalizer set for the LP curve. Watch the output indicator or wattmeter. The reading should be almost the same (say within 2 or 3 db at most) for all the test tones in band 1. Listen for a change in pitch on each tone; such a change will indicate wow.

2. Measure the intermodulation at the beginning and end of each of the two IM bands. When the record is new, the IM should run from about 3 or 3½% with the finest pickups to 5% with average pickups on the outermost band, and should not rise to more than 5 to 8% on the innermost one. If the rise

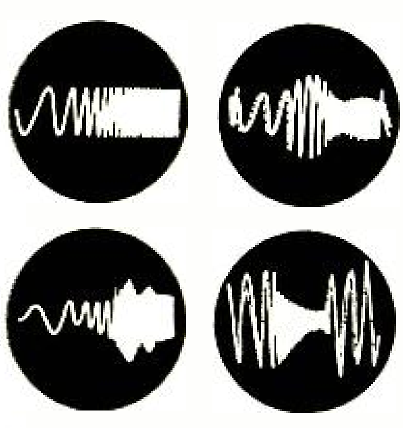


Fig. 1—Various response patterns.

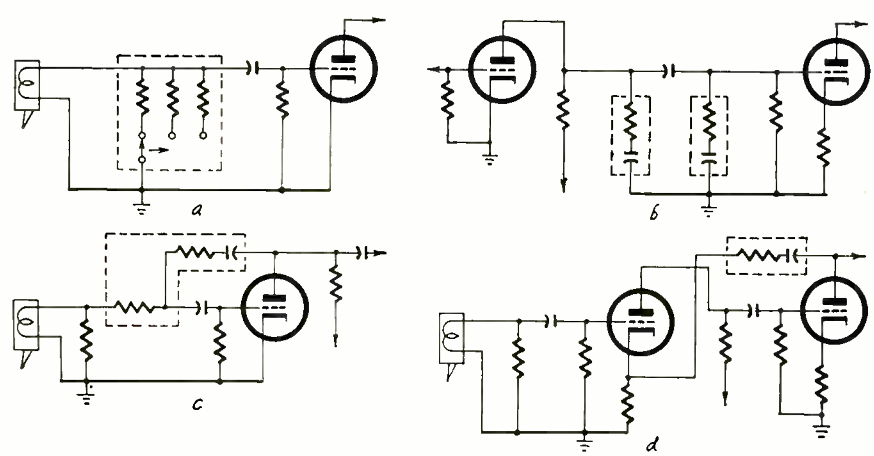


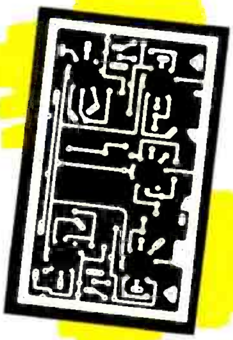
Fig. 2—Types of equalizer circuits.

NEW 1955

Heathkit Engineering Features

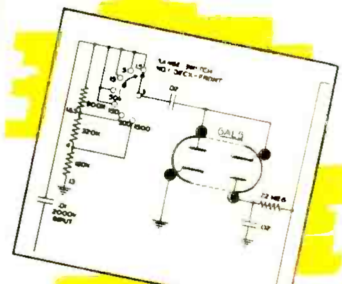
New PRINTED CIRCUITS

One of the many tremendous improvements in the new 1955 Heathkits is the use of an etched metal process printed circuit board. Printed circuits will be used in Heathkits whenever they will affect construction simplification, performance stabilization, and lend themselves to instrument design. Now for the *first* time a kit instrument company offers the advantages of modern printed circuit instrument construction technique. For the *first* time consideration has been given toward reducing kit assembly time. Also this is the *first* time that printed circuit boards have been hand soldered on a volume basis. Offered only by Heathkit, the pioneer and leader in kit instrument design.



New PEAK-TO-PEAK VTVM CIRCUIT

New 6AL5 full wave rectifier in AC input circuit permits full scale peak-to-peak measurements. Seven ranges — upper limits 4000 volts peak to-peak. Just the thing you TV servicemen have needed in making TV circuit voltage checks. Precision resistor voltage divider limits AC RMS level to 150 volts. Prevents overloading the rectifier—extends upper limit AC RMS ranges to 1500 volts—further protects meter and circuitry against AC flash-over or arcing. Another definite example of continuing Heathkit design leadership in the kit instrument field.

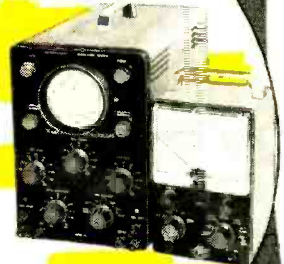


New HIGH READABILITY PANELS

New 1955 Heathkits feature complete panel redesign. Sharp white lettering applied to the beautiful charcoal gray panels, provide a new high in readability. Lettering is easy-to-read open style and panel calibrations are vividly clear against the pleasing soft gray background. New knobs of exclusive Heathkit design.

New 3" UTILITY SCOPE

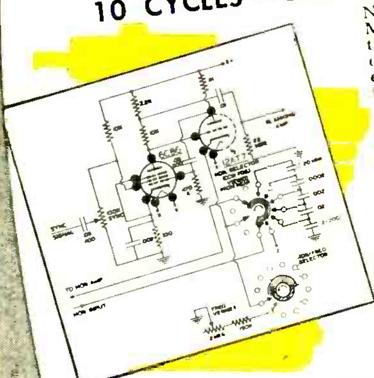
The new 3" Scope is a "natural" for the well rounded line of Heathkit instruments. Small in size, 11¾" deep, 6½" wide, 9½" high, yet big in performance. Just think of the value, an Oscilloscope for $29.50. Brilliant intensity, sharp focusing, wide positioning range. An ideal portable Scope for the TV serviceman—a second shop scope—modulation monitor for you hams (deflection plate terminals in rear of cabinet). Performance to spare for all general scope applications. See specifications on following page.



New STYLING *New* COLOR

New styling and coloring is responsible for tremendous improvement in Heathkit appearance. The new instrument panel color combination is high definition white lettering in a soft charcoal gray panel. Cabinet color is a lighter feather gray. The satin gold baked enamel cabinet for the WA-P2 Preamplifier is further indicative of the modern pacesetting trend in Heathkit styling.

New SCOPE SWEEP CIRCUIT 10 CYCLES — 500 KC



New 1955 Heathkit Model 0-10 Scope features a new wide frequency range sweep generator covering 10 cycles to 500,000 cycles. This coverage is available in five virtually decading sweep ranges and is five times greater than the sweep frequency range usually available. Excellent retrace time characteristics, actually less than 20% at 500 KC. Use of the free running Heath circuit provides a larger margin of stability and a new high in Heathkit Scope performance.

Continuing PROGRESS FUTURE LINE EXPANSION

The outstanding improvements featured in the 1955 Heathkit line are representative of the progress characterized by Heath Company operation. Long range planning will provide a continuing succession of new kit releases to further expand the Heathkit line which already represents the world's greatest selection of electronic kits. The innovations in the 1955 line, are representative of additional new models scheduled for release for the coming years.

SEE THE INSTRUMENTS ON THE FOLLOWING PAGES

HEATH COMPANY • • Benton Harbor 20, Mich.

does exceed 2 or 3%, check the needle, alignment, and tracking. If you do not have an IM analyzer, it is possible that you can detect a rise in IM by ear. It takes a very critical ear to discern a rise from 3 to 5%; but if you do perceive a rise from the outermost to the innermost grooves, the chances are you have at least that much rise and probably a good deal more.

3. Band 3 of side B sweeps the low end of the spectrum down to 20 cycles. The output meter should give a uniform response (with the LP equalizer) at least down to 50 cycles and preferably all the way down to 20 cycles. Listen carefully through this band for it will reveal arm and cartridge resonances, speaker resonance, and tracking and compliance troubles. Resonance is indicated by a sudden rise in output at some portion of the sweep band. Poor tracking or compliance will be evidenced by a buzzing or a fuzzy tone. This is also an excellent band for checking frequency doubling in loudspeakers. Since very few systems are capable of reproducing fundamentals below 40 cycles, listen very carefully as the tone sweeps below that point. On a speaker with no distortion, you should get a sudden, very marked reduction or complete cutoff at some point below 40 cycles. Most speakers, however, do produce frequency doubling and so they will continue to emit sound; but this sound will suddenly rise about an octave in pitch.

4. Turn the record over to side A and change the equalizer to the flat position of treble. This side will play back flat only with an equalizer which does not de-emphasize the highs. Amplifiers which do not provide a flat position will show a slope at the high-frequency end, and the slope at 10,000 cycles gives a good check of equalization. I suggest that you play the 1,000-cycle band to adjust the output level, and then move the pick up to the sixth band, the 10-kc band—unless the pickup is one of the very wide range type. I suggest this because the bands above 10 kc are subject to rapid wear and should be reserved for use when they are really needed.

If the amplifier in question does not have a flat position, this series of bands can be played back with an LP equalization. The bulletin which comes with the records gives a table showing the readings for an LP curve. If this portion gives a reasonably flat response, the chances are it will provide good equalization in all equalizer positions.

5. Note the reading on the 10,000-cycle band as compared with the refer-

CURVE RESPONSE
(1 volt at 1 kc)

Curve	Reading at 10 kc
LP	−15 db or 0.15 to 0.20 volt
New RIAA	−14 db or 0.20 to 0.25 volt
Old AES	−12 db or 0.25 to 0.33 volt

ence reading on the initial 1,000-cycle band. This is necessary for the transla-

NEW *Heathkit*
5" PUSH-PULL

OSCILLOSCOPE KIT

FOR COLOR TV

BRAND NEW DESIGN: The new Heathkit Model O-10 Oscilloscope would be something special at any price, but is almost unbelievable at $69.50. Completely re-designed scope has broadband amplifiers for color TV work and offers brilliant overall performance. Vertical frequency response within 5 db from 5 cps to 5 mc. Even more astounding, the response is down less than 1½ db at 3.58 mc, the color TV sync burst frequency. It is essential that scopes for color work have these broadband characteristics.

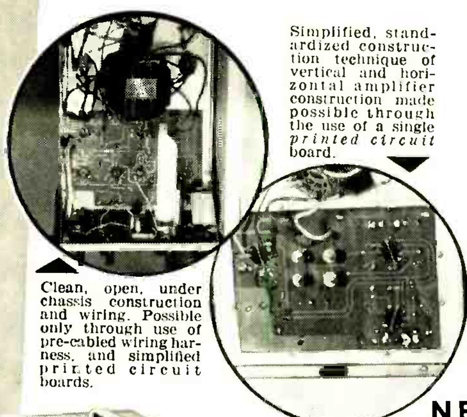
PRINTED CIRCUITS: Two printed circuit boards used in this fine instrument to insure stable, consistent performance. Problems solved by pre-engineering of boards, and their use guarantees completed unit that will have same characteristics as lab development model. Printed circuits simplify construction and save labor.

NEW SWEEP CIRCUIT: Sweep circuit operates with exceptionally good linearity from 20 cps to over 500,000 cps. 5 times the usual range for scopes in this price range. An entirely new circuit introduced for the first time in any Heathkit.

MODEL O-10

$69.50

Shpg. Wt. 27 lbs.



Simplified, standardized construction technique of vertical and horizontal amplifier construction made possible through the use of a single *printed circuit* board.

Clean, open, under chassis construction and wiring. Possible only through use of pre-cabled wiring harness, and simplified printed circuit boards.

FEATURES: Other outstanding characteristics of this professional oscilloscope are: Built-in 1V peak-to-peak reference for calibration of plastic CRT face-plate; 5" 5UP1 CRT; push-pull hor. and vert. deflection amplifiers; hor. trace width expandable to 3 times diameter of CR tube to allow inspection of any small portion of the signal; deflection sensitivity, .025 volts per inch; wiring harness pre-formed and cabled to save construction time and insure professional appearance and operation. Incorporates efficient retrace blanking. Frequency compensated step attenuator at the vertical input. Entire tube face useable. No foldover on vertical over-load. Performance obtainable only in much more expensive laboratory models.

Uses 5UP1, 6AB4, 6BQ7, 12BH7, 6CB6, 12AT7, 2-12AU7, 6X4, 1V2, and 6C4. Quality components used throughout so that outstanding performance characteristics may be maintained for years to come. Plastic molded condensers are used in all coupling and by-pass applications. The "new-look" in Heathkit styling produces professional appearance in keeping with the professional performance of this instrument.

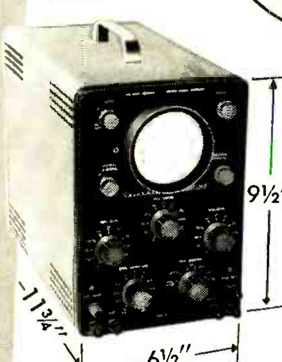
NEW *Heathkit*

3" PRINTED CIRCUIT

OSCILLOSCOPE KIT

MODEL OL-1

$29.50 Shpg. Wt. 15 lbs.



3GP1 CR TUBE

New compact utility Scope—lightweight—portable for service work.

Deflection plate terminals—ideal for ham transmitter modulation monitoring.

New easy-to-build printed circuit board with high insulation factor.

New Heathkit instrument styling—charcoal gray panel with high readability white lettering.

New Heath twin triode sweep generator 15–100,000 cycle sweep.

EXCEPTIONAL VALUE: The brand new Model OL-1 Utility Oscilloscope is designed especially for portable applications so that outside servicemen or persons performing field tests can have the advantages of a scope available. Then too, it is ideal for home workshop, the ham-shack, or as an "extra" scope for the service shop. It is compact, light in weight, and surprisingly versatile in operation. An outstanding instrument for the price.

Front panel controls are "bench-tested" for ease of operation and convenience. Printed circuit board used for constant circuit performance. Assembly time cut in half!

SPECIFICATIONS: Vertical amplifiers feature frequency response within 1 db from 10 cps to 100 kc. and within 5 db from 5 cps to 500 kc. Vertical sensitivity .2 volts per inch at 1 kc. with input impedance of 12 mmfd shunting 10 megohms.

Horizontal response within 1 db from 10 cps to 200 kc. and within 5 db from 5 cps to 500 kc. Hor. sensitivity .25 volts per inch at 1 kc, input impedance of 15 mmfd shunting 10 megohms. Sweep generator covers 10 cps to 100,000 cps with stable positive lock-in circuit. Cathode follower input in both vert. and hor. amplifiers; push-pull vertical and horizontal deflection amplifiers; 3" CRT; electronic positioning controls for wide range of vertical and horizontal spot deflection; provision for internal and external sync; 60 cycle line sweep. New modern color styling and unusual performance make this instrument an outstanding value.

NEW *Heathkit*

5" PRINTED CIRCUIT

OSCILLOSCOPE KIT

MODEL OM-1

$39.50 Shpg. Wt. 24 lbs.

5BP1 CR TUBE

VERSATILE INSTRUMENT: The new Model OM-1 general purpose Oscilloscope represents an outstanding dollar value in reliable test equipment. Full 5 inch CRT. Printed circuit boards for ease of assembly, constant circuit characteristics, and rugged component mounting. Includes all the design features necessary for servicemen, students, experimenters, radio amateurs, etc. Frequency response of amplifiers flat within 1 db from 10 cps to 100 kc, and down only 7 db from 10 cps to 500 kc. Sweep generator range from 20 cps to 100,000 cps. Also features new Heathkit color styling with charcoal gray panel and high definition white lettering for readability even under subdued lighting conditions.

DESIGN FEATURES: A full-size, versatile oscilloscope at a price you can afford. Other features are: adjustable spot shape control; RF connections to deflection plates; direct coupled centering controls; external and internal sweep and sync; 60 cycle line sync; built in 1 volt peak-to-peak panel terminal reference voltage; professional appearance of cabinet, panel, and knob styling.

HEATH company

BENTON HARBOR 20, MICHIGAN

tion-loss test to come. It also gives a pretty good check of equalization. The table gives the approximate readings at 10,000 cycles for the several commonly used curves when the 1,000-cycle tone is set for 1 volt. The New RIAA Standard is identical with both the new AES and the ortho curves.

Don't expect exact readings. A variation within the range given will be generally indistinguishable to the listener.

6. When you get to the innermost band, reset your volume control to get the same reading for the 1,000-cycle tone as at the beginning.

Now take a careful reading of the level of the following 10,000-cycle tone. Compare this with the reading noted in step 4. If the reading in step 6 is from one-third to one-half that in step 4, the needle is still O.K.; if it is less than one-third, the needle (or alignment) is poor. I would check the alignment first, correct it if necessary, and run another check. If this reading comes within tolerance, the needle is all right. In that case, repeat the IM measurement on side B; chances are it, too, has been improved.

If the outfit is not producing a reasonably flat response curve, the equalization is off. If the departure is entirely above 5 or 7 kc, check the translation loss as in step 6. If it is too high, chances are very good that the needle alone is at fault. Change the needle and try again. If you still are off on the high-frequency end, check to see if you get about the same variation, or at least in the same direction, on all equalization positions. If the curve is off in the same direction at all positions, it is almost certainly due to either high-frequency losses in the cable from pickup to equalizer or improper loading of the pickup, or both.

Every cartridge, whether magnetic or piezoelectric, must work into an optimum load to provide a flat curve. In magnetic pickups variations in the resistive load produce variations in high-frequency response; in piezoelectric pickups, the variation is in the low-frequency response. In either case, as the resistance of the load is increased so is the response at the affected end. This principle is very often employed in equalizers to produce desired high-frequency equalization, as in *a* of Fig. 2. Check the diagram or circuit to see if that is true in this instance.

But before doing anything at all about it, first determine if the equalizer was designed for the cartridge in use. The Pickering requires a load about half that of the G-E and will produce a rising response at high frequencies with a G-E load; a G-E on the other hand, when used with a Pickering load, will produce a falling response. Many of today's amplifiers and preamplifiers have a switch which changes the load resistance for different pickups. Check to see if that is the case with you equipment.

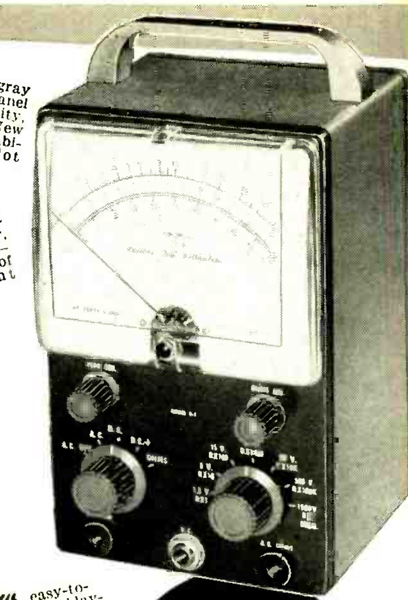
In many equalizers the load remains

NEW *Heathkit* VACUUM TUBE VOLTMETER KIT

PRINTED CIRCUIT DESIGN

New charcoal gray baked enamel panel with high readability white lettering. New soft feather gray cabinet, subdued pilot light indicator.

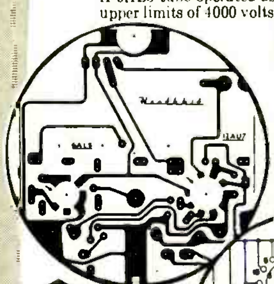
New printed circuit board for faster, easier construction—exact duplication of Lab development model.



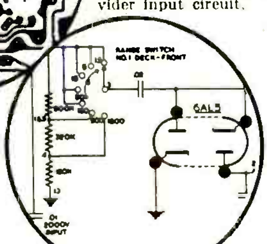
Another outstanding example of continuing Heath Company pioneering and leadership in the kit instrument field. A new **printed circuit** VTVM. New peak-to-peak circuit—new styling and new panel design. A prewired, prefabricated printed circuit board eliminates chassis wiring, cuts assembly time in half, assures duplication of Engineering pilot model specifications, and virtually eliminates possibility of construction error.

CIRCUIT:

A 6AL5 tube operated as a full wave AC input rectifier permits seven peak-to-peak voltage ranges with upper limits of 4000 volts P—P. Just the ticket for you TV servicemen. Voltage divider in the 6AL5 input circuit limits applied AC input to a safe level. This circuitry and the isolation of the meter in the cathode of the 12AU7 bridge circuit affords a high degree of protection to the sensitive 200 microampere meter.



Full wave rectifier in AC input circuit. Read peak-to-peak and RMS volts with upper limit of 4000 P—P and 1500 volts RMS. Voltage divider input circuit.



The first kit instrument to offer a labor-saving, error-free *printed circuit* board. Your instrument an exact wiring replica of Engineering development model.

RANGES:

Seven voltage ranges. 1.5, 5, 15, 50, 150, 500 and 1,500 volts DC and AC RMS. Peak-to-peak ranges 4, 14, 40, 140, 400, 1400, 4000. Ohmmeter ranges X1, X10, X100, X1000, X10K, X100K, X1 meg. Additional features are a db scale, a center scale zero position, and a polarity reversal switch.

New easy-to-read open panel layout. Off-on switch now incorporated in the selector switch.

MODEL V-7

$24.50

Shpg. Wt. 7 lbs.

IMPORTANT FEATURES:

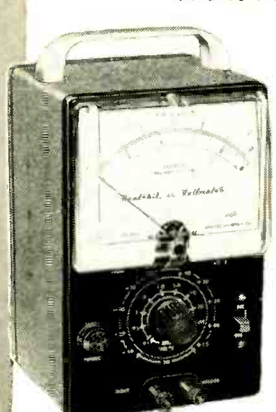
High impedance 11 megohm input—transformer operated—1% precision resistors, 6AL5 and 12AU7 tube—selenium power rectifier— individual AC and DC calibrations—smoother improved zero adjust control action—new panel styling and color—new placement of pilot light—new positive contact battery mounting —new knobs—test leads included.

The new V-7 also sets the pace as a kit instrument style leader. Smart, good-looking charcoal gray panel and soft feather gray cabinet. High readability panel with sharply contrasting white calibrations. The pleasing, eye catching, modern styling is in harmonious balance with the outstanding circuit design improvements. Easily the best buy in kit instruments.

New peak-to-peak meter scale—new color harmony—new knobs.

Heathkit AC VACUUM TUBE VOLTMETER KIT

MODEL AV-2



$29.50 Shpg. Wt. 5 lbs.

Extreme sensitivity has been emphasized in the design of the Heathkit AC VTVM. Ten full scale RMS ranges are .01, .03, .1, .3, 1, 3, 10, 30, 100, and 300 volts. Frequency response is substantially flat from 10 cycles per second to 50 KC with input impedance of 1 megohm at 1 KC. Will accurately measure as low as 1 millivolt at high impedance. Total db range is —52 db to +52 db. An excellent kit for measuring the output of phono cartridges and the gain of amplifier stages. Use it also to check power supply ripple, as a sensitive null detector, and for compiling frequency response data. Features one knob operation, 200 microampere Simpson meter and precision resistors.

Heathkit 30,000 VOLTS DC PROBE KIT

Measure up to 30,000 volts DC with the Heathkit VTVM and the 336 high voltage Probe. Precision resistor provides multiplication factor of 100. Can be used with any 11 megohm input VTVM. Housed in a Polystyrene two color sleek plastic probe body for safety of operation.

No. 336

$4.50

Shpg. Wt. 1 lb.

Heathkit PEAK-TO-PEAK PROBE KIT

No. 338-C

$5.50

Shpg. Wt. 2 lbs.

Peak-to-peak values not exceeding 80 volts at a DC level of not more than 600 volts, can now be read directly by using 338-C Probe with previous model Heathkit VTVM's or any VTVM with 11 megohm input resistance. Probe construction features a modern printed circuit board for easy assembly. Frequency range 5 KC to 5 MC.

Heathkit RF PROBE KIT

The Heathkit RF Probe will permit the measurement of RF voltages up to 250 MC with an accuracy of ± 10%. The limits are 30 volts AC and a DC level of 500 volts. Designed for any 11 megohm input VTVM. Modern styling, Polystyrene aluminum housing, Polystyrene insulation, and printed circuit board for easy assembly.

No. 309-C

$3.50 Shpg. Wt. 1 lb.

Heathkit AUDIO WATTMETER KIT

Read audio power output directly without using external load resistors with the new Heathkit Audio Wattmeter. Built-in non-inductive load resistors provide impedances of 4, 8, 16, and 600 ohms. Flat response from 10 CPS to 250 KC. Full scale power ranges are 0–5 MW, 0–50 MW, 0–500 MW, 0–5 W and 0–50 W. Model AW-1 will operate continuously at 25 watts and has a duty cycle of 3 minutes at 50 watts. Total db range in five positions is —50 db to +48 db, using the standard 1 milliwatt 600 ohms.

MODEL AW-1

$29.50

Shpg. Wt. 6 lbs.

HEATH company

BENTON HARBOR 20, MICHIGAN

AUDIO—HIGH FIDELITY

constant (Fig. 3-a) and the equalization is obtained either in a feedback loop as in *c* and *d* of Fig. 2 or by an interstage bypass as in *b* of Fig. 2, If you get a constant variation in response at 10,000 cycles in the same direction on all equalizer positions, you can probably correct the slope by adjusting the load. If the response rises at high frequencies on all positions, you can shunt the preamp input with a resistor (Fig. 3-b). The best thing to do is to connect a 250,000-ohm potentiometer across the preamp input or cartridge output, and adjust it to obtain the flattest possible response in all equalizer positions at 10 kc. When you have found the right position, replace it with a fixed resistor.

If, on the other hand, the variation is downward, put the potentiometer in series with the load resistor (Fig. 3-c) and again adjust for the flattest possible response. If you can't achieve complete equalization with a change in load, shorten the pickup cable or replace it with one of lower capacitance.

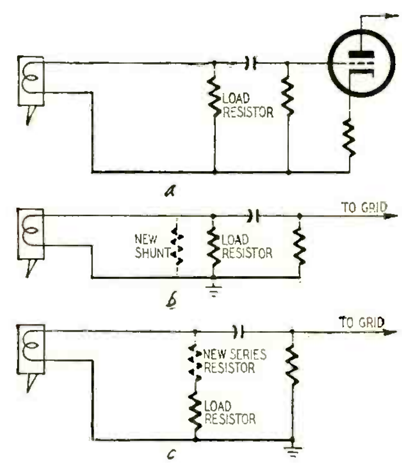


Fig. 3—Circuits for loading pickup.

When the departure is only on one curve, check the values of the resistors and capacitors and check for opens or shorts. Resistors should be within 10% of the specified value.

The Dubbings Company has met the need for a test record suitable for rapid testing of phono conditions with its D-100 and D-101 records. The former offers a frequency band with flat treble equalization and a 6-db-per-octave slope below 500 cycles; it also has bands for testing rumble, hum, wow and flutter, as well as stylus compliance and tracking. The D-101 is unique in offering test runs for the four American curves: LP, RIAA, old NARTB, and old AES.

The D-100 will test all aspects of a phono system except needle condition and intermodulation—though the tracking bands offer some clue of needle condition. The first 13 bands are frequencies from 30 to 12,000 cycles. The next band is unmodulated for checking hum and rumble. The following band has a tone suitable for checking wow and flutter. The four innermost bands are

AUDIO—HIGH FIDELITY

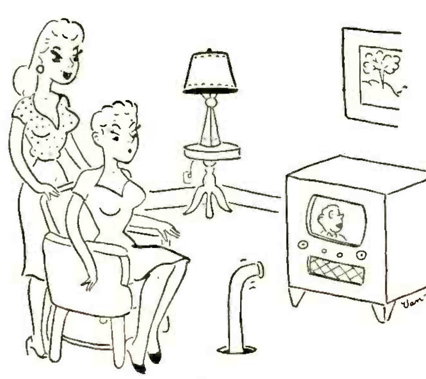
unique in that they offer a simple test for compliance tracking ability. These bands are modulated with a 400-cycle tone whose amplitude increases by 4 db from band to band, so that the innermost band is 12 db higher than the outermost. Poor compliance or tracking is indicated by a buzzing or a fuzziness of tone. Only the highest quality professional pickups and arms will track all four bands perfectly; good home systems, however, should track at least the first two perfectly.

D-101 is a most useful record which tests equalization for the four American curves. Do not expect complete flatness. Few equalizers provide exact equalization for all curves. As long as the variation does not exceed 2 or 3 db, for any curve, reproduction will be considered satisfactory.

TO BE CONTINUED

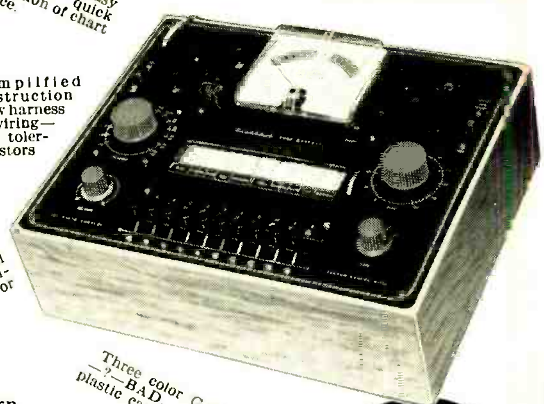
MILLIONTH TRANSISTOR

A milestone in transistor history was reached on June 15 when Raytheon produced its one-millionth transistor. The company, which states that it has produced three times as many transistors as all other manufacturers combined, made point-contact transistors available in 1948. In late 1952 it began production on germanium junction units, which comprise the large majority of all transistors made to date. So far, most of Raytheon's transistor output has gone to the hearing aid industry. The photo shows Charles R. Adams, Jr. (left), president of the Raytheon Manufacturing Co., presenting the one-millionth transistor to Massachusetts Governor C. A. Herter.



"Even while in his workshop, he can't stand to miss his programs."

Heathkit TUBE CHECKER KIT



The Heathkit TC-2 Tube Checker was primarily designed for the convenience of radio and TV servicemen and will check the operating quality of tubes commonly encountered in this type of work. Test set-up procedure is simplified, rapid, and flexible. Panel sockets accommodate 4, 5, 6, and 7 pin tubes, octal and loctal, 7 and 9 pin miniatures, 5 pin Hytron, and a blank socket for new tubes. Built-in neon short indicator, individual 3-position lever switch for each tube element, spring return test switch, 14 filament voltage ranges, and line-set control to compensate for supply voltage variations, all represent features of the TC-2.

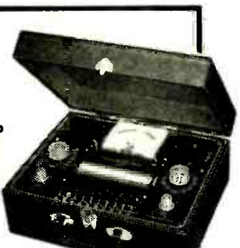
Results of tube tests are read directly from the large 4½" Simpson 3-color meter. Checks emission, shorted elements, open elements, and continuity. Wiring procedure has been simplified through the use of multi-wired color coded cable providing a harness type installation between tube sockets and lever switches. This procedure insures standard assembly and imparts a "factory built" appearance to the instrument. New Construction Manual furnishes detailed information regarding tube set-up procedure for testing of new or unlisted tube types. No delay necessary for release of factory data.

MODEL TC-2

$29.50

Shpg. Wt. 12 lbs.

Heathkit PORTABLE TUBE CHECKER KIT



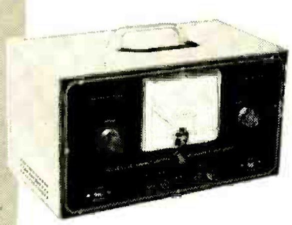
The portable model is supplied with a strikingly attractive two-tone cabinet finished in rich maroon proxylin impregnated fabric covering with a contrasting gray on the inside of the detachable cover.

