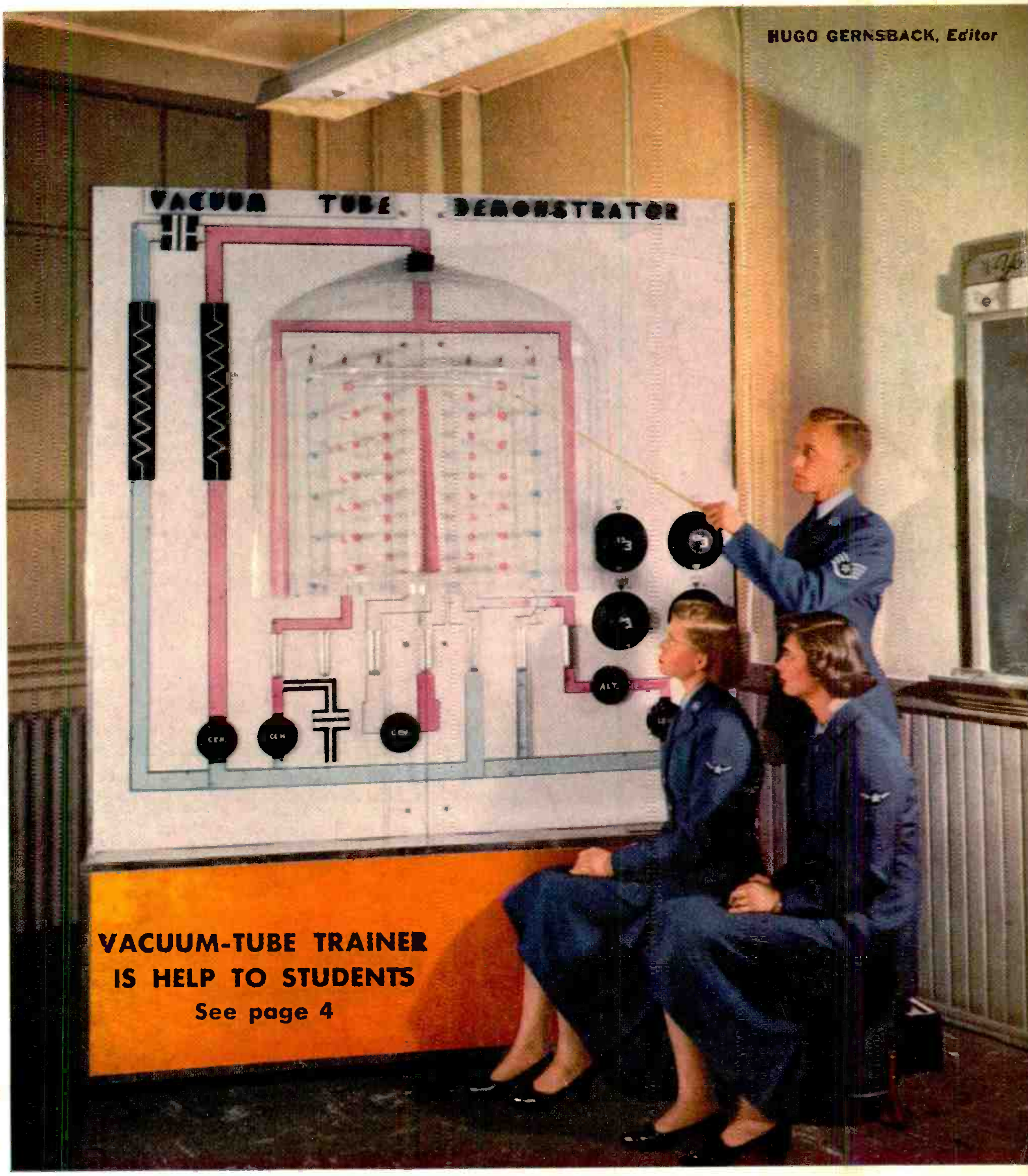
JUNE 1952

RADIO-ELECTRONICS

LATEST IN TELEVISION • SERVICING • AUDIO

HUGO GERNSBACK, Editor



VACUUM-TUBE TRAINER IS HELP TO STUDENTS

See page 4

30¢ U. S. and CANADA

In this issue: **Hard-to-Locate TV Troubles • Radio-Controlled Plane • Dynamic Signal Tracer**

You're top-man on our Totem Pole

...here's why:

You're in the *Radio Business.* So are we.

You're interested in promoting the sale and use of *radio products.* So are we.

If You prosper, so do we!

That's why we are so anxious to *give you help* when you stock, sell and promote the *RCA Battery Line.*

That's why we continue to channel our principal battery distribution to You, the radio dealer-serviceman, thereby assuring *You* the repeat business for RCA RADIO BATTERIES.

That's why we advertise You, The Radio Service-Dealer, on national network radio and TV programs . . . and tell millions of listeners that *You are best qualified* to *sell and install* RCA RADIO BATTERIES.

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Remember: You're a *Radio Man.*
We're a *Radio Company.*
If You prosper, so do we!

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So call your RCA Battery Distributor. Let's get started selling RCA Batteries together . . . *right now.*

RADIO CORPORATION of AMERICA

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I send you all the parts to build Transmitter shown below as part of my new Communications Course. Conduct actual procedure of Broadcast Operators, practice interesting experiments, learn how to actually put a transmitter on the air.

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EXTRA PAY IN ARMY, NAVY, AIR FORCE

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I TRAINED THESE MEN

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"I accepted a position as Radio and Television Technician . . . was promoted to manager of Television Service and Installation."—L. HAUGER, San Bruno, California.

"Four years ago, a bookkeeper on a hand-to-mouth salary, am now a Radio Engineer ABC network."—N. H. WARD, Ridgefield, Park, New Jersey.

"While learning, made $5 to $10 a week in spare time. Now have a profitable spare time shop."—L. ARNOLD, Pontiac, Mich.

"Have my own shop. Am authorized serviceman for five manufacturers and do servicing for 7 dealers."—P. MILLER, Maumee, O.

"When I enrolled, had no idea it would be so easy to learn. Have equipped my shop out of spare time earnings. I am clearing about $40 to $60 a month." J. D. KNIGHT, Denison, Tex.

I Will Train You at Home with MANY KITS OF PARTS I SEND

Do you want good pay, a job with a bright future and security? Would you like a profitable shop of your own? The fast growing, prosperous RADIO-TELEVISION industry is making these opportunities for you. Radio alone is bigger than ever. 90 million home and auto Radios, 3100 Broadcasting Stations, expanding use of Aviation and Police Radio, Micro-Wave Relay, Two-Way Radio for buses, taxis, etc., are making opportunities for Servicing and Communications Technicians and FCC-Licensed Operators.

Television is TODAY'S Good Job Maker

In 1946 only 6,000 TV sets sold. In 1950 over 5,000,000. By 1954, 25,000,000 TV sets will be in use, according to estimates. Over 100 TV Stations are operating in 35 states. Authorities predict there will be 1,000 TV Stations. This means new jobs, more jobs, good pay for qualified men.

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Send for my FREE DOUBLE OFFER. Get actual Servicing lesson. Also get my 64-page book, "How to Be a Success in Radio-Television." Read what my graduates are doing, earning. Send coupon in envelope or paste on postal. J. E. SMITH, President, Dept. 2FF, National Radio Institute, Washington 9, D. C. OUR 39TH YEAR.

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Mail me FREE Lesson and 64-page book. (No salesman will call. Please write plainly.)

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RADIO-ELECTRONICS

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

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JUNE 1952

ON THE COVER: Staff Sergeant Wm. L. Stevens instructs Pfcs. Nancy A. Edwards and Anna M. Lockard in the vagaries of the electron tube with the help of the demonstrator described on page 42.
Color original by Avery Slack.

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Deep scratches. If not too deep or conspicuous, try filling in with varnish stain or a polish stick. (One of the furniture touch-up kits now on the market will help here). If the scratch is deep or if it has chipped off any veneer, stripping, or inlay, *leave it alone or turn the job over to an experienced furniture repairman.* Wood fillers seldom produce satisfactory results in these cases.

Liquid marks, cigarette burns, other "party hazards." These usually damage the finish permanently and make it necessary to call in a cabinet refinisher. (Some dealers and distributors maintain their own cabinet repair departments—you might check on this in your own locality.) Small, slightly-damaged areas may respond to one of the wax-spot treatments already described.

Finger-marks. Remove with warm water, mild soap, and a soft cloth. Dry quickly. In some cases blowing on the spot and quickly wiping with a soft, dry cloth will remove them. Do *not* use carbon tetrachloride or similar cleaners on any plastic surface.

Candy marks, food marks, grease spots. Use warm water, a soft cloth (and mild soap if necessary). *Do not* scrub, but rub gently *with* the grain. Dry and polish with soft tissue or a soft, lint-free cloth, and finish with furniture polish or cabinet wax.

Pencil marks, crayon marks. Remove with Simoniz cleaner and polish with a soft cloth. Carbon tetrachloride, benzine, gasoline, or other available cleaning agents can be used on *wood* cabinets if removed immediately and the surface polished with a good wax or furniture polish. An art gum eraser is effective on pencil marks if they have not dented or punctured the finish.

Fingernail polish. If damage is not too serious, try softening with nail-polish remover. (Extreme care is required to prevent further damage to the finish.) Remove with Simoniz cleaner and polish to the desired luster. If the finish is damaged, try one of the wax-spot methods to smooth out the surface. If the damage is extensive or too noticeable, turn the cabinet over to a professional refinisher.

Refinishing plastic cabinets

To clean: Use mild soap and a soft cloth dampened with warm water. Do *not* use carbon tetrachloride or any kind of cleaning powder which contains fine abrasives or chemicals. These will ruin the finish and roughen or even dissolve the plastic.

To polish: Use Simoniz Kleener, Johnson's Carnu, Wright's Silver Cream, or equivalent. Apply with a soft, lint-free cotton cloth or tuft of absorbent cotton.

Soft drinks, liquids. These will roughen or pit plastic surfaces. To restore the finish, try rubbing with No. 0000 steel wool, moistened with light sewing-machine oil. (*Do not* use this method on lacquered or enameled surfaces.) Polish with Johnson's new liquid cream wax or a similar high-luster wax.

Aerosol bombs, DDT, similar liquids. Direct application may attack the surface of plastic cabinets and plastic safety masks. If the mask is fogged or roughened, it must be replaced. If the damaged area is small, try rubbing it *gently* with Bon Ami or similar cleaner and then buff with jewelers' rouge. Apply these with a soft, damp cloth. Apply pressure with the tips of the fingers. If this smoothes the area, finish by polishing with Glasswax.

Scratches on plastic cabinets. Extreme care is required in removing these scratches. The following method will be satisfactory in many cases:

a. Use No. 400 sandpaper; apply with a generous amount of water. Use free, easy, circular motions in applying. Finish with very light strokes.
b. When the area has been sanded, clean thoroughly with wet cotton, then dry with a clean tuft of cotton.
c. Apply polish generously and rub vigorously with rapid circular motions. Several minutes may be required to give a good luster.
d. Remove the polish with a damp piece of cotton and dry with another piece. Go over the entire area if necessary with another piece of dry cotton.

Materials for touch-up work

You can do these jobs faster and more efficiently if you have the following items arranged in a portable case.

1. Hand-type vacuum cleaner with furniture-cleaning attachment.
2. Assortment of small camel's-hair brushes.
3. Small bottle of carbon tetrachloride.
4. Several clean, lint-free cloths.
5. Touch-up kit for cabinet work.
6. Small-size Johnson's new liquid cream wax.
7. Small amount of rottenstone.
8. Small can of 3-in-1 machine oil.
9. Small jar of Simoniz Kleener.
10. Small bottle of furniture polish.
11. Polish stick.
12. Small vials of analine dye (mahogany, walnut, etc.).
13. Small bottles of walnut and mahogany varnish stain.
14. Razor blades (single-edge for safety).
15. Several small pins or needles.
16. Small can of benzine.
17. Small bottle of nail-polish remover or solvent.
18. One-half bar of mild (vegetable) soap.
19. Small jar of Wright's Silver Cream.
20. Small roll of absorbent cotton.
21. No. 0000 steel wool. Wrap to prevent mixing with other items.
22. Several sheets of fine sandpaper (No. 400).
23. Small can of Bon Ami.
24. Small jar of jewelers' rouge.
25. Small bottle of Glasswax.
26. Small bottle of window cleaner.

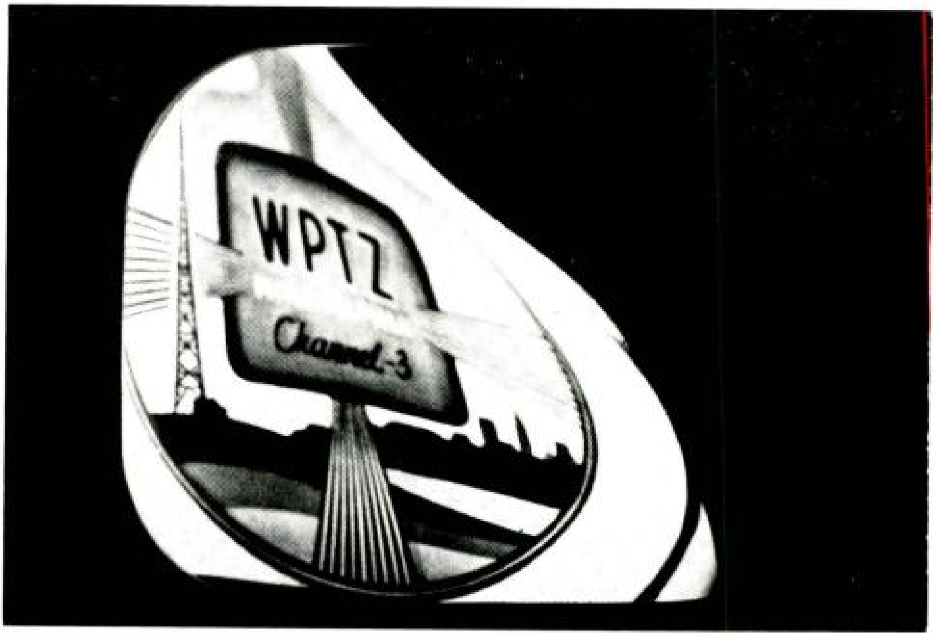
Assembling all these items and fitting them into a small bag may represent quite a job. It is entirely practicable, however, and will save you many steps as well as providing you with materials *when you need them!*

—end—

hard-to-locate TV TROUBLES

There's a solution to every TV service problem —often of the "Why didn't I think of that before?" variety. Here are a few that had an expert guessing.

By WALLACE WANER



Picture distortion caused by proximity of speaker magnetic field.

WHEN the experienced television technician runs across a "toughie" in his daily servicing, he usually sets it aside until he has gone through the receivers that have lesser troubles. Then his procedures usually include signal tracing, voltage and resistance checks, and other tests until the fault is finally located.

On occasion, however, he runs into a real sticker which taxes not only his ingenuity but his patience. Ordinary checks often fail to localize the defect and the problem child defies time-tested and usually reliable methods of diagnosis. Eventually, after endless chain-smoking and head scratching, he stumbles on some simple little item that takes only a few minutes to correct. Admirably refraining from throwing his v.t.v.m. through the picture tube, he sits down and wonders how he can avoid this time-consuming and nerve-racking experience in the future.

Unfortunately, however, he rarely comes up with any pat solution. Next time he may get an entirely different set of symptoms and find the same part responsible as in the previous case. The only thing he really learns is to be suspicious of *every symptom* in such instances and to exhaust every possible cause and effect. Swallowing his pride and consulting other experienced men also helps. After all, if doctors need an occasional consultation, the television technician should not feel any hesitation in doing likewise. Maybe the other fellow doesn't have the answer either, but he probably can add to your "could it be this or that" routine, and between the two of you the trouble can often be found in much shorter order.

Just to nudge you into adopting such an open-minded attitude, let's run over a few of the tougher problems which had to be solved recently by one eastern service shop. Perhaps you will be smarter than we were, and put your finger on the sore spot right away. To us, however, these and many prior toughies no doubt contributed to the distinguished gray which now graces our temples. While this may capture the adoring glances of the female of the species, we'd rather dispense with the charm and knock these television headaches out in quicker time.

Check the line voltage!

One problem which defied routine checks was a Hallicrafters T-54 7-inch receiver which had developed severe vertical and horizontal sync instability. The condition seemed to be intermittent and on occasion the receiver would be perfectly stable. The set was removed to the shop and thoroughly checked. All tubes, parts, and voltages were found to be normal. The set was run for two days yet developed no horizontal sync instability. It was returned to the customer and immediately the sync instability returned.

At first it was suspected that the line voltage was below normal, but inasmuch as the customer had a 17-inch receiver in the same home which was working perfectly, no a.c. voltage check had been made. This oversight was, of course, our first mistake. Upon checking the line voltage in the evening it was found to be less than 100. After additional thought the solution became apparent. The Hallicrafters, like many other receivers, uses a low-voltage tripling system to develop the proper plate potentials for the vertical and horizontal sweep oscillators. (See Fig. 1.) A voltage tripling system suffers more severely than a conventional power supply during line voltage fluctuations. Thus, if the line voltage is 115 volts, an unloaded voltage tripler develops over 460 volts because the capacitors charge to the peaks of the rectified a.c. signal. Under load, however, the voltage may drop to about 300. If the line voltage decreases to 90 (a 25-volt difference) the final voltage in the tripling process may reach only

1,945 New Television Stations

. . . . The second U.S. Television boom is now on. . . . . .

By HUGO GERNSBACK

THE long interdict of new TV station construction was rescinded by the Federal Communications Commission on April 14, 1952. The so-called television "freeze" had run for three and one-half years, during which time only the 108 television stations, now on the air, went into operation.

The future transmitter construction program will eventually put on the air in continental U. S. a total of 2,053 v.h.f. and u.h.f. television stations.

When this program is completed, there will be almost 350 cities with television stations instead of the 65 cities operating transmitters now. Recognizing the great power of television in the educational field, the FCC has assigned 242 channels to non-commercial educational stations, 115 in the present v.h.f. band and 127 in the u.h.f. band.

The FCC wisely inaugurated the television station freeze in 1948 because of the then-prevailing great interference of the low-band v.h.f. channels and to forestall the otherwise inevitable chaos of interference between television stations.

It should be realized that the coming second television boom which the unprecedented number of projected TV stations is bound to bring, will not come overnight. Fortunately for the economy of the country, it will be extended over many years. The reasons for this are simple. To begin with, completely equipped television stations are not built overnight. Moreover, prospective television station owners must first be licensed by the FCC in Washington. This means hearing after hearing to ascertain who is entitled to get such a practically priceless license, and what the prospective owners in turn will do for the public's good. A television station nowadays is a tremendous responsibility, and it cannot be one hundred percent commercial. It must render a valuable service to the public. Hence, long extended hearings are in prospect in Washington.

It should also be noted that the majority of the new stations will not be connected with present networks—and may never be—on account of their geographical location. This means that most of the new stations will have to be independent, using local talent and motion pictures almost exclusively.

It is felt that within about five years, all the 1,945 new stations will be operating full blast, blanketing the entire country with television. This contrasts with the fact that only 60% of the U. S. population has television today. In the future there will be few sizable towns that will not have one or more television outlets.

Fortunately, there is at present no freeze or shortage of television equipment. The manufacturers of television transmitter equipment had foreseen the lifting of the freeze and had made preparations to meet it. The prospective television station operators therefore will have no difficulties in building their stations as fast as they have been licensed by the FCC. According to the *Radio and Television Manufacturers Association*, more than 20 stations in cities not now served by TV will be operating before the end of the year.

What does the second television boom mean to the country's economy? Benjamin Abrams, president of the Emerson Radio and Phonograph Corporation, predicted in the middle of April that the industry's present annual turnover of two billion dollars would reach five billion to six billion dollars within three years. All sources agreed that the new boom will be one of the important factors in the national economy, and is certain to last for five years and in our own estimation perhaps longer.

The reason for the last statement is that it is fairly certain that the boom will be extended beyond five years, when color television has come into its own.

Up to the present time, American manufacturers have produced 17,000,000 television sets. Spokesmen for the industry assert that by the time all of the new television stations are operating, there will be over 50,000,000 TV sets in continental U. S.

From the servicing, converting or adapting standpoint of television sets now in use, it is interesting to note that for once American manufacturers had foreseen what was ahead. Many of them had for years designed their sets in such a manner that they could be adapted to the new u.h.f. stations with little additional cost. Tuning strips will be supplied—they are even available now—by many of the television set manufacturers whose sets use turret tuners. Thus the service technician can convert a receiver to receive one or two u.h.f. stations in a matter of fifteen minutes to one-half hour by means of a tuning strip supplied by the manufacturer. The cost in many cases will not be much more than $10.00 per set. Converters will be available for sets which do not use turret tuners, or where a larger number of u.h.f. stations are to be received.

Set manufacturers also say that the u.h.f. sets will give better pictures in some instances, for the reason that these frequencies are not so sensitive to man-made static caused by home appliances, X-ray, diathermy and other electrical apparatus.

In the past, the radio press has been criticized by some members of the radio servicing industry who felt that radio magazines and the press in general have devoted too much space to television. Inasmuch as a large part of the country from which such complaints originated was not served by television, this criticism was understandable. All such objections have now been removed and radio technicians who have not had a chance to service television receivers before, now have the opportunity of their lives. They should immediately get ready for the coming boom in their sections of the country if they wish to share in the new prosperity.

We have mentioned before, and we now reiterate, that radio technicians in areas soon to be equipped with television must immediately take active steps to become expert in television servicing. The best way to do this is to get a television chassis and go to work on it and familiarize oneself with its intricacies. Nor is it necessary to work on a "dead" set. Even if there is no television station in the neighborhood, many tests can be made with a signal generator, which all service technicians possess. And with a good, high antenna some excellent dx is bound to be received in all parts of the country during the summer season. Nor is it necessary to buy a brand new television set. Many dealers in the larger cities all over the country have second-hand 10-inch chassis for sale at low prices. They are ideal for the purpose.

START YOUR TV HOUSECLEANING NOW

"Now is the time—"
This will be a busy summer for TV. Sell maintenance for slack-time profit

By JOHN B. LEDBETTER

EVERY TV receiver, regardless of age or make, should be given a thorough inspection, tube-check, and cleaning at least once a year. In a year's time, the cumulative effects of heat, tube-aging, vibration, and dirt invariably degrade the picture.

Normally, the most logical time for cleaning and overhauling a set is in summer, when the average owner uses it least. This summer, however, the presidential nominating conventions and the following campaigns will stimulate televiewing to an all-time high.

Start your own campaign, by mail, newspaper advertising, or phone, reminding your customers of what the summer will mean on TV. When you get a receiver, be sure to cover *everything*. Make a brief but thorough inspection of the chassis for corrosion, loose mountings, dust, and wax. Examine the wiring, terminal strips, components, and sockets for evidence of overheating or arcing, poor terminal contacts, and poorly-soldered joints. After this, you can proceed with the cleaning chores.

Cleaning the picture tube

Wear protective goggles when you remove the picture tube. As soon as the tube is exposed, lay a heavy canvas cloth or towel over the top and sides as added protection. This may seem repetitious or over-cautious, but take a look at page 114 in the February issue of RADIO-ELECTRONICS. This shows what *can* happen when a kinescope implodes.

Clean the tube face with a soft, lint-free cloth dipped in mild soapy water (or use regular window cleaner). *Do not* wipe the glass with a dry rag—it may scratch the surface and pave the way for a subsequent implosion. Clean the inside of the safety glass in the same way and dry with a soft paper towel or lint-free tissue. If lint collects on the safety glass, remove it with the furniture-cleaning attachment of a vacuum-cleaner. This is much more effective in removing lint than blowing or attempting to wipe it off with a cloth or brush. Several portable-type vacuum cleaners are now available which will serve this purpose very well.

In restaurants and taverns, nicotine-and grease-laden smoke deposits a yellowish coating on the safety glass and face of the picture tube. Owners of these sets should have them cleaned regularly (at least twice a year, and oftener if required). Check the position of the mask—it should fit snugly around the picture-tube face as dirt and grease will accumulate very quickly. In many cases this can be corrected by sealing the mask to the picture-tube face with masking tape. Sealing the edges of the tuner shield compartment in the same way will keep grease from getting into the head end and seriously affecting reception.

For cleaning rubber ring masks or gaskets, use a piece of soft cotton saturated with carbon tetrachloride. Be careful not to get the liquid on any plastic mask or insulating sleeve.

Cleaning the receiver chassis

A layer of dust on the chassis reduces normal air circulation around the tubes and other components. In addition, it increases the danger of arcing and breakdowns (especially in the high-voltage power supply) by absorbing moisture. The best way to clean the set is with the vacuum-cleaner attachment mentioned above. A blower is *not* recommended because it only blows the dust *into* the set where it may cause trouble on switch contacts and other moving parts. After cleaning, make sure all tubes, tube shields, connectors, and leads are in place and properly seated.

Refinishing wood cabinets

After the picture tube and chassis have been cleaned, start on the cabinet. Usually the finish will show some damage, but with a little effort it can be made to look like new. Here are a few hints on cabinet rejuvenation—BUT—if you have never done any cabinet refinishing don't practice on TV receivers! Learn the game on some of those old radio sets the customers didn't call for. Strange and irreversible things can happen when a green man and a rag of furniture stain get together on a good cabinet.

Wax spots, polish marks, cloth burns. For high-gloss finishes use Johnson's new liquid cream wax polish. Rub gently with a soft cloth. For satin finishes, saturate a soft cloth with rottenstone and light machine oil and rub lightly *with* the grain until the marks disappear. Another method is to use a soft cloth saturated with Simoniz cleaner. Rub gently with the grain. *Never use circular motions or rub across the grain.*

Minor scratches. Use regular furniture polish, a polish stick, or analine dye (available at most furniture repair shops). If the scratch has not completely penetrated the finish, take a fine needle and carefully scratch through the surface to the wood. This allows the stain to soak *into the wood* instead of merely filling in the hard top finish. Analine dye should be applied carefully with a small water-color or camel's-hair brush. Apply several times if necessary until the scratched area matches the cabinet finish in color. Wipe the excess from the surface and allow a few minutes for drying before wax or polish is applied.

200, *a 100-volt difference*. This was the cause of the instability. A line regulator transformer solved this problem.

A tube teaser

Another case of unstable horizontal sync occurred in an Emerson receiver using Synchroguide horizontal lock. The vertical was relatively unaffected, though the hold control seemed critical. Again, all parts, tubes, and voltages were normal. The step-by-step alignment procedures for the Synchroguide were undertaken with an oscilloscope but this was no help. The sync separator and amplifier tubes and their associated resistors, capacitors, and voltages were checked. Again, nothing seemed amiss. Finally, even though the tubes checked well in an emission-type tube tester, the tubes in the sync-separator and amplifier circuits were replaced. This cured the trouble. It was found that the sync amplifier tube had varying characteristics which caused intermittent output amplitude.

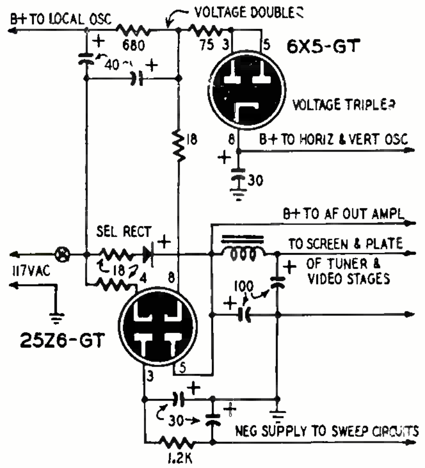


Fig. 1—Voltage tripling system used in Hallicrafters TV models T-54 and T-155.

The Synchroguide responds to the *area* of the signal at the grid of the control tube. For this reason, manufacturers strive to present a constant amplitude sync level to the Synchroguide circuit. This solution also helped the vertical system, although this does not rely as much on sync amplitude as on the repetition rate of the incoming pulses.

Laying a ghost

Another job which consumed considerable time before a solution was found was an Admiral 20A1 with intermittent ghost reception. Pictures were often ghost-free, but at other times pronounced ghosts were present. As there were no high buildings or water towers in the neighborhood, our first thought was that the characteristics of the tuner or video i.f. stages were changing and causing an unsymmetrical bandpass. If the bandpass of the video i.f. stages is such that it is humped at the high-frequency sidebands of the television carrier, it will often pulse video-amplifier stages into momentary transient oscillation at the higher modulating frequencies. This can simulate ghost reception.

A check at the shop showed the i.f. response to be correct and the set operated normally. When the set was returned, the intermittent ghost reception appeared again. Upon further checking it was found that the reflections were coming from another receiving antenna off the path of the stations in the area.

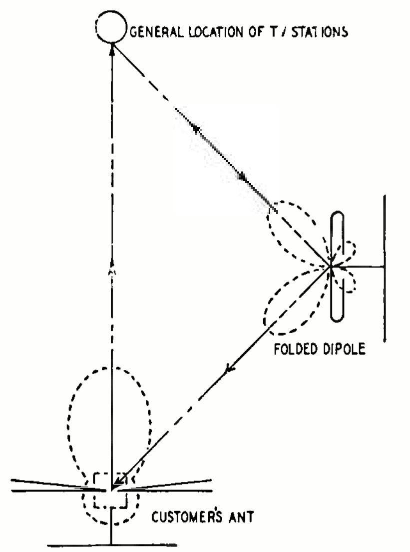


Fig. 2—Ghost signals were caused by reradiation from a distant rotary antenna.

This is shown in Fig. 2.

The offending antenna was motor-driven. When rotated, it would, in certain positions, reflect sufficient signal to cause ghost reception. Additional checks indicated that this condition is much more pronounced when the two antennas have the same physical length. This condition is also aggravated by antennas having two primary lobes, such as a folded-dipole with reflector working on the higher channels.

There was nothing that could be done except to ask the owner of the offending antenna to keep it stationary or to erect a screen between the customer's antenna and the remote antenna. It was found that a small section of chicken-wire screening, erected eight feet away from the antenna, and grounded to the roof, was sufficient to suppress the undesired reflections.

The perfect alibi

Manufacturers are sometimes at fault. They will bring out a new model and publish complete service notes for it. Often, however, field tests and reports from dealers indicate that certain circuit changes should be made. Future runs of this model are modified, and supplementary service notes covering the changes are issued. Thus, unless such design changes and corrections are made by the servicing technician, a characteristic trouble may never be entirely corrected. The technician should always check to see if supplements have been issued.

Possible faults or omissions in the original assembly should not be overlooked. In one instance, a pronounced buzz was traced to the speaker. It was found that the leads running to the speaker terminals were mechanically fastened but not soldered.

Another instance which proved particularly troublesome occurred recently in a receiver of a well-known make. The picture and raster were intermittent but the sound was all right. Checks were made at the grid of the picture tube and the associated controls. All voltages were normal and remained stable for hours of operation. Even the picture tube socket was inspected and found to be all right. A new picture tube was about to be installed when one of the technicians applied pressure to the base of the original tube and found that it was loose. A closer inspection revealed that some of the socket pins were not cleanly soldered. As the base cement was not holding to the glass neck, the pin leads were unsoldered and the base removed. Two of the wires were found badly tarnished and had been cold-soldered during the tube assembly.

Each lead was cleaned and tinned and the base reconnected and recemented. This cured the trouble.

Divide and conquer

Some cases are recurrent and eventually are recognized for that reason. Earlier, we had a habit of replacing only one of a pair of parallel 5U4 rectifiers if one of the tubes went bad. This often resulted in the new tube carrying most of the load. Manufacturers use paralleled low-voltage rectifiers for the prime purpose of distributing the load evenly between the two tubes. When one is replaced, it will have greater emission than the old one and the current will be unevenly divided. The new tube will have a much shorter life than if both tubes were replaced. This is also good practice in high-voltage systems where two 1B3 or 1X2 tubes are used in voltage-doubling circuits.

Mistakes are costly in terms of wasted time. One of our men had placed a chassis on its side to replace a low-voltage filter capacitor. When finished he checked the receiver without putting it right side up, and got the picture shown in the photo on the opposite page. After an hour of frantic (and useless) linearity and centering-control adjustment he found the trouble. The speaker was wedged under the glass picture tube and its magnetic field was distorting the beam. Fortunately the tube was not metal, or we would have had a demagnetizing job to perform. Which just goes to show, you never know what you'll run up against next in this TV business. Never a dull moment, though.

—end—

A discussion of new features in the circuits of modern television sets and 3-way portables

short circuits

By ROBERT F. SCOTT

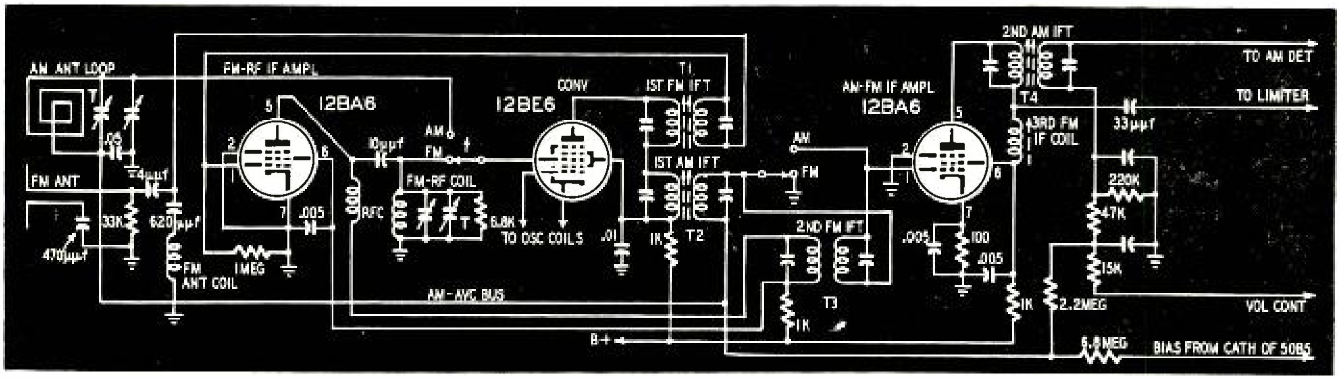


Fig. 1—A partial schematic showing the operation of the reflexed r.f.-i.f. amplifier used in the G-E model 218 receiver.

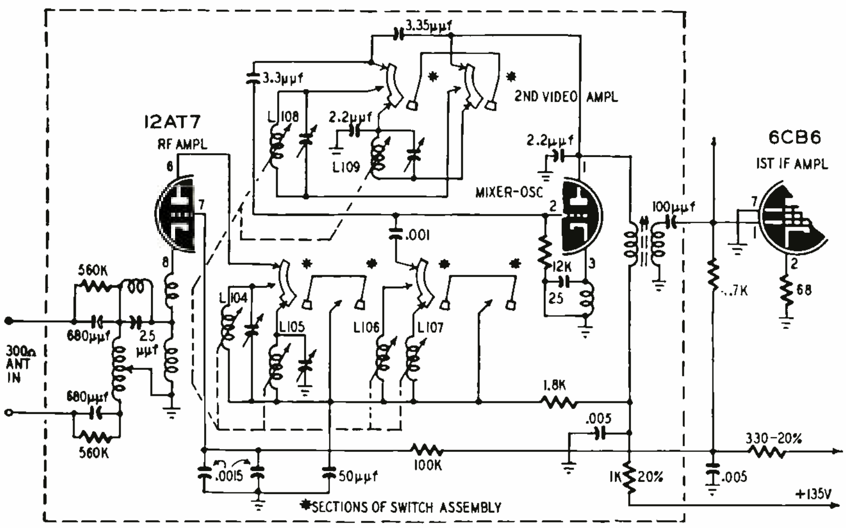
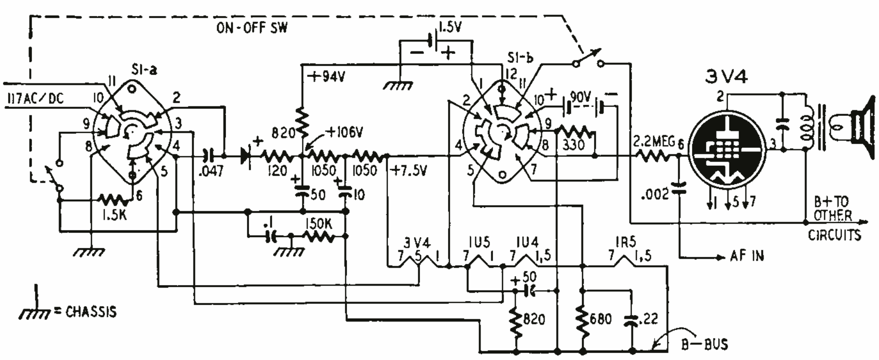


Fig. 2 (above)—Diagram of the 1-tube TV tuner used in some Tele-Tone chassis. Fig. 3 (below)—Diagram of the filament switching circuit in the Philco 51-629.



SOMETIMES we feel that a title like "The Unexpected" or "Surprise!" would be far more descriptive than the one which we have chosen for this column. The drawing-board wizards and assembly-line Houdinis are certainly coming up with some shockers. We have been keeping an eye on foreign receiver circuits for a few years and are not too surprised when we see an r.f. or i.f. amplifier also used as an audio amplifier. But when we find a set in which the r.f. amplifier serves as a reflex i.f. amplifier, as in the G-E 218 6-tube AM-FM receiver, it's time to swear off and reach for an aspirin. The reflex circuit of this set is shown in Fig. 1.

On FM operation, the 12BA6 acts as both r.f. and i.f. amplifier. The signal from the antenna is developed across the antenna coil and fed *through the secondary of the first FM i.f. transformer* T1 to the grid of the 12BA6 amplifier. The r.f. signal is amplified and fed through a 10-μμf coupling capacitor to the grid of the 12BE6 (The r.f. choke has sufficient reactance to prevent the FM r.f. signal from straying into the primary of the second FM i.f. transformer.) The r.f. signal is reduced to 10.7 mc and appears in the primary of the first FM i.f. transformer. The signal in the secondary is fed back to the grid of the first 12BA6 now operating as first FM i.f. amplifier.

From the plate of the 12BA6, the signal passes through the r.f. choke to the primary of T3, the second FM i.f. transformer. The signal then passes from the secondary of T3 to the grid of the second 12BA6 which is used as the first AM and second FM i.f. amplifier. The amplified 10.7-mc signal next appears across the third FM i.f. coil where it is coupled into the grid of a 12AU6 limiter (not shown) through a 33-μμf capacitor.

On AM, the circuit is more conventional. The signal is fed from the AM loop antenna directly to the grid of the 12BE6 converter. The 455-kc AM i.f. signal passes through T2 to the 12BA6 i.f. amplifier, then through T4 to the AM detector and a.v.c. diode of the 19T8. The a.f. signal follows the same path as it does during FM operation.

closed one side of the power line connects to B minus through the on-off switch and contacts 9 and 10 of S1-a. The other section of the line connects through contacts 2 and 11 to the selenium rectifier which supplies A and B voltages. Contacts 5 and 6 connect a shunting resistor between the center-tap of the 3V4 and ground. Pin 1 of the 3V4 is 4.5 volts positive with respect to the grid. This voltage provides fixed bias for the 3V4 during line operation.

Approximately 94 volts from the B supply is fed to the plates and screens through contacts 11 and 12 of S1-b. Part of the output of the selenium rectifier is dropped to 7.5 volts for the filaments. The 820- and 680-ohm resistors carry the cathode currents of tubes between the dropping resistor and B minus. Contacts 8 and 9 of S1-b ground the grid return of the 3V4.

For battery operation, sections 8 and 9 of S1-a connect the B minus bus to the chassis through the on-off switch. Sections 4 and 5 connect the 3V4 center tap to B minus. One of the filament pins of the 1U4 and 1U5 is connected to B minus through sections 3 and 4 of S1-a. The ungrounded filament pin of each tube in the string is connected to the positive side of the 1.5-volt filament battery through contacts 1, 2, 4, and 5 of S1-b. The negative side of the filament battery connects to the chassis so the line switch must be on and S1 set for battery operation before current can be drawn from it.

Sections 10 and 11 of S1-b connect the positive side of the 90-volt B battery to the B plus line in the set. Sections 7 and 8 connect the negative side of the battery to the junction of the 330-ohm and 2.2-megohm resistors so the smaller resistance is between B minus and ground. This resistor biases the 3V4 during battery operation.

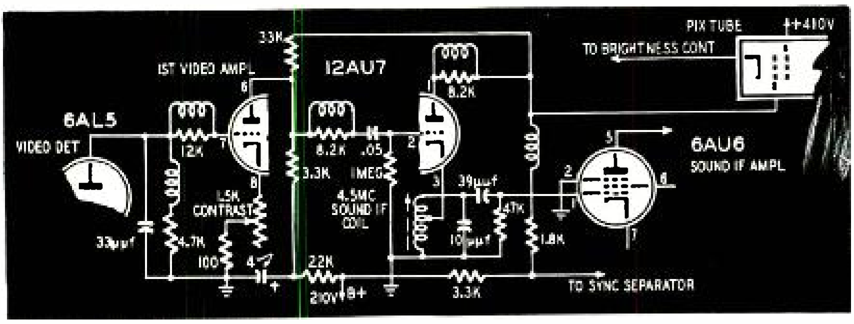


Fig. 4—Interesting sound take-off employed in a number of Majestic models.

One-tube TV tuner

Have you ever seen a one-tube TV tuner? If you haven't, take a close look at the next Tele-Tone TV set that comes in. If it uses a TAM or TAP chassis, you are likely to see one lone 12AT7 on the tuner chassis. This tube performs the functions of r.f. amplifier, mixer, and oscillator. The TV band is covered in two ranges, channels 2 through 6 on one, and 7 through 13 on the other.

One triode of the 12AT7 is a grounded-grid r.f. amplifier—a circuit which minimizes oscillator radiation through the tube into the antenna while generating comparatively little noise. See Fig. 2. The remaining triode is the oscillator and mixer. The various channels are selected by a combination of variable-inductance and variable-capacitance tuning. The r.f. amplifier plate coils L104 and L105, mixer coils L106 and L107, and oscillator coils L108 and L109 are stamped into bakelite sheets sandwiched between movable brass plates which act as the rotor plates of a capacitor. The oscillator is a modification of the familiar ultraudion. The sound i.f. is 21.25 and the picture i.f. is 25.75 mc.

Three-way filament operation

The filament switching circuits of many 3-way portables are complex and are likely to cause trouble for the service technician who is not too familiar with them. Therefore, we will discuss the switching circuits of a typical 3-way portable.

Fig. 3 is the circuit used in Philco's 51-629. The voltage-selector switch S1-a and S1-b is shown in the LINE position. When the on-off switch is

Novel sound take-off

In most intercarrier TV sets, the sound is taken off either at the output of the video detector or the plate circuit of a video amplifier. The novel arrangement shown in Fig. 4 is used in the Majestic 700, 712, and 801. These sets have a 2-stage video amplifier using a 12AU7. The sound take-off is in the second video amplifier stage which has its cathode grounded through a tap on the 4.5-mc sound i.f. coil.

—end—

TV DX IN JUNE

If you've had the idea up to now that TV dx is something that happens to somebody else, June is your month. Sporadic-E dx occurs somewhere in the United States practically every day.

June, 1951, reports received by RADIO-ELECTRONICS showed 26 days of dx, and there is every reason to expect that 1952 will be at least as good; perhaps better, as there is some evidence to indicate that sporadic-E dx is more prevalent in years of low sunspot number.

Dx reception will be frequent in the mid-morning hours, dropping out usually around the middle of the afternoon, and often returning in the early evening. The best dx will usually be over by 10 to 11 p.m., local time, but as the month wears on, late-evening reception will become more common. In fact, there will be times in the latter part of June when dx will be receivable during just about any hour that there are stations on the air in the right places.

The most frequently logged distances will be 600 to 1,100 miles, but intense ionization will bring the skip distance down to as little as 300 to 400 miles at times. Ionization over wide areas simultaneously will make multiple-hop effects possible, and the distance you can cover will be limited only by the number of stations on a given channel. Eastern viewers who don't mind staying up until their nearer stations have left the air should be able to log some West Coast stations, though the multiple-hop reception will not generally be as good as the single hop. Reports of reception in excess of 1,500 miles, particularly, are solicited.

Though the main item of interest to the TV dx enthusiast will be the sporadic-E skip sessions, we should not overlook the possibilities of tropospheric dx, particularly on the high channels. Along both our coasts, all across the southern part of the country, and in the region around the Great Lakes, June will provide the kind of weather that makes for considerable extension of the normal reception range. Look for excellent high-band reception in the early morning hours, particularly on fair calm days. Late evening hours will also provide good hunting on the high channels. (The normal range will be extended on the low bands, too, but tropospherically reflected signals may often be obscured by sporadic-E dx on channels 2 through 6.)

While all this early-summer dx will be fun for the viewer who is interested in long-range propagation, it will be a source of trouble for TV technicians. A high percentage of TV set owners are interested only in entertainment. Few of them will know what causes the pile-up of signals that is almost certain to occur when stations a thousand miles away start rolling in with almost local signal strength.

—end—

TV SERVICE CLINIC

Conducted By
MATTHEW MANDL*

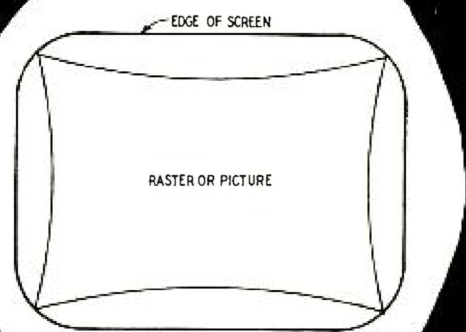


Fig. 1—"Pincushion" effect.

MANY of the new receivers use the curved-face (or so-called "cylindrical") rectangular tubes designed to eliminate room glare. These include the 17LP4, 17QP4, 21EP4A, 21FP4A, and 21KP4A. When a cosine-wound yoke is used with these tubes for sharp edge-to-edge focus, pincushion effects are set up.

To eliminate them, two magnet slugs are placed above and below the tube at the beginning of the flare. These magnets extend slightly beyond the frame of the yoke housing and are suspended by an adjustable wire support.

When replacing defective picture tubes of this type, the magnets may have to be readjusted, particularly if they are accidentally moved from their original position.

Unless a station pattern is on, or a cross-bar generator used, the pincushion effect may not be too noticeable. But when viewing televised scenes with vertical or horizontal sections, the viewer would notice the bending effect and distortion. Adjustments are simplified if the picture size is reduced slightly so the pincushion effect is noticeable as shown in Fig. 1. The magnets should then be adjusted until the picture is perfectly rectangular, after which the size can be increased to fill the mask properly.

This adjustment will not correct poor sweep linearity or overdrive conditions. Such defects must still be overcome with the usual controls.

Another factor important in servicing such television receivers: Adjustments of the centering ring may disturb the edge-to-edge focus procured from the cosine yoke. Thus, after positioning the picture with the centering ring adjustment, check the edge-to-edge focus by closely observing whether the horizontal line trace is sharp along its entire length.

If this is difficult to see, misadjust the vertical hold control slightly until the picture rolls slowly. This will eliminate interlace and cause line-to-line pairing. Under this condition the line structure is heavier and edge-to-edge focus is easier to check. Readjust the focus control and recheck picture centering, for the focus control has a slight effect on picture position. Finally, readjust the focus control until full beam clarity is regained.

Also check the ion trap magnet. Too weak a magnet will make it difficult to eliminate corner shadows at the setting which gives maximum brightness. Incorrect ion trap magnet position will cause ion burns eventually—the length of time depending on how far off true position it is. (See the article on that subject in the February, 1952, issue.) If the magnet is weak it may have to be placed closer to the focus unit. The fields of the latter will influence the ion trap and make it difficult to adjust either one correctly. A new ion trap magnet is relatively inexpensive and can save costly picture tubes as well as permit you to make proper adjustments for better performance.

Intermittent interference

In a location across the street from a high-voltage substation there is an intermittent roaring noise from the speaker, accompanied by sync loss. Could this noise and interference originate in the substation? J. P. F., Roan's Prairie, Texas.

It is quite possible that an intermittent high-voltage arc at the substation could cause the symptoms you describe. When this condition again occurs, remove the antenna lead-in from the receiver to see if the interference decreases. If the noise is still present, the a.c. mains are feeding it into the receiver. A line filter would then help.

This test, however, could also indicate that the trouble might be a loose or intermittent connection within the receiver itself. This can be verified by trying another receiver in the same house.

If the interference is from a radiated source the solution is more difficult. You will have to get the power company to check their equipment to eliminate the arcing condition, for at such a close distance little can be done in the way of antenna line filtering.

High-voltage rectifier troubles

In a Sylvania model 7120BF receiver I've had to replace the 5642 high-voltage rectifiers repeatedly. Some picture blooming now occurs. R. L. B., Canton, N. Y.

The high voltage circuit of this receiver uses the voltage-doubling principle with two 5642 rectifiers. Try a 3.3-ohm resistor in series with the filament wire to the tube which burns out more frequently. You could also rewire the circuit to accommodate the more rugged 1B3.

Replacement tuners

Would fringe area reception be improved by the installation of one of the new type front ends using the cascode circuits? Would the receiver or tuner require alignment after installation? C. E. C., Lynchburg, Va.

The new front ends containing the cascode tuner have exceptional characteristics for fringe areas. They have considerably more gain and much less snow effect than the older tuners. Most of these replacement tuners are accurately tracked at the factory, so extensive realignment procedures would not be needed. Usually all that is required is a slight retouching of the output picture and sound coils. Complete installation information is usually furnished with the new replacement tuners. Make sure you get one to match your present i.f.

Booster oscillation

I have three boosters hooked up to an RCA 630TS. All the boosters are of different makes but all use 6AK5's. I have trouble keeping them from oscillating between each other. Would you tell me how to keep them from oscillating? R. D., Washington, D. C.

Your boosters oscillate because of overloading the inputs to the second and third booster. Virtually all boosters are designed for the specific purpose of building up a very weak signal. When you inject the output of one booster into another, the second booster (and third) receive signals far in ex-

* Author: *Mandl's Television Servicing.*

cess of those for which they were designed. This trouble often occurs when *two* boosters are placed in series and would be even more likely with your combination of three.

You could install gain controls in the first two boosters so the output of each one does not overload the next one. These could be potentiometers in the cathode circuits. They would regulate the bias, and thus the gain. The potentiometers should have slightly more resistance than the existing cathode resistors. With sharp-cutoff tubes the control would not be as effective as with remote-cutoff types.

Tuner trouble

I have installed a new Standard tuner in an RCA 8-T-243. The tuner works all right except for channel 5. For this station there is a difference of about 3 or 4 turns of the oscillator screw between the sound and picture. How can I correct this trouble? B. D., Knowlton, Quebec, Canada.

As there is an appreciably greater difference in the trimmer adjustments of the oscillator screw on channel 5 than on other channels, it may indicate improperly adjusted coils. Since the coils are of the snap-in type, you can remove the two and increase the coupling between the coil sections. This will increase the band-width and might give you both picture and sound for one setting of the oscillator trimmer adjustment.

This receiver is of the split-sound type and will always receive best picture and best sound at slightly different settings. The receiver should be adjusted for best sound for both the oscillator set-screw and the fine-tuning control.

If coil correction cannot cure the trouble, you can get coil replacements for channel 5.

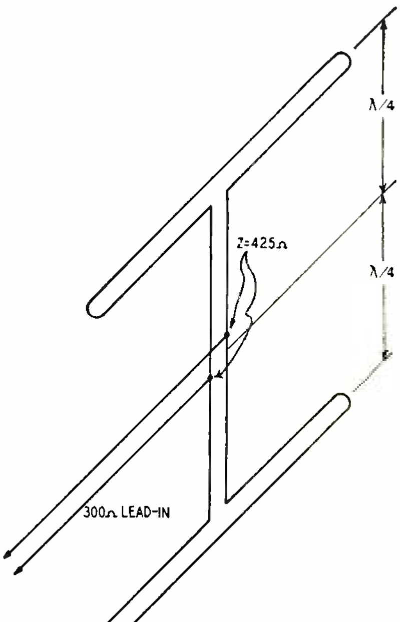


Fig. 2—A method of connecting 2 stacked antennas to a common transmission line. Although folded dipoles are shown, the method and impedance values shown in the drawing apply equally to vertically-stacked Yagi antenna arrays. Matching section is described in the text.

Interference traps

What can be done to reduce diathermy interference? I have tried homemade traps, but these had little effect except to reduce signal strength. E. M., Ottowa, Ontario, Canada.

Probably your homemade traps were tuned within the television band and therefore diminished the desired signals instead of the interference. Try commercial traps; these are calibrated at the factory and are more effective. They are made by several companies, including Drake, JFD, and Telematic. The JFD BR 106-10-30 is for shortwave and diathermy from 30 to 60 megacycles. The BR 106-60-90 is for diathermy or other interference from 60 to 90 megacycles, as is also the Telematic WT-16. The Drake model is the TV-300-50HP. A number of manufacturers will now supply traps gratis for any of their models subject to such interference.

Stacking Yagi antennas

We are located in an extreme fringe area and receive channels 3 and 6 from Omaha and channel 4 from Kansas City. The five-element tuned Yagi antennas have proved satisfactory, but I would like to stack this type. What is the best spacing? W. H. K., Mankato, Kansas.

For best reception with the Yagi antennas you should stack them one-half wave-length apart. In this manner you will get true broadside reception with a gain increase of approximately 4 db. Often, broadband antennas are stacked less than this to favor the higher channels, but, since you are using a single channel Yagi, a half-wavelength spacing is recommended. Use parallel bars to interconnect the two and feed them in the center. See Fig. 2. The impedance of the matching section should be 425 ohms. This may be ¼-inch tubing spaced 4½ inches or No. 12 wire spaced 1½ inches. You'll get additional gain if you use the double-stacked Yagis for one channel because stacking gives the 4-db gain mentioned above.

Antenna choice

In this area all channels (2 through 13) are broadcast from Mount Wilson, about 90 miles away. Evidently a Yagi would not be suitable because it is not broadband. What suggestions do you have for an antenna system? J. J. D., Edwards, Calif.

If all your channels are broadcast from Mount Wilson, 90 miles from your receiver, you could use a stacked biconical antenna array with reflectors. If it is mounted high enough you should get good results. Use an open-wire transmission line for minimum lead-in loss. Use the biconical with three rods each side of the insulator, for this helps broadband reception and increases impedance. A Yagi would give some 5 db greater gain but—as you stated—would be narrowband. Some Yagis are available for two-channel operation but are not much use beyond that. Several Yagis, of course, could be used with separate lead-ins and a switch arrangement for antenna selection. If more gain is desired, use a booster.

TV conversion for Europe

I am planning to send a television set to my brother in Sweden. He is located 12 miles from a TV station which is transmitting on a frequency similar to channel 3 here. They use FM for the sound and AM for video but they are using a system of 625 lines and 25 frames.

The set I expect to send is an RCA Victor, model 17T172.

I am wondering how many changes would be necessary to make this set work over there. G. A., North Wildwood, N. J.

You mention that the receiver is to be used in an area where a system of 625 lines and 25 frames is used. This would give a horizontal sweep frequency of 15,625 in contrast to the 15,750 in use in the United States. This would be close enough so that no changes need be made in the horizontal sweep circuit. Possibly, slight readjustment of the hold control or the frequency control in the Synchroguide system may assure better stability.

The vertical sweep of the RCA is designed for 60 cycles, using the interlace principle. Our standards of transmission utilize 30 frames per second, interlaced 2:1, which results in 60 fields per second. We are using 525 lines per frame (525 times 30 equals 15,750). If this receiver is to be used with interlaced scanning at a 50-cycle rate, no vertical changes would be necessary either.

You should ascertain whether the power supply requirements in Sweden can be satisfied. Many parts of that country use 25 cycles. Is this receiver to be used in an area where 110-117 volts, 50 cycles is available?

Another factor would be the r.f. tuner. You mention that transmission is from a station on a frequency "similar to" channel 3. Possibly, slight oscillator slug adjustments would have to be made if there is a slight frequency difference. Other factors are bandwidth and type of transmission. The RCA is designed for a bandwidth of transmission in the tuner of 6 mc. U. S. TV standards call for vestigial sideband transmission and spacing of 4.5 mc between video and sound carriers, with the sound carrier 4.5 mc *above* the video.

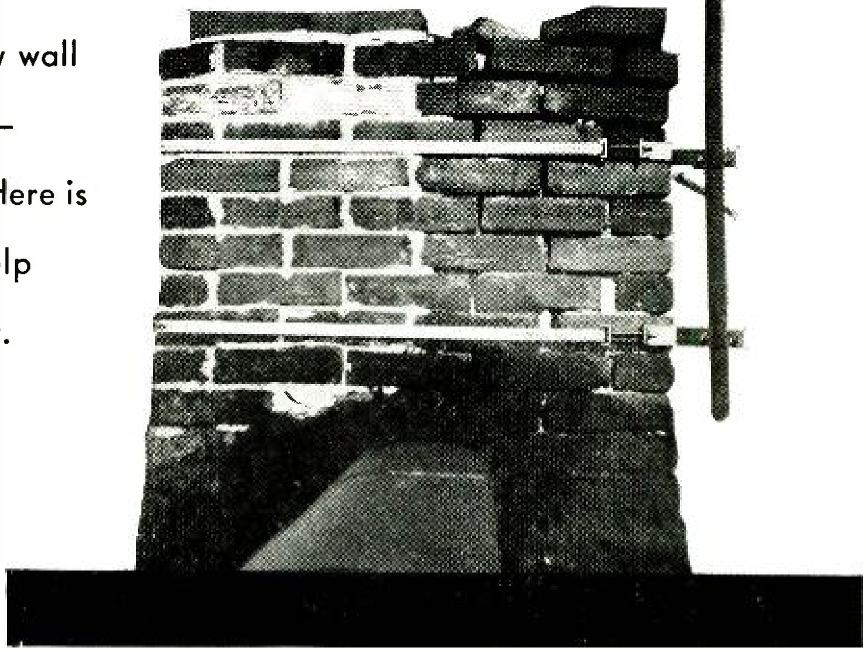
Note: Letters addressed to this Clinic are answered directly and those of general interest are published. When writing to this department enclose a stamped, self-addressed envelope and give model number of receiver, name of manufacturer, and chassis number. Include such information as antenna type, channel numbers of stations which can be received in your area, and what preliminary checks you have undertaken prior to writing us. Explain in detail exactly what the trouble symptoms are.

—end—

BEWARE THAT INSTALLATION

Every chimney and party wall carries an invisible sign—"NO TRESPASSING!" Here is some advice that may help you avoid costly liability.

By H. L. MATSINGER



Two costly mistakes for the installer: The antenna mounting straps cross the property line (marked by the parapet); the brickwork tells its own story.

SUPPOSE that one morning while you are tangling with the innards of a recalcitrant receiver a customer dashes into your shop and excitedly announces that he is being sued because of an antenna installation that you made. Would you consider his remark preposterous and impossible? If you would, read on, brother!

On November 9, 1951, the Philadelphia *Evening Bulletin* carried the headlines: "Neighbor Sues Over TV Antenna; Court Says That Mast Is On Wrong Roof." The article goes on to state that Robert and Maria Egizi of 913 South Delhi filed an injunction suit in Common Pleas Court against Alex and Ida Giordano, who live at 911 South Delhi, charging them with maintaining the antenna despite repeated requests to remove same, including a written request made on June 29, 1951. The suit asks relief from a number of retaliatory measures taken by the Giordanos, asks for removal of the antenna, and for $1,500 as punitive damages, holding that the presence of the antenna is a "continual trespass."

Unfortunately, this is not an isolated case, although few ever are brought to court. Normally, the aggrieved neighbor just goes to work on the moorings with a hacksaw or tinsnips. Dual chimneys, of the type commonly found in row-house construction, belong only in part to any individual owner. It is apparent, therefore, that when you use chimney straps to support a TV antenna on such a chimney, you are trespassing on the other man's property. This is true, not only of the straps but of any part of the antenna structure which may extend over the property line. The abutting owner, at his discretion, may insist upon the removal of all parts so offending, or trim them back to the property line.

If, in the process of trimming back the chimney straps, the antenna mast happens to fall down (and it likely will), your customer has no redress unless the straps have been trimmed too far. If you have failed to get a signed easement from the adjoining owner you have no recourse but to erect a new mast for your customer, since you were negligent in the original installation.

Aside from the legal aspects of chimney mounts, certain mechanical considerations are also involved. Brick chimneys, being a layer type of masonry, do not offer very high resistance to a bending moment or torsional type of strain. This means that when straps are used, the continual swaying of the antenna and mast will loosen and eventually ruin any such chimney. Even the practice of inserting lead plugs in a top and bottom brick of the chimney is bad, for the strain is concentrated on these two bricks, and in a very short time the mast is likely to be leaning at a precarious angle.

Then, too, when the antenna and lead-in are mounted over the flue, hot corrosive gases play over the elements and connections, while soot deposits create a low-resistance short circuit. Naturally, this will reduce the efficiency.

To be on the safe side, it is always best to mount the antenna in the center of the roof if possible. Mount the mast on a plank or block of wood to prevent piercing the roofing, and use a floor flange or a base collar to keep the end of the mast from kicking out. Add a mast ring, and at least four guy wires, with turnbuckles to permit adjustment, and anchor the ends with adequate screw-eyes. If you do this you can feel reasonably certain that you will have no nasty come-backs. It is highly improbable that this type of mounting will blow down, even in an extremely heavy wind, but if it does the antenna will remain solely on the property of your client.

(In many localities, building department and fire department regulations may require installation of an antenna in such a manner that its movement or collapse will not endanger, damage, or obstruct access to adjoining property. Deeds and leases on semi-detached or row-type structures often contain restrictive clauses of the same character. Even if the antenna structure is to be entirely on your customer's building, and there is no normal trespass on adjacent property, you should check the possibility of existing restrictions for your own protection. Remember that the liability is yours, and that lawsuits are expensive even if you win them.—*Editor*)

The photograph accompanying this article serves to accentuate the main points made, and to act as a signpost for your guidance. —end—

Fig. 1—The completed dummy antenna selector. The coax connector is for the receiver input cable.

DUMMY ANTENNA SELECTOR

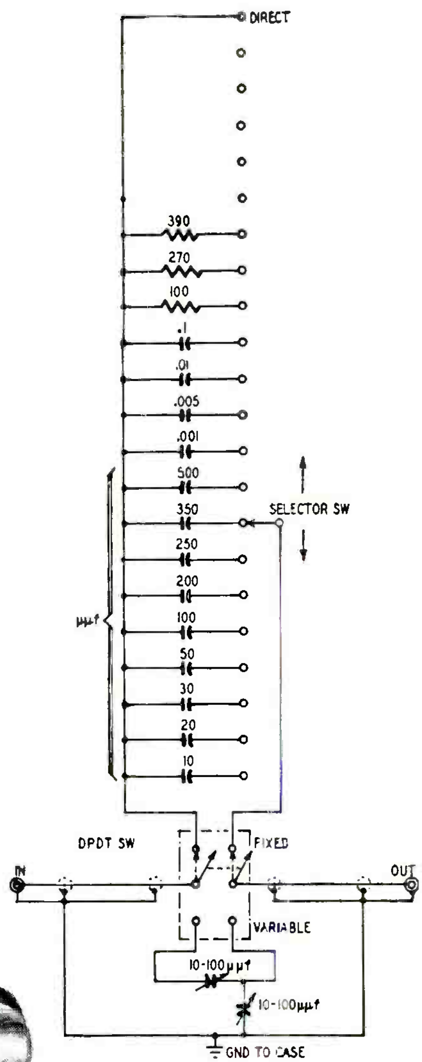


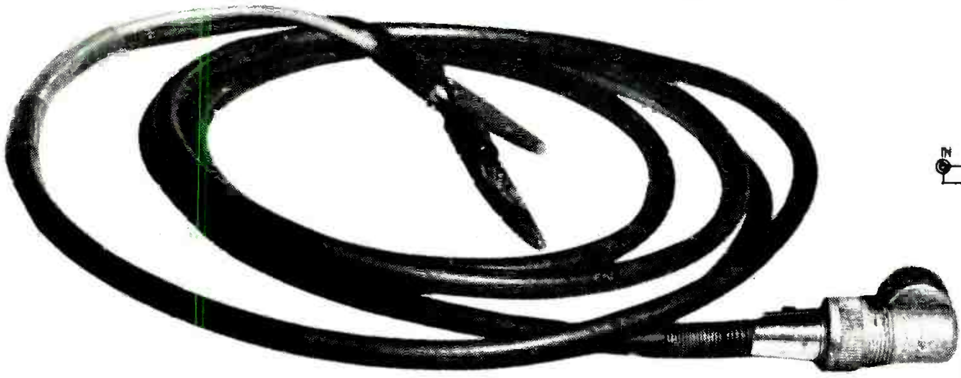
Fig. 2—Schematic of selector unit.

By HENRY C. CORDES

EVERY receiver alignment job calls for the use of one or more different dummy antennas between the signal generator and the receiver. Most technicians have an assortment of made-up dummy antennas lying around *somewhere*. These usually consist of a resistor, a capacitor, or an unmounted combination, with a clip at one end for connecting to the receiver, and a fragile bare wire lead at the other end for the signal generator cable clip.

Whenever one is needed, the technician generally has to dig it out of a box of miscellaneous junk, only to find that one of the leads is broken.

Since the number of types required is already large and is constantly increasing, the well-equipped service shop should have some device for quickly selecting the right unit and automatically connecting it in the generator output circuit. An additional advantage of such a device would be to simplify



the connections to the receiver. Instead of cluttering up the chassis with a bulky network and an assortment of clips (especially when working with miniature tubes), the dummy antenna selector could be installed at or near the signal generator, and only a single cable run to the receiver. This would also reduce the radiation problem.

After much planning and experimenting this versatile dummy-antenna selector was born. It was built in a metal can from an old auto-radio power supply. Any enclosed metal box large enough to accommodate the components without too much crowding may be used.

Fig. 1 shows the completed unit and the locations of the controls. On the front panel are the dummy-antenna selector switch and the output jack. On the top are two variable-capacitor control knobs and a d.p.d.t. VARIABLE-FIXED switch. These variable capacitors are connected in a series-parallel arrangement required only for aligning the front ends of some late-model auto radios. Technicians who do not handle this type of work can omit these capacitors and the VARIABLE-FIXED switch.

The circuit diagram is given in Fig. 2. The dashed lines show the connections with the VARIABLE-FIXED circuit eliminated. With the d.p.d.t. switch in the FIXED position the selector switch connects the desired dummy antenna in series with the hot side of the signal-generator output cable. The selector switch used in this model had 22 taps, but any nonshorting switch with at least 17 taps may be used.

The sizes of the fixed capacitors and resistors were selected after a detailed search through many volumes of service manuals, as representing the most commonly needed values. Special dummy antenna networks can be inserted in the external circuit, as described later.

In the VARIABLE position of the d.p.d.t. switch, the special series-parallel combination for auto-radio use is connected between the generator and the receiver. The variable capacitors are of the straight-line-capacitance type, to simplify calibration.

Construction details

If used, the variable capacitors should be mounted at least one-half inch apart at their nearest points to minimize interaction. Leads to the variables should be dressed away from each other and from all other wiring and the case. Do not use shielded wire for these leads. The series-connected variable capacitor must be completely insulated from the case.