MODEL TC-2P

$34.50

Shpg. Wt. 15 lbs.

Heathkit REGULATED POWER SUPPLY KIT



MODEL PS-2

$33.50 Shpg. Wt 15 lbs.

Here is a source of regulated D.C. voltage for circuit development work. Power supply voltage and current drain to the circuit under test are constantly monitored by the 4½" panel mounted meter. Separate 6.3 volt at 4 ampere A.C. filament source available. The regulated and variable output voltage will be constant over wide load variations, and hum ripple will not exceed .012% at 250 volts under a 50 MA load. Completely isolated circuit, standby switch, and other desirable features, make the Model PS-2 extremely useful in a wide variety of applications.

Heathkit TV PICTURE TUBE TEST ADAPTER

The Heathkit TV Picture Tube Test Adapter used with the Heathkit Tube Checker Kit, will quickly check picture tubes for emission, shorts, etc. and determine tube quality. Consists of standard 12-pin TV tube socket, four feet of cable, octal socket connector, and data sheet.

No. 355

$4.50 Shpg. Wt. 1 lb.

Heathkit DECADE RESISTANCE KIT

MODEL DR-1

$19.50

Shpg. Wt. 4 lbs.

Twenty 1% resistors are decaded in 1 ohm steps to provide any value between 1 ohm and 99,999 ohms. Sturdy ceramic switches with silver plated contacts insure reliable service. Use the Decade Resistance in bridge circuits, meter multipliers, calibrations, or any application requiring a wide range of precision resistance values.

Heathkit AUDIO GENERATOR KIT

Here is an Audio Generator with features generally found only in the most expensive instruments. Sine wave coverage from 20 cycles to 1 Megacycle—response flat ±1 db from 20 cycles to 400 Kc—continuously variable and step attenuated output. Because the output voltage is relatively constant over wide frequency ranges, the AG-8 is ideal for running frequency response curves in audio circuits. Once set by means of the attenuator, this voltage may be relied upon for accuracy within ± 1 db. Instrument features low impedance 600 ohm output circuit and distortion less than .4 of 1% from 100 CPS through audible range.

MODEL AG-8

$29.50

Shpg. Wt. 11 lbs.

Heathkit DECADE CONDENSER KIT

The Heathkit Decade Condenser provides a ready source of capacity values from 100 mmf to .111 mfd inclusive in capacity steps of 100 mmf. Silver plated contacts on husky ceramic switches, assure positive contact for each switch position. Precision silver mica condensers ±1% accuracy for close tolerance accurate work.

MODEL DC-1

$16.50

Shpg. Wt. 3 lbs.

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MODEL AR-2

$25.50

(Less Cabinet)

Shpg. Wt. 12 lbs.

Heathkit COMMUNICATIONS RECEIVER KIT

An excellent example of typical Heath Company ability to produce top quality kit merchandise at ridiculously low prices, is the AR-2 Communications Receiver. Here is a transformer operated all-wave receiver with all of the desired features and none of the disadvantages commonly encountered in so-called "economy sets."

Receiver employs high gain miniature tubes and IF transformers, chassis mounted 5½" PM speaker, headphone jack, slide rule dial with Ham Bands plainly identified, and easy tuning with direct planetary drive. Continuous frequency coverage from 550 KC to 35 MC on 4 Bands, with electrical bandspread tuning and logging scales. Other features are RF gain control with AGC on-off switch—phone-standby-CW panel switch—prewound coils in a shielded turret assembly and copper plated chassis and shielding.

Uses 12BE6 mixer-oscillator, 12BA6 IF amplifier, 12AV6 detector-first audio, 12A6 beam power output, 12BA6 BFO oscillator, and 5Y3 rectifier. A lettered control plate is provided for the cabinet of your choice or you can order the optional Heathkit cabinet featuring the full size aluminum panel.

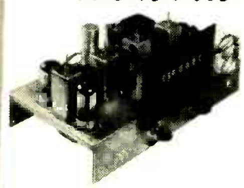
RECEIVER CABINETS

Proxylin impregnated fabric covered plywood cabinet available for BR-2 and AR-2 receivers. Includes aluminum panel, flocked reinforced speaker grill and protective rubber feet.

For BR-2 Receiver, Cabinet 91-9 Shipping weight 5 lbs. **$4.50**

AR-2 Receiver, Cabinet 91-10 Shipping weight 5 lbs. **$4.50**

Heathkit FM TUNER KIT



MODEL FM-2

$22.50

Shpg. Wt. 8 lbs.

Here is an FM Tuner that can be operated with your Hi-Fi Amplifier or through the "phono" section of the ordinary radio. Completely AC operated to eliminate problems usually encountered in "economy type" AC-DC tuner circuits. Features 8 tube circuit with separate mixer and oscillator, 3 double tuned IF stages followed by a limiter discriminator providing maximum sensitivity and selectivity across the full FM frequency band of 88 MC to 108 MC. The tuning unit is factory assembled and adjusted, thus eliminating tedious critical "front end" alignment problems. The attractive slide rule dial and vernier tuning combine to make the Heathkit FM-2 Tuner simple to operate.

Heathkit BROADCAST BAND RECEIVER KIT

The Model BR-2 Broadcast Band Receiver is designed especially for the beginner without any sacrifice of quality. This receiver features a transformer operated power supply, high gain miniature tubes, sharply tuned IF transformers, new rod type built-in antenna, and a trouble-free planetary tuning system. Exceptional performance with unusually high sensitivity, good selectivity, and excellent tone quality from the 5½" PM chassis mounted speaker. Can be used either as a receiver, tuner, or phono amplifier. Uses 12BE6 mixer-oscillator, 12BA6 IF amplifier, 12AV6 detector, 12A6 beam power output, and 5Y3 rectifier.

MODEL BR-2

$17.50

(Less Cabinet)

Shpg. Wt. 10 lbs.

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HIGH-QUALITY AUDIO

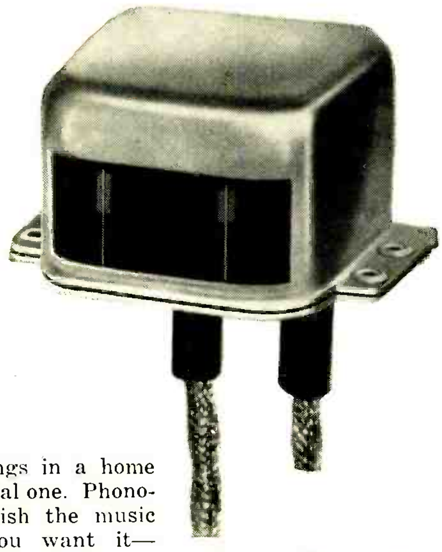

Fig. 1—Shure recording - playback head.

Part XV—Tape recorders—mechanical and electrical characteristics

By RICHARD H. DORF*

THE role of recordings in a home music system is a vital one. Phonograph records furnish the music you want when you want it—assuming, of course, the music you want has been recorded and you can afford to buy it. And home recording has recently assumed a very much different meaning from the one it had when tape was not available and when high fidelity was an experimental hobby of a few instead of the religion of millions.

Tape recorders are plentiful today and simple to operate. A great many music system owners use them as part and parcel of their equipment to supplement the music supply and to have just plain fun. But because tape machines are easy to get and use, it does not mean they are ideal for every purpose. Nor does it mean that the serious music enthusiast need know nothing about them. There is the matter of selection of an appropriate recorder, of how to "build" it into the system, and of how to use and maintain it to best advantage.

The basic idea of tape recording is extremely simple. The tape is a paper or plastic material coated with fine particles of iron oxide in an adhesive binder. The tape passes over an electromagnet, the field strength of which is varied by the incoming audio program. The tape is thus magnetized at varying strengths along its length, the comparative strengths being a record of each audio wave in turn. In playback, the tape is passed over a similar electromagnet whose coil is connected to the input of an amplifier. The moving magnetic lines of force from the tape are picked up by the electromagnet core and cut the wires of the coil, inducing in them voltages of varying amplitude. These are amplified and the audio is thus re-created.

The electromagnet in recording is

*Audio Consultant, New York City

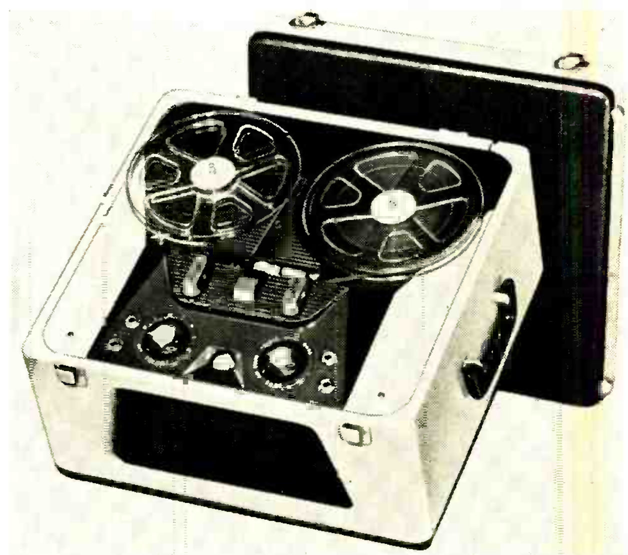

Fig. 2—The Pentron tape recorder.

Fig. 3—Concertone tape recorder.

the recording head and the other electromagnet mentioned is the playback head. They are so much alike in requirements (though not necessarily identical) that a single head is often used for both purposes with appropriate circuit switching. The Shure type 815 head (Fig. 1) is an example. Such heads are used in all of the less expensive nonprofessional machines, such as the Pentron shown in Fig. 2. Professional recorders such as the Concertone (Fig. 3) have separate heads. This has a dual advantage. First, each head can be designed for particular application. Second, with separate heads for recording and playback, the recording can be monitored from the tape during the recording process.

Fig. 4 is a diagram of one kind of recording or playback head, viewed from the edge of the tape. The core

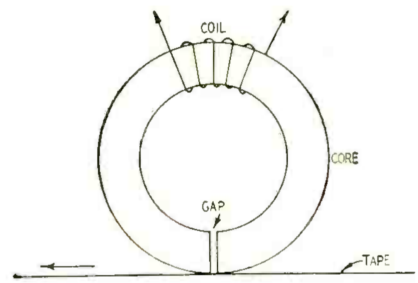

Fig. 4—Construction of recording head.

is a ring of magnetically "soft" material with high permeability. Such a material is very easily magnetized but does not retain appreciable magnetism when the current is removed from the coil. A typical substance is mu-metal.

The iron-oxide coating of the tape is magnetically "hard"; that is, once magnetized, it retains much of its magnetism for a long period. The tape moves continuously over the small gap in the core. When magnetic lines of force pass through the core they find the reluctance, or magnetic resistance of air (or whatever other material may fill the gap) is comparatively high. These lines pass more easily through the tape coating, and in doing so they magnetize the coating within the gap. Since the strength of the field varies with the audio, each successive small area of tape coating that passes the gap is magnetized to a somewhat different field strength.

In playback, the tape may again be passed over the same head. This time the coil is connected to an amplifier input. As each little magnetized section of tape passes the gap, its magnetic field causes lines of force to pass through the core and cut the coil. The induced voltage is then amplified.

The first complication comes through magnetic hysteresis. When an unmagnetized tape is subjected to a magnetic field of certain strength, it is magnetized to a corresponding strength (over a certain range). However, when the magnetic field is removed (the section of tape leaves the head), the tape magnetism falls to a certain lesser value. The lesser values vary with the inducing field over only a very small range—not going down to zero. As a result, a sine wave recorded on tape is distorted (Fig. 5). This distortion is removed by ultrasonic bias—a signal of between 30 and 60 kc is superimposed on the audio fed to the head. The signal for bias is generated by an

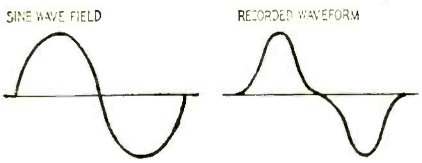

Fig. 5—Sine-wave field is distorted.

oscillator. How it works to remove distortion is too involved for this article—those interested can refer to "What Is Supersonic Bias?," RADIO-ELECTRONICS, January, 1949.

Frequency response

While head inductance causes a change in head reactance as frequency varies, this is usually countered by feeding the head from a constant-current source such as a pentode tube. Since the magnetic field depends on coil current, the recorded magnetism on the tape is fairly constant from low frequencies up to some midrange frequency. Above this point, however, core losses and gap effect reduce the treble. In playback, there is reduction in output between the midrange and the bass, as well as from midrange to treble. Fig. 6 shows the general shape of the output curve of a playback head from a tape recorded without equalization. The lower part of the curve is due to the induced voltage, depending on the speed at which the lines do the cutting. At lower frequencies the velocity is obviously lower; therefore, so is the output.

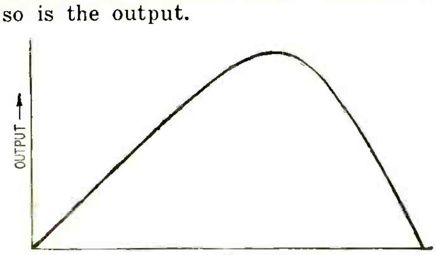

Fig. 6—Output of a playback head.

An additional loss occurs in the treble, due largely to gap effect. In Fig. 4, note that the length of tape played back at any one instant is equal to the gap length. If the gap is very small with respect to a wavelength, say 1/20 wavelength, then it scans only 1/20 of the wave at a time and the output voltage will show a good representation of the wave. Suppose, however, that an entire wavelength fits under the gap at one time. The wavelength contains all values of magnetism from zero to maximum in both directions, the sum total of which—and therefore the head output—is zero. It follows that there is a loss of output as soon as the wave-

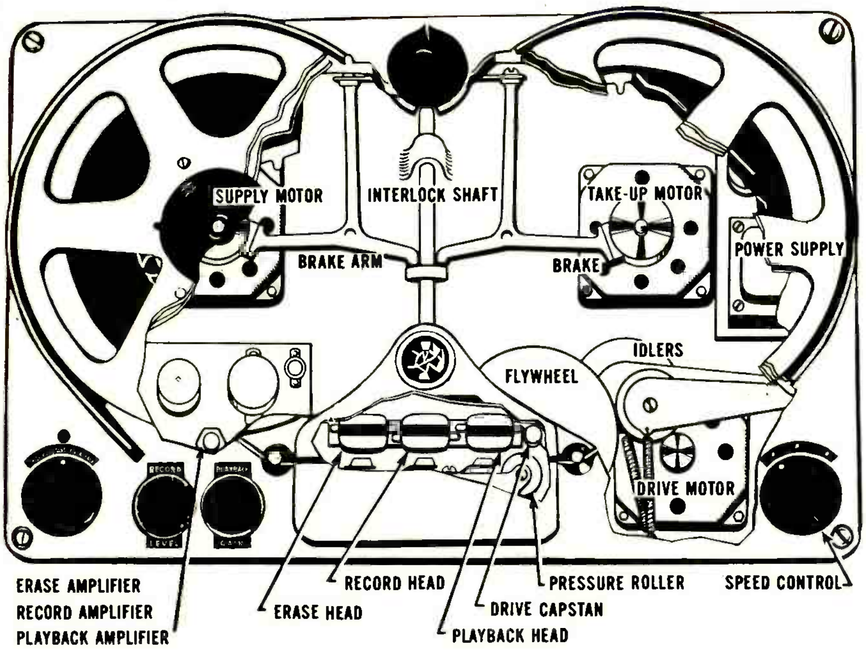

Fig. 7—Concertone mechanical system.

Fig. 8—Presto 6-N recording assembly.

length of recorded sound on the tape begins to approach the length of the gap, and that there is total loss when the wavelength and gap are equal. The losses are rather easy to calculate and the results show that loss is 6 db when the gap is 0.6 wavelength, about 13 db when it is 0.8 wavelength, and so on. This largely accounts for the rather sharp dropoff of highs in the curve of Fig. 6.

There are two ways of extending the high-frequency response before it is necessary to equalize electrically for the rest. They are important, because equalization causes loss of gain, increased noise, and is seldom obtained with real precision. First, the gap should be made as small as possible. Second, the length of waves can be increased by making the tape run faster; this spreads out each wave over a longer bit of tape.

Let us take a numerical example. Suppose the gap is 1 mil (.001 inch) long, and the tape is running at 7.5 i.p.s. (inches per second). In the 7.5 inches of tape running past the head each second there are 7.500 segments, each 1 mil long. If, therefore, we record 7,500 cycles, each wave will be as long as the gap, and output at this frequency will be zero, no matter how hard we try to equalize.

Now suppose we halve the gap length. Wavelength becomes twice the gap length and the output droop due to gap effect is only about 4 db. (It is actually a good deal more, due to core losses in both recording and playback heads.) Or suppose we leave the gap at 1 mil and run the tape twice as fast—at 15 i.p.s. The result is the same. In actual practice, manufacturers try to keep effective gap width to around 0.5 mil. This makes reproduction to 15,000 cycles impossible, but, with equalization, satisfactory response is possible to around 10,000 and output can easily be linear to 7,500 cycles, at 7.5 i.p.s. Raising the speed to 15 i.p.s. gives full linear 15,000-cycle response, necessary for high fidelity. A few manufacturers have succeeded in reducing core losses and controlling gap length effectively enough to make possible responses more extended than these.

While you are unlikely to design or manufacture tape recorders from the above information, it does show a couple of important points to remember when buying and using a machine. The 3.75-i.p.s. speed with which most inexpensive recorders are equipped simply does not do for good sound. It is usable only for speech—and even then it is suitable only for record purposes, not when the speaker's voice must sound with faithfulness. The 7.5-i.p.s. speed is also—except on a very few machines—unacceptable for high fidelity since its results will be much below those obtained from your tuner and records.

Mechanical system

This part of a tape recorder is as important as the electrical characteristics. Fig. 7 is a cutaway drawing giving some idea of the mechanical system of the Concertone shown in Fig. 3.

There are three motors. The principal one is the drive motor which is coupled to a capstan. Between the capstan and a pressure roller, the tape is pinched. Constant tape speed depends on this drive system. In less expensive models the drive motor is a 4-shaded-pole unit. These being subject to speed changes with load changes, a better model is available with a motor synchronized by the 60-cycle power frequency and almost completely free of speed changes. This is extremely important, because speed changes cause variations, slow and fast, of music pitch, a more annoying defect than perhaps anything else.

The take-up motor drives the take-up reel. During recording and playback its power is reduced with a series lamp so that it is just strong enough to make sure the tape winds up tight, but not strong enough to affect the speed of the drive capstan. The supply motor is similar. During recording and playback it is off entirely; during rewind it is on full. A better system, utilized in other machines, supplies a small amount of power so that the supply reel cannot spill tape even if it is not braked. In this model a mechanical brake stops the reels when the drive capstan is not pulling tape.

In using recorders, it is essential that power not be removed from the motors while the mechanical system is engaged; that is why mechanical con-

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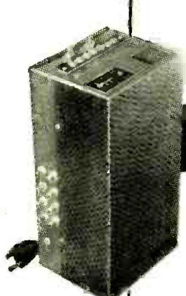

trols are always provided. Any of the rubber rollers resting against something will develop a flat, and the flat will cause small speed variations called flutter.

The flywheel in Fig. 7 illustrates another advantage of recording at higher speed. The drive motor has any small variations ironed out to some extent by the flywheel. At high speeds any flywheel has greater effective inertia and wows or flutter in the recording are less.

Off-the-air recording

While there is great satisfaction in taping good air performances and adding them to the recorded library, there are drawbacks. Tape is expensive—just how expensive depending (in addition to the tape quality) on recording speed. For high-quality recording at 15 i.p.s., a 7-inch (1,200-foot) reel will record only 15 minutes; even dual-track machines make the tape good only for 30 minutes—and then with a break for turning over the tape. This is almost as expensive as buying a complete LP record with a maximum of 50 minutes of recording time. Even at 7.5 i.p.s., costs are comparable. Machines such as the Concertone which take 10-inch reels will record for a continuous half-hour at 15 i.p.s. For a full hour with dual-track, costs are considerably more than for an LP record which will record the same symphony, quartet, or other piece of music.

Tape storage takes more space than record storage. But even more important, it is impossible to take the same spur-of-the-moment pleasure in threading a tape as in throwing a platter on a turntable, to say nothing of having to rewind it again. On all counts, therefore, it seems that the best way to carry music in the library is to put in on discs.

Disc recording has been available to amateurs for many years, but principally through cheap assemblies incapable of making records of any quality. Most of these were dropped in favor of the easier and quicker tape process.

However, a really serious music enthusiast who is located where good FM concerts are heard has a great advantage if he procures a good professional disc-making assembly. My record library includes a great many very fine discs made on a Presto 6-N assembly like that of Fig. 8. The ideal process is to make off-the-air recordings on a *good* tape machine first, since timing is usually unknown and the tape (if it is on 10-inch, 2,400-foot reels) lasts long enough to take care of most things, especially at 7.5 i.p.s. Later, then, the tape is scanned and selected music is put on a disc. The disc becomes part of the record library, while the tape is used again.

In the next and final article of this series, we shall discuss selecting the components of a disc-recording system.

TO BE CONTINUED

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FOR GOLDEN EARS ONLY

A review of the latest in audio components and recordings of interest to the hi-fi enthusiast

By MONITOR

NOW that high fidelity is spreading beyond the great metropolitan centers and "good music" stations are to be found all over the country, the item most needed by many audiophiles is an FM tuner capable of real high-fidelity performance in the remote fringe areas. The Fisher model 70-RT fills the bill very nicely. It appears to live up to the claim of 1.5- to 3-microvolt sensitivity for 20 db of quieting. The quality of the audio it delivers is excellent; it is convenient and simple to use; the built-in phono equalizer and tone-control circuits are versatile and equal to those of many independent control units, and it is well engineered to make it adaptable to various combinations of record players, amplifiers, and speakers.

To give an idea of possible performance let me describe my situation. The nearest city is 40 airline miles away and has one educational FM station, radiating about 3 kw, that provides hi-fi programs in the evening. A much larger city 140 airline miles away has three FM stations offering hi-fi programs but none of the three radiates over 10 kw. Taking elevation into account, my antenna is still some 30 miles beyond line of sight. However, I have a large horn antenna for TV and FM that delivers around 14 db of gain throughout the FM band and feeds the receiver remarkably steady signals from the three hi-fi stations varying from 1 to 5 microvolts in value. The average receiver with a sensitivity of 10 to 25 microvolts will not bring these stations in and most will show no trace of them whatever.

The 70-RT brings in two of them with complete quieting more than 99% of the time; the third is slightly in the noise, but a homemade cascode booster helps. The tuner doubles or triples the number of stations receivable regularly from all directions and on a good night you can find a station on almost every channel despite the fact that most are more than 100 miles away.

Granting that both my situation and antenna are unusual, the question is: "What can you expect of the 70-RT with a commercial antenna?" I would say that if the average receiver shows a steady trace of the desired signal but it is not strong enough to produce complete quieting, the 70-RT would almost certainly bring it up to completely satisfactory quality. The chances are very good, too, that you would hear many stations you do not hear at all now. It is very risky to generalize but I believe that, given an antenna with an honest 8 to 10 db of gain, the 70-RT ought to provide reliable reception of stations 75 miles away; in locations with a low noise level up to 100 miles.

Aside from excellent sensitivity, the 70-RT has several other commendable features. The bandwidth is 200 kc at 6 db down, and around 180 kc at 3 db down; that means very low distortion especially on hi-fi programs with a lot of pre-emphasized highs. The a.f.c. (see diagram) is both adjustable and removable—a fine idea. A control on the back of the chassis can be adjusted to set the range within which the a.f.c. will operate; as near as I can determine it can be set so the a.f.c. takes over when a signal is as much as 500 kc off resonance or as little as 150 kc. Moreover, the selector switch on the panel permits choice of reception with or without a.f.c. However, I foresee little use for the shut-off switch; I was able to use the a.f.c. with no trouble whatever on a weak distant station only 200 kc removed from a very strong local 10 miles away.

The AM portion is also excellent. The small loop antenna which comes with the receiver will suffice almost anywhere to bring in all the stations one wants. Two bandwidths are provided and the wide one produces an audio curve flat to 5,000 cycles and down about 5 db at 8,000 cycles. There is a whistle filter and the combination provides acceptable quality with very low interference from interchannel whistles, monkey-chatter, etc. This is as good fidelity as is usable except in the one or two metropolitan centers having wide-range AM stations. A magic-eye tuning indicator makes both AM and FM tuning simple enough for the most unskilled member of the family.

The audio control unit is about as good and flexible as most independent-control units. Besides the AM and FM inputs, two others are provided. One is for a magnetic pickup and is loaded with 220,000 ohms. This will yield a flat or rising high-frequency response with the G-E, Audak, and Ferranti pickups; pickups that require a lower load can be loaded very simply with a ⅓-watt resistor at the cartridge terminals. Another input for a crystal pickup, TV set, tape player, or what have you, has a 500,000-ohm input load.

Two outputs are also provided. One is ahead of the tone-control circuits for use with tape recorders, etc.; the other follows the tone-control circuits for use with amplifier and speakers. Incidentally, although the unequalized output is labeled DETECTOR OUTPUT, it also includes the phono and TV channels. Both outputs are through cathode followers so that long cables can be used, and both can be used simultaneously.

There is a good loudness control that can be switched on and off. A nice refinement is that the loudness control and the switch disabling it are mounted coaxially with a double knob. The loudness control can be switched on and off, to suit the need, without moving the hand from the one set of knobs. The tone-control circuit is adequate though the bass boost may not be as high as many people would like it to be. There are two a.c. receptacles on the chassis so that the power amplifier, turntable, tape recorder, or whatever, can be controlled with the on-off switch of the tuner. Up to 500 watts, in addition to the drain of the 70-RT, is permissible.

The phono equalizer provides four equalizations—AES, LP, ORTHO and NARTB. Actually there are only two treble and three bass slopes, but the results are acceptable. A run with the Dubbings D-101 test record showed a

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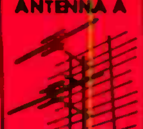	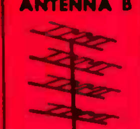	
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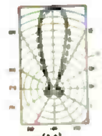

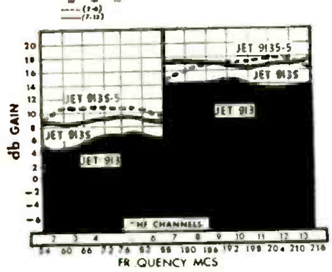

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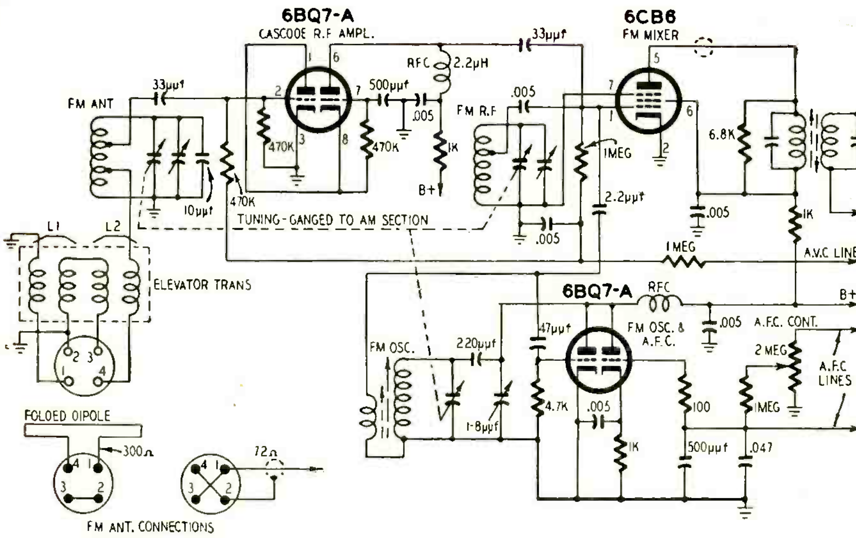


The Fisher 70-RT's front-end with cascode r.f. amplifier and optional a.f.c.

response (with the Ferranti) flat within plus or minus 2 db—mostly within 1 db—at almost all points of all four curves. The NARTB and ORTHO curves showed a bass boost of between 5 and 8 db below 50 cycles but I don't consider this a disadvantage, provided a low rumble and hum turntable is used. Almost all speaker systems can use at least that much boost in that region.

The 70-RT will provide very high quality reception with very simple antennas in normal station areas; it is capable of bringing noise-free hi-fi reception to fringe areas where less sensitive receivers are inadequate.

New Records

HOFFMAN: *Mandolin Concerto*
Gerd Lindner-Bonelli and Symphony Orchestra of Radio Leipzig

DITTERSDORF: *Harp Concerto*
Irmgard Helmis and Chamber Orchestra of Radio Berlin
Urania URLP 7910

MOZART: *A Musical Joke* (K522)
Chamber Orchestra of Radio Berlin.

MEHUL: *Symphony No. 1*
Symphony Orchestra of Radio Berlin.
Urania URLP 7109

All this music dates from the Mozartian or post-Mozartian era and will be enjoyed by everyone who likes Mozart's music—and who doesn't? The connoisseur will welcome acquaintance with some obscure and almost never heard music and composers of the period, while the hi-fi man will find here some interesting listening.

The Mandolin Concerto dates to around 1800 when the mandolin (in a more complex form than the modern counterpart) was popular in Vienna. Since this instrument is seldom heard in serious music, the collector will want to latch onto this recording as an excellent example of the quality of the instrument. The recording produces marked "presence." Indeed, one sometimes gets the feeling the mandolin is right on one's lap. This, I presume, is due to close-up miking of the solo instrument that makes many of the incidental noises of fingering and plucking audible. At any rate you have the odd effect of listening to this music *not* as it would sound to a member of the audience, but rather more as it would sound to the soloist. This makes for an interestingly intimate realism on a good hi-fi system and very superior show-off or demonstration material. The transients of the plucked strings are very well reproduced and should be fine test material for this, too.

The Harp Concerto was written for the cembalo—a keyed dulcimer or early type of piano—and in consequence the harp sounds very different from its usual self. Here it is "played with two hands," like a harpsichord, and you hear a much greater interplay of the familiar mid and top registers with the less often heard low register. The effect, I suppose, is a cross between that of a harpsichord and a rather ill-tempered piano, which, possibly, is what a cembalo sounded like. Anyhow this is charming music. If you listen carefully, you'll hear an occasional vibrato as the low harp notes decay, changing pitch as they do. The two sides provide an interesting contrast in plucked strings—the mandolin highly damped, the harp resonantly undamped. The recording is excellent.

The Mozart piece, heard occasionally at children's concerts, is a satire on the musical clichés and performances of his day, and good fun. It is noteworthy for the very clean and vibrant double bass in spots. Played back with NAB or AES bass compensation, it will vibrate the floors very gratifyingly.

I'm not ashamed to say that I had never heard of Etienne Henri Mehul before this or, if I did, he slipped my mind. The way portions of it remind me of various better known symphonies suggests that Mehul's music didn't slip the minds of some of his illustrious successors. If he wrote any more stuff as good as this, I hope Urania will dig it up. The recording is not remarkable in any single respect from a hi-fi point of view but it is well balanced, fairly clean, and up to the excellent standards of Urania's 50- to 15,000-cycle series of which it is an example. You can also hear, in several spots, a very mightily blown piccolo.

By the way, Urania is now using on these discs the ORTHO curve, although they sound better to me with an NAB bass and the ORTHO treble.

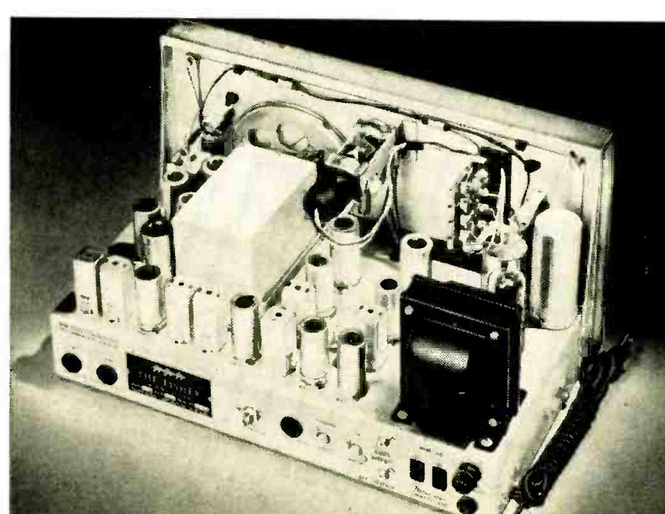
STRAVINSKY: *Pulcinella Suite and Apollon Musagètes*
Vienna Chamber Orchestra
Vox PL8270

STRAVINSKY: *Histoire du Soldat*
Instrumental Ensemble under Fernand Oubradous Vox PL7960

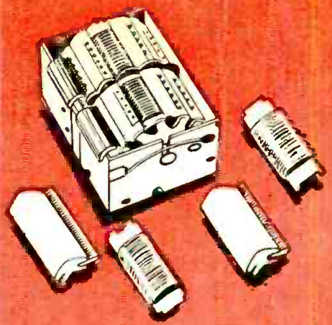
RAVEL: *Bolero, Spanish Rhapsody, Alborada Del Graciosa, La Valse, Pavanne for a Dead Princess*
Symphony Orchestra of Radio Paris
Vox PL8150

LISZT: *Piano Concertos Nos. 1 and 2*
Orazio Frugoni and Pro Musica Symphony Vox PL8390

All except the Histoire du Soldat (Story of a Soldier), are in the new ultra-high-fidelity series of Vox records and very good they are, especially in



The Fisher 70-RT, an AM and FM tuner with phono preamplifier-equalizer.



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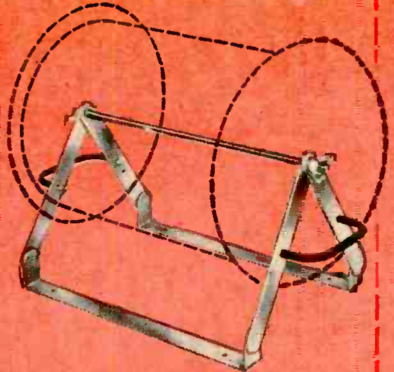

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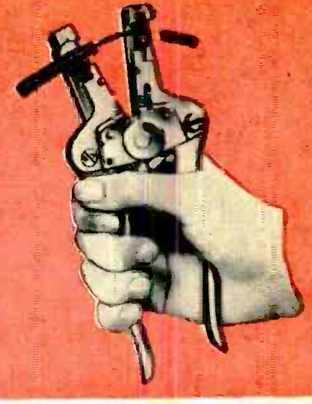

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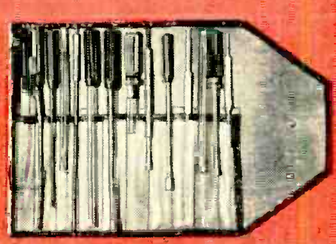

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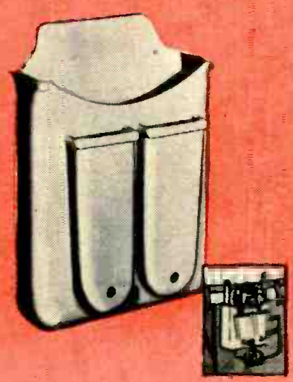

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the bass end. Cook, Mercury, and Capital have been doing a good job recently with drums, but the double basses and piano bass on these discs are tops for me so far. In places they will almost vibrate the dust out of your rugs. Moreover, this is a clean vibrant bass, not a mere rumble or boom. Practically guaranteed to pop the buttons off the vests of owners of good horns and other enclosures capable of doing a good bass full justice.

The highs are also good and I for one did not miss the incessant tinkling of triangles in the background like flocks of belled cows. These are well-balanced recordings, and give an excellent illusion of presence, whatever the miking.

The Pulcinella Suite is a top-drawer test and demonstration record. It is possible I'm slightly prejudiced because this is one of my favorite pieces of music. Stravinsky's free-wheeling rendition of some old tunes of Pergolesi hits me in both my musical weak spots—the polyphony of them good old days, and the remarkable though not always pleasant tonal inventions of the moderns. But aside from being delightful music, this recording offers excellent material for taking the measure of a sound system. I have already mentioned the really big bass often heavily underlining solo instruments and offering an excellent measure of intermodulation. There is, in addition, the interplay of many instruments, winds and strings, enriched by Stravinsky's characteristic coloring. It rises to one of the most wonderful polyphonic crescendos I know of in the *Duetto* about an inch from the end, in which brasses and double basses play around each other at high levels—offering as good a measure of definition in a different way as the opening fanfare of the Final Movement of Copland's Third Symphony. Also the solo instruments, or rather voices of polyphony, include the flute, oboe, bassoon, trumpet, and trombone; and there is a string orchestra behind them. There is plenty of opportunity to judge the naturalness of all, and to compare the differences between them.

The Apollo ballet on the other side is not particularly remarkable, but it is an excellent recording of strings with an exceptional definition in the choirs.

The Story of a Soldier would be a fine addition to a Stravinsky collection if the narration were in English instead of the original French, for the voices are natural and the music good and not without some hi-fi interest. But since the voices occupy so large a portion of the disc, it will be of interest primarily to fans of Stravinsky, particularly those who can follow spoken French.

The very well recorded Ravel record is a fine show-off disc and, with nearly an hour on both sides, represents a lot of music for the money. It is, moreover, music which most people will enjoy. The Bolero, for instance, reveals the fine

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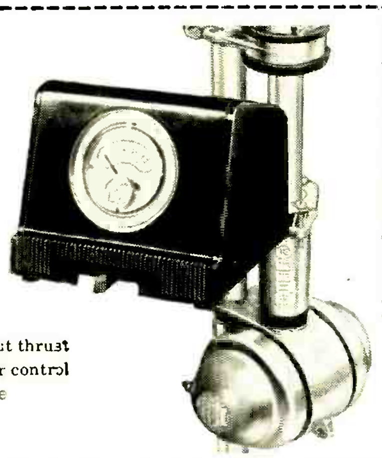

model TR-12
A special combination value consisting of complete rotor including thrust bearing. Handsome modern cabinet with meter control dial, uses 4 wire cable.

model TR-11
The same as the TR-12 without thrust bearing, complete with meter control dial cabinet, uses 4 wire cable

model TR-2
The heavy-duty rotor with plastic cabinet featuring "Compass Control", illuminated "perfect pattern" dial, uses 8 wire cable

model TR-4
The heavy-duty rotor complete with handsome, modern design cabinet with meter control dial, uses 4 wire cable.

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nuances of Ravel's clever composition—such as blending two dissimilar instruments, an octave or more apart, in close unison to produce a sound which at first hearing appears to be that of a single, novel instrument. Both Valse and Rhapsody provide spectacular effects.

The Liszt Concertos are noteworthy for dynamic range, volume and depth of the piano bass. This is very big piano. If your system can be thrown into motorboating, portions of this are likely to do it. Listen especially for the reverberations produced when the left hand hits those chords as hard as Liszt intended them to be hit.

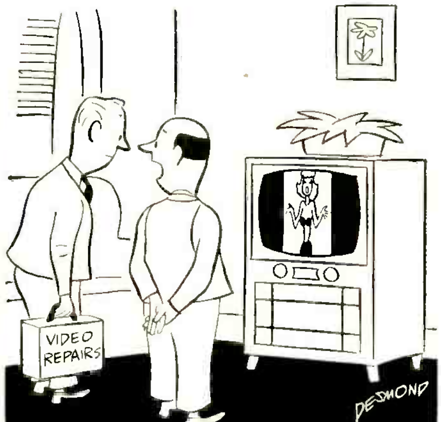
The only marring notes on these records are an occasional, very slight, trace of very low rumble in the Pulcinella Suite that will be audible only when a rumble-free turntable is used, and an occasional distortion in the highs of the Ravel.

Listen to the Band. Vox Concert Band
Vox VX590

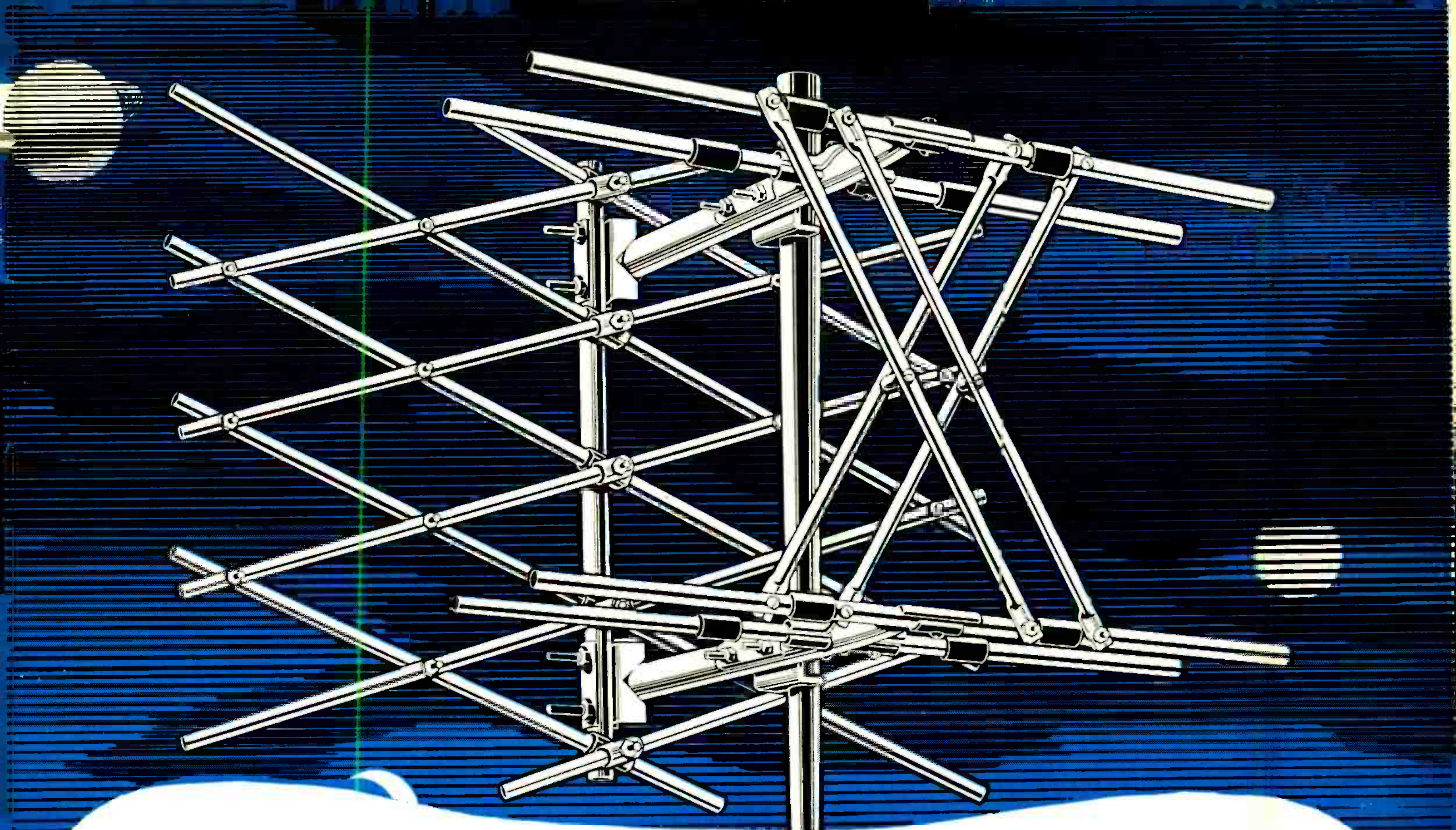
Marches. Deutchmeister Band
Westminster WL 3003

One kind of music pleases practically everybody and usually provides good material for showing off both highs and lows and definition—good old-fashioned band music of the kind they used to play in the town square on a Sunday afternoon. These two records are capable of transporting you the 20, 30 or more years back to your home town and such a Sunday afternoon. Well recorded, they present relatively small bands, playing the conventional rather corny band style. The Vox has the more familiar music with, curiously enough, the big drums on one side and the triangles and tubas on the other. The drums are not as big as in some other records I know of and the highs not so striking either. But they do create that "you are there" feeling.

The Westminster has more of a small-band sound and a kind of beery playing style which is amusing. Connoisseurs of band music will like the less familiar works on these two sides. Highly recommended, if for no other reason than to give the whole crew a lift just before quitting time. END



"I think it's interference from my wife's reducing machine"



ELECTRONICS

Now—Diodes Amplify!

THE crystal diode is now an amplifier. Indeed, in new circuits designed by A. W. Holt of the Bureau of Standards, the ordinary germanium or silicon crystal not only amplifies but oscillates. Power gains up to 10 per stage have been obtained with the diode amplifier, and it is believed that future improvements in diode manufacture may make these amplifiers useful even up to microwave frequencies.

The principle on which the new amplifier works has long been known, but has been considered a weakness in diode rectifiers. It is the *reverse current* flow which occurs when a diode is switched from the conducting to the nonconducting state. When voltage is applied to a crystal so that the anode is more positive than the cathode (*a* of Fig. 1), its conductivity is high. The applied voltage creates a steady stream of *carriers*. These are the "holes" or electrons of transistor terminology. (This article is written in terms of holes, with current flowing from positive to negative.)

If the voltage is applied in the opposite direction (*b* of Fig. 1), no carriers are injected, the impedance of the diode remains high, and current flow is negligible.

But this drop in current is not instantaneous. The carriers already in the crystal are swept out by the *back voltage*, creating a large reverse current for a short time. This reverse current is used to make the crystal amplify.

A transistor example

The diode amplifier action resembles that of a transistor, which can be thought of as two diodes with a common semiconductor element. One diode—the emitter—has voltage applied in the conductive or "forward" direction which causes large numbers of carriers to flow through the crystal. The other diode—the collector—is connected in the reverse direction, and a large voltage applied to it causes very small currents to flow. The current which does flow in the collector circuit depends on the number of carriers injected by the emitter. If the emitter voltage is raised or lowered, causing more or less emitter current flow, the collector current also becomes greater or smaller.

In some junction transistors, the variations in collector current almost equal those in emitter current, and we can think of the action as transferring current from the emitter to the collector circuit. But the collector circuit is one with higher voltage and a higher load resistance, so a given change in current in that circuit represents a much greater amount of power than in the emitter circuit ($P=I^2R$). "Power gain in the transistor is obtained by a transfer of current from one circuit of low impedance to another circuit of high impedance."

If alternating current is applied to a crystal diode, it acts like an emitter during half the cycle; like a collecter during the other half. The diode amplifier must be supplied with power from an r.f. source whose frequency is at least as high as that of the modulating signal frequency. In the examples described here, a square waveform at 1 mc, entirely positive-going (point A in Fig. 2 varies from 0 to 20 volts positive to ground), is used. The power supply is also called the clock, because it controls the time during which the crystal is in the conductive or the high-impedance state. The diode amplifier is therefore in a class with magnetic and dielectric amplifiers in that it requires an alternating power supply, as opposed to tubes. Like the magnetic amplifier, too, it has so far been used for pulse amplification and control applications, though experiments indicate that it might be used for audio amplification, should there be any reason for so doing.

Signals are applied at point B in Fig. 2, through a rectifier shown here as a vacuum-tube diode, which prevents back-action into the signal circuit.

When there is no input at point B, there is no current in the circuit A-C-R_L-ground. The diode passes no current during one alternation of the power supply because the voltage is zero, and none during the other because it is in the high-impedance direction of

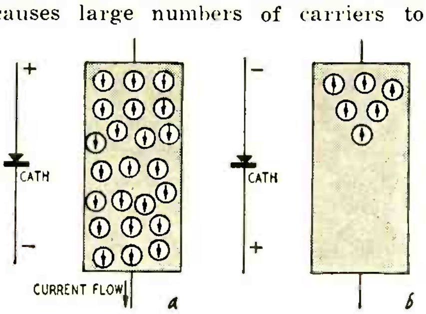


Fig. 1—How the crystal is filled with carriers on the forward alternation and emptied during the reverse cycle.

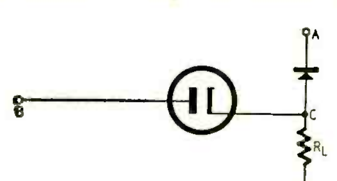


Fig. 2—The simplest diode amplifier.

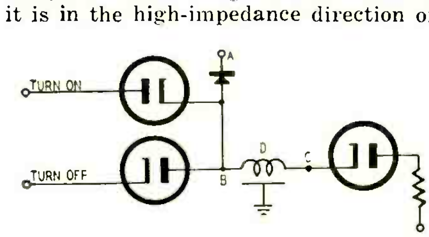


Fig. 3—This flip-flop circuit runs until turned off by a negative pulse.

the diode. A small spike—due to the diode capacitance—appears in the output, but can be reduced if desired by shunting R_L with a capacitor.

If point B is raised to about 2 volts while the clock is at zero, carriers are injected into the crystal, current flowing in the direction B-C-A. When the voltage again rises at A, these carriers are swept back out of the crystal, and a current flows through R_L, creating a voltage across it. Transfer of current from a low-impedance to a high-impedance circuit results in power gain.

To increase the amount of current gain for application to another stage, the voltage gain across R_L must be changed to current gain. This is done with a stepdown transformer, and various circuits have been worked out to compensate for the complications introduced by the transformer inductance.

Flip-flops and current doublers

A number of special circuits—for pulse amplification and for use in electronic computers—have already been designed by Bureau of Standards scientists. One of the most interesting is a flip-flop circuit in which the diode oscillates. A 2-volt positive pulse is injected through the TURN ON gate (Fig. 3) while the clock (power supply) is at zero volt. When point A raises to 20 volts, a surge of current goes down delay line D. The line is an open circuit for a positive pulse, so the surge is reflected and arrives at point B (if the delay-line's time constant is correct) just in time to inject carriers into the crystal, and the cycle is repeated. (The diode beyond point C is to absorb a negative pulse reflected from point B due to mismatch between delay line and crystal.) The circuit continues to oscillate till a negative pulse is applied through the TURN OFF gate.

Another interesting circuit is a "current multiplier" which uses capacitors in a manner reminiscent of a vacuum-tube voltage multiplier. When point B of Fig. 4 is more positive than point E, electron flow (more convenient to consider in this circuit than positive "carriers") in the direction E-D-C-B charges the capacitors in series. Diodes 1 and 3 do not conduct. With the voltage reversed (or cut to zero), diode 2 cuts off and the capacitors discharge in parallel (B-C-E and B-D-E). This circuit has been used with a germanium diode amplifier to make a flip-flop whose frequency can be carried over a very wide range. END

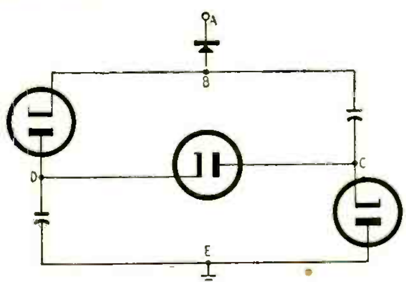


Fig. 4—Diode current-doubler circuit.

THE PHOTOTRANSISTOR

veloped the first piece of phototransistor commercial equipment for Bell Telephone. This was a card translator (Fig. 1) installed in 1952 as part of a complex nation-wide telephone switching system, and resulted in a great saving of space and power.

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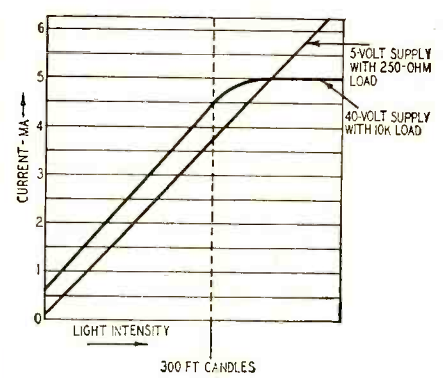

Fig. 5—Diagram shows characteristics of an n-p-n junction phototransistor.

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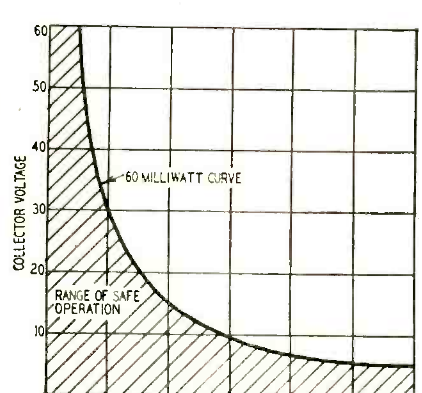

Fig. 6—Operating range of the X-25. The unit has maximum rating of 60 mw.

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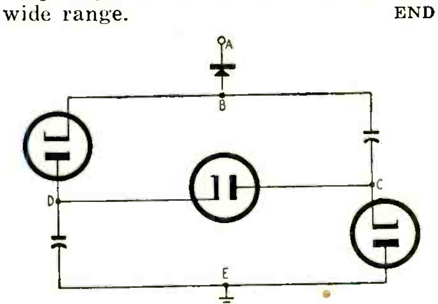
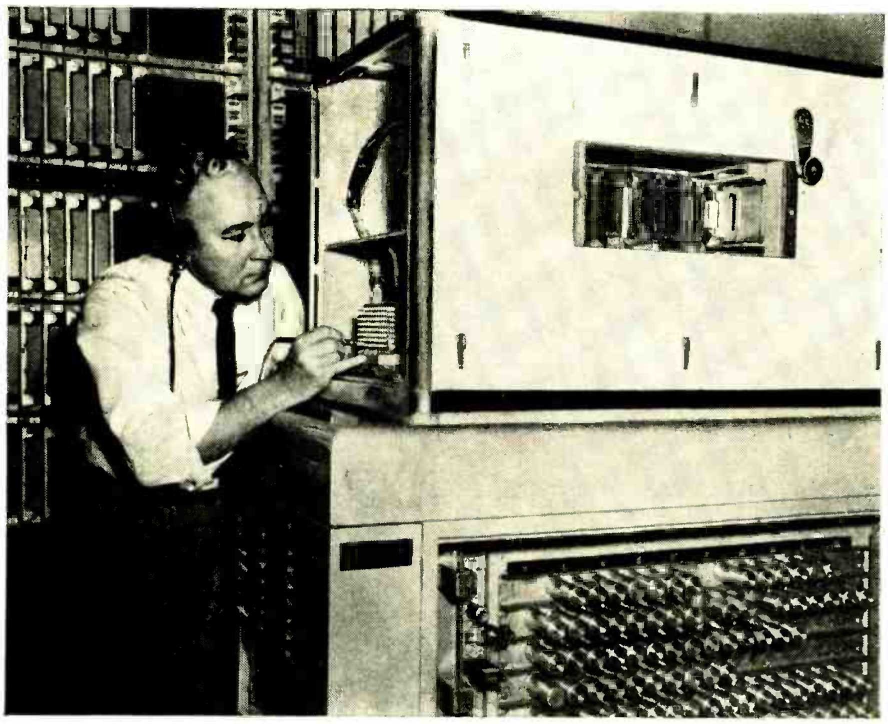


Fig. 4—Diode current-doubler circuit.

THE PHOTOTRANSISTOR

By HARRY MILEAF

An outgrowth of transistor research, this unit is remarkably photosensitive and widely applicable



Courtesy Bell Labs.

Fig. 1—First application of the phototransistor—card translator equipment.

THE amazing transistor has invaded the realm of the vacuum tube and, in a short span of time, shown that it will soon become the most important factor in electronics. In radio, television, computers, counters, and many other phases of electronics, it has brought us promise of space conservation, power efficiency, and design simplicity.

An important adaptation of the transistor, the phototransistor, shows even more immediate promise of being used in the industrial field. Besides having all of the advantages of the transistor, it is the most photosensitive device produced because of its current-amplifying characteristics.

Photosensitivity has been an important part of automatic equipment for many years. It has been used extensively in automatic "on-off" devices such as automatic door openers, counters, keyers, light dimmers, and other applications. Up to now, the ordinary phototube has enjoyed a monopoly in photosensitive equipment. But it has the disadvantage of supplying only small amounts of photosensitive current. Amplifiers have to build up these small variations to a high enough value to operate the automatic equipment. The phototransistor, on the other hand, can supply enough current to operate a relay directly. (Phototubes deliver microamperes; phototransistors deliver milliamperes.) Because of this characteristic, the phototransistor requires less complementary equipment and is more efficient.

The phototransistor is not exactly new, in the strictest sense of the word. Some companies have spent the last couple of years constantly improving the phototransistor. Western Electric, pioneers in transistor construction, de-

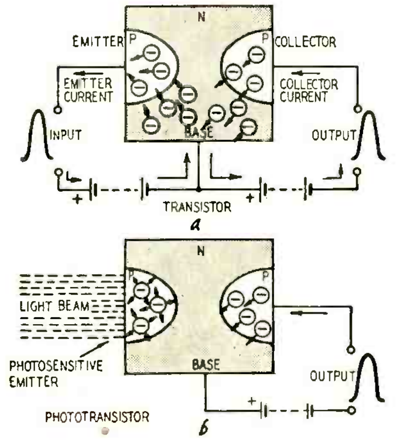


Fig. 4—Diagrams show comparison of transistor and phototransistor theory.

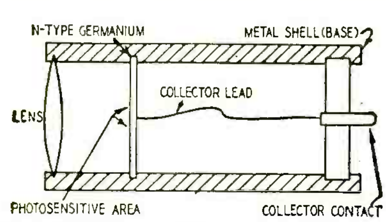


Fig. 2—A coaxial phototransistor—similar to a point-contact transistor.

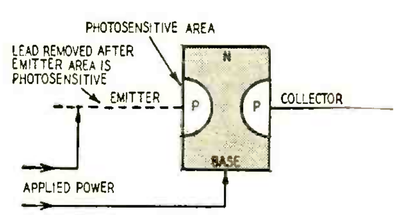


Fig. 3—In processing transistor, power is applied between base and emitter.

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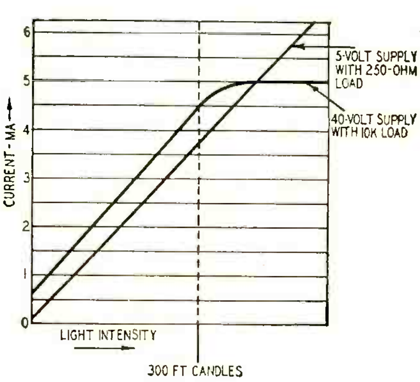

Fig. 5—Diagram shows characteristics of an n-p-n junction phototransistor.

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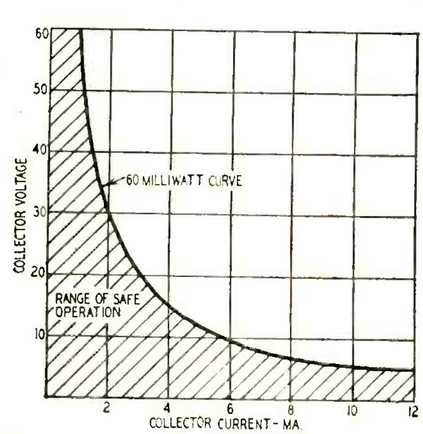

Fig. 6—Operating range of the X-25. The unit has maximum rating of 60 mw.

amplifier tube so that the relay cannot be energized. However, when an object blocks the beam of light, the phototube current drops off and the bias at the amplifier tube decreases. The plate current then increases and actuates the relay. Its contacts close and the door-opening mechanism operates.

The phototransistor control circuit (b) does not require an amplifier. The beam of light on the photosensitive base supplies enough current to actuate the relay. The relay in this circuit is connected so that the contact points are open when it is energized. Therefore, when the light source is cut off, the current decreases and the relay is de-energized. This causes the contact points to close and energize the door-opening mechanism.

Fig. 7 shows the simplicity of the phototransistor circuit. In the phototube circuit only one amplifier was used because plenty of light change was available. But, if the circuit had to react to smaller changes of light intensity, the phototube would require much more amplification as compared to the phototransistor. Of course, a photomultiplier tube could be used in such a case, but the amount of noise that would be developed would limit its usefulness with critical circuits. The circuit shown in Fig. 7 is also similar to those used for counting.

One of the latest developments in phototransistors is that associated with the phototransistor control unit, described on p. 118, RADIO-ELECTRONICS, November, 1953, another Bell patent. This circuit uses an n-p-n junction phototransistor with two photosensitive surfaces (emitter and collector) that can be set up in a bridge circuit so that changes can be more accurately measured. It can be used to maintain brilliancy in photographic exposure processes, stage light intensity, and infra-red baking processes (the phototransistor is sensitive to infra-red). END

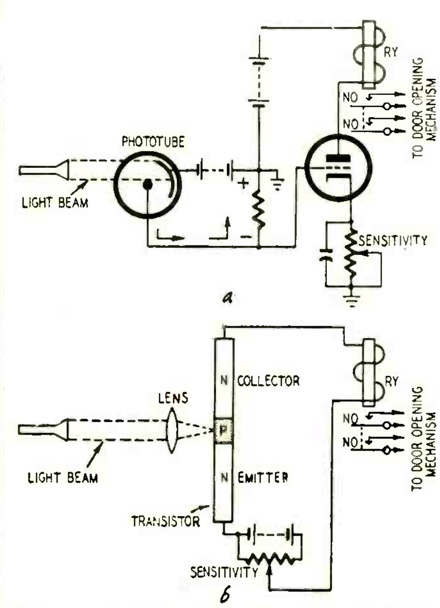

Fig. 7—Comparison diagrams of basic photosensitive control circuits.

the magnetic AMPLIFIER

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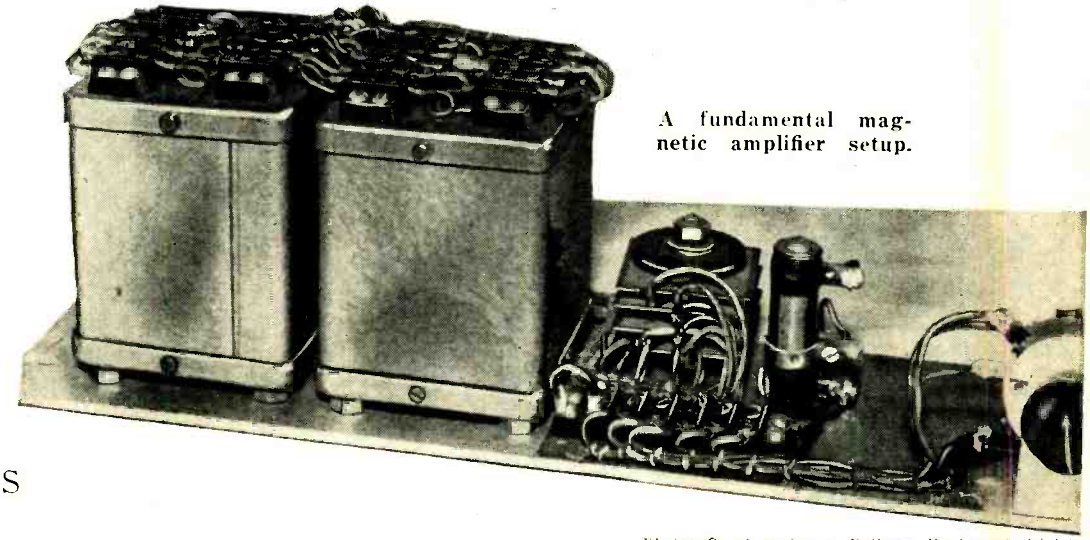


A fundamental magnetic amplifier setup.