For best results and minimum size the fixed capacitors (up to .01 μf) should be of the ceramic type. Half-watt resistors are adequate. One lead from each fixed capacitor and resistor is soldered to a common bus from the d.p.d.t. switch. Their respective opposite ends are soldered to taps on the selector switch, with the values increasing in the clockwise direction as viewed from the knob end of the shaft. Note that the last tap on the selector switch is connected directly to the bus bar. This feeds the generator output directly to the circuit under alignment, or permits the insertion of special dummy antennas between the output cable and the receiver. Unused taps on the switch may come in handy later if additional dummy antennas are required.

Drill a hole in the metal housing for the shielded input cable, and ground the shield to the housing. The hot lead is connected directly to the d.p.d.t. switch. Also ground the shielded lead to the output jack. A jumper wire between the shields of the input and output cables inside the unit insures good ground continuity.

The dial scales were made from white card stock cemented to the top and front of the case and marked with India ink. The variable-capacitor circuit was drawn on the top scale to show the function of each control.

Based on the manufacturer's rating of the variable capacitors, the low point on each calibration scale was marked 10 μμf, and the high point 100 μμf. The mid-point was marked 55 μμf. Other capacitance values were marked off uniformly in proportion. (*These markings may be inaccurate, especially at the low end of the scale, because they do not include stray capacitances. If possible, the actual values should be measured on a bridge after the unit has been completed.—Editor*)

The unit is connected to the generator via the new input cable. The original generator test cable is connected to the selector output jack.

Testing the selector

The selector unit can be tested with a signal generator, an ordinary radio, and an output meter.

Turn on the generator and the radio and allow time for thorough warmup. Set the generator and radio to the same frequency and connect the output cable from the selector unit to the receiver antenna post. See that the switch is in FIXED position. Set the selector switch on the .1-μf tap. Connect the output meter across the receiver voice coil and adjust generator and volume control for normal output.

Switch the selector to the next lower sized dummy. A lower reading should be noted on the output meter. Each successive reduction in the size of the dummy antenna capacitors should result in a lower output reading.

The resistor dummies can be checked with an ohmmeter between the input and output cable ends.

There may be a few types of sets which require dummy antennas which cannot be simulated by this selector. Even in these cases it will be useful, as the setup usually will call for only one or two resistors or capacitors in addition to those in the unit.

One point should be checked regardless of which selector you decide to build. The selector-switch arm must make perfect contact with all taps for trouble-free operation.

Materials for dummy antenna selector

Resistors: 1—390 ohms, 1—270 ohms, 1—100 ohms, ½ watt.

Capacitors: (Paper) 1—0.1 μf, 400 volts. (Ceramic) 1—10 μμf, 1—20 μμf, 1—30 μμf, 1—50 μμf, 1—100 μμf, 1—200 μμf, 1—250 μμf, 1—350 μμf, 1—500 μμf, 1—.001 μf, 1—.005 μf, 1—.01 μf. (Variable) 2—100 μμf max. midget air trimmers (National UM-100, Hammarlund APC-100, Bud LC-2081, or equivalent.)

Miscellaneous: 1—single-circuit rotary switch, 17 or more contacts, nonshorting type (Mallory 13124L or equivalent); 1—d.p.d.t. toggle switch; 1—coaxial output connector, chassis type; 1—coaxial input connector, cable type (see text); 2 feet signal generator cable; 1—6 x 5 x 3-inch metal box; wire, solder, hardware, knobs.

—end—

Suggested by Burton J. Teague, Canton, Ohio

"The set fades a lot."

AVOID LAWUIT

Costly legal pitfalls may trap the service technician or dealer. Some recent adverse decisions should serve as warning guideposts.

By LEO T. PARKER*

RADIO and television technicians and dealers will do well to keep informed of new higher court cases involving others in the same business. A great deal of money, time, and effort may be saved by *avoiding adverse lawsuits.*

In the following higher court decisions, various points of law are discussed which may help readers avoid suits, or win those which are unavoidable.

Law of warranties

Higher courts now consistently hold that a seller who breaches his warranty or guarantee must take back the subject of the sale and refund *the full purchase price*, plus interest. Therefore, sellers of radio and television sets must avoid making unreasonable guarantees such as that "the set will operate satisfactorily to the purchaser," or that "satisfaction is guaranteed."

For example, in *Keeler v. General Products, 75 Atl. (2d) 486*, the testimony showed facts as follows: A restaurant owner bought a television set from General Products for $1,523.25. The purchase was made in reliance upon the assurances of the seller's president and vice-president, and one of its salesmen, that the set would operate satisfactorily in his town. However, it failed to provide good reception, and the seller replaced it with another model. The same officials renewed their assurances of satisfactory performance by the substitute set. The second set proved to be no better than the first. The purchaser then demanded the return of the purchase price and offered to return the set, which was in substantially the same condition as when delivered. Although the demand was repeated on numerous occasions, the seller refused to accept the set or to refund the money. The restaurant owner sued the seller to recover the full purchase price of $1,523.25 plus legal interest.

The higher court promptly ordered the seller to take back the television set and refund the full purchase price. The higher court said:

> Several remedies were available to the plaintiff upon the breach of warranty. He elected to rescind the sale. When the defendant refused to take the set back, the plaintiff held it as bailee and acquired a lien thereon to secure repayment of the purchase price.

The seller could have avoided an adverse decision in this litigation by proving that its officers and salesman had merely represented that the television set would operate *as satisfactorily as other sets at the same price.* However, when the officers and the salesman made a positive statement and guaranteed that the set "would be satisfactory," the purchaser had a legal right to sue and recover the full purchase price upon proof that the set did not operate *satisfactorily to him.*

Uncertain sale contract

Higher courts now consistently hold that all contracts of sale are void if made through error, violence, fraud, or menace. Hence, where a purchaser proves that he did not receive *what he thought he was purchasing*, there is no valid contract, and the purchaser may compel the seller to take back the merchandise and refund the purchase price.

For example, in *Jake v. Blem Electrical Company, 46 So. (2d) 631*, these facts were proved: The Blem Electrical Company, a retailer of television receivers and other appliances, had in its employ a salesman who was learning to sell television sets. He sold the plaintiff a television set for an agreed price of $1,095.00, plus an installation charge of $200.00, and taxes and freight charges of $48.85, or a total amount of $1,343.85, to which were to be added finance or carrying charges. The purchaser made a deposit of $100.00, and verbally obligated himself to pay a further sum of $350.00 cash when the set was delivered, and to execute a note for the unpaid balance. It is important to observe that two disinterested witnesses were present when the order was placed with the salesman.

When the television set was delivered it was not in a cabinet, but was mounted on a chassis and enclosed by a steel frame. Later a service technician volunteered suggestions as to the manner in which a cabinet might be constructed to enclose the set. It was then that the purchaser realized that a misunderstanding might have occurred, and he immediately telephoned the seller, stating that he was rescinding the contract because he had been under the impression that a "beautiful cabinet" would enclose the set.

In subsequent litigation the higher court held that the seller must take back the television set and refund the payments. This court said:

"After carefully considering the record, our opinion is that there was never a meeting of the minds as between plaintiff and defendant's representative, with respect to the sale and purchase of the television receiver. We are impressed by the fact that plaintiff testified that C and S (the disinterested witnesses) were present during the entire negotiations leading up to the sale . . . The testimony convinces us that he did not get delivery of what he *intended* to buy . . .

This court explained that sellers of merchandise may eliminate controversies of this nature by having a written contract signed by the purchaser.

Therefore, the seller could have avoided taking back this television set if the salesman had been provided with a *printed* order form which the purchaser would have signed. Under these circumstances the court would not have listened to the testimony of the two disinterested witnesses in favor of the plaintiff. Verbal guarantees, statements, and assertions are *not* good evidence nor acceptable by the court when a written contract determines the legal rights and liabilities of the contracting parties.

Motto: Never sell any merchandise on a verbal agreement. Always have the purchaser sign an agreement printed, typewritten, or written in ink.

Repairman liable for tax

According to a recent higher court decision owners of television service shops must render bills to customers, *clearly separating material charges from labor charges*. Failure to do so renders the technician liable for the state's sales tax on *the full amount* of the bill.

For example, in *Muench v. Glander, 93 N.E. (2d) 606*, it was shown that a technician failed to charge any sales

*Attorney at Law, Cincinnati, Ohio

tax to customers for repairs. In subsequent litigation the higher court held that he was liable to the state for the sales tax on the full amount charged, notwithstanding the repairman had made no deliberate attempt to evade the sales tax law. The court said:

> Where a person sells material and in connection therewith furnishes labor or service in applying such material to his customer's property, the entire transaction shall be considered a sale and subject to tax, unless there is a clear separation, in the making or billing of a charge therefor, of the material furnished and the labor or service performed.

Here is a specific example: Assume that a television technician installs a part for which he charges 25¢. If he charges the customer $3.25, that is: 25¢ for the part and $3.00 for labor, *without separating the part cost from the labor cost*, he must pay the state a sales tax on $3.25. The technician *cannot* go back over his books and correct or separate the cost of materials from the labor cost. On the other hand, if the technician makes out a bill to the customer, or if the customer pays cash, the technician may enter the account as 25¢ for parts; $3.00 for labor, and he may pay the state's sales tax on only 25¢, instead of $3.25.

Don't forget this! If you do, two, three, or four years from now the state's tax collector may go back over your books and collect a considerable amount of delinquent taxes, plus heavy penalties.

Minor cancels contract

Recently a higher court held that if a television dealer sells to a minor, the latter can rescind the contract, return the set at any time and demand refund of the *full* purchase price. This is so, although the minor's father may have signed the purchase contract, mortgage, or notes.

In *Davis v. Clelland, 92 N.E. (2d) 827*, minor sued a dealer alleging that as a minor he was entitled to rescind the purchase contract and recover the full purchase price.

The dealer defended the suit by contending that the appliance was purchased by the father of the minor. However, since the testimony showed that the title was made to the minor, the higher court held that the dealer must refund the full purchase price to the minor. The court said:

> If the father purchased it, the dealer was required by law to deliver to him the title. The source of the purchase money was immaterial as to the right of the defendant (dealer) and did not fix the identity of the purchaser.

In other words, irrespective of who pays the purchase price, the minor may rescind the contract and recover the full purchase price if the testimony shows that the seller delivered the merchandise to the minor.

—end—

Battery failures in portable equipment can be costly and aggravating. Here are some methods of preventing them.

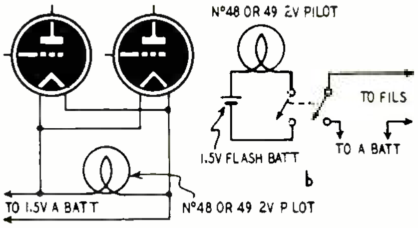
MONITORING BATTERY INSTRUMENTS

By RUFUS P. TURNER

IT'S often a good idea to use test instruments with self-contained batteries. Battery power allows operation at locations remote from power lines. It also provides complete isolation from the a.c. line and thus prevents introducing hum into either the instrument or the device under test. The battery unit is portable—often an important feature. Instruments in which battery operation frequently offer advantages include electronic voltmeters, oscillators and signal generators, distortion meters, frequency meters, wave-shapers, field-strength meters, and instrument amplifiers.

One of the annoying drawbacks of battery operation is the rapid rundown of batteries due to needlessly leaving the power switch in its ON position during periods when the instrument is not actually in use. This costly nuisance has caused much concern to users and designers of battery-operated equipment, and often prompts the sacrifice of the obvious advantages of battery operation in favor of more foolproof a.c. operation.

There are several practical ways in which battery power supplies can be monitored, and often protected, to prevent untimely exhaustion of the batteries. With civilian battery supplies still in uncertain condition and with high prices prevailing, it will pay builders and users of battery-operated equipment to utilize these schemes. The particular method chosen will depend upon a number of factors, mainly electrical and mechanical feasibility. The writer makes no claim to originality, since each scheme has been used in some piece of battery-operated electronic equipment. Our aim is to call attention to what can be done.



a

Fig. 1—Protection with low-current lamps.

Pilot lights

The mere thought of a current-consuming pilot light in a battery power supply ordinarily creates horror. However, there are instances where the drain of an A-battery pilot light is not unreasonable. An example is the case of 1-volt tubes operated from a large-size dry cell. Type 48 (screw base) and 49 (bayonet base) lamps draw only 60 milliamperes at 2 volts and around 50 ma at 1.5 volts. This current drain is small for the protection provided, and a large-size cell will handle the load. The pilot light is connected in parallel with the tube filaments (See Fig. 1-a) and glows only when the A battery is switched on. For designers who do not favor the shunt connection, there are other methods of pilot-light operation.

Pilot light with separate battery

To remove extra drain from the A battery, a separate flashlight battery may be provided for a type 48 or 49 pilot lamp. This lamp gives adequate light on 1.5 volts. By using a d.p.s.t. on-off switch, a separate set of contacts is provided for the pilot-light circuit. This arrangement is shown in Fig. 1-b.

Pilot light in series with tube

The pilot lamp may also be operated in series with the tube filament so that it lights only when the switch is on.

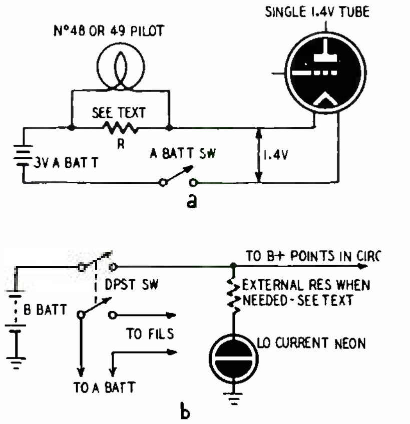


Fig. 2 (left)—Series pilot-lamp and shunt neon-lamp methods of monitoring.

This arrangement is shown in Fig. 2-a and is best applied to instruments and devices employing one tube.

A 3-volt A battery supplies the lamp and tube filament in series. When a 0.1-amp filament is employed, the lamp must be shunted with a 27-ohm, ½-watt resistor R. When using a tube with 0.05-ampere filament, no resistor is required across the lamp, but a 140-ohm, ½-watt resistor must be connected in parallel with the tube filament. In either case, burnout of the lamp will not damage the tube.

Neon B-battery pilot light

When at least 90 volts of B battery are available, a low-power neon lamp (¼-watt or 1/25-watt size) may be connected as shown in Fig. 2-b to glow when the on-off switch is closed. Types NE-2 and NE-51 1/25-watt lamps, each require a 200,000-ohm external series resistor. In the ¼-watt group, types NE-17 and NE-48 require external series resistors of 30,000 ohms. All other ¼-watt types have built-in resistors. The technician who desires a more elaborate and economical set may use the blinker system described in RADIO-ELECTRONICS, October, 1949. The neon lamp, flashing only at intervals, uses negligible current and attracts more attention than a steady light.

Switch flags

Where no extra current may be drawn from the batteries, on-off switches may be provided with eye-catching "flags" of one sort or another to signal the ON position. Individual mechanical ingenuity can provide many variations of this scheme.

Fig. 3-a shows a simple flag arrangement. A rotary on-off switch is provided with a disc-plate in which a hole or slot is cut. A piece of brilliant white paper or plastic is cemented to the instrument panel in such a position as to be visible through the hole when the switch is in its ON position.

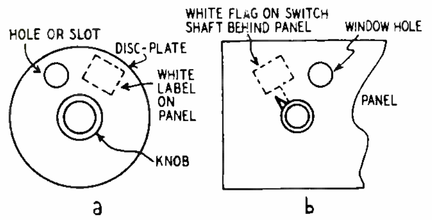


Fig. 3 (above)—Eye-catching indicators mounted on the battery on-off switch.

Another scheme which may be used with a rotary switch is shown in Fig. 3-b. Here, a small white flag is attached to the switch shaft behind the instrument panel by a stiff wire or blade. A window-hole is drilled through the panel at a point where the flag will show through when the switch is on.

Lid-operated switch

A scheme used by several instrument manufacturers, which makes it impossible to store the instrument with batteries running (provided the cover or lid of the instrument case is closed), is the lid-operated switch (See Fig. 4). The switch is a spring-return pushbutton type with normally-closed contacts. This switch is wired in series with the battery power supply and may be provided with two sets of contacts, one for the A battery and the other for the B battery. A small dowel or plug is attached to the inside of the lid so as to push down on the switch button when the lid is closed. This action opens the switch contacts and disconnects the batteries.

The on-off switch may be wired in series with the lid-operated switch.

Additional methods

Where cost is not a factor, a miniature panel-type d.c. voltmeter may be connected in parallel with the tube filaments or wired from a B plus-circuit point to ground. This meter will serve the dual purpose of warning when the batteries are on, and also of showing continuously the condition of the batteries. In order to minimize drain, the meter circuit must have as high resistance as possible. Under no circumstances should this be less than 1,000 ohms per volt. In lieu of a voltmeter a plate current milliammeter in one B-battery lead may be used if desired.

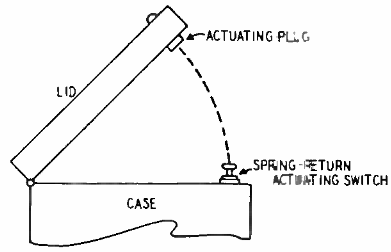


Fig. 4—Automatic protection for cased instruments with a lid-operated switch.

A small clockwork-driven switch may be employed as the regular on-off switch in battery-operated equipment. These mechanical timers may generally be set for any running time up to one hour, which would appear to be ample for most testing operations. Its timing action will be started automatically when the instrument is switched on, and the batteries will be switched off automatically at the end of the interval.

Undoubtedly, there are numerous other methods of signaling to the operator that his batteries are switched on. Only a representative few could be covered in this space, but the methods suggested should provoke thought on the part of technicians. Battery-operated instruments are preferable to line-operated devices in many applications, and their advantages should not be sacrificed because of fear that the batteries will run down through carelessness.

—end—

A DYNAMIC SIGNAL TRACER

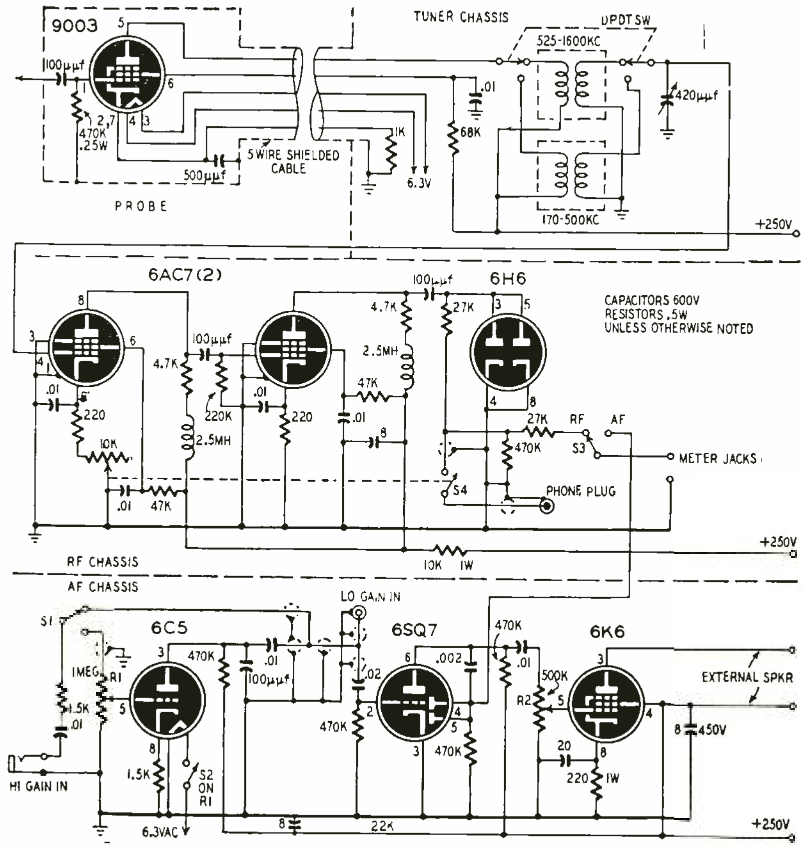
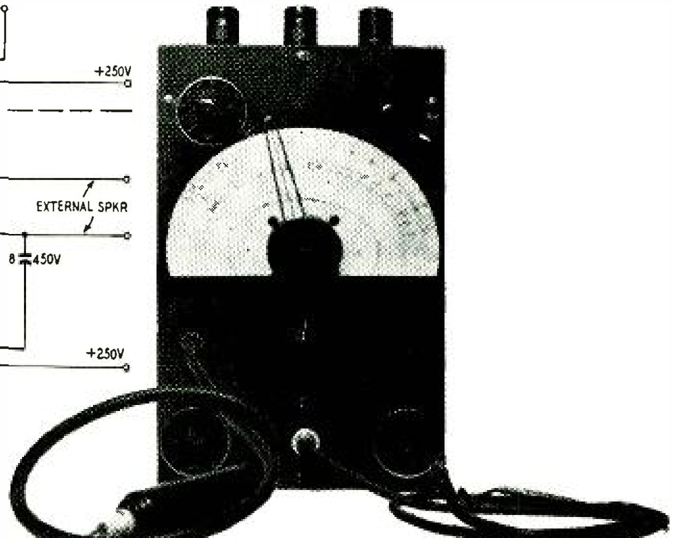


Fig. 1—Signal circuits of the tracer. Probe and tuner sections are at the top; the r.f. amplifier-detector unit is in the center; the audio amplifier at the bottom. The completed tracer is shown at the right. Its housing may be enlarged to accommodate the power supply and speaker.

By W. CARL MARSH

Extra-sensitive r.f.-a.f. tracer has valuable features, many service uses



SERVICE technicians have been offered many signal tracers which claim to trace the signal "from the antenna to the speaker", but they neglect to tell you that *you* have to furnish that signal, either from a strong local station or a signal generator.

We have no local stations where I am located. The nearest stations, WSM Nashville and WREC Memphis, are more than 100 miles away, so a signal tracer that will follow a signal from antenna to speaker has to be a sensitive one. With this in mind I have, through an evolutionary process, arrived at a practical and extremely flexible signal tracer. It has been used in my shop for approximately twelve months and is invaluable in saving time and eliminating some tough jobs of hunting with voltmeter and soldering iron. As proof of its sensitivity I can place the contact point of the prod against the insulation of my antenna lead-in and tune in half a dozen stations, including WSM and WREC.

The signal tracer is built in a steel cabinet 7½ x 12 x 7 inches. The schematic is shown in Fig. 1. Power supply and speaker were not included because I already had both built into my bench. Any power supply delivering 6.3 volts a.c. at 2.5 amps and 250 volts d.c. at 100 ma will serve the purpose.

The audio section is a straightforward 3-stage high-gain amplifier. Metal tubes should be used in the first two stages for maximum stability. The main volume control (R2) is in the grid circuit of the 6K6 with an auxiliary control (R1) at the input to the first amplifier. Where extremely high gain is not required switch S1 can be used to bypass the input stage. S2 is ganged with R1 and opens the 6C5 heater circuit when this stage is not used. A low-gain input connection is also provided for direct connection to the second stage.

A portion of the audio signal is rectified by the diode plates of the 6SQ7, and fed to one terminal of S3 for signal voltage measurements. Be sure to take proper precautions to eliminate feedback by liberal shielding and separation of grid and plate leads. The audio section is placed in the bottom of the signal tracer cabinet.

The r.f.-i.f. section uses two untuned 6AC7 amplifiers and a diode detector. The control in the cathode of the first 6AC7 is a sensitivity control. Switch S4 disconnects the output of the r.f. unit when only the audio section is being used, to prevent spurious sounds issuing from the speaker.

Each stage of this unit is completely isolated from the next by interstage shields. The interstage coupling-capacitor leads run through small holes in the shields. Be sure to use a bottom shield as well to eliminate the possibility of pickup from the audio amplifier. The r.f.-i.f. amplifier is placed in the upper part of the cabinet with the tubes projecting through holes in the top.

After this unit has been completed and connected to the audio amplifier it can be tested by connecting an antenna. through a 100-μμf mica capacitor, to the input. (*Editor's note:* Temporarily connect a 10,000-ohm resistor from the grid of the first 6AC7 to ground.) As there is no selectivity in this unit several stations should be heard simultaneously.

The coils for the tuner were made from i.f. transformers with enough turns removed to bring the frequency up to the proper range and the primaries wound over the secondary. The tuning capacitor is a war surplus job and has a capacitance of 420 μμf, but any coil and capacitor combination that will cover the desired frequency ranges can be used. The ranges of this tracer are 170–500 kc on the i.f. band and 525–1600 kc on the r.f. band.

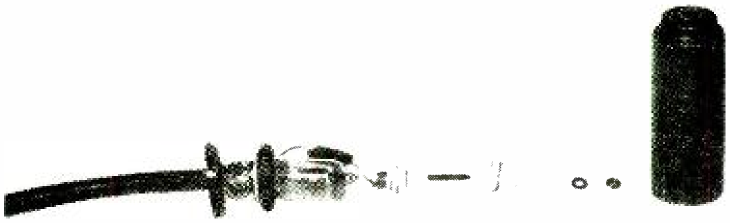
The probe assembly is shown in Fig. 2. The housing was made from the shell of an old MG type 6F6 tube. The crimps holding the shell to the base were pried out and the inside glass tube removed from the base. The guide pin was broken off and the hole enlarged to pass a 5-wire shielded cable. The base of another tube was also used as an insulating washer by grinding it down until it fit inside the shell. The cable was passed through the holes in the base piece and washer and connected to a 7-pin miniature socket for the 9003 pickup tube. A hole was made in the closed end of the shell to take a small feedthrough insulator. A long bolt through this insulator serves as the probe tip and connects to the 100 μμf mica isolating capacitor. Be sure to ground the shielding on the cable to the shell of the probe and connect an external ground lead and clip.

The tuner was calibrated with a signal generator. Broadcast stations can be used for the 525–1600 kc range if enough are available.

After calibration you are ready to use one of the handiest test instruments you will ever own. The possible uses are limited only by the ingenuity of the operator.

Due to the high sensitivity of this tracer it is not necessary to make actual contact with the circuits being tested. Thus there is no detuning of critical circuits.

To check a receiver oscillator, turn S3 to the RF position and connect a v.t.v.m. set to the 10- or 15-volt range to the meter terminals. Tune the receiver to the low end of the dial and add the i.f. to the dial reading. Tune the signal tracer to this frequency and hold the probe tip near the oscillator coil or tuning capacitor. If the oscillator is operating on or near the correct frequency, the meter needle will kick strongly as the tracer is tuned back and forth across this frequency.



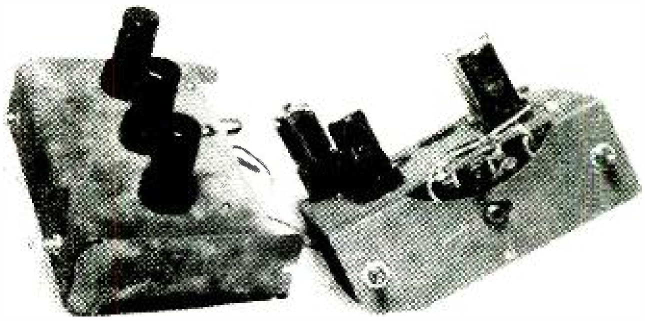
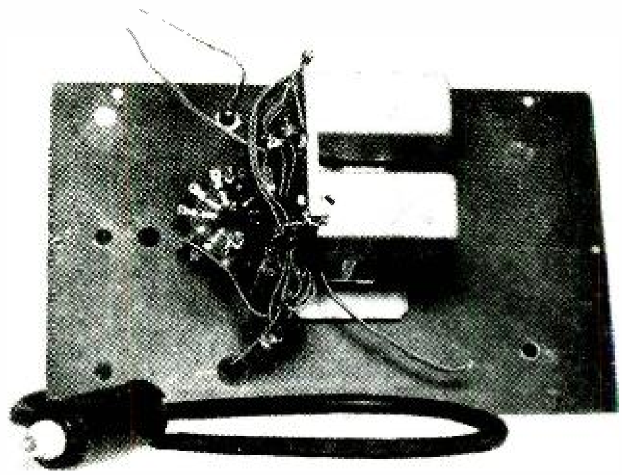


Fig. 2 (above)—r.f. probe assembly; (right)—a.f.- and r.f.-amplifier unit sub-chassis.



The r.f.-i.f. selector unit sub-assembly, shown mounted to the tracer panel, and the completed r.f. probe unit.

To locate trouble in a dead receiver where supply voltages are normal, simply tune the receiver to the frequency of a strong station and trace the signal from grid to plate through each stage. Use the correct tuning range of the signal tracer for the r.f. and i.f. sections of the receiver. Only the audio section of the tracer is needed when you have passed the detector.

For testing phono pickups and microphones, simply feed the output into the proper stage of the audio amplifier. For crystal pickups use the low-gain input and volume control R2. If the crystal is good you will be able to hear the output with plenty of volume. With a standard test record and a good crystal pickup you can calibrate the v.t.v.m. for comparison checks. The high-gain input should be used for dynamic (variable-reluctance) pick-ups, and microphones.

If proper precautions and good workmanship are used in constructing this signal tracer, you will have an instrument that you will depend on more and more as time goes by. Many new uses will suggest themselves as you become more accustomed to handling your tracer.

Materials for the signal tracer

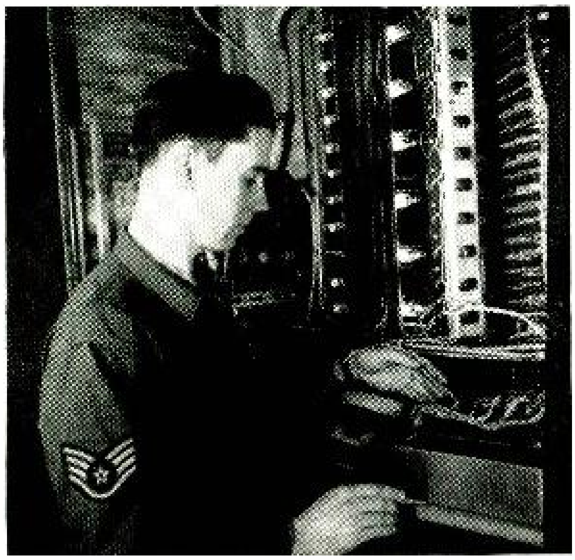
Resistors: 2—220 ohms, ½ watt; 1—220 ohms, 1 watt; 1—1,000, 2—1,500, 2—4,700 ohms, ½ watt; 1—10,000 ohms, 1 watt; 2—27,000, 2—47,000, 1—68,000 ohms, ½ watt; 1—220,000, 6—470,000 ohms, ½ watt; Potentiometers: 1—10,000 ohms; 1—500,000 ohms; 1—1 Megohm, with s.p.s.t. switch.

Capacitors: (Mica) 4—100, 1—500 μμf; (Paper) 1—0.002, 8—0.01, 1—0.02 μf, 600 volts; (Electrolytic) 2—8 μf, 450 volts; 1—20 μf, 25 volts. (Variable) 1—420 μμf (max).

Miscellaneous: Tubes: 1—6H6, 2—6AC7, 1—6C5 1—6SQ7, 1—6K6-GT, 1—9003. Tube sockets. Coils (see text). Switches: (Wafer) 2—s.p.d.t.; 1—d.p.d.t. Cabinet. Chassis. Connectors. Hardware. Wire. Solder.

—end—

VACUUM TUBE TRAINER HELPS STUDENTS



Checking the circuits of the vacuum-tube trainer.

Air Force trainees learn electronic principles from huge animated tube model.

By M/S FORREST C. WOLFERD

THE problem of constructing a classroom trainer that would clearly and swiftly demonstrate electronic activities of the radio vacuum tube was presented to me in March, 1948, while I was stationed at Chanute Air Force Base, Illinois. The "poser" was handed me by Major General Charles C. Chauncey, then deputy commander of the United States Air Force's technical training program. His decision to seek a new-type trainer was the result of advice from instructors that existing trainers and charts were hopelessly inadequate in helping a student to understand the elusive behaviorisms of the vacuum tube.

To assist in the construction of the trainer, I called on Technical Sergeant Robert C. Williams, a man with five years experience designing training aids for Army and Air Force schools. We decided on a device that would demonstrate every vacuum tube operation, from the diode to the pentode tube.

We wanted to show current and voltage variations, space charges, erratic movement, grid action, and secondary emission. We wanted everything that happened in an actual tube to occur clearly and simply on the face of our trainer.

To present these effects in a way that would appeal to students, we decided to use moving lights, similar to those seen on a theater marquee. These lights would vary in brilliancy to show changes in the amount of voltage; change colors to demonstrate polarity and increase or decrease in number to illustrate the strength of current. Lights would move about, imitating electron flow exactly.

In addition, all parts of the tube were to be included in the trainer, looking as much like themselves as possible.

Planning these effects was one thing—achieving them another.

We began construction with the face panel. Williams suggested all parts be made of Plexiglas, as it was durable, light, and easy to work and handle.

For our filament, we used a V-shaped rod, inside a half-cylinder representing the cathode. This was cut away in front so the filament could be seen.

Next came the grids—1-inch tubing curved like a coil. To reveal the lights demonstrating electron flow, they were also cut away.

We made the external circuits of half-inch plastic strips with corners beveled and outlined in black.

The plate element was a large half-cylinder which fitted over the other elements and grids.

All these parts were mounted on a translucent Plexiglas panel. The external circuits and grids were detachable and could be added one at a time to build in succession a diode, triode, tetrode, and pentode tube. The filament, cathode, and plate circuits, were cemented to the panel.

Behind the panel glowed the lights. Because of the translucence of the Plexiglas, the lights could be seen, but not as distinct individual bulbs. This gave a more realistic effect.

We then drew up the arrangement of all bulbs within the tube. We arranged the bulbs in 43 horizontal rows, 44 to a row. Even-numbered rows showed normal electron flow and odd-numbered rows demonstrated space charge, erratic movement, and secondary emission.

Each of the even-numbered rows was cut in half, placing 22 bulbs on each side of the cathode. Each side was then divided into four circuits of 5 to 6 bulbs each. The divisions were: (1) cathode to control grid; (2) control grid to screen; (3) screen to suppressor; and (4) suppressor to plate.

In the odd-numbered rows we used 24-bulb circuits to demonstrate erratic movement and secondary emission. All remaining bulbs showed space charges.

External circuits for the filament, control grid, and screen grid came next. They contained 5- to 6-bulb circuits and were arranged in their proper positions.

Next came the plate circuit. To show greater variations in current, it contained 24 bulbs per circuit.

The final step in the lighting system was the design of lights inside the elements. These were 110-volt lamps mounted behind the Plexiglas pieces representing the filament, cathode grids, and plate. To make the moving lights flow smoothly, we spaced our bulbs only five-eighths inch on centers.

We searched six months before finding enough bulbs to do the job. We finally discovered what we needed: 28-volt, miniature screw-base, type T lamps. Getting suitable commercial sockets to fit the bulbs proved impossible, so all sockets were designed and built by Sergeant Williams.

After designing and building our lighting system, we began wiring. This was the toughest part of the project. It took us two years, and it required 60,000 feet of wire to connect the maze of bulbs so they would operate the way we wanted.

First, we went to work on the marquee flow. On the 5- and 6-bulb circuits, we connected each bulb to four rings of spiral-wired breaker points. Every ring contained six points, one for each bulb.

A cam revolved continually inside the rings, activating the six points in succession. Thus, by energizing one ring, one light moved across the circuit. By energizing another ring we put another light in motion. In this way up to four lights in each circuit flowed. This gave us our marquee effect plus a varying number of bulbs to show changes in current.

To achieve both these effects in the 24-bulb circuits we used a commutator switch with 24 brushes. The commutator contained 16 segments, each energized by a slip ring. This gave us up to 16 bulbs in motion.

Changes in polarity were shown by passing cellophane shields in front of bulbs, while variations in the amplitude of voltage were illustrated by changing the brilliancy of the lights, using variacs.

All these effects—current, polarity, voltage, and marquee-flow—were regulated by only four front-panel controls. Five motor-control systems, interconnected with bridges and micropositions, enable proper interaction throughout the trainer. Wafer switches connected to the motor controls automatically energize the rings of breaker points, brushes of the slip rings, and sections showing space charge.

Because of the automatic interlocking controls, a change in one element is always followed by the proper reaction elsewhere.

In use, the filament control is turned on and one side of the filament circuit glows red (positive), the other side green (negative).

As the voltage is turned up, brilliancy of the lights increases. As current increases, more lights appear.

After a short time delay, the filament and cathode glow red, indicating heat. As their glow becomes more intense, white lights representing electrons move away from the cathode.

At first, these electrons form no definite pattern, demonstrating erratic movement. As more are emitted, however, they form clusters representing space charges.

Next, the plate control is turned on, causing the plate circuit to glow red (positive). As voltage increases, the plate becomes brighter and electrons move toward it from the cathode in definite patterns.

At the same time red lights in the plate circuit become brighter and increase in number, illustrating stepped-up voltage and current. Space charges diminish, erratic movement stops.

By applying a negative voltage to the plate control, lights in the plate circuit change to green and movement ceases. The ground circuit, represented by blue lights, automatically increases as current becomes greater.

When the diode demonstration ends, the Plexiglas control grid is attached to the face panel and a triode tube is formed. By regulating the next front panel control, all activities in a triode tube take place on the trainer's face.

Tetrode and pentode demonstrations are given in the same way: successively adding a grid and turning on another control panel for each one.

By the end of March, 1951, we had ironed out the last of the bugs and our project was ready for display.

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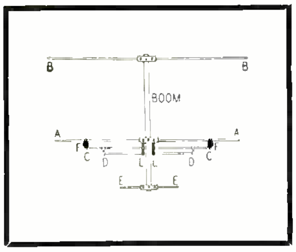
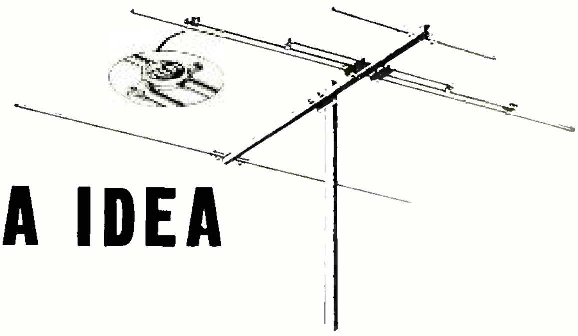
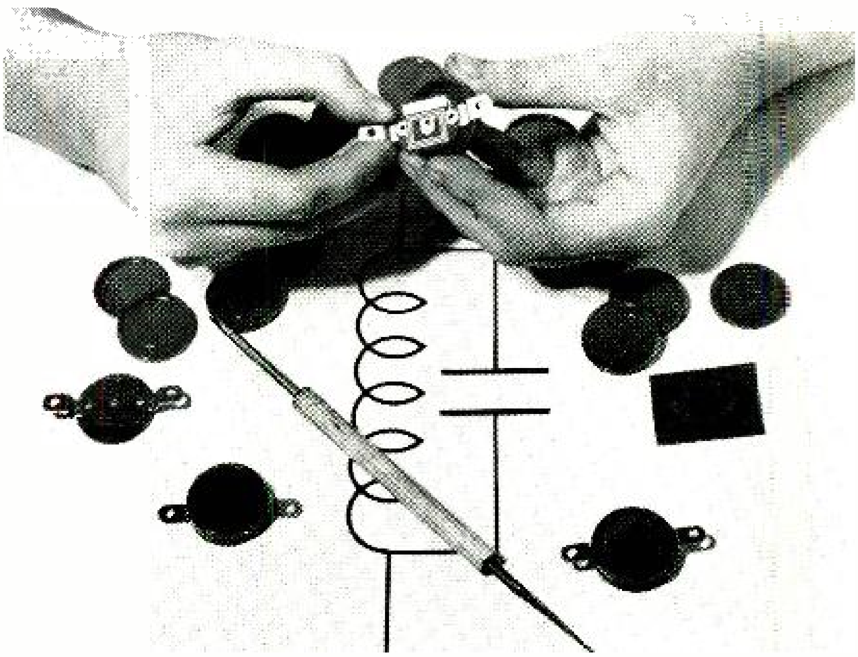


NEW ANTENNA IDEA





The printed circuit has now reached the top in its advance as a radio and TV component! It is used by Vee-D-X antenna, whose driven element consists of a series of T-matched dipoles which provides a 300-ohm match on both the high and low channels. The printed circuit is a part of the matching system and prevents detuning effects between the high- and low-channel elements, while providing a driven element of extremely low Q. The close proximity of the high and low elements and the elimination of the adverse interaction by the printed circuit results in an exceptionally broadband driven element. A high-channel director and a low-channel reflector give it the desirable front-to-back ratio and gain characteristics of parasitic type antennas such as the Yagi.

The printed-circuit matching unit is shown in the photo and the complete antenna in the diagrams above. Operation fundamentals can be understood easily with the help of the figure. On the low channels, B-B acts as a reflector for dipole A-A. F and F are the printed circuit isolation filters in weatherproof plastic housing—on the low channels they have low reactance and connect A-A through sections C-C and D-D to the 300-ohm line at L and L. Thus C-C and D-D act as a T-match between the line and dipole A-A. The printed circuit filters F and F are antiresonant at the center of the high channels (195 mc) and effectively isolate A-A from the 300-ohm line at these frequencies. However, C-C forms a fullwave antenna in this range, coupled to the 300-ohm line through the T-match of sections D and D. In these high channels, E-E acts as a director for optimum forward gain and directivity.

The multiple T-match further adds to the broadband characteristics of the antenna because the proximity of A-A and C-C provides capacitance coupling that makes the elements appear to be "fatter" and thus have a lower Q and consequent broader frequency response.

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ELECTRONICS and MUSIC

Fig. 1—The Model J Minshall Electronic Organ has two manuals, pedal clavier, and built-in amplifier and speaker. Other models have external tone cabinets rated at 20 and 40 watts. The instrument is all-electronic, with tube generators; tones are colored by formant method.

Part XXIV—The simple Minshall electronic organ—Ingenious circuitry produces true organ tones with few components.

BY RICHARD H. DORF

THE Minshall electronic organ (Minshall-Estey Organ Co., Inc., Brattleboro, Vt.) is one of the most interesting instruments in the electronic music field. It is capable of producing excellent organ tones and is used with great success in churches, homes, and radio stations; yet its circuits and mechanical construction are remarkably simple. It contains just about the minimum of circuitry and materials necessary to produce a genuine musical instrument, a goal which is not easy to achieve. Electronic organ design tends to become complex if for no other reason than that there must be at least 61 tone generators and a multiplicity of tonal effects. It is not really difficult to design an instrument that will sound good and have good flexibility. To get the same results with economy is hard but very desirable—it makes possible a low price and easier servicing, as well as reduced bulk.

The simplicity of the Minshall centers first in the ingenious frequency dividers, each of which employs only half of a duo-triode tube, five capacitors, and three resistors. The tone-color circuits (of the formant type), instead of using a separate filter for each stop, have several of the filters "collapsed" into a few groups so that any one filter component is used for more than one tone color. A unique type of vacuum-tube filter is employed. All of this will be explained in detail and diagrammed.

Fig. 1 is a photograph of the Minshall model J, a two-manual instrument with a 25-note radiating pedal clavier. This type has a built-in loudspeaker for maximum compactness. Where space is not at a premium model E is usually installed. The E is similar to the J but has a solid wood front and requires a separate tone cabinet (model C-20 or C-40, giving 20 or 40 watts output). A single-manual organ, model H, is also in wide use. Its circuitry is even simpler than that of the J and E. In this article we shall describe models E and J.

(Readers should note that the present-day Minshall organ is entirely electronic, with vacuum-tube tone generators. It should not be confused with an amplified-reed organ (model B) which was made by this company shortly after the war. The reed organ is no longer manufactured.)

The block diagram of Fig. 2 illustrates the scheme of operation of the Minshall electronic organ. The tone-generator assembly produces five octaves of notes. The tones go to the two key manuals and the pedal clavier, thence to the tone filters through the tablet-board control switches. The resulting tones are amplified and fed to a loudspeaker.

Tone generators

Each of the 12 tone-generator chassis contains three 12AX7 duo-triodes, power and output plugs, and a tuning control. It produces five octavely related notes. One of these chassis strips is shown in Fig. 3.

The topmost tone for each chassis is generated by a phase-shift oscillator, illustrated schematically in Fig. 4, using half of the first tube. The usual phase-shift oscillator has series capacitors and shunt resistors; the opposite arrangement, however, appears to be

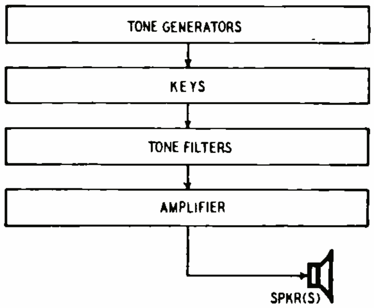


Fig. 2—Simplified block diagram of the Minshall organ operation scheme.

more stable. The 5,000-ohm variable resistor between the bottom of the network and ground permits tuning each oscillator over a range of slightly more than one semitone above and below the desired frequency. The .0015-μf capacitor across the control minimizes leakage between oscillators.

Eight different oscillators are manufactured on the Minshall assembly lines, differing in the values selected for C1, C2, C3, and C4. The capacitors used are standard high-quality micas with 10% tolerance. As they come off the production line the oscillators are tested for center frequency and are then inserted into appropriate generator chassis. This is an economy which would not be possible if very small component tolerances were necessary or if each component had to be individually selected and measured.

The remainder of a generator chassis is shown schematically in Fig. 5. The first triode, which is the second half of the 12AX7 used in the oscillator of Fig. 4, is a buffer stage used to isolate the highest-note output connection from the oscillator itself. It is also used to feed the first frequency divider.

The circuitry of the frequency dividers is unique in commercial electronic musical instruments. With only a single tube per divider, they produce sawtooth output waveforms, the type best suited for use with formant filters because of their progressive harmonic content.

The output of the master oscillator, which is approximately sinusoidal, is fed to the buffer grid through blocking capacitor C1. Because the triode is operated at zero bias with a fairly large grid-leak resistor R1, the grid draws current on positive input half-cycles. As a result the tube is biased to cutoff over most of the input cycle. When the tube is cut off, its plate is at maximum voltage, since no current is drawn through plate resistor R2. Plate shunt capacitor C3 therefore charges at a rate determined by the R-C time constant. During the small portion of the cycle when the tube conducts, it acts almost as a short circuit across C3 and discharges it quickly. The result of the slow charge and fast discharge is a sawtooth potential across C3, at the same frequency as the master oscillator. The sawtooth signal is taken through blocking capacitor C2 to the keying circuits, as the highest of the five notes generated on the chassis. The circuit of this buffer is extremely interesting since it transforms a sine wave to a sawtooth.

The first divider has been redrawn in Fig. 6 to make its operation clearer. C4-C5 is a capacitive voltage divider which reduces the amplitude of the input signal. If C_x were omitted, the divider would operate in the same way as the buffer. The reduced signal fed to the grid is large enough to cause the tube to cut off after the initial input peak. While the tube is cut off capacitor C6 will charge through R3. On the next positive peak of the input cycle the tube will conduct, C6 will discharge, then charge slowly again as the tube again is cut off. Output is taken from the plate, just as in the buffer, both for the keying circuits and for the next divider.

However, the presence of the feedback path from plate to grid through C_x changes all this and makes the tube respond only to *every other* input peak, so that the output is at half the input frequency.

C_x is a large capacitor whose only function is to provide a feedback path from plate to grid. At the initial peak of grid voltage from the buffer, a negative pulse appears at the plate of the tube. (This is the time at which C6 discharges through the tube.) This pulse is fed back to the grid through C_x. However, the feedback voltage reaching the grid is delayed by the series circuit of R2 and C5. For this reason the fedback negative pulse does not reach the grid in full strength until the second input peak from the buffer arrives. Now the grid is so negative—due to the fedback negative pulse—that this second input peak cannot make the tube conduct. Therefore C6 continues charging.

When the third input peak comes along C6 is almost fully charged. The charge on C5 due to the fed-back negative pulse has leaked off through R1 and R2. Again the grid is excited by the input pulse, the tube conducts momentarily, and C6 discharges. And again the tube is quickly cut off by the drop across R1-R2 caused by the grid current.

Because the tube is sensitive to the first, third, fifth, and following *odd* input pulses, while the even input pulses do not affect the charging of C6, the output taken from the plate for the keying circuit and the next divider input is one-half the frequency of the input from the buffer. And because the output is the potential across a slow-charge, fast-discharge capacitor—as in

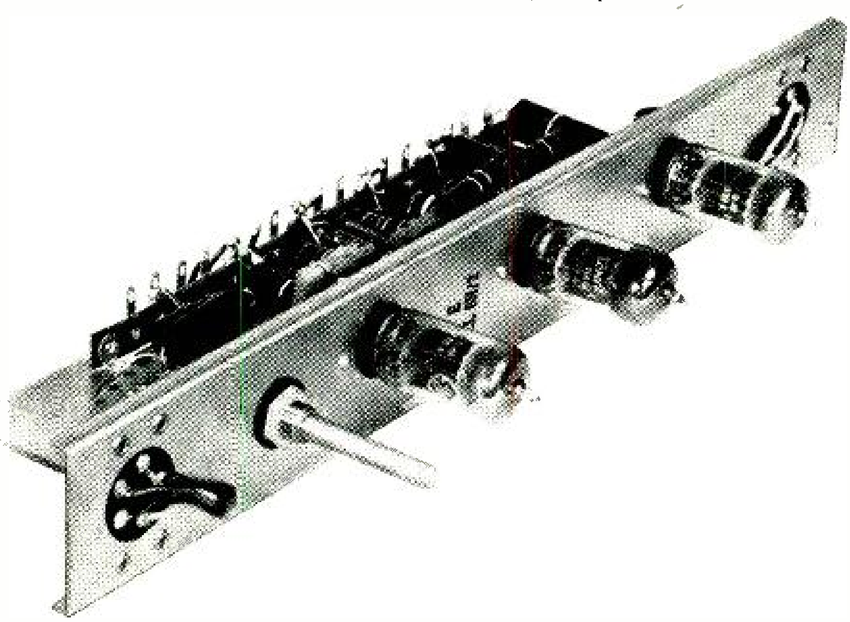


Fig. 3—Each of the 12 generator chassis holds four tubes, two connectors and tuning control.

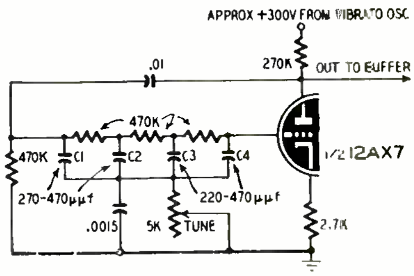
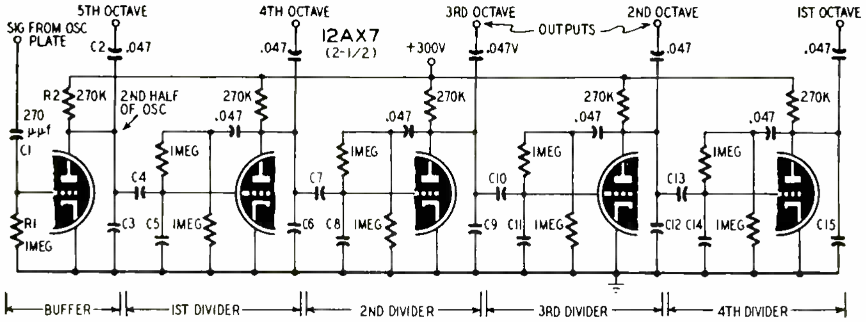


Fig. 4—Special phase-shift circuit used to generate the highest frequency for each oscillator-frequency divider chassis unit.



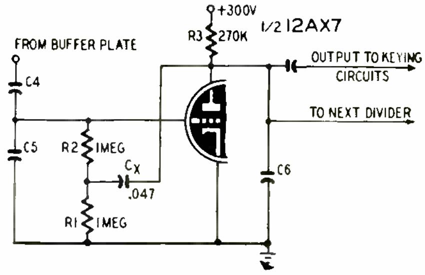


Fig. 5 (left)—Schematic of an oscillator-divider chassis. Fig. 6 (right)—A single frequency-divider circuit redrawn.

the buffer—the waveshape is a sawtooth.

The succeeding three dividers work in exactly the same manner, each energized by input waves from the previous divider, each having sawtooth output of half the input frequency. In order to understand this circuit thoroughly it is helpful to remember that the outputs are *not* voltage drops across resistors due to tube plate current, as in ordinary vacuum-tube circuits. They are potentials appearing across a charging and discharging capacitor. The tube is used merely to control the charge and discharge of the capacitor between plate and ground.

This unusual frequency divider can be explained in another way, which analyzes its operation in a more exact manner. Fig. 7 shows waveforms at various points in the circuit. The input waveform is represented by *a*, the sawtooth from the buffer or previous divider. If we assume initially (leaving the proof until later) that the tube conducts on alternate input-wave peaks, the plate current waveform is as shown in *b*—with pulses at half the input frequency.

The solid line in *c* of Fig. 7 shows the plate voltage—which is the voltage across the charging and discharging capacitor C6 (Fig. 6). The capacitor discharges each time the tube conducts, and the solid line shows the accompanying fall of plate voltage. After each pulse of plate current (*b* in the figure) the capacitor again charges slowly and the plate voltage (*c*, solid line) rises. Notice that this plate-voltage waveform is a sawtooth at half the frequency of the input (*a*).

The sawtooth voltage—appearing across C6—is a complex wave consisting of a fundamental and even harmonics. Because the output network is capacitive the fundamental component of the output voltage lags almost 90 degrees behind the pulse of plate current. This fundamental component (which cannot of course actually be seen with an oscilloscope) is shown by the dashed line in *c* of Fig. 7. It is

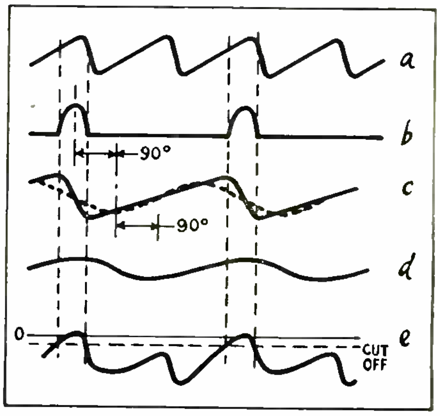
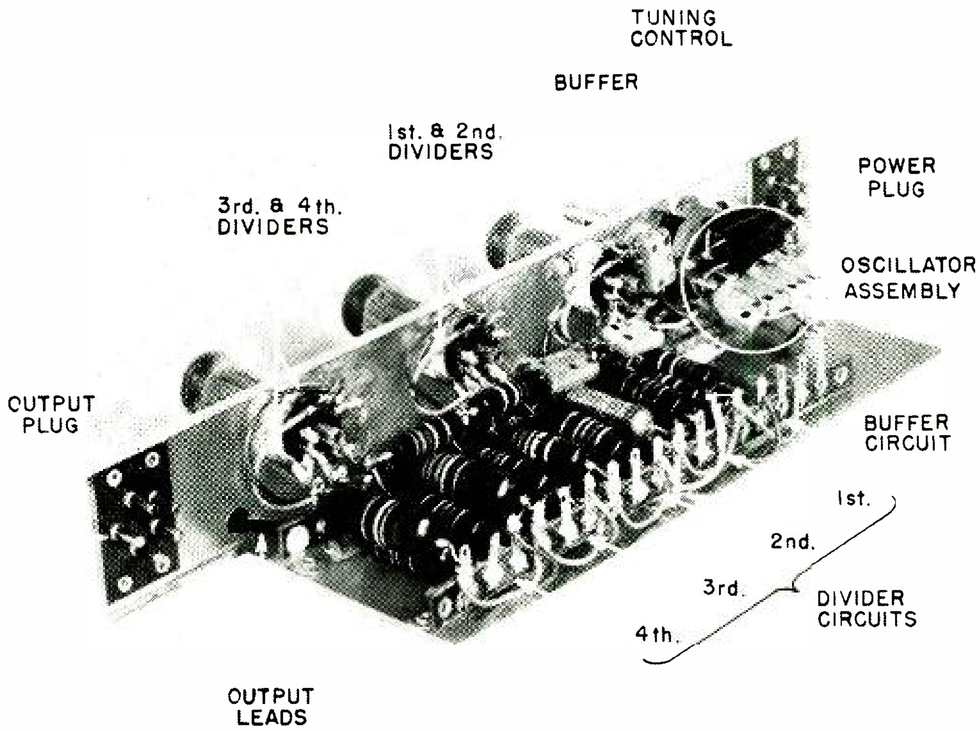


Fig. 7—Waveforms in the frequency-divider circuits of the Minshall electronic organ. Their derivation is explained in the text.

important because of the feedback.

Feedback from the plate takes the path through C_x (a blocking capacitor of large value which has no effect on phase or waveform), and the series



This underside view of one of the 12 divider chassis shows the compact, yet accessible arrangement of the resistors and capacitors. The oscillator assembly at right is a separate unit and is selected and added as the last operation in divider manufacture.

S-METER FROM SURPLUS

By GEORGE H. HAGUE

AS the owner of a low-priced communications receiver I have come to realize the advantages of a signal-strength indicator. The prospects for adding one looked poor since there is no suitable space on the front panel. A cable-connected S meter mounted in its own cabinet or chassis seemed a likely alternative.

During the process of designing an S meter a glance across the work-bench, discovered, bold as brass, a BC-442-A antenna relay. Here was a neat looking unit, with a fairly sensitive meter already mounted in a small metal box. The current required for full-scale deflection was checked. This was between 4.5 and 5 ma, but 1 ma swung the needle to the point marked 6 on the meter scale. (It apparently has a nonlinear movement with a linear scale.)

Construction was started by removing all parts except the local-remote switch from the relay. The meter was remounted so it could be read in a horizontal position. When the antenna standoffs were taken out the three large holes were concealed by mounting the zero-set control in such a position that the dial plate would just cover them. Another hole was drilled in the bottom plate for the connecting cable.

Because of the current requirements of the meter, I preferred the circuits that use the plate current of an i.f. tube connected to the a.v.c. The basic circuit shown in Fig. 1 makes the meter read backward and hard to calibrate.

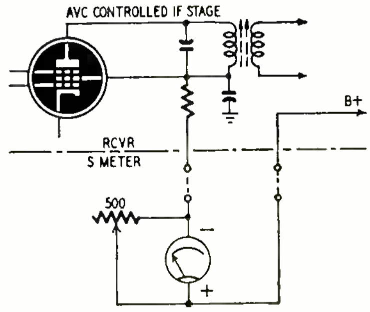
After mulling it over I decided to use the circuit shown in Fig. 2. This allows the meter to read up-scale. It is the familiar bleeder type using the meter in a balanced bridge circuit. Since the value of the bleeder resistor R will

Complete cable-connected S meter.

vary with the tube types and voltages used in other receivers, the constructor should try different values until the proper size is found. I use a 25,000-ohm 2-watt resistor. It gives the S meter fairly good sensitivity and does not impose too heavy a load on the power supply. It would be a good idea to insert a milliameter in the B+ lead of the connector cable to check the actual current drain. In my receiver this amounted to only 3.5 ma, and allowed a weak signal to register on the meter.

The local-remote switch shunts the meter and disconnects the bleeder from the B supply when the meter is not being used. A 3-wire cable from the receiver to the meter is required. A terminal strip at the back of the receiver and lugs at the ends of the cable leads facilitate connection. The brackets on the relay case make it possible to mount the instrument on the wall.

The S meter could be calibrated with



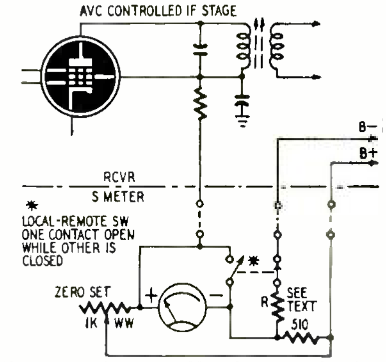


Fig. 1 (above)—Fundamental circuit.
Fig. 2 (below)—Final meter circuit.

an accurate signal generator but since the object is merely to compare relative signal strengths, this is, of course, unnecessary. The zero-set control is adjusted by shorting the antenna post on the receiver to ground and setting the meter to zero. Taking the ground off the antenna post puts you in business with an S meter, which should not cost you over four dollars.

Materials for the S meter

Resistors: 1—510 ohms, 2 watts, 1—24,000 ohms (see text) 2 watts, 1—1,000 ohms, wire-wound potentiometer

Miscellaneous: 1—dial plate and knob; 1—3-wire connector cable and terminal strip; 1—BC-442 A antenna relay or a metal box-chassis and a 0-5 milliammeter; rubber grommet, hardware, wire, solder, etc.

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combination of R2 and C5. The C5-R2 combination will be recognized as a low-pass filter or simple integrating network and has two effects. The harmonic content of the sawtooth plate voltage which is fed back through it is almost completely attenuated, so that

TABLE I
Capacitor Values for Fig. 5

Cap.	C / C♯ / D	D♯ / E / F	F♯ / G / G♯	A / A♯ / B
C3	.015	.012	.010	.0082
C4	330	270	220	180
C5	.0027	.0022	.0018	.0015
C6	018	.015	.012	.010
C7	680	560	470	390
C8	0047	.0039	.0033	.0027
C9	.033	.027	.022	.018
C10	0015	.0012	.0010	820
C11	.0032	.0068	0056	.0047
C12	.068	.056	.047	.039
C13	.0039	.0033	.0027	.0022
C14	.018	.015	.012	.010
C15	0.12	0.10	.082	.068

Decimal capacitances in microfarads; others in micromicrofarads. Tolerance ±10%.

what appears across C5—and is fed to the grid—is almost a sine wave. This sine wave is the fundamental component of plate voltage shown in the dashed line of *c*. Second, it introduces an additional lag of almost 90 degrees in the phase of the fed-back signal. As a result, the feedback voltage reaching the grid is of the shape and phase indicated in *d* of Fig. 7.

Note the relation between wave *a*, the input signal, and fed-back voltage *d*. The fed-back signal reaches its negative peak at the same time as the input signal reaches every other crest. Combining the input and the fed-back voltages gives the form of *e* in Fig. 7. Every even crest is negatively displaced, preventing it from bringing the tube's grid voltage above the plate-current cutoff point; while every odd crest is displaced positively, aiding tube conduction. Thus it is easy to see that our original assumption—that the tube conducts only on alternate peaks of the input signal—is justified, and a frequency division of 1 to 2 takes place.

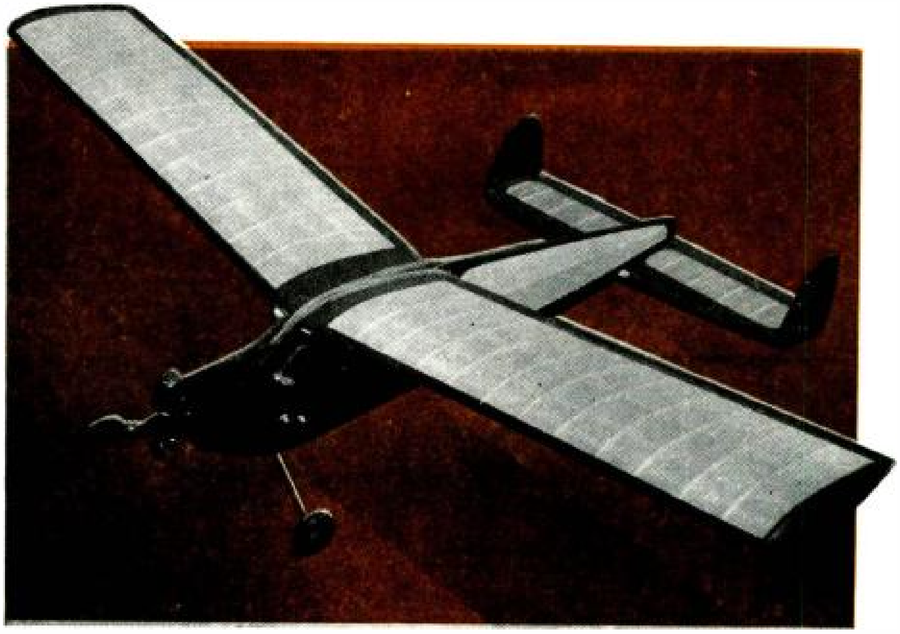
The frequency-sensitive capacitor values for the divider strings are given in Table I and refer to the numbered capacitors in Fig. 5. Standard 10%-tolerance capacitors are used. The resistor values are constant, since either R or C may be varied.

A single divider usually works well over a range of six to eight semitones, or more than half an octave. In an actual generator string, however, the ranges of the four dividers are staggered to some extent by parts tolerances, and the over-all range through which all four dividers work successfully may be limited to five semitones or less. The most important value is the plate (output) capacitor since it affects not only frequency but also level, which must be the same from note to note. In the Minshall plant four different generator string designs are manufactured, as Table I indicates, each useful for three notes.

In next month's article we shall discuss the vibrato, keying, and control circuits of the Minshall organ, the tone-color system, and the amplifier.

(to be continued)

MODEL PLANE CONTROL...



. . . . . with 27-mc signals . . .

A fascinating hobby—combining the techniques of electronics and flying—now open to non-amateurs too, with the assignment of an exclusive Citizens'-Band spot frequency. Simple equipment gets you started.

By E. J. BROWN

MILITARY use of guided missiles and radio-controlled miniature planes for targets and test purposes has become a part of everyday news. The use of radio control has spread to amateurs who build and fly small gas-engined planes as a hobby. The development of miniature components and compact hearing-aid batteries have reduced the size of radio-controlled model planes to half that of prewar types.

The opening of the Citizens band and the marketing (by the Vernon McNabb Co.) of a complete Citizens band control unit, including a transmitter, receiver, and escapement control, has greatly expanded the number of radio-controlled-model builders.

One of the most valuable aids to radio control of plane models is the Raytheon RK-61 tube. This tube, a gas thyratron triode, requires so little operating current that it is possible to reduce the weight of the airborne radio equipment to only 7½ ounces. The RK-61 was in short supply for a while, but is now available again. A British tube, the XFG-1, also may be used without any circuit changes.

This article describes a complete model-control system which can be easily constructed in the home. It is intended for use in the amateur bands above 26,960 mc., and on the new Citizens band radio control frequency of 27.255 mc. While much radio control work is also being done on the 460–470-mc Citizens band, the RK-61 thyratron is not considered suitable for use at frequencies above 100 mc. (Editor's note: No attempt should be made to use radio control for any purpose until the necessary licensing requirements have been met. Consult the FCC for latest regulations.)