By LEO G. SANDS

Photos Courtesy Bogue Railway Equipment Division

THE transistor, the electrostatic amplifier, and the magnetic amplifier are competitors, but not necessarily successors to the vacuum tube. Only seven years ago, the transistor was invented at the Bell Telephone Laboratories. Since that time it has been the subject of much discussion and is now finding its place in practice.

The magnetic amplifier, on the other hand, is not new and has been used for many years. But it was not generally known by the name magnetic amplifier. Many radio technicians will remember an early Majestic radio receiver in which the dial light dimmed when the receiver was tuned to resonance with an incoming signal. This is a form of magnetic amplifier.

It has been widely stated that the Germans invented the magnetic amplifier. Records indicate that it is an American invention used as far back as 1885 for the control of electrical machinery.

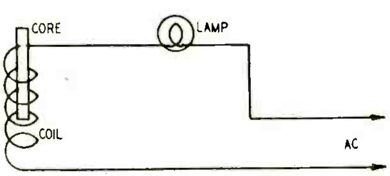


Fig. 1—A magnetic a.c. light dimmer.

The Germans, however, should be credited with reviving interest in magnetic amplifiers and developing them into practical forms for a wide variety of applications. They applied magnetic amplifiers to many tasks formerly assigned to vacuum tubes, such as in servo systems, regulators, fire control, frequency control, and computer circuits.

Statistics indicate that the great majority of electronic equipment failures are caused by vacuum tubes. If tubes are the weakest link, it seems logical that the tubes themselves should be improved or, whenever possible, replaced by devices which do not wear out as readily. Ruggedized vacuum tubes have been made available, with the result that failures and replacements are reduced. The vacuum tube is, in reality, a very reliable device, but its applications are limited by its fragility and the fact that it wears out in a short time.

A magnetic amplifier is a static device which will perform many of the functions of vacuum tubes. Its applications in its present stage of development are limited, but the many jobs it is capable of doing, it can do well and with greater reliability than can vacuum tubes.

A few examples

The basic principles of operation of the magnetic amplifier may be more easily understood by studying the circuit of a coil and lamp in series as indicated in Fig. 1. When a core of magnetic materials is inserted in the coil, the lamp glows dimly because the coil's impedance increases. When the core is removed, the current increases and the lamp glows more brightly. By adjusting the position of the core, the brilliance of the lamp may be varied by degrees.

The radio tuning indicator system shown in Fig. 2 illustrates the principle of electrical control with a saturable reactor. The decrease in plate current flowing through the coil because of a.v.c. action when the receiver is tuned to resonance increases its inductance, and therefore its impedance to the flow of current through the lamp. The principle can be further demonstrated by connecting a transformer of suitable characteristics in the manner shown in Fig. 3. Varying the amount of d.c. flowing through L1 changes the impedance of L2 to the flow of current through the lamp.

In Fig. 4 the circuit is modified to include a rectifier in series with the load. This is a basic simple form of magnetic amplifier. The pulsating d.c. which now flows in the secondary L2

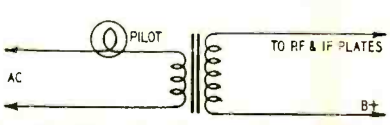


Fig. 2—Circuit of a tuning indicator based on magnetic amplifier principles.

aids the primary L1 or control winding to cause saturation of the core. As this circuit requires less power for control than the device which is to be controlled, we now have a true amplifier.

A practical magnetic amplifier is not as simple to design and build as the foregoing might infer. The saturable coil, transformer, or "transductor," as it is called by the magnetic amplifier

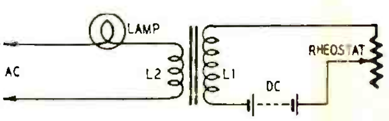


Fig. 3—A rough experimental hookup.

engineer, is the most important element. The transductor is a special type of transformer using *core materials that are easily saturated.* A great variety of core materials are used to meet the requirements of specific applications. So if the experimenter hooks up the circuit of Fig. 3 or Fig. 4, he is likely to get results which may demonstrate the principles of magnetic amplification, but should not be surprised if his control power is as great as that being controlled. That is because of the core material of the ordinary transformers,

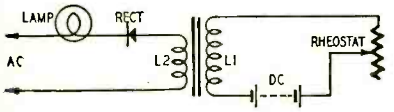


Fig. 4—This circuit really amplifies.

which is much harder to saturate than cores in magnetic amplifier equipment.

Practical magnetic amplifiers

A typical transductor consists of control coils and load coils wound opposed to neutralize any transformer effect into the control winding. A practical magnetic amplifier is shown in Fig. 5. Here the transductor is provided with control windings and two opposed load windings. The selenium rectifiers permit flow of current through one of the load coils during one half of a cycle only and through the other load coil during the other half of the cycle. Varying the current flow in the control windings causes a wide change in the impedance of the load coils.

The circuit of Fig. 5 may be modified to permit control of a d.c. load by adding a bridge rectifier as shown in Fig. 6.

To increase the gain of a magnetic amplifier, positive feedback has been used to realize gains up to several million per stage. In practical applications, gain in the order of several thousand times is common. Fig. 7 illustrates a circuit employing such feedback. Negative feedback is also used to increase linearity.

The development of the magnetic amplifier did not get a real push forward until selenium rectifiers with extremely high forward-to-reverse current ratios become available. Run-of-the-mill selenium rectifiers intended for power applications usually are not suitable.

The availability of satisfactory rectifiers in sufficient volume became so acute that Bogue set up its own selenium rectifier manufacturing facilities to build rectifiers with suitable characteristics. Belcon rectifiers are being manufactured by Bogue with forward-to-reverse currernt ratios in the order of 1,500 to 1.

Some applications

New applications for magnetic amplifiers are being discovered continuously. They have been made to operate at frequencies higher than 1 megacycle, although it is not economically feasible to build radio receivers or public-address amplifiers using magnetic amplifiers instead of vacuum tubes.

The armed forces and many industrial and educational organizations are probing further into the development and applications of magnetic amplifiers. Electronic equipment is being redesigned to substitute magnetic amplifiers for vacuum tubes. New military and industrial electronic devices with few or no vacuum tubes are being developed.

Magnetic amplifiers are being used to operate motors and relays directly from photocells, strain gauges and thermocouples. They are also being used to replace mechanical relays by utilizing the flip-flop characteristics of magnetic amplifiers. As contacts and moving

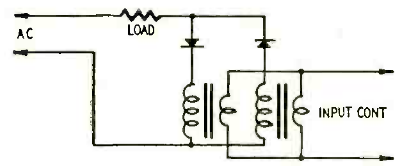


Fig. 5—A practical magnetic amplifier.

parts are eliminated, greater reliability under all kinds of weather and moisture conditions can be achieved. Furthermore, they are explosion-proof.

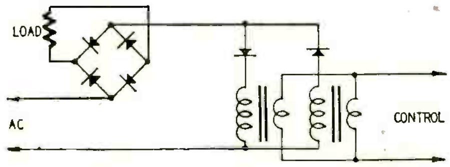


Fig. 6—How a d.c. load is controlled.

A very popular application of the magnetic amplifier is in automatic regulation of the output voltage of electrical generators. The Bogue 400-cycle motor-generator power-supply systems use magnetic amplifier voltage regulators which maintain output voltage to plus or minus ½% or better, no load to full load, with frequency remaining at 400 cycles no load to full load.

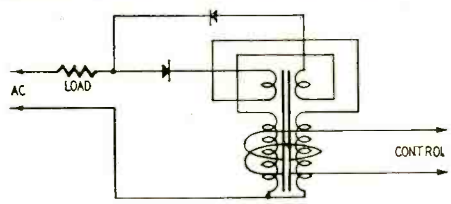
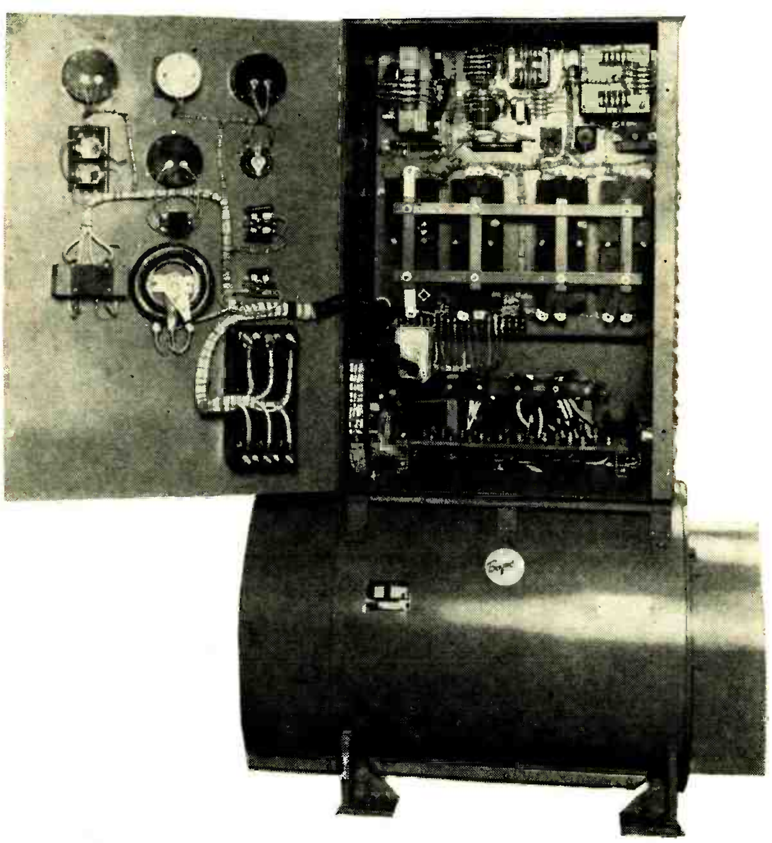


Fig. 7—Feedback increases sensitivity.

The speed of a motor may be controlled within very close limits with magnetic-amplifier regulators, and a large number of motors may be kept in step with each other. The speed may be adjustable with magnetic amplifiers holding the speed to the desired value.

Servo systems using magnetic amplifiers instead of vacuum tubes are inherently more reliable because there are no tubes to wear out or filaments to burn out. A typical magnetic amplifier servo system is the Bogue ship-steering servo. This particular servo system causes the ship's rudder to track automatically with the steering wheel to an accuracy of a quarter of a degree.

The life of a magnetic amplifier is not easy to predict. The transductor is a form of transformer. If well designed, its life is a great many years. Selenium rectifiers operated within their ratings have a service life estimated conservatively at more than 50,000 hours, which is many times more than the life expectancy of a vacuum tube. END



A magnetic amplifier control used with 400-cycle motor-generator equipment.

References
"The Magnetic Amplifier," by A. A. Bosschart, RADIO-ELECTRONICS, September, 1951.
"Simple Magnetic Amplifier," by Erwin Levey, RADIO-ELECTRONICS, June, 1952.

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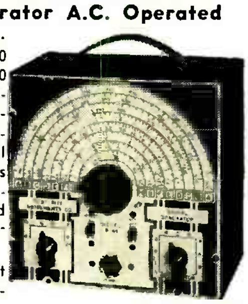

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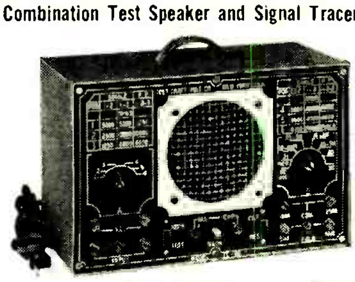

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Technicians' News

TEA CLINIC AND FAIR

The Texas Electronics Association, sponsor of the Radio and Television Service Clinic and Electronics Fair, reports the program was highly successful. The event was held in Dallas, Tex., and was the second annual affair.

The program featured a broad series of technical and business topics with emphasis on color television. The subjects covered color TV lectures, service cost analysis, public relations and advertising, credits and collections, legal aspects, TVI causes and cures, color test equipment, transistors, and merchandising. Each was discussed by a specialist recognized in his field.

The distaff side was treated to a sight-seeing tour, Cinerama and an ice revue.

NETSDA ELECTS HEAD

At a meeting of the National Electronic Technicians and Service Dealers Associations held in New York, Max Liebowitz of New York City was elected president. Other officers elected at the meeting were Dave Van Nest of Trenton, N.J., vice-president; John A. Wheaton of Mineola, L.I., secretary, and T. L. Clarkson of Harrisburg, Pa., treasurer.

Provision was made for incorporation as a nonprofit organization and plans were formulated for rotating meetings in different states and more particularly at local meeting halls of member associations. Group directors are being set up on a state-wide basis to coordinate local and state activities of national interest to radio and TV technicians and dealers.

ALL WORK AND NO PAY

Members of the Television Association of Battle Creek offered to clean the picture tube and cover glass of TV sets free during a 3-day period. The operation was aimed at boosting service business by promoting the goodwill of television users.

The members who took part in the experiment cleaned about 100 sets; few reported any increase in service business. It seems that most of those who asked for the free cleaning service were old customers whose sets were operating perfectly.

FRSAP MEETING

Completed reports concerning an educational program, price survey, and investigation of unethical service advertising were represented at the monthly meeting of the Federation of Radio Servicemen's Associations of Pennsylvania in Altoona, Pa. Upon complete reports from each chapter, the federation plans to make up a questionnaire for distribution to all member chapters throughout the state concerning the charges involved in radio-TV servicing. A standard price-rate sheet based on the answers received will be prepared.

The group's educational committee supplied all delegates with an outline of a service course to be followed by member chapters for the purpose of aiding technicians in each chapter. A copy of the federation's anti-bait advertising bill was also submitted to delegates for possible action by local civic officials in their areas.

COLOR TV SEMINAR

In preparation for color TV in the Miami area a symposium was held in that city, sponsored by the Radio and Television Technicians Guild of Florida, Inc.

A capacity crowd turned out to hear Dr. T. T. Goldsmith, Jr., vice president of Du Mont, speak on the history of color TV and its future as well as various technical subjects. Other speakers also discussed the many phases of this subject of interest to service technicians.

ECTRA ETHICS

A streamlined code of ethics has been outlined by P. O. Ferra, president of the Erie County Television Radio Association. Reduced to five points, it pledges ECTRA members to:

1. Guarantee radio and TV work for 90 days from date performed and replacement parts for 90 days from date installed.
2. Use only parts of recognized quality.
3. Charge no more than list price for parts.
4. Keep charges for labor fair and reasonable.
5. Perform only such repair work as is necessary or authorized.

GUILD STARTS PRP

The Radio Television Guild of Long Island has released the August issue of their publication, *The Guild News*. It features an editorial on a new venture called PRP (Public Relations Program).

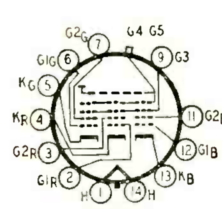
The purpose of this program is to elevate the standards of the service industry to the level of a recognized profession. A business group will be set up within the guild, composed of members who are shop owners or self-employed service technicians. This group will embark on an extensive public relations program.

To be eligible to participate in this program, members will have to meet certain minimum requirements, such as full-time employment in the service industry, and good reputation. Excluded are shops that offer free service, free estimates, dollar service or the various other gimmicks used in bait advertisement. END

new Tubes & Transistors

NEWS of the season was expected to be the 21-inch RCA color tube unveiled by that company at the David Sarnoff Research Laboratories, Princeton, N.J., September 15 in connection with the advance announcement of RCA's new 28-tube color receiver. The new tube uses the conventional three-gun shadow-mask principle, with a curved mask like that of the CBS Colortron. The new tube is a 70°-deflection round metal type, $25\frac{3}{8}$ inches long, with picture area of 250 square inches, and a special *color equalizer* which takes the place of the coil formerly used to neutralize the effect of the earth's field. This consists of a large polepiece in the form of a double ring which goes around the tube just behind the face. On this polepiece are mounted a number of short bar magnets which may be turned to vary the field at any point around the circumference of the tube. The new color equalizer not only gives more effective neutralization of the earth's field, RCA spokesmen pointed out, but cuts manufacturing costs. The ultor voltage of the new tube is 25,000, and the focusing voltage in the order of 4,500, with other element voltages in proportion. The basing diagram was not released, but would probably follow the 19-inch tube. Price to manufacturers was $175, and tubes were to be available in November.

The CBS-Colortron 205 (briefly described in September) marked a significant advance in color tube development. The tube has a 6.3-volt filament, drawing 1.8 amperes. It uses electrostatic focusing, electromagnetic convergence



19VP22

and deflection, and has a deflection angle of 62°. Length is $26\frac{7}{16}$ inches. The tube screen is a metal-backed, tricolor, phosphor-dot type.

Under typical operating conditions, the anode voltage is 25,000; the No. 3 grid (focus) voltage is 6,500 to 8,000; with 200 volts on the No. 2 grids, the grid No. 1 voltage, for visual extinction of the raster, is −45 to −100; with −75 volts on the No. 1 grids, the grid No. 2 voltage is 150 to 330.

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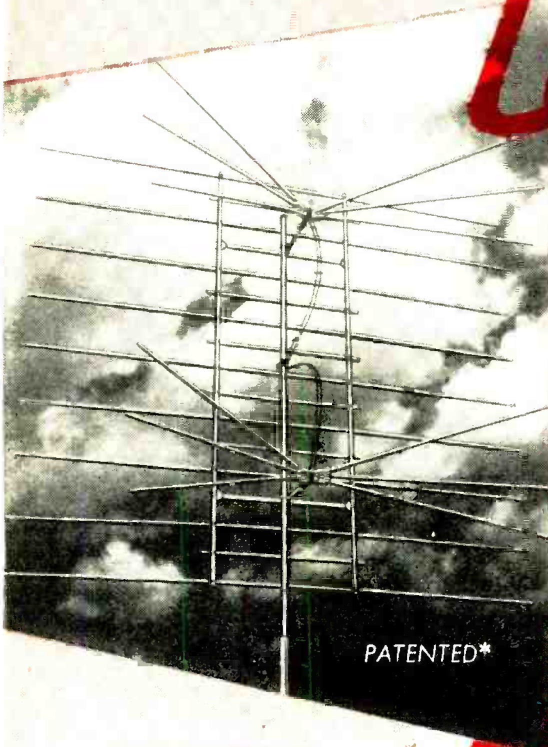

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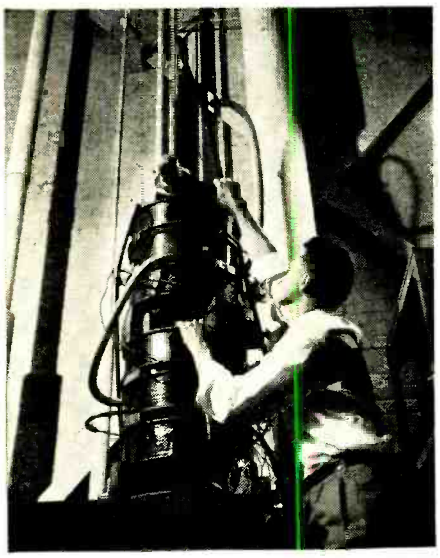
Having broken the "electron barrier" that once limited radar performance, a giant electronic tube (see photo) produced by Sperry Gyroscope Co. makes its way into this column. Known as a megawatt klystron, the tube is 8 feet tall and produces 4,000,000 watts, more than 250 times the wattage developed in the radar that beamed pulses to the moon and back in 1946. More important, the frequency of this power can be held 20 to 200 times closer than the frequency limits of radio and TV transmitters in the United States.

Westinghouse has announced a new 17-inch picture tube having a deflection

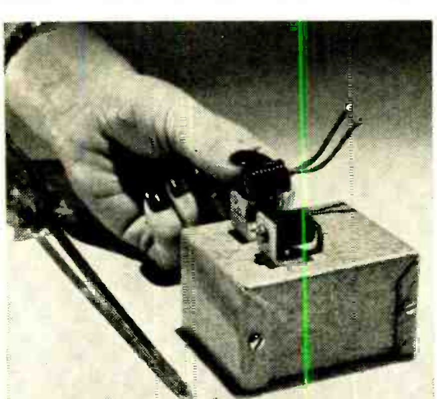


The 4-megawatt klystron is installed.

angle of 90°. The 17ATP4 and its aluminized counterpart, the 17ATP4-A, use electrostatic focusing and magnetic deflection. They are of all-glass, rectangular construction.

Two new 21-inch, aluminized, all-glass, rectangular television picture tubes, with a deflection angle of 72°, has been announced by Sylvania. The new tubes have gray, filter-glass, spherical face-plates with 265 square inches of useful picture area.

The electrostatically focused 21AVP4-A and the magnetically focused 21AWP4 use a single-field ion-trap magnet. These tubes are designed for magnetic deflection and are supplied with an external conductive coating.



New Westinghouse power transistors.

NEW TUBES *(Continued)*

A series of 13 hydrogen thyratron tubes has been announced by Kuthe Laboratories, Inc., of Newark, N.J. Designed for a wide variety of applications in industrial and military equipment, they range from the type 1528, a miniature tube rated at a peak output of 10 kw at an average power level of 25 watts, to the type 1257, a giant rated at 38,000 kw peak, 45 kw average.

Two new pentodes, designed especially for high-fidelity audio sound systems, have been announced by Amperex. The pentodes, types 6CA7 and EL84, are capable of high plate dissipation. The 6CA7 (25 watts) and the EL84 (12 watts) deliver high power without drawing control-grid current.

Through a combination of special mounting and physical design (see photo), Westinghouse has produced a new germanium power transistor having a 1-watt rating. The black-ribbed mounting provides the cooling necessary for the high collector dissipation.

The p-n-p transistor, type 2N71, can be used in any low-frequency circuit, such as class-A amplifiers, where output power is desired.

CORRECTIONS

A .0015-μf capacitor should be connected between pins 8 and 3 of the 6H6 in the diagram at the bottom of page 96 in the July, 1954, issue. The omission of this capacitor results in a short across the 24-mc coil.

We thank G. P. Oberto of Richmond, Va., for calling our attention to this omission.

In the article "Tracking Down Horizontal Instability," September, 1954, page 62, a statement is made in the third column, 23rd line: "If a.g.c. tube change does not eliminate pulling, place 0.5-μf paper capacitor (if keyed a.g.c. is used, 4 μf) from a.g.c. bus to ground." It should read "(if keyed a.g.c. is used; otherwise 4 μf)."

We thank the author of the article, Mr. Cyrus Glickstein, for calling this error to our attention.

There is an error in Fig. 3 of the article "Color TV Circuits" in the August, 1954, issue. The connections to the screen and controls are reversed. The primary (right-hand) winding of T3 is shown connected between the plate and control grid. The primary winding should be between the plate and screen.

Our thanks to H. T. Fuller of San Bernardino, Calif., for this correction.

A typographical error destroys the meaning of Will's first statement on page 48 of "Television . . . it's a cinch" in the October issue. Will's statement should read: Then, with cathode injection, we'd use negative-polarity detection for one stage and positive for two.

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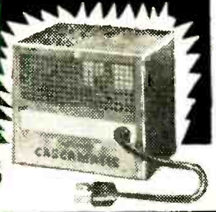

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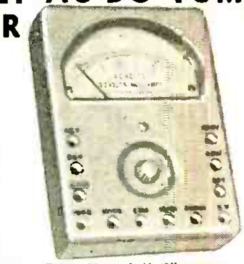

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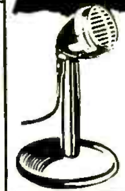

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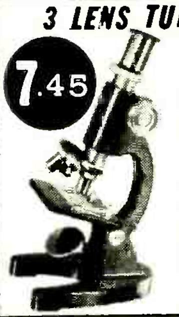

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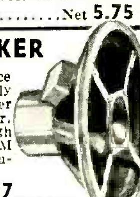

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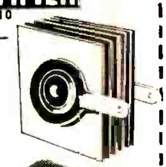

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RE-14	75 MA	.67	.64
RE-10	100 MA	.80	.75
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RE-16	200 MA	1.19	1.08
RE-11	250 MA	1.29	1.19
RE-17	300 MA	1.39	1.29
RE-18	350 MA	1.57	1.50
RE-13	400 MA	1.75	1.68
RE-19	450 MA	1.77	1.70

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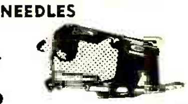

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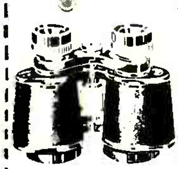

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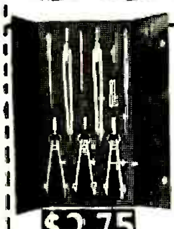

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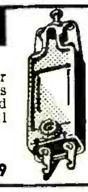

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RCA 3-HES-5 (RS-146)

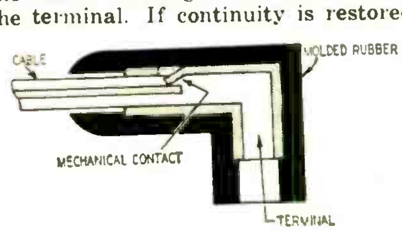
Cases of hard-to-locate hum have been experienced in this record player. This trouble has been traced to an electrostatic condition that causes an accumulation of dust and minute cuttings between the chassis apron and the terminals of the loudness control. This causes a partial short that produces the hum. The difficulty can be eliminated by cleaning the space with an air blast or a soft brush.

Later production models have a coating of black insulating paint at this point.—*RCA Service Co.*

IGNITION INTERFERENCE

Try checking the continuity of the spark-plug leads when stubborn cases of ignition noise do not respond to the usual treatment. Use an ohmmeter or continuity checker consisting of a battery and small bulb. You may find an open lead between the distributor and a spark plug.

Check first the spark plug end of the cable. When the lead end and terminal are molded in rubber, the terminal is probably not soldered to the conductor. The connection will be purely mechanical. Use pliers to squeeze the rubber housing at the cable end of the terminal. If continuity is restored,



the connection is probably satisfactory. If the contact is intermittent, the quickest remedy is to open the rubber housing and solder the lead to the terminal. Reinsulate the terminal to prevent corrosion. The drawing shows the cross section of a typical ignition terminal.

If you decide to replace the open lead, be sure to check continuity in the new lead. Open leads may be satisfactory from an ignition standpoint; they are unsatisfactory for interference-free radio reception.—*Motorola Newsgram*

ADMIRAL 24D1

The complaint was flickering, with a 2-inch wide bar moving vertically across the screen. The trouble was difficult to localize because any movement or tapping anywhere on the chassis caused interference in the picture. It proved to be intermittent grounding of the top tuning slug in the ratio detector transformer.

Originally the slug was fixed in place with wax. In time, the wax melted from the heat and left a thin film between the slug screw and the ground clip. Vibration from the speaker or any other source caused intermittent contact.

The remedy is to clean the slug screw with contact cleaner and then rotate the screw back and forth while pinching the clip to the screw with the fingers. Wrap a rubber band around the shaft and clip to hold the final adjustment. Rewaxing is an invitation for the trouble to return.—*Elmer M. Woods*

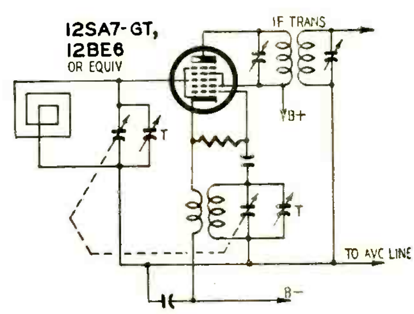
STROMBERG-CARLSON TV

If you have trouble with poor interlace in Stromberg-Carlson TV sets, check the circuit for a 10,000-ohm resistor (R48 in most sets) connected in series with a capacitor between ground and the B plus end of the vertical oscillator transformer.

Removing this capacitor will probably cure the interlace troubles.—*Carl Hennig*

A.C.-D.C. SETS

When poor sensitivity in a.c.-d.c. sets is not due to low voltages, weak tubes, and other usual causes, use a v.t.v.m. to check for a high negative voltage on the signal grid of the converter tube. A high negative voltage is usually caused by a leaky oscillator grid coupling capacitor in sets using the circuit shown. Any leakage in the oscillator grid capacitor couples the oscillator's d.c. bias voltage to the a.v.c. line and causes loss of sensitivity. Replacing the capacitor restores the original performance quality of the receiver. This defect is troublesome because usual servicing procedures doe not lead to suspicion of the grid-leak circuit.



This trouble occurs often in sets with the tuning capacitor rotor and both coils returned to the a.v.c. line as in the diagram.—*Ralph S. Thompson*

G-E MODEL L-573

A flickering pilot lamp accompanied by hum is often caused by an intermittent short or high leakage in the pilot lamp socket. Replace the socket with a new one.

The same symptoms may occur in other a.c.-d.c. sets that have a tapped heater for the pilot lamp.—*John C. Chepla*

END

Patents

EFFICIENT TV RECEIVER

Patent No. 2,683,805
George W. Fyler, Lombard, Ill.
(Assigned to Motorola, Inc., Chicago)

A TV receiver consumes considerable power. Most of it is necessary for proper operation of the set, but a significant fraction represents useless heat loss. This is because certain TV tubes operate at only 150 volts. Some require 250 volts for maximum efficiency, while still others need higher voltage, approximately 400. With a single power supply, the lower-voltage tubes must be supplied through voltage dividers or dropping resistors. These generate plenty of heat that raises the electric bill. They also complicate the circuit.

This invention cuts power loss in a receiver by connecting tubes in series. A voltage doubler supplies 400 volts to the set. A lower string of six tubes includes low-voltage types. They are supplied with 150 volts. An upper string comprises 250-volt tubes. Their plates are connected to the 400-volt line, but their cathodes are tied to the 150-volt bus. In other words, the tubes themselves divide the higher voltage.

Tubes requiring a full 400 volts are connected from the 400-volt line to the negative bus. Three others—the horizontal output, vertical oscillator and vertical output tubes—are fed from the boosted (500-volt) supply.

The plate voltage of the a.c. tubes in the lower string tends to fluctuate with signal strength. To prevent this, the audio output tube is placed in the upper string. This tube passes considerable plate current which loads and stabilizes the 150-volt bus.

One problem remains. The audio output tube is usually a high gm type. A slight change in grid bias results in a large variation of plate current. This might affect the voltage on the tubes in the lower string. To prevent this a large cathode resistor is connected in series with the first audio tube. This stabilizes its plate current. Then the audio output tube is *directly coupled* to the plate of the previous tube, assuring a constant plate current from the output tube and, in turn, a constant potential at the 150-volt line.

TRANSISTOR BIAS CIRCUIT

Patent No. 2,680,160
Robert E. Yaeger, Califon, N.J.
(Assigned to Bell Telephone Labs., Inc.)