The schematic of the superregenerative receiver which is mounted in the plane or other controlled unit is shown in Fig. 1. A spiral-wound inductor L1 is used to reduce space requirements. L1, consisting of 9½ turns of No. 16 enameled wire with a tap at about 3½ turns from the inside, can be seen in Figs. 2 and 3. The relay and the escapement-type control unit (Fig. 4), which moves the rudder, are separate,

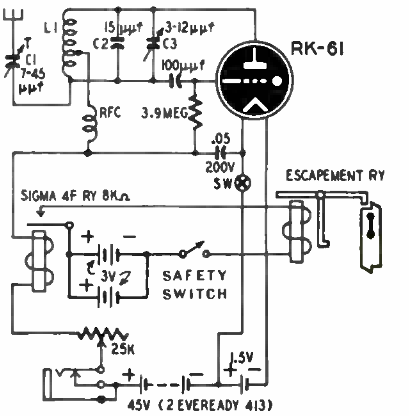
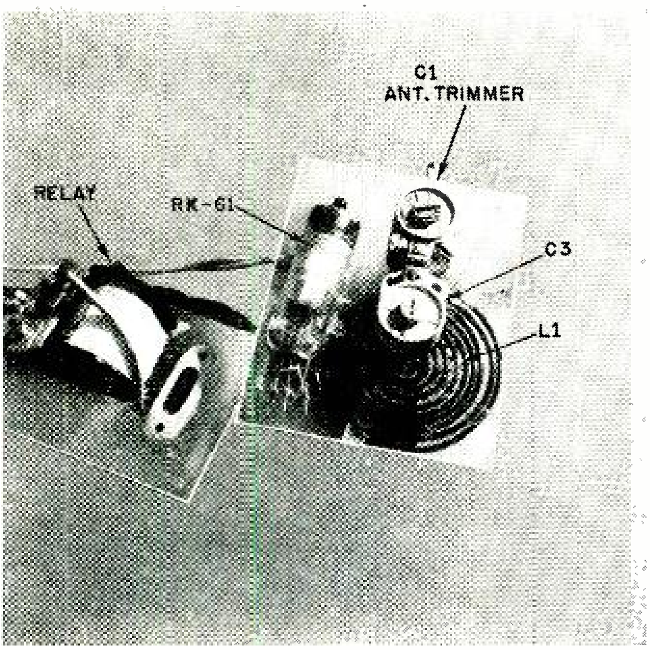


Fig. 1—Schematic of the receiver. An incoming signal closes the relay contacts.

Fig. 2 (below)—Close-up view of the receiver tuning assembly, showing the special spirally-wound tuning inductor. The underside of the control relay for the escapement mechanism appears at the left.



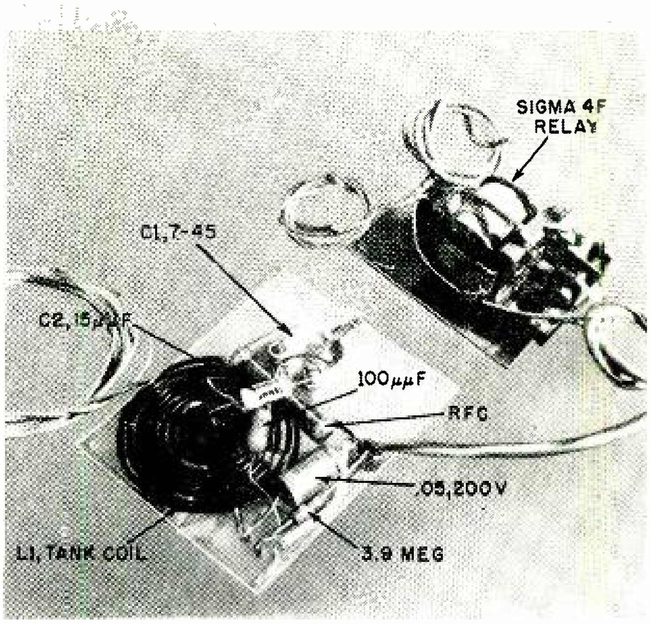


Fig. 3 (above)—The opposite side of the receiver mounting plate, showing the placement of related components and the connecting cable to the control relay unit.

and may be mounted in any convenient location in the model.

The receiver is constructed on a base of polystyrene as shown in the photos. Do not solder the tube wires directly to components, as it may damage the tube and would prevent quick removal. All parts are standard except the r.f. choke, which is made from a burned-out tubular glass fuse, close-wound with a 1-inch long, single layer of No. 32 enameled wire. The three-wire cable connects the receiver to the relay and the batteries.

If dimensions vary from those shown it may be necessary to change the value of the fixed band-spread capacitor C2 to keep the receiver in the band. The L-C ratio of the tank is not critical, but if trouble is experienced try varying the number of turns on the coil and try changing the point of the choke connection to control regeneration.

A 25,000-ohm potentiometer is used to control plate current. Filament current is supplied by two penlite cells wired in parallel. A switch in the A plus–B minus lead turns the receiver on or off.

A closed-circuit jack is used in the B plus lead for plugging in a 0–5-ma d.c. meter to tune the receiver. The no-signal plate current should read between 1.3 and 1.5 ma, dropping to 0.1 to 0.3 when a signal is received. The receiver antenna should be a piece of stranded wire about 60 inches long. Lengths as short as 18 inches will work at short ranges. The antenna-tuning capacitor, C1, will compensate for incorrect lengths.

The relay used in the receiver is a Sigma 4F, 8,000-ohm unit, obtainable on the surplus market or from Control Research Co., P.O. Box 9, Hampton, Virginia, who carry other radio control supplies and specialize in kits for radio-control equipment. This relay is the heart of the set and must be supersensitive and have adjustable contact spacing and armature spring tension.

Adjust the relay to pull in the armature at 1.1 ma and release it at 0.7 or 0.8 ma. The armature spring tension and contact spacing must be reduced from the original settings. The contact spacing should not be over 10 one-thousandths of an inch to start with, and the armature must not touch the pole piece when pulled in.

The control units may be of the escapement type, pulse type (which rotates back and forth 180°), or small electric motors with self-centering limit

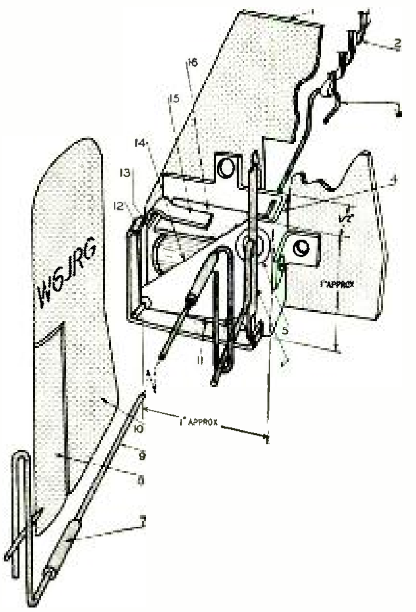
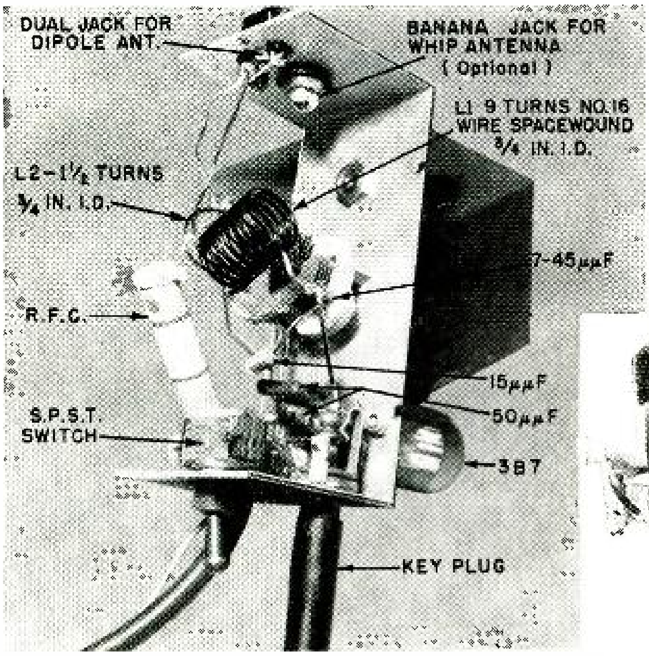
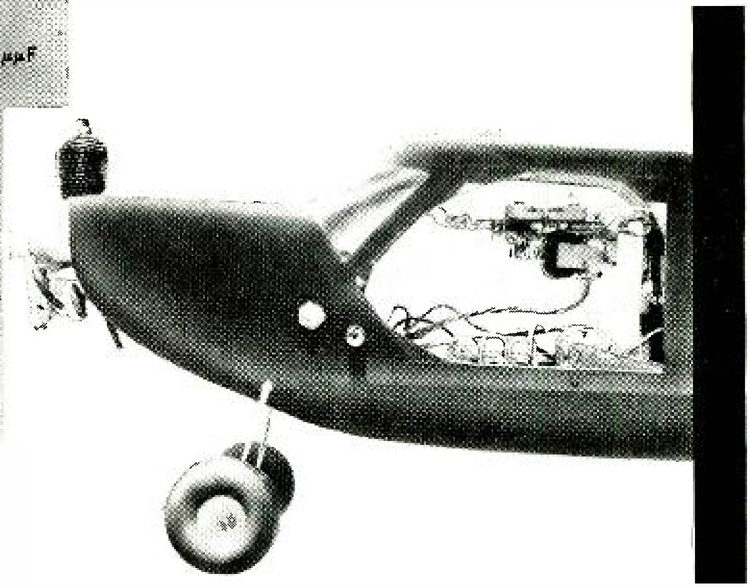


Fig. 4—The escapement mechanism. The parts are identified and described below.

1. Bulkhead.
2. Rubber loop, 1/8-inch flat rubber.
3. Crank-pin hook, 1/16-inch music wire.
4. Frame, .025-inch hard brass sheet.
5. Bearing, model airplane type.
6. Control arm, 1/8-inch brass rod.
7. Bushing, brass tubing.
8. Rudder.
9. Yoke shaft, 1/16-inch music wire.
10. Fin.
11. Spring, .012-inch music wire.
12. Pawl.
13. Armature, 1/16-inch soft iron.
14. Coil: 90 ft. No. 32 enameled wire (or equivalent in No. 31 to give resistance of 6–10 ohms), wound on soft iron core 3/16-inch diameter, 3/4 inch long. This coil draws 300–500 ma at 3 volts.
15. Armature stop.
16. L-shaped coil bracket.



(Left)—The 27-mc transmitter assembly
(Below)—A typical receiver installation in the cockpit of a flying plane model.



switches. These may be covered in a future article.

The escapement shown in Fig. 4 is also from Control Research Co., available in kit form. The dimensions shown will produce a slightly larger unit with more reliability for operation in a large plane or boat model. This unit should weigh from ½ to 1 ounce completed.

The escapement is wired to the relay so the relay opens the circuit when energized by the no-signal plate current. The circuit closes when the relay opens as a signal is received. A s.p.s.t. switch is required in the escapement circuit to open the circuit when the receiver is turned off.

The batteries used are a factor in weight. Eveready 413E B-batteries will last three to four months, and two penlite batteries in parallel will provide

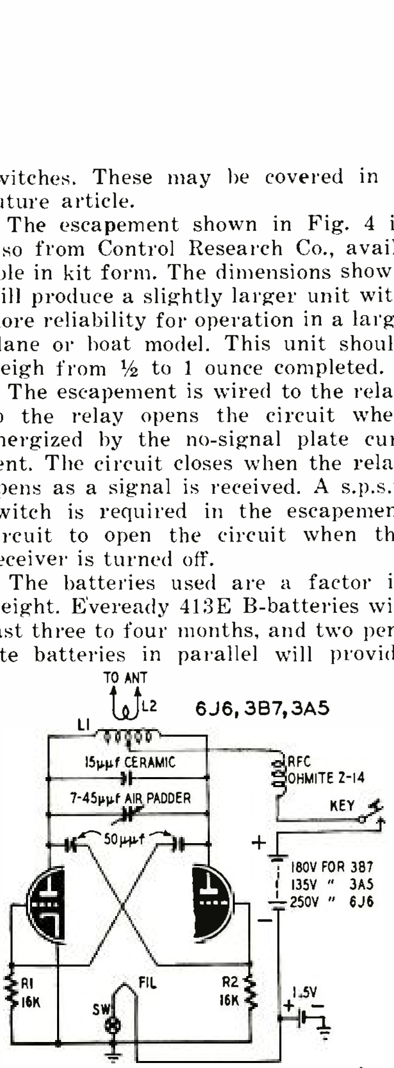


Fig. 5—Schematic of the transmitter. For a 6J6, heater battery should be 6.3v.

filament current for a month or more. The batteries used to control the escapement or control unit draw the most current and should be as large as possible. The author uses four to six penlite batteries in series-parallel to develop 3 volts. They are usually good for 12 to 20 flights of 5 to 10 minutes duration each. The weight of the complete installation with above batteries will be about 12 ounces. Smaller batteries may be used to reduce weight, with a corresponding reduction in life and reliability.

The transmitter, diagrammed in Fig. 5, is a conventional push-pull circuit and may use a 3A5 or a 3B7. A 6J6 may be used if operation from a car battery is desired. The author started with a dry-battery-operated 3A5 unit but now uses a 6J6 transmitter with a surplus-bargain dynamotor for B-supply. Both units were equally reliable, but the dynamotor eliminates the worry of battery drain affecting signal strength.

The grid-leak resistors R1 and R2 shown in Fig. 5 were reduced to 6,800 ohms for the 6J6 to increase output.

The transmitter is constructed on the U-frame part of a standard 2¼ x 2¼ x 5-inch aluminum box, as shown in the photo above. The tube socket is at the bottom of the U with the tube outside for better cooling.

The control switch in the B plus lead can be any type of push-button switch mounted either on the transmitter or at the end of a 5- or 6-foot cord to permit moving around while operating.

The r.f. choke is an Ohmite Z-14, but one similar to the type used in the receiver will do as well. L1 is 9 turns of No. 16 center-tapped, with an inside diameter of ¾ inch. Turns are spaced one wire diameter. L2 is 1½ turns with ¾-inch inside diameter.

A folded dipole antenna has been found to be the most effective for transmission over distances up to three miles. The dipole is a piece of 300-ohm ribbon line 14 feet, 5 inches long, shorted at the ends. A 300-ohm lead-in connects to the center of one of the antenna conductors. The mast must be mounted in a piece of pipe or other support to permit rotation. A 9-foot vertical rod antenna may also be used if operation is limited to ranges of one-half mile or less. One side of L2 is grounded when using this type of antenna.

Tune the transmitter with an absorption-type wavemeter or grid-dip meter and then tune the receiver to the transmitter frequency as described above.

The transmitter and receiver circuits shown may be used also for operation in the 50- to 54-mc amateur band with the advantage of shorter antennas.

The equipment described above provides an excellent beginning for the newcomer to radio control. The author wishes to thank the Control Research Co. for permission to use the transmitter schematic and the receiver circuit (as modified by the writer with the spiral coil).

—end—

Fig. 1—Interior layout of the frequency spotter.

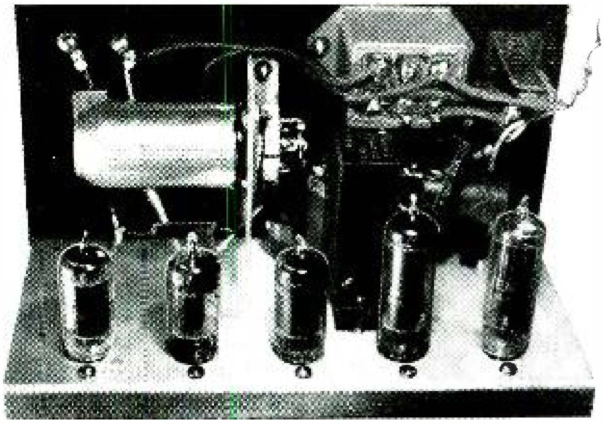
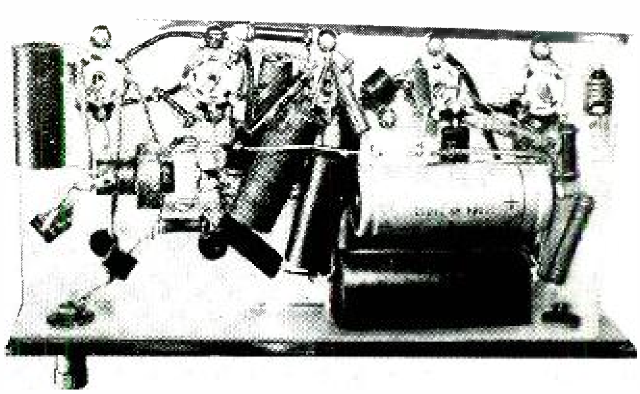
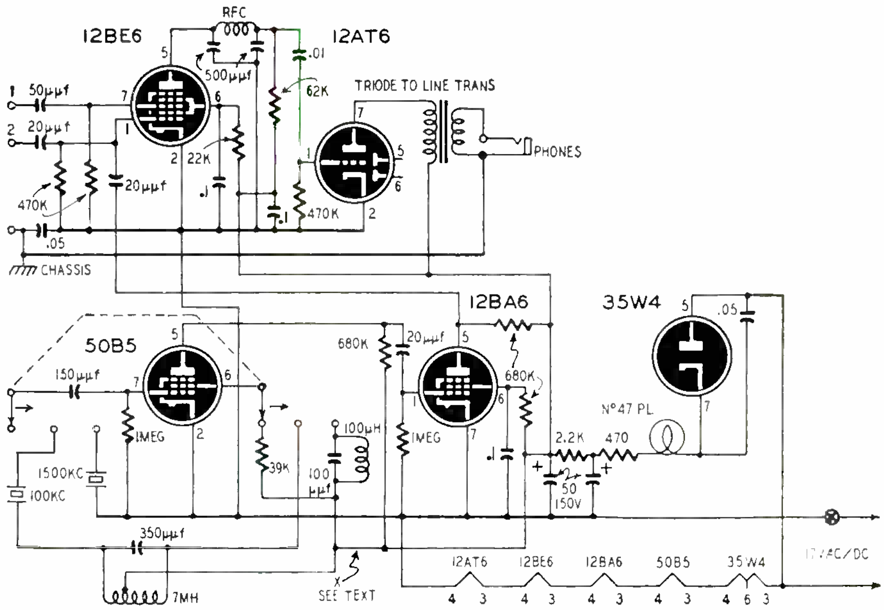


Fig. 2—Component placement beneath the chassis.



CRYSTAL FREQUENCY SPOTTER

By ALFRED HAAS



THE increasing need for v.h.f. and u.h.f. signal sources calls for critical marker frequencies, having fractional megacycle values.

It is not easy to build a highly accurate signal generator with wide frequency coverage, and very few service-type oscillators have the required stability, or scales readable in decimal fractions of a megacycle.

It *is* possible, however, to build a relatively simple crystal oscillator of high accuracy and stability. Its harmonics provide a great many check points that can make even a poor signal generator temporarily accurate.

A diagram of such an instrument for a.c.-d.c. operation is shown. It consists of a 50B5 crystal oscillator, a 12BA6 harmonic amplifier, a 12BE6 mixer with two inputs, and a 12AT6 audio amplifier. The 35W4 rectifier provides B plus voltages.

In practice, a crystal having a relatively high fundamental frequency (1500 kc in this case) is used first.

Harmonics of this frequency are fed into the mixer along with the output of the signal generator. If the generator is tuned close enough to one of the crystal harmonics, the difference becomes audible. As the generator approaches the exact frequency of the harmonic, the audible difference decreases in pitch, and at zero difference disappears entirely.

When a sufficient number of check points 1500 kc apart have been marked on the generator dial a 100-kc crystal is switched on. Harmonics of this crystal should zero-beat at each of the original check points and produce 14 additional check points between each original pair.

The parts layout is shown in Fig. 1 and Fig. 2.

Circuit details

Precision crystals are sometimes sluggish in starting. For this reason ringing-type oscillator circuits are used. The 100-kc circuit requires a 7-millihenry coil, tapped at one-tenth the total number of turns. The coil is tuned by a capacitance of approximately 350 μμf. The 1-mc circuit is tuned by a 100-μh coil and a 100-μμf capacitor. (Slug-tuned r.f. chokes suitable for this circuit are available from several manufacturers—*Editor.*)

The three-position selector switch allows use of either crystal, or a stand-by position in which the oscillator is disabled by reducing the screen voltage. The mixer can then be used for comparing two external oscillators.

The type 47 pilot lamp in the rectifier cathode circuit acts as a fuse and indicates failure of the oscillator circuit by an increase in brightness.

Tuning procedure

To tune the oscillator ringing circuits, a 0–10 d.c. milliammeter shunted by a 0.1-μf capacitor is inserted at X in the diagram. Each circuit should be tuned for a screen current of about 2 ma. Lower currents may cause instability.

An accuracy of approximately 1% can be obtained by this method. For utmost accuracy terminal 2 should be coupled loosely to the antenna post of a receiver tuned to one of the standard frequency transmissions from WWV. By adjusting the tank circuits to zero beat in the receiver speaker, a short-time accuracy of one part in ten million may be obtained.

Materials for frequency spotter

Resistors: 1—2,200, 1—470 ohms, 1 watt; 2—1 megohm, 3—680,000, 2—470,000, 1—62,000, 1—39,000, 1—22,000 ohms, ½ watt.

Capacitors: (Electrolytic) 2—50 μf, 150 volts. (Paper) 3—0.1 μf, 1—.05 μf, 1—.01 μf, 400 volts. (Ceramic or mica) 2—500 μμf, 1—350 μμf, 1—150 μμf, 1—100 μμf, 1—50 μμf, 3—20 μμf.

Miscellaneous: 1—50B5, 1—35W4, 1—12AT6, 1—12BA6, 1—12BE6 tubes; 1—triode-to-line low-level output transformer; 1—2-pole-3-position wafer switch; 1—s.p.s.t. toggle switch; 1—1500-kc crystal; 1—100-kc crystal; 2—crystal sockets; 5—7-pin miniature sockets; terminals, chassis, wire, solder, hardware.

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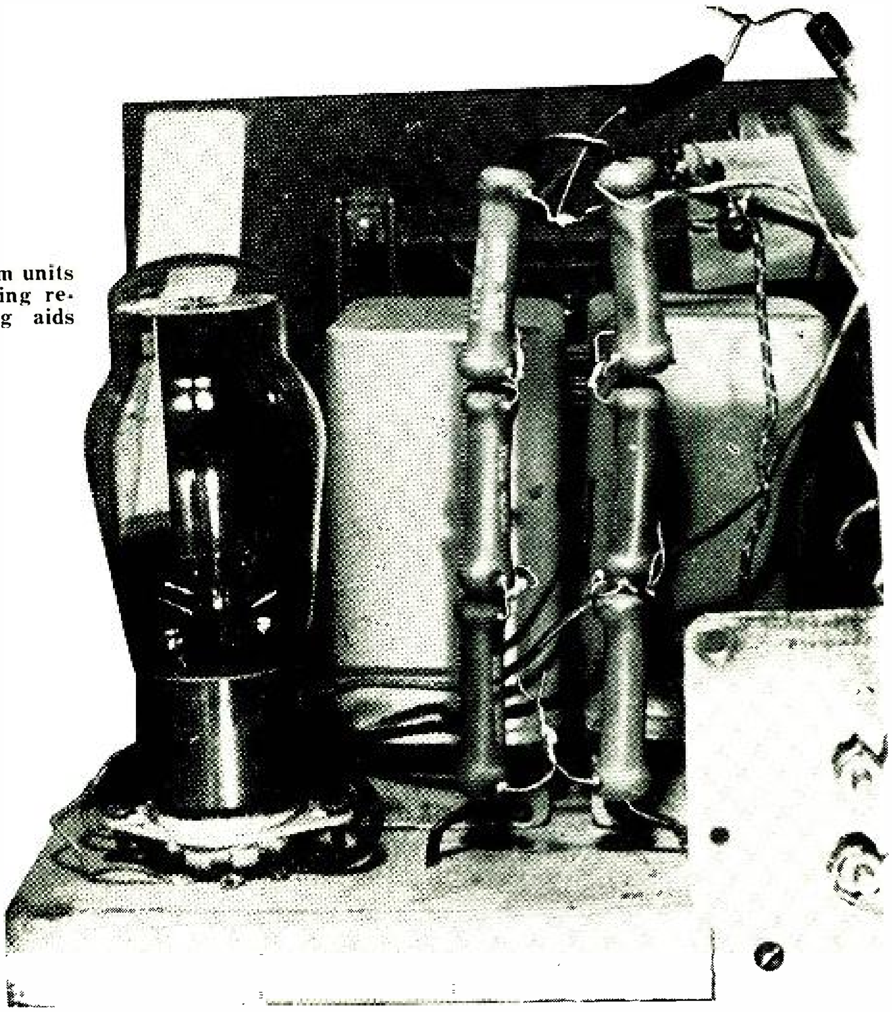


This view shows the six 4,000-ohm units that form the 807 screen-dropping resistor. Above-chassis mounting aids heat dissipation.

Economical, simple, efficient, this unit swings an 807 to 90 watts peak output

CLAMP TUBE MODULATOR

By FRED J. LINGEL, W2ZGY

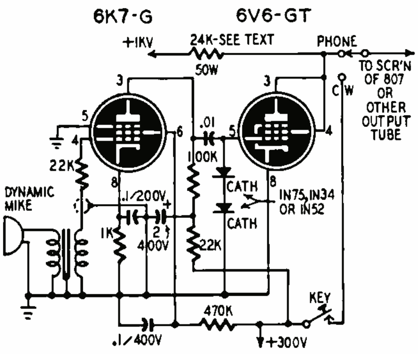


Fig. 1 (above)—Circuit of the clamp-tube modulator. Use of crystal diodes in the 6V6 grid circuit reduces hum modulation.

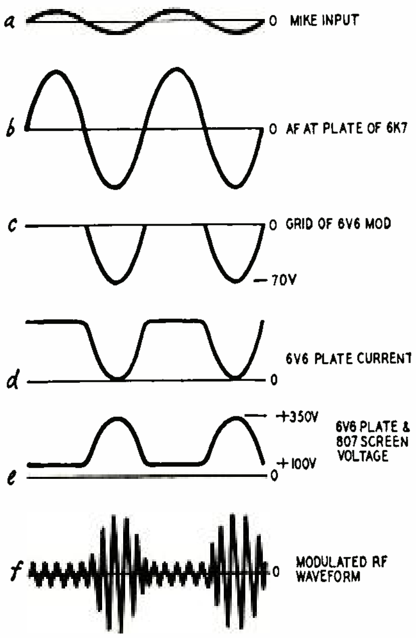
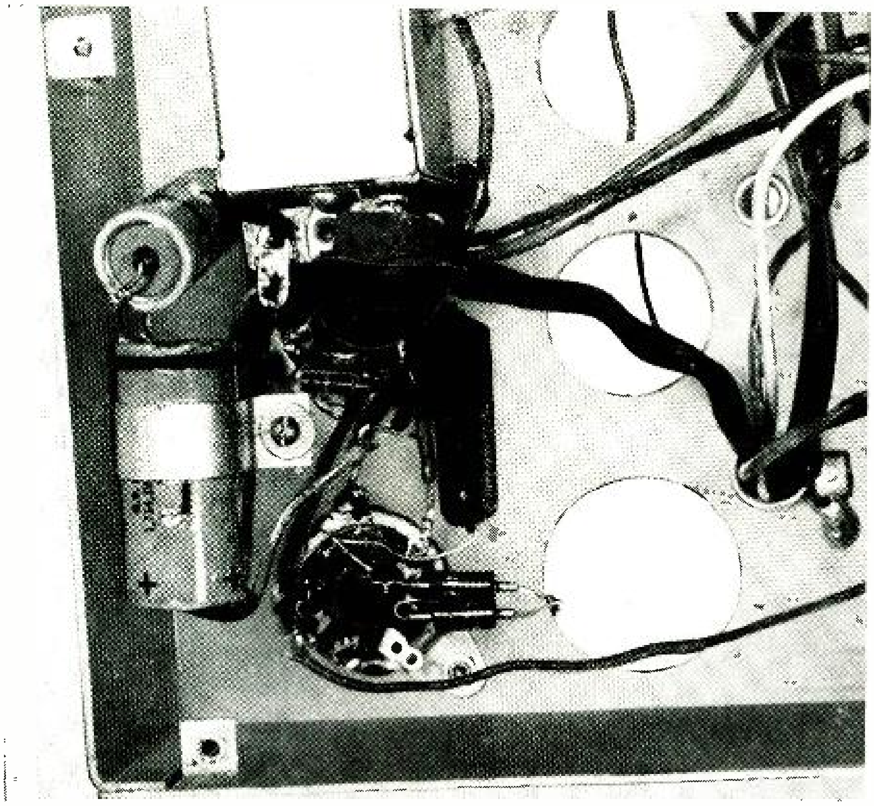


Fig. 2 (right)—Controlled-carrier modulation waveforms from microphone to transmitter output. Details in text.

THIS article describes a two-tube controlled-carrier modulator using two germanium diodes as the audio rectifier. The unit was designed around the intercom amplifier used in the No. 19 Mark II surplus tank transmitter-receiver. Normal telephone speech level at the dynamic mike fully modulates an 807 to 90 watts peak power output. The two-tube assembly reduces r.f. feedback and gives a much simpler modulator than any previously described.

Controlled-carrier modulation is popular in amateur transmitters for a number of reasons:

- Few parts—no transformers.
- Low cost—uses receiving type tubes.
- Small size.
- Higher power—phone operation at maximum c.w. ratings.
- Easy to adjust—impossible to overmodulate.
- Ideal for portable rigs—modulated amplifier plate and screen power on only when speaking.
- Simple power-output control—speak low for locals, loud for distance.



Underside of the clamp tube modulator, showing the compactness of the layout. The microphone transformer is at the top, partially concealing the 6K7-G socket. The series-connected germanium-crystal diodes are at the bottom.

Automatic speech clipping—more complete modulation.

The complete circuit diagram is shown in Fig. 1.

The modulator operates as follows: The 6K7 is the a.f. amplifier, and the 6V6-G is the clamp tube, operated with zero bias. With no audio signal input, the 6V6 draws enough current through the 24,000-ohm resistor to drop the voltage on the 807 screen and the 6V6 plate to 50–100 volts. The reduced screen voltage on the 807 drops the plate current to about 20 ma. and the plate power input is limited to about 20 watts.

When an audio signal (*a* in Fig. 2) is applied to the 6K7, the positive half-cycles of the amplified signal (*b*) cause the series-connected germanium diodes to conduct and short-circuit the audio to ground so it does not affect the operation of the 6V6.

On the negative half-cycles, the audio signal drives the 6V6 grid to a maximum of about 70 volts negative with the voltage following the negative half of the speech envelope (*c* in Fig. 2). This negative audio voltage causes a corresponding drop in the clamp-tube plate current (*d* in Fig. 2), which decreases the drop across the 24,000-ohm 807 screen and 6V6 plate resistor. The screen voltage rises as shown at *e*. The r.f. output is modulated by the varying screen voltage.

Although the audio modulating component includes harmonics generated by the clipping action on positive speech half-cycles of the series-connected crystal diodes, and by the non-linearity of the screen characteristic, the halves of the modulated r.f. envelope are symmetrical (see waveform *f* in Fig. 2) because of the flywheel effect of the tank circuit.

By connecting the two diodes across the grid, we eliminate the two grid resistors sometimes used in this type of modulator. The two series-connected diodes provide a high grid resistance with a greater control action. If only one diode is used, the rectified grid voltage is roughly half the value obtained with two.

The 807 screen dropping resistor consists of six 4,000-ohm, 10-watt resistors connected in series. By connecting the 6V6 plate to a tap on the resistor string, you can vary the ratio between the strengths of the unmodulated and fully-modulated carrier.

For c.w. operation and for tuning up on phone, the screen of the 807 is connected to a 300-volt d.c. supply rather than to the modulator resistor. This is preferred to cathode-biasing the 6V6, since the plate of the 6V6 is then not held at an abnormally high voltage for an appreciable period of time with eventual tube failure.

I have used this arrangement very successfully for several months on my "souped-up" No. 19, Mark II surplus transmitter. It runs approximately 10 watts idle carrier and 100 watts peak. The germanium diode rectifier helps keep a.c. hum at a low level, since there is no heater supply in this sensitive portion of the modulator system.

The 807 final amplifier of the Mark II is run with 1,000 volts on the plate. The resting plate current is about 20 ma. It rises to 100 ma on modulation peaks. The screen-grid is run at 50–100 volts in its quiescent state and rises to a maximum of 350 volts under modulation. The modulation is limited to about 80% because the final plate current is not completely cut off on peaks. The 807 plate-current meter indicates comparative r.f. output, audio level, and tank-circuit resonance.

When answering a CQ, I have found it best to switch to the c.w. position for a couple of seconds before modulating. During this interval I check plate current and tuning of the final amplifier. The full carrier power also gives the calling station a more definite indication that he is being answered.

—end—

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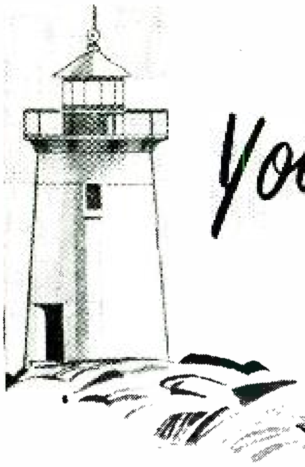

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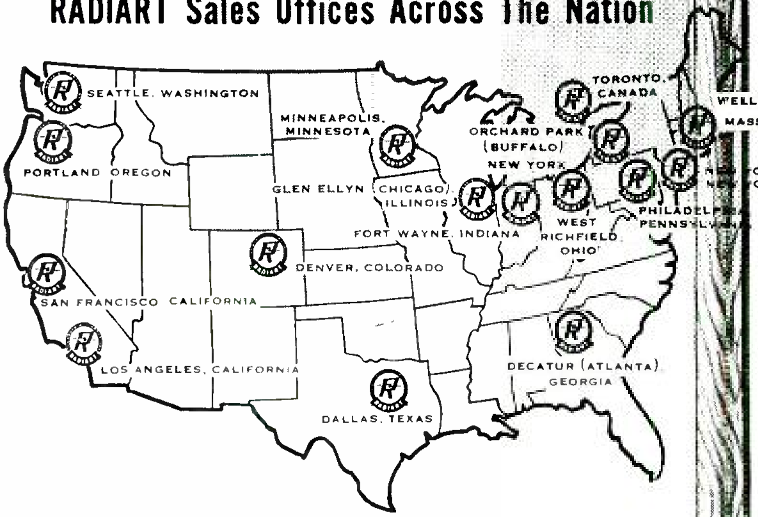

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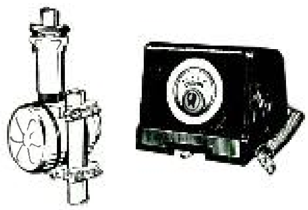

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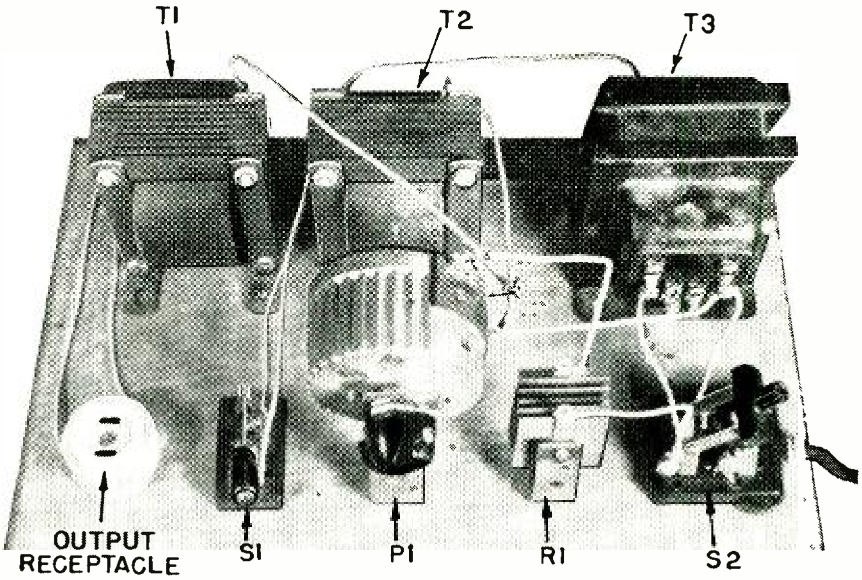

Fig. 1—Layout of the magnetic amplifier. The large potentiometer controls its gain.

By ERWIN LEVEY

THE growing use of magnetic amplifiers in military and industrial electronic equipment has stimulated considerable interest in these relatively unfamiliar devices. This article describes a simple setup for demonstrating the basic principles of magnetic amplification and applying them to controlling the speed of a small a.c. motor.

The equipment requires only three standard filament transformers and a few other readily available parts, all of which are mounted on a 7 x 12-inch wood baseboard.

The layout and all parts are clearly seen in the two photographs, Figs 1 and 5.

Magnetic amplification

In its simplest form a magnetic amplifier is a magnetic core with two windings (Fig. 2). One of these, the *d.c.* or *control winding*, usually has a large number of turns and is connected across a source of variable d.c. The other, called the *a.c.* or *load winding*, is connected in series with the load and an a.c. supply line. A small amount of power applied to the d.c. winding will control a larger amount of power in the a.c. winding.

This is because varying the amount of current in the d.c. winding can vary the inductance of the a.c. winding over a wide range. As its inductance is varied, so is its impedance to a.c. and consequently the amount of power which can be applied to the load.

When the d.c. is zero the self-inductance of the windings is high and little power is applied to the load. As the amount of d.c. through the control winding is increased, the impedance of the secondary goes down, because the core is becoming saturated magnetically, and variations in the a.c. field no longer have any effect on it. Hence these variations do not set up the bucking voltages which keep the secondary impedance high.

With a large amount of d.c. in the winding, the secondary has practically no impedance, and the load is, in effect, connected directly across the a.c. supply.

The apparatus is an *amplifier* because the amount of power applied to the control winding is less than that controlled in the a.c. winding. This unit—built with ordinary transformers for demonstration purposes—has a gain in the order of two, but magnetic amplifiers made with special core material have extremely high gains. For a more complete and highly understandable treatment of this subject, see the article "Magnetic Amplifiers" in the September, 1951, issue of RADIO-ELECTRONICS.

This model uses a two-core arrangement. Since a low-voltage control system was desired, two 6.3-volt filament transformers were used. These are transformers T1 and T2 in Fig 3. The type of transformer used does not matter but the two must be identical or they will not function as a saturable reactor when connected. When used in this way no physical changes are required; it is necessary only to interconnect the windings so that certain phase relations exist.

Phasing procedure

To phase the transformer windings correctly the following simple test is used. (A schematic of the arrangement is shown in Fig. 4.) Connect the two primaries in *parallel*. Designate one side of the line as S (start) and the other as F (finish). Mark the leads on each of the transformers accordingly. (It doesn't matter at this point which leads are used, as this coding will be the starting point.) Next, connect the secondaries of the two transformers in *series* and connect a 6.3-v pilot light across the two outside terminals. If the bulb glows brightly when the primaries are connected to the a.c. power line, connection is correct. Under this condition the two coils are in "series-aiding", which means that the total terminal voltage is 12.6. If the bulb is extinguished the connections are incorrect and *one* of the two secondary windings should be reversed.

When the proper connections have been made, mark the two windings as shown in Fig. 4. It is extremely important that this be done correctly, otherwise the unit will not operate in the final circuit.

The transformers can now be connected together to function as a saturable reactor. The 110-volt primaries are used as the d.c. control winding and are connected in "series-opposing" as shown in Fig. 3. The 6.3-v secondaries are used as the a.c. winding and are connected in parallel.

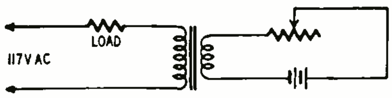

Fig. 2—Basic magnetic amplifier circuit. The magnetizing effect of the d.c. controls the permeability of the iron core.

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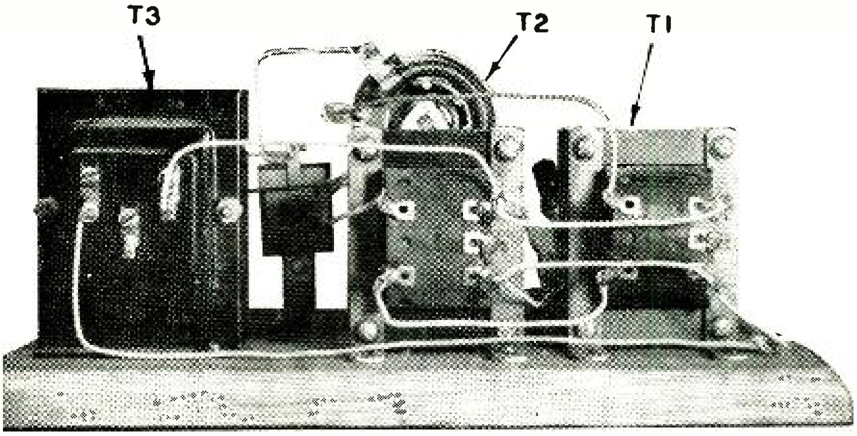

Fig. 5—Rear view of the magnetic amplifier. The two control transformers are at the right. The shielded transformer provides power for a small motor load.

A third transformer (T3) is needed to provide proper voltage for the load. Any small low-voltage motor will serve if the proper operating voltage is obtainable.

A much higher line current is required to *start* a motor than to keep it running. In this circuit even the minimum inductance of the a.c. windings would limit the current to such a small value that the motor could not start. A shorting switch (S1) is connected across these windings to allow full current to be applied to the motor when the power is first turned on. Once the motor is running the switch is opened, transferring control to the magnetic amplifier.

A half-wave selenium rectifier supplies the d.c. control current. The inductance of the d.c. windings provides good smoothing action, and no additional filtering is necessary. A 5,000-ohm, 50-watt potentiometer controls the current to the d.c. coils.

After the circuit has been assembled and all connections checked it can be put in operation. For this test the motor should not have a load attached. First close the shorting switch S1; then set the potentiometer so that full d.c. will flow when the power is turned on. Next close switch S2 to energize the circuit. The motor should start immediately. When it is up to full speed open S1. The motor speed can then be varied by turning the potentiometer. If the d.c. falls below a certain value the motor will stop because of the high inductance of the a.c. windings. It may be started again by closing S1.

The motor speed may be varied over wide limits. A little experimenting will show the best control ranges for different operating conditions.

If the motor stops when S1 is first opened, vary the potentiometer slowly over its full range since it may have been hooked up backwards. If the motor still will not operate, shut off the power. If wiring is correct, transformers T1 and T2 should be checked and the phasing test repeated.

If transformers T1 and T2 do not have adequate current rating they may burn out or give only limited control. If too heavy a load is placed on the motor the control range will be reduced since a larger amount of d.c. will be needed. In this case, two similar rectifiers may be paralleled and the power rating of the potentiometer doubled.

The power gain of this unit is fairly low because ordinary 4%-silicon steel is used as the core material of the transformers. In commercial magnetic amplifiers high-permeability core materials give extremely high amplification. The power gain may be calculated from the formula:

$$\text{gain} = \frac{\text{a.c. power output}}{\text{d.c. power input}}$$

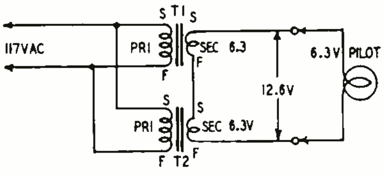

Fig. 4—Connections and polarity markings for the transformer phasing test.

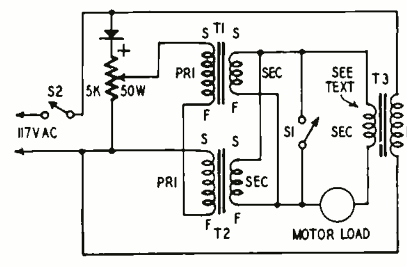

Fig. 3—The magnetic amplifier circuit. Characteristics of the three transformers and rectifier are given in the text.

The simple magnetic amplifier described here will help to understand some of the basic operating principles of these units. For clarity the information in this article has been limited to only one application of a specific type of circuit. By varying the circuits and parts almost any amount of a.c. power may be controlled at any voltage desired.

PARTS LIST

1—200-ma selenium rectifier; 1—5,000-ohm, 50-watt potentiometer;
2—double-pole, single-throw switches; 3—6.3-volt, 5-amp filament transformers (see text for T3);
1—motor (see text).

—end—

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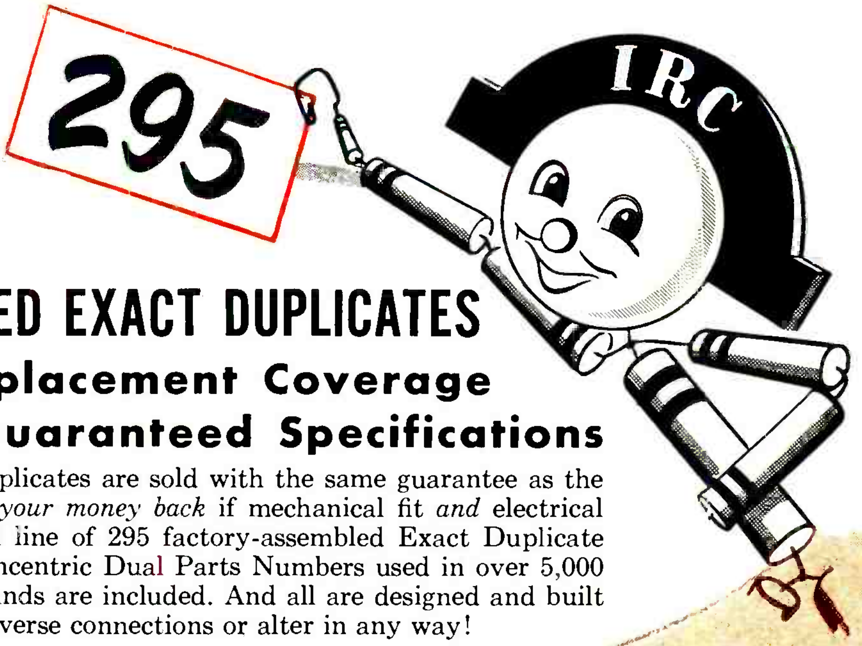

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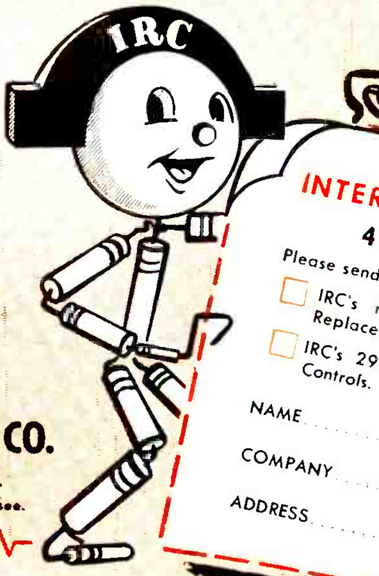

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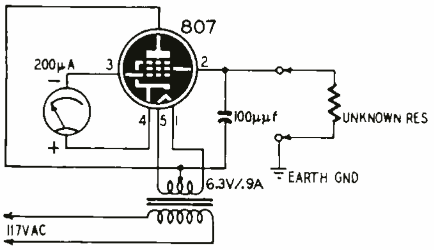
"EDISON EFFECT" FINDS A NEW USE

By IRVING GOTTLIEB

Interesting and useful effects may result from using vacuum tubes in unconventional ways. Commonly all the tube elements are parts of closed circuits, with proper external voltages applied. But there are cases where an element may be left "open." A capacitance-operated "floating-grid" relay was described in this magazine in June, 1943, and a biological microvoltmeter with a normally-open grid circuit in the May, 1944 issue. As can be seen from the dates, these accounts are rare.

The long known but little used Edison Effect (flow of current in a vacuum tube between a hot cathode and any other element having a lower temperature, but no applied a.c. or d.c. potential) may also have its uses. The author worked out this simple circuit to demonstrate a possible use of this effect—measurement of very high resistances. It has the great advantage that it does not require the high potentials found in most equipment designed for high-resistance measurement.

The circuit will measure resistance values of 10 to 1,000 megohms. When applied to composition and film type resistors used in conventional electronic equipment, and to the measurement of surface leakage of insulating materials it yields good accuracy over a far greater range than the average ohmmeter. It is not suitable for determining the insulation resistance of dynamos or other devices in which the capacitance between measuring points exceeds about 15 μμf. This circuit is shown below.



The principle of operation is: Electrons are emitted from the heated cathode. Some of these electrons are intercepted by the control grid and return to the cathode through the meter circuit. Others, which have higher velocities or are emitted at different angles, pass the control grid and accumulate on the screen grid. If these electrons are not removed from the screen grid, their cumulative negative charge will deflect free electrons back to the control grid and increase the current in the meter circuit.

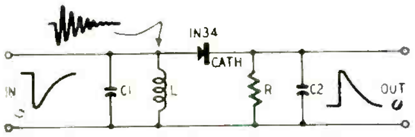
On the other hand, if the negative charge on the screen grid is removed, fewer electrons will be intercepted by the control grid. This will reduce the current circulating between cathode and control grid. If any of the inter-grid electrons are deflected back to the control grid, the external current will have a proportional value.

The best way to remove the charge from the screen grid is by means of an earth-ground. The meter should be calibrated by using known resistors. The scale calibration will not be linear. The 100-μμf capacitor reduces the effects of distributed or lumped capacitance in the resistance being measured. A capacitor larger than 100 μμf will reduce the sensitivity. An air-dielectric capacitor connected by short, heavy leads will give best results.

The 807 tube should be mounted inside a metal box and the screen grid connection should be brought out through a large porcelain feed-through insulator. Most effective shielding is obtained by connecting the plate terminal of the tube and the metal box to the center-tap of the filament winding.

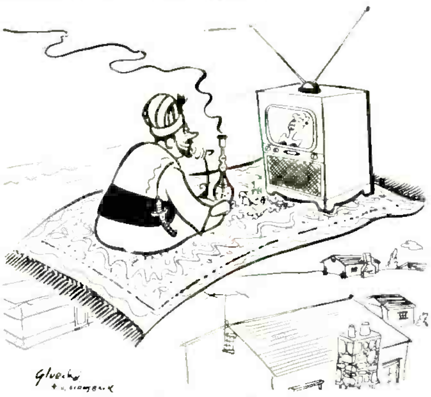
SIMPLE PULSE INVERTER

Electronic counters, radar, loran, and many other electronic devices often require pulses of a specific polarity for proper operation of a particular circuit. In some instances, the pulse provided by the source is of opposite polarity to that required by the circuit. In such cases, a transformer or tube is usually used as a phase inverter. Leonard Reiffel, in *The Review of Scientific Instruments*, describes a simple circuit which may be used for phase inversion when the pulse does not require further amplification.



The inverter is shown in the diagram. When a negative pulse is applied to the input terminals, it shock-excites the tuned circuit (L-C1) and sets up a train of damped oscillations. The positive half-cycles of the oscillations are rectified by the 1N34 and integrated by R and C2 into a positive pulse with a gradual decay.

The voltage across the output terminals is a positive pulse having a decay corresponding to the positive half of the envelope of the damped oscillations. The output pulse is delayed one-half cycle with respect to the input cycle. To invert positive input pulses, reverse the connections to the 1N34. —end—



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THICKNESS GAUGE

Patent No. 2,572,908

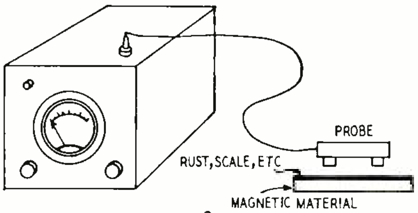
Irving R. Brenholdt, Chicago, Ill.
(assigned to Standard Oil Co., Chicago)

This instrument measures iron or steel from 1/64 inch to one inch thick. Accuracy is not affected by rust or dirt on the metal. A practical form of the device is shown at *a* and the basic schematic is drawn in B.

An oscillator generates a frequency of 50 cycles which is fed to an LC circuit. L is the inductance of a laminated core probe. Its coil may have about 1500 turns. LC is tuned to slightly below 50 cycles. When the probe approaches magnetic material, its inductance drops and resonance is reached. LC may be designed for resonance when the probe is about 1/8 inch from a mass of metal.

To measure thickness, the probe is brought near the metal. When the gap is 1/8 inch, peak probe voltage occurs. This peak is rectified and stored on C1 which is unloaded. The v.t.v.m. indicates C1 voltage. The probe may be moved about, but only the peak voltage (at 1/8-inch probe distance) is indicated.

Although the peak always occurs with the same probe gap, the maximum depends upon metal thickness. The thicker the metal, the greater the eddy current loss, therefore the lower the peak. The instrument is calibrated by potentiometer P on a metal sample of known thickness. After completion of a measurement, SW is closed to discharge C1 and bring M to zero.



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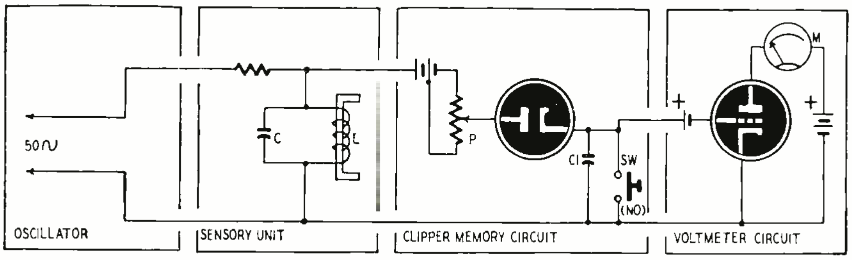


b

AID TO THE BLIND

Patent No. 2,582,728

Joseph B. Walker, Hollywood, Calif.

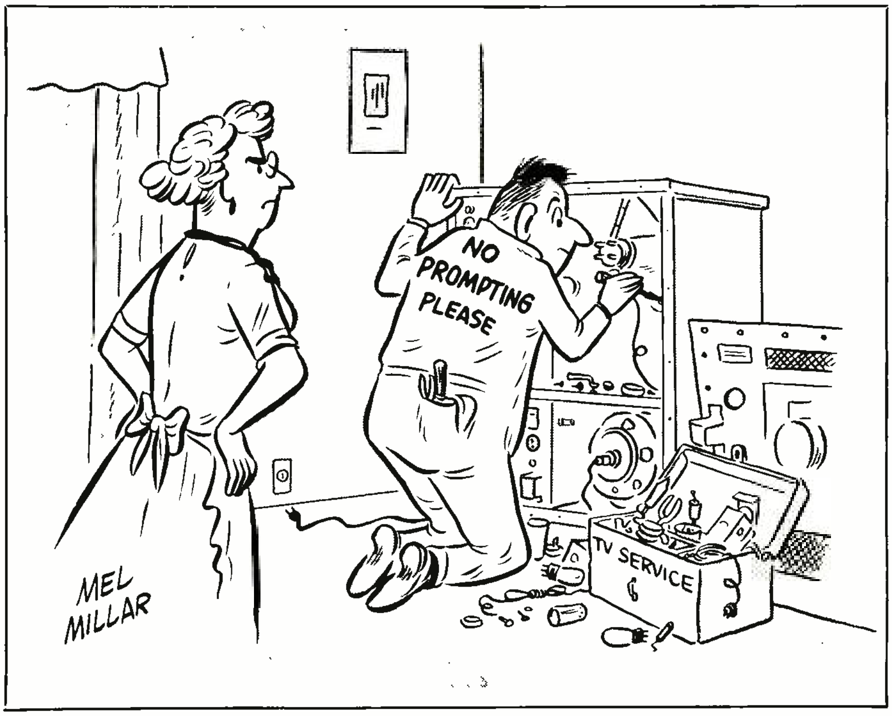
This invention detects obstacles by means of light beams. Reflected light from an obstacle is converted to sound to warn the blind person. The apparatus is portable and powered by batteries.

Essential parts are shown in the illustration. Lamps 1 and 2 project light beams through perforations in revolving disc D. Another view of D appears in the insert. Light from 2 passes through the inner perforations and is deflected *upwards* toward A. Therefore this beam can detect obstacles several feet above ground. If reflections occur at this level, the light falls on mirror AA and photocell PE. As the reflected light is interrupted at an audio rate by the perforations in the rotating disc, the photocell current is modulated and its amplified output heard in the reproducer.

Light from 1 passes through the outer perforations and is projected *downward* by the lens. This detects obstacles nearer the ground. Reflections (if they occur) fall on mirror BB and on PE.

Note that the outer ring of perforations has twice as many holes as the inner ring. Therefore the 1 beam is interrupted at twice the rate and is responsible for a higher frequency than the beam from 2.

Output from PE may operate an ear-phone or other reproducer. When the blind person hears a low-pitched tone he is warned of an obstacle several feet above ground. A high-pitched tone indi-



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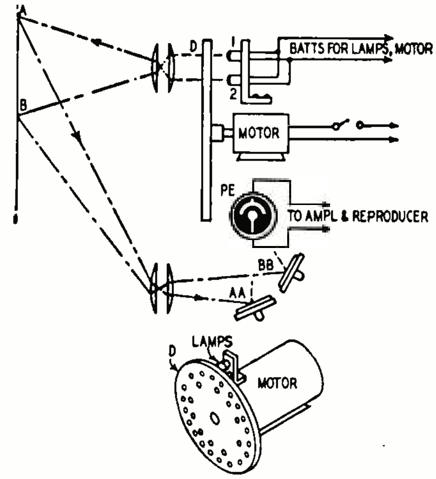


cates a lower obstacle. With experience, obstacles may be judged as to height, distance and even approximate outline by manipulating the device in various ways.

In another form of the device covered in the same patent, a single light source is used. By an interlocking lever arrangement, the light beam and a reflecting mirror are made to scan the area to be covered. The rotating light-modulator disc has several concentric rings of perforations, each ring containing a different number of holes. As the beam moves vertically, reflections pass through different rings, modulating the output according to the height of an obstacle.

PULSE REGISTER CIRCUIT

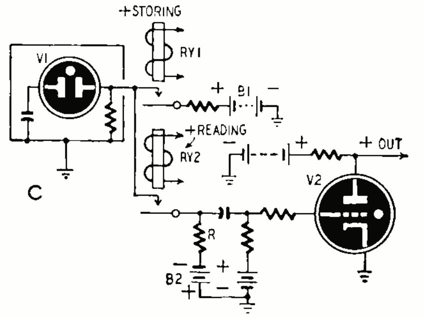
Patent No. 2,582,480
Thomas L. Dimond, Rutherford, N. J.
(Assigned to Bell Telephone Laboratory, Inc.)

This device stores a pulse or voltage, and subsequently registers it. It can be used in computing machines, telephone switching networks, and similar devices. No heater type tubes are used. No stand-by power is wasted.

The circuit shown here can store a *positive* voltage and register it. When RY1 is energized (even momentarily) a positive voltage fires the gas tube V1 (similar to a neon lamp) and therefore charges C. As the charge grows, the potential drops across V1. Finally V1 is extinguished and the charge is trapped on C.

Later, RY2 may be energized to test for a positive charge on C. The negative voltage from B2 adds to the positive charge on C. The total is large enough to trigger V1 again. A pulse of current flows through R and this transmits a voltage pulse (through a capacitor) to thyratron V2. If desired, the output from V2 may be fed to a mechanical register or counter.

Additional relays and associated circuits may be used to store and read *negative* voltages. The circuits are like those shown except for reversal of power-supply polarities. For example, negative pulses are read by a circuit like that of RY2, except for a reversal of B polarity.



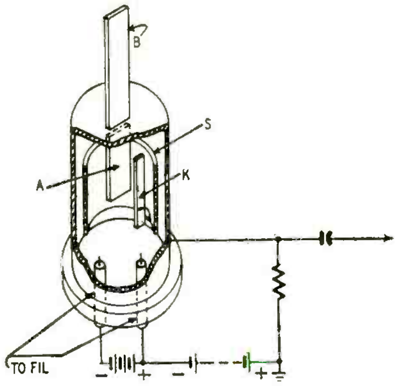
ULTRASONIC MICROPHONE

Patent No. 2,579,136
Leslie J. Anderson, Moorestown, N. J.
(assigned to Radio Corp. of America)

This microphone is designed specifically for ultrasonic frequencies used in secret signalling, obstacle detection, and similar applications. It does not respond to audible waves which may also be present.

The invention utilizes a flat metal bar fixed at its center. End A is inside a metal vacuum tube and may be used as the anode. End B is outside the tube. K is the cathode. A cylindrical shield S surrounds these elements and the heater.

Ultrasonic waves set end B into vibration and the energy is transmitted to A. When the anode vibrates, it causes corresponding variations in



tube current. The signal is then amplified as required.

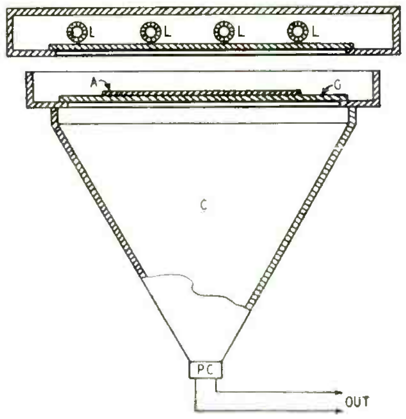
Bar dimensions depend on the frequency of operation. As an example, the bar may be 2.54 cm long and .1 cm thick. The top of the tube (which supports the bar) may be .2 cm thick and 1 cm in diameter. The bar may be of stainless steel or beryllium. Under these conditions, the resonant frequency will be about 26 kc.

The bar is bidirectional. Each side is sensitive to supersonic waves.

AREA MEASUREMENT

Patent No. 2,578,882
George H. Eosh, Toledo, Ohio
(Assigned to Selby Shoe Company, Portsmouth, Ohio)

This is a form of light-measuring circuit. An opaque pattern is placed in the path of a steady light beam. It partially blocks the light falling on a photocell and there is correspondingly less cell output. The unknown pattern area is determined from the cell output either by calibration or comparison with a known area.



The figure shows a recommended arrangement. L is a bank of lamps, fluorescent or incandescent. The lighting must be uniform. Light from the lamps falls upon G, a layer of translucent glass which diffuses and equalizes the light. The area to be measured (A) is placed in front of G. At the other end of C is photocell PC. Cell output corresponds to light transmission through G.

Without A, maximum light falls upon PC and the output current is noted. Now if a flat object of any shape is placed in front of G, it blocks part of the light. For example, if A has half the area of G, output from PC will be reduced to one-half (assuming proportional output).

—end—

ANTENNA DESIGN DATA

The data in the table is based on material in an Admiral radio course and was prepared as an aid to antenna installation crews and experimenters. Adding radiators or reflectors to an antenna causes a sharp reduction in the antenna impedance and makes it necessary to use a matching section to couple the array to standard transmission lines. The impedance of the matching section can be found by finding the square root of the product of the antenna and transmission line impedances or, $Z2 = \sqrt{Z1 \times Z3}$, where Z1, Z2, and Z3 are impedances of the antenna, matching section, and line, respectively. The length of the matching section or stub is

$$L = \frac{246}{f} \times VP,$$

where L is the length of a quarter-wavelength section in feet, f the operating frequency in megacycles, and VP the velocity of propagation. VP is 0.77 for 150-ohm lines and 0.68 or 0.71 for 75-ohm coaxial lines.—*W. G. Eslick.*

(See "Transmission-Line Constants" in the January 1950 issue. The folded-dipole impedances are approximately correct only when the dipole conductors are the same size. If the driven conductor is smaller than the other, the impedance will be higher. The stepup in impedance over a dipole depends on the conductor diameters and spacing. —*Editor*)

TYPE	IMPEDANCE	GAIN (DIPOLE AS ZERO)
DIPOLE	72	0
FOLDED DIPOLE	300	0
DIPOLE WITH REFLECTOR	60	2-2-1/2
FOLDED DIPOLE WITH REFLECTOR	250	2-2-1/2
DIPOLE, REFLECTOR & DIRECTOR	20	2-1/2-5
FOLDED DIPOLE, REFLECTOR & DIRECTOR	80	2-1/2-5
DOUBLE DOUBLET, REFL. & DIR.	225	4
DOUBLE STACK "TWO OVER TWO" (λ/4, λ/2, λ/4)	300	5

RECEIVING FM ON TV SETS

If you are using a TV set which has a turret-type tuner, it is quite possible that you can modify it so you can receive a few of the local FM broadcast stations. Channel 6 must be vacant in your locality. Sets with intercarrier sound won't work.

You simply adjust the channel 6 oscillator-tuning slug until you receive FM stations in the low-frequency half of the band. The printed-circuit tuner can be adjusted to bring in stations between 88 and about 94 mc. The Standard Coil tuner can be adjusted to bring in stations a few megacycles higher. The fine-tuning control can be used to tune in stations adjacent to the one on which the oscillator is centered.

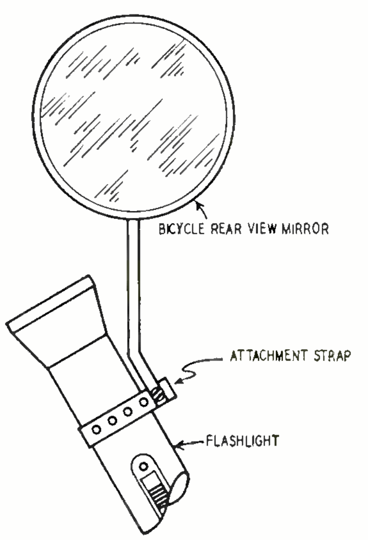
The mixer and antenna circuits are not tuned to the FM band, so this trick works best for local stations.—*M. G.*

IMPROVING IMAGE REJECTION

Many sets which use external antennas have poor image rejection on the broadcast band. The region between 550 and 800 kc is often filled with heterodynes and garbled speech. A simple remedy for this is to insert a 2.5-mh r.f. choke in series between the antenna lead and the top of the primary of the antenna coil. If the set has short-wave bands, install a switch to cut out the choke because it will attenuate signals in the short-wave range. On band-switching receivers, install the choke between the broadcast antenna coil and the band-switch.—*Charles Erwin Cohn*

HANDY SERVICING LIGHT

Time after time, I have run into TV sets which have flat, wafer-type miniature sockets mounted behind i.f. cans, capacitors, transformers, and other components where they cannot be seen without pulling the chassis. Taking the tubes out for checking isn't so bad, but



getting them back into the sockets can be a time-consuming, frustrating job. The same problem also arises frequently in seating alignment tool tips in tiny tuning slug slots.

After several such experiences, I devised the flashlight-mirror combination shown in the drawing. A bicycle rear-view mirror is fitted to the barrel of the flashlight with a metal strap clamp. With this arrangement, I can throw light into the socket and see the reflection clearly in the mirror. The swivel on the mirror permits it to be set at the most convenient angle.—*Harry E. Brooks*

HUM REDUCING KINK

Sometimes, you may find that hum in an audio amplifier is originating in a push-pull driver or output stage which uses directly heated tube types such as the 45, 47, 2A3, 6A3, 6B4-G, and 6B5. In this case, try transposing the filament leads of *one* tube and use the connection which gives the least hum. This connection is the one which makes the hum voltages in phase in the plate circuits so they cancel out. —*John Sareda*

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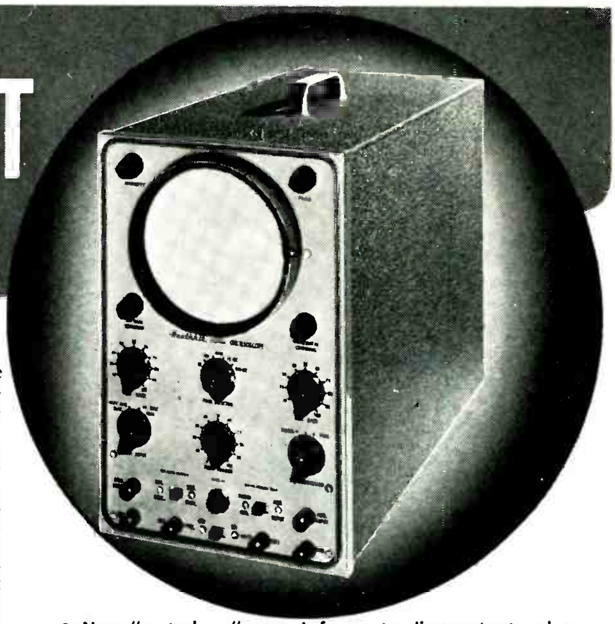


The Heathkit 0-7 Oscilloscope with its 10 tube lineup (including CR tube) and carefully engineered circuit using highest quality components is truly the most outstanding scope value on the market today.