Base current of a junction transistor varies considerably with temperature. Therefore constant bias cannot be obtained from a resistor in the base lead. This invention uses a resistor in the emitter circuit. It stabilizes the flow into the emitter as well as the collector current.

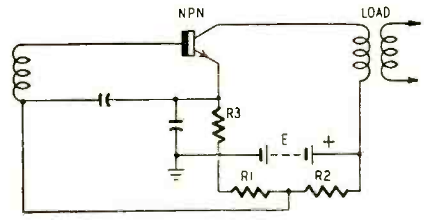
The diagram shows an n-p-n transistor using a single battery of about 4.5 volts. Resistors R1 and R2 divide this voltage so that about 0.5 volt is impressed at the base. R3 is chosen for approximately the same voltage to the emitter. Thus the potential difference between base and emitter is near zero. For an n-p-n crystal, the emitter should be slightly negative.

If the base current is kept small, the emitter current is nearly constant and equal to:

$$I_e = E \frac{R_1}{R_3 (R_1 + R_2)}$$

This also gives the value of collector current.

Temperature effects are minimized by this circuit. A power amplifier may be designed for optimum output without fear that a rise in ambient temperature will damage the crystal.



TV RECORDING

Patent No. 2,682,572

George K. Graham, Oceanside, N.Y.

(Assigned to Radio Corp. of America)

TV broadcasters record their programs on 16-mm motion picture film. A film camera is mounted in front of a special kinescope and the pictures are photographed. A kinescope recording—or more briefly, "kinescope"—does not have the best quality since it is photographed from a scanned TV image. This new invention permits improved quality by using a film camera alongside each TV studio camera. As the director switches from one TV camera to another, he automatically energizes the corresponding film camera.

At the beginning of each scene, the camera number is "fogged" on the film for identification. A relay system also marks on the film the number of the camera that took the previous scene. Thus the separate strips of negative may be spliced in correct order, no matter how many cameras are used for a particular program.

One important matter is the lag between the instant a film camera is energized and the time it reaches synchronous speed. A line is fogged on the film to indicate the exact frame at which the camera reached proper speed. In addition, the camera shooting the previous scene must continue to operate until the succeeding one reaches correct speed.

The sound track is no problem. No matter how many cameras are in use, a single strip of film can record the sound of the entire program.

VOLTAGE MULTIPLIER

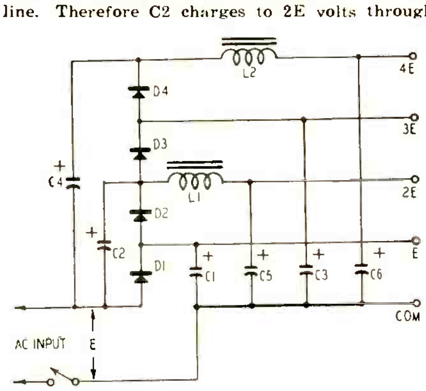
Patent No. 2,682,002

Van R. Gibson, Jr., North Syracuse, N.Y.

(Assigned to General Electric Co.)

No tapped transformers or voltage dividers are found in this circuit, yet it provides for several stepped-up voltages. Each of the available outputs is a multiple of the input.

A quadrupler is shown in the diagram. During the first (positive) input half-cycle, C1 charges to the peak value (E) of the input through D1. During the next negative alternation, D1 blocks, but C1 is in series with the line. Therefore C2 charges to 2E volts through



D2. During the next half-cycle, the line is positive again and acts in series with C2. Therefore C3 is charged to 3E volts through D3. During the fourth alternation, C4 charges to 4E volts through D4. More rectifiers could be added for still greater voltage multiplication.

(Continued on page 124)

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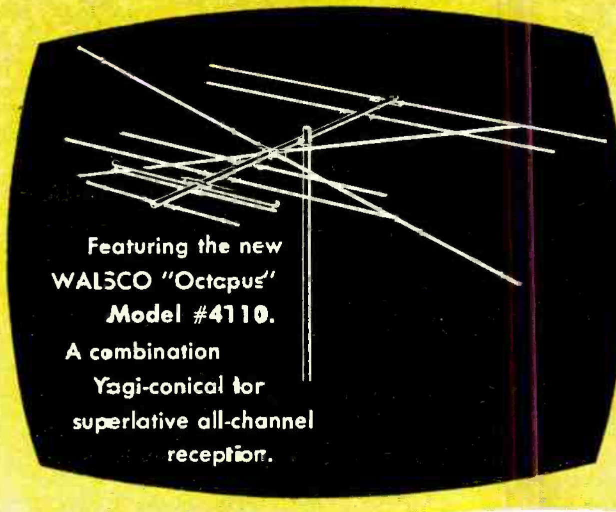

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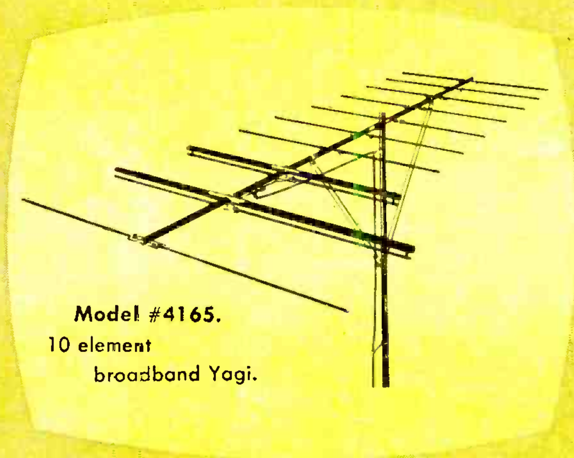

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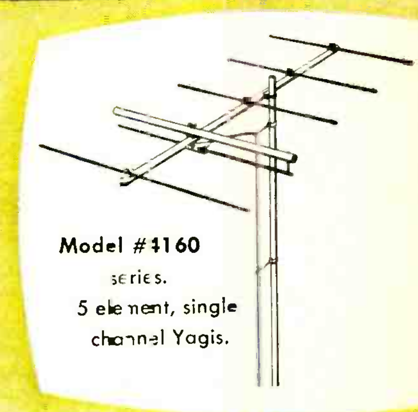

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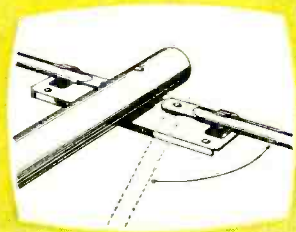

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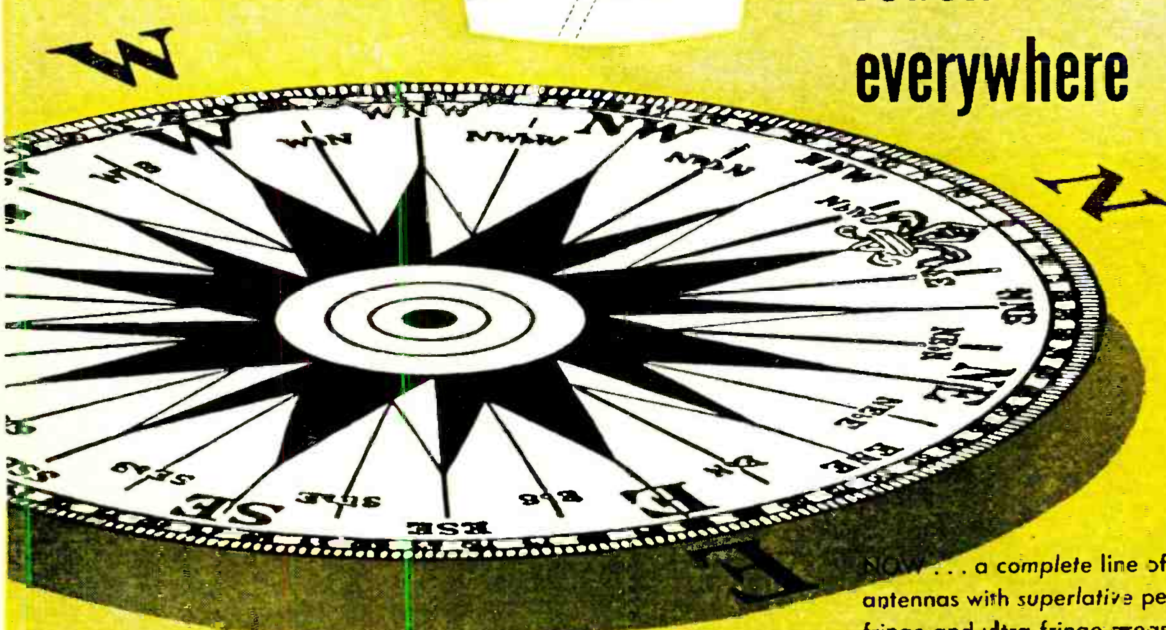

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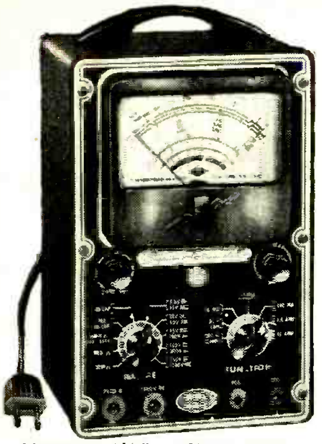


Superior's new Model 670-A

SUPER METER

A COMBINATION VOLT-OHM MILLIAMMETER PLUS CAPACITY REACTANCE INDUCTANCE AND DECIBEL MEASUREMENTS

SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,500 Volts
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
OUTPUT VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes
RESISTANCE: 0 to 1,000/100,000 Ohms 0 to 10 Megohms
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd. (Good-Bad scale for checking quality of electrolytic condensers.)
REACTANCE: 50 to 2,500 Ohms 2,500 Ohms to 2.5 Megohms
INDUCTANCE: .15 to 7 Henries 7 to 7,000 Henries
DECIBELS: −6 to +18 +14 to +38 +34 to +58

Measures 6¼" x 9½" x 4½"

ADDED FEATURE:

Built-in ISOLATION TRANSFORMER reduces possibility of burning out meter through misuse.

The Model 670-A comes housed, in a rugged crackle-finished steel cabinet complete with test leads and operating instructions.

$28.40 NET

Superior's new Model TV-11

TUBE TESTER

SPECIFICATIONS:

★ Tests all tubes including 4, 5, 6, 7, Octal, Lock-in, Peanut, Bantam, Hearing Aid, Thyratron Miniatures, Sub-miniatures, Novals, Sub-minars, 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 TV-11 as any of the pins may be placed in the neutral position when necessary.

★ The Model TV-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.

★ Newly designed Line Voltage Control compensates for variation of any Line Voltage between 105 Volts and 130 Volts.

★ 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.

EXTRA SERVICE — The Model TV-11 may be used as an extremely sensitive Condenser Leakage Checker. A relaxation type oscillator incorporated in this model will detect leakages even when the frequency is one per minute.

The model TV-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover

$47.50 NET

SUPERIOR'S NEW MODEL TV-40

C.R.T. TUBE TESTER

★ **A complete picture tube tester for little more than the price of a "make-shift" adapter!!**

★ **Tests *all* magnetically deflected tubes . . . in the set . . . out of the set . . . in the carton!!**

The Model TV-40 is absolutely complete! Self-contained, including built-in power supply, it tests picture tubes in the only practical way to efficiently test such tubes: that is by the use of a separate instrument which is designed exclusively to test the ever increasing number of picture tubes!

EASY TO USE:

Simply insert line cord into any 110 volt A.C. outlet, then attach tester socket to tube base *(Ion Trap Need Not Be on Tube)*. Throw switch up for quality test . . . read direct on Good-Bad scale. Throw switch down for all leakage tests.

SPECIFICATIONS:

- Tests ALL magnetically deflected picture tubes from 7 inch to 30 inch types.
- Tests for quality by the well established emission method. All readings on "Good-Bad" scale.
- Tests for inter-element shorts and leakages up to 5 megohms.
- Tests for open elements.

Model TV-40 C.R.T. Tube Tester comes absolutely complete—nothing else to buy. Housed in round cornered, molded bakelite case. Only..........

$15.85 NET

SHIPPED ON APPROVAL

NO MONEY WITH ORDER—NO C.O.D.

Try any of the above instruments for 10 days before you buy. If completely satisfied *then* send down payment and pay balance as indicated on coupon. **No Interest or Carrying Charges Added!** If not completely satisfied return unit to us, no explanation necessary.

MOSS ELECTRONIC DISTRIBUTING CO., INC.
Dept. D-76, 3849 Tenth Ave., New York 34, N.Y.

Please send me the units checked. I agree to pay down payment within 10 days and to pay the monthly balance as shown. It is understood there will be no carrying, interest or any other charges, provided I send my monthly payments when due. It is further understood that should I fail to make payment when due, the full unpaid balance shall become immediately due and payable.

Name ....
Address ....
City .... Zone .... State ....

☐ Model 670-A..........Total Price $28.40 $7.40 within 10 days. Balance $3.50 monthly for 6 months.

☐ Model TV-11..........Total Price $47.50 $11.50 within 10 days. Balance $6.00 monthly for 6 months.

☐ Model TV-40..........Total Price $15.85 $3.85 within 10 days. Balance $4.00 monthly for 3 months.

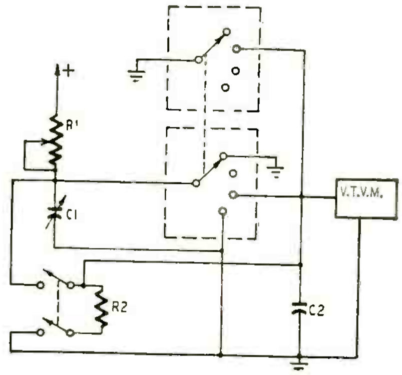
Note that the line in series with C2 carries a pulsating voltage. For example, when E is *positive*, the total is 3E volts. When it is *negative*, the resultant is only E volts. The a.c. component would charge and discharge C5 at line frequency, if it were not for L1. Similarly, L2 blocks a.c. from passing through C6.

ELECTRONIC STOP-WATCH

Patent No. 2,673,956

Joseph G. Beard, Haddonfield, N.J.
(Assigned to Radio Corp. of America)

This timer can measure successive intervals without error. A mechanical stop-watch cannot be used in this way because it must be reset to zero each time. In this circuit the time indication is stored while the next interval is being measured.

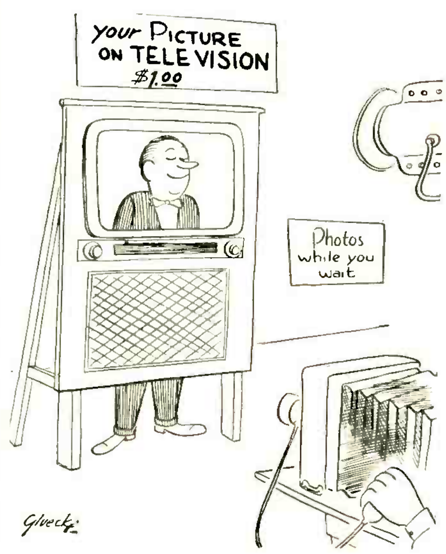


In the position shown in the diagram, C1 is shorted out by the switch. To begin the timing, the switch is moved to its next position, discharging C2, a storage capacitor, while C1 begins to charge through R1 from a d.c. source. At the end of the period the switch is moved another step. This puts C1 across C2 so that part of the charge on the first capacitor is transferred to the second. The voltage across C2 is measured on a v.t.v.m. The indication remains on the meter for a long time because there is no leakage path.

In practice, the ganged switch should remain on the third contact for a very-short predetermined time before moving to the fourth. For quick readings, the v.t.v.m. may be calibrated in terms of seconds, although it actually measures the charge accumulated in a given time.

R2 is a calibrating resistor. When switched across C2 it forms a voltage divider which delivers a known voltage across the v.t.v.m. Thus the voltmeter may be adjusted to its proper setting, for example, full scale.

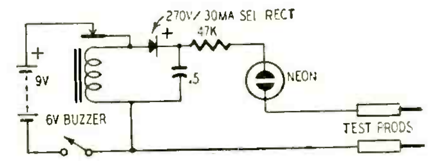
This electronic stop-watch may find a great deal of use in industrial applications such as time study involving stop-and-go manufacturing processes. END



radio-electronic Circuits

CONTINUITY CHECKER

Simple and inexpensive continuity checkers have been made from time immemorial by connecting a small pilot lamp or flashlight bulb and a low-voltage battery in series with a pair of test prods. These devices, suitable for locating shorts and tracing continuity when circuit resistance is low, are not usable when the circuit resistance drops the voltage to the point where the indicator lamp will not light.



In *The Radio Constructor* (London, England), G. A. French describes a combination continuity and capacitor tester that operates from a 6–9-volt dry battery and checks leakage and continuity up to about 10 megohms. High voltage for the neon-lamp indicator is obtained from a vibrator-type supply using a standard 6-volt buzzer as shown in the diagram.

When the circuit is broken by the vibrator, the quick collapse of the magnetic field induces in the coil a voltage many times higher than the battery voltage. This voltage is rectified and filtered and then applied to the neon tester. The brightness of the glow in the tube is determined by the resistance between the test prods.

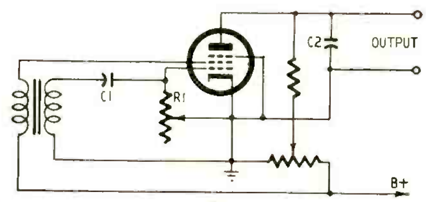
Paper and mica capacitors can be tested for leakage, opens, and shorts by observing the action of the neon lamp. A good capacitor with very high leakage causes the lamp to flash once when the prods are touched to it. Fairly high leakage resistance causes the lamp to flash continuously at a low rate. Compare the flash rate of the capacitor under test with a good capacitor of the same value to determine its quality. Leakage high enough to make the capacitor unusable is indicated when the indicator glows faintly but does not flash. A shorted capacitor causes a bright continuous glow.

A selenium rectifier rated at approximately 270 volts r.m.s. at about 30 ma is recommended for this application. Rectifiers of this type are made by several firms but may not be readily available at radio supply houses. You can substitute two standard 130-volt rectifiers connected in series. The neon lamp should strike at about 80 volts d.c. Try an NE-2 or NE-7.

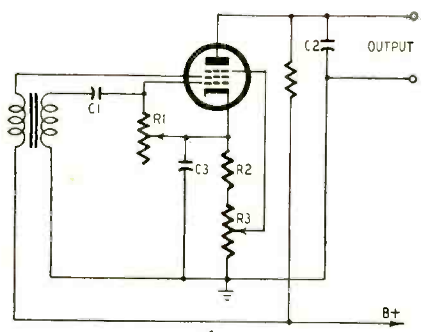
A miniature battery and buzzer will enable you to tuck this instrument into a pocket-size cigarette case.

BLOCKING OSCILLATOR

When a pentode tube is used as a blocking oscillator as at *a* in the illustration, the transformer is usually connected so oscillation occurs between the control grid and the screen grid while the plate controls the action of discharge capacitor C2. In these circuits, the amplitude of the output wave-



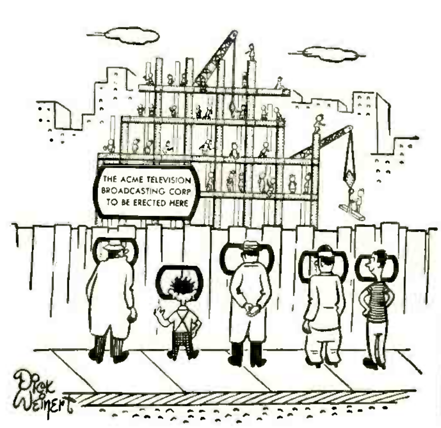
a



b

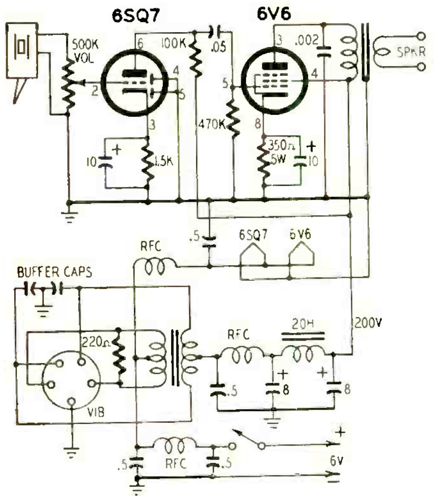
form is usually controlled by varying the plate-supply voltage with a potentiometer. The frequency of oscillation is controlled by the time constant of R1-C1 (the setting of R1). When the suppressor grid is at or near ground potential, the amplitude of the output signal varies with the setting of R1.

The diagram at *b* shows a circuit modification that makes amplitude independent of frequency. In this circuit, described in *Electronic Engineering* (London, England), the amplitude is controlled by varying a bias voltage on the suppressor grid. The bias is developed across R2 and R3. R2 prevents the suppressor from being brought too close to zero bias.



MOBILE PLAYER

Here is a neat little mobile record player that can be used for picnics and for advertising purposes where a microphone is not required. A spring-wound



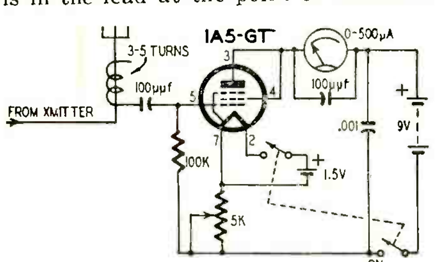
or 6-volt turntable is used. The power transformer and synchronous vibrator may be salvaged from an old auto radio.

The chokes in the 6-volt circuit consist of 30 turns of No. 18 wire on a ½-inch form. Wind two layers on the form—30 turns for each choke. The choke in the B plus lead is a winding from a 455-kc i.f. transformer. These chokes, plus adequate shielding, will minimize vibrator hash and hum.

The system works best with a horn-type speaker.—*Carl Hennig*

V.T.V.M. FOR ANTENNA TUNING

Long-wire antennas and low-powered transmitters are generally used during field-day contests and emergency radio drills. Under these circumstances, it is often difficult to tune the transmitter and match it properly to the antenna. Pilot lamps and r.f. ammeters in the antenna lead often require more current for a usable indication than there is in the lead at the point of insertion.



The solution to this problem is to use a simple battery-operated v.t.v.m. like that described by John Pickard in *Radio Constructor* (London, England).

The unit consists of a triode-connected 1A5-GT with a meter in its plate circuit as shown. The grid is coupled to the antenna lead-in with 3 to 5 turns of insulated wire. The 5,000-ohm bias resistor is adjusted for a deflection of 50-100 μa, then the transmitter is keyed and its tuning controls adjusted for maximum deflection on the meter.

try This one

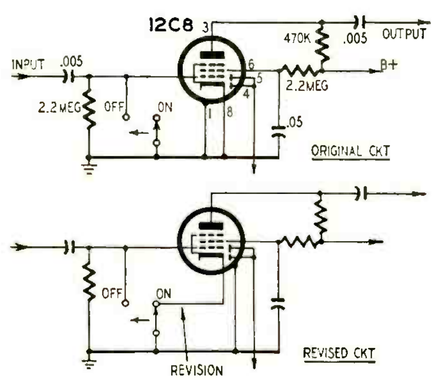
EMERGENCY CAPACITOR

While visiting a friend I was asked to see if I could repair a small portable radio so we could use it on a fishing trip. I found an open coupling capacitor between the arm of the volume control and the grid of the first a.f. stage. A replacement capacitor was not available so I made a coupling gimmick by winding about 3 feet of hookup wire tightly around the lead to the arm of the volume control and connecting the other end to the grid of the tube. The gimmick provided sufficient coupling to restore the volume to a level high enough for use on the trip.—*Bill Kelly*

(When the defective coupling capacitor is from a diode detector it can be bridged to make a temporary repair of the simpler circuits. Do not bridge the capacitor when fixed bias is used on the following grid.—*Editor*)

T-3 SIGNAL TRACER

Hum was objectionable when using my Heathkit T-3 signal tracer to trace audio circuits. Various methods of hum elimination were tried without success. In this kit the pentode section of a 12C8 amplifies the output of the r.f. probe. When the tracer was used for audio work, a switch was closed to short the grid to ground. Hum disappeared when this tube was removed from the circuit.



The HIGH GAIN switch in my particular kit has an extra lug which connects to ground in the ON position and is removed from ground in the OFF position. By connecting the cathode to this lug as shown in the revised schematic, I was able to eliminate the hum. The metal envelope of the tube (pin 1) must remain connected to ground, as this reduces the possibility of the tube

AMERICA'S MOST DEPENDABLE ROTATOR

THE TRIO
"ARISTOCRAT"

NOW . . .
America's most beautiful!

The sleek, modern, low silhouette of the new TRIO rotator control case marks a new high in styling.

Beauty, here, is more than skin deep since its low center of gravity makes it tip-proof! Note, too, that there are NO unsightly control knobs or switches to spoil its beauty. These are located at top rear of case — where your hand naturally rests in operation of rotator! There is no obscuring the easily-read lighted dial. Available in either blonde or mahogany, the unit with its graceful flowing lines blends perfectly with any decor.

Yes, America's most dependable rotator is now America's most beautiful as well!

Switch and directional controls are located at top rear of case for most convenient manual operation. Lighted dial permits operation in darkened room and also indicates when rotator is on. When on, pointer always shows exact position of antenna.

✔ Only Rotator With Two Motors

✔ Only Rotator With Two-Year Guarantee

THE TRIO
"ARISTOCRAT"
. . . CULMINATION OF SIX YEARS RESEARCH AND PRODUCTION

TRIO *Manufacturing Co.*
GRIGGSVILLE, ILLINOIS

picking up stray noises while the cathode circuit is open.

On some kits a replacement switch may have to be used, but this should not be difficult to locate in the inevitable box of spare parts around any shop. The improved performance will more than justify the small amount of time and effort expended.—*Francis J. Stifter*

CALIBRATING A V.T.V.M.

After assembling my v.t.v.m. kit I found that I could not expect better than 5% accuracy on the a.c. range because of possible variations in the line voltage applied to the transformer used to deliver calibration voltages. To combat this, I made an octal plug and obtained my test voltages from a tube tester with the line voltage control adjusted to set the meter to the calibrate point. The d.c. scale was calibrated with two new dry cells connected in series to read 3.1 volts on the 5-volt scale.

This idea is also useful for recalibrating the v.t.v.m. after replacing critical tubes.—*E. F. Sharp*

IMPROVED MIKE STAND

Often when the microphone is removed from an adjustable stand, the inner tube slides down and damages the connector or slips all the way down into the outer tube. Drill a 1/16-inch diameter hole about 2 inches below the threaded part of the inner tube and screw in a No. 6 self-tapping screw. The screw is small enough to be inconspicuous and large enough to prevent the inner tube from sliding down too far.—*Hart Webber*

NUTS IN SMALL CHASSIS

Do you have trouble starting small nuts in crowded or inaccessible parts of a chassis? If so, try this method: Put a drop of service cement on the tip of your forefinger and let it set a few seconds, then place the nut in it. The cement holds the nut securely enough for you to start it on the screw. —*H. C. Harris*

HANDY WIRE STRIPPER

A large alligator clip makes an efficient and economical wire stripper for plastic-covered wire. Fasten the clip to your workbench with one jaw flat against the top and the stripper is ready for use. Open the jaws and feed the wire into the "snout." Allow the jaws to close; if the spring is not strong enough, press down on upper jaw with finger. Pull wire straight out, and insulation will be stripped off.—*Clarence C. Lewis*

"REALIGNMENT SOLVENT"

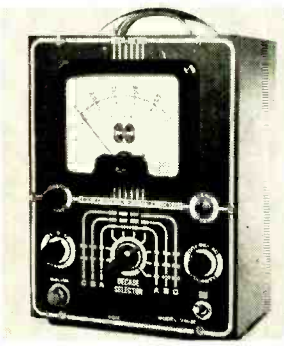
To keep i.f. transformers from detuning many manufacturers seal the slug with glyptal or some type of cement. When realignment is necessary, a few drops of solvent must be used to loosen the glyptal. I have found that lacquer thinner or amyl acetate (banana oil) does the job nicely.—J. Kane

END

new Devices

DECADE V.T.V.M.

American Scientific Development Co., 334-336 So. Main St., Fort Atkinson, Wis., is producing its new model VM-30 *Deca-Meter*, a v.t.v.m. with 30 cascaded ranges in 10-volt steps to 100 volts, 50-volt steps to 500 volts, and 100-volt steps to 1,000 volts. Assuming that the range selector is set for 10-volt steps and

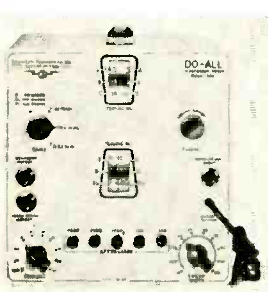


the decade switch is set to 90 volts, an input of 90 volts will read zero on the meter. Voltages between 90 and 100 are spread across the scale. The voltage indicated on the meter must be added to the voltage setting of the decade selector to get the true value of voltage.

The instrument has an 11-meghom input resistance, a polarity reversal switch, and a full-wave 6AL5 rectifier for r.m.s. measurements. The circuits are voltage-regulated to minimize drift and the effects of line-voltage fluctuations.

SWEEP GENERATOR

Radio City Products Co., Inc., Easton, Pa., has introduced a new all-electronic sweep generator which is designed for both color and black-and-white television. The unit, model 780, can also be used in servicing FM, AM, and communications equipment. Its range is from 3.2 to 900 mc.



TUBE CHECKER

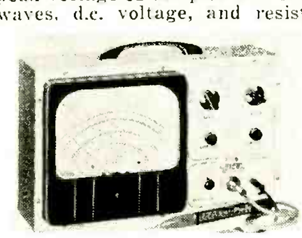
Television Engineers, Inc., 311 E. 79th St., Chicago 19, Ill., has introduced a *Vis-U-All* tube checker designed for testing over

300 television and radio tubes, including battery tubes. It weighs 10 pounds, measures 15 x 12 x 6 inches, and is built into a brown leatherette carrying case. In addition to checking the individual sections of multisectional tubes, the checker tests separately for grid-to-cathode and heater-to-cathode shorts, as well as providing a gassy short test.

NEW V.T.V.M.

Electronic Instrument Co., Inc., 84 Withers St., Brooklyn 11, N. Y., has announced a new peak-to-peak vacuum-tube voltmeter, model 249, with a 7½-inch meter. It is available in both kit and wired form.

The instrument reads peak-to-peak voltage of complex and sine waves, d.c. voltage, and resist-



ance. It provides for center-scale zero adjustment for TV and FM alignment and for calibration from outside the cabinet.

The d.c. voltmeter ranges are: 0-1.5, 5, 15, 50, 150, 1,500 volts. The a.c. voltmeter ranges are r.m.s. values and are the same as the d.c. ranges. The peak-to-peak readings of sine and complex waves are: 0-4, 14, 42, 140, 420, 1,400, 4,200 volts. There is a separate scale for 0-1.5 volts r.m.s. and corresponding 0-4-volt peak-to-peak ranges. The frequency response is 30 cycles to 3 mc, and the ohmmeter measures 0 to 1,000 megohms in seven ranges.

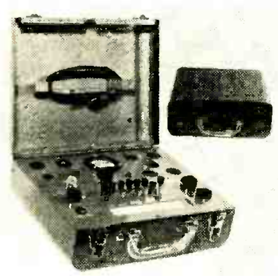
OSCILLOSCOPE CALIBRATOR

Service Instruments Co., 422 Dearborn Street, Chicago, Ill., is now manufacturing an oscilloscope calibrator for measuring peak-to-peak voltages. The system employed is a comparative method by which the line voltage is calibrated and compared in amplitude to the unknown waveform on the scope.