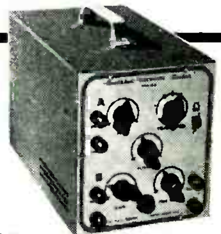
The "spot shape" (astigmatism) control working in conjunction with the focus control assures clear, sharp focusing . . . extended sweep range and faster retrace time permits the study of high frequencies . . . step-attenuated frequency-compensated cathode follower vertical input contributes to the excellent frequency response of the vertical channel . . . .03V RMS per inch vertical sensitivity makes weak input signals easy to study . . . push-pull operation of both vertical and horizontal deflection plates reduces pattern distortion . . . specially designed extra-wide CR tube mounting bracket places vertical cascade amplifier, vertical phase splitter, and deflection amplifiers near base of CR tube to reduce distributed wiring capacity and increase high frequency response.

Ideal for TV servicing — steep wavefronts encountered in TV work are easily handled. Fine for production line testing — rugged quality components can stand up under continuous hour-after-hour use. Excellent for laboratories — electrical performance comparable to scopes costing 4 and 5 times as much.

You'll like the complete instructions showing all details for easily building the kit — includes pictorials, step-by-step construction procedure, numerous sketches, schematic, circuit description. All necessary components included — transformer, cabinet, all tubes (including CR tube), completely punched and formed chassis — nothing else to buy.

- **New "spot shape" control for spot adjustment — to give really sharp focusing.**
- **A total of ten tubes including CR tube and five miniatures.**
- **Cascaded vertical amplifiers followed by phase splitter and balanced push-pull deflection amplifiers.**
- **Greatly reduced retrace time.**
- **Step attenuated — frequency compensated — cathode follower vertical input.**
- **New mounting of phase splitter and deflection amplifier tubes near CR tube base.**
- **Increased frequency response — useful to 5 Mc.**
- **Tremendous sensitivity .03V RMS per inch Vertical — .6V RMS per inch Horizontal.**

MODEL
S-2



Heathkit ELECTRONIC SWITCH KIT

SHIPPING WT.
11 LBS.

$19.50

The companion piece to a scope — Feed two different signals into the switch, connect its output to a scope, and you can observe both signals — each as an individual trace. Gain of each input is easily set (gain A and gain B controls), the switching frequency is simple to adjust (coarse and fine frequency controls), and the traces can be superimposed for comparison or separated for individual study (position contol).

The kit is complete with tubes, switches, cabinet, power transformer and all other parts, plus a clear detailed construction manual.

NEW *Heathkit* AUDIO FREQUENCY METER KIT

MODEL AF-1
SHIPPING WT. 15 LBS.

$34.50

The ideal instrument for determining frequencies from 20 cycles to 100 KC. Set the selector switch to the proper range — feed the signal into the input terminals — and read the frequency from the meter — completely simple to operate, and yet dependable results.

Quality Simpson 200 microampere meter has two plainly marked scales (0-100 0-300). These scales read in conjunction with the seven position selector switch, give full scale readings of 100, 300, 1000, 3000, 10,000, 30,000, and 100,000 cycles. Convenient ranges for fast and easy readings.

For greatest accuracy, the 1-3-10 ratio of ranges is maintained and each range has an individual calibrating control.

A signal voltage anywhere between 2 and 300V can be fed directly into the instrument and a change in signal voltage between these limits will not affect the meter reading. In addition, input wave shape is not critical (the unit will read the frequency of either sine wave or square wave input).

The tube complement consists of a 6SJ7 amplifier and clipper, 6V6 amplifier and clipper, 6H6 meter pulse rectifier, 6X5 power supply rectifier, and OD3/VR150 voltage regulator.

Construction is simple, and quality components are used throughout.

Heathkit INTERMODULATION ANALYZER KIT

MODEL IM-1
SHIPPING WT. 18 LBS.

$39.50

Intermodulation testing of audio equipment is rapidly being accepted by more and more engineers and audio experts as the best way to determine the characteristics of audio amplifiers, recording systems, networks, etc.

The Heathkit Intermodulation Analyzer supplies a choice of two high frequencies (approx. 3000 cycles and 7000 cycles) and one low frequency (60 cycles). Both 1:1 or 4:1 ratios of low to high frequencies can be set up for IM testing, and the ratios are easily set by means of a panel control and the instrument's own VTVM. An output level control supplies the mixed signal at the desired level with an output impedance of two thousand ohms. The Analyzer section has input level control and proper filter circuits feeding the instrument's VTVM to read intermodulation directly on full scale ranges of 30%, 10% and 3%. Built-in power supply furnishes all necessary voltages for operating the instrument.

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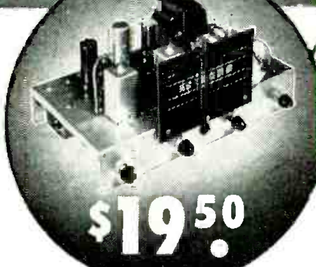

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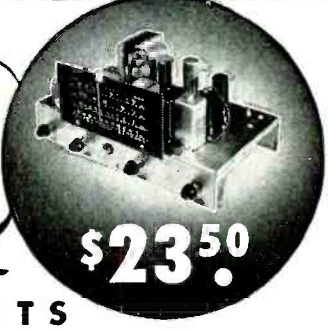

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Both are transformer operated quality units. The best of materials used throughout — six inch calibrated slide rule dial — quality power output transformers — dual iron core shielded. I.F. coils — metal cased filter condenser. The chassis has phono input jacks, 110 Volt output for phono motor and there is a phono-radio switch on panel. A large metal panel simplifying installation in used console cabinets is included. Comes complete with tubes and instruction manual incorporating pictorials and step-by-step instructions (less speaker and cabinet). The three band model has simple coil turret which is assembled separately for ease of construction.

Model FM-2
Ship. Wt. 9 lbs.

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Utilizes 8 tubes: 7E5 Oscillator, 6SH7 mixer, two 6SH7 IF amplifiers, 6SH7 limiter, two 7C4 diodes as discriminator, and 6X5 rectifier.

The instrument is transformer operated making it safe for connection to any type receiver or amplifier. Has ready wound and adjusted RF coils, and 2 stages of 10.7 Mc IF (including limiter). A calibrated six inch slide rule dial has vernier drive for easy tuning. All parts and complete construction manual furnished.

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PEAKING TWO-BAND SET

A fisherman friend wanted to hear the marine band on an old two-band broadcast set which uses 6D6's and other tubes of that vintage. (The set was insensitive on short waves; only a few mushy police calls could be heard.) To further complicate matters, he wanted to use a 6-foot wire as the antenna.

Realigning the set did not improve its sensitivity on short waves. The detector trimmer couldn't be peaked without disturbing calibration on the broadcast band. We hooked the 6-foot antenna wire to one end of a 10-turn scramble-wound loop of No. 28 e.c. wire. The loop was just large enough to pass over the antenna coil. We tuned the set to ship frequencies and moved the loop down the coil until a sensitive spot was found where signals and noise peaked up. Then we scramble-wound 10 turns of wire around that spot and cemented it tight with coil dope. The end of the new antenna coil was left ungrounded as a precaution against shock because set was an a.c.-d.c. type with one leg of line going to chassis. Previous signal strengths of R1 and R2 are now R9. Broadcast signals are louder and more stations are received.—*B. W. Welz*

STICKY VIBRATORS

New vibrators and those which have not been used for a long time often fail to start on d.c. because of oxidization of the contacts. The usual method of clearing up this trouble is to connect a 50-watt lamp in series with the vibrator and run it on 117 volts a.c. for a few minutes.

I find it more convenient to plug the unit into a tube tester and operate it on 12 volts a.c. from the filament transformer. If the tube tester does not have a flexible switching arrangement, test leads fitted with banana plugs can be inserted in the filament pins of a 4- or 6-prong socket and the other ends clipped to the vibrator pins.

This method does not harm the tester. Usually a few seconds of running on a.c. is all that is needed to remove the oxidization. When the hum of the vibrator changes to an unsteady buzz, this is an indication that the contacts have cleaned up and that the vibrator will start without trouble on d.c. —*Frank Greene*

TOOL FOR COAX CABLE

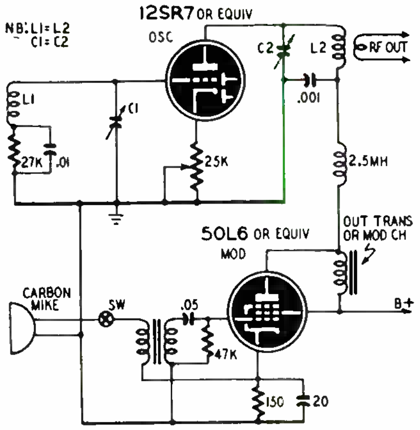
A standard copper-tubing cutter, available at most hardware stores for less than a dollar, is a handy tool for preparing coaxial cable to receive fittings. In using the tool, the first step is to twirl the cutter around the plastic jacket, cutting through it to the outer braid.

After removing the jacket, cut through the outer braid and remove it. The cable can now be finished with a pocket knife and the fitting can be installed in a professional manner—*Clyde C. Cook, W6GBV*

—end—

STABLE OSCILLATOR

The stability of a heavily loaded, modulated, tuned-plate tuned-grid oscillator may be greatly improved by installing a carefully chosen cathode biasing resistor. Moving the grid-leak and its bypass capacitor from the normal position to the grounded end of the grid coil provides more constant output over the tuning range when the cathode biasing resistor is correctly adjusted. A variable potentiometer is recommended. When it is adjusted for best modulation quality, and antenna loading is optimum, the band-width and audio quality of the modulated oscillator compares favorably with a well-designed AM transmitter running the same power input.

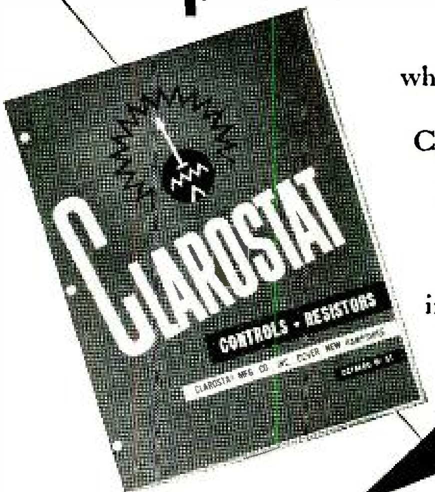


When loaded with a dummy antenna, the oscillator performed well on the broadcast band as well as on 2 and 3 mc. The basic circuit of the modulated oscillator is shown in the diagram. It may be used as a phono oscillator, home broadcaster, or carrier-current transmitter. The tuning range depends on the inductance of the coils and the values of the variable capacitors. Power output may be raised by using heavier tubes and raising the power input to the oscillator plate and modulator. For phonograph and home broadcast use, antenna length and power input should be held to a minimum, to avoid illegal radiation.—*G.P. Oberto*

HEAR YOUR OSCILLOGRAM

An oscilloscope is a highly useful instrument. However, when working on a radio receiver or audio amplifier, it is often difficult to interpret the oscillograms, because the signals which they represent are intended for the ear instead of the eye. When using an actual signal for servicing, it is often difficult to tell whether the observed waveforms are normal or not. The obvious solution is to connect a headphone jack somewhere in the vertical deflection circuit of the oscilloscope, enabling the waveform to be heard as well as seen. However, such a direct connection is useful only for audio-frequency signals. The circuit shown is capable of making audible audio-frequency signals, and the modulation on rf. signals.

Its operation is simple. Throwing the switch to the AF position connects the



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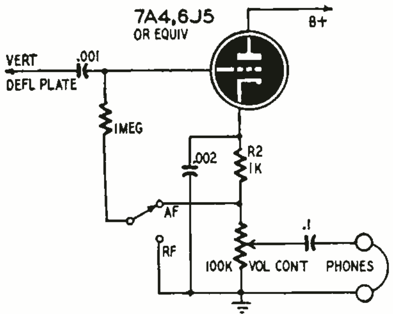
tube as a cathode follower, while the RF position connects the tube as an infinite-impedance detector. The input is connected through the .001-μf capacitor to the vertical deflection plate or the output of the vertical amplifier, thus getting plenty of signal. The output is controlled by the potentiometer which also acts as the tube load resistor. The oscilloscope circuit should be checked carefully to make sure that the signal take-off point is not at a dangerously



high potential. In any event, the .001-μf coupling capacitor must have a voltage rating high enough to withstand the peak potential at the point of signal takeoff.

Although it requires a little work to add this circuit to an oscilloscope, it can make a great improvement in the instrument's usefulness. It makes it possible to use the ears to detect troubles such as distortion, noise, or hum, which are difficult to detect from oscillograms, especially when they are slight. Then, a close examination of the oscillogram of the defective signal can be used to determine the electronic nature of the defect.—*Charles Erwin Cohn*

VOLUME EXPANDER

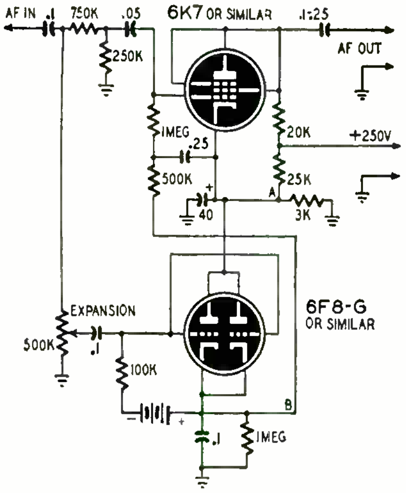
Various types of volume expanders and their relative merits have long been the subject of debate among sound engineers and high-fidelity music lovers. Expanders of different types have been incorporated in PA and high-fidelity amplifiers and in some of the more elaborate receivers. They may be classified into variable-gain and variable-output types. A new expander design of the former type is described in patent No. 2,556,692, granted to V. L. Holdaway and assigned to Bell Telephone Laboratories.

The circuit of the variable-gain amplifier is shown at *a*. The 6K7 is the main amplifier and the 6F8-G is the side or control amplifier. The cathode of the 6K7 and the plates of the 6F8 are tied together and connected to point *A* on a voltage divider which sets the bias on the 6K7 cathode at 25–30 volts. The 6F8 is biased to (or nearly to) cutoff by the battery in series with its grid return. The signal which is applied to the 6F8 control tube appears across the 500,000-ohm expansion control. The signal to the 6K7 is taken from the junction of the 750,000- and 250,000-ohm resistors which make up a voltage divider.

When no signal is applied to the input terminals, the 6F8 is cut off and no current flows through the 1-megohm cathode biasing resistor. Point *B* remains substantially at ground potential, thus holding the bias on the 6K7 to that value supplied by the tap at *A*.

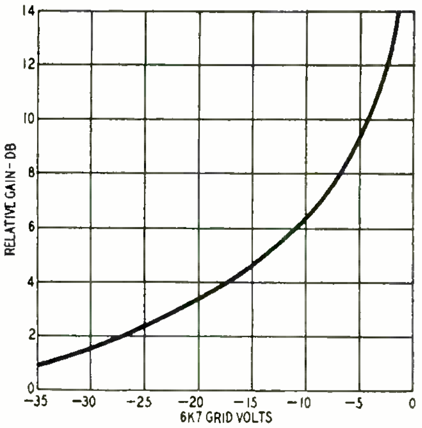
When a signal of increasing amplitude is applied to the expander, the 6F8—if initially biased to cutoff—conducts on the positive half-cycles and develops a positive voltage across the 1-megohm resistor. The positive voltage thus developed at *B* biases the grid of the 6K7 and opposes the positive bias supplied to its cathode from point *A*. The effective bias of the main amplifier will decrease, thus increasing its gain. The gain-grid-bias curve is shown at *b*.

The drop between plate and cathode of the 6F8 insures that the maximum



a

voltage developed at *B* can rise to within a volt or two of point *B* but cannot exceed it. Therefore, the grid of the 6K7 always operates with negative bias, preventing any distortion

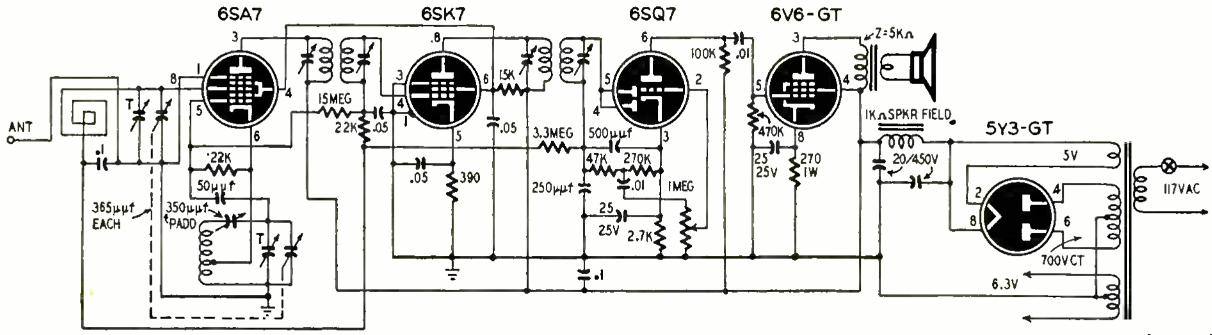


b

which would occur if the tube were operated with positive grid bias. Since the 6K7 operates with only one or two volts of bias with high input signals, the voltage divider in the input circuit holds the maximum signal drive below this value.

The sizes of the resistors and capacitors in the 6F8 cathode circuit and in the 6K7 grid return determine the attack and decay times of the expander action. These values may be varied to control the rate of expansion.

—end—



Schematic of a 5-tube, a.c.-operated broadcast receiver, following standard commercial circuit practice throughout.

5-TUBE BROADCAST SET

? I would like to construct a 5-tube AM broadcast receiver using a 6SQ7 detector, a.v.c., and a.f. amplifier, 6SK7 i.f. amplifier, 6SA7 converter, and a 6V6-GT power amplifier tube. I would like the diagram to show a loop antenna and connections for a speaker with a 1,000-ohm field.—E.S.T., New York, N.Y.

A. The diagram of the receiver is shown. All components are conventional and the circuit should work nicely after alignment. The intermediate frequency may be anywhere in the range of about 450-470 kc. The oscillator padder capacitor is correct for most broadcast oscillator coils, but consult the coil manufacturer's recommendations for exact value.

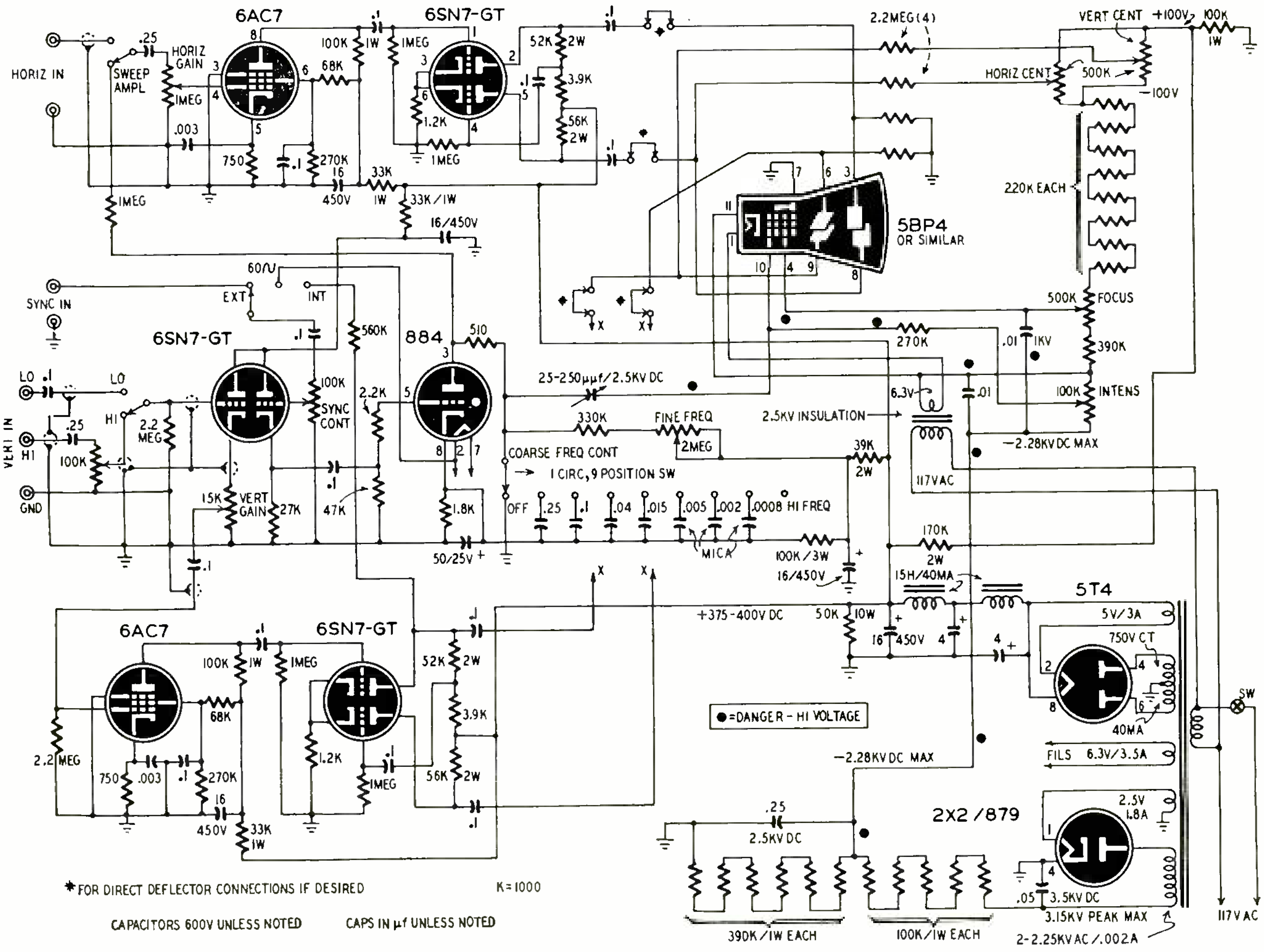
5-INCH OSCILLOSCOPE

? I have a high-voltage transformer which has a 700-volt, 40-ma low-voltage secondary, a 2,250-volt, 2-ma half-wave high-voltage secondary, and filament windings delivering 5 volts at 3 amp, 6.3 volts at 3.5 amp, and 2.5 volts at 1.8 amp. Please show how I can use this in a general-purpose scope using a 5BP1 or 5BP4 tube.—G. H. K., Chicago, Ill.

A. The scope diagram is shown. The power transformer and filter chokes should be placed well away from the amplifiers and the picture tube to prevent hum pickup. The centering, focus, and intensity controls should be insulated from the chassis and driven from the front panel through insulated shafts. The deflection-signal leads and interstage coupling capacitors should be dressed well away from the chassis to minimize wiring capacitance which causes loss of high frequencies. Shield the scope against external fields with a steel case. Be sure to discharge the high-voltage filter capacitors before beginning work under the chassis.

I.F. INTERFERENCE

? I live on the coast where there are a number of marine and commercial stations operating on the low-frequency side of the broadcast band. Their fundamentals and harmonics fall within the i.f. range of my superhet-type high-fidelity tuner and spoil reception with cross-talk and whistles. Please tell me how to eliminate this trouble.—A. R. G., Atlantic City, N. J.



Circuit diagram of the 5-inch cathode-ray oscilloscope. A steel or iron case should be used for magnetic shielding.

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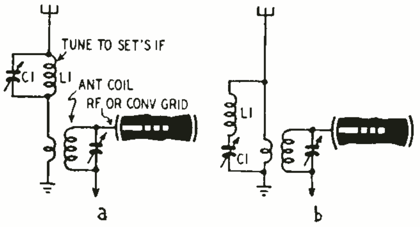
A. Most likely, the interfering signals are coming in on the antenna. If so, you



can eliminate them by inserting one or more tuned traps in the antenna circuit of the set. The drawing at *a* shows a parallel-tuned trap, and the drawing at *b* shows one which is series-tuned. If the interference is severe or is from two stations, it may be necessary to use both types of traps. In any case, the traps should tune to the i.f. range of your set. L1 and C1 may be one winding and tuning capacitor from a standard i.f. transformer.

RECEIVER-TRANSMITTER QUERY

? *I have a model 11-UF-ED-6 Link receiver and a model 32-UFM-ED-2 transmitter. Both are crystal controlled on 39.46 mc. I want to shift the frequency to 33.86 mc. The transmitter crystal is at 1,059.25 kc. The receiver uses two crystals: one at 5.456 and the other at 6.892 megacycles. What crystals must I use for the new frequency?—G. F. B., College Park, Md.*

A. The transmitter output is on the 32nd harmonic of the crystal frequency. Therefore, the new crystal frequency is 33.86/32, or 1.05812 mc (1,058.12 kc).

The receiver is a double superheterodyne with the first i.f. at 5 mc and the second at 456 kc. The 5.456-mc crystal is in the oscillator circuit of the second converter and is not changed. The heterodyning frequency for the first converter is 5 mc below the signal frequency and is the fifth harmonic of the 6.892-mc crystal. Therefore, at the new frequency, the heterodyning signal is 33.86 minus 5, or 28.86 mc. Since the 5th harmonic of the crystal is used, the new crystal for the receiver must be 28.86/5 or 5.772 mc.

Some of the tuned circuits may not have sufficient range to tune down to the new frequencies, so you may have to shunt the coils with small padders or add a few turns to the coils. A grid-dip meter will be helpful in checking the tuning range of the coils and in making sure that you don't pick up the wrong harmonic of the crystal.

TUBE NUMBERING SYSTEM

? *I am preparing for an amateur examination and have been studying the various types of tubes used in transmitters. I find it difficult to compare different types of tubes without referring to the tube manual or the handbook. Is there any way that I can determine pertinent data on a tube from its number?—E. E. K., Bronx, N. Y.*

A. This can't be done under the old numbering system in which we have such tubes as the 812, 813, and 815. There is no similarity between them.

A new numbering system is in use by Eimac and other manufacturers. Many of the older types are now identified under a dual numbering system. The new number enables the user to determine the type, plate dissipation rating, and amplification factor. The old familiar 250TH now bears the numbers 3-250A4/250TH. The number ahead of the dash indicates the number of elements in the tube, the number or numbers between the dash and the letter gives the plate dissipation rating in watts, and the letter stands for the version of the tube. The letter A is used on the original design; B, C, and so on indicate later modifications. The modified versions of a given basic type are not necessarily interchangeable either physically or electrically.

The number (if any) following the letter indicates the mu of the tube. The number 1 is used for a mu of 10 or less, 2 is for a mu of 11 to 20, 3 for 21 to 30, and so on. The new 4E27A's are now marked 4E27A/5-125B. The 5- stands for pentode or 5-element tube; 125 is the plate dissipation in watts; and B is the version of the tube.

In some receiving-transmitting types, such as the 6L6, the first numeral(s) gives heater voltage to the nearest lower whole number; the letter (s) shows the type; the last numeral gives the number of independently-connected elements in the tube.

—end—

SENTINEL MODEL 312

When these sets are inoperative on line operation, replace the 1R5 oscillator tube and the selenium rectifier. If the tube and rectifier are good, the set will operate at line voltages as low as 105. If either unit is weak, the 1R5 is likely to stop oscillating when the line voltage drops to 112 or lower.

A three-way set which operates on the service bench may not operate correctly in the customer's home if the line voltage is low. Before returning such sets to the owner, always check their operation on low line voltage. A Variac or other voltage-reducing device can be used for this purpose.—*Sentinel Radio Service Dept.*

STROMBERG-CARLSON TV-12

The 12JP4 picture tube in these sets is directly replaceable with a 12RP4. The operating characteristics of these tubes are identical and the latter type can be used as a replacement in any set using the 12JP4. When making the substitution, be sure to use an ion trap on the 12RP4.—*Stromberg-Carlson Current Flashes*

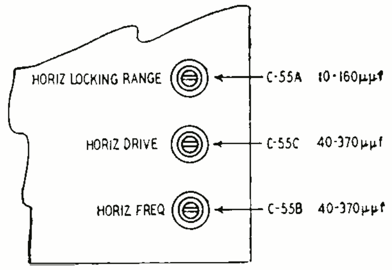
HOWL IN FM SETS

When using superregenerative-type FM receivers like the Fremodyne, a howl may be heard during commercials on some stations. The stations which cause the howl are storecast stations which transmit ultrasonic tones to control the volume of storecast receivers. The ultrasonic tone is not heard on standard superhets but it beats with the ultrasonic quench frequency of the superregenerative detector and produces an audible howl. This is one of the inherent disadvantages of these circuits and cannot be eliminated.—*Charles Erwin Cohn*

(Some listeners of course will prefer the howl to the commercial.—*Editor*)

AIRLINE 94WG-3006A, -3009A

In some sets, the trimmer capacitor strip consisting of C-55A, C-55C, and C-55B is physically reversed. This places C-55A at the bottom instead of the top. These capacitors were wired normally. Therefore the 10-160-μμf capacitor was connected in the HORIZONTAL FREQUENCY CONTROL circuit and the 40-370-μμf capacitor in the HORIZONTAL LOCKING RANGE circuit. The correct positions of these capacitors are shown in the drawing.



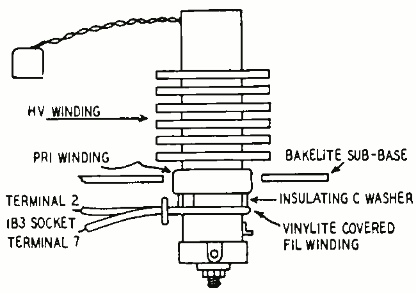
This error does not affect the operation of the sets as long as all circuit constants remain normal. Variation of some components with age may make it necessary to run the horizontal-lock capacitor at extreme minimum capacitance and the frequency control at maximum. If it is difficult to set these two controls, check the positioning of the capacitor strip. The low-capacitance unit (10-160 μμf) should be at the top and the two 40-370-μμf units at the bottom.—*Montgomery Ward General Service Letter*

AIRLINE 84BR-3004 TV SETS

The high-voltage winding of the r.f.-power-supply coil extends through a bakelite subpanel and cannot be removed without first removing the rectifier filament winding. The latter winding is not considered a part of the high-voltage oscillator coil and new coils do not have this winding on them.

To remove the coil:

1. Unsolder the vinylite-covered filament leads from the 1B3-GT socket. Use minimum heat to prevent damage to the insulation on the leads.
2. Loosen the fiber spacer on the fil-



ament winding and enlarge the loop to clear the coil form.

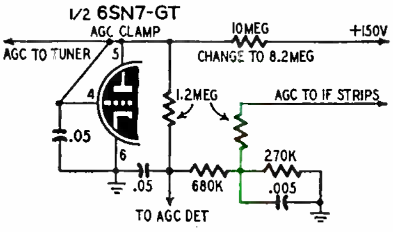
3. Remove the C-washer. Take care to avoid damaging the primary winding (See diagram.)

4. Unsolder the other leads to the coil form and remove the coil.

The replacement coil is installed in the reverse order. Place the original filament winding in the same position on the new coil.—*Montgomery Ward Service Letter*

DUMONT RA-109A

To reduce snow on weak signals, increase the a.g.c. delay bias so the signal level at the grid of the first i.f. stage is high enough to override the tube noise of the i.f. amplifiers. To do this, substitute an 8.2-megohm resistor



for the 10-megohm unit connected in the 150-volt line to pins 4 and 5 of the 6SN7-GT a.g.c. clamp and horizontal saw-tooth forming (discharge) tube. The position of this resistor is shown in the partial schematic above. This change has been made in all chassis beginning with No. 0959931.—*DuMont Service News*

OLYMPIC 762, 783, 967, 968, 970

Horizontal oscillator drift which causes the picture to deteriorate into bars sloping downward to the left is caused by the 150-μμf mica capacitor in the oscillator circuit. Replace this capacitor, C75, with a 150-μμf, 10%, N750 negative temperature coefficient ceramic capacitor. This capacitor is connected from terminal F of the horizontal oscillator coil to pin 4 of V18, the 6SN7-GT tube. Reset the horizontal oscillator as described in the service manual.—*Olympic Service Bulletin*

BUZZ IN TV SETS

An annoying buzz is sometimes present in the audio of TV sets which use a 6T8 as a discriminator and first-audio tube. This buzz, which can be heard with the volume control turned all the way down, is comparatively common when the 6T8 is located under or close to the picture tube. The trouble can be eliminated by placing a well-grounded shield over the 6T8—*Hubert L. Frazier*

FARNSWORTH GV-260

Flashes of light or unsteady background illumination can be traced to trouble in the d.c. restorer circuit. This is usually caused by an increase in the value of R40, a 10,000-ohm resistor, which changes the time-constant of the d.c. restorer. This resistor connects to the grid of the picture tube.—*Wilbur J. Hantz*

—end—

ELECTRONIC LITERATURE

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. All literature offers void after six months.

SUN RADIO CATALOG

Sun Radio's Catalog No. 52 is a large (8½ x 11-inch) book containing 164 pages. Special attention is called to the comprehensive transformer and capacitor sections covering 50 pages, to the listings of connectors which take up 10 pages, and to the industrial sound section, containing 12 pages. There are also very complete listings of tubes and crystals, including special, transmitting and industrial types and transistors, as well as a great number of small hardware items. There are two indexes—one by product and one by manufacturer—and the user is told on the cover just where the index is.

Gratis from Sun Radio & Electronics Co., Inc., 122-124 Duane St., New York 7, N. Y.

SELENIUM RECTIFIERS

A 28-page booklet which describes rectifier fundamentals, the process of manufacturing rectifier stacks, design details and applications of these increasingly important devices. A complete glossary of rectifier terms is included.

Gratis from General Electric Co., Schenectady 5, N. Y.

PRODUCT INDEX

A condensed catalog of P. R. Mallory products, including mercury batteries, capacitors, contacts, rectifiers, resistors, switches, vibrators, resistance welding necessities, metals and ceramics, and tuners. Considerable descriptive material, in language designed to be equally readable by engineer and layman, is devoted to each set of items, thus making the publication considerably more valuable than an ordinary catalog.

Gratis from P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Indiana.

1952 HEATHKIT CATALOG

The Heathkit line now includes 6-volt power supplies, intermodulation analyzers, audio-frequency meters and Williamson audio-amplifier kits as well as the older and more familiar pieces of test equipment advertised in earlier catalogs. All these items are described in a 16-page catalog, which also carries some information on Heath Company facilities.

Gratis from Heath Co., Benton Harbor, Michigan.

COUNTER TUBES

The radiation counter tubes manufactured by Amperex are described in a 22-page loose-leaf catalog. A six-page introduction reviews briefly the history

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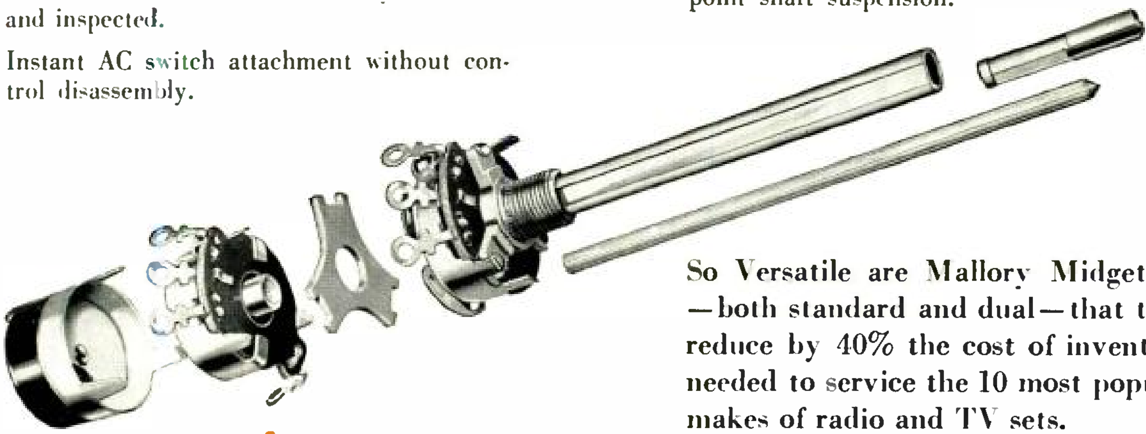

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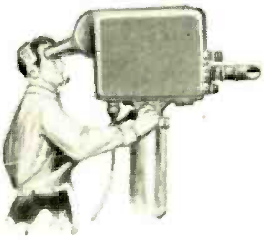

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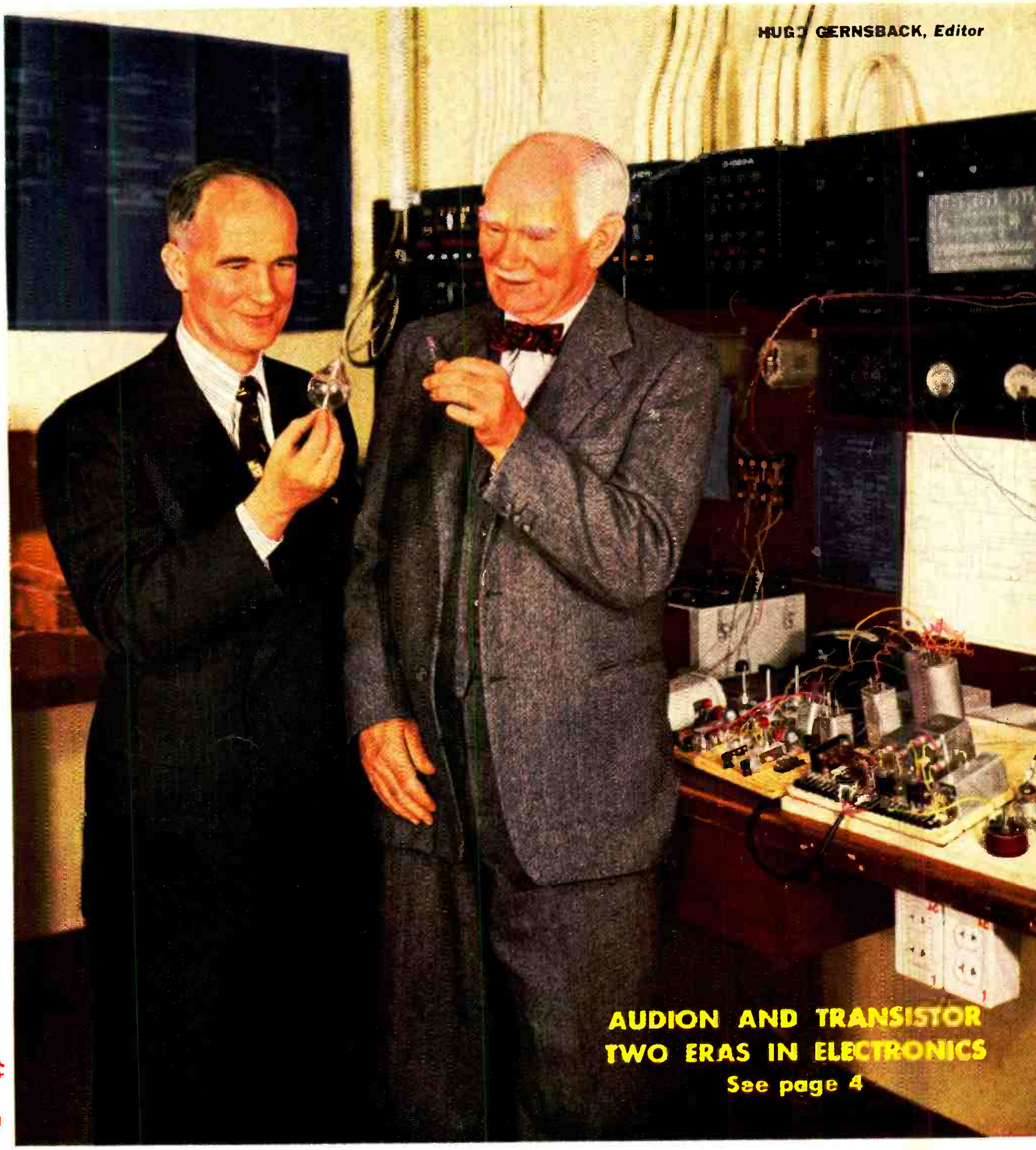

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CONTENTS — JULY 1952

ON THE COVER
Dr. Lee de Forest and Dr. William Shockley hold a transistor and an Audion, respectively, during de Forest's recent visit to the Bell Telephone Laboratories in New Jersey.
Color original courtesy Bell Telephone Labs.

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53 Million TV Sets by 1960

. . . unlimited vistas are opened for television . . .

By HUGO GERNSBACK

IN THE past we have been highly optimistic about the future of the electronics industry—and sometimes we have been criticized for it. It appears now that perhaps we held our enthusiasm too firmly in check.

In a forecast made last month, Dr. W. R. G. Baker, vice president of the General Electric Company and general manager of its electronics division, declared that more than 53,000,000 television receivers would be in operation by 1960. This would constitute a 300% rise over present-day receivers, which now number around 18,000,000. This is 5,000,000 more than the number of homes which may reasonably be expected to have electricity by 1960. Dr. Baker also indicated that there will be a very substantial increase in the number of television sets in clubs, bars, and many other non-home locations.

What did Dr. Baker have in mind when he said that 5,000,000 more sets would be used than the number of houses wired for electricity? Obviously either a significant percentage of homes will have more than one television receiver (this closely parallels the present vogue of multiple radio sets in the home) or, there would be battery-operated television sets, now practically unknown.

The latter, in view of the terrific strides made by electronics recently, now looms as a certainty. The reason, of course, lies in the transistor—electronics' latest wonder child. To us it seems certain that by 1960 there will be millions of such battery television sets, and most of them will be portables for home and outdoor use. This again would parallel the vogue of portable radio sets, which has been on the upgrade during the past few years. It is certain, also, that these receivers will parallel the engineering of some of our present radios, which can be either used as straight portables with batteries, or can be plugged into any handy electric outlet.

Indeed, if we add the portable television sets to the stationary ones, we will find that by 1960, Dr. Baker's 53,000,000-television-receivers forecast may well be exceeded.

Add to this dizzying pyramid of television receivers, color television, which will be here long before 1960, and it will be found that many more millions of television receivers will have to be added to the grand total.

From the present outlook, it would appear that when color television sets are finally placed upon the market, they will be operated by compatible means. That is, present-day receivers will be able to receive color telecasts *in black and white* just as they do now, while color television sets will, of course, have full color. This inevitably means that many homes, public places, hotels, etc., will have a multiplicity of sets, the old ones receiving in black and white, the new ones—installed in another location in the building or in another room—in full color.

It remains to be seen what the impact of color television will mean to the public, but from the meager experience that we have had with color television so far, it seems reasonably certain that once color television receivers are made, the manufacture of black and white sets will lag far behind color sets. Indeed, it would appear that within 25 years, the black and white television receiver will be on a par with the crystal set today!

One of the largest television outlets in the future probably will be our larger hotels. Just as most first-class hotels today have radios in every room, so they will have television in every room, if they wish to be up-to-date and give their guests every facility that Americans demand. While television sets are costly, by 1960 they will be as much a hotel necessity as the proverbial bath tub, and no up-to-date hotel will wish to be without them. How many millions of television sets will be installed in hotels between now and 1960 is anyone's guess. One thing is certain, the quantity will be enormous.

The small and medium size hotels will probably furnish regulation TV receivers to their guests on a rental basis at so much a day, as is the present custom. The big hotels however, of 300 rooms and up, even today find it a nuisance to send up sets from their store rooms—the wear and tear is too great and the manpower requirements often impossible. Then there is the inevitable antenna problem—always a difficult one in large congested cities.

The future large-hotel television receiver will probably be compact, the size dependent upon the screen dimension. The main component will be a television tube, power supply and speaker with a switch for the different channels. A central point will feed the amplified TV impulses to each room. This system also eliminates the antenna nuisance. Such hotel television receivers will be reasonable in price, yet they will bring in as good a picture as a complex regulation set.

At the present time, practically all hotels charge a fee for television receivers in hotel rooms. It is quite possible that by 1960 most hotel-room television sets will be coin-operated. We already today have such receivers in many hotel and motels. You feed the set either quarters or dimes and thus have its use for a certain length of time. Most guests do not object to this; the coin-operated television sets also will pay their way, making the installation attractive to the hotel management.

In the future the hotel television set also may help advertise the facilities of the hotel. Many of our big hotels have night clubs and public dining rooms, all of which can be televised throughout the hotel, thus at a given time guests can see what is going on in the public rooms of the hotel. To be sure when it comes to night clubs located in hotels—which feature high-priced entertainers—the hotel may not wish to televise such shows free, but they may give you a short "peek" once in a while, just as the motion pictures do in advertising their coming attractions. This usually has been good business for the motion picture interests and will probably prove itself to hotels as well.

While we are on the subject of electronics, Dr. Baker also predicted that one of the major increases in the use of electronics would be the elimination of electric meter reading as done at present—by humans. Household electric meters will be read electronically in the future, according to Dr. Baker, and while such applications will be costly, they are feasible, because industry must cut costs and servicing.

In our November, 1951, issue, we predicted that by 1960 the electronics industry would reach a turnover of $10,000,000,000. It now appears that our prediction will probably be found far too conservative.

THE FUTURE OF THE TRANSISTOR

The "Father of Radio" sees transistors and tubes inseparable active partners

By LEE de FOREST

Dr. de Forest's granddaughter, flanked by the inventor (right), and Admiral Ellery W. Stone, unveils the bust presented to Yale University by *The de Forest Pioneers.*

IF IN the year 1912 some editor had requested of me an article on the "Future of the Electronic Tube," I probably would have felt quite as incompetent and short-sighted a prophet of the developments of that, my most outstanding invention, the grid amplifier and oscillator tube, as I feel today as Mr. Gernsback requests from me an outlook over the future of the transistor, that possible successor of the grid tube.

In 1912 I had already accrued the benefit of six years experimentation with the electron tube, whereas today I have had little experience with these delightful little transistor midgets recently handed to me, ready made, by the Bell Laboratories.

The transistor is as yet far too young a baby for even its most intimate engineering parents, under the astute guidance of Dr. William Shockley, to predict with absolute certainty its future possibilities, the degree or scope of its acceptance by the engineering and manufacturing professions, its unquestionable advantages, and its inherent limitations.

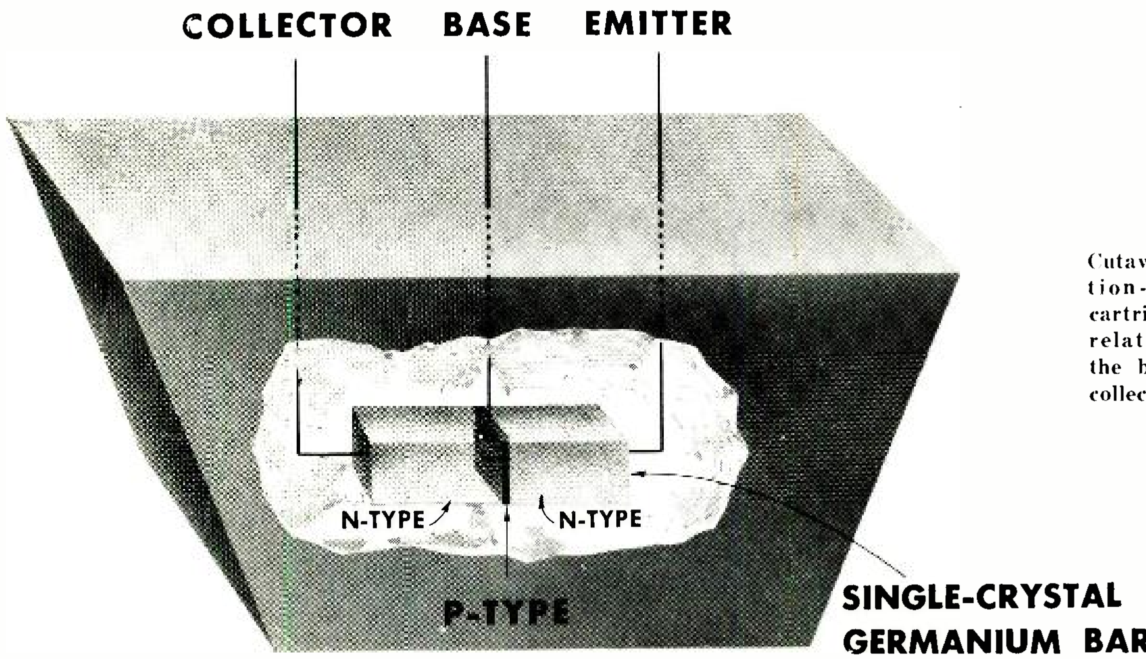
When Admiral Ellery Stone, president of the All America Cables and Radio Corporation, recently informed me that his ever-progressive company was now estimating a proposed trans-Atlantic coaxial relay cable, similar to that which the A. T. & T. Co. recently laid between Key West and Havana, I remarked that of course his engineers would use transistors in place of the 22-year-life triode tubes now in the Havana cable for two important considerations: first, the great saving in electric current which the 30 or 40 cable-enclosed amplifier groups would demand (transistors vs. tubes); and second, that the life of the transistors would be eternal—the relays would never need replacement. To my amazement, Admiral Stone replied that as yet no one knows what is the useful life of the transistor!

Later conversations with Dr. Shockley and other Bell Laboratories engineers confirmed this uncertainty as to the life endurance of the transistor, contact or junction types. The device is yet too young to afford positive knowledge regarding its useful life. Although one would naturally feel justified in assuming it to be eternal, it is actually "indefinite" today, for the reason that the transistor crystal is a synthetic compound, made up, in molten state, of germanium plus one or several other elements as impurities (gallium, arsenic, and others). It is conceivable, although apparently highly improbable, that a gradual dissemination or diffusion of the injected impurities which might in time occur would act to alter materially the initial amplifying characteristics of the presently preferred junction type of the transistor.

It must be recognized that transistor development is today in a state of flux, being carried on independently in each of a substantial number of independent laboratories: Bell, RCA, Sylvania, Westinghouse, Hazeltine, and others, all operating under licenses from the Bell Laboratories' parent patents. The sum of all the knowledge and manufacturing know-how that is certain to result from all this intensive investigation ultimately may make appear quite rudimentary all that is known today regarding this amazing little triode, the transistor. For, after all, the transistor, like its predecessor, the audion tube, *is* a *triode*. The two instrumentalities have this in common: both are triodes, three-electrode devices, and both amplify electronically—one using free electrons *in vacuo* or in gas, the other using electrons bound (not very tightly) to solid metal, where they can yet hop, skip, and slide about, like bunker marbles, from hole to hole.

Obviously the prime basic advantage possessed by the transistor over the audion tube is its smallness. In bulk the transistor is less than one quarter that of the smallest sub-subminiature tube. Twenty of them could be packed within the envelope of a normal-sized miniature tube. This fact alone proves its great advantage in every case where amplifier space is an important item. Unquestionably the transistor will soon replace vacuum tubes in all hearing-aid devices, in all proximity fuses, in self-guiding missiles. Its indestructibility under terrific shock and impact indicates the absolute certainty of its employment in possible future warfare.

Already the Western Electric Company is turning out a thousand contact-type transistors per day, all of which are at present for the U. S. Government. The cost is estimated—so I am informed—at more than $10.00 each, a figure which soon should be greatly reduced.



Cutaway view of junction-type transistor cartridge, showing the relationship between the base, emitter, and collector electrodes.

In all types of calculating machines, regardless of its noise factor or any other shortcomings inherent in today's transistor (which are certain to be reduced or eliminated by the research now devoted to the problems) there are great advantages to be derived by its use, as against the shortcomings of the electron tube.

Where operations are enormously involved, communications by elaborate permutations and combinations of an on-off, yes-no, dot-dash, or 0-1 symbolism, the "flip-flop" circuits employing transistors offer the ideal in simplification. I have in mind especially that great marvel in electronic calculating and computing machines, the IBM selective-sequence electronic calculator, which now occupies three sides of a gigantic hall on Madison Avenue, New York City, and comprises among its labyrinthian circuits and relays 6,000 electron tubes, occupying a tube rack some 150 square feet in size. Barring the space required in the rear for the essential conductors, this tube area could now be reduced to one-fiftieth of the present required board area, with corresponding reduction in cathode heating requirements.

A tremendously useful field for the transistor of the future will include every type of calculating machine, where compactness and durability of electron-operated components are desirable or essential features.

Certain limitations on reduction of space requirements are imposed upon the designer of such apparatus in the future by the unavoidable space requirements of the electromagnets and the necessary cabling requirements. But in the realm of calculating machines the advantages of the transistor over the heretofore employed electron tubes are obvious.

In the field of radio and television receivers, it is yet too early to speak with authority as to just how far the substitution of the solid-bound electron for the vacuum-free electron can be advantageously carried out. Unquestionably there will be such radical substitutions in many types of radio and television receiver and amplifier circuits. The day is coming when, by virtue of the small volume of the transistor units in miniature printed circuits, the dimensions of present television chassis will appear gigantic by comparison. **The match-case radio receiver and the pocket-size television chassis will make possible radical price reductions.**

We will still demand loudspeakers rather than head-telephone sets, and will demand kinescopes of ever enlarging dimensions—at least until the future "projector lens" popularizes the roll-down, roll-up, wide-angle viewing screen in the home.

Would God that the cultural improvements in television programs were as certain as are the engineering improvements hereinabove visioned!

After all is said of the transistor and its wide horizons of utility, it will be found that for certain purposes and employments the audion tube will continue to maintain its present indispensability; and unquestionably the tetrode and pentode tube will continue to perform circuital functions not so readily achieved by any type of triode, vacuous or solid-state. Especially will such considerations dictate circuiting designs where factors of larger voltage and grid-control are dominant.

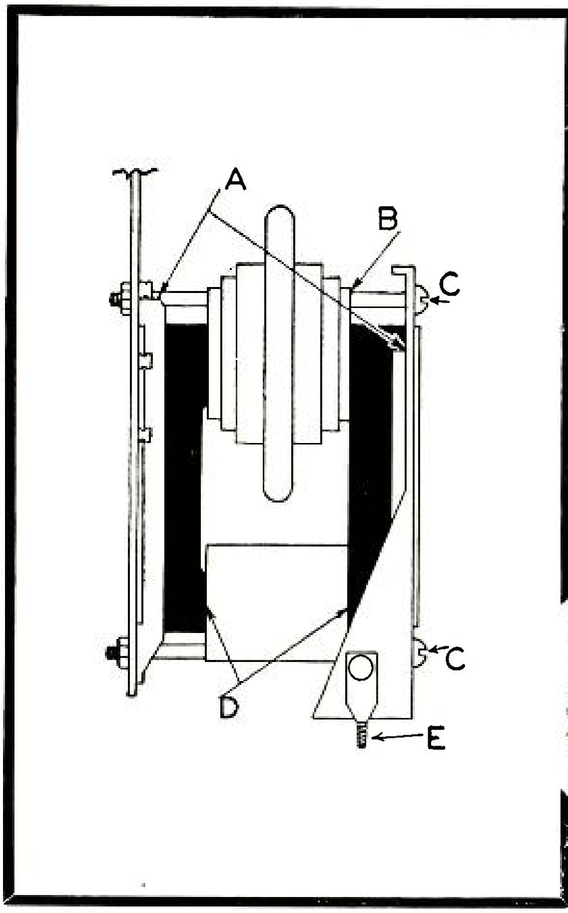
As yet we know very little regarding the power limitations of the solid-matter type of amplifier, having in mind also its frequency limits, defined today by the inverse capacitance limitations inherent to the transistor type of detector and amplifier.

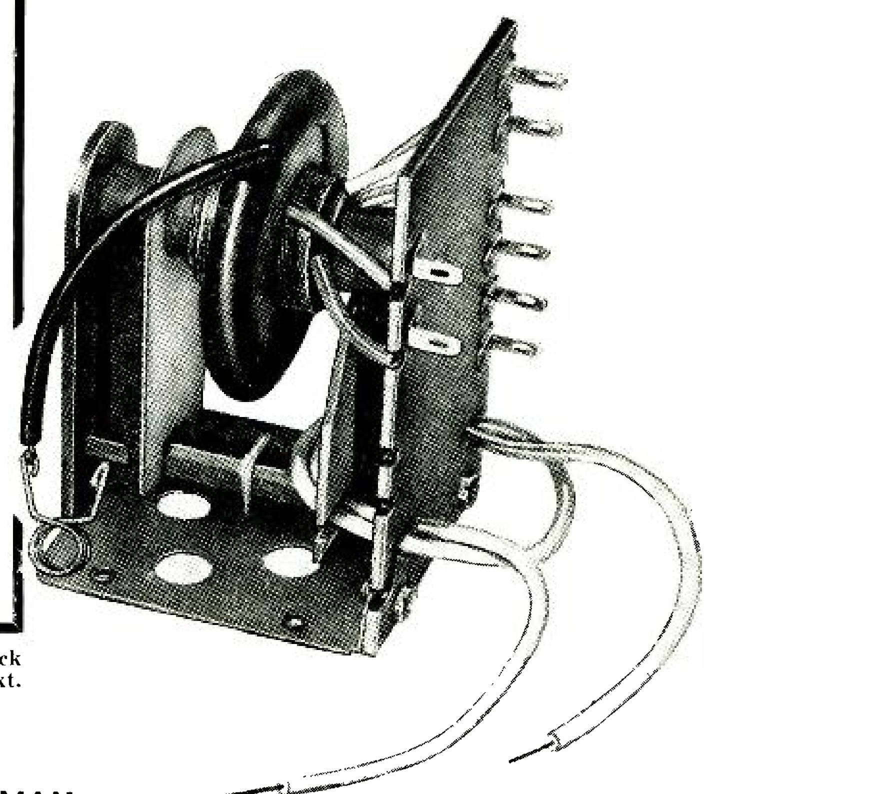
Certain it is, however, that this new type of triode amplifier, typified by the transistor and its kin (already discovered and soon to multiply) in today's new solid-state physics, is destined greatly to alter our heretofore-held concepts of the practical application of electronics to the multifarious projects to be faced by the engineer.

—end—

The recent banquet in New York, honoring Dr. Lee de Forest for his invention of the three-element electron tube, was given by *The de Forest Pioneers*, a group of past and present associates of the noted inventor. In reporting the event in "The Radio Month" column of last month's RADIO-ELECTRONICS, sponsorship was inadvertently attributed to *The Radio Pioneers*, another organization whose members have contributed notably to the development of modern electronics.

FLYBACK SQUEAL





Methods of quieting squeal from horizontal flyback transformer are described in detail in the text.

By FRED SHUNAMAN

A LETTER from Leo W. Maki, printed in our March issue, has aroused more comment than any communication in several years. He complained about "the worst form of TVI" which to him was "the nerve-racking, insanity-producing whistle heard in all TV sets." This 15,750-cycle note, he said, is heard by about half the TV viewers under 30, and is a reason why many people will not buy a set.

The letter was not taken too seriously by the RADIO-ELECTRONICS editorial staff (most of whom are over 30) and some members even wondered if the writer might not be a crank. He himself admitted: "Magazines, books, and other sources that cover TV, blithely ignore it." One of the staff remembered, however, that his wife could always tell whether the TV set was on or not—even with brightness and volume controls turned all the way down. She said it was because of a whistle the receiver emitted. The letter was printed without comment and with no idea that that it would get more answers than any letter which has appeared in the communications section in recent years.

The first response—from a Washington, D. C. technician—took the matter rather lightly. The Washington man stated in part: "Many of my customers are under 30 years of age and I have never had complaints of this nature. . . . If Mr. Maki is troubled with headaches I would suggest that he check the horizontal frequency and turn the volume of the TV set to normal room level."

Service technician David C. Graves of Barnesville, Ohio, was more familiar with the situation. He reported: "We had a 17-inch table model on which the complaint was a very loud audio whistle. I could not hear it, and thought perhaps the customer might be fooling me. The noise is the 15,750-cycle horizontal sweep frequency, and is due to mechanical vibration either of the chassis or the horizontal output transformer core. Since that first complaint, I have experienced the same circumstance several times, and have always been able to eliminate the sound by simply tightening nuts and screws till the vibrating part is damped down. Elimination is easy enough, but in my case I have to use somebody else's ears!"

But there are TV repair technicians under 30 years—plenty of them. Have they all been immunized to the near-ultrasonic sound? Service technician John W. Carey of Hopkinton, Mass., writes: "I must heartily endorse Mr. Maki's complaint. . . . Being a "dog" myself, the only thing I can suggest is a 7-inch electrostatic set. At a manufacturer's school I asked one of the instructors what to do about the trouble. The answer was a laugh and the advice to find a set the customer couldn't hear." Mr. Carey would like to see the problem solved "if only for comfort on the service bench."

What can be done about it

And a solution exists—in more than one form. Elmer Cummings of Oakland, Calif., referred us to our own magazine. The answers, he says, are in the August and November, 1951, issues. The August item, a Sentinel service note, states that a steady or intermittent squeal in models 419, 420, or 423 may be caused by mechanical vibration in the horizontal output transformer. To eliminate it, pour Glyptal or similar cement between the U-shaped channel brackets and the iron core (point A in the figure). Then, with a pair of pliers, squeeze the channel brackets until they touch both sides of the core, being careful not to damage the coil. If the coil is loose on the core, push wedges B towards the coil's center, using additional wedges if necessary. If the noise doesn't stop, tighten the screws C, apply Glyptal to the cardboard sleeving D so it is glued to the core, tighten nuts on E, and make sure all leads are dressed away from the transformer, being especially careful with the lead going to the fuse.

A similar suggestion is made in the Television Clinic, November, 1951. Matt Mandl suggests curing "transformer sing" by boiling the transformer in sealing compound. On direct inquiry, Mr. Mandl confirmed that large numbers of young people hear the squeal, and that in one of his classes at Temple University, "most of the students" heard it. "Some youngsters," he said, "actually have a rise in the reception of higher frequencies. In such instances the 15,750-cycle squeal would sound abnormally loud. Evidently Mr. Maki has a 'resonant hump' around that frequency. This is unfortunate and it would almost seem that television is not for him." Mandl goes on to suggest "proper drive adjustment and a well-designed horizontal output transformer and yoke" as a means of minimizing the squeal.

J. W. Richards, Lakeland Television, Warsaw, Ind., refers to Stewart-Warner service notes: "Careful inspection of the flyback transformer for loose turns or leads, coating it with a compound such as *Insulex*, and proper lead dress around the width and linearity coils will aid materially in correcting this fault."

One or two correspondents appear to believe that the sound comes from the speaker, and suggest low-pass audio filters. These would not help—the sound comes directly from the transformer, not through the speaker. Those whose hearing goes up past 15,750 cycles hear the whistle at the same level regardless of the volume control setting. And the audio system of the average TV is a fairly efficient filter for frequencies above (and considerably below) 15,000.

The 15,750-cycle audio squeal undoubtedly does annoy some listeners to the point of going without television. It probably mars reception for many listeners who may feel (as Mr. Maki reports children commonly do) that it is an unavoidable part of the program. Any work done to kill this whistle is certainly worth while. And there may be another dividend. It is quite possible that transients set up by vibrating parts in the field of the horizontal sweep coils may be a factor in producing the oscillations which interfere with nearby broadcast receivers. Measures taken to remedy the high-audio squeal may help reduce or eliminate the r.f. hash which infuriates the surviving radio listeners!

—end—

21-MC HAMS AND TVI

TVI from 21-mc stations appears in sound i.f. Realigning set removes the trouble

RICHARD I. BALDWIN, W1IKE*

SOMETHING new has been added—amateur radio occupancy of the 21.0 to 21.45-mc band. As a service technician, make a mental note of this; it will undoubtedly cause TV set owners to call on you for advice and assistance. Amateur operation on these frequencies will create some interference problems. Two things must be kept in mind. First, such interference is *not* the fault of the amateurs' transmitters. Second, in most cases you can readily eliminate such interference by i.f. realignment.

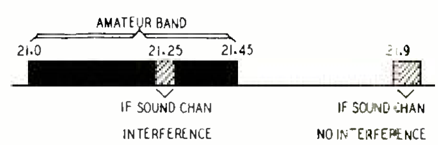
So that there'll be a better understanding of the situation, let's briefly review 21 mc history. In the latter days of the war the United States proposed that a new band for amateurs be established in the vicinity of 21 mc. As a result of the Atlantic City conference in 1947, the band 21.0 to 21.45 mc was earmarked for amateurs. However, it was not until May of this year that they were permitted to use that band.

Meanwhile, the manufacturers of TV receivers decided to use the frequencies 21.25-21.9 mc as the frequency range of the i.f. sound channel. When this proposal was announced by the Radio Manufacturers Association, the American Radio Relay League protested and pointed out that amateurs were scheduled to occupy a band of frequencies in that region. Nevertheless, RMA adopted that i.f. sound channel in 1946.

Realizing that eventually there would be trouble, the League secured permission from FCC to conduct special tests on 21 mc, to determine just what interference would result from amateur transmissions on that frequency and what could be done about curing or preventing it. A special station was set up outside New York City and observations and tests were made for several months. These tests, conducted by the national organization of amateur radio operators, are going to make it easy for you to overcome interference to TV sets with 21-mc. i.f.'s resulting from amateur transmissions on the 21-mc. band.

This type of interference either reduces or entirely wipes out the TV sound. Depending on whether the TV set is intercarrier or not and on the nature of the interfering signal, there may be miscellaneous effects on the picture. This interference will be more severe on TV sets whose sound

Efficient stations like this can cause interference on sets with 21-mc i.f.'s.



TVI is unavoidable when sets' i.f.'s are in range covered by black bar. Realigning i.f.'s to 21.9-mc will cure trouble.

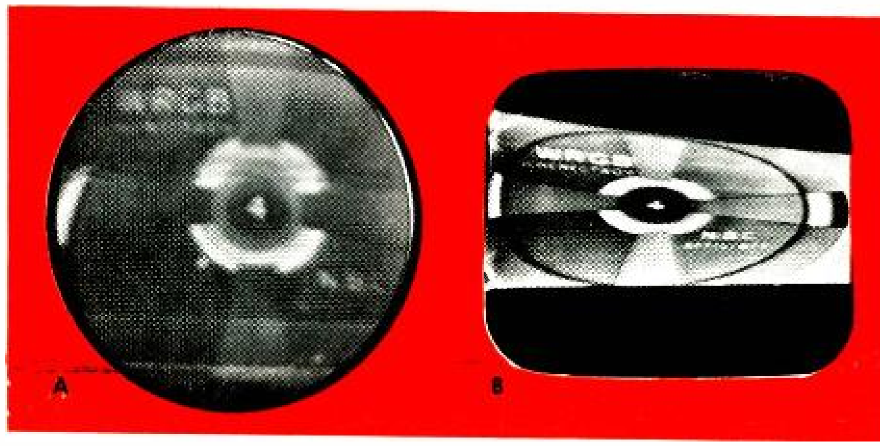
i.f.'s are in the vicinity of 21.25 mc. It can be eliminated or largely reduced by moving the i.f. up as far as possible in the direction of 21.9 mc. Certainly you should make an effort to move the i.f. up above 21.45 mc, which is the upper edge of the amateur band.