Two mounting bars are provided so that the meter can be permanently connected to the scope. When the meter is turned off, the input is connected "straight through," and the unknown waveform is applied directly to the scope input.

AUTO RADIO TESTERS

D. W. Thomas Engineering, Inc., 1820 W. 54th St., Los Angeles, Calif., has announced a new tube and vibrator tester, model 1402, for automobile radio servicing which operates from either 6 or 12 volts d.c., and a novel battery eliminator, model 1400. Although the two are designed to operate as a single



unit, the tube tester may be used independently. It works directly from the power supply of an automobile through a plug inserted into the cigarette-lighter socket.

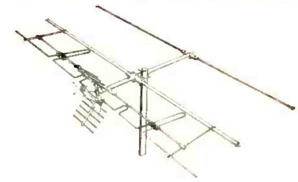
The battery eliminator is powered by 115 volts 60 cycles for bench testing of all types of automobile radios and contains a variable transformer so that the voltage output is continuously variable from 0 to 15, at 10 amperes.

27-INCH CHASSIS

Transvision, Inc., 460 North Ave., New Rochelle, N. Y., is now marketing a 27-inch chassis with aluminized tube, containing remote-control and dual sound systems. Special alignment procedures insure 4-mc bandwidth, and the keyed a.g.c. circuit minimizes interference from outside noise. An 18,000-volt second-anode supply insures optimum picture brightness.

NEW ANTENNA

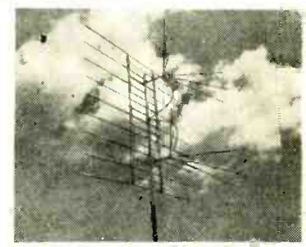
Alliance Manufacturing Co., Lake Park Blvd., Alliance, Ohio, has introduced the *Monolober*



antenna, available in single or double bay. A feature of this unit permits the gain of a v.h.f. antenna to be added to that of a u.h.f. antenna.

ANTENNAS

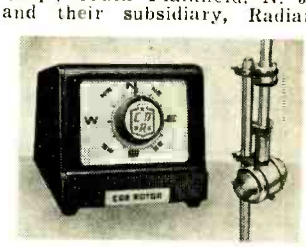
Telrex, Inc., Asbury, N. J., has announced the new *King Pin* Conical-V-Beam single-bay and two-bay screen arrays—models 201 and 202.



The two-bay array was designed for fringe area reception. Its gain is 7½ to 8½ db on the low v.h.f. channels; 15 to 17 db on the upper v.h.f. channels. Through the use of Conical-V-Beam dipoles, a uniform match is obtained to 300-ohm standard or 200-ohm low-loss line over the entire band over which the antenna operates.

AUTOMATIC ROTOR

Cornell-Dubilier Electric Corp., South Plainfield, N. J., and their subsidiary, Radiart

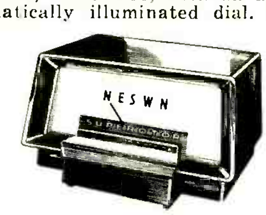


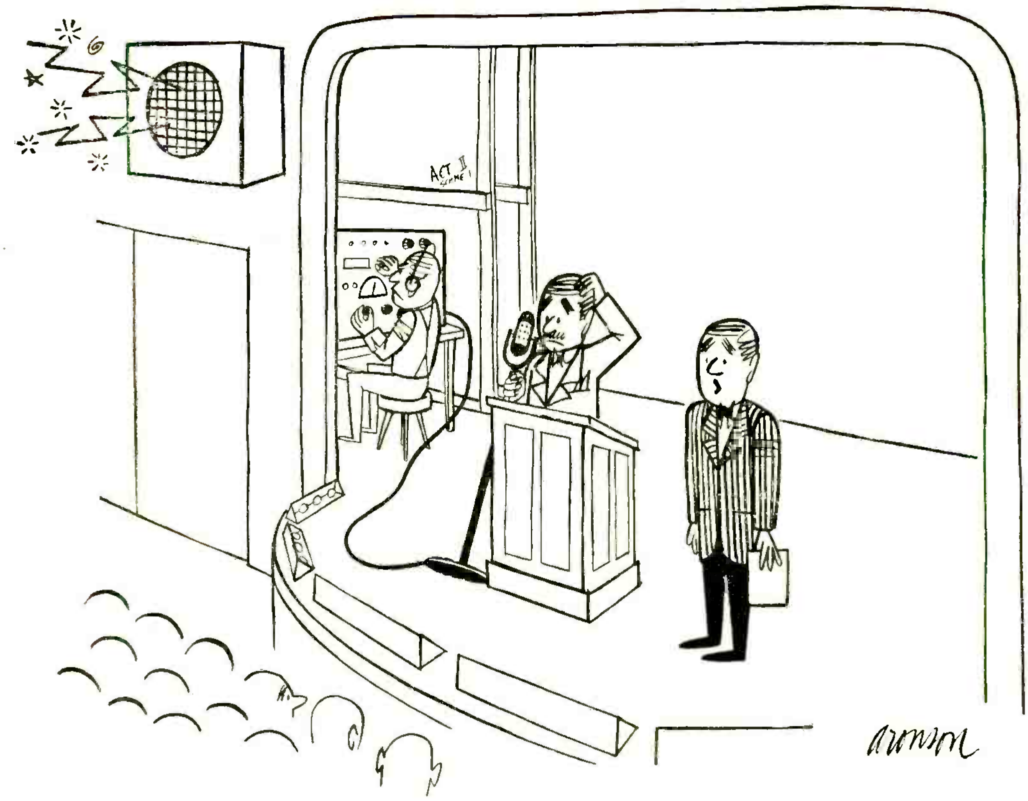
Corp., 3455 Vega Ave., Cleveland, Ohio, have put out an automatic rotor using 4-wire cable. It is housed in a plastic cabinet. Model AR-2 includes a thrust bearing, and model AR-1 is for ordinary installations without a thrust bearing.

Both of the above models have a mechanical brake that is released magnetically.

ANTENNA ROTATOR

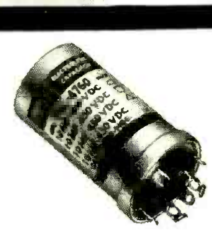
Leader Electronics, Inc., 2927 E. 55th St., Cleveland, Ohio, has announced a new antenna rotator, model 500, with an automatically illuminated dial. The





IS THERE A SPRAGUE CAPACITOR IN THE HOUSE?

Don't Be Vague...Insist on SPRAGUE

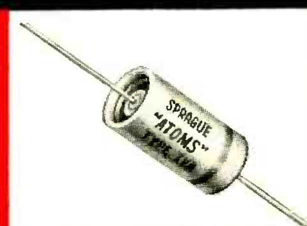


Insist on Sprague
TWIST-LOK☆ 'LYTICS

Sprague TVL's fill the top performance bill in the toughest TV circuits. High temperatures, surge voltages, ripple currents won't faze them. Like all Sprague capacitors, Twist-Lok 'Lytics are your first line of defense against expensive call-backs.

Insist on Sprague
TEL-OHMIKE®

This capacitor-resistor analyzer is the handiest instrument you can buy! Moderately priced for radio and TV repair shops, the Model TO-4 Tel-Ohmike offers top quality and accuracy for every service need. Priced so you can afford it at **$73.50 NET**



Insist on Sprague
ATOMS®

The smallest TV 'lytics made—and the only small ones for 85°C (185°F) up to 450 volts d-c. Guaranteed for low leakage and long shelf life, they withstand high temperatures, high ripple currents, high surge voltages. From crowded TV chassis to jam-packed portables, Sprague Atoms fit 'em all.

Accept no substitutes. There is a Sprague Distributor in every sales area in the United States. Write for the name of your nearest source of supply today.

☆ Trademark

Get your copy of Sprague's latest radio and TV service catalog C-610. Write Sprague Products Company*, 105 Marshall St., North Adams, Mass.

Distributors' Division of Sprague Electric Company

SPRAGUE

WORLD'S LARGEST CAPACITOR MANUFACTURER

face lights when the rotator is in operation and shuts off when the tuning has been completed. A new control box features vernier precision tuning.

NEW TOWER

Rohn Manufacturing Co., 116 Limestone, Bellevue, Peoria, Ill., announces a new No. 6 tower suitable for home TV installation and other communication requirements. This tower is self-supporting to 50 feet in height or guyed to 150 feet. It features a 12½-inch triangular design with heavy-duty corrugated cross bracing which utilizes mass production machinery.

U.H.F. CONVERTER

Fenton Co., 15 Moore St., New York 4, N. Y., is now distributing the new *Fen-tone* model Cl u.h.f. converter for continuous tuning of channels 14 through 83. The unit uses a high-pass filter input circuit, a germanium diode mixer, and a 6AF4 oscillator tuned by silver-

plated parallel lines. The input and output impedances are 300 ohms. The converter is factory-set for 82-mc output on channels 5 and 6 but any vacant channel can be used by shifting the tuning knob the difference between 82 mc and the frequency of the channel selected as the i.f.

The 9 x 5¼ x 5¾-inch metal cabinet is topped by an illuminated 7¾ x 7¾ x 3¾-inch glass brick that can be used as a lamp, plant vase, or illuminated aquarium. Power consumption from 110–125-volt, 60-cycle lines is 5 watts for the converter alone and 7.5 watts for the lamp.

NEW ANTENNA MAST

JFD Manufacturing Co., 6101 16th Ave., Brooklyn, N. Y., has announced a new telescoping television antenna mast, *Aluzoom*. The top section has an outside diameter of 1½ inches. The wall thickness is .056 inch.

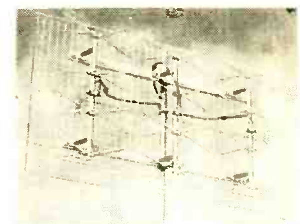
The top 6 inches is shaped to fit all rotators.

This aluminum mast is one-third the weight of steel masts, making it easier to handle and install.

U.H.F. ANTENNA

Technical Appliance Corp., has announced a new u.h.f. antenna, *Super 12*, that comprises 12 open bowtie driven elements plus a large screen reflector. Driven elements are connected in parallel to a common terminal panel, while the individual 4-bay arrays are driven in series-parallel for perfect polarization. The reflector screen is made in one piece folded at the center.

The *Super 12* shows a voltage gain of approximately 18 db over the v.h.f. spectrum. Directivity is sharp, varying between 5° to 10°, depending upon frequency of operation. Front-to-back ratio is high.



NEW FLYBACKS

The Stancor Division of the Chicago Standard Transformer Corp., Addison and Elston, Chicago, Ill., has announced the addition of six new flybacks for Muntz, RCA, Airline, and Sentinel—A-8242, A-8243, A-8244, A-8245, A-8246, and A-8247.

NEW AMPLIFIER

Newcomb Audio Products Co., 6824 Lexington Ave., Hollywood 38, Calif., has announced a new *Compact 12* amplifier. It combines a 12-watt amplifier, preamplifier, and control unit. Separate bass crossover and treble roll-off controls provide up to 36 basic playback curves.

Distortion in the *Compact 12* is below 1% at 12 watts, and frequency response is within ±1 db from 20 to 20,000 cycles. Seven inputs include radio, microphone, high-output magnetic pickup, low-output magnetic pickup, crystal pickup, tape input and auxiliary or TV. A new tape output jack allows recording while listening. A six-position selector offers the choice of various recording curves.

AUDIO CONTROL CENTER

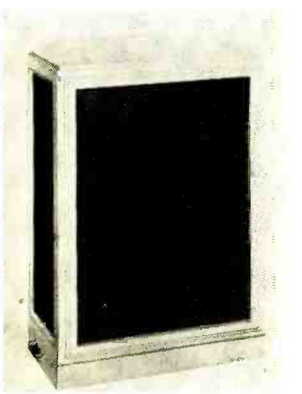
Brociner Electronics Laboratory, 344 E. 32nd St., New York 36, N.Y., has announced the Mark 30C audio control center. It is a self-powered preamplifier that provides complete facilities for selection of radio, TV, tape, or phonograph inputs, separate turnover and roll-off controls for record compensation; continuously adjustable bass and treble controls providing boost and cut, and a loudness control.

Either of two phonograph inputs may be used. One is provided with a sharp-cutoff, high-pass filter of the feedback type for rumble suppression. An adjustable rear-panel control permits correct termination of any phono pickup. A tape take-off jack is mounted on the rear apron.

Negative feedback circuits reduce IM distortion to less than 0.1% for outputs as high as 4 volts. The output stage is a feedback type and has the low-impedance feature of the conventional cathode follower, but with marked improvement in distortion figures.

JENSEN CABINETS

Jensen Manufacturing Co., 6601 So. Laramie Ave., Chicago, Ill., is making two back-loading cabinets for 12-inch (model BL-220) and 15-inch (model BL-250) speakers. The cabinets have been designed with an eye to flexibility in mounting coaxial or triaxial speakers, mid- and high-frequency units and woofers, tweeters or supertweeters in any desired combination without changes to the cabinets.

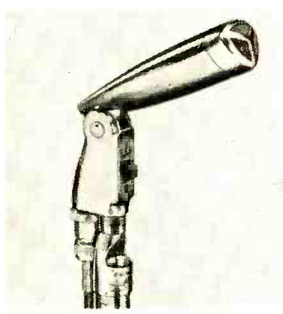


They may be fitted into a corner or placed against a wall.

These units were erroneously described under incorrect model numbers—one of them a superseded model—in our September issue.

MICROPHONE

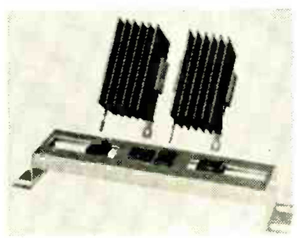
Electro-Voice, Inc., Buchanan, Mich., has introduced a new model 623 slim-design general-purpose dynamic microphone. It can be used indoors and outdoors for public address, home recording, paging, and radio amateur communications.



The 623 can be used on a stand or in the hand. Its frequency response is 60 to 11,000 cycles, and its output level is −55 db.

RECTIFIER CHASSIS

Sarkes Tarzian, Inc., 415 No. College Ave., Bloomington, Ind., is now making available to distributors a simple conversion unit that when installed on a chassis will permit the use of the firm's plug-in selenium rectifiers. This simplifies replacement of rectifiers and eliminates removing the chassis and soldering.



FOUR-WAY TUBE TOOL

General Cement Manufacturing Co., Rockford, Ill., has announced a *4-in-1 Tube Gadget* made of plastic and rubber. This unbreakable tool has four functions—pin straightening for 7- and 9-pin tubes, tube pulling, and tube tapping.

TUBE BRIGHTENER

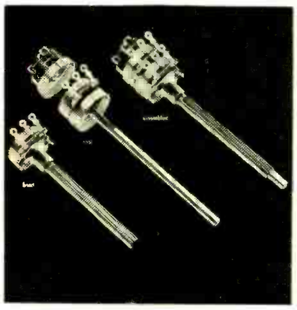
C-B-C Electronic Co., Inc., 1310 Callowhill St., Philadelphia 23, Pa., has announced a new *Picboost* television picture-tube brightener model UB.

This unit will restore brightness to dim picture tubes in any television receiver, whether series or parallel wired, a slide switch on the cap of the unit giving the technician the type of heater connection he needs. The transformer is a heavy-duty type drawing negligible current.

REPLACEMENT SYSTEM

Centralab, a division of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis., has introduced a new *Fastatch* system of dual concentric-control replacements which eliminates the problems of finding a special control. The rear unit, complete with inner shaft, has been separated from the front unit, complete with the outer shaft, so that the shafts can be cut to the proper length. Then the units snap together.

The number of controls in the new system is limited to the differences in resistance and taper—a total of 61 fronts and 65 rears instead of more than 500 custom units. These 126 controls, making 4,000 possible combinations, will handle any carbon dual replacement in TV now and the great majority of future units including color.



INSULATING COMPOUND

Insl-X Sales Co., 26 Rittenhouse Square, Ardmore, Pa., has announced a new dielectric, abrasion-resistant insulating compound for tools and equipment.

Designated E-33, the new compound is chemically inert, will not corrode or injure any equipment to which it is applied, nor will it be damaged by exposure

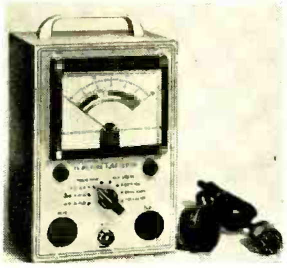
to oils, greases, ordinary acids or alkalis.

Items to be protected with E-33 need only to be dipped into the compound, permitted to drain and dry—a 15-minute operation. Three coats an hour apart are recommended for 110-220-volt exposure. The dielectric strength (dry) is 1,200 to 1,500 volts per mil, the approximate thickness of one dip coat.

TUBE TESTER

Boland & Boyce, Inc., 236 Washington Ave., Belleville 9, N.J., has announced a new picture-tube and TV-receiver tester that checks all magnetically deflected black-and-white or color tubes under actual receiving conditions. The model 701 picture-tube tester is available in kit form or factory-wired. The complete assembly, including a 4½-inch, 100-microampere Simpson meter, is housed in a steel carrying case 9 x 6 x 5 inches.

In operation, the socket is disconnected from the base of the picture tube and inserted into the tester by a cabled adapter cord. A second adapter cord connects between meter and picture tube. With the receiver turned on, accurate measurements are rapidly made of the current and voltages applied to any tube element. Quantitative and qualitative tests include: grid to cathode, heater to cathode, and grid to screen leakage; grid-cathode voltage from receiver; receiver d.c. screen and video-signal output voltages.



FLYBACK TESTER

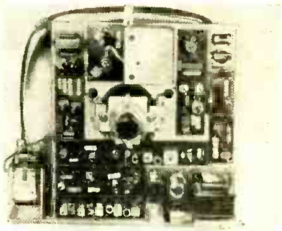
TeleTest, Inc., 30-01 Linden Place, Flushing, L.I., N.Y., has introduced a new portable and compact flyback tester which tells exactly what condition any flyback is in, testing good flybacks as well as showing if one bad. It also checks yokes, width coils, and linearity coils for shorted turns.

TV CHASSIS

Walsco Electronics Corp., 3225 Exposition Place, Los Angeles 18, Calif., has introduced a new printed-circuit TV chassis, model PC-9, containing 25 tubes. Using nine circuit units printed on removable plastic strips, the usual 2,900 hand-soldered connections have been reduced to only 56.

The motor-driven remote control automatically finds the channel and locks in the best balanced picture and sound.

Only the volume and channel knobs are exposed. END



All specifications given on these pages are from manufacturer's date.

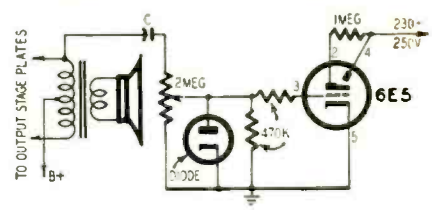
Question Box

A.F. LEVEL INDICATOR

I would like to have the circuit of a 6E5 or similar tube as an output level indicator for audio amplifiers and different types of recorders.—E. W. S., Central Islip, N. Y.

The circuit of a simple level indicator is shown. A portion of the signal voltage in the plate circuit of the output stage is rectified and used as negative bias on the indicator tube. The rectifier may be a germanium diode or any convenient vacuum tube.

Coupling capacitor C should have a rating of at least 600, preferably 1,000 or 1,500 volts. Use the largest value of capacitance that you can without



noticeably reducing high-frequency response.

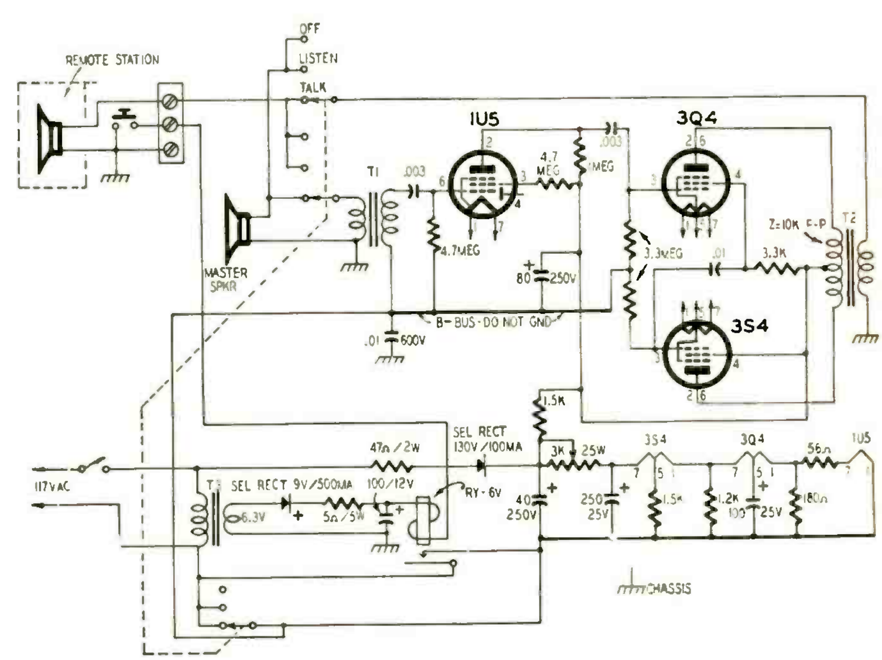
QUICK-HEATING INTERCOM

I want to construct an intercom using battery type tubes so it can be turned off until needed and yet be ready for operation as soon as a switch is thrown. I would like to use a 1H5-GT and push-pull 3Q5-GT's or equivalents and want the remote station to be able to signal or preferably originate a call to the master.—F. G. M., Billings, Mont.

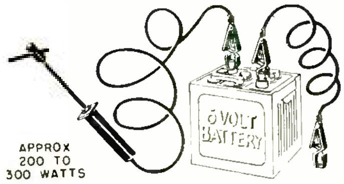
This circuit is a modification of one that appeared in the September, 1948, issue, now out of print. With it the remote station originates a call by pressing a push-button or normally open lever switch. This switch operates a 6-volt d.c. relay whose contacts connect one side of the line to the filament and plate supply rectifier.

A 3S4 and 3Q4 are used in push-pull to simplify the problem of supplying bias. The grid bias is the voltage difference between the control grid and the negative end of the filament (pin 1). Pin 1 of the 3S4 is about 7.5 volts above ground and pin 1 of the 3Q4 is about 4.5 volts above ground, so both have correct bias.

There is a slight difference in the optimum plate load impedances of the 3S4 and 3Q4 but this should not affect the quality or output. Signal voltage for the grid of the 3S4 is obtained from the screen circuit of the 3Q4. For optimum performance you can vary the value of the 3Q4 screen resistor for



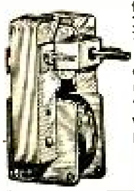
6 VOLT BATTERY SOLDERING IRON AND WELDER



U.S. Army release. Brand New—Never Used. Fully Guaranteed. This soldering iron can be used to solder or weld when connected to any six-volt storage battery. Uses approximately 200 to 300 watts. The high intensity arc created between the metal to be soldered and the carbon electrode (carbons supplied free with iron) can be used to heat tin or aluminum solder. Suitable also for light brazing and spot welding. Arc can be used for melting metals, cutting holes and soldering seams in chassis. Also useful for analyzing metals and minerals.

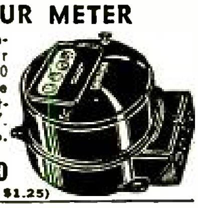
Battery soldering iron outfit includes 2 carbons, 3 heavy duty spring clips, 2 pieces 5 ft. heavy duty wire cable. (Battery not included.) Ideal for use where current is not available. Ship wt. 4 lbs. **$1.95**
ITEM NO. 126
UNUSUAL BUY ....(Shp. Chgs. 40¢)

POWERFUL ALL PURPOSE MOTOR



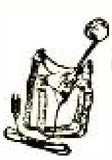
Sturdy shaded pole A.C. induction motor. 15 watts, 3000 rpm. 3"x2"x1¾"; 4 mounting studs; ⅞" shaft, 3/16" diameter; 110-120 volts, 50-60 cycles. A.C. only. When geared down, this unit can operate an 18" turntable with a 200 lb. dead weight. Use it for fans, displays, timers and other purposes. Ship wt. 2 lbs. **$2.45**
ITEM NO. 147
UNUSUAL BUY (Shp. Chgs. 35¢)

WATTHOUR METER



Leading makes—reconditioned. Ideal for trailer parks. 100-110 volts, 60 cycles, 2-wire A.C. 5 amp. Heavy metal case 8½" x 6¼" x 5". Easy to install. Ship. wt. 14 lbs. **$4.50**
ITEM NO. 33
NOW ONLY (Shp. Chgs. $1.25)

WESTERN ELECTRIC BREAST MIKE



Lightweight 1 lb. carbon microphone. Aircraft type. Breastplate mounting, adjustable 2-way swivel. Easily fastened straps. For home broadcasts, communications etc. Complete with 6 foot cord, hard rubber plug. Sheradized plate, non-rusting finish. Ship. wt. 2 lbs. **$1.98**
ITEM NO. 152
NEW LOW PRICE (Shp. Chgs. 32¢)

AMAZING BLACK LIGHT

250-watt ultra-violet light source. Makes fluorescent articles glow in the dark. Fits any lamp socket. For experimenting, entertaining, unusual lighting effects. Ship. wt. 2 lbs. **$2.45**
ITEM NO. 87
A SAVING AT (Shp. Chgs. 35¢)

250 POWER TELESCOPE LENS KIT

Make your own high powered 6 ft. telescope! Kit contains 2" diam., 75" focal length, ground and polished objective lens and necessary eye pieces. Magnifies 50x to 250x. Full instructions. Ship. wt. 1 lb. **$2.95**

ITEM NO. 123
YOU SAVE AT (Shp. Chgs. 10¢)

HUDSON SPECIALTIES CO.
25 West Broadway, Dept. RE-11-54
New York 7, N. Y.

I am enclosing full remittance for items circled below. (Be sure to include shipping charges.)

OR, my deposit of $......... Ship balance C.O.D. MINIMUM C.O.D. ORDER $5.00.

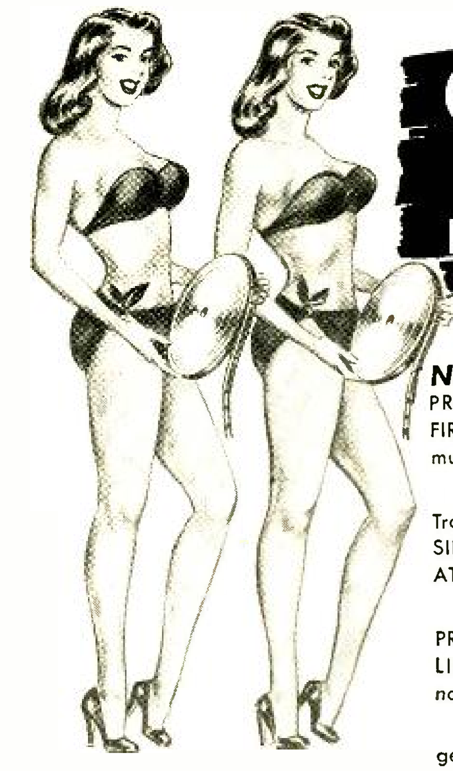
C.O.D. ORDERS ACCEPTED ONLY WITH 20% DEPOSIT INCLUDE SHIPPING CHARGES.

Circle Items Wanted
87 147 33 152 126 123

Name ....
Please Print Clearly

Address ....

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



GOODLINE *is Virgin* POLYETHYLENE

Now—SILICONE "WETPRUF"® PROCESSED, ANOTHER GOODLINE FIRST, Extends useful wet service life as much as 400%.

ALL GOODLINE Low Loss Television Transmission Lines are now especially SILICONE PROCESSED to repel moisture AT NO INCREASE IN COST TO YOU.

Your distributor has these SILICONE PROCESSED, WATER REPELLENT GOODLINE TRANSMISSION LINES in stock now — ready for you . . .

Ask for them by name. Insist on these genuine GOODLINE "WETPRUF" TELEVISION LINES.

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GOODLINE SHEATHLEED — 812 GS & 823 GS **GOODLINE TELEAD**

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Get samples "in your hands"
—you'll realize why
Don Good Products make
the finest television
reception possible.

1-20

DON GOOD, INC.
1014 Fair Oaks Ave., So. Pasadena, Calif.
Please rush Samples and Complete Information covering Don Good Products.

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Street ______________________

City ______________ *State* ________

Floritone EXTENSION SPEAKER
"CONTROL AT YOUR FINGERTIPS"

The extra "personal" speaker for your TV—a "must" for the "hard of hearing" and the utmost in luxurious listening pleasure for every TV or radio owner. 4 in 1 switch controls either speaker—both speakers—or shuts off sound. Easily installed and lists for only $14.95.

Dealers and distributors, write for liberal discount information.

SAMPLE **$10.00**
(Dept. R.E.)

SOOTIN'S, INC.
321 NW 3rd Ave., Miami 36, Fla.

UHF COIL BOARDS

(Standard Coil Product)

$2.50 per set
Postage prepaid

- Small lot orders OK (Minimum order—12 sets)
- Servicemen—a real buy while they last!

CHANNELS (Types Q, K, F/G)

18	23	27	46
20	21	29	56
21	26	34	

- ***Enclose check with order. No C.O.D.'s***

Send to: **Pacific Mercury Sales Corp.**
8345 Hayvenhurst Ave.
Sepulveda, Calif.

equal signal voltages on the control grids.

When putting the unit into operation for the first time, set the 3,000-ohm, 25-watt resistor so its full resistance is in the circuit. Then gradually reduce the resistance until there is 9.8 volts between pin 7 of the 3S4 and the B-minus bus.

If the stations are reasonably close together, you can use standard 3–5-ohm PM speakers. T1 may be a 25,000-ohm plate-to-voice-coil transformer with the primary in the grid circuit and T2 a standard output transformer to match the speakers to a plate-to-plate impedance of about 25,000 ohms. If the run between stations is fairly long, use 40-50-ohm speakers and output and input transformers to match. T3 is a 6.3-volt filament transformer.

AMPLIFIER CONVERSION

I like the performance of the low-cost amplifier in the Question Box of the February, 1954, issue, so I'd like to construct another using push-pull power amplifiers for more output. Please show the necessary circuit changes.—R. B. D., Tacloban, Leyte, P. I.

Push-pull power amplifiers with three different methods of phase inversion are shown. The diagram at *a* is self-explanatory. It shows the tone controls and a vacuum-tube phase inverter.

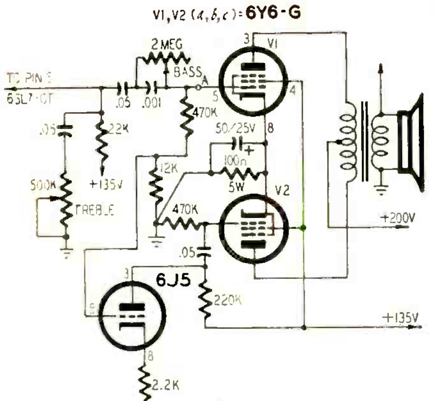
The circuits at *b* and *c* use tubeless phase inversion. The tone controls are not shown. Point A is a common reference on the three diagrams. In circuit *b*, the input signal is fed directly to the grid V1. Its screen current varies about 7 ma between zero input and full-signal input and produces an out-of-phase audio voltage across the 1,800-ohm screen resistor. This voltage is tapped off and fed to the control grid of V2. For best results, adjust the value of the screen resistor for equal signal voltages on the control grids.

The circuit at *c* produces phase inversion by autotransformer action. The signal on the grid of V1 flows to ground through the upper half of the audio choke and produces an out-of-phase voltage of equal amplitude in the lower half to drive V2.

The choke should be a center-tapped type with an inductance of at least 10 henries. You can use the primary of a push-pull output transformer that is designed to work with a plate-to-plate load of about 14,000 ohms.

The power-supply requirements are

Interest in the Question Box, as indicated by letters received, is not high, and the question has arisen as to whether the space might not be better devoted to other subjects. What do our readers think? Should we: (1) continue the Question Box as is; (2) discontinue it; or (3) substitute some other material, and if so, what? Please mail your vote to Question Box, Radio-Electronics, 25 West Broadway, New York 7, N.Y.



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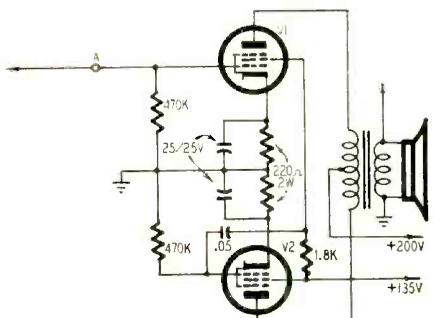

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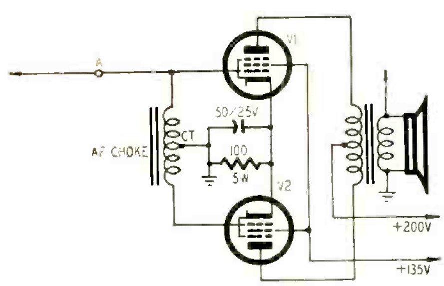


c

nearly doubled by the addition of the second 6Y6-G, so the power transformer should be able to supply at least 160 ma. END

Radio Thirty-Five Years Ago

In Gernsback Publications

HUGO GERNSBACK *Founder*	
Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some of the larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

In November, 1920 Science and Invention (formerly *Electrical Experimenter*)

The Belin System of Telephotography
300-K.V.A. Transmitter at Bolinas, Calif. by Allan C. Forbes, Assoc. I.R.E.
The Audion in a New Rôle
Simplest Long Wave Receiver (Part II), by Elliott A. White
New Radio License Rules at New York

Business

Merchandising and Promotion

General Cement Manufacturing Co., Rockford, Ill., is planning to launch a stepped-up advertising and promotional campaign next year in celebration

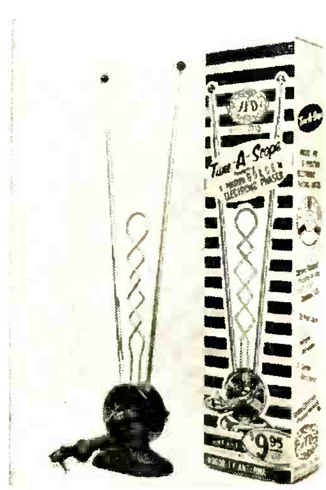
Art director D. Rice points out artwork details to General Cement executives.

of its 25th anniversary which occurs January 6, 1955. Paul J. Steffen Co., Chicago, the company's advertising agency, is working out the details of the campaign.

Pyramid Electric Co., North Bergen, N. J., developed a new 6-month inventory record and interchangeability chart for distributors who handle its capacitors. The chart gives Pyramid's equivalent for capacitors manufactured by other companies as well.

Radio City Products, Easton, Pa., designed a new point-of-sale display to aid distributors in promoting the sale of its recently issued model 480 universal multitester.

JFD Manufacturing Co., Brooklyn, N. Y., is now packaging its *Tune-A-Scope* v.h.f./u.h.f. indoor TV antenna in a colorful new container. The company also announced that its chief antenna engineer, Doug Carpenter, had traveled 87,000 miles during the past year conducting antenna tests and lectures



BUSINESS *(continued)*

throughout the U. S. and Canada. JFD will continue this informative program to aid distributors and dealers in selling its products.

RCA Tube Division, Harrison, N.J., announced a new parts inventory plan for service technicians to aid in the promotion of the use of replacement parts for its 45-r.p.m. Victrola phonographs.

Calendar of Events

Polytechnic Institute of Brooklyn Symposium on Modern Advances in Microwave Techniques, November 8-10, Auditorium of the Engineering Societies Building, New York, N. Y.

Audio Fair, Los Angeles, February 10-12, Alexandria Hotel, Los Angeles, Calif.

Business Briefs

. . . **Alliance Manufacturing Co.**, Alliance, Ohio, manufacturer of the *Tenna Rotor* antenna rotor and *Lift-A-Door* automatic garage door operator, entered a new field with the introduction of its *Triceptor* line of all-channel antennas. John Bentia, Alliance executive vice-president, stated that the company is presently featuring its *Monolober* model in single or double bay.

Sylvania Electric Products, New York City, launched a new promotional program for West Coast distributors of its renewal tubes. The campaign, intended to help service technicians cut down on call backs, includes the introduction among new tube types of Sylvania's 5U4-GB and 6BQ6-GTA tubes.

Raytheon's Receiving and Cathode Ray Division has announced to its industrial tube distributors a price reduction on its popular type CK722 transistor, according to F. E. Anderson, distributor sales manager. Effective September 1, 1954, users may purchase this popular Raytheon type transistor for $3.50.

New Plants and Expansions

Ward Products Corp., Cleveland, Ohio, established a new antenna research laboratory in Ashtabula, Ohio, for the design and testing of TV and automobile antennas.

RCA Tube Division, Harrison, N. J., has set up ten new warehouses strategically located throughout the U. S. for the distribution of its radio and industrial batteries. Batteries were formerly warehoused with other RCA products. The new program will speed delivery to battery distributors.

Erie Resistor Corp., Erie, Pa., announced that two of its subsidiaries had opened new enlarged plants: Erie Resistor Ltd. of Canada, in Trenton, Ontario, Canada, and Fryling Electric Products in Holly Springs, Miss.

Lowell Manufacturing Co., St. Louis, Mo., opened an additional plant directly east of its present plant. The company manufactures low-level sound equipment.

Blonder-Tongue Laboratories, Westfield, N. J., has expanded its production facilities with the opening of a second plant. Production Manager Arthur Janus heads factory operations. The company also announced an increase in its personnel.

Raytheon Manufacturing Co. moved its New York offices to larger quarters at 589 Fifth Ave., New York. The office conducts sales functions of the company's international operations, equipment sales, and receiving and special tube sales.

Permoflux Corp., Chicago, moved its Distributor Division to new quarters at 2835 No. Kedzie Ave. The move concentrates the division's various functions in one building to permit better and faster service to its distributors.

General Electric plans to establish a new electron tube development laboratory on Stanford University land in Palo Alto, Calif. The new laboratory will concentrate on developing and exploring the application of microwave electron tubes. It will be under the direction of H. R. Oldfield, Jr., former manager of the G-E Advanced Electronics Center at Cornell University.

National Co., Malden and Melrose, Mass., established a New Products Department which will be managed by Robert J. Caldwell, formerly of High Voltage Engineering Corp. The company also revealed plans to double its research and engineering facilities.

Fanon Electric Co. moved to 150-09 South Road, Jamaica, N. Y.

Telematic Industries is now located in larger quarters at 16 Howard Ave., Brooklyn, N. Y.

Business briefs

. . . **Admiral Corp.**, Chicago, is using "automation"—the use of high-speed robot machines—to assemble automatically part of the chassis in its new line of TV sets.

. . . **NEDA** held a banquet and its annual general membership meeting in conjunction with the regional educational seminar for parts distributors at the Baker Hotel in Dallas.

. . . **Gramer-Halldorson Transformer Corp.**, Chicago, recently held a sales meeting via a 20-station nation-wide telephone hookup during which J. M. Blacklidge, president of the corporation, addressed his entire sales force in all sections of the country. C. A. Hansen, Distributor Division sales manager, also addressed the reps.

. . . **JFD Manufacturing Co.**, Brooklyn, N. Y., was issued a U. S. design patent for its *Pal* line of standoff insulators.

. . . **Capitol Radio Engineering Institute**, Washington, D. C., was authorized by the District of Columbia Board of Education to confer the degree of Associate in Applied Science to resident school graduates who complete a specialized course now being offered. END

VIDEO ELECTRIC COMPANY

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1A4P	.29	6BD5	.59	7F8	.59
1A7	.49	6BE6	.39	7J7	.59
1B3	.59	6BG6	.99	7K7	.59
1B4P	.79	6BH6	.49	7U5	.49
1C6	.29	6BJ6	.49	7Z4	.39
1C7	.29	6BK7	.69	12AL5	.39
1E7GT	.39	6BL7	.69	12AT6	.39
1F5G	.29	6BN6	.99	12AT7	.69
1H5	.49	6BQ6	.79	12AU6	.39
1L4	.49	6BQ7	.79	12AU7	.59
1L6	.59	6BY5G	.59	12AV6	.39
1LA6	.39	6BZ7	.79	12AV7	.69
1LC5	.39	6C4	.39	12AX7	.59
1LC6	.39	6CB6	.49	12BA6	.39
1N5	.49	6CD6	.99	12BA7	.59
1R5	.49	6CU6GT	.99	12BE6	.39
1S5	.39	6F6	.39	12BH7	.59
1T4	.49	6F7	.69	12SA7	.49
1T5GT	.69	6J6	.59	12SK7	.49
1U4	.49	6J8	.79	12SN7	.59
1U5	.39	6K6	.39	12SL7	.59
1X2	.59	6L6	.69	12SQ7	.39
2A3	.29	6N6	.69	14S7	.79
2A7	.29	6S4	.39	19BG6	.99
3AGT	.99	6S8	.59	19T8	.69
3Q4	.49	6SA7	.49	25BQ6	.79
3Q5	.59	6SD7	.49	25L6GT	.39
3S4	.49	6SK7	.49	25W4GT	.39
3V4	.49	6SL7	.59	25Z6	.39
5U4	.39	6SN7	.59	35B5	.39
5V4	.49	6SQ7	.39	35C5	.39
5Y3	.29	6SR7	.49	35W4	.29
5Y4	.49	6T8	.69	35Z3	.29
5Z3	.29	6U8	.69	35Z5	.29
6AB4	.39	6V6	.49	35/51	.29
6AG5	.49	6W4GT	.39	36	.29
6AJ5	.69	6X4	.29	37	.29
6AK5	.69	6X5	.29	39/44	.29
6AL5	.39	7A4/XXL	.39	49	.29
6AQ5	.49	7A6	.49	50B5	.49
6AS5	.49	7A7	.49	50C5	.49
6AT6	.39	7A8	.49	50L6	.49
6AU6	.39	7AK7	.79	75	.29
6AV6	.39	7B4	.49	76	.29
6B7	.79	7B5	.49	77	.29
6BA6	.49	7B6	.49	80	.29
6BA7	.59	7B7	.49	117L7GT	.99
6BC5	.49	7F7	.59	117Z3	.29

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25% deposit with order. Balance COD. If full remittance is sent, please include postage. Excess money will be refunded. We have more than 250 types in stock at all times. Order your other needs at similar savings or write for quotations. Quantity users—write for special discounts!

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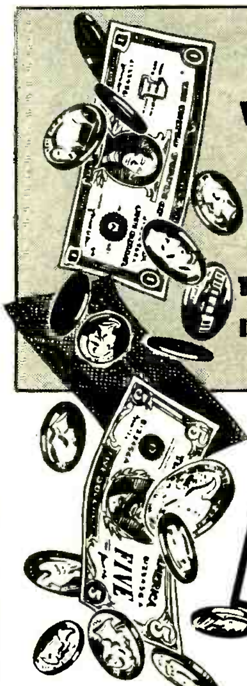

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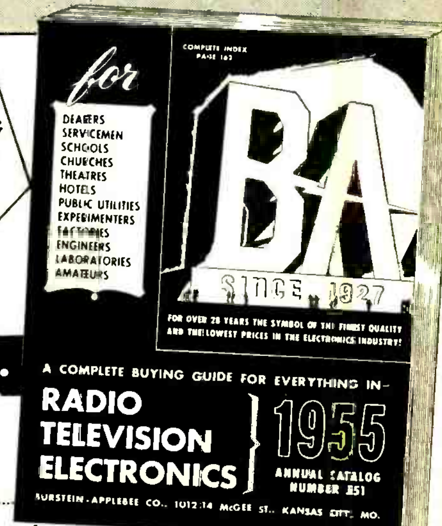

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Douglas Y. Smith was appointed vice-president and general manager of the Tube Division of R.C.A. He was general marketing manager of the Tube Division since October, 1953.

Charles W. Hosterman was promoted to the newly created position of assistant general manager of Sylvania Electric Products' Electronics Division with headquarters in Woburn, Mass. He was formerly manager of the Sylvania Radio Tube Division's plant in Shawnee, Okla.

John D. van der Veer was appointed assistant general sales manager of Tung-Sol Electric Co., Newark, N. J. He had been manager of initial equipment electron tube sales.

Carl Goudy and **Herbert Brown**, co-founders of Technical Appliance Corp., Sherburne, N. Y., were presented with tokens of appreciation by company personnel at a clambake and field day held on the company's 20th anniversary.

Carl Goudy, board chairman of Taco, receives presentation from A. C. Lescarboura.

Newton Cook was appointed jobber sales manager of Chicago Standard Transformer Corp., Chicago. He is a 20-year veteran in the electronic industry and has spent many years with Chicago Standard. In his new position, he will direct the activities of the Chicago and Stancor Jobber Sales Divisions.

PEOPLE *(Continued)*

Richard T. Orth joined Westinghouse Electric Corp., as vice-president in charge of the Electronic Tube Division, succeeding E. W. Ritter, who continues with the company as a consultant. Orth was formerly a vice-president with RCA and general manager of its tube division.

Julian K. Sprague, president of Sprague Electric Co., North Adams, Mass., was named chairman of the Advisory Group on Electronic Parts of the Department of Defense.

Walter E. Sutter was appointed manager of sales for instruments and industrial electronic products of the Commercial Equipment Department of the General Electric Co., with headquarters at Electronics Park, Syracuse, N. Y. He has been associated with G-E since 1946.

Everett E. Leedom joined Electro-Voice Inc., Buchanan, Mich., as advertising manager. He was formerly with Acme Steel Co. and Warner Press.

Obituary:

Albert M. Margolis, vice-president and treasurer of Almo Radio Co., Philadelphia distributors, and well known throughout the parts industry, passed away recently at the age of 52.

Personnel Notes

. . . **Dr. W. R. G. Baker**, General Electric vice-president, was reappointed chairman of the RETMA Television Committee. **Robert Sprague, Jr.**, Sprague Electric Co., was named chairman of the association's Industrial Relations Committee.

. . . **Leon B. Ungar**, Ungar Electric Tools Inc., was elected president of the Radio Parts and Electronic Equipment Shows, Inc., sponsors of the annual Electronic Parts Show. Other officers include **Elliott Wilkinson**, Wilkinson Bros., vice-president; **Karl Jensen**, Jensen Industries, secretary, and **Bernard L. Cahn**, Insuline Corp., re-elected treasurer. The 1955 Electronic Parts Show will be held in Chicago, May 16-19.

. . . **Mrs. Helen B. Anderson** joined Pyramid Electric, North Bergen, N. J., as a sales engineer. She was previously associated with General Electric as an engineer and technical writer.

. . . **Dr. Donald L. Benedict** was named director of physical sciences research of Stanford Research Institute, Stanford, Calif. He was formerly assistant director of the Engineering Division and had served as a consultant to Raytheon Manufacturing Co. END

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Type	Price
0A2	.89
0A3/VR75	.99
0B2	.79
0B3/VR90	.95
0C3/VR105	.98
0D3/VR150	.89
0Z4	.54
1A5GT	.43
1A7	.53
1AB5	.39
1AX2	**.59**
1B3	.69
1D8GT	.77
1G6GT	.54
1H5GT	.43
1J6G	.59
1L4	.49
1LA4	.59
1LA6	.79
1LB4	.79
1LC5	.59
1LC6	.79
1LD5	.52
1LE3	.78
1LG5	.77
1LH4	.78
1LN5	.57
1N5	.61
1P5GT	.56
1Q5GT	.57
1R5	.54
1S4	.58
1S5	.45
1SA6	.48
1T4	.55
1U4	.53
1U5	**.39**
IV	.69
1V2	**.50**
1X2A	**.59**
2A3	.95
2A4G	.99
2A6	.49
2A7	.64
2B7	.62
2X2	.39
2X2A	1.85
3A4	.44
3A5	.90
3A8	.60
3B7	.39
3D6	.39
3LF4	.79
3Q4	.55

FREE OFFER! 7 Assorted 12, 7, 6, 1 and 2-volt type tubes. List Value approx. $23.00. FREE with every order for $25.00 or more!

Type	Price
3Q5GT	.69
3S4	.56
3V4	.58
5T4	1.28
5U4G	.55
5V4	.82
5Y3GT	.39
5Z3	.44
6A3	.89
6A6	.51
6A7	.82
6A8	.69
6AB4	.51
6AB7	.75
6AC5GT	.99
6AC7	.89
6AF4	.89
6AF6	.75
6AG5	.56
6AG7	.95
6AH6	.89
6AJ5	.89
6AK5	.79
6AL5	.41
6AL7	.89
6AM8	**.69**
6AQ5	.49
6AR5	.45
6AS5	**.48**
6AT6	.41
6AU6	.46
6AV5	.79
6AV6	**.34**
6AX4GT	.59
6B7	.95
6B8G	.53
6BA6	.49
6BA7	.56
6BC5	.54
6BD6	.49
6BE6	**.36**
6BG6	1.24
6BH6	.48
6BJ6	.49
6BK7A	.96
6BL7GT	.89
6BN6	.79
6BQ6	.95
6BQ7A	.92
6BZ7	.92
6C4	.41
6C5	.39
6C6G	.57

Type	Price	Type	Price	Type	Price
6C8G	.85	6SH7GT	.50	**7C5**	**.49**
6CB6	.57	6SJ7	.50	7C7	.65
6CD6	1.49	6SK7	.49	7E5	.59
6CF6	.64	6SL7GT	.59	7E6	.59
6CS6	.51	6SN7GT	.59	7F7	.65
6D6	.69	6SQ7	.45	7F8	.95
6D8G	.98	6SR7	.45	7H7	.59
6E5	.48	6SS7	.60	7J7	.75
6F5	.39	6ST7	.49	7L7	.59
6F6	.45	6SV7	.99	7N7	.62
6F7	.93	6T4	.95	7R7	.65
6F8G	.69	6T7G	.79	7S7	.85
6G6G	.65	6T8	.79	7V7	.91
6H6	**.32**	6U7G	.45	7W7	.85
		6U8	.79		

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Our new policy brings you greater tube savings than you thought possible! As a GOODWILL offering, we are giving, each month, a number of popular tube types (listed in extra bold) — AT PRICES BELOW OUR OWN COST! Look for these terrific offers of different types each month, in industry-wide publications!

Type	Price	Type	Price	Type	Price
6J5	.40	6V3	1.02	7X7	.70
6J6	.59	6V6GT	.47	7Y4	.44
6J7	.49	6W4GT	.45	7Z4	.49
6K6GT	.45	6W6	.56	7Z7	.85
6K7	.39	6X4	.39	10Y	.69
6K8G	.65	**6X5GT**	**.29**	12A6	.59
6L7G	.59	6X8	.79	12A7	.99
6N7	.98	7A4	.54	12A8GT	.63
6Q7	.49	7A5	.59	12AL5	.49
6R7	.49	7A6	.69	12AT6	.41
6S4	.49	7A7	.69	**12AT7**	**.59**
6S7G	.59	7A8	.59	12AU6	.45
6SA7	.54	7AH7	.56	**12AU7**	**.53**
6SB7Y	.89	7B4	.44	12AV6	.44
6SC7	.79	7B5	.59	12AV7	.72
6SD7GT	.38	7B6	.59	12AX4GT	.68
6SF5	.45	7B7	.59	12AX7	.63
6SF7	.59	7B8	.63	12AY7	.89
6SG7GT	.49	7C4	.58		
6SH7	.60				

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Type	Price
12BA6	.49
12BA7	.59
12BD6	.49
12BE6	**.39**
12BH7	**.59**
12BY7	.69
12BZ7	.65
12C8	.34
12F5GT	.35
12H6	.45
12J5GT	.45
12J7GT	.58
12K7	.55
12K8	.58
12Q7GT	.59
12SA7GT	.64
12SC7	.69
12SF5	.49
12SG7	.75
12SH7	.75
12SJ7	.59
12SK7	**.44**
12SL7GT	.57
12SN7GT	.58
12SQ7GT	.56
12SR7	.49
12Z3	.39
14A4	.69
14A5	.59
14AF7	.59
14B8	.65
14C7	.69
14F7	.67
14F8	.95
14H7	.59
14N7	.69
14Y4	.69
19	.49
19BG6	1.35
19T8	.79
22	.44
25AV5GT	.84
25BQ6GT	.89
25L6GT	.49
25Y5	.85
25Z5	.64
25Z6GT	.48
26	.44
27	.38
32L7GT	.98
35B5	.49
35C5	.48
35L6GT	**.37**

Type	Price
35W4	.43
35Y4	.45
35Z3	.43
35Z5GT	.47
41	.41
42	.41
43	.55
45Z3	.42
46	.49
47	.89
49	.44
50A5	.55
50B5	.49
50C5	.49
50L6GT	.61
50X6	.64
50Y6GT	.59
56	.49
57	.55
58	.58
7DL7GT	1.00
71A	.54
75	.49
76	.43
77	.55
78	.45
81	1.11
82	.69
83	.79
84	.54
85	.59
89/Y	**.29**
117P7GT	.98
117Z3	.38
807	**.99**
2051	.95
9001	1.49
9002	.98
9003	1.48
9004	.97
9006	.68

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Type	Price
5BP1	**3.98**
5BP4	5.95
5CP1	5.95
7BP7	7.45
12DP7	19.50
16HP4A	18.95
16DP4	18.95

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technical Literature

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Empire Devices has issued a 6-page catalog which describes noise meters, distortion analyzers, impulse generators, attenuators, and crystal mixers.

Included are engineering specifications on noise and field-intensity meter models NF-105 and NF-114. The catalog also gives technical data on noise and distortion analyzer ND-110. Additional items covered in the catalog are step attenuators, u.h.f. attenuators, and a broad-band crystal mixer.

Empire Devices Products Corp., 38-15 Bell Blvd., Bayside 61, N. Y.

> 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.

HOUSE ORGAN

EICO is now putting out a house organ called "The EICO News Bulletin," a bimonthly publication that describes sales and technical facts. Humor. Dale Carnegie philosophy, and general human-interest material are also included.

Electronic Instrument Co., Inc., 84 Withers St., Brooklyn 11, N. Y.

SERVICE PARTS DIRECTORY

A 36-page service parts directory, SP-1021, offers basic service and parts-replacement data for all 1952-model RCA home television receivers. It contains schematic and wiring diagrams, parts lists, and top and bottom chassis views for 27 different table models and console receivers. The television receivers are indexed by model name and number for quick identification and location. Also included is a special cross-reference which identifies by model name and number all RCA receivers produced between 1946 and 1952, and indicates previously issued service parts directories in which they are described. The SP-1021 features spread-out easy-to-read schematics.

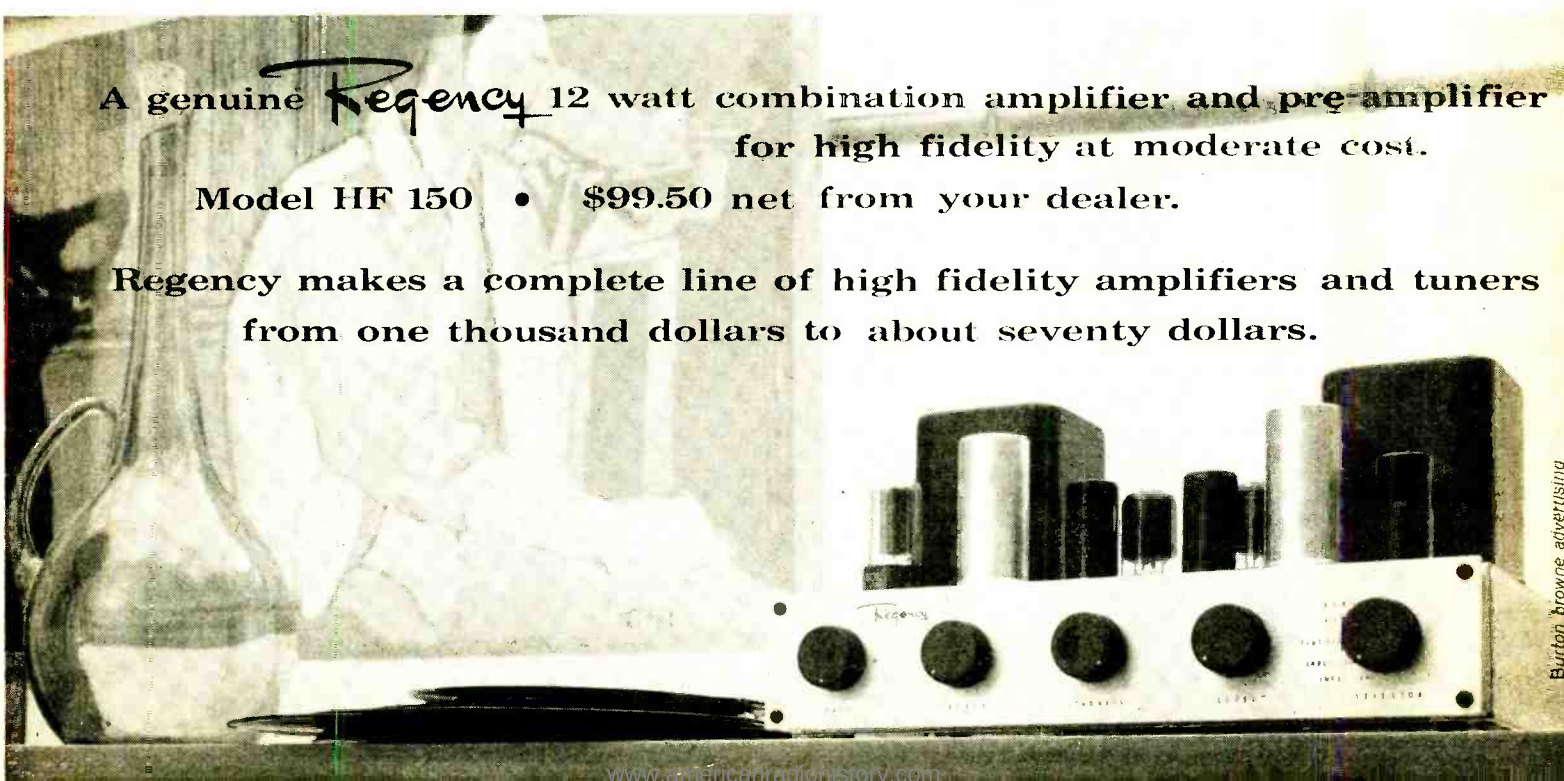
RCA electronic parts distributors or Commercial Engineering Dept., RCA Tube Division, Harrison, N. J. 50 cents.

TRANSFORMERS

Chicago Standard Transformer has issued a new transformer catalog, CT-554. This 32-page book contains detailed descriptions of over 500 stock transformers for military, new equipment, general replacement, and power and control circuit applications. A simplified classification system makes it easy to locate any particular unit, and

WATCH FOR OUR ANNUAL INDEX

in the December Issue



the dimensions of all cased units are shown.

Almost 100 new transformers are listed, including many not previously available as stock units. These include military, standard transformers, hermetically sealed 400-cycle transformers, and molded toroidal inductors. High-fidelity transformers, miniature audio transformers, and ultra-miniature transistor transformers are some of the other new units listed.

Chicago Standard Transformer Corp., 3501 Addison St., Chicago 18, Ill.

CAPACITORS

Folder AB-19A contains technical data and operating characteristics of Astron *Hy-Met* high-temperature metallite metalized paper capacitors. It provides information on the types of *Hy-Met* available and gives their capacitance stability, voltage rating and derating, and other characteristics.

Folder AB-18A contains all pertinent information on *Meteor* capacitors. Also shown are accessories, mounting hardware, and constructional variations available to meet individual requirements.

Folder AB-20B gives technical information on the *Blue Point* type of molded plastic paper capacitors.

Astron Corporation, 255 Grant Ave., East Newark, N. J.

DISC RESISTORS

Bulletin T-1 on resistance strips and concentric disc resistors gives data on construction, tolerances, resistance values, power and voltage ratings, dimensions, machining techniques, temperature coefficients, and voltage coefficients. It contains charts and graphs.

International Resistance Co., 401 No. Broad St., Philadelphia 8, Pa.

AUDIO EQUIPMENT

Catalog 55 describes microphones, accessories, magnetic recording heads, and phono pickup cartridges. It also contains cartridge and recording-head replacement charts. Catalog 33 describes the new *Concert-Line 333* studio microphone.

Shure Brothers, 225 W. Huron St., Chicago, Ill.

TV ANTENNAS

A catalog, "Ward Antenna Rama," illustrates and describes v.h.f. and u.h.f. TV antennas. *Tele-Vane*, *Dymon-Vane*, and *Circle-Vane* Yagi antennas are also described.

Available to distributors and dealers from Ward Products Corp., Division of the Gabriel Co., 1148 Euclid Ave., Cleveland, Ohio.

ELECTRIC PLANT

A 16-page booklet with many photographs, entitled "Power Points Digest," describes how Onan electric plants are used as emergency standby units, for contractors' portable power needs, as magnet chargers for cranes and trucks, and for primary power for a display coach.

D. W. Onan & Sons Inc., Minneapolis, Minn. END

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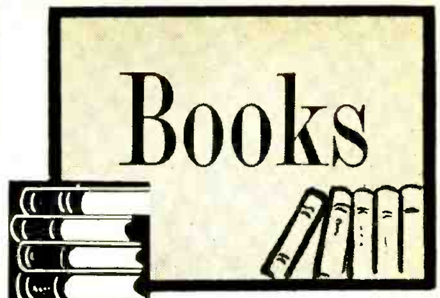
RADIO SCHOOL DIRECTORY

Watch for the December Issue of* RADIO-ELECTRONICS *on Sale Nov. 23



THE MAGIC OF ELECTRONICS, by Edward J. Bukstein. Frederick Ungar Publishing Co., 105 E. 24 St., New York City. 6x9 inches, 256 pages. $3.95.

In this day of increasingly complex circuitry and equipment it is refreshing to read a technical book written at the layman's level. It also reminds us that there is more to electronics than much-publicized radar and television.

Of the more than 60 "chapters" in the book, Bukstein spends only three discussing fundamentals of electronics. From there—in the straightforward easy-to-read style familiar to RADIO-ELECTRONICS readers — the electronic curtain is pulled aside, and a fabulous assortment of electronic applications is put on display.

Given a thorough review is such diverse equipment as the pyrometer, that regulates both the temperature of furnaces and the constancy of color patterns in textiles; the chromalizer, that teaches deaf children to speak; the radio knife, that makes possible bloodless surgery; equipment that surface-hardens metal parts without flame, and numerous other devices in the fields of medicine, industry, and aviation.