Newer TV sets are coming out with i.f.'s in the vicinity of 40 mc, and 21-mc amateur transmissions will probably cause little difficulty. But there are still a good many of the older models around. In most cases realigning the i.f.'s to bring the sound channel at least above 21.5 mc will do the trick, but don't overlook the possibility of traps in the antenna lead-in, or a high-pass filter.

We repeat again that this 21 mc i.f. pickup interference resulting from amateur transmissions on the 21 mc band is definitely not the fault of the amateurs, and the amateur can do nothing to improve the situation at the transmitter end. It results from an unfortunate choice of intermediate frequencies by the TV manufacturers, but it's the sort of thing you can easily cure. In other words, here's a good way for you to improve your customers' TV set and your reputation as a skilled technician.

—end—

* Assistant Secretary, ARRL



CAN YOU DIAGNOSE THESE

By JOHN B. LEDBETTER*

WHILE the picture tube screen is one of the most reliable test instruments for diagnosing and tracing receiver troubles, it is not infallible. Here are a few effects which can easily be misinterpreted. How many can you diagnose correctly at first glance?

Increase in vertical and horizontal size; loss of brightness (Photo A). This trouble *could* be hard to find. The symptoms indicate a loss of high voltage, which ordinarily suggests a defective high-voltage rectifier or horizontal output tube, a leaky high-voltage terminal or filter capacitor, or similar trouble in the h.v. supply. In this case the trouble was caused by a poor connection under the rubber hood at the second-anode contact of the picture tube. The resultant arc caused the drop in high voltage.

Vertical keystoning (Photo B.) Caused by a short circuit in one of the vertical-deflection coils. A similar short in the opposite half of the vertical windings would cause keystoning in the opposite direction. Although this trouble is not rare, it can result in wasted time if you attempt to repair or trace the short. (Most shorts occur deep within the windings.) Yoke replacement is the only remedy.

Similar troubles may occur in the horizontal deflection coils. In this case, keystoning would appear at either the top or bottom, depending on which half of the coil is affected. Yoke replacement is necessary here, too.

Vertical black lines at left of screen (Photo C). In most cases you would describe this trouble as Barkhausen oscillation or incorrect adjustment of horizontal drive. It was actually caused by an arc at the solder connection to the plate cap of the 1B3-GT. The arc evidently generated frequencies which approximate those usually developed by Barkhausen oscillation. Be sure to check all such points for poor solder connections, loose or corroded mechanical connections (plate caps and high-voltage fuse connectors), sharp bends, and protruding solder edges, when the usual checks for Barkhausen oscillation and horizontal drive misadjustment do not locate the trouble.

Vertical foldover (Photo D and Photo E). This trouble is not unusual, but a knowledge of its various sources can save a lot of time in checking the vertical sweep circuits. The "curtain-raising" effect (Photo D) is probably the most common. This is usually caused by a leaky grid-bypass capacitor in the vertical oscillator circuit, a leaky coupling capacitor in the vertical output stage, or a changed value in the vertical oscillator cathode circuit. These correspond to C304, C312, and R304 in Fig. 1. (This is part of the vertical sweep circuit in current G-E receivers).

Complete vertical foldover (Photo E) is caused by leakage across one of the integrating capacitors (C37 in Fig. 2). This circuit is used in the G-E 810 and in other receivers. When this is replaced, be sure to check the series resistors, and replace the other integrating capacitors at the same time. Use 600-volt units for replacement.

"Pie-crust" oscillation (Photo F). Ordinarily caused by an open or defective capacitor in the horizontal oscillator grid circuit. In receivers which use an r.f. or kick-back high-voltage power supply, this can be caused by stray or direct coupling between the power supply and the kinescope leads. (In the Motorola VT-71 and similar receivers, direct contact between the power-supply shield can and the metal shield around the picture tube neck will cause "pie-crust" oscillation. This can happen if the insulating sheet between the two is left off or moved.) A similar effect can result if the ground return of the picture-tube grid circuit is not making good contact with the chassis.

Horizontal retrace (Photo G). This trouble shows up in many receivers converted to larger-screen picture tubes. In most cases, it is due to the use of too large a capacitor across the horizontal output winding, or failure to change the horizontal output transformer when picture tubes having different deflection angles are used. (The retrace in either case is too slow.) If the receiver has not been modified or converted, a simple circuit like Fig. 3 will usually correct the trouble. (This circuit, suggested by G-E, supplies normal B plus voltage to the picture tube accelerator grid during the horizontal scanning period, but applies a negative blanking pulse during the retrace.) Remove the capacitor from one side of the horizontal deflection coil. (This is shown as 47 μμf in Fig 3 but may be a different value in other circuits.) Replace this capacitor with a piece of 72-

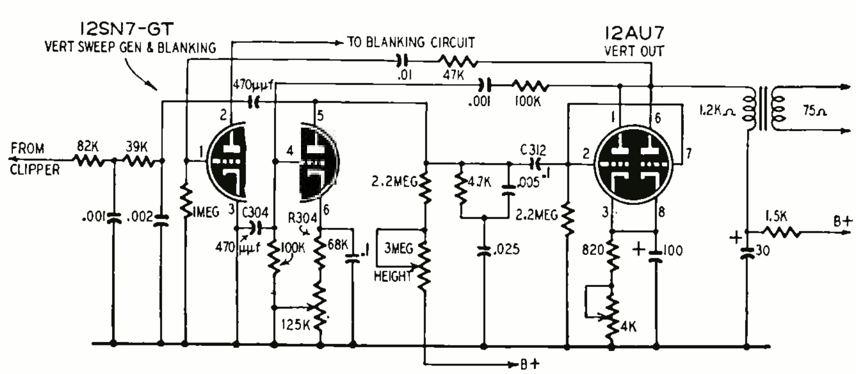
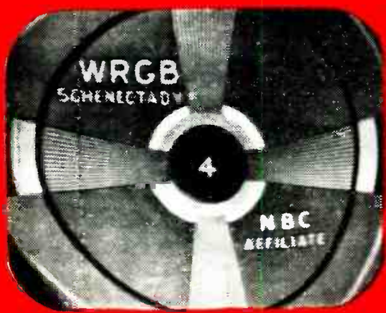


Fig. 1—Partial schematic of vertical sweep circuits in recent G-E receivers.

*Engineer, WKRC-TV



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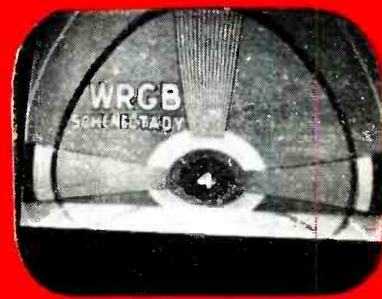

D

E

TV TROUBLES?

ohm coaxial about 12 or 14 inches long (the length will depend on the size of the capacitor removed; some experiment may be required.) Disconnect the lead to pin 10 of the picture tube and tape it out of the way. Then connect the coaxial as shown. *Do not* ground the coaxial shield. Tape the coaxial to the neck of the picture tube as its length requires.

Striations or vertical ripple (Photo H). Would you diagnose this as "ringing" or oscillation, or trouble in the damper circuit? Actually, this trouble is due to cross-talk from the horizontal sweep circuit into the vertical deflection coils. One source is the capacitor which shunts one half of the horizontal deflection winding. This capacitor is used to eliminate cross-talk by balancing each half of the horizontal winding to ground. If the capacitor is leaky, open, or has changed value, the balance is upset and the horizontal pulses cause amplitude modulation of the vertical deflection coils. If replacing this capacitor does not correct the trouble, the deflection yoke is probably defective.

Photo I and Photo J. These effects are unusual and apparently indicate horizontal foldover or damper troubles. Actually, both are caused by open filter capacitors in the low-voltage power supply. These troubles occurred in a G-E 805 (see Fig. 4), but could also happen in similar receivers. In Photo I, filter capacitor C373 (Fig. 4) is open. This reduces the 265 volts which supplies the horizontal output and damper tubes and causes the extreme foldover at the left. In Photo J, the alternate dark and light vertical bars (left to center of raster) and the large white area at the right are caused when filter capacitor C374 in Fig. 4 is open. This drops the 150-volt line to such an extent that the horizontal a.f.c. tube is inoperative. The horizontal hold control also will not function properly.

Many other odd and misleading effects will be found in various receivers. Study the effect, *but take nothing for granted!* Even *simple* defects can be misleading. (Photos and schematics in this article first appeared in G-E's service publication *Techni-Talk*. Their permission to use them in this article is gratefully acknowledged.)

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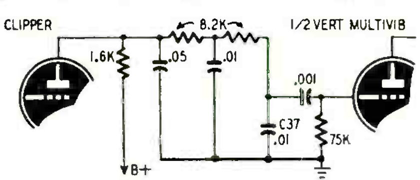


Fig. 2—Vertical-sync integrator circuit.

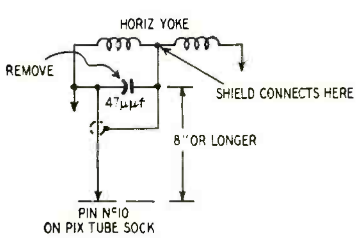


Fig. 3—Horizontal retrace elimination.

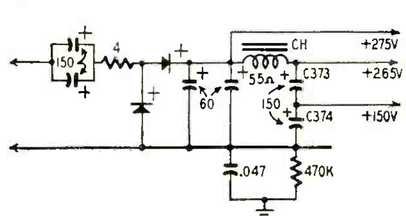
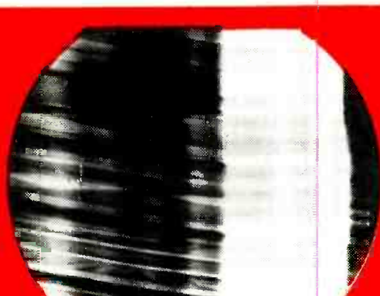


Fig. 4—G-E 805 voltage-doubler circuit.

F

G

H



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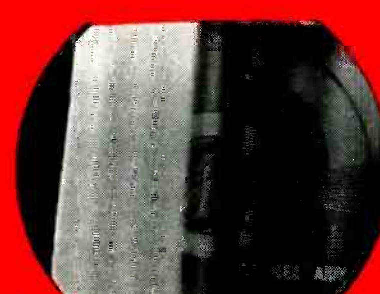


I

TV SERVICE CLINIC

Conducted By

MATTHEW MANDL*

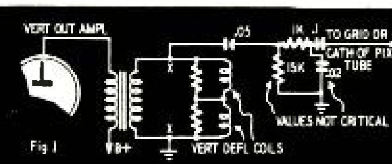


Fig 1

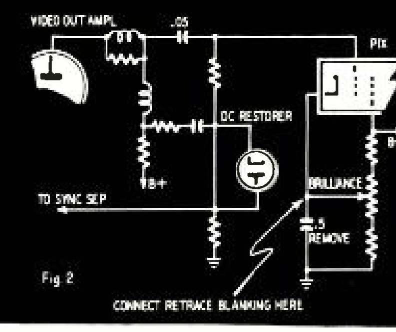


Fig 2

AN INCREASING number of queries are being received regarding retrace elimination. The circuit itself is simple, but several precautions must be taken to minimize loss of fine detail or brilliancy. Such a circuit should not be used to correct for circuit faults or poor reception. If retrace lines are annoying, there may be trouble in the brilliancy control circuit or in the picture signal amplification. Except in extreme fringe areas, retrace lines should not show if the contrast and brilliancy controls have been properly adjusted. Poor alignment and tracking, a misadjusted ion trap, or a deficient antenna system all can contribute to insufficient blanking or improper bias in the picture tube. Thus, retrace lines are visible on most channels.

If the set is working properly you may see occasional retrace lines during camera changes or station breaks. If this is troublesome, or if weak fringe-area reception is to be improved, the retrace-elimination circuit can be added.

The circuit can consist of a single coupling capacitor from the secondary of the vertical output transformer to the picture tube. The R-C network shown in Fig. 1 is preferable because of its better blanking waveshape. This type circuit is used in many Raytheon receivers. Since the output of this circuit is a shunt capacitor combination (0.1 μf in series with .02 μf), it will diminish high-frequency signal detail if applied to a circuit carrying the composite video information. If the last video amplifier feeds the grid of the picture tube, the eliminator circuit should be put in the cathode. If the video amplifier is connected to the cathode, the elimination circuit can be applied to the grid. Use the eliminator in the circuit containing the brilliancy control.

Other precautions may be necessary. Refer to Fig. 2, where a typical video output system is shown. If the retrace elimination circuit were applied to the cathode, the 0.5-μf bypass would shunt the retrace elimination pulse.

To prevent this, the 0.5-μf cathode bypass capacitor must be removed. This will not affect performance, because its duties will be largely taken over by the two series capacitors in the output of the eliminator. Since a positive pulse is needed, the terminals marked "x" in Fig. 1 should be reversed if the system doesn't eliminate retrace. It can be tested by advancing brilliancy and decreasing the contrast-control setting. At extreme settings retrace lines may be faintly visible. For any setting less than full brilliance, retrace lines will be eliminated. Fig. 3 shows the screen of a receiver (Admiral 30A1) which, in spite of high brilliancy and poor signal (to the point of sync instability) still has perfect retrace elimination with this circuit.

Retrace elimination circuits are used in many late-model receivers. In the General Electric 20C150 series, a special vertical blanking amplifier is used as shown in Fig. 4 to assure adequate retrace blanking at all times.

Flyback transformer burnout

Q. I have recently converted a Traveler model 12L50A to use a 16RP4 picture tube. The manufacturer uses the same horizontal output transformer and yoke in both 12- and 16-inch models. The only changes I made were to substitute a 6CD6 for the 6BQ6, replace the width coil, and make the necessary changes for the 6CD6 circuit. The receiver worked for several hours, after which the horizontal output coil burned out. It had overheated to the point where the insulating wax melted, but the fuse did not blow. I could find no defective components which might cause this. R. O. B., Rochester 9, N. Y.

A. The probable cause of this was an over-age and weakened secondary winding. The additional sweep voltage developed by your 6CD6 was probably sufficient to cause breakdown. Use a replacement transformer designed for 16-inch tubes and, for best results, a matching yoke.

Line reflections

Q. This is a fringe area and I have installed an antenna on a nearby hill 1,000 feet from the receiver. Originally 300-ohm ribbon line was used, but because of breakage caused by wind conditions, I installed an open wire line.

Since then ghost reception seems to prevail. A stub section seems to reduce this effect, but the picture still isn't as clear as it was. What causes this? P. R., Morgantown, W. Va.

A. The open wire line you used was evidently a 400-ohm impedance type which does not match the receiver. This causes line reflections which now blur your picture. With a very long run and severe mismatch, distinctly separate pictures are produced by the direct and reflected waves. This simulates ghost reception.

Try moving the stub along the line until the best picture is secured, or leave the stub in one place and vary its length until the best value is obtained. Start with a long stub and keep cutting off small sections. Shorted sections of ribbon line will work well.

For low losses slotted 300-ohm ribbon line can be used instead of the 400-ohm open wire line.

CRT socket defects

Q. On a Westinghouse 636T17 receiver the picture (and raster) are intermittent. On occasion the raster would remain but the picture would disappear. During this time arcing occurs in the 1X2-A tube and at the ground strap for the cathode-ray tube. I've cleaned the strap and replaced the 1X2-A without results. By tapping the base of the tube I can snap the picture back for a short time. Could this trouble be a defective picture tube? G. K. S., Council Bluffs, Iowa.

A. From your description it would seem that you have a defective cathode-ray tube socket. This would explain why normal operation can be restored by tapping the base or socket of the picture tube. An intermittent connection could open the cathode circuit and cut off emission. This would also remove the load from the high-voltage power supply and cause the arcing you describe. Without load the high voltage increases and usually causes corona and

*Author *Mandl's Television Servicing*

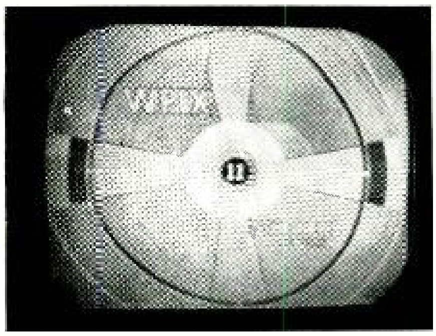


Fig. 3—Absence of retrace lines indicates efficient vertical blanking system.

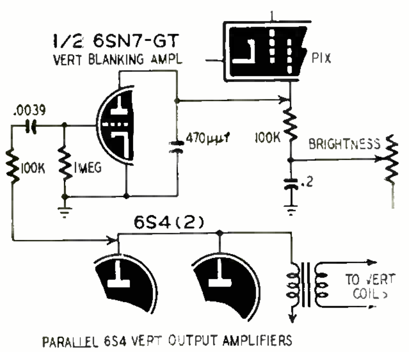


Fig. 4—Circuit of a blanking amplifier.

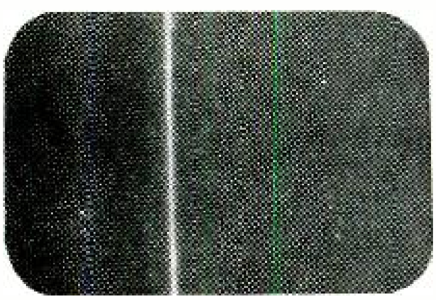


Fig. 5—Line caused by poor linearity.

arcing. This would also cause repeated burnout of the rectifier tube.

Remove the picture-tube socket and inspect all soldered connections. Resolder where necessary or replace with a new socket. Also inspect the base of the tube and note whether or not it is loose from the glass neck. Also check the soldered connections at the base of the tube pins. If the socket is all right, the trouble could be caused by defects in the base or in the tube itself.

Rhombic dimensions

Q. What are the actual dimensions of the diamond-shaped true rhombic? I've heard conflicting stories on this and would appreciate information and comparisons with the Yagi type. E. E. H., Massena, N. Y.

A. The true rhombic gives optimum results when each leg of the diamond-shaped affair has a length of at least three wavelengths for the lowest frequency to be received. Thus, for channel 2, based on an approximate wavelength of 16 feet, each leg of a true rhombic would have to be at least 48 feet long for best results! This makes such an antenna too cumbersome for ordinary use at v.h.f. television frequencies.

Gain in excess of 10 db can be secured with a Yagi, but the bandwidth is reduced to one channel (and sometimes less than that). Stacked biconicals are fairly broad-band, but have a gain of only about 5 db. As soon as both wide-band and exceptional gain are desired, the design becomes too unwieldy for v.h.f. television—though it will probably find use in the new u.h.f. channels.

Vertical center bar

Q. In an RCA TC166 receiver there is a bright bar (vertical) near the center of the screen. This shows in the picture and started after I had to correct for a decrease in width. I've adjusted the drive control and changed tubes (including the damper). What would cause this condition? R. W. M., Memphis, Tenn.

A. This condition is usually caused by a combination of misadjusted drive control, horizontal linearity, and width. Reduce the drive until the picture no longer shows a compressed center, then adjust the linearity and width to fill out the screen horizontally with good linearity. Do this on a test pattern or with a linearity pattern generator.

An oscillogram of the sawtooth would show a sharp dip at the center of the slope, indicating poor linearity. This causes the white line (or lines) near the center which will be present with or without a picture. (See Fig. 5.) Vertical white lines caused by damping defects are nearer the left of the screen.

If control adjustments fail to give results, check capacitors and resistors in the discharge circuit feeding the grid of the 6BG6 tube, as well as cathode and screen capacitors. Replace any components more than 10% off rated value.

Pulling on one channel only

Q. In an Emerson 663 receiver horizontal pulling has developed recently. This occurs only on channel 6, and tube changes do not seem to help. Could this be caused by a.g.c. defects? H. J. S., Hatboro, Pa.

A. Yes, this condition could be caused by overload which the a.g.c. circuit is unable to overcome. This receiver doesn't have adjustable a.g.c. The a.g.c. and sync take-off points are ahead of the contrast control, which is of no help in relieving the condition.

Try antenna reorientation for channel 6, or insert attenuating traps in the antenna system to cut the signal down below the pulling point. See that no defect exists in the a.g.c. line to the first r.f. stage and the first i.f. amplifier. An open circuit would remove the a.g.c. bias and cause overloading, particularly on the strongest station in your area. Measure each r.f. and i.f. tube's grid-to-cathode voltage with a v.t.v.m. (This receiver does not apply a.g.c. to the second and third video i.f. stages.)

—end—

TV DX IN JULY

If our last TV dx forecast was correct many of you will have received TV broadcasts direct from stations several hundred or a thousand miles away. If you haven't, it may be that local stations are blocking out dx on the channels which they occupy.

The reader of this monthly forecast will do well to take careful note of what happens during June, if he would know what to expect in July. The major openings of June are almost certain to recur in July, about 27 days later, so June's record is probably the best indication of what July holds in store.

Sporadic-E dx will not be quite so frequent during July as it was in June, but will follow a very similar pattern. Signals from distances of 600 to 1,200 miles will be very strong at times, and there will be several opportunities for "double-hop" dx, bringing in signals from points as much as 2,500 miles distant. There is some possibility that South American stations may be received, too. Since such reception has been extremely rare to date we are particularly interested in hearing complete details of any such intercontinental dx.

Tropospheric propagation will be generally good, and there will be many times when the high channels, particularly, will come through extraordinarily well. The full potentialities of the high channels have not been realized heretofore, because of the relatively poor high-band performance of TV receivers manufactured prior to this year. Many among the 1952 crop of receivers have greatly improved performance on channels 7 through 13. Where high-gain antenna systems that favor these channels are used it should be possible to get results on some occasions over distances as great as 500 miles, perhaps more. This type of propagation is most likely to develop in the early morning hours, in the early evening around sundown, and late at night. It is associated with fair calm weather, or increasing cloudiness preceding a storm. A steady high barometer reading, or the beginning of a slow fall after a prolonged high period, are good indications that tropospheric propagation well beyond normal distances can be expected.

July is usually good for at least one pronounced aurora display, and in this month aurora is frequently accompanied by sporadic-E type dx reception. A directional array aimed north to west (for an eastern station) or north to east for a western station, may bring in two kinds of signals under such conditions. One will be shadowy and distorted reception from stations up to 500 miles or so; the other will be strong and clear dx from the normal sporadic-E distances. Aurora effects are much more pronounced on the low channels, though the possibility of high-band dx should not be ruled out entirely.

—end—

THE SERVICE TECH AND TVI

By NORMAN HELFANT, W2EBP

ONE cause of television interference is faulty operation of nearby short-wave equipment. The other is inadequate design of the receiver being "interfered with." Interference of the first kind is seldom found. The FCC rules and regulations just don't permit it. If the owner of transmitting, diathermy, or other equipment can show one TV receiver operating within 100 feet with no interference, the short-wave equipment cannot be accused of causing the trouble.

Manufacturers of TV sets have underestimated the need for filters, traps, and screening. The job therefore becomes one for the service technician.

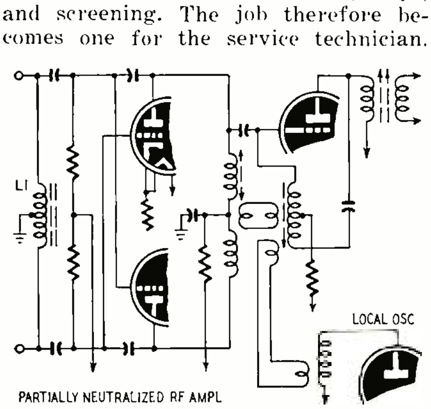


Fig. 1—Broad-band TV input circuit.

I. Front end overloading

This trouble produces internal harmonics. Refer to Fig. 1. L1 is the only tuned circuit at the input of the set. This circuit (typical of many front ends) has a curve which is expected to pass the TV spectrum 54 to 216 megacycles, and cannot be expected to drop off sharply at 54 or 216 mc. Therefore a local signal from approximately 27 to 54 and 216 to 255 mc will pass to the grid circuit with only slight attenuation. A signal on any service between 54 and 216 mc. will pass with *no* bucking. Therefore an unwanted local signal can have a much higher strength at the grids than the desired TV sigs. This may cause the first r.f. tube to double or become completely saturated. Obviously, short-wave equipment operating properly at half the frequency of a given channel can thus appear as if it had a second harmonic.

The cure is to prevent the unwanted signal from reaching the front end. You can do that in either of two ways. If the unwanted signal is within or above the TV spectrum, use tuned traps for its frequency in the lead-in wire. If it is below the TV band it may be a better idea to use a high-pass filter which sharply attenuates all signals below the TV band, because stations in the short-wave region often change frequency to suit communication conditions. Interference from stations above 216 mc is rare, and for this reason low-pass filters to attenuate signals above the TV spectrum are rare. High-pass filters for TV are readily obtainable from the average radio jobber. The service technician may have to build traps, however. Construction information on traps and filters can be found in the article "Practical TVI Filters," in the May issue of RADIO-ELECTRONICS, in many of the publications of The American Radio Relay League, and in the Rand book "Television Interference," (Remington Rand, 315 Fourth Ave., New York 10, N. Y. 25*c*.)

Most interference is due to equipment in the 54-mc region or below and a high-pass filter should be tried before time is consumed finding out what frequency the unwanted signal is on.

Be sure to install the trap or filter *as close as possible* to the front end of the set. Otherwise the wire from the filter to the front end may act as an antenna and pick up the unwanted signal.

II. Interference at the i. f.

Unwanted frequencies may be brought directly into the i.f. amplifier through the three series capacitors to the mixer grid along the top line of Fig. 1. Interference is seen on all channels. It is treated the same as Trouble I.

III. Direct i. f. pickup

Signals at the intermediate frequency may be picked up direct through the bottom of the set. This usually becomes bothersome only when the picture or sound i.f. strip is very close to or on the same frequency as the unwanted signal. It shows up on all channels on either the respective picture or sound carrier. Don't confuse it with an exaggerated case of Trouble I where saturation of the first r.f. tube may cause severe interference on all channels, both sound and picture. Direct i.f. pickup can be seen definitely with antenna grounded.

Complete screening of the bottom and top of set are usually required. Most sets with i.f. pickup will also need treatment as in Trouble I.

IV. Grid-leak detection

Strong AM signals may be detected in the audio or video stages. All channels are affected, with or without front end and i.f. stages operating.

Pickup of this type is more common in the audio section than in the video. The cure for the audio trouble here also applies to phonos, public-address systems, and radios, and is cleared in the same manner. Refer to Fig. 2. All or one of the following steps may be necessary to clear audio trouble: Make all audio leads short. Shield hot leads in the high-gain voltage-amplifier stage or stages. Use resistors R1 and R2 as shown in all voltage amplifiers. The value should be reduced in stages drawing grid current. The capacitors C, from grid to ground—if found necessary—should be as small as possible. Using mica capacitors, start with 100 μμf and work upward until the trouble disappears. If the smallest value that clears the interference also mars the audio highs, leave it out and screen the stage or stages not cured by the other steps.

Video pickup, also through grid detection, cannot be cleared in this way. Screen the set as in Trouble III.

V. Signals via the line cord

Most manufacturers include a certain amount of line filtering, which usually suffices. An additional line filter should be tried if the preceding cures don't

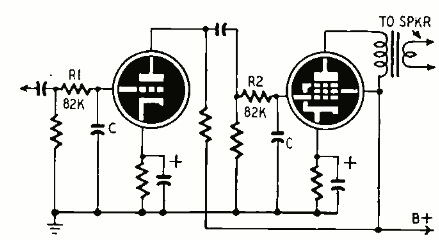


Fig. 2—Remedies for a.f. grid detection.

completely clear the trouble for which they are intended. A line filter may be obtained readily or built from one of the many obtainable circuits. Install close to back apron, inside or out, and ground to chassis or cold side of line. Beware of a.c.-d.c. sets. If you are using a filter on one of them, connect a .001-μf mica and 0.1-μf paper or oil capacitor in parallel and hook the combination between the case of the filter and earth.

Screening as recommended in Trouble III and IV (video) should be done carefully with the purpose in mind of keeping the r.f. from entering the set's wiring. Usually when screening is needed, only a thorough job does the trick. Copper window screening is probably best adapted to the work. Obviously one can't screen the front of the picture tube. Luckily the aquadag grounds it capacitively. But the average speaker—if left unscreened on the front—can let enough r.f. through to defeat the purpose of the whole job. Closely bond the edges of the screening and spot-solder to chassis at regular intervals.

—end—

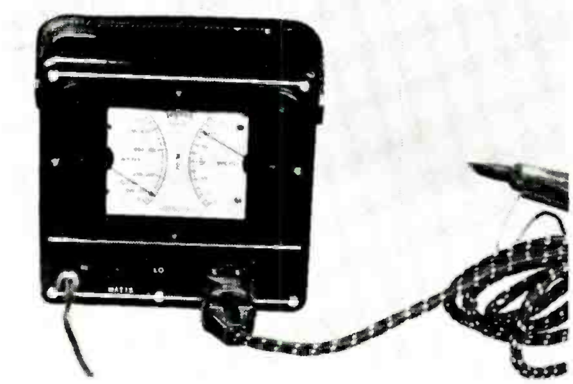
how to use and handle a LOAD-CHECKING METER

By HARRY LEEPER

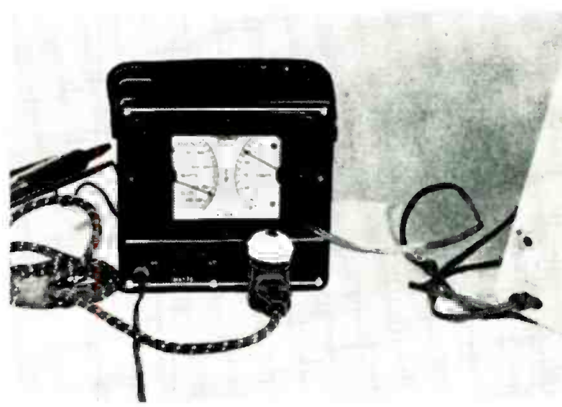
Many radio and TV receiver troubles can be spotted quickly by checking actual power consumption against manufacturer's nameplate ratings. For example, shorted or leaky filter capacitors cause an increase in consumption; an open bleeder or a burned-out tube will reduce the load below normal. Use of the method has been limited in the past by the high cost and complexity of the equipment. However, the recent introduction of compact, reasonably-priced instruments makes this method of diagnosis generally available.

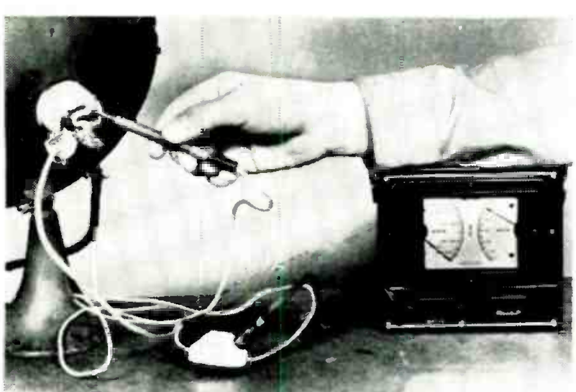
Use of the wattmeter as illustrated often makes it possible to give the customer a quick and accurate estimate of repair costs. As a final check before returning the set, it may save an unpaid return call.

The Triplett "Load-Chek" is typical of the new instruments. The a.c. line voltage and power consumption of the device to be tested are measured simultaneously when the equipment is plugged into the meter. Two ranges on the wattmeter scale will measure equipment loads up to 1,000 watts maximum.

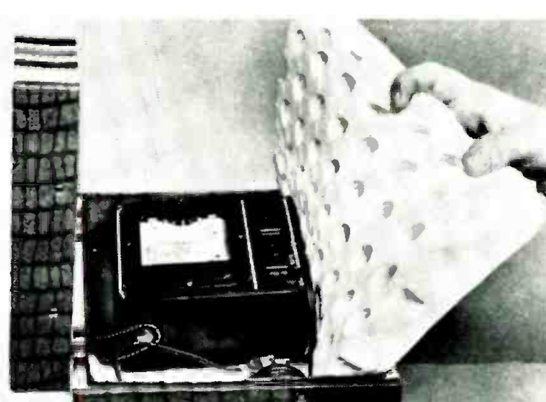


Accuracy in measuring loads of less than 100 watts can be improved by using a cube tap and a fixed load (such as a soldering iron), to move the pointer up to the more expanded portion of the scale. The device to be checked is then added, and the difference between the readings is the live-load wattage.



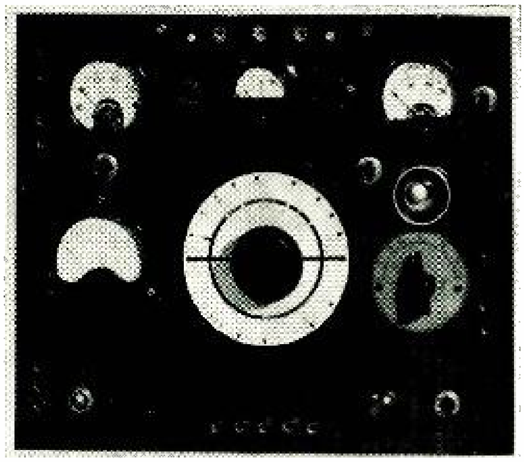


The voltmeter section may be used independently by plugging the instrument line cord into an extension-cord receptacle, with test prods or any suitable connector at the other end of the extension. Test leads may also be clipped directly to the meter line plug.



An inexpensive case will protect the meter in the car or shop. The case shown in the photo is 8½ x 12 x 5 inches, and cost about $1.50. A piece of sponge or foam rubber is placed in the bottom and another folded over the top and sides of the instrument.

COMBINED MEASURING SET



Front panel of the combined measuring set.

Five instruments in one form a complete portable laboratory for the service technician or experimenter —any section may be built as a separate unit.

By A. IWANIWSKY

THIS device combines five highly useful electronic instruments in a single compact unit. It will handle practically any measurements required in routine servicing, and in addition provides facilities for capacitance, inductance, and high-resistance measurements.

The circuits used are not original with the author, but have been selected on the basis of successful application over a period of years in this country and abroad.

The five functions of the instrument are as follows:

Straight volt-ohm-milliammeter (2,000 ohms per volt).
Audio output meter.
V.t.v.m.
Capacitance and inductance grid-dip meter.
High-resistance and capacitance bridge.

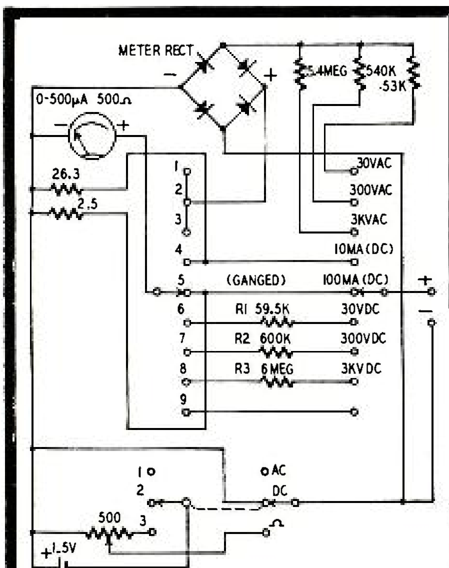


Fig. 1—Schematic of the v.o.m. section.

Volt-ohm-milliammeter

The schematic of this section is shown in Fig. 1. The meter is a 0-500 μamp movement with an internal resistance of 500 ohms. The rectifier is a full-wave-bridge instrument type available from several manufacturers. Voltage ranges of 30, 300, and 3,000 (a.c. or d.c.) are provided, although these can be changed or extended by substituting suitable values for R1, R2, and R3. The values shown for these resistors should be obtained by combining suitable units in series or parallel. The current ranges are 10 ma and 100 ma. These too can be changed by the use of different shunts. (See "Multirange Milliammeter", on page 37 of RADIO-ELECTRONICS for April, 1952.) A single resistance range is included, with a mid-scale value of 500 ohms.

Audio output meter

For maximum sensitivity, this section is designed to operate from the primary side of the receiver or amplifier output transformer. (See Fig. 2.) The meter and instrument rectifier are identical to those used for volt-ohm-milliampere measurements. Any meter of the same sensitivity may be used provided its internal resistance is at least 250 ohms. The adjustable series resistor is for calibrating the meter.

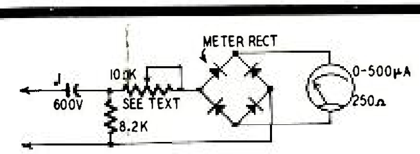


Fig. 2—The audio output voltmeter.

V.t.v.m. section

The circuit shown in Fig. 3 is used for grid-bias and signal voltage measurements in low-level audio stages and oscillator circuits. Its full-scale sensitivity is 3 volts a.c. or d.c. The 2,000-ohm potentiometer is a calibrating control. Zero adjustment is provided by the 250-ohm control.

Capacitance and inductance tests

A grid-dip oscillator (Fig. 4-a) is used for these measurements. This principle is used in many commercial instruments, and the circuit employed here was suggested by M. Katreczko, E.E., of the YMCA Radio School in Brunswick, Germany.

Capacitance values up to 500 μμf are measured by connecting the unknown capacitor directly across L2 (terminals 1 and 3). This forms a resonant circuit. The oscillator is then tuned to the same frequency by varying C1. Resonance is indicated by *minimum* grid current. Higher values (up to 5,000 μμf) are measured by connecting the unknown capacitor across terminals 2 and 3. The C1 tuning dial is calibrated by connecting various standard capacitors across the test terminals. Coil details are given in Fig. 4-b.

Small inductance values may be

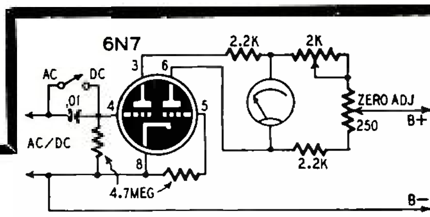
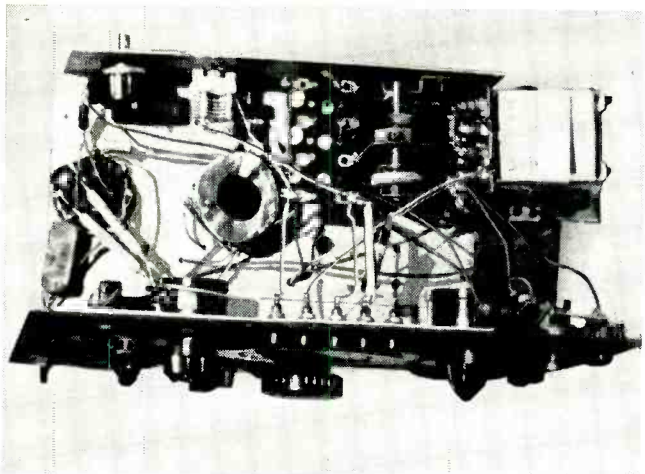


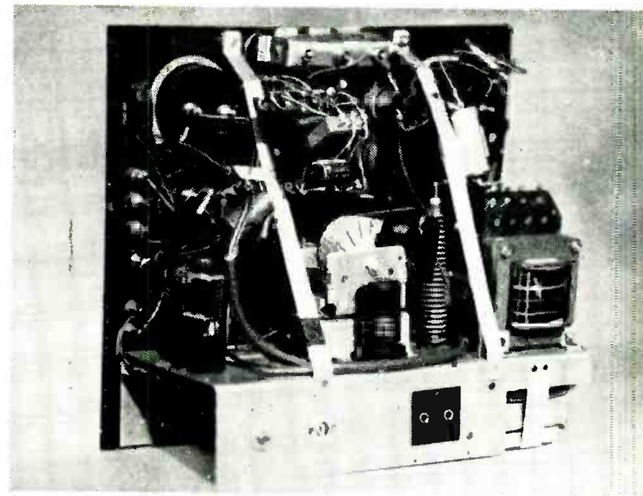
Fig. 3—Vacuum-tube-voltmeter circuit.

checked in the same way. R.f. chokes and TV peaking coils can be used for calibrating the inductance ranges of the instrument.

The meter should have a minimum full-scale reading of 10 ma. Its sensitivity is controlled by the 25-ohm rheostat. The trimmer capacitors across L2 and



Under-chassis view of the combined measuring set. Some European-type components were used in this version.



Behind the panel. The multi-plate metallic rectifier mounted next to the power transformer has been changed to a 6X4.

L3 are used to balance out stray capacitances. Coils and capacitors should be connected directly to the terminals.

Resistance-capacitance bridge

Higher values of resistance and capacitance are measured by the circuit shown in Fig. 5. A low a.c. voltage from the heater circuit is applied through standard resistors or capacitors to the 6H6 diode rectifier. The output of the 6H6 is fed to the 5,000-ohm potentiometer which controls the shadow area of the 6E5 electron-ray indicator. This control is adjusted for maximum shadow area with the test terminals open.

Any impedance (resistance or capacitive reactance) inserted in the a.c. supply reduces the current through the 6H6 and narrows the shadow. The potentiometer is then adjusted to restore the shadow to its original size, and the unknown value read from the dial, which may be calibrated with standard resistors and capacitors.

Three 6.3-volt pilot lamps wired to an extra section on the selector switch, show which range is in use.

Power supply

A standard rectifier circuit (Fig. 6) using a small power transformer and 6X4 supplies all operating voltages.

Although individual meters are used in each of the first four circuits, a single 0-500-μa movement can be used by providing pin jacks at the meter terminals in each section. This will also require a number of different scales for the meter.

Obviously, any one of the sections described may be built as a separate unit. For that reason, separate parts lists for each section are given below.

Materials for Measuring Set

Volt-ohm-milliammeter

Resistors: 1—5.9 megohms, 1—590,000 ohms, 1—59,000 ohms, ½ watt (see text); 1—250 ohms, 1—2.5 ohms, ½ watt (see text); 1—500-ohm potentiometer.
Miscellaneous: 1—2-pole, 9-position selector switch; 1—1-pole, 3 position selector switch; 1—0-500 microammeter, internal resistance 500 ohms; 1—full-wave-bridge instrument rectifier (Conant 160B, Electrox AA-4, or equivalent); 1—1.5-volt dry cell; wire, hardware.

Audio output meter

Resistors: 1—8,200 ohms, ½ watt, 1—100,000-ohm potentiometer.
Capacitor: 1—0.1 μf, 600 volts, paper.
Miscellaneous: 1—0-500 microammeter; 1—full-wave-bridge instrument rectifier (Conant 160B, Electrox AA-4, or equivalent); wire, hardware.

V.t.v.m.

Resistors: 2—4.7 megohms, 2—2,200 ohms, ½ watt; 1—2,000-ohms, 1—250-ohms, potentiometers.
Capacitor: 1—.01-μf, 600 volts, paper.
Miscellaneous: 1—0-500 microammeter; 1—6N7 tube; 1—s.p.s.t. toggle switch; wire, hardware.

L-C grid-dip meter

Resistors: 1—510 ohms, ½ watt; 1—25-ohm rheostat.
Capacitors: (Paper) 1—.01 μf, 600 volts. (Ceramic or mica) 1—500 μμf. (Air variable) 1—500 μμf. max. (Trimmers) 2—20 μμf max.
Miscellaneous: 1—oscillator coil (see text); 1—6C5 tube; 1—octal socket; wire, hardware.

R-C bridge

Resistors: 3—1 megohm, 2—100,000 ohms, 2—10,000 ohms, 2—220 ohms, ½ watt; 1—5,000 ohms potentiometer.
Capacitors: (Paper) 1—1.0 μf, 2—0.1 μf, 1—.02 μf, 1—.01 μf. 600 volts; (Variable), mica trimmers 2—20 μμf.
Miscellaneous: 1—6H6 tube, 1—6E5 tube; 2—tube sockets; 1—2-gang 6-position wafer switch; 3—6.3-V pilot lamps; 3—pilot-lamp sockets, wire, terminals, hardware.

Power Supply

1—power transformer (470 volts center-tapped, at 40 ma; 6.3 volts at 1.5 amp) 1—6X4 or 6X5 tube; 2—4-μf, 350-volt electrolytic capacitors, 1—6,800—ohm, 2-watt resistor; 1—tube socket; 1—s.p.s.t. toggle switch; 1—line cord and plug; wire, hardware.

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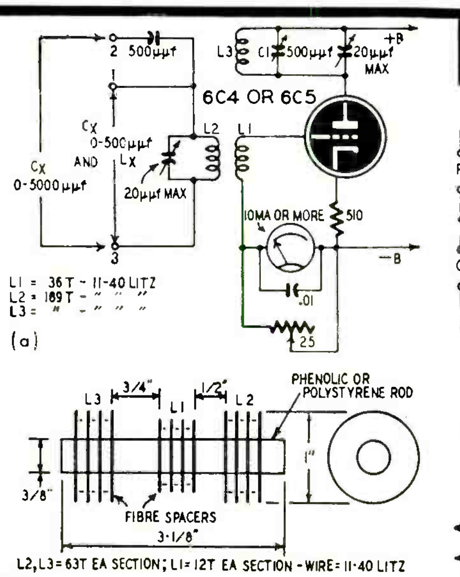


Fig. 4—Grid-dip oscillator and coil data.

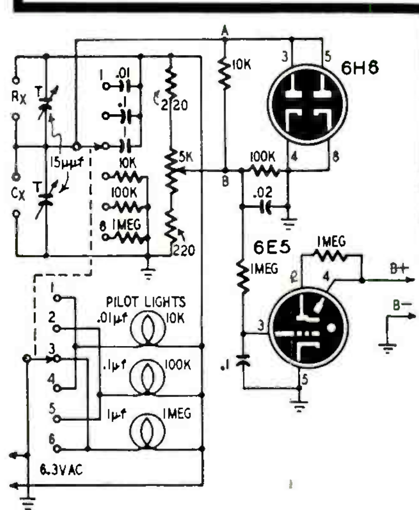


Fig. 5—Bridge for R-C measurements.

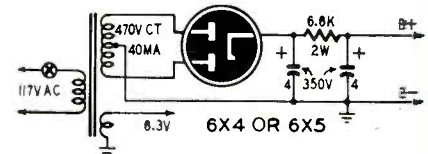


Fig. 6—Power supply for the set.

Familiar tube types find unusual applications in late-model TV receivers. **By ROBERT F. SCOTT**

short

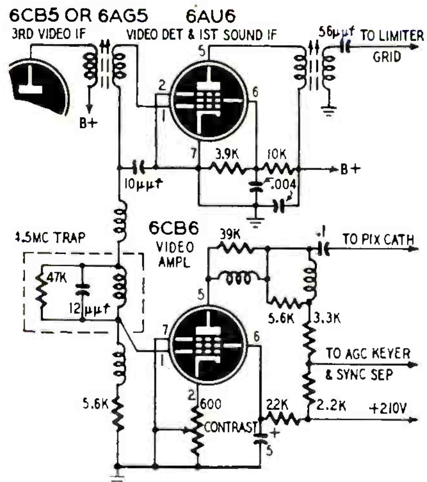


Fig. 1—Magnavox video-detector circuit.

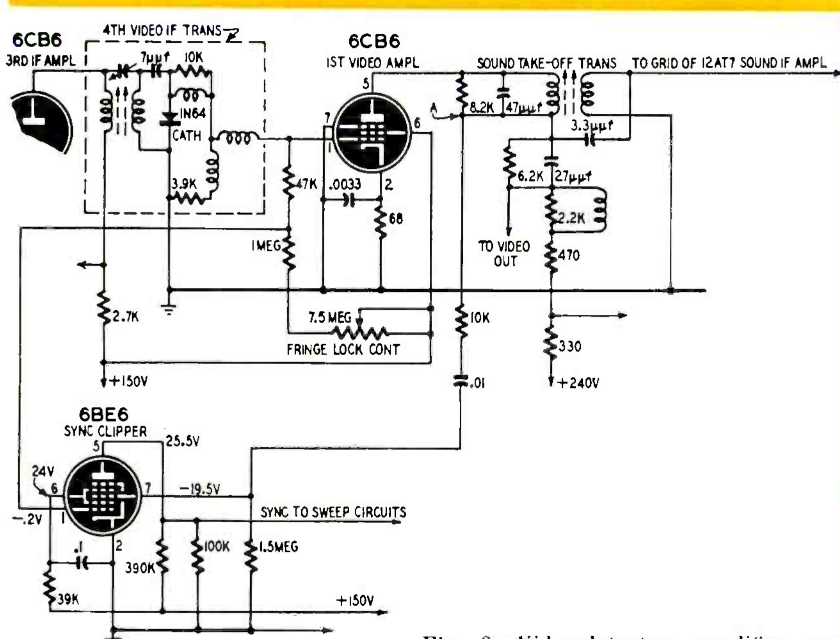
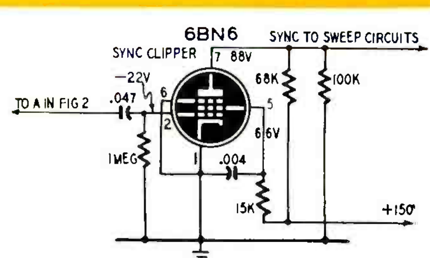


Fig. 2—Video-detector, amplifier, and sync-clipper stages of the Zenith 20J21.



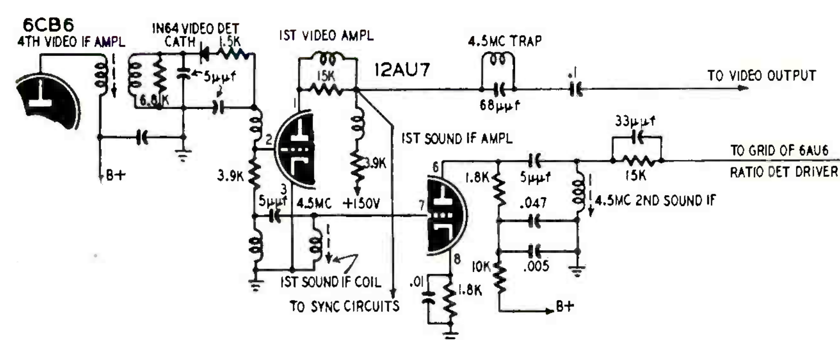


Fig. 3 (above)—6BN6 sync-clipper circuit used in Zenith model 20H20.
Fig. 4 (right)—Stromberg-Carlson twin-triode video and sound-i.f. amplifiers.

THE average TV service technician has had sufficient experience with receiver circuitry and common tube types to be able to make a good guess as to the circuit function of each tube in the set simply from its type and its position in relation to transformers, traps, and other components on the chassis. Recently some TV designers have omitted a few of the usual tube types or have substituted types which are foreign to the usual circuitry. One manufacturer has abandoned the usual diode video detector in some of his models, another has taken a 6BE6 from the usual All-American-5 broadcast receiver line-up and has incorporated it in his new receivers as a sync clipper. We have selected these circuits for discussion, as well as a few other unusual ones which we feel will interest the technician, the engineer, and the home TV experimenter.

Magnavox series 105

No matter how hard you look, you'll never find the usual vacuum-tube or germanium-diode video detector in the Magnavox CT341-D and similar sets of the 105 series. Instead, the designers have used a 6AU6 sharp-cutoff pentode in a novel circuit which enables it to perform as the video detector and the first sound-i.f. amplifier. The circuit shown in Fig. 1 is a modified grid-leak detector. The control grid corresponds to the plate of the conventional video-detector diode. Rectified grid currents flow through the 5,600-ohm resistor. The video-modulated d.c. voltage appearing across this resistor is fed directly to the grid of the 6CB6 video amplifier where it is amplified and fed through a 0.1-μf coupling capacitor to the cathode of the picture tube.

The parallel-tuned 4.5-mc trap is in series with the detector and the video amplifier grid, where it effectively prevents any 4.5-mc beat from entering the

circuits

video amplifier and appearing in the picture.

The rectified output of the grid-cathode section of the 6AU6 also contains the sound-modulated 4.5-mc beat. Since the 4.5-mc trap is in series with the grid and its 5,600-ohm grid resistor, its high impedance accentuates the 4.5-mc sound i.f. signal appearing at the grid. This voltage is amplified as in any i.f. stage and appears in the plate circuit of the 6AU6. A double-tuned 4.5-mc transformer is used in the plate circuit of the 6AU6 video detector and first sound i.f. amplifier to discriminate against any video signal in the plate circuit and prevent it from appearing in the second sound i.f. amplifier. In this operation, the circuit may be considered as a sound i.f. amplifier direct-coupled to the output of the video detector. The amplified signal is applied to the grid of a 6AU6 second sound i.f. amplifier.

This stage operates as a limiter and drives a discriminator detector.

Zenith sync clippers

According to the data in tube manuals, the 6BE6 is a pentagrid converter designed "to perform simultaneously the combined functions of the mixer and oscillator in superheterodyne circuits, especially those of the all-wave type." Similarly, the 6BN6 is described as a "miniature beam tube designed primarily to perform the combined functions of the limiter, discriminator, and audio-voltage amplifier in FM and intercarrier television receivers." In addition Dr. Robert Adler and other engineers of the Zenith research laboratories have developed circuits which use these tubes as sync separators and clippers. The sync separation circuits—called Fringelock—are used to insure positive sync stability over a wide range of noise and signal levels present in different TV receiving areas.

The Fringelock circuit of the Zenith 20J21 and similar models uses a 6BE6 in the circuit shown in Fig. 2.

The video detector develops a negative-going composite video signal of about 2 volts peak. This signal is applied simultaneously to the control grid of the 6CB6 first video amplifier and to the oscillator grid (grid 1) of the 6BE6 sync clipper. The signal applied to the video amplifier is amplified to about 40 volts peak and appears with positive polarity in the plate circuit of the 6CB6. This signal is tapped off at point *A* and applied to the control grid (grid 3) of the 6BE6 through a 10,000-ohm resistor and .01-μf coupling capacitor.

The time constant of this combination and the 1.5-megohm grid leak is such that the grid is biased negatively to about 20 volts. Since the major portion of the video information is below this level, the plate current controlled by grid 3 flows only during the time that the sync pulses are strong enough to overcome the developed operating bias. The tube is operated with low plate voltage so the sync tips drive the plate to saturation and the tips are compressed or clipped in the plate circuit. Weak noise pulses on grid 3 are below the plate-cutoff point so they are not passed on to the oscillators. Strong noise pulses are clipped in amplitude just as the normal sync pulses.

With grid 3 alone controlling the plate current, strong noise pulses may ride through and trigger the oscillators. For this reason, the unamplified negative video from the detector is applied to grid 1 which is operated with a positive bias set with the variable FRINGELOCK CONTROL. When the normal 2-volt sync pulses are applied, grid 1 has no effect on the flow of plate current. However, if a noise pulse drives grid 1 beyond the 2-volt level, the plate current is instantly cut off. Thus the noise—although it appears on grid 3—cannot pass through to falsely trigger the sweep oscillators. During the brief period that the plate current is cut off, the flywheel action of the sweep tank circuits enables these oscillators to remain in sync.

The Fringelock in the 20H20 chassis uses the 6BN6 connected as in Fig. 3. The circuit of the video detector and first video amplifier are substantially the same as those in Fig. 2 so they are not shown. The 40-volt composite video signal is taken off the plate circuit of the video amplifier at point *A* (see Fig. 2) and applied to grid 1 of the 6BN6. The time constant of the 1-megohm grid resistor and the .047-μf coupling capacitor is such that the capacitor charges and biases the grid to the point where plate current is cut off during the period that video information is being transmitted. If the positive-going grid signal overrides the bias, the plate current rises sharply and reaches saturation when the grid is more than 3 volts positive. Operating bias is set automatically by the strength of the composite video signal, so only the middle portions of the sync pulses are passed. The bottoms are clipped because they are not sufficiently positive to overcome the cutoff bias and the tips are clipped by plate saturation.

One disadvantage of this 6BN6 circuit is that frequent high-amplitude noise pulses charge the coupling capacitor to such a high bias level that sync pulses are clipped to the point where sync output is drastically reduced or removed entirely for several horizontal periods. This results in a loss of sync or tearing and jitter.

Another disadvantage is that noise pulses are clipped top and bottom in exactly the same way as the sync pulses and they appear in the sync output where they may falsely trigger the sweep oscillators.

In the April, 1952, issue of *Electronics* magazine, Mr. Meyer Marks of Zenith's research staff describes a modification of the 6BN6 circuit in which the amplified composite video is applied to grid 3 and the unamplified detector output is applied to grid 1. This circuit then operates in much the same manner as the 6BE6 described previously.

Triode video and i.f. amplifiers

The 12AU7 twin-medium-mu triode is widely used in TV receivers in almost every type of circuit where medium-mu triodes are applicable. According to popular engineering conceptions, triodes are not suitable for use as i.f. amplifiers because of the need for neutralization. Within the last few years, a few receiver design engineers—who apparently didn't know better—have dared to defy engineering conventions and have installed triode sound i.f. amplifiers in their sets. They seem to have the necessary savvy to do the trick and get away with it without neutralization. We know that some of those i.f. strips radiate, but we know that oscillation would play havoc with the sound. As an example of what can be done with triode i.f. amplifiers, take a look at Fig. 4, which was taken from the schematic of the Stromberg-Carlson 321 series.

The first triode section of the 12AU7 is a direct-coupled video amplifier which is entirely conventional. The second triode is the first sound-i.f. amplifier operating at 4.5 mc. Under normal conditions, any triode would require neutralization to prevent feedback through the plate-to-grid capacitance whenever the plate and grid circuits are tuned to the same frequency. However, by operating this amplifier at low gain with a small plate load resistor it is quite possible to prevent oscillations through careful layout of components in the grid and plate circuits.

—end—

This shop likes midgets —and has a drive-in bank of lockers for sets left during non-business hours.

THERE'S MONEY IN MIDGETS

By H. L. MATSINGER

WHEN I was a young lad, a vaudeville troupe known as "Singer's Midgets" was highly successful from a monetary standpoint. "General" and Mrs. Tom Thumb enriched the coffers of P. T. Barnum. So too, if properly handled, the much-maligned midget radio can fatten your purse.

At the risk of being branded a heretic, I suggest that you establish and advertise that you will repair, cash and carry, any midget radio for the sum of \$3.50 or \$4.00. Don't be shy about this feature. Hang a sign in your window, put it in your local paper, even put out circulars proclaiming the fact, but get it out there in front of the people! We all know that there is nothing wrong with business today that a few customers wouldn't correct, so let's go out and get them.

A lot of technicians hate the very sight of a midget. They claim there are too many parts in too small a space, that they're too hard to work on, and bring up countless other objections. This is a negative attitude which should be corrected. The average midget set is one of the simplest electronic devices to service.

In the first place, the customer is not too critical of its quality. He is often satisfied if he can get his favorite stations without too many squeals—he will even tolerate a lot of hum before he gripes.

In the second place, the set is easy to service. Most consist of a combination oscillator and first detector, an i.f. stage, second detector and a.v.c., a stage of audio, and the necessary rectifier. This means about a dozen resistors, maybe six paper capacitors, a dual hi-mike electrolytic, two i.f. transformers, r.f. coil, an oscillator coil, an output transformer and speaker, and five tubes. Certainly not a formidable combination for a service technician of any ability.

To make any money you must achieve two things: volume and a change of pace. Most service technicians approach a radio chassis under test as though it were some new version of an electronic computer. News for you, boys! The same old time-tested theory still holds. With a little acumen one can spot the trouble in the first few moments of twiddling, often at the time the customer drops it on your counter. (In this connection, it is always a matter of good policy to plug in the set while the customer is present, get his version of the complaint, and find out the minimum for which he will settle.) You will often get a set which has a very bad rattle in the speaker in addition to some other complaint. Sometimes your client has become so accustomed to the rattle that he doesn't hear it, and is interested only in getting the set to play. Remember, you are working on a small margin—you can't afford to redesign the heap for \$3.50. If you have a counter tube checker, pull the chassis and check the tubes. Explain to the customer that while your price includes the replacement of those which are bad, it does not cover any which are merely weak or low in emission so long as they operate satisfactorily. Don't make a sermon of this. Don't waste too much time talking. Don't be abrupt, just be pleasant, and thank him.

If you find that your daily business in midgets increases as the direct result of an advertising campaign, keep at it, don't let it be a flash in the pan. Bear in mind that you have something to shout about, you are giving a guarantee that for \$3.50 or \$4.00 people may once more get pleasure out of a dead set. But they must be told, and constantly reminded of this fact in some manner. A 1-inch ad in your neighborhood weekly is usually better than the classified in the bigger daily.

As I hinted earlier, you must change your operating habits if you are to make money. Arrange to check several sets in succession, assuming that you have checked tubes at the time the set was brought in; quickly run through the voltages. If you have one of those signal squirters, touch it to each grid, starting with the audio. When you locate the faulty stage, and the trouble, lay the set aside with a written notation, and check the next. After you find the trouble in all sets on hand, then consider what you require to repair them. If only resistors and capacitors are needed you probably have them in stock. You can then make the repairs at once on all sets at the same time. When you follow this routine, you will be surprised at the amount of work you can do in a very short time. It is

Courtesy Harco Radio Service, Little Rock, Ark.

This station is devoted entirely to the cash-and-carry service of small receivers.

much better than approaching each set as an individual task.

Except for tubes, the most common causes for trouble are blown filters, line bypasses, and audio coupling capacitors. Next are open coils, oscillator or i.f. An oscillating i.f. can usually be cured by putting a larger resistor in the screen circuit.

Normally, it requires too much labor to align midgets with a standard type signal generator; you spend too much time in changing frequencies. An auxiliary generator similar to the one shown in the schematic will provide amply for the alignment frequencies required by midgets, with each one available at the twist of a knob or the push of a button.

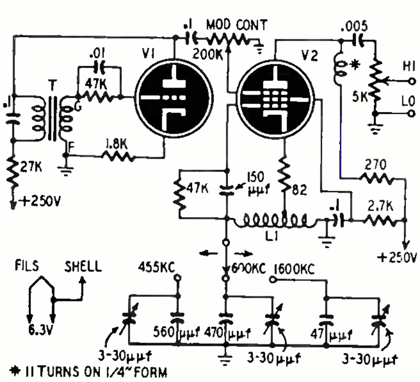
Almost any triode will do for V1, and a wide range of pentodes for V2. If you have a wide choice, try a 6J5 or 6C5 for V1, and a 6J7 for V2. Since midgets are not the most sensitive of sets, that small audio amplifier, the 89, is well adapted for the job. It is an excellent oscillator and puts out plenty of power. The transformer T may be almost any audio type, though one of the old cheap 3–1 transformers is best. Put the primary in the plate circuit. The coil L1 is an oscillator coil used in the cathode circuits of superhets (6SA7 or 6BE6 hookup). The switch may be either a rotary or push-button type.

In this type of work, an output meter is generally impractical. That extra minute or two that you lose hooking it on is not repaid in increased performance.

Don't get me wrong! I'm not suggesting that you turn out sloppy work. I am merely trying to impress upon you the fact that **you can't afford to spend more than an average of thirty minutes on any one set.** Some may take a little longer, some may take a little less, but if the total **average time** is more than a half hour from start to finish, you should better do a little analysis! In the depression days of 1932, I tested and aligned some little things at the rate of thirty-five an hour, and that included a police band, so my experience with midgets is not entirely theoretical.

The shop illustrated in the photographs, I am told, advertises that it makes "most repairs" for a small fixed labor fee plus the price of parts. Large jobs are not welcomed, and the business is strictly cash-and-carry. Sets are accepted 24 hours a day. If the proprietor is not around, the customer puts his set into a locker, closes and padlocks it, and calls later for a report on the repair.

There are millions of these little sets in the country, and about half of them need repairs. Most folks are afraid to call a technician because they hesitate to pay eight to ten dollars for a set that cost fifteen or twenty originally. If you offer repairs at a reasonably low figure, and can establish yourself as a man who does a good job, you are getting a foothold in a virtually unlimited field. You need no expensive test instruments, no vast stock, no delivery truck. Your low price is cash and carry. Naturally, in a few cases, you will lose money, but in the aggregate you will prosper.



Switch-tuned alignment signal generator.

Materials for Signal Generator

Resistors: 1—27, 1—1,800, 1—2,700, 1—27,000, 2—47,000 ohms, 1/2 watt; 1—5,000-ohm, 1—200,000-ohm potentiometers.

Capacitors: (Paper) 1—.005, 1—.01, 2—0.1 μf. (Mica) 1—47, 1—150, 1—470, 1—560 μμf. (Variable trimmer) 3—3-30 μμf.

Miscellaneous: 1 audio transformer (see text); 1 tuning coil (see text); 1 radio-frequency choke (11 turns No. 30 or smaller wire on 1/4-inch form); wire, hardware, minor essentials.

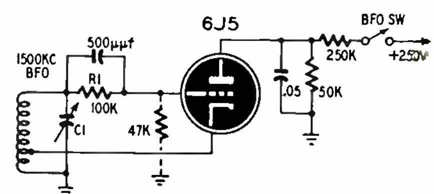
—end—

RARE TROUBLE IN A B.F.O.

By GEO. RULFFS, JR.

A local novice ham brought his homemade superhet in to be checked and aligned. Among the several bugs which were isolated and cleaned up was one persistent cuss which affected the proper operation of the beat-frequency oscillator. Fig. 1 shows the circuit employed, an old reliable one in use for many years in superhets.

The trouble which developed was unusual. When voltage was applied to the b.f.o. no beat note was produced but the b.f.o. could be heard to "swish" by the intermediate frequency (1500 kc) as C1 was varied. However, in the background a weak and very high-pitched audio squeal was evident. The squeal could not be peaked nor the pitch varied by tuning either C1 or the ganged r.f., mixer and h.f.-oscillator tuning capacitors. Changing the setting of one trimmer in the i.f. transformers did attenuate the unwanted oscillation, and of course the gain. Further tests indicated no regeneration in the i.f. amplifier and that the value of the grid resistor R1 was correct.



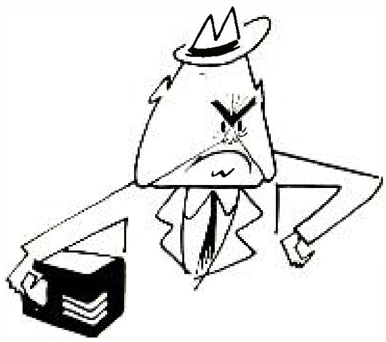
The difficulty was finally eliminated by connecting a 47,000-ohm resistor between the grid and ground. This solution was suggested when it was observed that by momentarily shorting either the grid or cathode to ground, the condition would correct itself for a few seconds duration, resulting in normal b.f.o. behavior.

Apparently the grid resistor specified had too much resistance to drain off the charge on the grid and produced parasitic oscillations.

We put the additional grid resistor between grid and ground because the original resistor was inside the can and it was more convenient to compromise than to dig into the b.f.o. coil enclosure.

TV SERVICE KINK

Don't throw away those weak 5U4's, 5Y3's, and similar rectifier tubes which you remove from TV receivers. The next time you have a set with an intermittent B plus short in it, stick in one of these weak tubes and save the new replacement until after the short has been located and eliminated.—*Ralph E. Hahn*



THE PEST

By B. W. WELZ

ALL radio repairmen, jewelers, auto mechanics, and the like are crooks. Everybody knows they take the parts out of what you bring in for repairs and put in old stuff; that they're out to get all they can from you and don't care what cheap tricks they use to do it.

That's why I insisted on *watching* the repairs on my 5-tube table model set when I brought it to the service shop. I kept a careful eye on the repairman while he made some tests and when he picked up a pair of snippers and started to cut something out of my radio, I let him know I was watching.

"What are you doing?" I asked.

"Move over a little," he said, and prodded me with his elbow. I suppose I was crowding him. I moved, but kept my eyes on my radio.

"The trouble is an open resistor," he said, holding up a small, colorful object. He looked through some boxes and found another jigger that looked something like it, and soldered it into my radio. When he turned the set on it worked all right.

Then right away he tried to sell me something else.

"The speaker's warped," he said. "You'll need a new one."

"It sounds all right if I keep the volume down," I said, feeling firmly that I wouldn't buy anything I didn't want.

"If I put in a new speaker now," he said, "it will cost you less because the time will be charged to the same hour with putting in the resistor."

"The speaker's good enough for me," I said with finality.

He was still probing around inside the set, and suddenly he found something else. "Oh, oh," he said, "the isolating condenser is shorted."

This man was deliberately trying to raise my bill. "The set sounds perfectly all right," I said.

"The isolating condenser," he explained, "isolates the 110-volt line from the chassis. If it's shorted you might get a bad shock or even electrocute yourself."

There seemed to be no stopping this fellow. He'd go to any lengths to make a sale, even to the extent of frightening people. I said coldly, trying to make myself perfectly clear, "Since my set works nicely as it is, I hardly think it necessary to buy anything else for it."

"Where do you keep this radio?" he asked.

I always kept it on a window shelf over a radiator. "I don't see why that should be important," I replied.

"Well," he told me, "this radio's got fancy metal designs on the front of the cabinet that touch the chassis. If you get between them and a grounded object you could get a fatal shock."

"I don't intend to buy a new condenser," I repeated, solid in my stand against having anything I didn't want forced on me. "The radio is O.K. as it is."

He sighed. I think he was getting the

idea I wasn't a yokel he could hoodwink. When he turned the set over it made a little static noise I had been noticing lately. He picked up a pencil and tapped the tubes with the eraser.

"Be careful," I warned.

Suddenly the radio went dead as he tapped one of the tubes.

Naturally that made me sore. "Now what did you do?" I demanded heatedly.

"The tube was shorting intermittently," he told me. "Tapping made the short permanent. You need a new tube."

"I never needed one before you hit it," I said.

He put his pencil down on the bench. I backed away from him because he seemed angry, but his voice was quite calm as he said, "You brought your radio here for repairs and I'm trying to repair it the best way I know. It has a bad tube. A radio in that condition never leaves this shop without a new tube or without the customer knowing about it. Otherwise it will come back and reflect on my workmanship, and to stay in business I have to do good work. You can buy your tube somewhere else. I'm interested in your knowing that the work you buy from me is complete."

His remarks didn't have the slightest effect on me. Like I told you, I've heard a hundred times how these fellows operate. "Put in a new tube," I said, "and let that finish the job. I definitely don't want anything else."

He looked angry again as he put the radio back in the cabinet. I don't think he was used to getting caught ruining tubes. One thing I was sure of: he was going to hear more about this from me. I planned to get action through the Better Business Bureau!

We went out to the front of the shop and he put my radio on the counter and wrote up my bill. Forty cents for the resistor—that was all right; two dollars and twenty-five cents for the tube—that was all right; but when he put down two dollars and fifty cents for labor, I blew my top.

"You're making a profit from the resistor and tube," I said. "What more do you want?"

"People like you ought to know," he said, pointing an angry finger at me, "that repairmen like me are in business to sell time. A shoemaker makes a profit on his leather when he repairs your shoes, doesn't he? But he charges you more for his time. So does a carpenter. Their time is their most valuable asset, just like my time is to me."

"Radio repairmen are all crooks," I retorted. "They get you one way or another. I've heard how they take hard-to-get parts out of radios and put cheap parts in their places. I've heard how they're liable to 'fix' a radio so it has to come back to the shop and they can make more money on it. And I've heard how they charge for parts they don't replace, and . . . "

He looked so mad that I thought he was going to jump over the counter at me so I backed a safe distance away. Then he opened up as if *I* was at fault:

"Once in a while I get a customer like you. You're in a very small minority, thank God! When are people like you going to learn that businessmen like me have to satisfy their customers to remain in business?" he said, getting control of himself. "If I can't satisfy them, the shop around the corner will. It doesn't take a customer long to learn when he's being robbed, and when he finds out he spreads the word around and the shop that's robbing him soon finds itself with bankruptcy papers. I've been in business for ten years. I wouldn't have lasted ten days if I were dishonest . . . "

A woman walked into the store, interrupting him. She wanted a radio she had brought in for repair.

"I'll get it from the back room," the repairman told her. To me he said, "I'll be back in a minute and we'll settle this."

While he was in the back of the store, I picked up my radio and hurried out without paying. He hadn't convinced me with all his talking. Radio repairmen and others in business like that are just plain dishonest.

—end—

Greater realism through correct dual-speaker phasing—A direct approach to

LOUDSPEAKER CROSSOVER DESIGN

By NORMAN H. CROWHURST

SOME points about the functioning of loudspeaker crossover networks should be clarified. Most classical treatments derive crossover networks from wave filter theory, which in turn is derived from the theory of artificial lines. The resulting designs may not satisfy all the requirements of a crossover network in the best possible way.

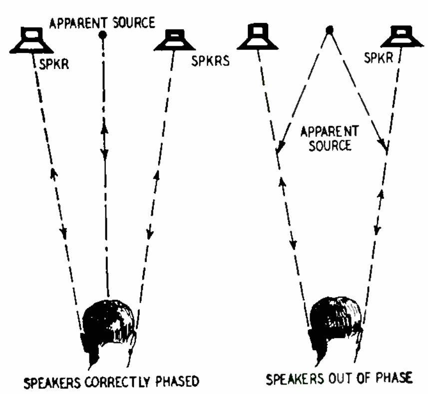


Fig. 1—The apparent source of sound shifts when speakers are not in phase.

The first and most obvious requirement of a crossover network is to deliver low-frequency energy to one speaker and high-frequency energy to another. This is usually taken care of reasonably well, using a roll-off slope to suit the designer's whim.

A second factor (and one that often receives less attention) is the impedance presented to the amplifier by the combined network. Frequently this varies widely over the audio range and includes sizeable reactive components in the vicinity of the crossover frequency. To obtain best performance from the amplifier, a constant, resistive impedance should be presented to it as a load.

The third requirement often receives even less attention. This is the *realism* of the acoustic output from the combination. While this is in some respects a matter of individual conditioning and preference, it depends fundamentally on certain electro-acoustic requirements. One of the most important, and frequently the one least considered, is the phasing, or apparent source of the sound output.

Tests have shown that phase distortion with single speakers is not normally detectable, but when *two* sources are employed, the phase relations between them influence the character of the radiated sound field. The frequency response as registered by a good pressure microphone may be flat, but what about the wave-shapes? The pressure microphone does not answer that, but a pair of human ears can detect such phase peculiarities, and failure to consider this factor has made many dual-unit combinations sound noticeably unreal, even though their frequency response may look perfect, and there may be no measurable distortion.

Source of the sound

The reader may have checked two speakers for phasing by listening to them while connections to one of them are reversed. Standing some distance in front of them, on the center line (as in Fig. 1), when they are correctly phased the sound seems to come from a point midway between the two units; but when incorrectly phased, two effects can be noticed: There is a deficiency of low frequencies (due to cancellation effects) and the source of sound at higher frequencies no longer seems to be associated with the units actually radiating it. This is because the air-particle movement caused by the radiated sound is no longer back and forth along a line from the common source, but approximately at right angles to it. The sound field around the listener's head is perpendicular to what it should be, causing, through our binaural perception, the confused impression which may be called "dissociation effect."

A similar dissociation effect will occur with dual units driven by a crossover system, at any frequency where the two speakers are out of phase. It is best to keep the two units close together. Some favor putting the smaller unit on the axis of the larger one and immediately in front of it. But, however the units are arranged, the dissociation effect can become noticeable if there is an out-of-phase condition at some frequency near the crossover point. The

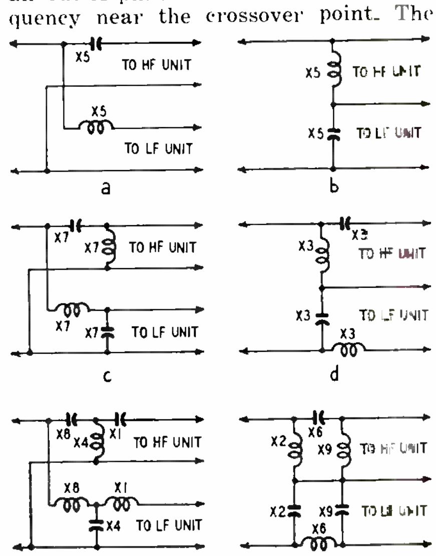


Fig. 2—Examples of crossover networks for two-way loudspeaker systems.

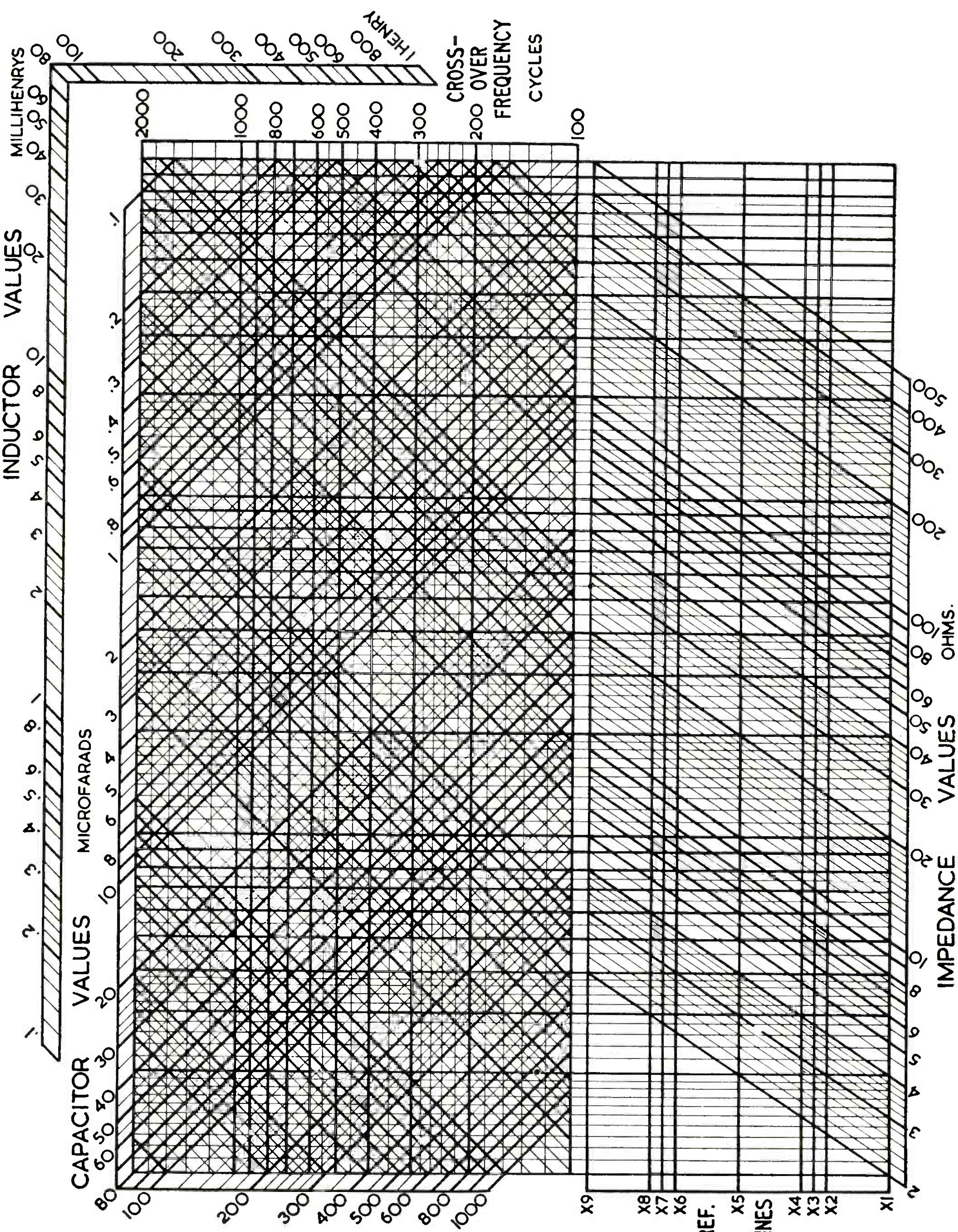


Chart for finding exact values of inductance and capacitance for any of the networks shown in Fig. 2. Use of the chart for a typical solution (Fig. 2-e) is illustrated in Fig. 3 on the opposite page.

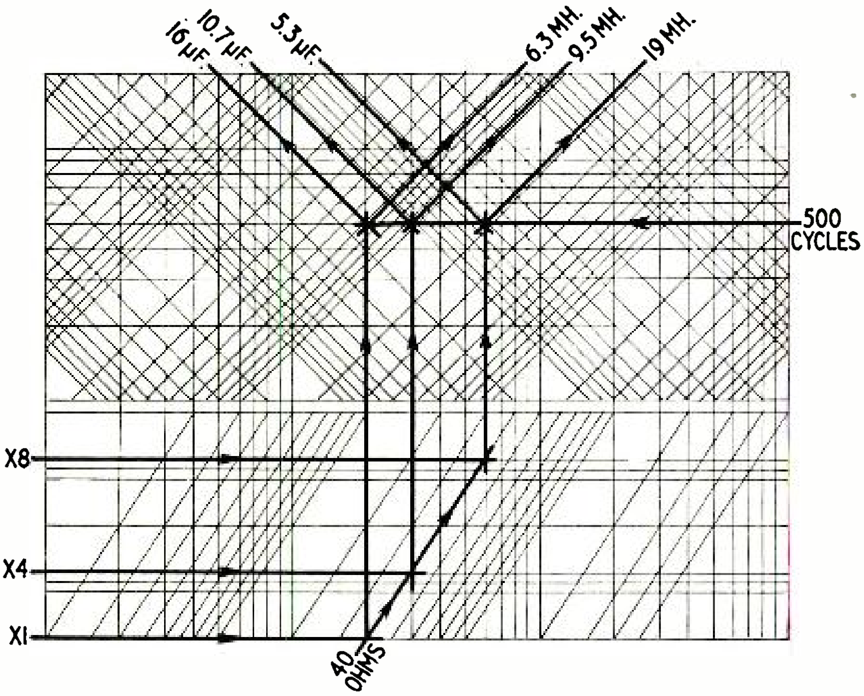


Fig. 3—How the chart on the opposite page is used to find inductance and capacitance values for Fig. 2-e. Each speaker has a 40-ohm voice-coil impedanc

relative phase at crossover can be adjusted by positioning the diaphragms on their common axis so the wave from the low-frequency unit emerges in phase with that from the high-frequency one. When the units are mounted side by side on the same baffle, the sound should emerge in phase at the baffle surface.

Constant-resistance networks

But how does the crossover network affect the relative phase at frequencies near crossover? This question often seems to be overlooked, and neglecting it can cause the trouble just described. Some networks, of the kind employing two or more reactances for each unit, have values adjusted to give an accentuated frequency rolloff. For example, the networks shown at Fig. 2, *c* and *d*, using values given by the chart in this article, are of the constant-resistance type, giving a rolloff of 12 db per octave; the phase difference between the outputs is always 180 degrees; but using values designed for a sharper rolloff, the phase difference is not the same. At frequencies near crossover, phase difference changes rapidly. Some out-of-phase effect in the vicinity of the crossover frequency is unavoidable unless a constant-resistance type network is used. It is fortunate that this type takes care of both the second and third requirements mentioned above.

The chart may be used to design any of the six types of crossover network illustrated in Fig. 2. Those at *a* and *b* give a rolloff of 6 db per octave and a constant phase difference of 90 degrees. For best results the positions of the two diaphragms should be adjusted so the difference in their distances from the face of the baffle is about one-quarter wavelength at the crossover frequency. The phase difference will not be serious within the range where appreciable energy is coming from both units.

The networks at *c* and *d* give a rolloff of 12 db per octave, and a constant phase difference of 180 degrees, which means that reversing connections to one unit will bring the phase right. The units should be mounted so their diaphragms are in the same plane.

For cases where the frequency response of the units used requires a rolloff steeper than 12 db per octave, the networks shown at *e* or *f* are recommended. These give a rolloff of 18 db per octave, and a constant phase difference of 270 degrees. This means that mounting the diaphragms a quarter-wavelength apart at the crossover frequency will give in-phase outputs by appropriate connection.

All these networks are designed to present a constant, resistive impedance to the amplifier over the entire frequency range.

The impedance varies

One more point is often overlooked: The networks are designed on the theory that they are feeding resistance loads of the same value as the nominal voice-coil impedance. The voice-coil impedance is *not* pure resistance, so the performance of the networks is altered. The most serious effect is usually due to the inductance of the low-frequency unit voice coil. By using networks *a*, *d*, or *e*, each of which feeds the low-frequency unit through a series inductance, this effect can be overcome by subtracting the voice-coil inductance value from the network inductance value derived from the chart. Even if the available data is insufficient to allow this, these networks will minimize the effect, because the inductance of the voice coil will add very little to the effective inductance of the network. In the other networks the shunt capacitor combined with the voice coil inductance will cause a greater variation in input impedance.

Each diagram in Fig. 2 has the inductors and capacitors marked with symbols. These identify the reference line (in the bottom part of the design chart) to be used for finding each component's value. Fig. 3 illustrates the use of the chart to find values for a network of the type of Fig. 2-*e*, and Fig. 4 shows the actual circuit calculated in this way for a crossover frequency of 500 cycles, at 40 ohms impedance.

The input impedance is the same as each speaker voice-coil impedance. Some prefer to design the crossover network for 500-ohms impedance and use matching transformers at the outputs to feed the individual voice coils. This method has two advantages: The two units need not have the same voice-coil impedance; and smaller capacitors can be used. The range of impedances covered by the chart extends up to 500 ohms to include such designs.

One modern trend has been to use separate amplifier channels for each unit. In this case the chart can be used for designing an interstage filter to separate the channels, by making the following adjustments: multiply all impedance values by 1,000 (this means the

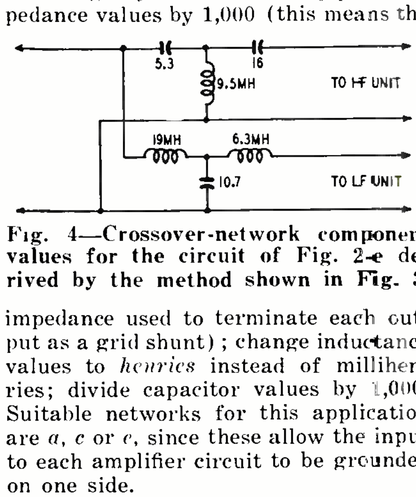


Fig. 4—Crossover-network component values for the circuit of Fig. 2-e derived by the method shown in Fig. 3.

impedance used to terminate each output as a grid shunt); change inductance values to *henries* instead of millihenries; divide capacitor values by 1,000. Suitable networks for this application are *a*, *c* or *e*, since these allow the input to each amplifier circuit to be grounded on one side.

The characteristics of the final output from any type of network and combination of speakers can only be predicted accurately if the source (amplifier) impedance is known. This can be measured with simple equipment by the methods described in the article "Audio Impedance Measurements," by James A. Mitchell, in the April, 1952, issue of RADIO-ELECTRONICS.

The amplifier impedance should be as low as possible, and practically constant over the entire frequency range to be reproduced. With present-day components, this can be achieved only by using multiple low-impedance output triodes, or by carefully-designed inverse feedback circuits. The series of articles "Audio Feedback Design," by George Fletcher Cooper (RADIO-ELECTRONICS, October, 1950—November, 1951), covers many applications of feedback to amplifier circuits.

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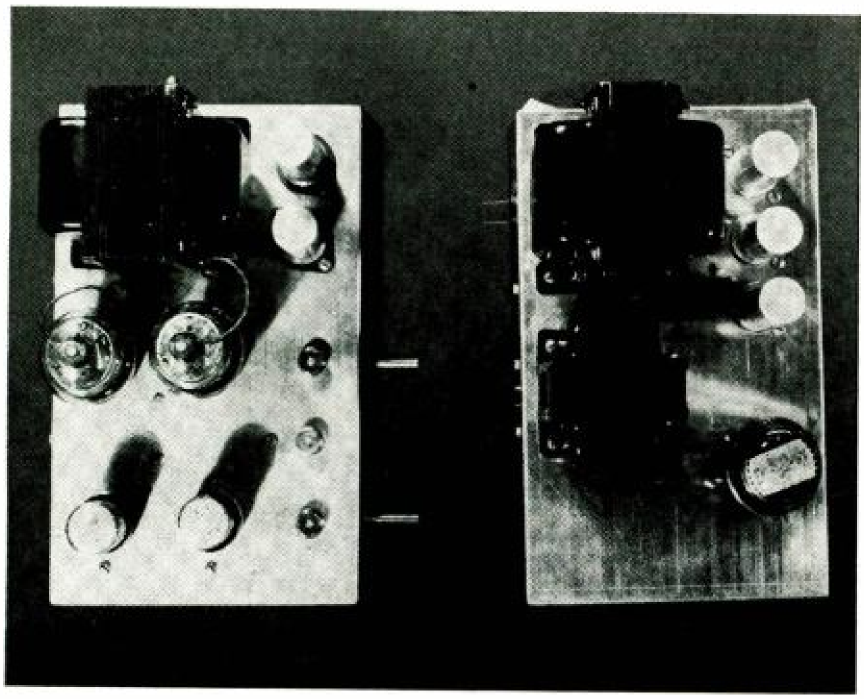


Separate amplifier and power-supply chassis reduce hum, allow uncrowded layouts.

Easily-built American versions of the Williamson circuits give superb results at comparatively low cost

PRACTICAL WILLIAMSON AMPLIFIER

By FRANCIS A. GICCA

FOR many years the high-fidelity fan has been looking for the "perfect" amplifier circuit, one that would be flat throughout the audio range, practically distortionless, with adequate power output, and relatively inexpensive. Many circuits have been devised and many have come close to the ideal, but each has left something to be desired. The most popular circuit of recent years is the Williamson amplifier.

Although the original specifications called for the use of a British-made output transformer (Partridge) and British tube types (KT-66), several American versions have appeared. Complete Williamson amplifier kits, including punched chassis, are now available from several American manufacturers, including Heathkit, Stancor, and UTC. Other American companies, such as Acrosound, ADC, Peerless, and Triad, are producing special Williamson output transformers. Many distributors are also supplying complete or foundation kits. This amplifier used Stancor transformers and follows that company's version of the Williamson circuit. (See Figs. 1 and 2.)

Construction

The power supply is built on a separate chassis to keep a.c. transformer fields away from the amplifier. Power is brought to the amplifier through a 4-wire cable.

Stancor suggests using two 9 x 7 x 2-inch chassis for the amplifier and power supply. However, this was found to be too small for the layout and wiring desired. We found an 11 x 7 x 2-inch aluminum chassis adequate.

The power supply itself is conventional and should cause no trouble. The core of the choke should be perpendicular to the core of the power transformer to reduce the effects of stray magnetic fields.

The layout of the amplifier is not critical, because of the isolated power supply. Be sure the 807's have enough ventilation. The layout used gave no trouble; it is suggested for ease of wiring.

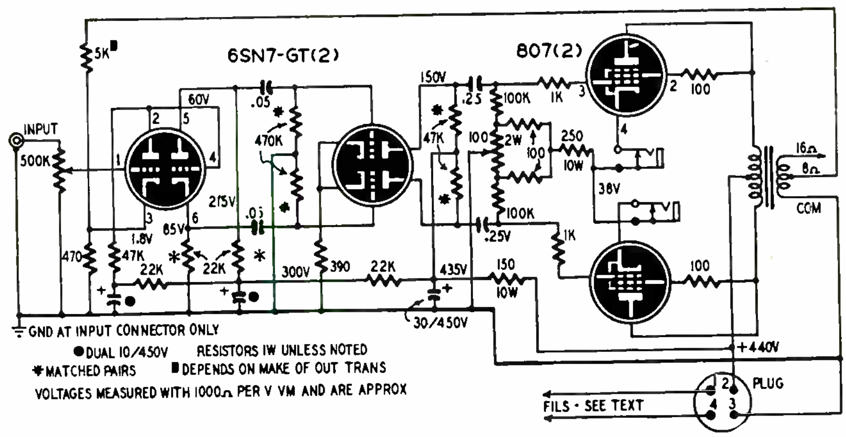
The heater circuits should be wired first with twisted pair. These leads should run first to the 807's and then to the 6SN7's. To prevent ground loops all ground returns should be connected to a floating bus and the bus grounded to the chassis only at the input connector. Be sure to use insulated mountings for metal-shell decoupling capacitors and connect their negative terminals to the ground bus. Use insulated mountings also for the jacks in the cathode circuits of the 807's.

All resistors should have a tolerance of 10% or better. It is very important that the starred resistors be matched pairs. If unbalance occurs in the direct-coupled stage it might bias the tube almost to cut-off. Unbalance in the phase-inverter circuit will cause unequal drive to the 807's. To get matched pairs take an ohmmeter to your parts distributor and measure resistors until you find two that give the same reading within 10% of the required value. Most distributors will let you do this. It is unnecessary to use a Wheatstone bridge to get two perfectly matched resistors; the ohmmeter will suffice.

A few precautions must be taken to prevent attenuation of the high audio frequencies. Do not use any shielded wire; mount all parts as far above the chassis as possible; keep all leads short; avoid cabling wires together; keep your wiring compact. It is amazing how much difference these small details can make. In this amplifier raising parts above the chassis extended the response 3 kc at the high-frequency end.

Tests and adjustments

Having completed the amplifier we started making the usual voltage checks. Suddenly we noticed one 807 glowing bright red just as the fuse blew out. We checked the setting of the potentiometer which balances the plate currents of the 807's. It was set at one



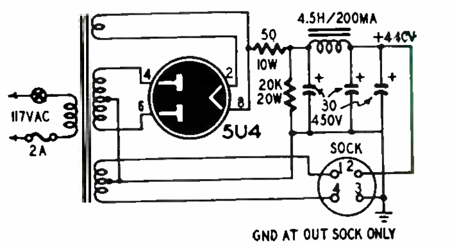
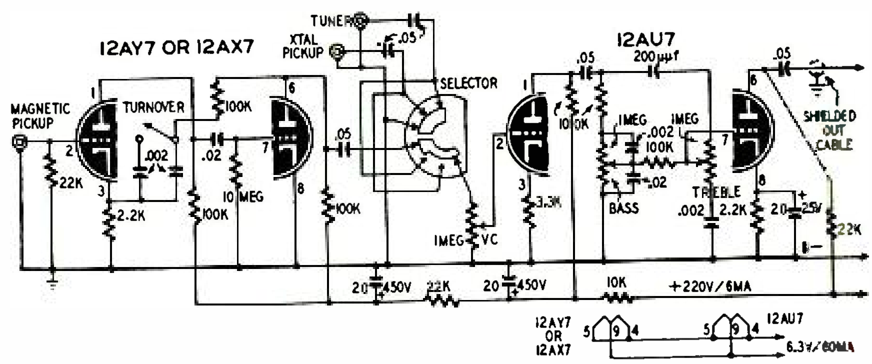


Fig. 1 (above)—The Stancor version of the Williamson amplifier circuit. Principal differences are the use of 807's instead of British KT66's, and R-C power-supply filtering in the first two stages. Fig. 2 (upper right)—The Stancor power supply schematic. Fig. 3 (right)—Schematic of the Heathkit model WA-P1 preamplifier-equalizer kit. The turnover switch compensates for the different frequency characteristics used in 78-r.p.m. and LP recordings. Bass and treble controls give flat response in midpositions, 15 db boost or cut at opposite ends. 12AY7 is a low-microphonic type.



end, so we reset it near the middle of its range and replaced the fuse. Again the 807 began to glow and the balancing control had no effect at all. We then checked the plate current of each tube and found one drawing 146 ma and the other drawing 23 ma. By this time we were worried. Tearing apart the balancing network we found nothing visibly wrong, so we suspected a faulty potentiometer and replaced it. Still the 807 glowed. In disgust we put in two new tubes and started over. Now everything was fine. The circuit balanced and both 807's drew normal current. We felt slightly silly when we found that one 807 was gassy. So—if your circuit does not balance—*check the 807's first.*

To balance the circuit plug a milliammeter into each of the jacks in turn and adjust the balancing potentiometer until both readings are equal at approximately 100 ma.

If the amplifier squeals, reverse the plate leads to the output transformer. This should correct the fault.

The response of the amplifier was checked with a Hewlett-Packard audio oscillator, an RCA audio voltmeter, and a Hewlett-Packard distortion analyzer. The frequency response is superior to broadcast standards and is truly high-fidelity. The unit has been in constant use for over four months and has not developed any trouble. It is currently being used as a standard for free-field acoustical measurements. The unit is free from any inherent circuit noise or microphonics and is very stable. It is well worth the time and trouble put into its construction.

(A preamplifier and equalizer should be used with this amplifier to obtain full output and optimum performance when using low-output pickups such as the variable reluctance and some magnetic types. A number of preamplifier-equalizer circuits have been developed by manufacturers and distributors of high-fidelity amplifiers. Some of these include loudness controls and rather elaborate preset equalizer circuits for almost every type of recording characteristic. Others are simpler but equally effective for most applications.

Typical of the simpler circuits is the Heathkit WA-P1 preamplifier-equalizer shown in Fig. 3. A switch selects either of two low-gain inputs for crystal pick-up or tuner, or the high-gain channel for magnetic pick-ups. A two-position turnover switch in the latter channel has positions for 78-r.p.m. and LP recordings. Separate bass and treble controls provide up to 15 db boost or cut at 20 and 20,000 cycles, respectively. Signal voltage input required to develop 1.2 volts output—the approximate value required to drive the amplifier to full output—is 0.2 volt into the low-gain channels and .004 volt for the high-gain input circuit.—*Editor*)

Materials for Williamson amplifier

Resistors: 2—470,000 ohms, (matched), 2—100,000 ohms, 1—47,000 ohms, 2—22,000 ohms, 2—22,000 ohms (matched), 1—5,000 ohms, 2—1,000 ohms, 1—470 ohms, 1—390 ohms, 4—100 ohms, 1 watt, 10%; 2—47,000 ohms (matched), 2 watt, 10%; 1—250 ohms, 1—150 ohms, 1—50 ohms, 10 watt, wire-wound; 1—20,000 ohms, 20 watt, wire-wound; 1—500,000-ohm potentiometer, audio taper; 1—100-ohm potentiometer, 2 watts.
Capacitors: (Paper) 2—0.25 μf, 2—0.05 μf, 600 volts. (Electrolytic) 3—30 μf, 475 volts; 1—30 μf, 2—10 μf, 450 volts.
Transformers: 1 Williamson output transformer (Stancor No. A-8054 or equivalent); 1 power transformer: (Stancor PC-8412 or equivalent); 1 filter choke (Stancor C-1411 or equivalent).
Miscellaneous: Tubes: 2—6SN7-GT; 2—807; 1—5U4-G. 2 chassis, 11 x 7 x 2 inches; 3 octal sockets; 2—5-prong sockets; 2—4-prong sockets; 2—4-prong plugs; 1—input connector; 2 circuit-opening jacks; 2 insulated plate-cap connectors; 1 output terminal strip; 1 fuse holder; 1—2-amp fuse; 1 s.p.s.t. toggle switch; 1 line cord and plug; wire, solder, terminals, hardware.

Materials for Preamplifier

Resistors: 1—10 megohm; 6—100,000 ohms; 3—22,000 ohms; 1—3,300 ohms; 2—2,200 ohms, ½ watt; 1—10,000 ohms, 1 watt. 3—1-megohm potentiometers.
Capacitors: (Paper) 4—.002 μf; 2—.02 μf; 5—.05 μf, 600 volts; (Mica or ceramic) 1—200 μμf; (Electrolytic) 2—20 μf, 350 volts; 1—20 μf, 25 volts.
Miscellaneous: 1—12AX7 or 12AY7 tube; 1—12AU7 tube; 2—9-pin miniature tube sockets; chassis, switches, hardware.

—end—

ELECTRONICS and MUSIC

Part XXV—Further interesting features of the Minshall electronic organ

By RICHARD H. DORF

Fig. 1—This Minshall spinet Model H is identical to 2-manual models except for pedals and fewer stops. Designed for the home and the small church and radio station, it has built-in power amplifier and speaker.

THE tone-generator system of the Minshall electronic organ, described in last month's article, is common to all models of the instrument. Model H, shown in Fig. 1, is a single-manual spinet organ with a standard 5-octave manual and a 12-note toe-pedal complement. With built-in power amplifier and speaker, it is probably the lowest-priced electronic organ available today and is suitable for the home or the small church or radio station.

Minshall power supply

Fig. 2 shows a schematic diagram of the power supply used in all Minshall models for the tone generators and electronic tone filters. It is standard except that it includes a vibrato oscillator. The vibrato system employs a 6SN7 connected as a Wien-bridge oscillator with a frequency of about 6 cycles. The oscillator is supplied from a regulated 300-volt source. The 5,000-ohm potentiometer in the plate circuit of the right-hand triode supplies plate voltage for the 12 master oscillators of the generator system. The tap for the master oscillators is bypassed for oscillator frequencies by the 1-μf capacitor. However, the voltage drop due to the plate current of the 6SN7 varies at the vibrato frequency, which is too low to be effectively bypassed. Thus, the voltage fed to the master oscillator plates is amplitude-modulated at a 6-cycle rate.

The master oscillators are unaffected by normal slow changes in supply voltage. However, the relatively rapid 6-cycle change varies the oscillator frequencies slightly and produces vibrato. The vibrato is turned off at the tablet board by shorting the grid of the right-hand 6SN7 triode to ground. This grid lead goes to the tablet board socket in Fig. 2.

The power output plug furnishes power for the dividers and the amplifier: 300 volts regulated for the oscillators; 300 volts unregulated for the dividers; 390 volts unregulated for the amplifier; and 6.3 volts for all heaters. The tablet board socket connects supply voltages and control lines to the tablet board, which holds the electronic tone filters and the controls.

Fig. 3 shows the compact electronic assembly of the model H spinet. This is a top view with the cover raised. A chassis frame running almost the width of the instrument carries the power supply on the left, the 12 tone-generator chassis in the center, and the amplifier on the right. Each of the tone-generator chassis is held in place by the two plugs at the ends, so that it can be removed for service or replacement merely by pulling upward. The plugs are tight enough to hold the strips firmly in place under normal shock or vibration with the lower protective cover removed.

Fig. 4 is a rear view of the console. The main chassis is protected from casually exploring fingers by a wire screen. A 12-inch speaker is mounted at the lower left of the front board, and the expression pedal is linked to a special attenuator assembly which will be described in next month's concluding installment on the Minshall electronic organ.

The keying system

The keying system of the Minshall is simple but not so simple as to throw away the desirable features of a good organ. It eliminates objectionable clicks, uses standard leaf-switch contacts, and provides three separate registers—4-, 8-, and 16-foot for the GREAT; 4- and 8-foot plus a "quint" for the SWELL; and a single pedal bus which gives the effect of an extra lower octave.

The keying for a single generator output is diagrammed in Fig. 5. The output from the plate of each divider tube is fed through 10-megohm, 2.7-megohm, and 1-megohm resistors to the output bus. The key switch connected between the 10-megohm and 2.7-megohm resistors and ground is normally closed, grounding the divider's output. When the key is pressed, the switch opens and the tone goes to the output bus. The capacitor and the first two resistors form a simple low-pass filter. The capacitor value is selected so that the fundamental and most of the harmonic content of each octave are unimpaired, but the "click band" (which is higher than the highest note on the organ) is attenuated. Although this system does not remove all clicks, their level is so low that even this critical listener was unable to find them objectionable.

The circuit for the entire GREAT manual is shown in Fig. 6 in explanatory form. Across the top of the diagram the octave designations indicate the five octave keys on the manual. The small circles above the 10-megohm resistors in octave 3 indicate divider output tones and are marked with the note and octave actually generated; thus, "C_2" means the second C generated or 130.8 cycles (see the note-frequency chart in the August, 1950, issue of RADIO-ELECTRONICS).

Each key operates three switches simultaneously. For example, when D in octave 3 is played, the switch in the uppermost section ungrounds the output of D_2, which is one octave below the actual key pressed. This sends D_2 tone through the 10-megohm and 2.7-megohm resistors to a sub-bus to which all 12 notes of this octave connect. This sub-bus is connected through a 1-megohm resistor to the main 16-foot bus and through a .0022-μf key-click capacitor to ground. The same action also takes place in the center section with respect to the output of the D_3 generator, which goes through a similar path to the 8-foot bus; and in the bottom section for D_4, which goes to the 4-foot bus.

In this way, each key produces three different tones in three different buses, and each octave in each register is separately filtered for key clicks. Since there are only five octaves of tones generated in the organ (plus the usual extra C), the 8-foot register is the only one of the three connected throughout in this manner. The bottom octave of keys produces for the 16-foot register the same octave of tones as does the second octave of keys; and the top octave of keys produces for the 4-foot register the same octave of tones as the fourth octave of keys. These tied-together octaves do not require different click-filter values so their octave sub-buses are commoned, as shown in Fig. 6.

In 2-manual models the SWELL manual is connected in exactly the same way, except that instead of a 16-foot register it has a quint bus. This carries tones one octave and a fifth above the key pressed. The quint note for C_3, for instance, is G_4; for G_3 it is D_5, and so on. The quint is not available on the stop controls as a separate register but is used in the tone-color blends for simulating certain organ stops.

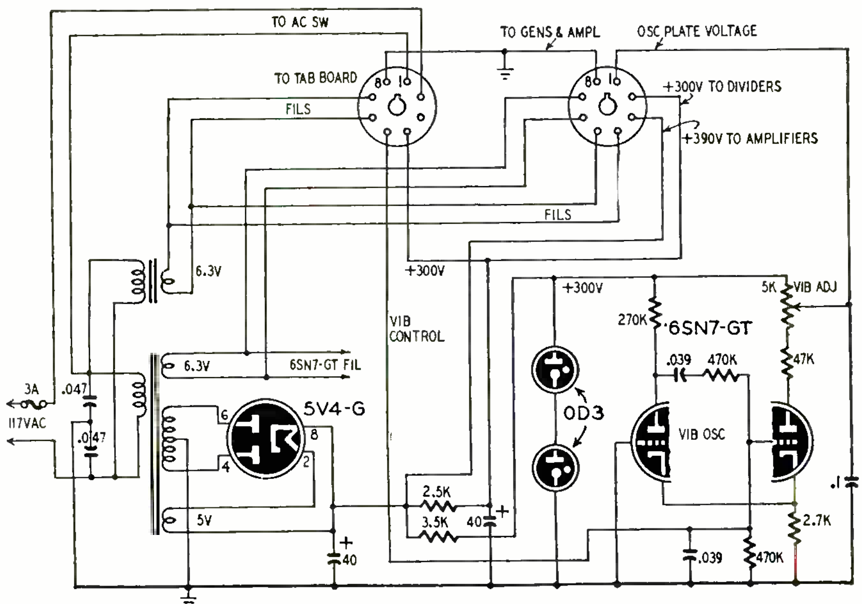


Fig. 2—The power-supply chassis furnishes regulated voltage to the tone oscillators, with vibrato if desired, and supplies all power for generator system and amplifier through bus wiring to plug-in receptacles under each unit chassis.

Obtaining low notes

The 25-note pedal clavier operates in the same basic manner but is wired somewhat differently for a good reason. The lowest note generated in the Minshall is equivalent to the 8-foot tone of the lowest organ pedal, but it is necessary to have a tone one octave below that, equivalent to a 16-foot, for a good bass foundation. This is obtained in the Minshall by mixing the fundamental and the tone a musical fifth above it.

Fig. 7 shows how this is done. The tone from divider C_1 is fed through the customary 10-megohm and 2.7-megohm resistors to the output bus. No click filters are needed in the pedal circuit, since there are only two octaves of tones and clicks are removed by the low-pass character of the pedal tone filter on the tablet board. Pressing the C_1 pedal ungrounds the generator output in the usual way.

In addition to the C_1 tone, however, a certain amount of tone from the G_1 divider, a fifth above, is injected as well through the 22-megohm resistor. The difference between the C_1 frequency of

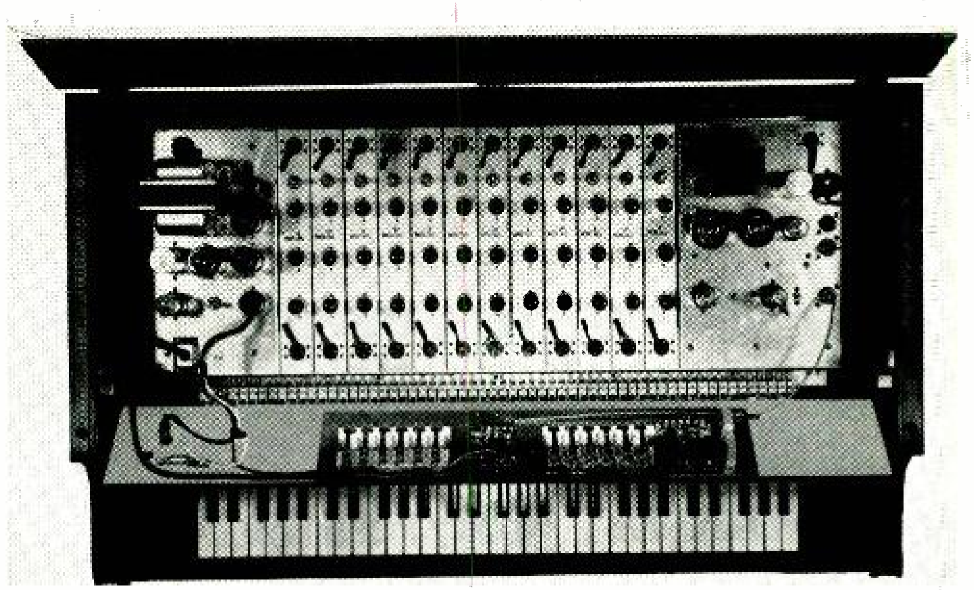


Fig. 3—Top view of the model H spinet with cover raised shows the single chassis which holds electronic assembly. Each sub-chassis is instantly removable for servicing.

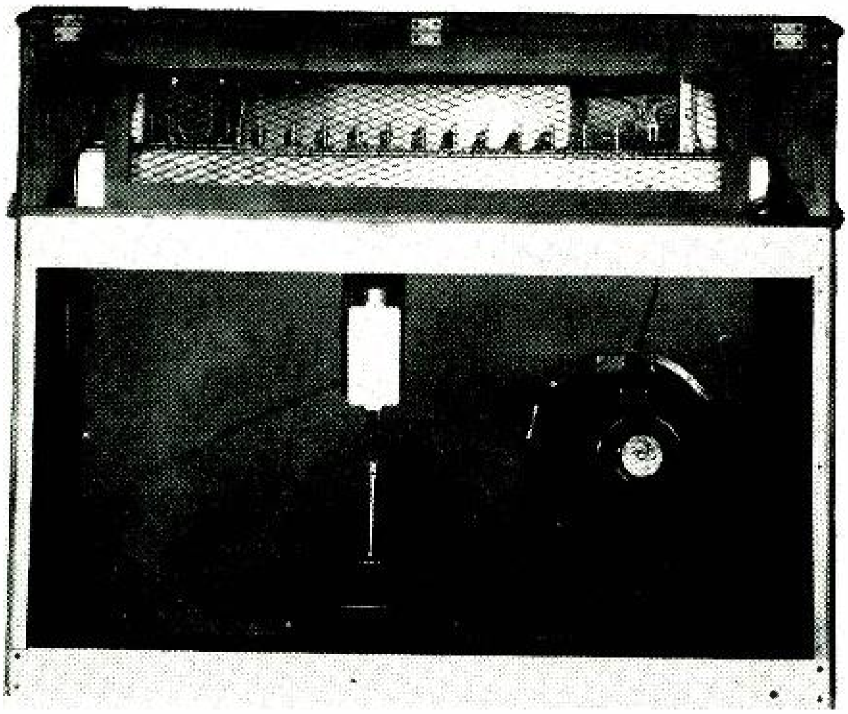


Fig. 4—Rear view of the Model H illustrates compact construction.

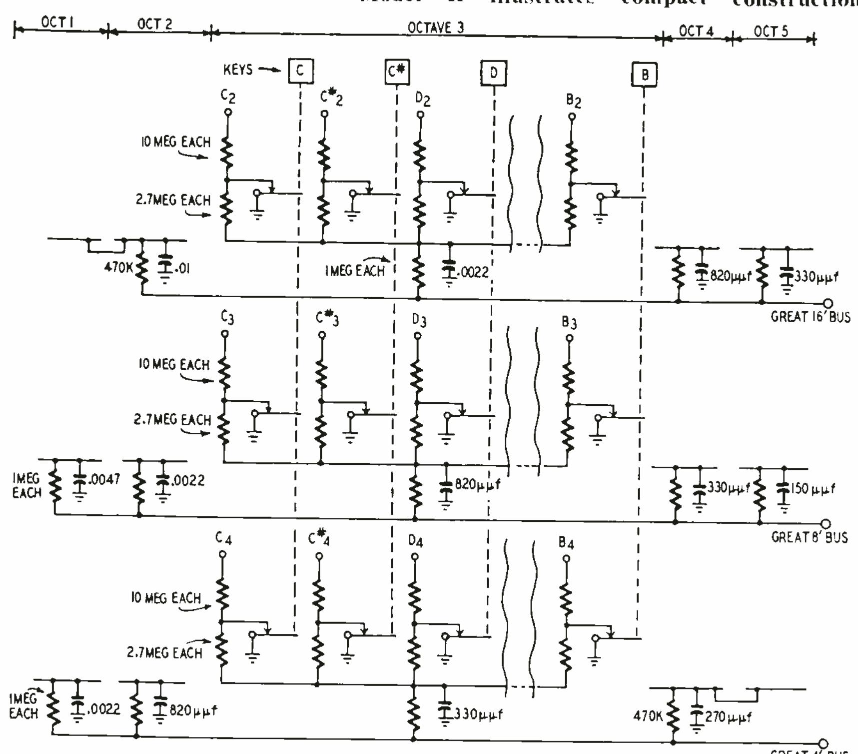


Fig. 6—Complete keying system for GREAT manual of larger models is similar to that for the spinet model. Capacitors are used to suppress keying clicks.

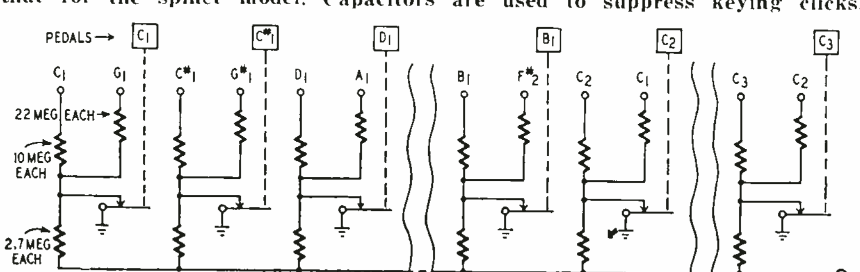


Fig. 7—Pedal key-switch circuit diagram shows how the quint is added to the basic tone in the first octave to give effect of a bass an octave lower than actual tone.

65.41 cycles and the G_1 frequency of 98 cycles is 32.59 cycles, within 0.11 cycle of the frequency of the C one octave below C_1. When the fundamental and fifth are mixed in the right proportions the fifth itself cannot be heard but the listener hears the 32-cycle tone and a good foundation bass is obtained.

This scheme of adding the fifth is carried through the first octave of the pedals, as Fig. 7 illustrates. Beginning with the second octave of pedals (C_2) the fifth is no longer needed, since the first octave of generated notes can be used. The fifth input is therefore replaced with a certain amount of tone from C_1, C_1 . . . , through the 22-megohm resistors.

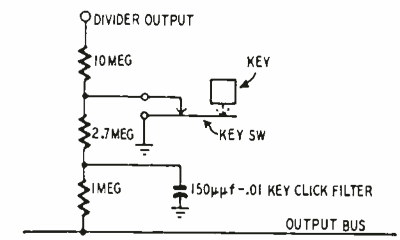


Fig. 5—Single keying circuit demonstrates the shunt keying system used in the Minshall electronic organ.

In next month's article our description of the Minshall electronic organ will conclude with complete diagrams of the electronic tone-color filters, the control system, and the amplifiers. Particularly interesting are the graphs showing actual frequency responses of the filters as illustrations of how the formant principle is used in this organ and how the colors can be duplicated experimentally.

(to be continued)

Other Organ Articles In This Series

Recording-studio control room. The echo box and its controls are at the top of the rack.

Echo effects for recording and broadcast work can be produced at low cost.

SIMPLE ECHO BOX

By CHARLES L. HANSEN

SEARCH for a simple artificial reverberation generator began when we lost a customer because we could not furnish a reverberation effect. The embarrassment of the situation sparked us into action.

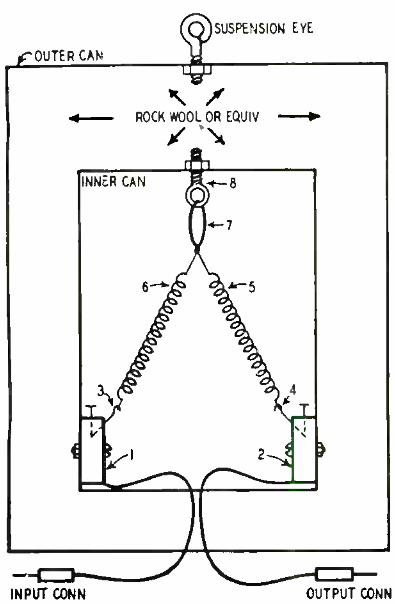
We had no space for a true reverberation chamber. A tape-delay system sounded good, but the cost of a commercial unit was too great. We considered a system using 50 feet or more of coiled-up hose with a speaker, mike, and equalizer, but did not think it versatile enough to investigate further. The idea of three or more pickup heads riding behind each other in the same record groove was also thrown out. A revolving disc painted with fluorescent material, actuated by a modulated light source, with photocells and an optical system to reproduce the transient images was discarded as too complicated.

In one attempt a contact mike was attached to the sounding board of a piano. A speaker inside the piano caused the strings to vibrate sympathetically. This effect is quite strange and when mixed with the proper amount of original sound gives a tremendous reverberation effect. But one piano is all we can afford and we have no padded closet for storing a piano reverberation generator. I even went as far as to have my wife make a gallon of Jello in a special container. A speaker would drive one side of the jello and a crystal pickup with multiple arms would pick up the vibrations at the other end. I recorded a reverberation effect but the stuff started to melt and I didn't have time to look for an elastic gel that would remain in a permanent state.

One day I connected a recording head to one end of a 50-foot length of iron wire and a phono cartridge to the other end. The results were so good my partner and I agreed that this system had possibilities if it could be reduced in size and installed in a soundproof box so that room noise would not affect it.

The unit was finally boiled down to a crystal driver, two piano-wire springs, and a reproducer mounted in a can about four inches long and two inches in diameter. This was inserted in a larger can packed with sound-absorbing material and suspended behind the equipment rack. (See Fig. 1.)

The delay mechanism consists of two piano-wire coil springs (5, 6) obtainable



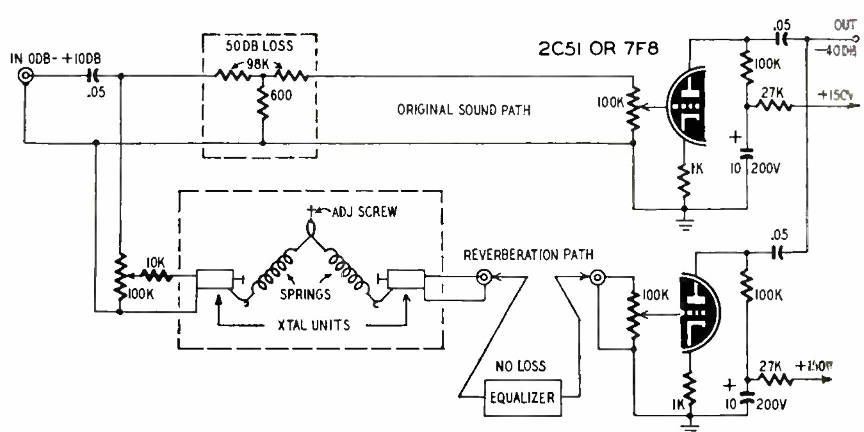


Fig. 1 (left)—Echo-box construction data. Fig. 2 (above)—Schematic of the complete reverberation unit. All units except the equalizer are on the top panel.

at any hardware store. The spring wire should be of smallest possible diameter. A good way to gauge such a spring is to hold one end and see that the other end droops downward. The springs should be about 2 to 2½ inches long.

The springs are attached at one end to the high-output crystal driver and the reproducer (1, 2) by hooked wires (3, 4) inserted in the needle chucks. The free ends of the springs are hooked together and connected by a stiff rubber band (7) to the adjusting screw (8).

The proper adjustment can be found by feeding the driver from a radio and connecting the reproducer to an amplifier and speaker. If the tension is too great the stress will distort the crystal cartridge. If the tension is too low no sound will be transmitted through the unit. The springs attached to a stiff material act like an improperly terminated electrical transmission line. The abrupt impedance change at the junction point sets up reflections in the line. The rubber band acts as a damper. If too much audio power is applied the springs will be shocked and the reproduced sound will contain "pings" like rifle shots at the start of each word. The volume level should be set so the crystal just starts to "talk back" on peaks. Maximum reverberation time is three seconds.

We also built a larger unit with a reverberation time of 10 seconds, which is installed in a trunk under the operating desk. Reverberation time naturally varies with the size, length, and stiffness of the delay mechanism. Our larger unit was wound with No. 20 armature binding wire.

The correct amount of original sound must be mixed with the artificially reverberated sound to produce the effect wanted. This is done by the three controls on the echo box panel at the top of the equipment rack in the photo. The schematic of this panel is shown in Fig 2. The first control on the left varies the mechanical drive to the spring. The second knob feeds through the desired amount of original sound. The third control is a reverberation quantity control. An infinite number of combinations can be obtained.

An equalizer is indispensable with this reverberation generator. The one used in our installation is a universal equalizer with zero insertion loss, mounted on top of the rack. With an equalizer in the output circuit the reverberated sound can be made to sound crisp. The effect can be described as changing the echo-chamber size, shape, and surface. It will be up to the builder to make adjustments and changes in the unit to obtain what he wants.

Although this unit was designed for voice, such a unit might be inserted in any amplifier playback system as a "presence control". Many weird and varied effects can be obtained. Television and radio stations could use such a device for obtaining novel effects in local programs and spot announcements. The disc jockeys would love it.

—end—

PUSH-BUTTON TUNER

By ROBERT G. MASCHING

SOME years ago no receiver could be sold unless it had push-button tuning. This feature has practically disappeared, but many of us would still appreciate the convenience.

If you would like push-button tuning, you can add it to your receiver with little trouble. All you need is a switch (latch type not necessary) and a supply of small fixed and trimmer capacitors. The time spent in hooking them up will be returned to you in the convenience of flicking on a favorite program or news broadcast instantaneously.

I built my own receiver from junk box parts. As is often the case, it was difficult to find mixer and oscillator coils which tracked. But fixed tuning solved the problem nicely. Having but two coils and only a 2-gang variable capacitor (for manual tuning when desired) I used no r.f. stage. A 2-gang 6-position switch tuned in six of the seven local stations. If more stations are desired a 12- or 24-position switch can be used, and of course additional capacitors. A 3-gang switch is needed if your receiver has an r.f. stage.

Notice in the circuit that each station is tuned by the capacitance of its particular switch position. Capacitors would be saved by using a progressively shorting type switch to add just a bit more capacitance as the switch is rotated, but this would mean that adjustment of one station would affect the adjustment of all. In the circuit shown the station adjustments are independent of each other.

First align the i.f.'s. Then solder a small variable trimmer across the switch in the first position for the highest-frequency station. Adjust the trimmer for the oscillator until the desired station is heard, or use a signal generator if available. Then solder a trimmer to the r.f. and or mixer stages and tune. Switch to the next position, solder in a capacitor and tune the next lowest station in frequency, always adjusting the oscillator first. Continue until all desired stations are tuned. The receiver's own variable capacitor may be then attached to the last switch position for regular manual tuning.

An idea of succeeding values of capacitance necessary to tune progressively lower frequency stations may be obtained from the formula

$$f = \frac{1}{2\pi\sqrt{LC}}$$

which shows that with a fixed coil the frequency is inversely proportional to the square root of the capacitance. Thus if 20 μμf is necessary to tune the r.f. to 1400 kc, 80 μμf will be needed at 700 kc. If the i.f. of your receiver is 455 kc the oscillator will tune from 1005-1955 kc in covering stations from 550 to 1500 kc. Therefore slightly less than four times the capacitance necessary to tune the oscillator at 1500 will be required at 550 kc.

Since the distributed capacitance of the switch, wiring and coil is part of the total minimum capacitance, and it cannot be calculated easily, the above will give only a rough estimate. The simpler method is by trial and error to add the capacitance necessary to tune the desired station.

To give an idea of expected capacitances, the values used in my receiver are given below. These values will vary with the individual receiver.

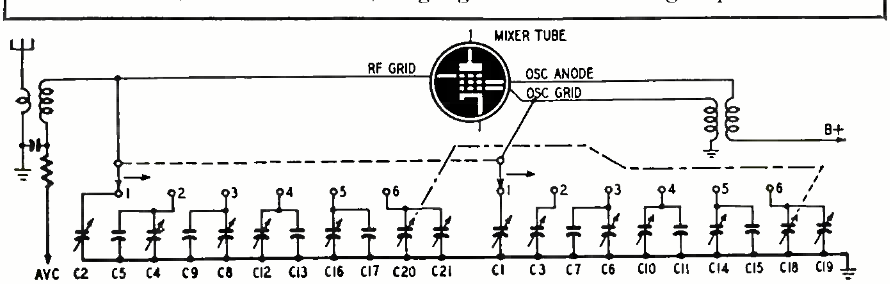
Results have been more than gratifying. The stability of the tuning is excellent despite the fact that no precautions were used in wiring, no special capacitors were used, and the switch is an ordinary bakelite wafer type.

—end—

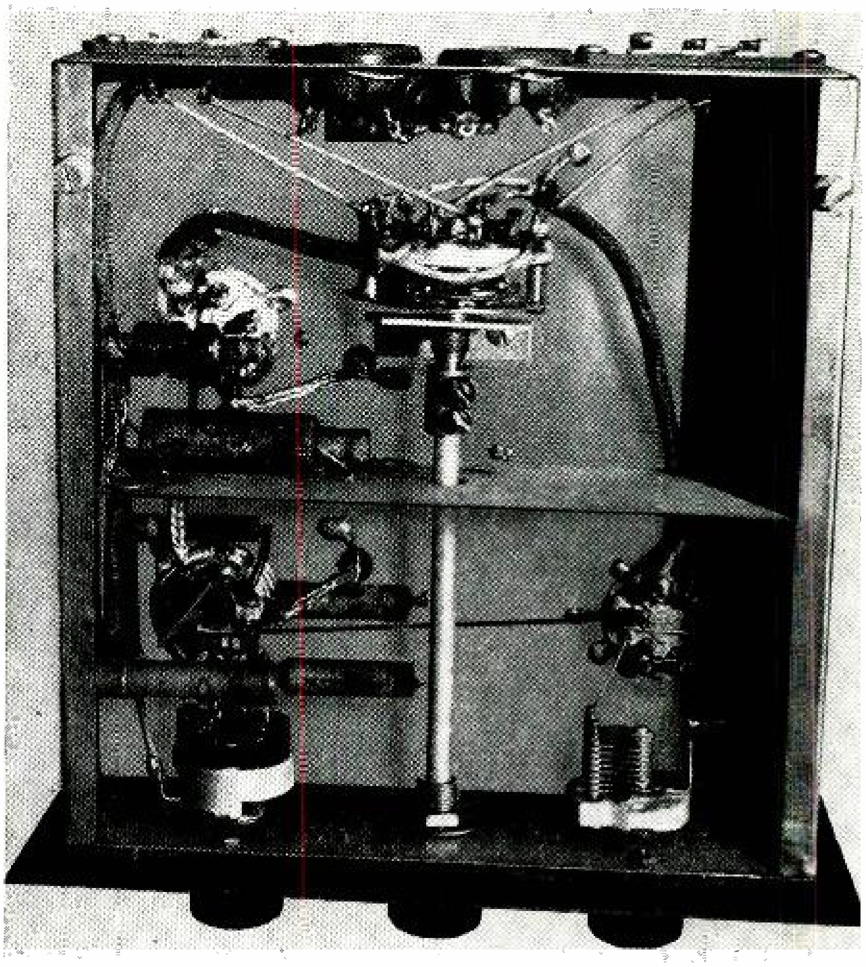
TABLE OF CAPACITANCES

Switch Position	Frequency of Station kc	Osc. Capacitance (μμf)	Mixer Cap (μμf)
1	1380	C1 —3-30	C2 —3-30
2	920	C3 —3-30	C4 —3-30, C5 — 25
3	760	C6 —3-30, C7 — 60	C8 —3-30, C9 —100
4	690	C10—3-30, C11— 80	C12—3-30, C13—100
5	590	C14—3-30, C15—130	C16—3-30, C17—150
6	Manual	C19—3-30	C21—3-30

C18 and C20 are the receiver's regular ganged variable tuning capacitors.



PRESELECTOR and its POSSIBILITIES



The underside of the preselector chassis. Thorough shielding prevents oscillation.

By JACK V. ROBERSON

EVERY amateur, whether novice, dx hound, or rag chewer, is limited in his contacts by two things—how many stations he can hear, and how many can hear him. Whether you're operating a 10-watt rig or a kilowatt, you must be able to copy the other station, and it's a comfortable feeling to know that you have plenty of receiving power. If your receiver has fewer than two r.f. stages, you may be missing many enjoyable contacts—or losing some of those rare ones. A preselector can be a big help.

The following list of stations illustrates the difference between using and not using a preselector. These stations were logged on December 23, 1951, between 1500 and 1530 CST.

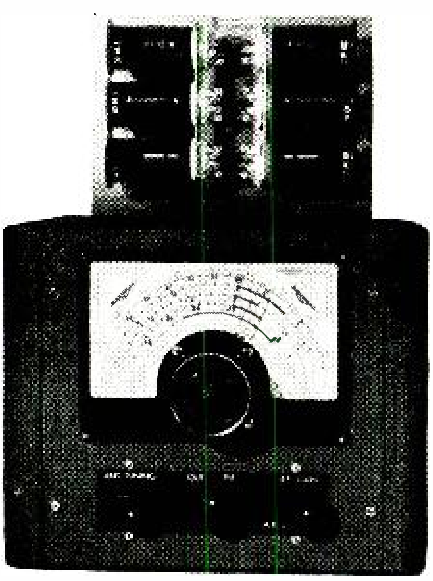
PRESELECTOR REGENERATIVE

Station	OUT	IN
W9OSR	S1 plus	S9 plus 10DB
K8ARR	**	S8
W4ITB	S2 plus	S9 plus 20DB

PRESELECTOR NONREGENERATIVE

Station	OUT	IN
W8LAX	S1	S5½
W2DYR	S1	S6
W8LIO	S2	S7
VE3DGX	**	S2

**Very slight indication on S meter—not readable



Completed preselector and plug-in coils.

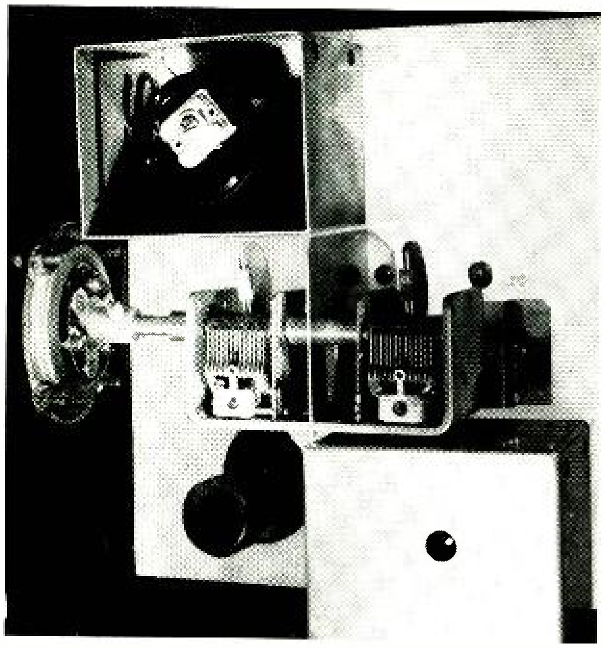
A preselector is primarily used to boost the signal strength of weak stations. A secondary function is, as the name implies, the "preselection" or the preseparation of frequencies.

Preselection cannot eliminate the effects of poor receiver alignment, but it can put more signal into your receiver, and assist the receiver to reject unwanted signals, especially image frequencies. A preselector usually consists of one or more t.r.f. stages, and controlled regeneration is sometimes introduced to increase gain and selectivity. A preselector should have a convenient method of IN-OUT switching, and a calibrated dial.

The preselector described in this article was built to work with an NC-57 receiver. The schematic diagram is shown in Fig. 1. Power supply requirements are low—6.3 v.a.c. at 0.3 amp, and 100 to 200 volts d.c. at 10 ma. Nearly all receivers will stand this small additional power drain. If not, a supply like the one suggested in Fig. 2 may be constructed. The preselector was built into an 8 x 10 x 8-inch metal cabinet, and the chassis size was approximately 2 x 7 x 7 inches. In order to get the rear of the chassis to come at the cut out space in the back of the cabinet, the chassis was bolted to the front panel ⅝ inch from the bottom—the rear of the chassis being supported by flat-head screws. The main tuning capacitor, C1 and C2, is a three-gang b.c. type of about 435 μμf per section. The center section was removed so that a shield could be placed between the front and back sections. All but two rotor plates were removed on each section in order to obtain enough bandspread. (Two ganged capacitors, each having a maximum capacity of 50 to 70 μμf may be used.) The shield across the bottom of the chassis (shown above) isolates the input and output coil sockets.

The IN-OUT switch is mounted under the chassis toward the back. Its shaft extends through the shield to the front panel. The antenna tuning trimmer has a capacitance of about 8 μμf. This was originally a 50-μμf air trimmer from which all rotor plates but one were removed.

The leads from the IN-OUT switch to



Shielded plug-in coils and modified broadcast-type tuning capacitor on the upper side of the preselector chassis.

the input and output coils are shielded. *Do not* shield the lead from the 6SG7 grid to the input coil since the shielding introduces too much capacitance. The grid lead should be stretched from the coil socket to the tube socket, and should not run along the chassis. It is also advisable to shield the filament and B plus leads.

Coils were wound on 1⅛-inch diameter 6-prong forms. The small trimmer capacitors are connected by heavy copper wire rigid enough to permit the trimmers to be adjusted from the top as shown above. The wires are first soldered to the trimmers and then positioned inside the coil form before soldering to the socket prongs. These trimmers are for peaking each coil set at the center of an amateur band. Each coil is enclosed in an aluminum box 2⅝ inches high, 2¼ inches wide, and 2⅞ inches deep.

The size of resistor R1 will depend on the B voltage and the value of R2. R1 is chosen so that the 6SG7 will cut off when the gain control is fully counterclockwise (maximum positive cathode voltage). This value may be determined by inserting a milliammeter in series with the plate lead and adjusting R1 until no plate current flows.