No attempt has been made at an exhaustive analysis—rather, it is the author's intent to give the reader a general idea of the underlying principles in the various applications of electronics.—*JK*

WORLD RADIO-TELEVISION HANDBOOK (eighth edition). Edited and published by O. Lund Johansen, Lindforsalle 1, Hellerup, Copenhagen, Denmark. Distributed in the United States by Ben E. Wilbur, 47 Mounthaven Drive, Livingstone, N.J. 6½x8½ inches, 136 pages. $1.50.

The eighth edition of the shortwave listeners' bible has added a television section, containing what appears to be the most complete list of TV stations published to date, together with addresses of their administrative offices.

The shortwave section has been increased in size—due apparently to an increase in broadcasting activity—and indicates the frequency, power, and operating periods of the high-frequency broadcast stations of the world, as well as the medium- and low-frequency stations of most countries.

A table in the front of the book informs the listener of the best frequencies for various times of the day and year, and the information under "Services" of the various countries also gives him hints as to where and when best reception can be expected. The

BOOKS (*Continued*)

world station list by frequencies still appears—a great convenience to dx seekers—as well as the station listings under countries.—*FS*

WORLD RADIO VALVE HANDBOOK, edited and published by O. Lund Johansen, Copenhagen, Denmark. Distributed in the United States by Ben E. Wilbur, Livingstone, N.J. 136 pages. $1.75.

The subtitle *Receiving Valves of the World, Their Data, Uses, and Interchangeability* sums up the aim and scope of this book. Tubes are listed in alphabetical and numerical order in a type index that refers the reader to a table including all tubes that are equivalents or near-equivalents. Differences in characteristics are covered by footnotes. A second index classifies tubes according to circuit function and construction.

SPECIALIZED AUTO RADIO MANUAL. John F. Rider Publisher, Inc., 480 Canal St., New York, N.Y. Volume 3-A: 123 pages, $1.80. Volume 5-A: 204 pages, $3.00.

These are two of a series of volumes of diagrams and servicing data covering all makes and models of radios in 1950-54 automobiles and trucks. Volume 3-A covers receivers in Chevrolet and Pontiac cars and GMC and Chevrolet trucks. Volume 5-C includes Henry J, Hudson, Kaiser-Frazer, Nash, Packard, Studebaker, and Willys products.

TABLES OF LAGRANGIAN COEFFICIENTS FOR SEXAGESIMAL INTERPOLATION (National Bureau of Standards Applied Mathematics Series 35). U. S. Government Printing Office, Washington 25, D.C. 157 pages. $2.00.

The most common Lagrangian tables used in astronomy, geodesy, ballistics, engineering, and geography provide decimal subdivision of the argument so no cumbersome interpolations are required to find the required coefficients. This table simplifies the problem by providing arguments in sexagesimal measure (angles or time in units of degrees, hours, minutes, and seconds).

MOST-OFTEN-NEEDED 1954 RADIO DIAGRAMS AND SERVICING INFORMATION, compiled by M. N. Beitman. Supreme Publications. 1760 Balsam Road, Highland Park, Ill. 160 pages. $2.50.

This is the latest addition in the continued series of volumes of diagrams and service data on modern home, auto, and portable radios.

The volume consists of reprints of data and diagrams on approximately 560 models made by 32 receiver manufacturers.

To simplify these rather complex tables, several pages are devoted to the scope of the material and illustrations of the use of the coefficients. Special explanations are given for use of coefficients near the beginning and end of a table, and in tables having differences. Prior to the tables is a chapter devoted to the methods of making computations.

END

ADVERTISING INDEX

Radio-Electronics does not assume responsibility for any errors appearing in the index below.

RADIO SCHOOL DIRECTORY PAGE 151

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OD3	.70	**3S4**	**.58**	**6BE6**	**.51**	6SG7GT	.41	7J7	.79	12SF5	.50	35A5	.58
OZ4M	**.65**	**3V4**	**.58**	6BF5	.41	6SH7GT	.49	7K7	.69	12SG7	.51	**35B5**	**.52**
1A5	.49	5AZ4	.59	6BF6	.37	6SJ7GT	.41	7L7	.59	12SJ7M	.67	**35C5**	**.51**
1A7GT	**.47**	5T4	.79	**6BG6G**	**1.25**	**6SK7GT**	**.53**	**7N7**	**.69**	**12SK7GT**	**.63**	**35L6GT**	**.51**
1AX2	**.62**	**5U4G**	**.55**	**6BH6**	**.53**	**6SL7GT**	**.48**	**7Q7**	**.66**	**12SL7GT**	**.57**	**35W4**	**.47**
1B3GT	**.73**	5W4GT	.50	**6BJ6**	**.49**	**6SN7GT**	**.59**	7R7	.89	**12SN7GT**	**.52**	**35Y4**	**.54**
1C5	.43	**5Y3GT**	**.37**	6BK5	.80	**6SQ7GT**	**.46**	7S7	.79	**12SQ7GT**	**.56**	**35Z3**	**.59**
1E7	.29	5Y4	.51	6BK7	.80	6SR7GT	.45	7V7	.89	12SR7M	.49	35Z4	.47
1G6	.24	**5Z3**	**.45**	6BL7GT	.83	6SS7GT	.42	7X6	.54	**12V6GT**	**.46**	**35Z5GT**	**.47**
1H4	.30	6A6	.51	6BN6	.59	6T4	.99	7X7	.70	**12X4**	**.38**	36	.39
1H5GT	**.49**	6A7	.69	**6BQ6GT**	**.98**	**6T8**	**.80**	**7Y4**	**.69**	14A4	.69	45	.55
1L4	**.46**	6A8	.62	**6BQ7**	**.90**	6U5	.57	7Z4	.59	14A5	.59	45Z5	.49
1LA4	.59	**6AB4**	**.44**	**6BZ7**	**.90**	6U6	.59	12A6	.54	**14A7**	**.63**	46	.69
1LA6	**.69**	6AC5	.69	**6C4**	**.40**	**6U8**	**.78**	12A8GT	.61	14AF7	.59	**50A5**	**.55**
1LB4	.69	**6AC7M**	**.86**	**6C5**	**.39**	**6V6GT**	**.50**	12AL5	.37	**14B6**	**.63**	**50B5**	**.52**
1LC5	.59	**6AF4**	**.90**	6C6	.58	**6W4GT**	**.47**	12AQ5	.52	14B8	.63	**50C5**	**.51**
1LC6	.79	**6AG5**	**.56**	**6CB6**	**.54**	**6W6GT**	**.57**	**12AT6**	**.41**	14C5	.79	**50L6GT**	**.61**
1LD5	.59	**6AG7M**	**.99**	**6CD6**	**1.11**	**6X4**	**.37**	**12AT7**	**.72**	14C7	.79	50X6	.49
1LE3	.59	**6AH4**	**.57**	6CF6	.64	**6X5GT**	**.37**	**12AU6**	**.46**	14E6	.75	50Y6	.49
1LG5	.69	**6AH6**	**.73**	6CS6	.51	**6X8**	**.75**	**12AU7**	**.60**	14E7	.88	50Y7	.50
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1LN5	**.59**	**6AK5**	**.55**	**6E5**	**.48**	7A4	.47	**12AV7**	**.73**	14F8	.69	56	.49
1N5GT	**.67**	**6AK6**	**.59**	6F5GT	.39	7A5	.59	12AX4	.67	14H7	.59	57	.58
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1S4	.59	**6AQ6**	**.37**	**6J5GT**	**.43**	7AD7	.79	12B4	.60	14S7	.89	76	.44
1S5	**.51**	**6AQ7**	**.70**	**6J6**	**.52**	7AF7	.53	**12BA6**	**.49**	14W7	.30	77	.57
1T4	**.58**	**6AR5**	**.45**	6J7	.43	7AG7	.69	12BA7	.60	14X7	.69	78	.47
1T5	.59	**6AS5**	**.50**	6K5	.47	7AH7	.79	12BD6	.45	14Y7	.62	80	.43
1U4	**.57**	**6AS6**	**1.49**	**6K6GT**	**.45**	7B4	.44	**12BE6**	**.51**	19BG6	1.39	83V	.68
1U5	**.50**	**6AT6**	**.41**	6K7	.44	7B5	.45	12BF6	.39	**19T8**	**.69**	84/6Z4	.46
1V	.43	**6AU4GT**	**.68**	**6L6**	**.64**	7B6	.69	**12BH7**	**.63**	19V8	.79	85	.59
1X2A	**.63**	**6AU5GT**	**.82**	6L7M	.68	**7B7**	**.49**	**12BY7**	**.65**	24A	.39	117L7	.99
2A3	.30	**6AU6**	**.46**	6N7M	.63	7C4	.59	12BZ7	.65	**25AV5GT**	**.83**	117P7	.99
2W3	.38	6AV5GT	.83	**6Q7**	**.45**	**7C5**	**.69**	12C8M	.34	**25BQ6GT**	**.98**	**117Z3**	**.37**
2X2	.49	**6AV6**	**.40**	6R7	.69	**7C6**	**.59**	12H6	.56	**25L6GT**	**.51**	117Z6	.69
3A4	.45	**6AX4GT**	**.65**	**6S4**	**.48**	7E5	.59	12J5	.42	25W4GT	.59	807	.99
3B7	.27	6B4	.54	6S7M	.79	7E6	.30	12J7	.49	**25Z5**	**.66**	866A	1.39
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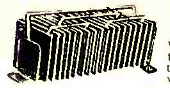

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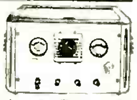

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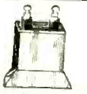

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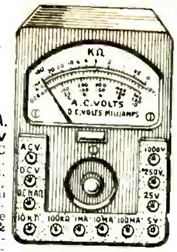

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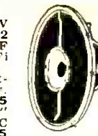
HI-FI SPEAKERS



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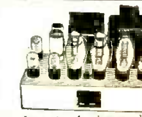
RPJ001/78 or RPJ005 .001 sapphire $1.35
RPJ003/78 or RPJ004/LP diamond $10.89
RPJ013 Dual diamond & sapphire ... $12.89
Replacement needles for all make phonos (except GE listed above) specify model & =
MGor78 single osmium ... 59c; 12 for $5.98
MGor78 single sapphire styli ... $1.15
MGor78 Dual sapphire $1.98; 4 for $7.50

HIGH FIDELITY AUDIO



You are there! Hear Carnegie Hall in your living room through the NEW TAB HI-FI Linear Amplifier. Check these outstanding features. Response: .5DB 20-50KC. Output: 12 watt. HUM: 80DB down. Input: 4 channels. Selector and equalizer switch. Calib bass & treble controls. 4, 8 & 16 ohm output. Handsome front panel for custom mounting. SPECIAL ... $49.98
LJ-3 GROMMES 10 watt HI-FI ampl 20-20KC 4 inpts. bass & treble contr $41.90
50-CM FISHER Master control. preamp equalizer, 4 inputs, freq & tone compensation controls. Self powered ... $97.50
70RT FISHER FM-AM tuner. Engineered to perfection for the HI-FI enthusiast $184.50
70-A FISHER Basic amplifier 25 watt for use with 70RT or 50CM ... $99.50
RC-80 GARRARD 3-speed changer ... $49.50
RC-90 GARRARD 3-speed changer ... $69.50

"TAB" PACKAGE SPECIALS

55PG amplifier, 12" coax speakers, RC80 changer RPX050 dual cartridge $127.25 reg. Special ... $114.00
LJ ampl, 12" coax speaker, RC80 changer & RPX050 cartridge. $110.84 Reg. Special ... $99.00
LJ ampl & 12" coax spkr $54.65 Reg: $45.00. 50CM Preamp, 70RT tuner, 70A ampl, RC90 changer, RPX053 dual diamonds. $476.98 Reg. SPECIAL $442.93.

TUBES

*From This Special List We Ship $10.00 and Up Tube Orders At Our Expense (Postpaid) Within Continental Limits of U.S.A. 90 Day Gtd. When ordering mention 11RE.

0A2	.88	6AQ5	.52	6H6	.60	6Y6G	.88	12SF7GT	.84	CK536AX	.99		
0A3/VR75	1.04	6AQ6	.81	6J4	6.66	7A8	.68	12SG7	.80	CK538DX	.98		
0B2	1.37	6AQ7GT	1.29	6J5	.54	7C7	.76	12SH7	.63	CK539DX	2.19		
0B3/VR90	.96	6AR6	3.27	6J6	.58	7F7	.82	12SJ7GT	.54	CK543DX	.99		
0C3/VR105	.92	6AS5	.79	6J7	.72	7F8	1.24	12SK7	.66	CK544DX	.99		
0D3/VR150	.92	6AS6	2.22	6K6	.54	7H7	.72	12SL7GT	.62	CK546DX	1.99		
1B3/8016	.80	6AS7G	3.48	6K7	.58	7N7	.92	12SN7GT	.68	CK571AX	2.49		
1L4	.48	6AT6	.54	6K4A	3.68	7V7	1.06	12SQ7GT	.54	CK1005	.68		
1L6	1.35	6AU5GT	1.10	6K8GT	1.08	7Y4	.68	19BG6	1.98	2050	1.48		
1LD5	.98	6AU6	.56	6L6	1.48	12A6	.48	19V8	1.98	CK5672	1.20		
1LN5	.78	6AV5GT	.98	6L6G	1.08	12AH7GT	1.45	25BQ6GT	.98	CK5678	1.28		
1P5	.78	6AV6	.49	6L6GA	1.08	12AL5	.54	25L6GT	.67	5687	3.74		
1T4	.79	6AX4 6U4	.74	6L6GAY	1.98	12AT6	.54	25Z5	.78	CK5702	2.90		
1R4	1.29	6B4G	1.18	6SA7GT	.66	12AT7	.89	25Z6GT	.58	CK5703	1.29		
1R5	.59	6BA6	.54	6SC7	.90	12AU6	.72	28D7	1.94	Xtal Diodes			
1U4	.52	6BA7	1.09	6SF5	.78	12AU7	.69	35B5	.52	1N21A	1.55		
1U5	.54	6BC5	.63	6SF7	.73	12AV6	.52	35L6	.67	1N21B	2.10		
2A4G	1.18	6BC7	1.23	6SG7	.64	12AV7	.98	35Z5GT	.54	1N22	1.22		
2X2	.42	6BD6	.83	6SH7	.61	12AW6	1.18	35Y4	.68	1N23	1.35		
5R4GY	1.20	6BE6	.54	6SJ7	.58	12AX7	.98	45Z3	.88	1N23A	1.89		
5R4GYW	1.75	6BF5	.98	6SK7GT	.56	12AY7	1.69	50A5	.76	1N23B	2.00		
5T4	1.48	6BG6G	1.58	6SL7GT	.64	12BA6	.59	50B5	.54	1N25	4.98		
5U4G	.55	6BH6	.63	6SN7GT	.68	12BA7	.94	50C5	.54	1N26	8.75		
5X4G	.79	6BJ6	.69	6SQ7GT	.62	12BD6	.59	50L6GT	.62	1N27	1.55		
6AC7	.80	6BK7	1.58	6SR7	.62	12BE6	.59	RK61/XFG1	2.65	1N34	.64		
6AG5	.71	6BL7GT	1.19	6SS7	.88	12BF6	.85	80	.58	1N34A	.88		
6AG7	1.14	6BN7	2.69	6T8	.96	12BH7	1.29	81	1.38	1N35	1.65		
6AH6	1.21	6BQ6GT	1.20	6U4	.74	12C8	.62	83	1.12	1N38A	1.29		
6AJ5	1.40	6BQ7	1.65	6U8	.99	12H6	.64	83V	1.22	1N41	8.95		
6AK5	.87	6C4	.52	6V6	1.39	12J5	.54	84/6Z4	.62	1N42	16.95		
6AK6	.92	6C5	.68	6V6GT	.59	12K8	.68	117L/M7GT	1.98	1N45	1.45		
6AL5	.48	6CB6	.59	6W4GT	.52	12Q7GT	.55	117Z6GT	.96	1N46	.69		
6AL7GT	.98	6D4	2.70	6X4	.49	12SA7GT	.68	CK502AX	1.49	1N47	4.00		
6AN5	3.27	6F6GT	.79	6X5	.54	12SC7	1.08	CK503AX	1.49	1N48	.47		
								CK505AX	1.79	1N51	.45		
								CK512AX	1.45	1N54	.78		
								CK531DX	1.89	1N60	.60		
								CK532DX	1.89	1N63/K63	2.49		
								CK533AX	1.29	1N69	.98		

OIL CONDENSER—SPECIAL

10 MFD 600 VDC **$1.75 ea.** lots of 3
Case dimensions, not including insulators 4⅛H x 3¾W x 1¼"D Smaller Quantities, special ... $1.98

106 WATT SEC PHOTOFLASH KIT—AC

Includes transf condensers two/525MFD/450V/Total 103W/Secds. Resistors, capacitors, rectifier, flash tube in indicating flash gun, guide = 40 on Kodachrome. Special $39.98

BATTERY 106 WATT/SCDS PHOTOFLASH KIT

Same specs, only batteries ... $36.98
525MFD/450V/53w'scds condensers, low leakage (2MA) ... Spec $9.00; 2/$17.00
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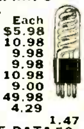
CK5517 mini (no-fill) gas rectifier $2.88
1600VDC selenium rectifier ... $2.98
Electronic Flash Handbook ckt data 50c.

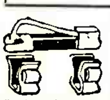
"TAB" PHOTOFLASH LAMPS



"Tab" No.	Replaces	W-Sec. Max.	Each
TLW	FA101/FT118	150	$5.98
THI	AMGLO 5804X	100	10.98
23ST	GE FT 210	200	9.98
THVA	SYLV. 4330	200	9.98
V4X4	X400	200	10.98
TLX	FA100/DX	150	9.00
353GTQ	FT 503	2000	49.98
FT105	FT 105	150	4.29

TRIGGER COIL FOR GE 86G41 ... 1.47
WRITE FOR "TAB" FLASH TUBE DATA 50c

CIRCUIT BREAKER FUSES



PUSH TO RESET
Amps 3—5—7—10—15—20 Ea. 27c; 5 for $1.00.
Asst (U-Select) ... 10/$15
Circuit Breaker Fuse with 2 Mounting Clips ... 39c
3 for $1.00; 20 for $5.98; 100 for $20
Fuse is 3AG Size. Operates up to 24 Volts
Please State Current (Amps) Desired
Heinmann Magn Bkrs. Amps: 0.22, .5, 7, 9, 12, 15, 30, 35, 40, 80, 180 ... Ea. $1.98; 12 $20; 50 $75
Klixon Thermal Push Button Bkrs Amps; 5, 10, 15, 20, 25, 30 89c ... 10 for $7.98

VARIABLE DC POWER SUPPLY

Full Wave rectification. 6000Mfd filter Condenser, fused, 6.3V or 12.6V at 2 amp. operates 115V/60cy.
Model 2DCF ... $12.98
As above except 6 Amp Model 6DCF ... $29.98

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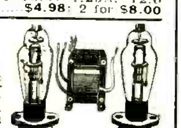
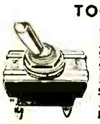
2.5VCT/10A 12.5KVINS ... $5.50; 3 for $14
2.5VCT/10A 5KVINS ... $3.59
7.5VCT/12A 15KVINS $10.95; 2 for $17.50
24V/1.25A CSD ... $1.98; 2 for $3.49
42.5V/2A Sel Rect Xmfr ... $4.98; 2/$8
64V 1Amp HMSLD ... $3.49; 2 for $5.00
2X12.6V 2A or 25.2V 2A or 12.6V 4A CSD ... $3.59; 3 $10.00; 12 $36.00
PRI 110 & 220V Sec 16.6V 1.25A, 12.6 VCT 3.5A ... $4.98; 2 for $8.00

866A KIT and XFORMER



(2) 866A Tubes & Sockets. Transformer Rated PRI 115V 60cy Sec 2.5VCT/10A Hi-Volt Insulation $4.98

TOGGLE SWITCHES



SPDT 15A/125V Center Off—AN3022-1B ... 69c; 5/$2.50
SPST 5A/125V used LN 4/$1
SPDT 15A/125V Center Off Mom. ... 79c; 3/$2; 20/$10
SPDT 15A/125V AN3022-3B ... 59c; 3/$1.25; 30/$10.00
DPST 20A/125V AN3027-2B ... 69c; 5/$2.50; 25/$10.00
DPST 5A/125V BKLT CSD ... 49c; 3/$1.20
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4PDT 10A/125V ... $1.98; 3/$5; 20/$30

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8 FT Test Leads, Hvy Dty, 26 Strand W/Alligator Clips, 2 Pair ... $1.00
15 FT Extension SJ Cord, Hvy Dty, Rubber Insul ... $1.00
4 FT Flexible Instrument Test Leads, Red & Blk, 2 Pr. $1.00
10 FT Line Cord & Plug Heavy Duty, 2 For ... $1.00
TROUBLE LIGHTS (As Shown) Extra Outlet & Switch in handle, 25 Ft $1.49; 3/$4
50 Ft $1.98; 3 $5.49
EXTENSION CORD 3-Way Receptacle & Plug, 6 Ft ea. 24c; 10/$2.10; 12 Ft ea. 35c; 10/$2.90

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Your selection of 10 at 39c each or smaller quantity at indicated prices.

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3X 20MFD/400VDC ... 79c; 2 for 1.29
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50 mf/350vde FP ... 5 for 1.00
30-15-10 mf/250vdc ... 5 for 1.00
16MFD/450V ... 55c; 3 for 1.20
Dual 8MFD/450V ... 75c; 3 for 1.50
Dual 16MFD/450V ... 85c; 3 for 2.00

PRECISION RESISTORS FOUR MILLION IN STOCK

All 1% Accuracy Gtd

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100 OF ONE VALUE ... $20.00
10 ASSORTED VALUES (U-SELECT) ... $3.00
INDICATE SECOND RANGE, NO MFGRS CHOICE, WE SHIP TYPES IN STOCK
NOTE: 1 MEG & UP ADD 25c EA RESISTOR

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All 115 V 60 Cyc Input TV, & CR pwr Xmfr up to 20" tubes. Hi VOLTS to 20KV (w/quadrupler ckt.) ALL tubes, PL & FIL windgs. 5000VDC/5MA
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950VCT/100MA, 5V/5A, 5V/2.5A, 45V/1A, 10V/1.5A, Western Elect ... $4.98
900V/35MA 2X2.5V/2A, XCLENT 1800V DBLR TWO 2X2 FIL WNDGS ... $1.98
778VCT/200MA, 5V/3A, 6.3VCT/5A $4.98
770V/2.5MA, 2.5V 3A, HVINS HMSLD Includes FILTER PARTS, 4/scope ... $3.69
700VCT/70MA, 5VCT/3A,6.3VCT/2.5A. $4
550VCT/250MA, 5V/2A, 6.3VCT/2.5A, 12.6V/2.5A, CSD RCA ... $4.50; 2/$8.00
500VCT/60MA, 6.3V/4A Hmsld ... $2.98
420VCT/90MA, 6.3V/1.9A, W/INPUTS 6, 12, 24 115VDC 115 & 230 VAC @ $1.49
2X330VCT/10MA, EACH WNDG ... 1.39

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50Hy/125ma, CSD, H'sld. $2.89
20Hy/300ma or 15Hy/400ma 12Kvins ... $8.95
13.5Hy 1 amp 17 Kvins Raytheon ... $35.00
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Dual 2Hy/300ma Cased ... 95c; 2/$1.49
12Hy/65ma HMSLD ... $1.25; 2 $2.00
2.5Hy 300ma 60/ohm ... $1.69; 2/$3

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For 220-240V/50-60 cy input. To 110-120V or step-up. With cord, Plug & Receptacle.
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AY5 Autosyn/26V/400Cy/E.P. ... $3.98
CK-2/Low-In-Servo Motor/EP ... $20
AY20 Autosyn/26V/400Cy/E.P. ... $4.98
AY6/Autosyn/26V/400Cy/E.P. ... $7.98
C44968/Sync Repeater/115V/60CY ... $16
C56701/Syn Rptr/115V/60Cy ... $21
C56776/Syn RPTR/115V 60Cy ... $15
C69406-1/Syn Rptr 115V/60Cy ... $21
C76166/Voltage Rcvr/115V 60Cy ... $16.50
C78248/Syn Trans/115V 60Cy $16; 2/$28
C78249/Syn Diff 115V 60Cy ... $7; 2 $12
C78386/Sync Trans 115V 60Cy ... $29.50
C78670 Synchro Special/50V/50Cy ... $21
3" Marslin/Hunter MKII ... $12.50
2J1F1/SynGen/115/57-5V/400Cy ... $9.00
2J1F3/Syn Gen/115 57.5V 400Cy ... $9
2J1G1 Syn Tran 57.5/57.5V 400Cy $6.00
2J5HA1/Gen/115/105V/60Cy ... $57
2JD5BA1/Syn Mtr 115 60Cy ... $57
1CT Sync Trnsf 90 55V 60Cy ... $59
5CT MKIII/MOD2 90/55V 60Cy ... $43
5F/MKII/MOD IV/115V/60Cy ... $43
5G/MKI/MOD6/115/90V-60Cy/BNDX $45
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SLIM DYNAMIC
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Net wt. 15 ozs. **List $49.50**

You get advanced styling...plus E-V quality...in this new pacesetter! Proved E-V features guarantee dependable operation indoors and outdoors...for public address, paging, recording and communications.

The "623" can be used on a stand or in the hand. Omnidirectional. Response 60-11,000 cps. Output −55 db. *Acoustalloy* diaphragm. Pressure cast case finished in Satin Chromium. Tiltable head. Built-in cable connector. ⅝"−27 thread. "On-Off" switch. Choice of Hi-Z or Low-Z by changing one wire in cable connector. 18 ft. cable. *Get full details now.*

Model 647 Lavalier

Small, rugged PA dynamic for chest, desk or hand use. Supplied with neck cord, support clips and 18 ft. cord. Omnidirectional. Response 60-13,000 cps at −57 db level. 150 ohms or Hi-Z. Acoustalloy diaphragm. Black anodized finish. Size 5" x 1". **List $80.00**

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Exceptionally fine dynamic for PA, recording and general use. Response 60-13,000 cps. Output −55 db. Acoustalloy diaphragm. Pop-proof head. Omnidirectional. Wide pick-up range. Tiltable head. "On-Off" switch. Satin Chromium finish. 18 ft. cable. 1-1/16" diam. Use for Hi-Z or Low-Z. **List $70.00**

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Smartly styled dynamic. Response 50-8000 cps. Output −55 db. Omnidirectional. Acoustalloy diaphragm. Tiltable head. "On-Off" switch. Satin Chromium finish. Available in 50, 150 or 250 ohms, or Hi-Z. With 6 ft. or 18 ft. cable.
Model 611-8. List $35.50
Model 611-20. List $37.50

Model 630

High fidelity, high output dynamic. Response 60-13,000 cps. Output −55 db. Use on stand or in hand. Acoustalloy diaphragm. Omnidirectional. Tiltable head. "On-Off" switch. Satin Chromium finish. Compact, rugged, versatile. 18 ft. cable. Available in 50, 250 ohms or Hi-Z.
List $47.00

Model 605

Durable dynamic. Response 65-7500 cps. Output −55 db. Omnidirectional. Acoustalloy diaphragm. Head at 22° fixed tilt. Satin Chromium finish. Choice of 50, 250 ohms or Hi-Z. Models with 6 ft. and 18 ft. cable.
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Model 605-20. List $29.50

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Provides wide-angle front pick-up—dead at rear. Reduces feedback and reverberation pick-up. High-Low impedance selector. Tiltable head. "On-Off" switch. Satin Chromium finish. 18 ft. cable.
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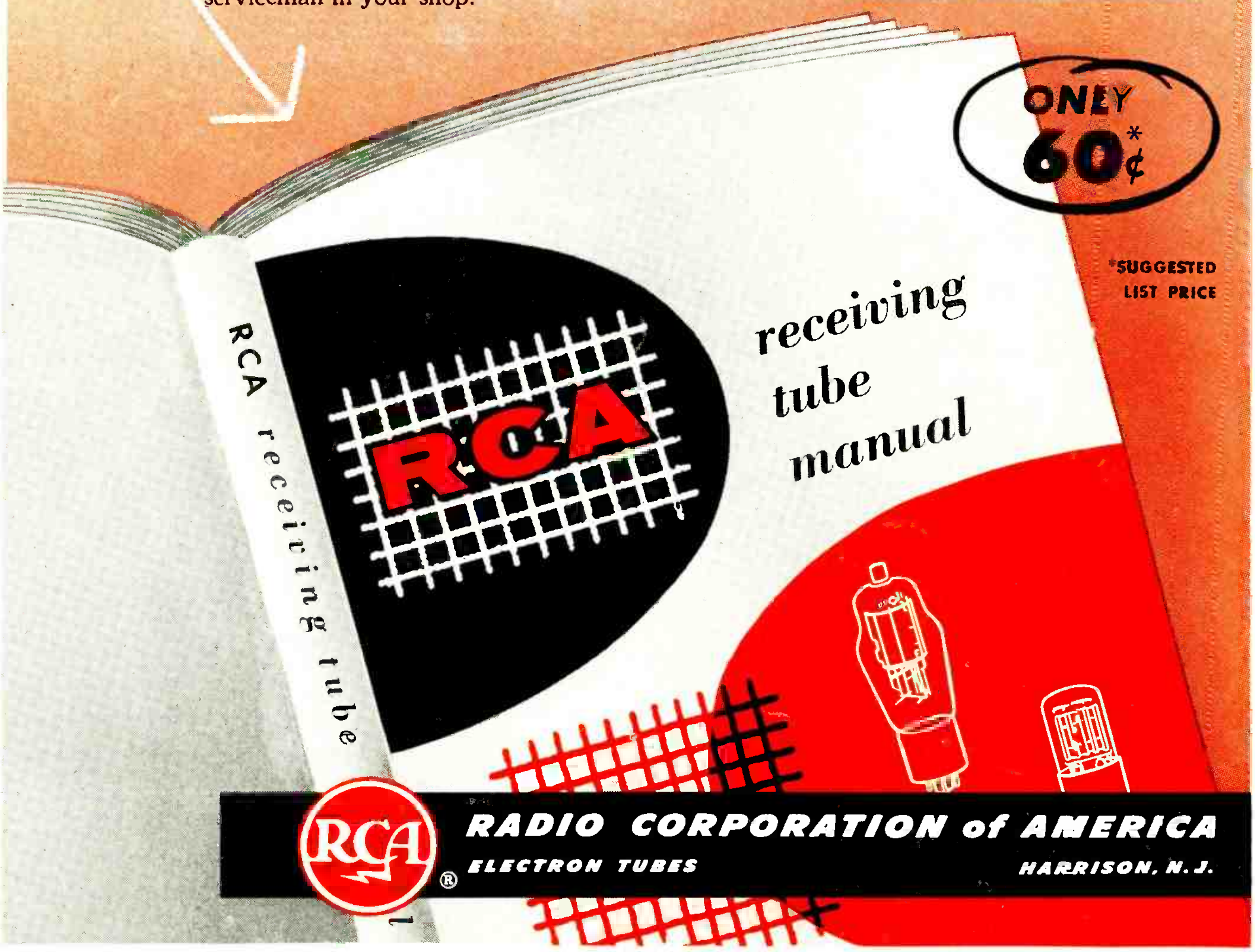

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