The preselector is connected to the receiver input terminals by *unshielded* twisted leads since regeneration may not be possible with shielded wires. Whether or not one input lead to the receiver should be grounded is determined by experiment. Reversing the twisted lead connections at the preselector output terminals will make the preselector either "normal" or regenerative. Under regenerative conditions, with an antenna connected to the preselector, advancing the r.f. gain control to maximum should cause the preselector to break into oscillation. It should be possible to bring the gain up to just under the point of oscillation. At this point a signal that normally can't be heard will often come up to S5 or better, and the selectivity is extremely sharp. Feedback on the lower amateur bands is ample, and the input and output leads should be physically separated as much as possible to prevent too much regeneration. On 10 meters adequate feedback may not be obtained unless a few turns of the antenna lead are wrapped around the twisted pair leading to the receiver.

With the r.f. gain set at maximum clockwise position (maximum gain) and with the preselector connected to the receiver input, but with no antenna, check to see that no oscillation exists in the preselector. Oscillation will be indicated by a sudden large change in S meter reading, or by a "plop" in the speaker. If oscillation *does* exist it will be necessary to improve the shielding between the input and output. As shown in the photo a small metal shield is soldered to pin 1 of the tube socket and serves to isolate the grid (pin 4) from the plate (pin 8).

Each set of coils should be peaked at the center of an amateur band. Tune the receiver to a weak amateur station (or use a signal generator) and adjust the receiver with the preselector out for maximum response on the S meter or maximum output. Now turn the preselector to the IN position and adjust the r.f. gain to just below maximum with the ANT TUNING trimmer in mid-position. Set the preselector tuning capacitor to the desired position on the dial and adjust the input and output trimmers for maximum volume. (If the trimmers do not peak at the desired points on the dial, add or subtract one or two turns from each coil and try again.) After the trimmers are set at the proper points, rock the *receiver* antenna trimmer and repeak the converter. Continue until no further improvement is noted (the r.f. gain may have to be backed off to prevent oscillation). If alignment has been carried out properly, moving the ANT TUNING trimmer from its mid-position should cause the S meter indication to decrease. It should not be necessary to vary the receiver's antenna trimmer after alignment, but the ANT TUNING may have to be adjusted slightly for the ends of the bands. Hand capacitance will have some effect under regenerative conditions, but this effect may be compensated for by increasing or decreasing the r.f. gain.

When using the preselector don't feel discouraged if you fail to work quite a few of the stations you hear—the guy on the other end may also need one.

Materials for Preselector

Resistors: 1—150,000 ohms, 1—10,000 ohms, 1—150 ohms, ½ watt; 1—1,000-ohm potentiometer.
Capacitors: (Paper) 1—0.1 μf, 400 v d.c. (Ceramic or mica) 4—0.01 μf. (Variable) 1—antenna trimmer (see text); 1—2-gang main tuning capacitor (see text); 2—3-30 μμf trimmers.
Miscellaneous: 1—2.5 mh r.f. choke; 1—2-section, 2-pole, 2-position wafer switch; 8 coil forms (see text); 2—6-pin ceramic sockets; 1—octal socket; wire; chassis, cabinet, dial, knobs, hardware, input and output terminal strips.

Materials for Power Supply

Power transformer—Merit 3045, Thordarson T-22R12, or equivalent; 60-ma filter choke; 75-ma selenium rectifier; 25,000-ohm, 25-watt wire-wound resistor; 2—30-μf, 150-v electrolytic capacitors; 1—0.1 μf, 400-v paper capacitor; s.p.s.t. toggle switch.

COIL TABLE

80 METERS
L1—15 turns No. 26 enameled, close-wound.
L2—26 turns No. 24 enameled, close-wound.
40 METERS
L1— 7 turns No. 26 enameled, close-wound.
L2—19 turns No. 20 enameled, spaced to 1 3/16".
20 METERS
L1— 7 turns No. 26 enameled, close-wound.
L2— 5 turns No. 20 enameled, spaced ⅝".
10 METERS
L1— 2 turns No. 26 enameled, close-wound.
L2— 3 turns No. 20 enameled, spaced 3/16".
Note: L1 and L2 are separated by ⅛".

—end—

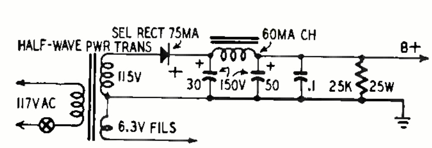


Fig. 2—Power supply recommended for use where preselector operating voltages are not supplied by the receiver.

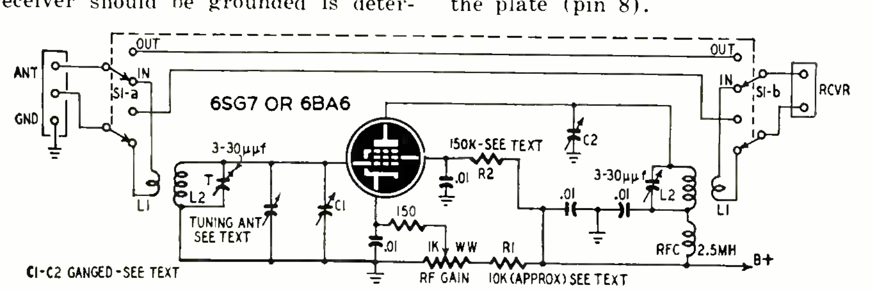


Fig. 1—Schematic of the preselector. Regeneration increases gain and selectivity.

A description of a photoelectric door-actuating mechanism that can be installed in the home. The system can be adapted to operate gates and garage or barn doors as well.

AUTOMATIC DOOR CONTROLLER

By DON ANGLIN

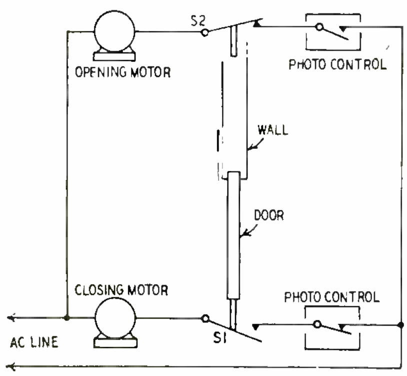


Fig. 1—Basic door-control system.

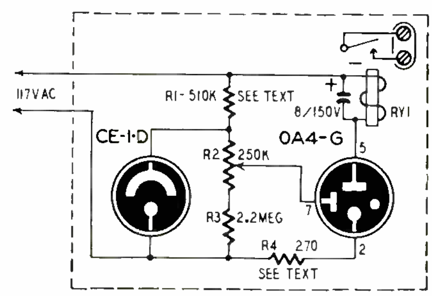


Fig. 2—The electronic control circuit.

DOORS that open automatically when someone approaches, and close after the person has passed through, can be just as useful in the home as in restaurants and railroad stations. The low cost and simplicity of the photoelectric controls and motor drives make it entirely practicable to build your own.

Fig. 1 is a block diagram of a typical installation. When the sliding-type door is closed, limit switch S1 is held open, and breaking either light beam turns on only the "opening" motor. When the door is open, it opens limit switch S2, and the next interruption of either light beam starts only the "closing" motor. (A single reversing motor can also be used.)

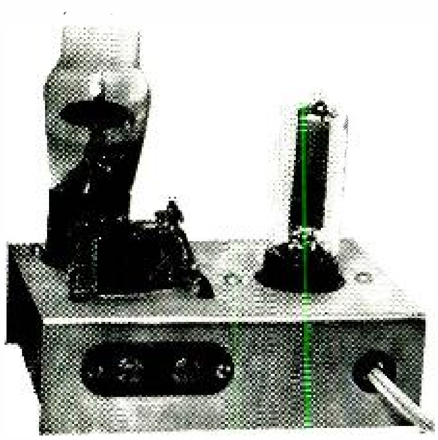


Fig. 3—Top-view photograph of the electronic part of the control system.

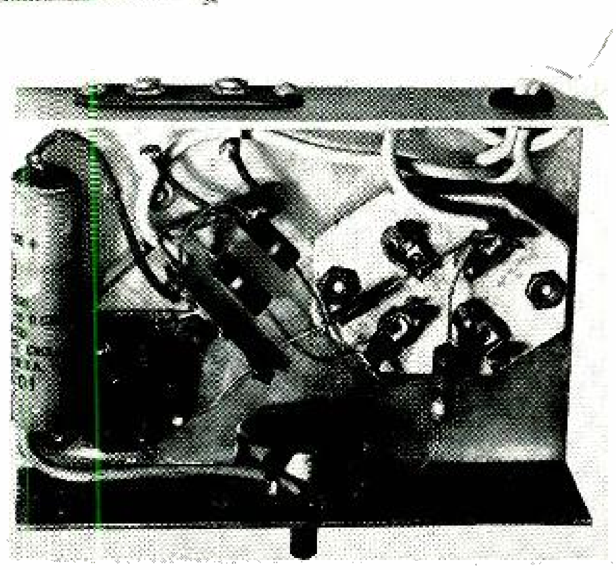


Fig. 4—Simplicity of the circuit is evident in this underchassis view of the photorelay control.

Photoelectric controls

The basic control element is a simple photoelectric relay. Two of these units are required. Fig. 2 gives the circuit, and the layout is shown in Fig. 3 and Fig. 4. The chassis is 3½ x 5 x 1½ inches.

Low-sensitivity phototubes may be used. Mine are Cetron CE-1-D's (Cetron indicates sensitivity by the last letter in the type designation, the CE-1-D being less sensitive than the CE-1-C.)

The values of resistors R1, R2, and R3 in the voltage-divider network are not critical, as long as the proper ratios are maintained. These resistors hold the control anode of the 0A4-G at a low voltage to keep it from firing when the phototube is conducting.

When the light beam is interrupted, the resistance of the phototube increases. The voltage across R2 and R3 rises enough to trigger the 0A4-G and energize the relay. The plate relay, RY1, may have a resistance of 2,000 to 5,000 ohms. The 8-μf capacitor keeps the relay from chattering. R4 limits the peak current through the 0A4-G, and may be from 250 to 1,000 ohms. To check the finished units plug them in and adjust sensitivity control R2 until

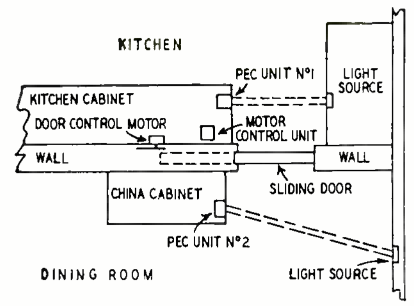


Fig. 5—One form of installation layout.

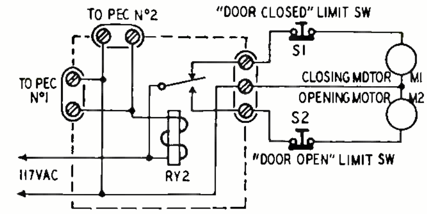
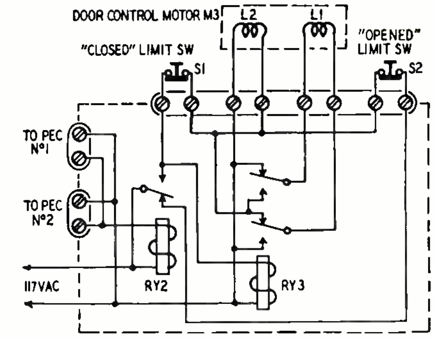


Fig. 6 (above)—Control circuit for two drive motors. Fig. 8 (right)—Two relays can be used to control a single drive motor with reversing winding.



the 0A4-G ionizes. The glow should be steady and the relay should hold in without chattering. A beam of light on the phototube plate should cut off the control tube. Interrupting the beams should ionize the 0A4-G and pull the relay armature down.

If you cannot adjust R2 to ionize the 0A4-G, check all wiring. R1 may be too large for the phototube you are using. If the 0A4-G will not de-ionize at any setting of R2, increase R1. The photorelay units should be installed in cabinets if possible, with a 1-inch hole in the side to admit the light beam. Keep stray light off the tubes. If you must put the unit where random light can get at it, use a black cardboard shield or black paint on the 0A4-G as well as on the phototube. Leave a window on the phototube for the light beam to enter.

I used separate light sources, placed in the wall in the dining room, and in a convenient cabinet in the kitchen (see Fig. 5). They are auto bulbs fed by a 6.3-v filament transformer. The light source may also be mounted in the relay unit. A mirror reflects the beam back to the phototube.

Driving mechanisms

A sliding type door is easiest to control. Two small motors, or one reversible motor, may be used to pull it in and out of the wall. Swinging doors require relatively expensive solenoids to open and close them. Two motors cost about the same as one motor and a reversing relay. Small a.c. motors such as fan motors, will work fine. A single door, or twin doors going into either side may be controlled with pulleys and ordinary sash cord. Fig. 6 shows the circuit for using two small motors, one for opening and one for closing. The two double terminals on the motor-control unit are tied to the relay contact terminals on the photorelay units.

Relay RY2 is a 110-volt ratchet type such as the Advance model 905. This relay was obtained as surplus, and may be hard to get. The Struthers-Dunn 85AXA (order direct from the manufacturer) can be used in its place. The limit switches are normally-closed microswitches, and are opened by the door as it reaches full open or full closed

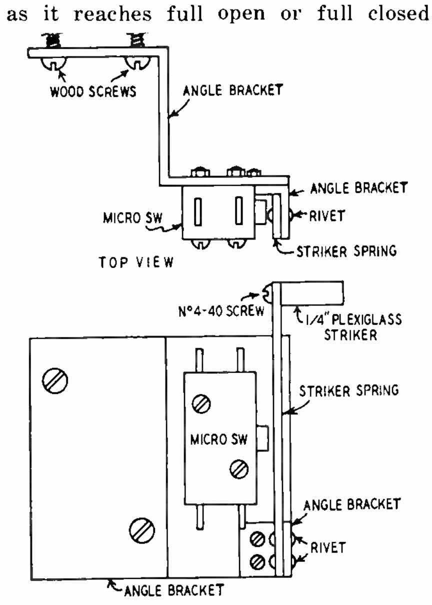


Fig. 7—Construction of limit switches.

position. The striker springs may be made of spring brass or steel and assembled as shown in Fig. 7. When the door is closed, limit switch S1 is open. Power must be applied to motor M2 to open the door. When either light beam is broken, the coil circuit of RY2 is completed by one of the plate relays (RY1) and RY2 turns on opening motor M2. When the door is fully open, it opens limit switch S2. This breaks the circuit to M2 and RY2 must again be energized to close the door. Final adjustment of the door-closing limit switch may be touchy, as the door should close tightly and still open the switch.

A control unit for a reversible motor is shown in Fig. 8. It is for the type of a.c. motor (M3) which is reversed by switching the phase of one of the two windings. Relay RY3 is a Guardian series 200 relay with a 110-volt coil and d.p.d.t. contacts. Operation is similar to the two-motor control unit except that the reversing relay RY3 is pulled in when the impulse-relay contacts are in the door-closing position, and power is applied to both windings in phase until the door is closed and S1 opens. This removes all power from the motor until RY2 is again energized by one of the PEC units and switches to the door-opening position. RY3 is not energized and winding L1 is out of phase with L2, reversing the motor. When the door is open, limit switch S2 removes power from the motor.

Fig. 9 illustrates the motor control unit I used. The motor and gear box are from a surplus antenna reel RL-42-A and operate from 24 volts d.c. I operate the motor on 12 volts from an old battery charger, and with the built-in gear box, the pulley speed is about 75 r.p.m. The motor has an electromagnetic clutch which disengages it from the gear box when power is removed. The pulley is 4½ inches in diameter. A s.p.s.t. switch across the photo-relay control terminals will let you operate the door manually for testing or in case the unit fails.

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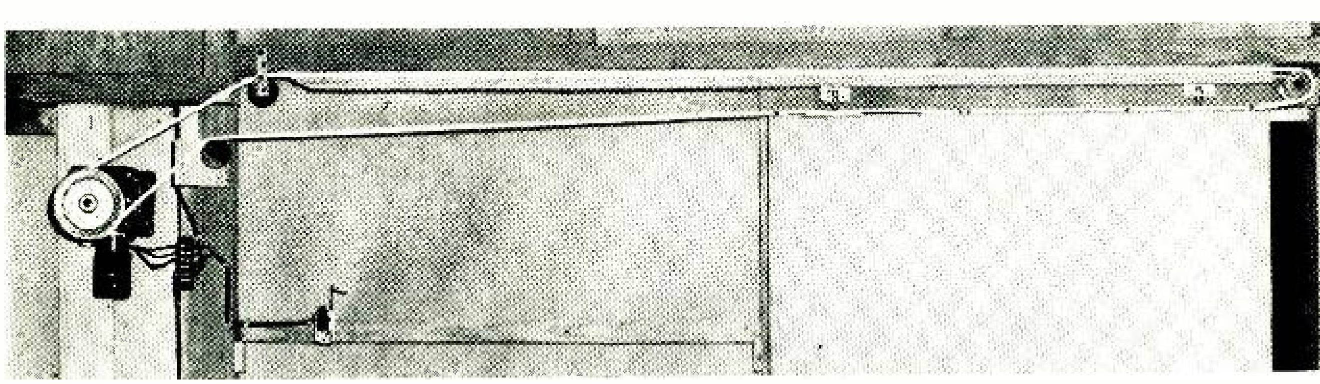
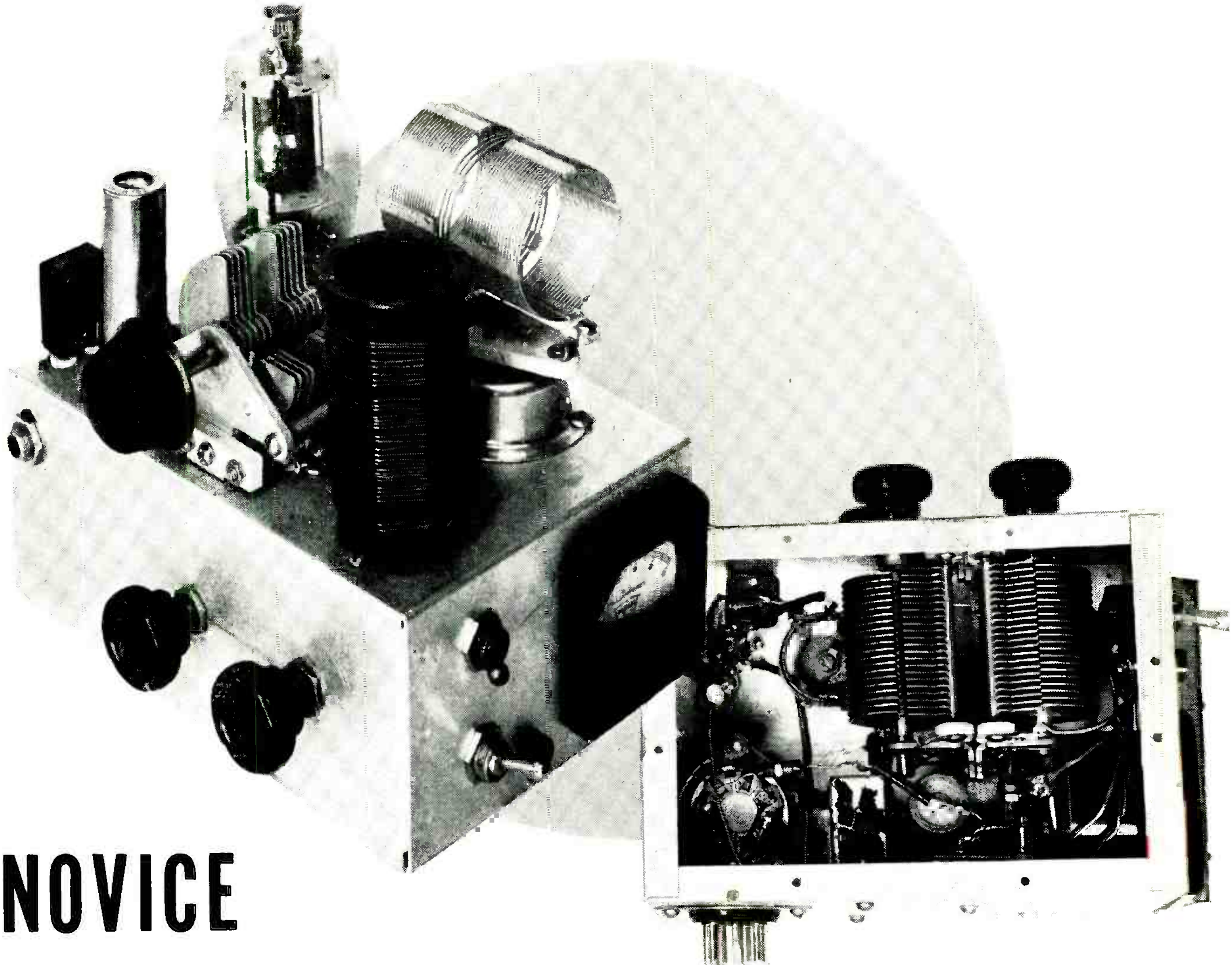


Fig. 9—Wall panels removed to show the sliding door, limit switch, and reversible drive motor with rope drive system.



NOVICE TRANSMITTER

An easy piece of equipment for the beginner to build, adjust and operate

By I. QUEEN, W2OUX

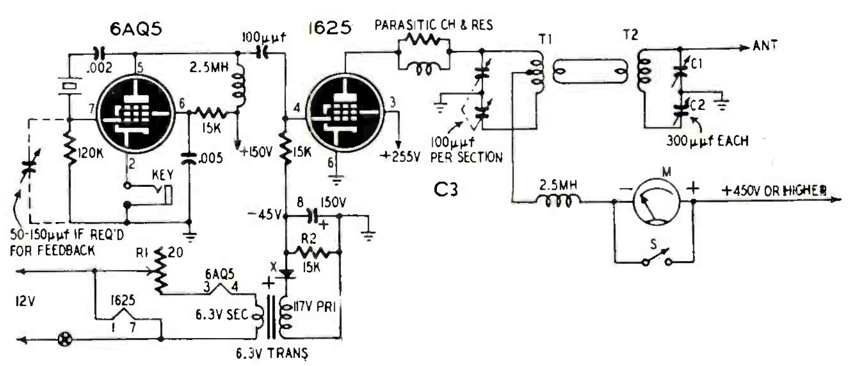


Fig. 1—The schematic. The 12-volt supply can be two 6-volt windings in series.

WE PLANNED this rig to meet the requirements most important to beginners. It features economy, efficiency, circuit protection, and future applicability. It is complete except for A and B power supplies and is built on a 3 x 5 x 7-inch aluminum chassis.

In spite of its small size, the rig includes an oscillator-amplifier circuit, a plate-current meter, antenna-matching network, and split-stator tank tuning. These features are ordinarily omitted from a small set, but each is desirable and helpful, especially for novice operation.

The circuit is a 6AQ5 Pierce crystal oscillator driving a 1625 class-C final amplifier. (See Fig. 1.) An amplifier is far more efficient than an oscillator and provides high output without endangering the crystal. Like a single-tube rig, this one has only one tuning control (exclusive of the antenna network). When the novice obtains his general license, the two-stage circuit will be suited for frequency multiplication to cover more bands.

No power supply is shown, as one already on hand may be adapted easily. The 1625 is a 12-volt-heater version of the popular and versatile 807. On the surplus market, you can buy several

1625's for less than the price of one new 807. This may mean buying a small (½ amp or more) 6-volt transformer to add in series with an available 6-volt transformer. However, many large power transformers have two separate 6-volt heater windings. Connect these filament windings in series with correct polarity. (Connect the heater of the 1625 across the two windings in series. If the tube fails to light, reverse the leads of *one* heater winding.) The final plate supply may be anything which will deliver from 400-750 volts, at 180 ma or more. Fig. 2 shows how easy it is to obtain the lower voltages needed for the 6AQ5 plate and screen, and the 1625 screen. The voltage regulation assures better stability even where the rig is crystal controlled. When a higher-class license is obtained, the regulated voltages will come in handy to supply a v.f.o. unit.

The transmitter includes its own C supply. This uses a 50-ma selenium rectifier and a small 6-volt filament transformer for isolation. The 6-v. winding, R1, and the 6AQ5 heater are in series across the 12-v. circuit. R1 is adjusted until the oscillator heater shows about 6 volts. Then about 2.5 volts will appear across the 6.3-v. winding transformer winding. The bias will be about 45 volts. If the bias is too low, increase R2. If too high, reduce this resistance.

This method of obtaining final bias is more efficient than a simple cathode bias resistor. The fixed bias completely blocks the final tube during key-up time. It pays off in power savings and longer tube life. The bias supply requires less space and wastes less power than a clamp tube arrangement. (If an 807 is used instead of a 1625, the 6-volt winding of the bias transformer and R1 may be connected directly across the 6-volt heater circuit.—*Editor*)

The parasitic suppressor is made by winding 15 turns of No. 36 enameled wire over a 15,000-ohm ½-watt resistor.

The split-stator capacitor minimizes

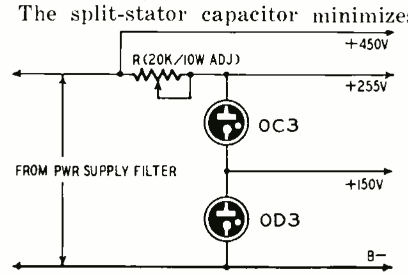


Fig. 2—Voltage divider also regulates.

harmonics. Link coupling between plate tank and antenna network reduces harmonics still further. The antenna network can feed any length antenna efficiently and also helps reduce harmonics. (Don't forget that harmonics of 3.7–3.75 mc do not fall within a ham band.) The antenna matching transformer (T2) is made by winding 30 turns of No. 20 enameled wire on a 1½-inch diameter plug-in coil form. The turns should be spaced to cover a winding length of 2¼ inches. The link is two turns of the same wire wound ¼-inch below the large winding.

If the transmitter is to be used with a dipole antenna, the antenna coupling network (T2, C1, and C2) may be omitted entirely.

Adjustments

If an inexperienced operator is to work the transmitter, it is a good idea to check whether the final tunes to 7 as well as 3.5 mc. We found that both these bands could be resonated with a National (TMS-100D) capacitor and a standard 80-meter plug-in coil. We eliminated the higher band by shunting a 10-µµf fixed ceramic capacitor across the tank coil.

Tuning is easy enough to satisfy any novice. The oscillator needs no tuning at all. Plug in the proper crystal. Detune the antenna network by setting C1 and C2 to maximum capacitance. Plate current will be high until C3 is tuned to resonance. Tune for the dip. Now tune C1 for maximum current on the meter. For greater power output, reduce C2 and again tune to maximum current with C1. To reduce power, increase C2 and retune C1 for maximum reading.

The meter may be a 100- or 150-ma instrument. If its full-scale reading is lower, it should be shunted by a resistor. To protect the meter, a switch shorts it out when tuning is completed.

This transmitter has given a good account of itself in actual operation. It is used with a single-wire antenna 20 feet long and about 12 feet high.

Materials for Rig

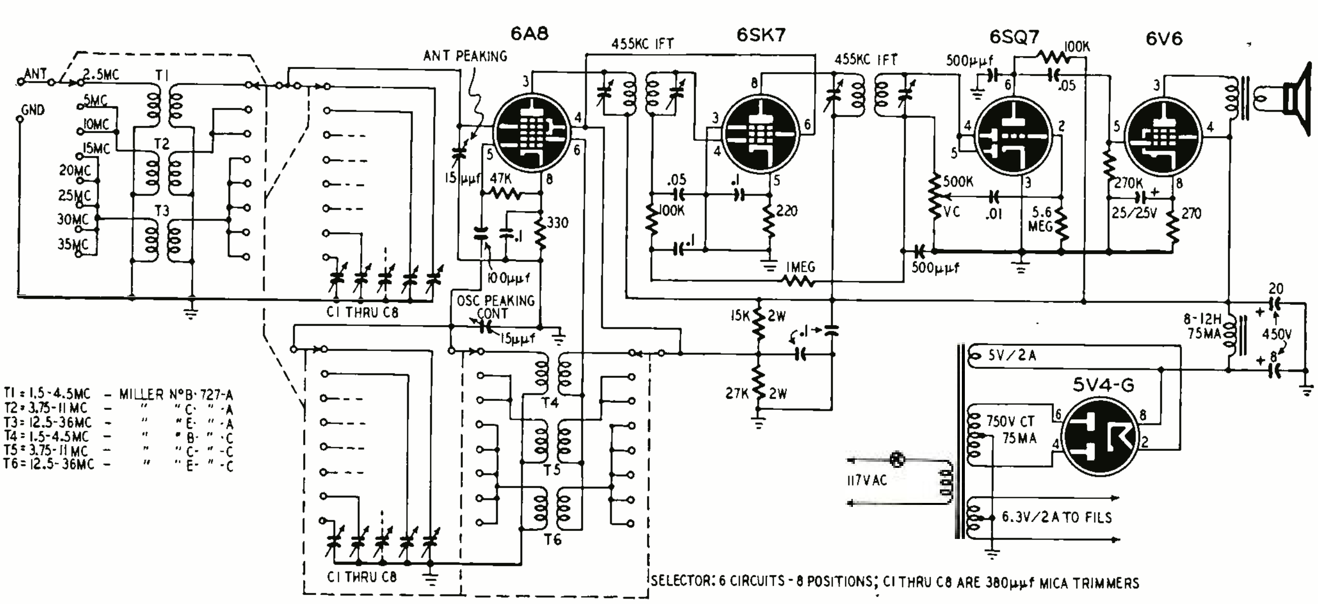
Resistors: 3—15,000 ohms, 1—120,000 ohms, ½ watt; 1-20 ohms, 10-watts, rheostat; 1—20,000 ohms, 10-watt, adjustable.
Capacitors: (Ceramic) 1—10 µµf if needed (see text), 1—100 µµf, (Paper) 1—.002, 1—.005, 400 volts. (Air) 1—split stator variable, 100 µµf each section (C3) 2-300 µµf, variables (C1, C2), (Electrolytic) 1—8 µf, 150 volts.
Inductors: 2—2.5 mh r.f. chokes 1—80 meter plug-in coil center-tapped, with link; 6.3-volt transformer.
Miscellaneous: Tubes: 1—1625; 1—6AQ5; 1—OC3; 1—OD3; 2—5-pin sockets; 1—7-pin socket; 2—octal sockets; 1—7-pin miniature socket; 1—socket for crystal; 50-ma selenium rectifier; key jack; meter (0-100 or 0-150 ma); s.p.s.t. toggle switches; knobs; hookup wire; aluminum chassis, 3x5x7.

—end—

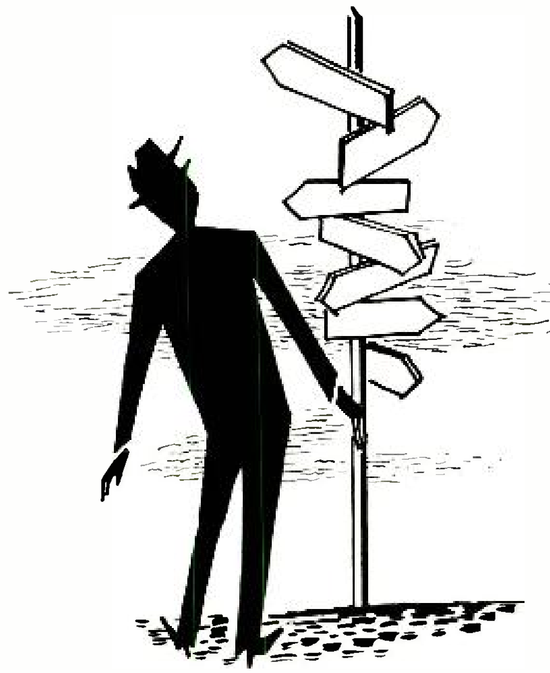
ALL-CHANNEL RECEIVER FOR WWV

WWV and WWVH are widely used as primary frequency standards and sources of accurate time signals. Since signal strength and readability depend on time of day, season, distance, etc., a multi-channel receiver is desirable. An eight-channel pre-tuned receiver is shown for selecting any one of WWV's operating frequencies.

The coils are tuned by small trimmer capacitors mounted on the selector switch. Only five of the eight tuning capacitors are shown in the antenna and oscillator circuits. A small 15-µµf trimmer may be mounted on the front panel and connected across the oscillator circuit to compensate for oscillator drift.



SELECTOR: 6 CIRCUITS - 8 POSITIONS; C1 THRU C8 ARE 380µµf MICA TRIMMERS



SELECTING THE RIGHT RADIO SCHOOL

By E. H. RIETZKE*

CONGRATULATIONS! The fact that you are reading this article tells us one of two things about you. Either (1) you have decided to enter a radio school, or (2) you are preparing wisely for the day when you will choose a school. In either event, you may look forward to the tremendous opportunities awaiting properly trained men in radio, television, and other electronic pursuits. Your future will be limited only by the extent of your ambition, initiative, and technical knowledge. This is the most rapidly expanding industry in America today. To properly trained men it offers almost unlimited opportunity.

Considering the career you have chosen, you are doubtless equipped with an "engineering" frame of mind. To some extent, you are probably scientific in your approach to problems. You carefully line up all the pros and cons. You match factor for factor, advantage for advantage. This attitude is very valuable to you when you set out to choose the right school.

First, what about yourself?

You must know what you have to offer the world of electronics, before you can determine what electronics can offer you, and what type of school is best for your needs.

Let's start with your schooling. Check yourself on the following subjects: (How much did you have, and what were your grades?)

Algebra	Manual Training
Chemistry	Mechanical Drawing
Electricity	Physics
Geometry	Trigonometry

If you did well in all or most of these subjects, and if you are a high-school graduate with sufficient credits, you should consider a full-fledged college of engineering. Not every subject mentioned is required, but if you think you qualify, find out the entrance requirements of the school you have in mind. If you lack some subjects, the registrar can advise you how to qualify.

The same qualifications apply for high-level technical schools, except that your background in cultural subjects would not be important and actual practical experience in some phase of electronics often takes the place of a high-school diploma. Some technical schools offer the necessary preparatory courses in mathematics.

At less-advanced levels of training, the qualifications named above become less important. If you attended specialized schools in the service, it should be of great value. If you are a radio amateur, or have any other practical experience in radio, and can handle required assignments, you may be reasonably sure of success. But the better the school, the more stress it places on previous training. Don't approach any level of training without the necessary background.

If you are now in high school, ask your guidance counselor what courses you should take in preparation for further technical training.

Finally, your personal habits have much to do with the case. Can you discipline yourself, or do you find it difficult to set your mind to study? Remember, no "high roads," no magic words will put knowledge in your head and skills at your fingertips.

A word of warning: Do not prejudge yourself too harshly and count yourself out of a radio career too hastily. If you *want* it, half the battle is won. Communicate with, or visit the school and discuss what you have to offer with the registrar.

What type of school?

We are often asked: Shall I go to a full 4-year engineering school, to a technical institute, or to a trade school? Shall I study at the school or at home?

If you want to be a full-fledged engineer, and if you have the required schooling, ability, and funds (anywhere from \$7,000 to \$10,000), seek admission to an accredited college of engineering.

Not everyone has the time, money, or desire for long-term college study. You may want to get into your chosen field as quickly as possible, in a really technical capacity. There are fine technical institutes offering residence advanced technical training, while omitting the cultural studies. (This does not mean that cultural pursuits are superfluous. If you choose concentrated training, round out your personality with broadening activities. Choose a school where you can devote spare time to music, art, theater, historical appreciation, and so on.)

Such a residence school may cost you from \$750 to \$1,400 for tuition alone, depending on how far you pursue your studies. Although such a school gets you into the market in less than 4 years (about 22 months on the average for the basic course), remember that the study period is continuous, and does not stop for summer vacations, so 22 months is the equivalent of about 3 years of college.

Graduates of good technical institutes usually enter industry as engineering aides. Many, by continued spare-time study and experience on the job, advance to the rank of full-fledged engineer.

If you are already in electronics or radio (or even in some other field) and cannot afford to give up your job for full-time schooling, consider a good correspondence school. Properly administered, correspondence (or home study) schools give you thorough training which takes effect in your work almost immediately. Furthermore, it is a

*Founder and President of Capitol Radio Engineering Institute.

wonderful opportunity to show your employer the interest and ambition you have. He can readily follow your progress, since most correspondence schools, if you wish, furnish progress reports to your employer. In correspondence training, you proceed as rapidly as you wish. You acquire the will-power training so useful in later life. You are your own master. If you invest your free time, you gain. If you hold back, you lose.

Another advantage of correspondence schools is the relatively small cost. A high-level technical home-study course may cost $200 to $400, depending, again, on how far you go.

You may not have the educational background for admission to an engineering college or a technical institute. However, because the field of electronics is so vast, there are opportunities for employment at all levels. There are good trade schools offering artisan-level courses, both in residence and by correspondence. The residence trade school offers the advantage of working with equipment while you study. Residence trade schools usually graduate you in less than a year, well-qualified for production assembly work and servicing relatively simple equipment under supervision. Since correspondence study is usually a spare-time activity, it takes longer to reach the same degree of skill. Correspondence schools offering beginners' courses supply kits of parts which give you experience in assembly, testing, and trouble shooting on comparatively simple equipment.

There may be a regular radio school, or a technical institute which offers night classes in your own community. Your city schools may offer trade courses on a basic level. Keep in mind the time and money you have available and the caliber of instruction required to help you attain the level you seek in electronics. You will command respect in industry in proportion to the level of your training and skills.

Now, you may ask, this is all very well, but how do I learn the level of the school I am considering? If you cannot get reliable information from radio-TV electronics people in your city, ask the school for a sample lesson. Though as a beginner, you might more easily understand an "introductory" lesson, you would find it rather unrevealing. Specify Lesson V, for example. Look it over, see if it is geared to your level. Check first before you find yourself enrolled in a course that is too elementary, or, on the other hand, too difficult.

How old is the school?

It is always wise to deal with an established organization. Given two schools equal in all other respects—it would be reasonable to select the older school, for it usually has established the close relations with industry so helpful in placing graduates. Its greater prestige will help you after graduation.

Faculty and facilities

A school stands or falls on the caliber of its teachers and its facilities. Carefully inspect the roster of faculty members listed in a school's catalog. Under each name should be his colleges attended, and his degrees attained These, together with the indicated industrial experience, serve as a reliable guide. Supplement what you learn from the catalog with information from well-placed electronics people in your city. The chief engineer of a local radio or TV station is a good man to ask. So are other electronics experts. They are better prepared than you to judge some of the faculty and equipment claims in a catalog. Get their opinions on the modernity of the school's facilities and techniques. Is it constantly revising its curricula and equipment as new discoveries appear, or does it still operate as it did back in the days when it was founded, when radio was just a new miracle? If you visit the school, take a good look at its library. Is it large? Are its contents broad and up-to-date? This should not be underestimated.

The courses offered

Study the catalogs of several schools. A complete catalog should list and describe the courses offered. Do they cover the specific fields you are most interested in? Are the specific courses amply treated? What do you know about the caliber of the men who prepared them? Are the courses being constantly brought up-to-date in light of new developments? Will you get personal instruction? Are you permitted to proceed at your own rate of speed? Or are you grouped in heterogeneous classes? Some individuals work better on their own, others may prefer being grouped.

If you are choosing a correspondence school, find out how your lessons will be handled. Will your examination papers come back to you after careful individual servicing, with suggestions for improvement, explanations, advice? Or do they come back after a merely mechanical grading, leaving you still in the dark as to what you have accomplished in a specific lesson? Are the school's examinations sufficiently comprehensive to determine whether or not you really know the subjects studied?

Is school accredited? By whom?

There are educational and technical associations which make studies of schools, their faculties and facilities. For example, the Engineers' Council for Professional Development is the official accrediting agency for engineering colleges and technical institutes. Is the school accredited by E.C.P.D.? Or is it accredited by the National Council of Technical Schools? Or, if a correspondence school, by the National Home Study Council? These are the leading accrediting agencies in their fields.

If not, what groups have accredited the school in which you are interested? You cannot minimize accreditation. Accreditation is one of the most important factors in selecting a school, because it is a major influence on the thinking of your prospective employer when he evaluates your educational and experience record.

What is industry's opinion?

In the last analysis, industry passes final judgment on the worth of a school in hiring its personnel. What can the school tell you about some of the firms which have hired its graduates? Is there further evidence available, such as the type and size of organizations which use the school's courses for the training of their own personnel?

What about employment aid?

A technical school should be able to offer concrete assistance in finding you employment after graduation. You should look for some form of guidance or placement service in the school's catalog or prospectus. Be wary, however, of wild promises of guaranteed jobs. Ethical schools do not make rash promises of any kind. No school can guarantee jobs to graduates, although at the present time the top schools have more demands for graduates than they can fill.

What about the school's location?

Is it well-situated in its city? Is it convenient to basic needs such as transit, entertainment, shopping, cultural activities (referred to above as so important)? Is it in a quiet area, conducive to undisturbed study? Is it convenient to radio stations and other electronic installations? Is housing readily available, and does the school offer you any assistance in finding housing?

What about tuition fees?

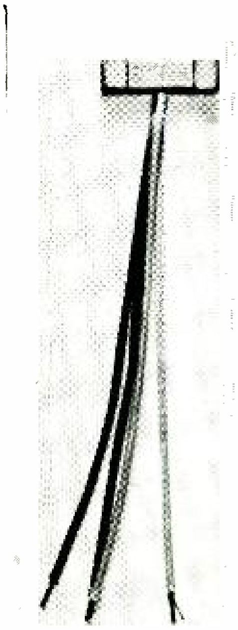
Are fees in line with your ability to pay and the quality of the training you will receive? Fees can be too low—that is, so low that the school cannot possibly offer you the quality of training that will make you really employable. Are extra fees clearly stated? (Books, laboratory fees, student activities, etc.) This should be clearly stated in the catalog.

To sum up

You are headed for a career in which scientific methods are vital, both in work and thought. Just as you apply known laws and principles to solving electronic, television, or radio problems, you should apply fixed rules and techniques in choosing the school which will provide you with thorough professional training. You want a career which will bring you lasting happiness, with financial return in line with your energy, ambition, and ability. Above all, remember that the expanding electronics industry is tremendously complex. No school can turn you out with a few easy lessons or in a few short weeks, truly competent to enter this industry with real hope of success. Get the very best education you can afford and take the time to do it right.

Good luck!

—end—



"Translator" assembly.

RECTIFYING without RECTIFIERS

New technique frees a.c. voltage measurements from the limitations of metallic rectifiers.

By H. B. CONANT*

THE most widely used instrument for measuring low-frequency a.c. voltages is the type that combines a small metallic bridge rectifier and a d.c. meter movement. (See Fig. 1.) Its low cost, simplicity, compactness and ruggedness have made it popular for service instruments. It is used almost universally in broadcasting and sound recording to measure volume levels.

In spite of its advantages and wide range of applications it has two serious drawbacks: (1) The current through a metallic rectifier does not vary in direct proportion to the applied voltage. In other words, the resistance of the rectifier does not follow Ohm's law. The relationship is logarithmic ($R \propto \frac{I}{\log E}$). At very low voltages the resistance of a metallic rectifier is so high that not enough current reaches the meter to give a readable indication. (2) At high audio frequencies the capacitance between the rectifier surfaces allows current to flow in both directions. This effect increases with frequency and makes this type of instrument useless for measuring r.f. voltages.

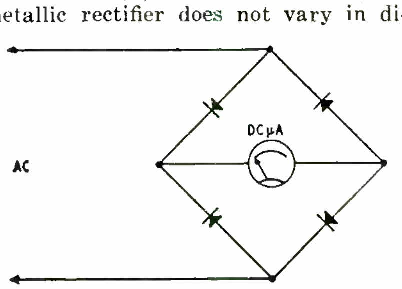


Fig. 1—Standard a.c. voltmeter circuit.

A third disadvantage, found in multi-range instruments, is also due to the nonlinear resistance of the rectifier. For maximum accuracy, a separate scale calibration must be made for each range. This is impractical and confusing on service-type instruments, and compromise calibrations are generally used, with an accuracy of about 5%.

The *Translator*

A new circuit called a *Translator* overcomes these basic limitations. It uses metallic rectifier elements (or nonlinear resistance materials like Thyrite) in the bridge arrangement shown in Fig. 2.

R1, R2, R3, and R4 are the nonlinear elements. R5 is a current-limiting resistor of ordinary permanent-resistance type. Battery E supplies a bias current, and M is a d.c. milliameter. R6 is a balancing potentiometer for setting the meter pointer to zero. The four bridge arms are closely matched.

The bias current flowing through R5 and the arms of the bridge develops a series of voltage drops in the circuit. With respect to point D, points A and B would have the same negative voltage, and point C would have twice the voltage of A and B. R6 is adjusted to the same voltage as C so that no current flows through the meter. If a.c. is applied across A and B the following action takes place: (See Fig. 3) During the first half-cycle the voltage at point A is increasing and the voltage at point B is decreasing. The resistance of nonlinear arms R1 and R2 decreases, while arms R3 and R4 increase. When point A reaches the same voltage as point D, the voltage at B will equal the voltage at C. At this instant no current can flow through R3 and R4, and these two arms are effectively eliminated from the circuit. The current path under these conditions is shown by the arrows in Fig. 3. The increased current through R1, R2, R5, and R6 changes the voltage at C and unbalances the meter.

As the voltage at point A continues to rise, potential differences again develop across R3 and R4, and their resistance decreases. Only part of the additional current drawn by R3 and R4 flows through the meter circuit. The meter reading increases logarithmically. (This characteristic is highly desirable for many applications. Ordinarily, logarithmic-scale instruments require specially-shaped magnets or complex circuitry.)

On the negative half-cycle the func-

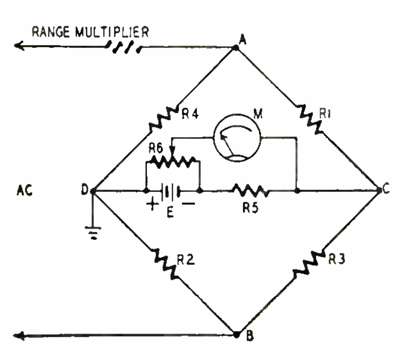


Fig. 2—"Translator"-type a.c. meter.

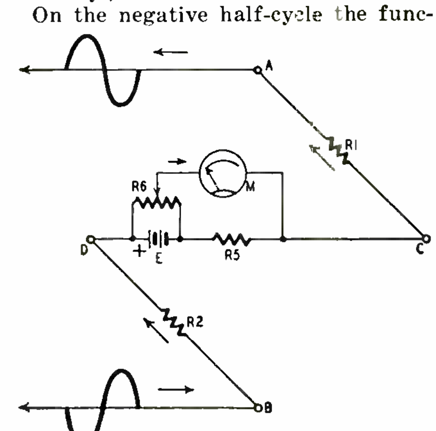


Fig. 3—Current paths in the circuit.

*President, Conant Laboratories.

tions of the opposite arms are reversed. The main current path is now through R3, R4, R5, and R6, but still in the original direction through the meter.

Higher bias current extends the low-voltage sensitivity of the circuit. (Increasing the bias current solely by reducing R5 will decrease the meter response by the greater shunting effect.)

Reducing the bias current increases the maximum voltage that can be read on any range, at the expense of low-voltage sensitivity.

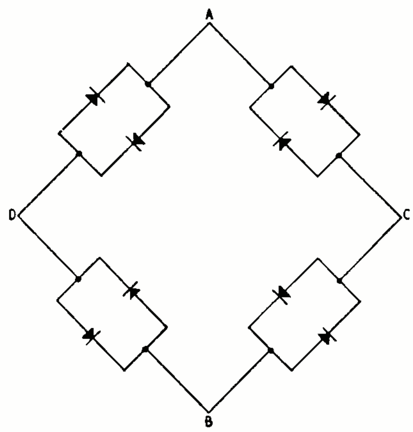


Fig. 4—A two-bridge translator.

Circuit variations

Both copper oxide and selenium rectifiers were tried in developing the translator circuit. With copper-oxide units, the low-voltage sensitivity was excellent. Slight instability in the selenium rectifiers caused some drift in readings.

The question of whether or not rectifying action was involved in translator operation was settled by constructing a bridge of nonrectifying Thyrite resistors (G.E. No. 8396839G1). Aside from requiring a higher bias voltage, the Thyrite bridge performed very well, although it was not as sensitive to very low voltages as the copper-oxide bridge.

A translator can be made by connecting two full-wave bridge rectifiers as shown in Fig. 4. An assembled unit is shown on the opposite page.

The frequency response of the translator appears to be perfectly flat up to 20 kc. While conventional rectifier-type instruments indicate the *average* value of the a.c. voltage, there is some indication that the translator shows *r.m.s.* voltages.

Like rectifier-type instruments, the translator does not have uniform scales

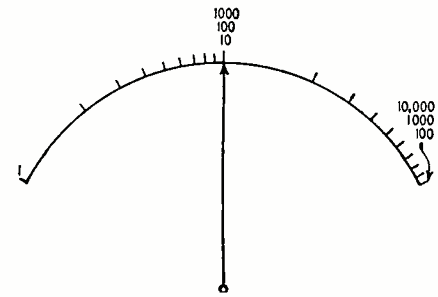


Fig. 5—Logarithmic scale calibration.

on all voltage ranges. The scale uniformity and accuracy are improved by using a different value for R5 as well as a different multiplier on each range.

Logarithmic scale calibration makes it possible to read low and high voltages accurately on a single range. (See Fig. 5.) With the translator circuit an instrument covering 0–10,000 volts in only three ranges can be built without difficulty.

—end—

TRANSISTOR PRODUCTION AT ALL-TIME HIGH LEVEL

The transistor has emerged from the laboratory to become a full-fledged production item. According to reports made at the Symposium on Progress in Quality Electronic Components held in Washington early in May, nearly 8,500 transistors were being produced monthly. Six companies were actually producing transistors in commercial quantities, and two others expected to be ready to manufacture in appreciable quantities within a few months.

Western Electric, with 6,000 transistors per month, was producing the bulk of the output. Raytheon followed with 1,000 per month, with General Electric and RCA making 800 and 400 respectively. RCA expected to up its output to between 2,000 and 3,000 per month by the end of the year, and other companies indicated that sharp increases in production were expected, though the exact quantity to be produced would depend on orders received.

Practically all the transistors now being manufactured or slated for immediate future production are of the contact type. Only Western Electric reported manufacture of junction transistors—on an experimental basis only, with an output of less than 100 per month.

Military procurement accounts for 6,000 transistors per month; the output of Western Electric being allocated as a result of an arrangement between the military departments and the company.

The limited production still hampers widespread use of the transistor, as a manufacturer would be unable to take a contract for equipment requiring a couple of thousand transistors unless he could obtain the whole unallocated output of the country for a month, or large fractions of it over a proportionally longer time. Price is the other barrier to wider use. The units are listed in mail order catalogs today at $18 each. Presumably those sold in larger quantities are somewhat—but not greatly—cheaper. At a price so much greater than the vacuum tube, the transistor becomes practical only when extreme miniaturization or other special necessity disqualifies the tube for the application.

The table below, abstracted from a paper presented by Lt. Colonel W. F. Starr at the Washington symposium, shows the present situation in transistor production.

—end—

AVAILABILITY OF TRANSISTORS

COMPANY	MONTHLY PRODUCTION		DELIVERY TIME		REMARKS
	CONTACT	JUNCTION	CONTACT	JUNCTION	
Federated Semi-Conductor Co., New York, N. Y.	...	...	...	...	Sample lots available in May, 1952
General Electric Syracuse, N. Y.	800	...	6-8 wks.	Not quoting	Sample lots Junction type Oct.-Nov. 1952
Kemtron Salem, Mass.	...	...	...	...	Sample lots Point contact Sept. 1952
RCA Harrison, N. J.	400	...	4-6 wks.	...	Sample lots Junction type Oct.-Dec. 1952
Radio Receptor New York, N. Y.	200	...	4-8 wks.	...	
Raytheon Newton, Mass.	1,000	...	4 wks.	Not quoting	Sample lots Junction type Nov.-Dec. 1952
Sylvania Boston, Mass.	...	...	...	...	Sample lots Point contact Aug. 1952
Western Electric New York, N. Y.	6,000	Less than 100	4-8 wks.	Not quoting	

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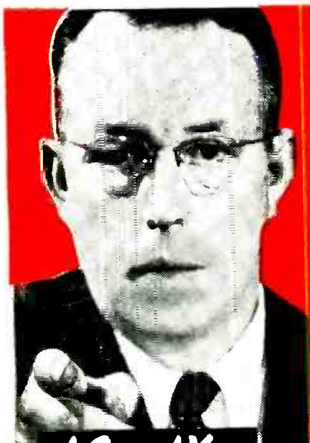

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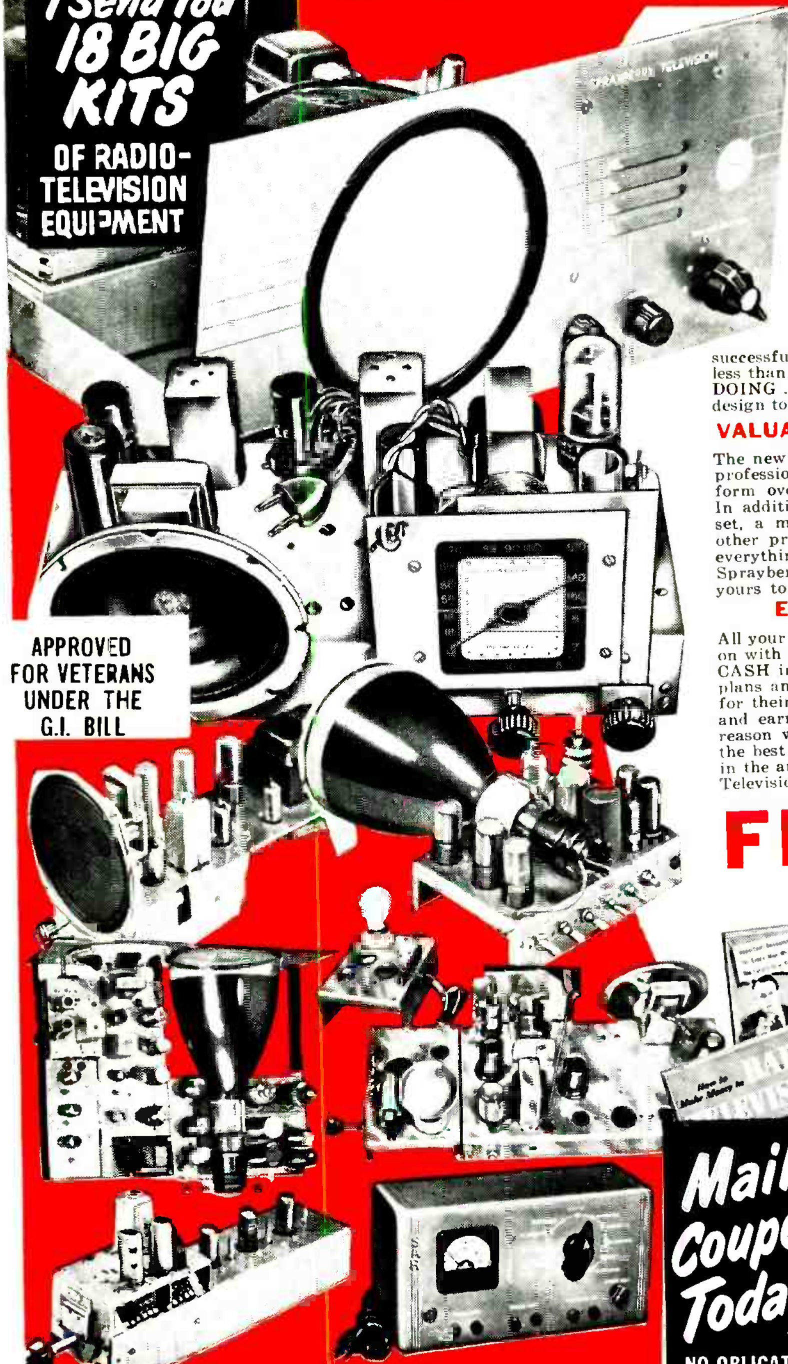

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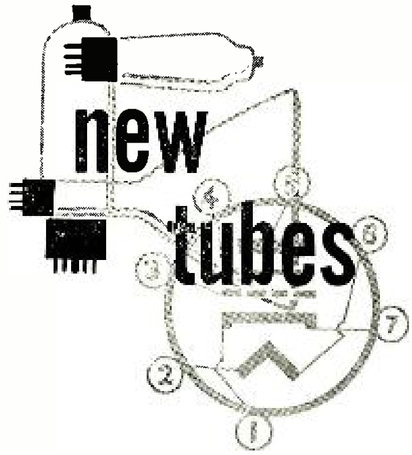
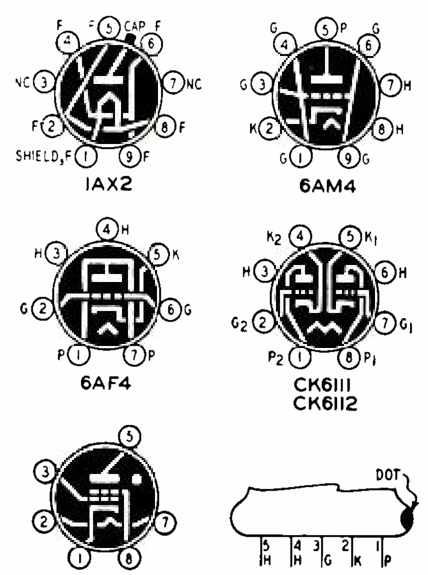


The 1AX2, incorporating several improvements over the 1X2 and 1X2A, has been announced by CBS-Hytron. A heavier filament, reduced interelectrode capacitance, and higher voltage ratings give better regulation and meet the load demands of new large-screen picture tubes. Filament rating is 1.4 v at 650 ma; peak inverse plate voltage 25,000 max.; d.c. load current 1 ma max. Basing is shown in the acccompanying diagram.

G-E has developed the 6AM4, a nine-pin miniature grounded-grid triode mixer for u.h.f-v.h.f. TV receivers. It has a conversion gain of approximately 4 at 900 mc. Average characteristics of the 6AM4 are: Plate volts, 150; plate current, 7.5 ma; amplification factor, 90; transconductance, 9,000 micromhos; cathode resistor, 100 ohms.

Both G-E and RCA are producing the 6AF4 7-pin miniature triode oscillator for u.h.f. TV converter service. Silver-plated base pins and double connections for both plate and grid reduce losses and enable the 6AF4 to be used up to 1,000 mc. The following ratings are for operation at 950 mc: Plate voltage, 100; grid voltage (from a 10,000-ohm grid resistor)—4; plate current, 22 ma; grid current (approx), 400 μa; useful power output, 160 mw. Base connections are given in the accompanying diagram.



Basing diagrams of some of the recent tube types described in this article.

Three new 6.3-volt heater-cathode subminiature types have been introduced by Raytheon. All are designed to withstand severe shock and vibration. Type CK6111 is a medium-mu twin-triode for u.h.f. service. Typical operating conditions for each triode unit: Heater current, 0.3 amp; plate voltage, 100; cathode resistor, 220 ohms; transconductance, 4,750 micromhos; amplification factor, 20; plate current, 8.5 ma.

Type CK6112 is a high-mu twin triode with each unit rated as follows: Heater current, 0.3 amp; plate voltage, 100; cathode resistor, 1,500 ohms; transconductance, 1,800 micromhos; amplification factor, 70; plate current, 0.8 ma.

Type CK6152 is a single u.h.f. triode with the following average ratings: Heater current, 0.2 amp; plate voltage, 200; cathode resistor, 680 ohms; transconductance, 4,000 micromhos; amplification factor, 15.5; plate current, 12.5 ma.

The three types have wire leads which may be trimmed to fit subminiature sockets. Connections are given in the accompanying basing figure. Their life expectancy at 30° C ambient temperature is 5,000 hours.

Special purpose types

Raytheon has announced a contact transistor, type CK716, for amplifier or switching applications. The CK716 has the following characteristics in grounded-base operation: Collector current, 2.5 ma; emitter current, 1 ma; collector voltage, –15; emitter voltage, 0.5; current amplification (minimum), 1.2; frequency response, 1 kc to 100 kc

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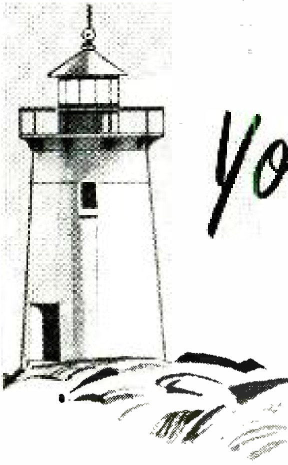

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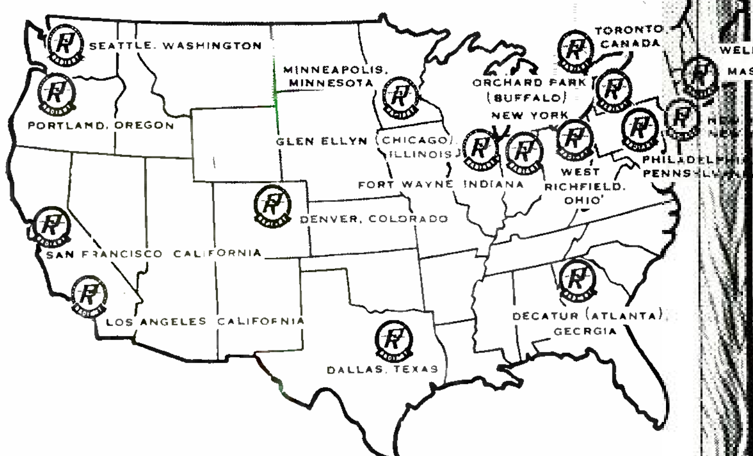

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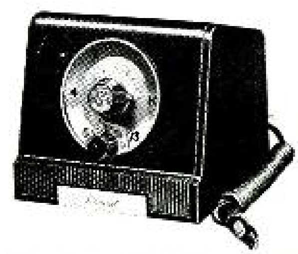

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within 3 db. The CK716 is enclosed in a small brass shell which forms the base connection. Emitter and collector connections are made to nickel pins which fit a Cinch Exp. 8749 socket or equivalent.

RCA has developed the 6012 hot-cathode thyratron for 60-cycle motor-control and low-power inverter service. Button-stem design gives the 6012 high resistance to shock and vibration, and reduces susceptibility to electrolysis. The 6012 can handle an average load current of 0.5 amp. Socket connections are given in the basing diagram.

A new RCA transmitting tetrode for u.h.f. TV, type 6181, is capable of 1,200 watts sync-level output at 900 mc. The 6181 features coaxial-electrode construction, ceramic-bushing insulation, and an integral radiator for forced-air cooling.

—end—

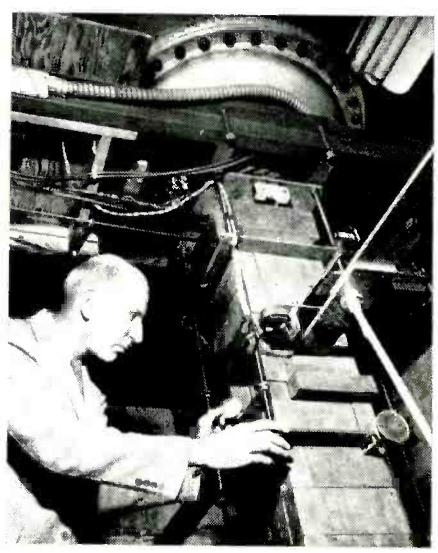
FREE ELECTRONS SERVE SCIENCE IN NEW WAYS

The Lenard ray, discovered in 1896, is finding new applications in the laboratories of General Electric and other leading research institutions. Electrons, accelerated practically to the speed of light, are allowed to bombard living tissue, biological specimens, and other materials.

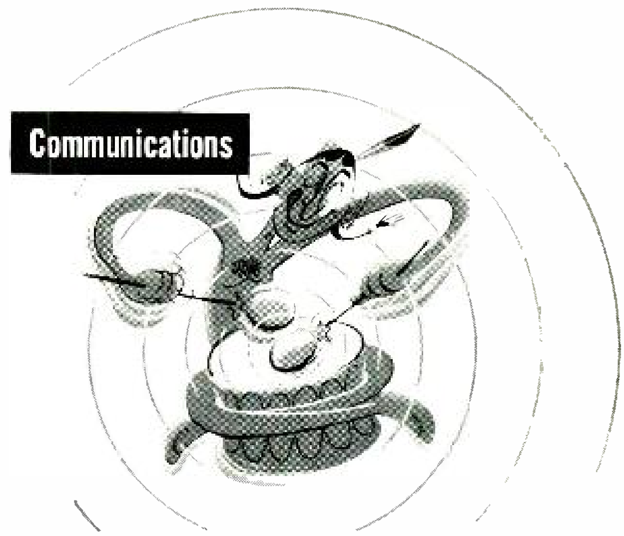
Decay-causing molds and micro-organisms are destroyed by the beam, indicating possible food preservation without refrigeration, and sterilization of substances such as blood plasma without destructive heating.

Formation of solid plastics from liquid bases through chain-reaction polymerization set off by high-speed electrons is also foreseen.

Deep-seated malignancies and tumors might be treated with less danger by this method, according to Dr. C. G. Suits, G-E director of research.



Common sawdust was converted to digestible cellulose cattle food by bombardment. The photograph shows Elliott J. Lawton of the G-E Research Laboratory placing a specimen in a lead-shielded chamber for bombardment by electrons at an acceleration of 70,000,000 volts.



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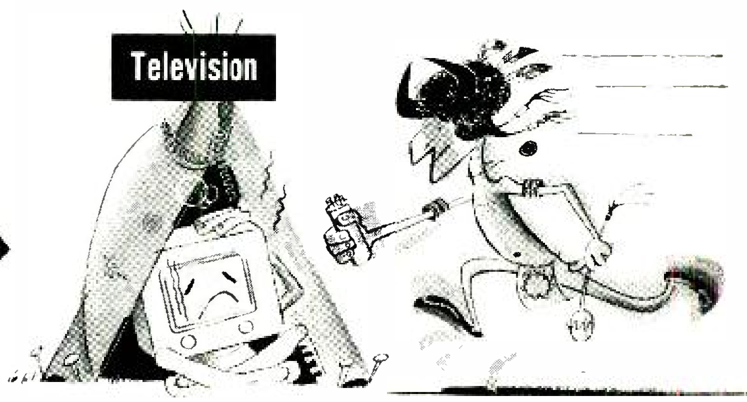

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SC52-3

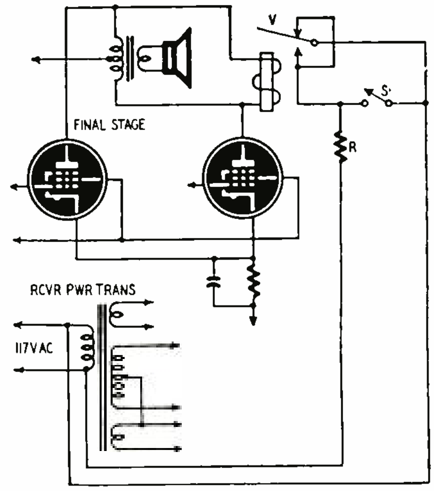
RADIO POLL DEVICE

Patent No. 2,587,213

Herbert S. Polin, Rio de Janeiro, Brazil
(Assigned to Audience Computing System, Inc. New York, N. Y.)

This device registers the size of a radio or TV audience. Such a count is important for determining which programs are most popular. At present, popularity data is obtained from personal or telephone inquiries, expensive and not highly satisfactory methods. The new method computes the number of sets tuned to a particular program.

Each receiver to be included in the poll is equipped with a 20-cycle vibrator V and a resistor R.



To measure the size of an audience, a 20-cycle signal is superimposed on the program. This low-frequency is inaudible and invisible at the receiver. However, it appears at the output stage and energizes V, which closes its contacts periodically, permitting pulsating current to flow through R. The power substation measures the pulsating current taken by all equipped receivers. Thus the total number of sets may be computed. The switch S is used for special purposes. For example, listeners may vote for a preferred contest winner by shorting the switch S when requested.

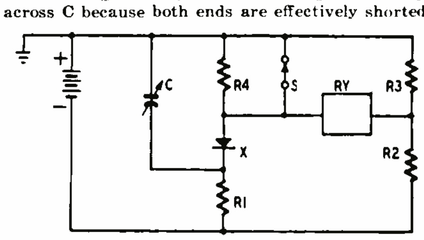
SLOW-RELEASE RELAY CIRCUIT

Patent No. 2,583,328

Thomas L. Dimond, Rutherford, N. J.
(Assigned to Bell Telephone Laboratories, Inc.)

This circuit gives any relay slow-release characteristics. This eliminates the need for copper slugs or special construction where slow release is required. The relay must have two armatures.

With S closed, battery current flows through R2 to energize relay RY. No charge builds up across C because both ends are effectively shorted



together by the low forward resistance of X. When S is opened, RY remains energized by current through R4, RY and R2. X becomes blocked for a short interval. Its cathode remains at ground potential (since it takes time for C to charge) while its anode goes negative immediately due to current through R4.

The relay holds until C builds up its negative charge through R1. When this charge exceeds the voltage drop across R4, X conducts. This creates a shunt path (through R1 and X) across the relay. It also increases the drop across R4. In time, the resistance of X drops to a relatively low value and the drop across R4 becomes large enough so that the relay drops out. This interrupts its load circuit and ends the timing interval. Release time is controlled by C and R1.

SEMICONDUCTIVE SWITCH

Patent No. 2,589,704

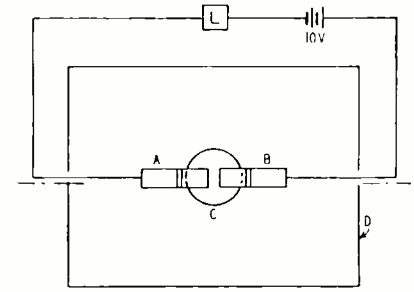
Wm. E. Kirkpatrick, Chatham, N. J., and Raymond W. Sears, West Orange, N. J.

(Assigned to Bell Telephone Laboratories, Inc.)

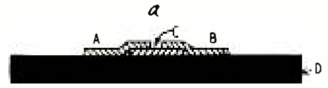
Germanium and cadmium sulphide crystals can be used as amplifiers and electron switches which are compact, operate instantly, and do not have moving parts.

Drawings *a* and *b* (below) show the construction of one of these switches. A thin film of germanium C (only a few microns thick) is evaporated onto an insulating block D. Metal contacts A and B are plated on the semiconductor. The switch is connected in series with a load L and a 10-volt battery (see drawing *a*). Normally the switch resistance is high, so practically no current flows. Under an electron bombardment, the switch is shorted out and current flows through the load (which may be a relay).

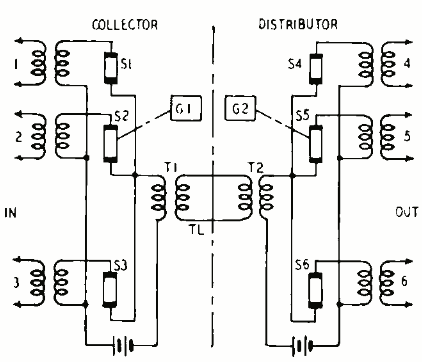
A practical switching arrangement is shown below. Switches S1, S2, S3 are enclosed within an input (collector) cathode-ray tube. An output (distributor) cathode-ray tube contains switches S4, S5, S6. In both tubes the electron beam is controlled (by deflecting plates) so that it falls on the desired switch. In the illustration the beam from electron gun G1 falls on S2. The distributor beam is shown falling on S5. Under this condition, an input signal at line 2 is passed through S2, T1, transmission line TL, T2, S5, and out through line 5. There is no coupling between any other pair of lines.



a



b



FREQUENCY DIVIDER

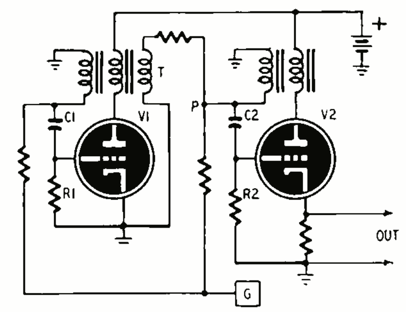
Patent No. 2,585,722

Jack A. Baird, Rockaway, N. J.

(Assigned to Bell Telephone Laboratories, Inc.)

Multivibrators are often used to reduce an input frequency by a whole-number ratio like 4, 5, or 6. This new circuit is more stable than a multivibrator because it can divide frequency only by an *even* integral ratio like 4 or 6. For example, the circuit may be adjusted to divide by 4. Division by 3 or 5 is excluded. The next possible division ratios are 2 and 6. These are so far removed from the desired ratio 4 that even extreme interference cannot upset the divider circuit.

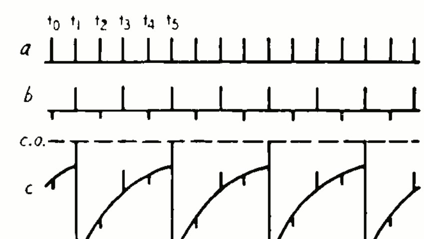
The divider uses two blocking oscillators controlled by a pulse generator G (see diagram). R1, C1 are adjusted so V1 oscillates at slightly less than one-half the pulse frequency. R2, C2 are adjusted for V2 oscillation at about one-fourth the pulse frequency. The diagram *a* below shows the positive pulses from G. They occur at times t_0, t_1, t_2. . . . V1 is triggered at t_0, t_2, t_4. . . . When this occurs, the tertiary winding T



provides a negative pulse which exceeds and overcomes the positive pulse from G.

The pulse voltage at P appears at *b*. The odd pulses are negative because V1 is triggered at these instants. At other times, the positive pulses from G are unopposed.

The alternate positive and negative pulses at P are impressed upon V2. Waveform *c* shows how these pulses are superimposed over the grid bias. It is assumed that V2 is triggered at t_1. Its grid is immediately brought far below cutoff (*c.o.*) and the voltage rises exponentially as



shown. Note that the fourth pulse (at t_5) is sufficient to trigger V2 again. The odd pulses at V2 are negative, so only even pulses can trigger the tube.

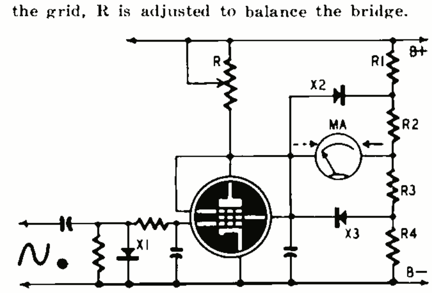
METER PROTECTION

Patent No. 2,584,800

George L. Grisdale, Great Baddow, Chelmsford, Eng.

(Assigned to Radio Corp. of America)

This voltmeter circuit protects meter against overload, without effect on the sensitivity or linearity of measurement. The a.c. signal is rectified by X1, filtered, and fed to the tube grid. The meter MA is connected in the diagonal of a bridge network. Two of the bridge arms are formed by the internal resistance of the tube and the adjustable resistor R. The third is R1, R2, and the fourth arm is R3, R4. With no signal at the grid, R is adjusted to balance the bridge.



Bleeder current flows through R1, R2, R3, and R4. The drop across R3 blocks rectifier X3. The drop across R2 blocks X2. Normally, therefore, MA is unshunted and sensitivity is not lost.

An overload current may flow through the meter in either direction. For example, a large negative signal at the grid will increase the tube resistance. Then there will be an excessive electron flow through the meter in the direction of the *full* arrow. On the other hand, too high a value of R or some defect in the bridge circuit may force excessive current through the meter in the direction of the *dotted* arrow.

In the first case, the overload unblocks X2, and part of the meter current is shunted through this rectifier. In the second case, X3 is unblocked and again the meter is protected by the shunt.

WIDE RANGE A.F. OSCILLATOR

Patent No. 2,583,649

William R. Hewlett, Palo Alto, Calif.

(Assigned to Hewlett-Packard Co.)

This invention deals with a Wien bridge oscillator in which R alone is varied. In a conventional instrument the control element is changed over a 10:1 ratio. This is shown in

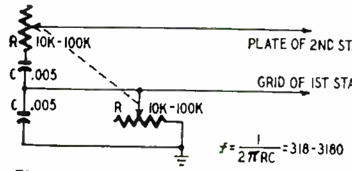


Fig. 1

Fig. 1. The equation given here shows that frequency will vary over a range of 1 to 10. For example, this particular network (followed by the usual two-stage amplifier) provides output from 318 to 3,180 cycles.

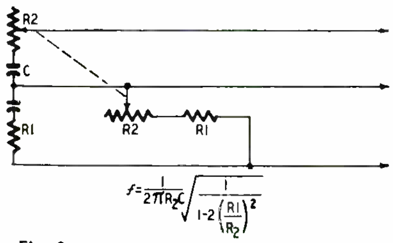


Fig. 2

Fig. 2 is a modified circuit for extended range. R may vary 10:1 as usual, and its minimum value may be 3/2 R1. Under these conditions the lowest frequency will be nearly equal to that of Fig. 1. At the high end, however, frequency is extended by the factor 3.

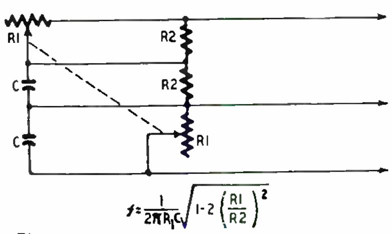


Fig. 3

Another modification appears in Fig. 3. Here the maximum value of R may be 2/3 R2. Using the equation for this figure we find no change at the h.f. end. The low end of the range is extended by the factor 3.

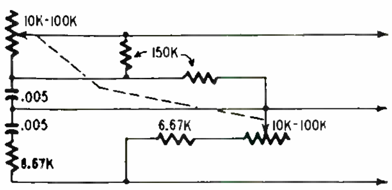


Fig. 4

The two previous circuits are combined in Fig. 4. Frequency range is extended in both directions. With the values given, the coverage is 106–9,540 cycles in a single range and with only 10:1 variation of R.

CORE-LOSS TUNING

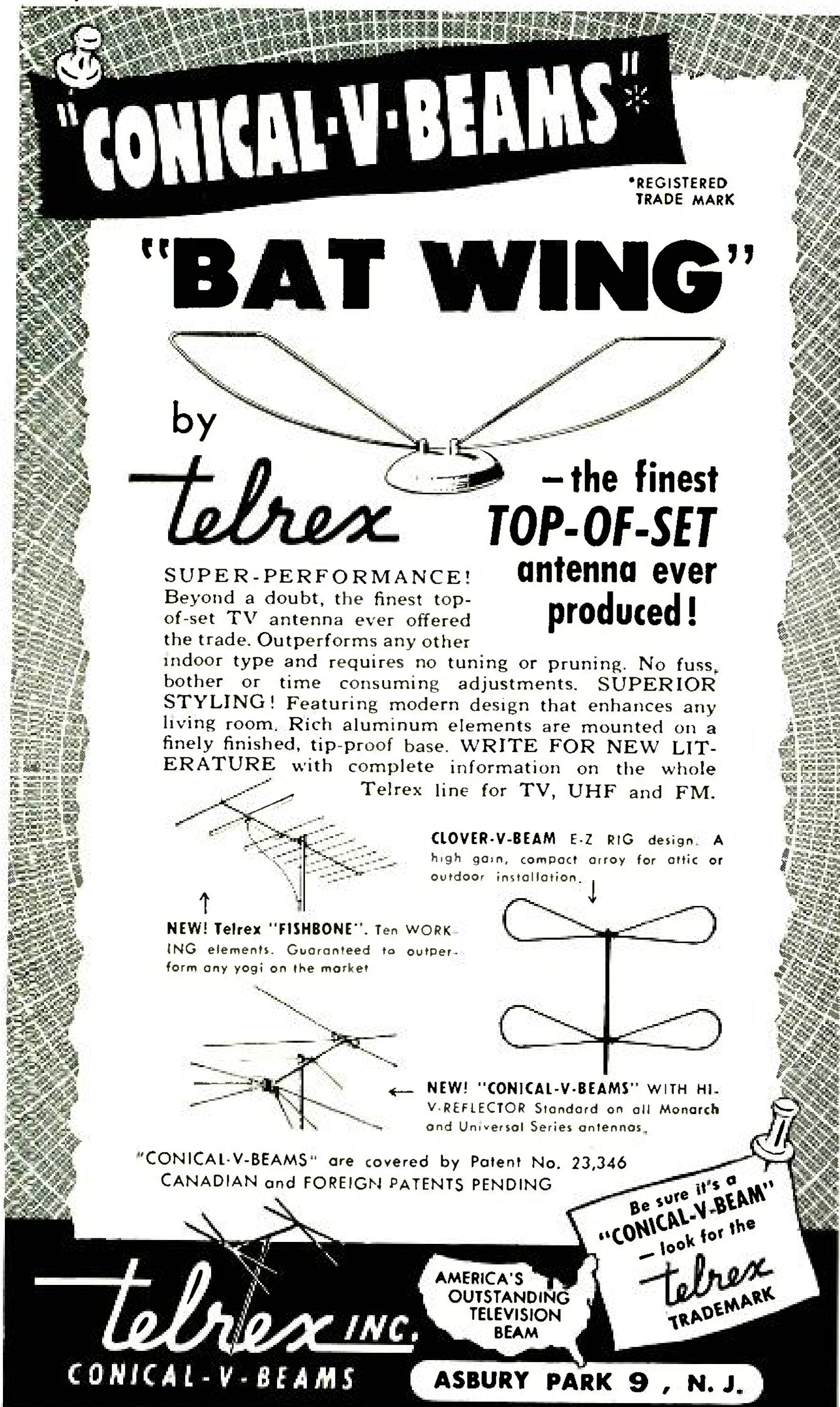
Patent No. 2,579,996

Loy E. Barton, Princeton, N.J.

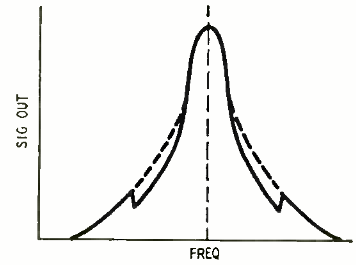
(Assigned to Radio Corp. of America)

This invention discloses an efficient and sharply-tuned i.f. transformer. Its cores are of magnetic ferrite. Considerable power is absorbed by these magnetostrictive cores at their resonant frequencies. The core losses are made to occur at adjacent channel frequencies, thus improving the selectivity of the transformer.

The transformer coils are tuned in the normal manner. In a typical AM receiver, the center i.f. may be 455 kc. The primary core may resonate at 445 kc and the secondary core at 465 kc. The dotted curve shows ordinary i.f. transformer response. The solid curve shows response when the new cores are used.



The frequency of maximum loss is determined by the core dimensions. For an i.f. of 455 kc, cores are approximately 1/16 inch square and 1/4 inch long. Each is ground to its exact frequency, like a quartz crystal.

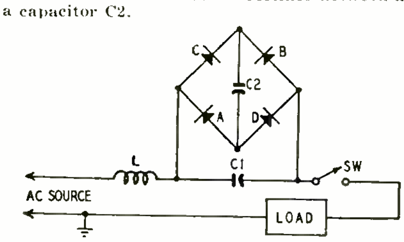


Normally each core would undergo a complete magnetic cycle during each half-cycle of i.f. Thus the core would resonate at twice the i.f. To prevent this, a permanent magnet biases each core.

TRANSIENT CONTROL

Patent No. 2,585,069
Hans K. Ziegler, West Long Beach, N. J.
(Assigned to United States of America as represented by the Secretary of the Army)

This invention absorbs transients which arise when a voltage is switched on and off. Due to resonance effects, the transient may reach a dangerous peak which may break down capacitors and other components. The figure shows the control circuit which includes a rectifier network and a capacitor C2.



The a.c. source may be a PM generator which feeds a load through a transmission line. To offset the inductance of the *generator* and *line* (represented by L) a capacitor C1 is connected in series. This capacitor is endangered when a transient peak is generated.

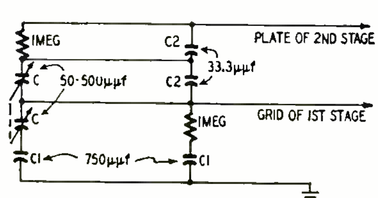
When SW is closed, a transient may occur. Assume that its first half-cycle is positive. Then it blocks A and B, while permitting C and D to conduct. During this short time, C2 is effectively in parallel with C1, adding to the total capacitance. C2 is large enough to absorb much of the transient charge and prevent it building up a high voltage peak. After a short interval, the transient subsides and the charge on C2 leaks off. Each rectifier normally has high resistance and C2 is effectively isolated from the remainder of the circuit.

When SW is opened, another transient occurs. Again C2 is momentarily shunted across C1 to absorb the charge and prevent a peak from building up across capacitor C1.

WIDE RANGE A.F. OSCILLATOR

Patent No. 2,583,943
William R. Hewlett, Palo Alto, Calif.
(Assigned to Hewlett-Packard Co.)

This invention is similar to the one described in Patent 2,583,649. This one is applicable to Wien-bridge oscillators where C (instead of R) is the control element.



The figure shows a preferred form of the new network. With the values shown, the frequency range is 106–9,540 cycles.

—end—

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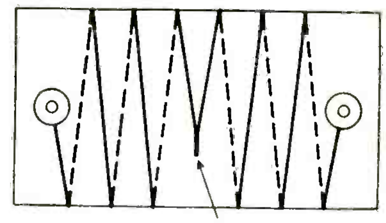
PRECISION RESISTORS

When winding precision resistors by hand, the usual procedure is to solder the resistance wire to the terminals and then check the resistance on a bridge. We have noticed that thermoelectric effects cause erroneous readings as long as the soldered joints are slightly warm. Instead of waiting for the joints to reach room temperature, we use the following procedure when winding resistors:



LENGTHEN SOLDER JOINT TO LOWER RESISTANCE

The resistance wire is cut slightly longer than necessary, then it is cut in the middle. The ends of the halves are permanently fastened to the terminals and the inside ends of the wires are then soldered together. The resistance is reduced to precisely the desired value by lengthening the soldered joint as shown in the illustration. With this type of construction, the thermoelectric effects are equal and opposite so they cancel.

If the resistance wire is difficult to solder, try wrapping the joint tightly with No. 30 tinned copper wire before soldering.—*Martin J. Brick*

SAFETY AND ELECTRIC TOOLS

Portable electric saws, drills, sanders, hedge clippers, and other devices which we use every day are potential killers when we do not take steps to protect ourselves against electrical shock. Most of these appliances have an extra wire protruding from the rear of the line plug. This is a ground wire which is attached to the metal frame of the motor or housing of the equipment. It is a good idea to check this connection with a low-range ohmmeter. The wire is included as a safety measure to protect the operator if one of the power leads should short to the frame.

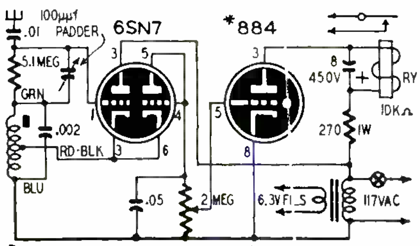
Never operate such equipment without first grounding the third lead. Solder it to a length of heavy flexible lead which terminates in a large battery clip for connecting to a convenient water pipe or electrical conduit, or a short length of metal rod pointed at one end so it can be pushed into the earth. If the appliance does not have a ground wire, install one. The third wire can be connected to the metal body of the device and taped to the outside of the power cord.

For safety in the household, connect a good ground lead to the motor on the wife's washing machine, ironer, electric mixer, and any other appliance which she uses while standing on a concrete floor or when working near the kitchen sink or wash basin.—*Norris C. McKamey*

IMPROVED ALARM SYSTEM

Here is an improvement in the circuit of the capacitance relay described by Ernest J. Schulz in RADIO-ELECTRONICS for July, 1950.

By using a commercial 456-kc b.f.o. transformer (Meissner 17-6753 or equivalent) for the oscillator coil, and shunting it with a .002-μf capacitor as shown below, the oscillator frequency



■MIESSNER 456KC BFO-SEE NOTE *6J5-G MAY ALSO BE USED

is brought low enough to avoid i.f. or r.f. interference in modern broadcast receivers. The unit shown in the photos uses the chassis and relay from a surplus BC-357-B marker-beacon receiver.

The antenna may be a wire around the object to be protected. A screen door or window screen makes a very sensitive antenna or "feeler."

—*J. Francis Nielsen.*

SIMPLE TEST FOR METERS

When it is necessary to test an ammeter or voltmeter for burnout, and no battery or other voltage source is available, proceed as follows: In the case of an ammeter, disconnect any shunts connected across the meter coil, whether inside or outside the case. Then, shake the meter sharply and note the pointer deflection. Place a short circuit across the meter terminals. With a voltmeter, be sure to get the short directly across the coil, leaving out any internal or external multipliers. After this is done, shake the meter as before and again note the pointer movement. If the meter coil is good, the deflection will be much less than before. This reduction is caused by electromagnetic damping by currents induced in the coil when the pointer swings. These currents flow through the coil and across the short-circuited terminals. However, if the coil is burned out or otherwise open-circuited, these currents cannot flow, and thus there is no reduction in deflection.—*Charles Erwin Cohn.*

—end—

ONE-TUBE INTERCOM

This simple two-station intercom is ideal for use between the kitchen and garage or any other points in the average home. It is easy to build. The parts can be purchased for about ten or twelve dollars.

A 117N7-GT is used as a half-wave rectifier and audio amplifier in the master unit. See Fig. 1. The remote station consists of a small speaker and a 2-position switch connected to the master through 3-conductor cable.

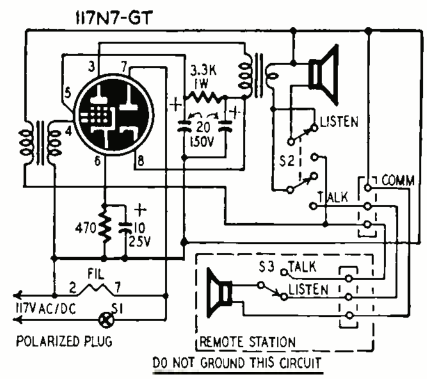


Fig. 1—Circuit of the 1-tube intercom.

S1 is a s.p.s.t. toggle or rotary switch. S2 and S3 are spring-return, nonshorting rotary switches. They are shown in the normal positions in the diagram. The input transformer matches the 4-ohm speakers to a grid and the output transformer matches the 3,000-ohm plate of the output tube to the voice coils.

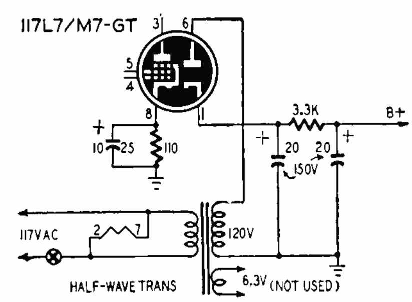


Fig. 2—Safe, more satisfactory hookup.

To minimize shock hazard, all returns should be made to a single B-minus point which is insulated from the chassis. The power cord must be fitted with a plug polarized so the B-minus bus is always connected to the grounded side of the power line.—*Frank W. Smith*

(In cases where the unit will not be operated on d.c. lines, we recommend substituting a 117L7/M7-GT with its heater and rectifier circuit connected as shown in Fig. 2. The transformer isolates the B-minus circuit from the power line, thus eliminating the possibility of a shock from this source. The power transformer may be a Merit P3045, Thordarson T-22R12, or equivalent. Do not attempt to operate the heater from the secondary side of the transformer because most inexpensive units of this type cannot stand the added drain of the 90-ma heater.

All components and connections not shown in Fig. 2 are the same as in Fig. 1, except that the output transformer should have a 4,000-ohm primary.—*Editor*)

MONITOR-OSCILLATOR

All amateurs should monitor the phone quality and the keying of their transmitters. A novel phone-c.w. monitor and code-practice oscillator is described in *G-E Ham News*. Its circuit is reprinted here through courtesy of the copyright owners, General Electric Company.

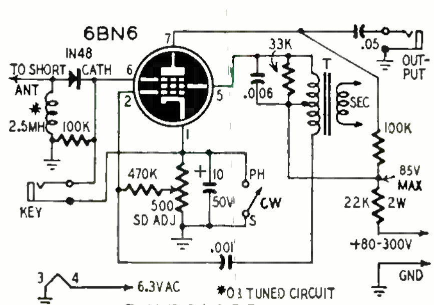
The unit uses a 1N48 germanium diode as the detector and a 6BN6 gated-beam tube with grids 1 and 2 operating as a transitron a.f. oscillator for monitoring code signals and code practice. The whole tube operates as an audio amplifier.

When no r.f. signal is present, the current drawn by grid 2 develops a drop across the 500-ohm cathode resistor producing enough bias on grid 3 to cut off the plate current. The arm of the 500-ohm cathode resistor sets the bias on grid 1 so the circuit oscillates. Although this section of the tube (grids 1 and 2) is oscillating, the signal cannot appear in the plate circuit because plate current is cut off by the bias on grid 3.

When the transmitter is keyed, the detector rectifies a part of the r.f. signal and develops a positive bias for grid 3. The oscillator signal then appears in the plate circuit and at the OUTPUT jack. The unit can be used as a code-practice oscillator by inserting a key in the KEY jack and a pair of phones in the OUTPUT jack. Closing the key connects grid 3 to the cathode, thus removing the bias and permitting the plate to pass current.

For phone monitoring, the cathode switch is closed to disable the oscillator circuit. The 6BN6 now operates as a straight a.f. amplifier for signals detected by the 1N48.

The oscillator uses the primary of a universal push-pull audio output transformer. The resistor and capacitor paralleled across one-half the winding may have to be selected experimentally if the transformer you use is of a type other than a Stancor A-3823. Plug in a key and headphones. Increasing the value of the capacitor lowers the pitch and decreasing the value raises it. Decrease the value of the resistor if you hear a tone in the output with the key open. Try progressively smaller resistors until you hear the tone only with

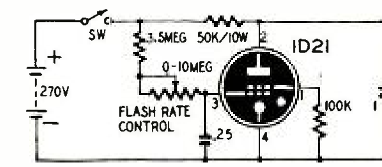


the key closed. Increase the value of the resistor if you don't get a tone when the key is closed.

The monitor-oscillator may be operated from a source delivering 80–300 volts. The 22,000-ohm, 2-watt resistor drops the voltage to a safe value (not more than 85 volts) for grid 2. Higher voltages may damage the tube. Whatever the value of the applied B plus, the dropping resistor must be changed so the voltage at the center-tap on the transformer does not exceed 85. The unit will work when this voltage is reduced as low as 50.

ELECTRONIC FLASHER

The simple electronic flasher shown in the diagram can be used as a flashing danger signal or as a portable stroboscope for timing and checking rotating and reciprocating mechanical parts. Operating voltage is supplied by a 270-volt B battery.

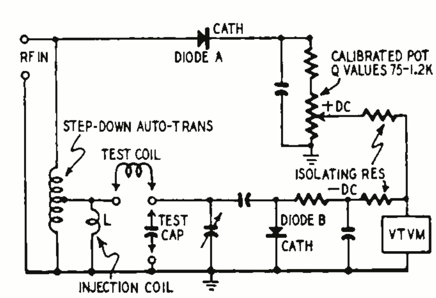


An R-C network consisting of approximately 13 megohms in series with a 0.25-μf capacitor is connected in parallel with the plate and cathode of the 1D21 Strobotron and the 270-volt supply. The starter anode of the tube is connected to the positive side of the capacitor. When the switch is closed, the 0.25-μf capacitor starts to charge through the series resistance. When the charge across the capacitor reaches approximately 60 volts, the starter anode ionizes the gas in the tube and causes the 1-μf capacitor to discharge through the plate-cathode circuit to produce the bright neon-red flash. The flash repeats at a rate controlled by the setting of the 10-megohm potentiometer. — *Harry Peach*

IMPROVED Q METER

An improved type of Q meter, which eliminates the need for two distinct measurements usually made, has been described in a recent British patent application. The voltage injected into the tuned circuit and the voltage across the tuning capacitor are the separate measurements eliminated, only one null indication being required.

R.f. from the generator is rectified by diode A and a fraction of the rectified output applied through a calibrated



potentiometer. A known portion of the r.f. is also taken from the auto transformer and injected into the tuned circuit by coil L. (L is very small compared with the test coil). This injected voltage is magnified by the Q of the tuned circuit and rectified by diode B. This second voltage is also fed to the v.t.v.m. through a large isolating resistor.

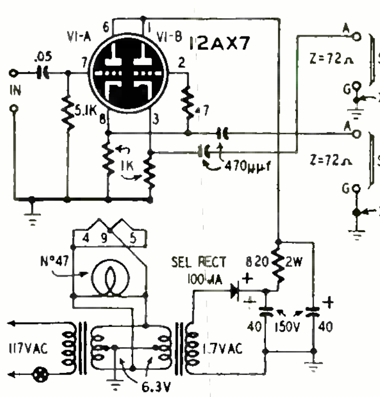
Note that the first rectified voltage is positive and that the second is negative. When these are made equal by adjusting the potentiometer, the v.t.v.m. indicates a null condition. The circuit Q is then read directly from the calibrated potentiometer dial which covers Q values from 75 to 1,200.

TV ISOLATION AMPLIFIER

The unit shown schematically was designed to permit two TV receivers to be operated from a common TV antenna without interaction between them. Unlike matching pads which are generally used for this purpose, this unit provides appreciable boost in the signal to both sets. It has a built-in a.c. power supply which can be connected across the primary of the transformer in the set so the on-off switch of the receiver controls both units.

The circuit consists of a 12AX7 twin triode, chosen for its high amplification factor and plate resistance. The grid of the input section is fed through a .05-μf capacitor from a balanced or unbalanced transmission line. The grid of the second stage gets its signal from the cathode of the first through a 47-ohm resistor. The output terminals are designed for two TV sets having 72-ohm antenna input terminals. If either set has a 300-ohm antenna circuit, insert a 150-ohm resistor at point X in the grounded side of the amplifier output lead.

The power supply is isolated from the a.c. line by two 6.3-volt filament transformers connected back-to-back. A small half-wave power transformer may



be used instead. We recommend Ohmite resistors for this circuit because we have found that they are more stable and do not develop as much noise as other types.

We have had nearly 200 of these units in service for about two years and have not had a single service call or difficulty with them.—*Walt Miller*

—enc—

75-WATT PUBLIC-ADDRESS AMPLIFIER OR MODULATOR

? *Please print a diagram of a 75-watt audio amplifier which can be used as a PA amplifier or modulator for a 150-watt transmitter. I would like the diagram to include a power supply. The output stage should be a pair of 807's or 1625's.—R. McB., Charleston, S. C.*

A. The diagram of the amplifier-modulator is shown. You may use either 1625's or 807's. The diagram shows the latter type. For the former, you will need 7-pin tube sockets and a 12.6-volt filament transformer rated at 1 ampere or more.

The driver transformer should have a turns ratio of about 2.2:1 (primary to ½ secondary) and the output transformers should be rated at at least 75 watts. Their primaries should have an impedance of 4,240 ohms plate-to-plate. One of the output transformers should have a tapped low-impedance secondary for matching lines and voice coils. The modulation transformer should have a tapped secondary to match a wide range of r.f. loads.

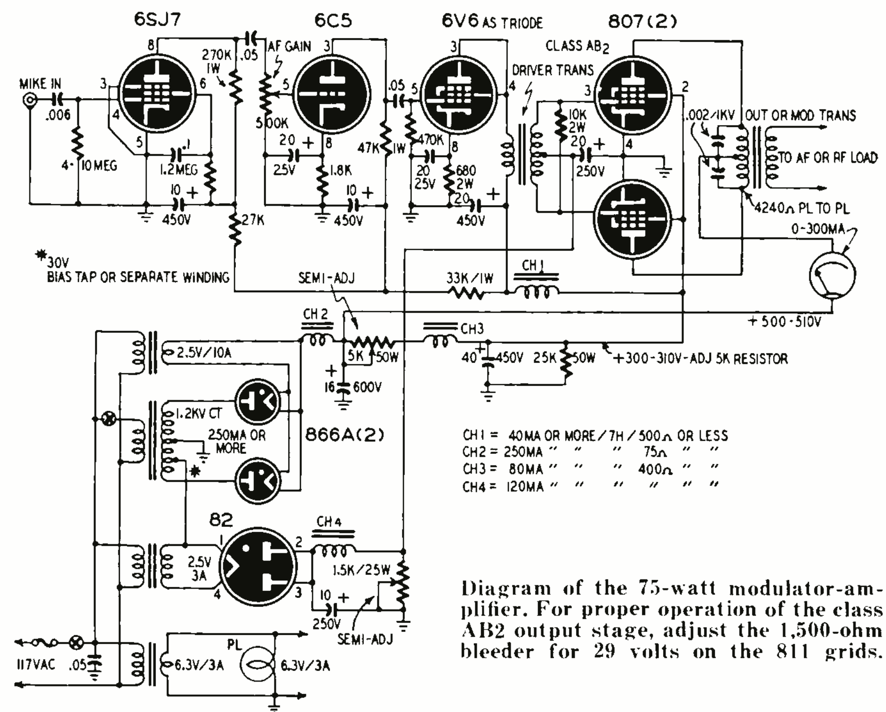


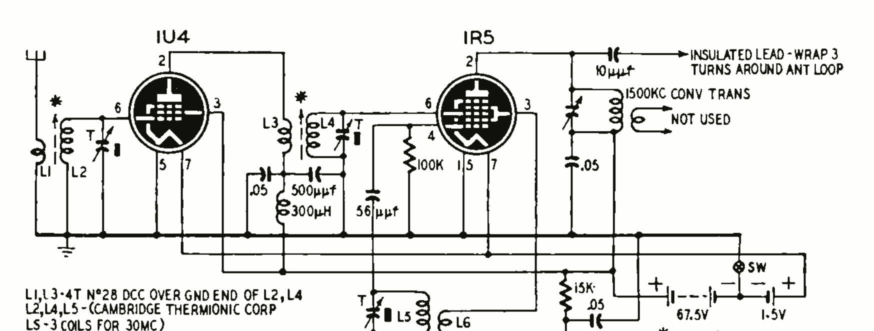
Diagram of the 75-watt modulator-amplifier. For proper operation of the class AB2 output stage, adjust the 1,500-ohm bleeder for 29 volts on the 811 grids.

PORTABLE CONVERTER FOR 39-MC FM TRANSMISSIONS

? *Please prepare a diagram of a battery-operated portable converter to be used with a portable broadcast receiver for receiving 39.58-mc FM transmissions.—H. G., Brooklyn, N. Y.*

A. This 2-tube converter should do a nice job for you. By making slight modifications in the values of the coils and capacitors in the antenna, r.f., and oscillator circuits, you can use the unit on almost any frequency up to about 60 mc. For frequencies between about 35 and 45 mc, L2, L4, and L5 may be Cambridge Thermionic Corporation's LS-3 coils. L1 and L3 are 4 turns of No. 28 d.c.c. wire wound over the ground ends of L2 and L4. L6 consists of 6 turns of the same wire wound over the ground end of L5.

The coils are tuned by 3-30-μμf mica or ceramic trimmers if the unit is to be used for fixed-frequency reception. For work in the amateur bands, the antenna and r.f. tuning capacitors may be ganged air trimmers and the oscillator tuning capacitor may be a small single-section air trimmer. The latter is used for tuning across the band. The ganged unit is used to peak the signal.

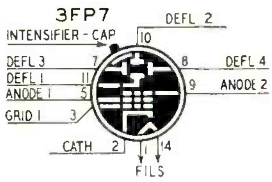


You will not require a special adapter for receiving FM signals. You can receive them simply by slightly detuning the converter or the receiver from the signal for best quality. With careful tuning, you will find it difficult to distinguish between AM and narrow-band FM signals.

3FP7 BASING DIAGRAM

? *I have a 3FP7 cathode-ray tube and cannot find the base connections for it. Can you help me by showing a drawing of the base connections?—Wm. E., Wheeling, W. Va.*

A. The base pin connections of the 3FP7 are shown in the diagram. Since this tube has a long-persistence screen and an intensifier anode, you will find that it is more useful for many applications than the more common types which have P1 or P4 screens. It should serve nicely in an audio analyzer or any other circuit where the sweep is at a comparatively low frequency.



FOREIGN RADIO TUBES

? *Are foreign radio tubes available in this country? I am particularly interested in purchasing tube types DAF11, DCH11, DF11, DL11, and UY11. Can you tell me where I can purchase these tubes?—S. S., New York, N. Y.*

A. You can purchase many types of foreign tubes from Philips Export Corp., 750 S. Fulton Ave., Mt. Vernon, N. Y. When you write, be sure to give the exact make and model of the set and type numbers of the various tubes.

CONNECTIONS FOR SELSYN

? *I have a pair of G-E model 2J1G1 57.5-volt, 400-cycle Selsyns. Can you tell me how to operate them from 117 volts, 60 cycles?—V. M., Federal, Pa.*

A. According to information supplied by Harrison Radio Corp., proceed as follows:

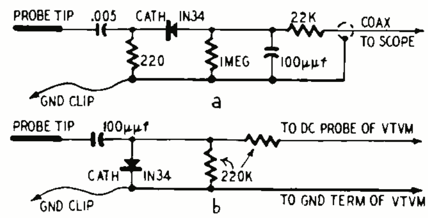
1. Connect like-marked terminals of each unit together (R1 to R1, S1 to S1).
2. Connect a step-down transformer delivering 20-35 volts at 60 cycles to R1 and R2. The 117-volt a.c. line with an oil-filled paper capacitor in series with one leg may be used instead of the transformer. If you use a 8-10-μf capacitor, connect to R1 and R2. For a capacitor from 4 to 6 μf, break the connection R1-R1 and connect one side of the line to each of these points.
3. To reverse the direction of rotation, interchange S1 and S3.

If you plan to use the Selsyns in a direction-indicating system for a rotary beam type antenna for transmission or reception in the u.h.f. or v.h.f. ranges, you will find details on mechanical and electrical modifications in the *A.R.R.L. Antenna Book* and in a number of articles published in amateur publications during the last six years or so.

CRYSTAL PROBES

? *Please show circuits of crystal detector probes for use with oscilloscopes and electronic voltmeters.—F. W., Clifton, N. J.*

A. Probes for v.t.v.m.'s and scopes are essentially the same. They have a few simple components which can be housed in a shielded can at the end of the cable connected to the instrument for which it is designed.



The diagram of a popular detector for a scope is shown at *a*, and a similar unit for a v.t.v.m. is shown at *b*. The 220-ohm input resistor shown in *a* may be increased in value to reduce circuit loading. This will cause some loss in high-frequency response.

YAGI DESIGN DATA

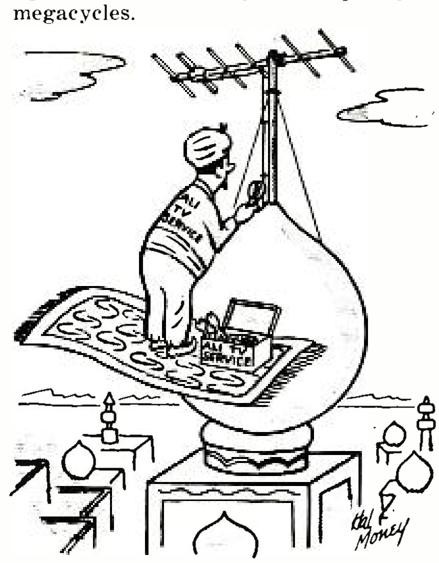
? *Please print formulas which I can use to determine element lengths and spacings for a 6-element Yagi antenna for transmitting and receiving in the u.h.f. and v.h.f. ranges.—M. R. S., Memphis, Tenn.*

A. The lengths of the elements in inches can be found from the following formulas:

Reflector	=5880/f
Radiator	=5544/f
First director	=5304/f
Second director	=5256/f
Third director	=5208/f
Fourth director	=5160/f

where f is the frequency in megacycles.

The performance of a Yagi antenna depends largely on the spacing between the elements and on the lengths of the parasitic elements. The antenna cannot be simultaneously adjusted for maximum gain and maximum front-to-back ratio. For a good compromise design, space all elements two-tenths wavelength apart. The spacing in inches equals 2361 divided by the frequency in megacycles.



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RADIO-ELECTRONICS prints several radio cartoons every month. Readers are invited to contribute humorous radio ideas which can be used in cartoon form. It is not necessary that you draw a sketch, unless you wish.

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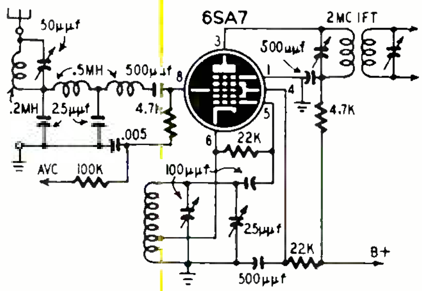
SINGLE-CONTROL TUNER

? *Some time ago you printed a schematic and description of a single-control receiver for the broadcast band. This set has a low-pass filter between the antenna and the grid of the mixer. The only tunable circuit was in the oscillator circuit. Can you tell me where this item appeared?—R. F., Bronx, N. Y.*



A. The article you are referring to appeared on page 722 of the August, 1945, issue of RADIO-CRAFT. Back copies of this issue are obtainable from this office.

The mixer circuit of this set is shown in the diagram. The low-pass filter in the input circuit passes all frequencies between 100 and 1750 kc. The intermediate frequency is 2 mc. The i.f., second detector, and audio circuits are conventional. The oscillator tunes from 2100 to 3750 kc with a 100-μμf capacitor. The oscillator coil has an inductance of approximately 50μh. A broadcast-band oscillator coil for a 455-kc i.f. system might also be used.

QUERIES ON 16-INCH TUBES

Q. *According to the "Picture Tube Replacement Guide" in the January issue, the 16AP4 uses a double-field ion-trap magnet. I have an Admiral 30D1 chassis which has a single-field magnet on this tube. Can you tell me which type beam-bender is correct for this tube?—H. L. H., Van Buren, Ohio.*

Q. *Your recently published picture-tube guide shows that the 16DP4 uses a double-field ion trap. One manufacturer publishes a folder which recommends a single-field magnet for this tube. Since I am using a 16DP4 in my set, I want to know which is correct.—J. L., Jr., Lorain, Ohio.*

A. According to RTMA specifications and to bulletins issued by most picture-tube manufacturers, both these tubes have electron guns designed for use with double-field ion-trap magnets. We have been advised that single-field beam-benders can be used with these and similar tubes, but the magnet strength may be extremely critical on some sets. It may be difficult to get maximum brightness and there may be some difficulty in centering the picture. Similarly, some double-field beam-benders can be used with certain tubes having electron guns designed for single-field magnets.

Manufacturers are probably using single-field magnets whenever possible because of the saving in critical materials.

—end—

DRIVING SCREWS INTO PLASTIC

Radio cabinets and similar objects made of thin plastic may be damaged by trying to force a screw into an unthreaded hole. To prevent damage, use the following procedure:

1. Insert the screw into the hole with the *fingers*.
2. While heating the screw slightly with a soldering iron, turn it slowly clockwise with a screwdriver. Remove the soldering iron when the screw is hot enough to turn easily.
3. Continue to turn the screw in until it is seated in the hole. Turn it back and forth until it has cooled. This prevents the plastic from adhering to the screw when it is finally tightened.—*Crosley Service Dept.*

AIRLINE 84HA-3010A, B, C

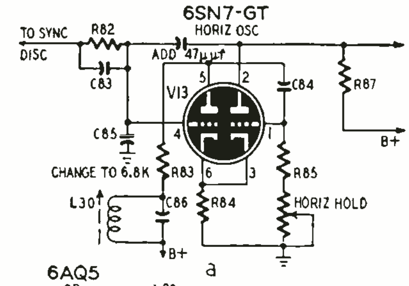
A number of circuit changes and improvements have been made since these sets have been in production. Whenever applicable, these changes may be made in sets being serviced.

To improve horizontal sync, install a 47-μμf ceramic capacitor between pins 2 and 4 of V13 (6SN7-GT horizontal oscillator) and change R83 from 5,600 to 6,800 ohms. See circuit at *a*.

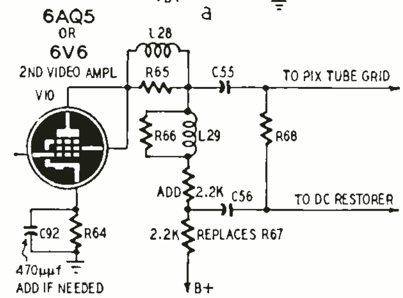
For greater white-to-black ratio, add a 2,200-ohm decoupling resistor as shown in circuit *b*, replace R67 (4,700 ohms) with a 2,200-ohm, ½-watt resistor. Change connection of C56.

Poor horizontal linearity as indicated by a bulge on the left of the picture may be improved by installing a 20,000- to 30,000-ohm, 10-watt resistor between pins 4 (or 6) and 8 of damper tube V21.

Definition and focus can be improved by installing cathode bypass capacitor C92—a 470-μμf mica unit, not used in some sets—in the circuit of V10 and by removing R116, the 1,800-ohm, 2-watt resistor in the focus control.



a



b

For improved high-band sensitivity, remove the grounding leads from socket terminal 4 of V1 and terminal 7 of V2 and solder these leads directly to the chassis. Remove capacitors C9 and C11.—*Airline Service Manual*

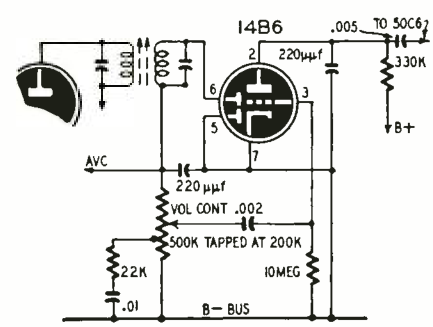
STROMBERG-CARLSON TV SETS

Horizontal pulling in the model 17 series sets may be caused by heater leakage in the 6J6's used as converters in the tuner. Both tubes should be replaced when this condition occurs.

If tube replacement does not help, connect a 50-μμf capacitor between ground and the cathode of the d.c restorer and sync clipper tube. The cathode of this tube is pin 6 in sets using a 6SN7-GT in this position and pin 3 in sets using a 12AU7.—*Stromberg-Carlson Current Flashes*

WESTINGHOUSE H-338T5U

The set had a bad case of 60-cycle hum which varied with the setting of the volume control and was louder than the audio signal. The trouble was traced to leakage in the 35W4 between the heater pins and pin 2 which is blank. The volume control (see diagram) has a tap for tone compensation. The compensating network consists of a 22,000-ohm resistor and .01-μf capacitor between the tap and B minus. The junction of the resistor

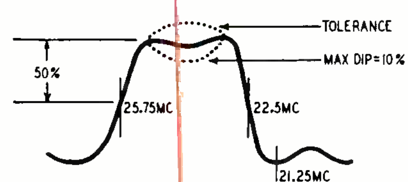


and capacitor is anchored to pin 2 on the socket of the 35W4. Leakage in this tube introduced hum in the grid of the first a.f. tube through the tap on the volume control.

The condition can be cleared up by replacing the 35W4. A permanent cure is to disconnect the components from pin 2 and connect them to an insulated tie-point—*Herbert H. Lenk*

EMERSON TV SETS

Performance of models 614C, 637A, (chassis 120095B), 650D, 654D, 655B (chassis 120123B), 650F, 654F, and 655F (chassis 120138B) can frequently be improved if the 25.75-mc picture i.f. and the 22.5-mc i.f. bandpass markers are placed at the 50% response points instead of 75% down as shown previously in service notes for these models. The new over-all intermediate frequency response curve is shown in the drawing below.



Set the sweep generator for 10 mc sweep width and adjust its output to produce about 0.5 volt d.c. across the 4,700-ohm resistor in the detector load circuit.—*Emerson Service Dept.*

MICROPHONICS IN RCA 8V151

When shipped from the factory the r.f.-i.f. chassis of this set is clamped to the door of the radio compartment with a shipping bracket. Shipping instructions (packed with each instrument) specify that the bracket should be removed at the time of unpacking. However, since the bracket is not visible from the back of the set, it is generally overlooked. If it is not removed, the rubber chassis mountings will be ineffective and microphonics are likely to occur.

To remove the bracket:

1. Remove the six knobs.
2. Remove the four hex nuts (threaded bushings) which hold the escutcheon in place.
3. Pull off the two push-button knobs which are just above the phono indicator lamp.
4. Remove the phono indicator lamp.
5. Remove the bracket, which is now visible, in the chassis opening for the indicator lamp.
6. Replace the lamp and other parts just removed.—*RCA Service Data*

WESTINGHOUSE H-242

When the channel selector will not turn beyond a given channel, readjust the oscillator slug for the channel that is opposite it on the front of the tuner. For example: If the selector cannot be turned to any channel higher than 9, reset the oscillator tuning slug on channel 5.—*G. N. Manning*

—end—

ELECTRONIC LITERATURE

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. All literature offers void after six months.

POPULARIZED STORY OF U.H.F. DEVELOPMENT

"U.h.f.—What It Means to Television and to You," is the title of a 24-page history of v.h.f. and u.h.f. telecasting, and RCA's contributions to its development. The behavior of u.h.f. waves is explained in nontechnical language. Many effective illustrations are included.

Available free from the Department of Information, Radio Corporation of America, 30 Rockefeller Plaza, New York 20, N. Y.

LOUDSPEAKER CATALOG AND REFERENCE HANDBOOK

The *Technilog* is a 28-page catalog of University loudspeakers and a handbook on speaker system design and installation. Impedance matching, power requirements and distribution, phasing, acoustics, and baffle construction are covered in the text and in charts and nomographs.

Available free of charge from University Loudspeakers, Inc., 80 South Kensico Ave., White Plains, N. Y.

RACK AND PANEL CONNECTORS

Hugh H. Eby, Inc., has issued an 8-page catalog giving dimensional drawings and detailed descriptions of male and female rack and panel connectors having from 3 to 34 contacts; miniature 5-, 7-, and 9-pin connectors; and watertight and universal binding posts.

A copy of Catalog Supplement No. 1 will be sent on request to Hugh H. Eby, Inc., 4700 Stenton Ave., Philadelphia, Pa.

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A 31-page book "Why Variable Reluctance," describes the construction, characteristics, and use of G-E single-play and triple-play phono cartridges, preamplifiers, styluses, and pickup arms. Schematics, response curves, methods for high- and low-frequency compensation, and full installation data for high-fidelity systems are given. Standard and professional types are covered, and some data on G-E 12-inch speakers is included.

Available at 25 cents per copy from General Electric dealers, or from Electronics Division, General Electric Company, Electronics Park, Syracuse, N.Y.

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Some of the larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

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- Woman Radio Expert Teaches Draft Men.
- Small Portable Radio for Field Work.
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- A Research Type of Detector, by Edward T. Jones.
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PLUMBERS' ATOM-SMASHER

Scientific plumbers at Stanford University have laid a thin copper pipeline 220 feet long that carries some of the most extraordinary atom-smashing energy yet created. Stanford physicists, working under an Office of Naval Research contract, designed the pipeline to accelerate electrons to approximately the speed of light.

A large glass cylinder at the base houses a cathode the size of a tomato can. A 400,000-volt, 1-microsecond pulse hits the cathode 60 times a second, starting a beam of electrons down the tube at about 4/5 the speed of light. In the first 12 inches the beam is traveling 180,000 miles per second.

Cavity resonators bunch the electrons, and every 10 feet a Klystron oscillator adds enough accelerating energy to light a city of 35,000.

At 1 billion volts, electrons will hit 99.9999987% the speed of light.

TV ALIGNMENT PRECAUTIONS

Many service technicians disconnect the deflection yoke and disable the high-voltage supply by pulling the horizontal oscillator or output tube when aligning a TV set. Some manufacturers issue warnings against this practice. Pulling the oscillator tube removes the drive from the output tube, with the result that the tube may be damaged.

Disconnecting the deflection yoke from some sets causes the horizontal output tube to draw excessive screen current. This results in damage to the tube, screen-dropping resistor, or both. The boosted voltage may also rise and break down the filter capacitors.

Correct alignment requires that the set be operating under normal voltage conditions. Removing tubes or yoke will cause a change in the bias and plate-supply voltages throughout the set. When a set is aligned under these conditions, the response curves may be far from ideal when the tubes are inserted and the yoke connected.—*R.F.S.*

ELECTRONIC BRIGHTNESS METER

A novel electronic meter for measuring the brightness of a surface which is emitting or reflecting light is described in patent No. 2,542,299 issued to Hugh M. Archer and Howard A. Boltz.

The instrument consists of a collimating tube to pick up the light, a phototube, a two-stage direct-coupled amplifier, and a meter to measure the current of the last amplifier stage. The circuit is shown in Fig. 1.

Grid 2—the screen grid—of the first amplifier is used as the signal grid. It is connected to the top of the phototube load resistor. An increase in the output of the phototube causes grid 2 of V1 to go negative and decrease the plate and cathode currents which flow through the 400,000-ohm resistor. As the current decreases, the voltage across the resistor decreases and the control grid of V2 is less negative. This causes increased current to flow through the meter which is calibrated in foot-lamberts or similar light units. Grid 1—the space-charge grid—of V1—is connected to the plate of V2 through 29,000 ohms.

Since the triode is passing current at all times, a bucking circuit is included to zero the meter when no light is being admitted to the phototube. The bucking current is provided by connecting the triode filament battery across the meter through a resistance of 13,000 ohms.

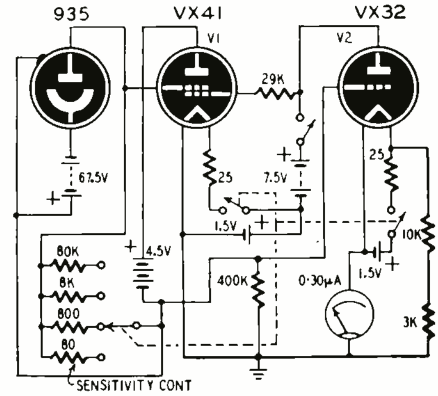


Fig. 1—Circuit of the brightness meter.

The collimating tube shown in Fig. 2 passes a constant amount of radiation to the phototube from a surface having constant and uniform brightness, even when the distance between the surface and the aperture is changed—as long as the viewing angle is intercepted by the surface being measured. The collimating tube consists of a series of metal diaphragms spaced inside a metal tube. The diaphragms have a viewing angle of 1½ degrees. Color filters may be inserted as shown to vary the color sensitivity of the instrument.

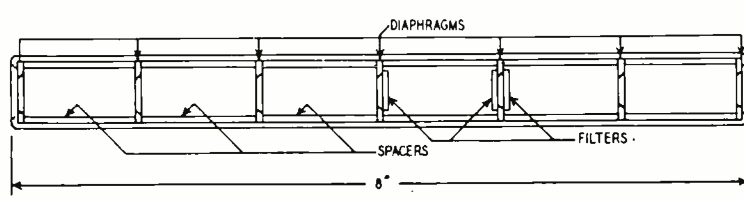
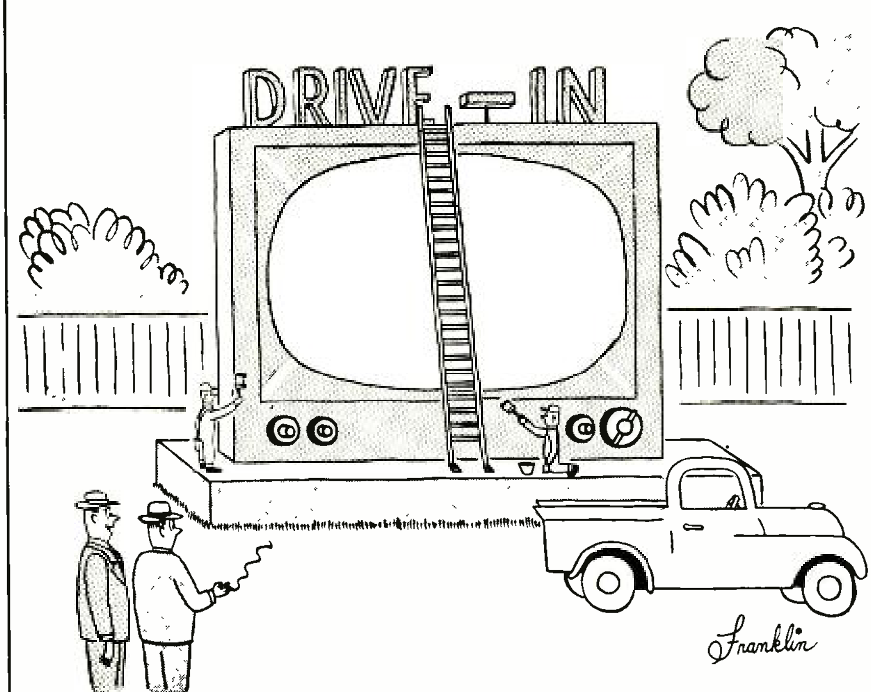


Fig. 2—Construction of the light-collimating tube used with brightness meter.



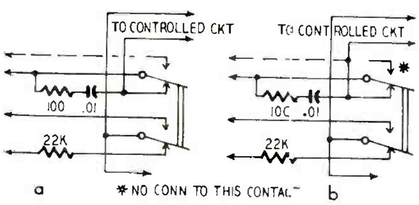
"It'll make 'em feel at home."

FLIERS FIGHT TV TOWERS

Ban on "Steel Needles"—fliers' name for 1,000-foot TV antenna towers—near airport control zones and airways is joint demand of Air Line Pilots' and Air Transport Associations. Pilots and industry want the FCC empowered to refuse construction permits where antenna height or location would constitute a flight hazard. Limited antenna heights through use of local TV booster transmitters, and radio warning beacons on all towers are also sought.

CORRECTIONS

There is an error in the drawing of the upper section of relay RY in the schematic in Fig. 1 on page 36 of the April, 1952, issue. The drawing shows a dashed line going to the normally closed contact on the upper section of the relay. This dashed line should connect to the lower of the two supply lines going to the controlled circuit. The normally closed contact of the upper relay section is *not* used.



Our thanks to the author, Mr. Rundo, for bringing this error to our attention. The drawing at *a* shows the wiring as it appeared in the original diagram. The drawing at *b* shows the correction.

In the article "Practical TVI Filter" in the May issue, we inadvertently listed a reference to an article in the November-December, 1949 issue of G-E Ham Tips. The correct title of the publication is *G-E Ham News*. The article referred to is the "Harmoniker."

We thank Mr. R. L. Voeller of G-E for calling this to our attention and extend our apologies to G-E, the publishers of *Ham News* and to the staff of *Ham Tips* at RCA.

The map on page 30 of the May issue has white discs in the states of Vermont, Maine, and New Hampshire indicating that these states have v.h.f. TV stations in operation. There are no v.h.f. stations in operation in these areas so blue discs should have been used. This correction is credited to Mr. Wm. C. Larkin, of Delmar, New York.

The following corrections should be made in the article "Transformers", in the April, 1952, RADIO-ELECTRONICS: Total secondary power *63.9* v/amp; primary power *70.3* v/amp; core cross-sectional area *2.8* square inches; primary turns *261*; turns-per-volt ratio *2.2*; Sec. 1 turns *1,540*; Sec. 2 turns *11*; Sec. 3 turns *13.9*; primary current *0.6* amp.

THE FUND NEARS $9,600

HELP-FREDDIE-WALK FUND

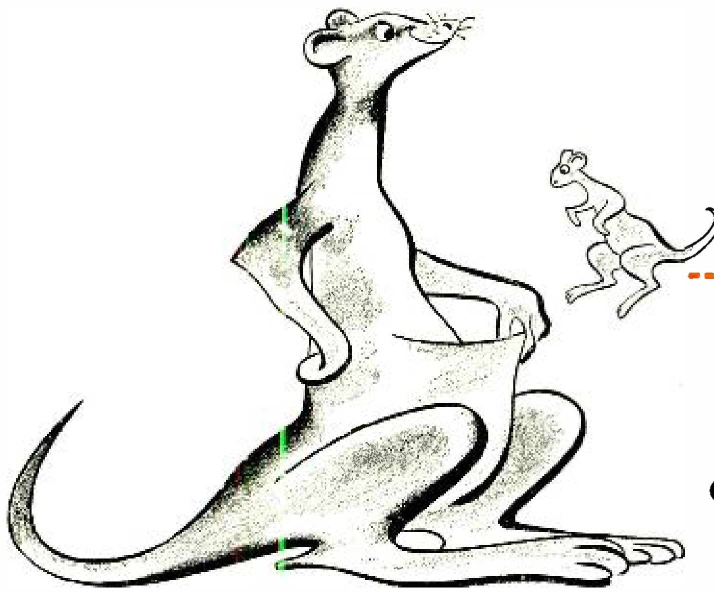
This month marks the beginning of the third year of existence for the Help-Freddie-Walk Fund, and we feel that it would be a good idea to review its history for the benefit of not only our newer readers, but also for those who have been following Freddie's progress for so long that the essential facts have become obscure. Little Freddie Thomason was born four years ago, the son of Herschel Thomason, radio technician of Magnolia, Arkansas, but unfortunately, he was born without arms or legs. At the time we learned of his plight, his parents were trying desperately to give him some semblance of a normal life, and the Help-Freddie-Walk Fund was inaugurated BY RADIO-ELECTRONICS in an attempt to aid them in what we knew would be a long and difficult and expensive fight.

Four-year-old Freddie poses with Dad

That Freddie, at four, is a healthy, happy youngster is a tribute to the faith and courage of his parents and the sincere interest and generosity of our readers. All his life, he will be dependent upon mechanical devices to serve him as arms and legs, and because he is normal in every other respect, these appliances will have to grow as he grows. Among other things, this means periodic trips to the Kessler Institute for Rehabilitation, West Orange, N. J., for checkups and new fittings, but at last report Freddie is learning to walk and it is hoped that in the not-too-distant future it will be possible to fit him with artificial arms, so that he can actually participate in the many activities in which he takes the same interest as any child his age.

It will be a long, up-hill fight to help Freddie become a useful and contributing citizen. Although the Help-Freddie-Walk Fund has reached almost $9,600, several times that amount will be needed

Fast Fit for the Job at Hand . . .



MALLORY MIDGETROL®

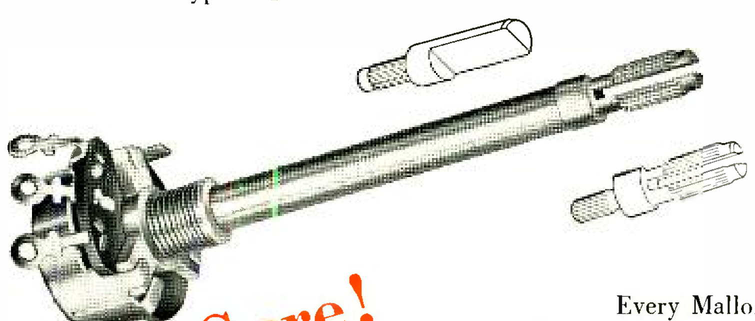
Round-Shaft Volume Controls

START FAST . . . FINISH FAST . . .

- Because of the wide and easy adaptability of Mallory Midgetrols, it's easy to stock—or get fast from your distributor—just what you need to do your job.
- Round tubular shaft designed and built for fast, easy and accurate cutting.
- Factory-tested AC switch may be attached instantly without disassembling control.
- Speedy adaptability to both split-knurl and flatted type knobs.

CUSTOMER-PLEASING RESULTS . . .

- Longer lasting resistance elements even in extremes of temperature and humidity.
- Better and more accurate taper curves resulting from precision processing methods.
- No pigtail connections to break—thanks to Mallory's exclusive sliding contact that gives EXTRA quiet operation.
- Minimum wobble with Mallory exclusive two-point shaft suspension.



So Versatile are Mallory Midgetrols—both standard and dual—that they reduce by 40% the cost of inventory needed to service the 10 most popular makes of radio and TV sets.

Make Sure! Make it Mallory!

Every Mallory Midgetrol is packed with two shaft ends to make it easy for you to use either split-knurl or flatted type knobs. The Mallory Midgetrol line, in addition to round shaft standard controls, includes dual concentric controls that offer fast, easy assembly in five steps *without* special tools. Front and rear sections are factory assembled and inspected. AC switch attachment is easy.

P. R. MALLORY & CO. Inc.

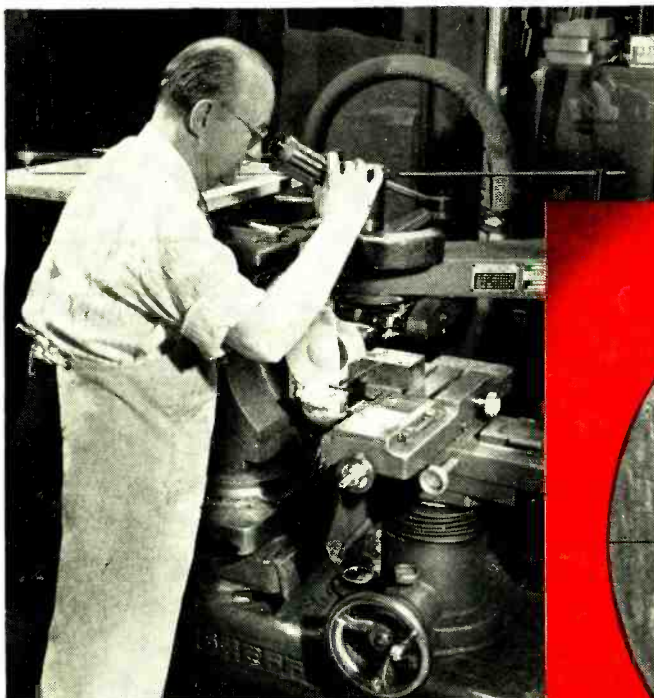
MALLORY

CAPACITORS • CONTROLS • VIBRATORS • SWITCHES • RESISTORS • RECTIFIERS • VIBRAPACK* POWER SUPPLIES • FILTERS

*Reg. U.S. Pat. Off.

APPROVED PRECISION PRODUCTS

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA



1. The machine that grinds the die.

2. The die that forms the cathode sleeve.

3. The cathode sleeve that helps make the tube.

Take a look at quality being born

DIMENSIONAL ACCURACY of the cathode sleeve is a vital factor in providing top-quality tube performance. And cathode-sleeve accuracy begins with the forming die.

What you see above are the two sections of a typical cathode-sleeve forming die, just as it is viewed by the die maker through a 30-power microscope. The die is finished in a "profile grinder" which employs a 50-to-1 pantograph that traces a template and precisely guides the grinding operation. The result is a die accurate to better than one ten-thousandth of an inch!

Such painstaking precision finishing of dies used to stamp, punch, and form critical tube parts is one more step contributing to the top quality of RCA Tubes. In this way, RCA closely guards its own reputation for quality *. . . and yours as well.*

With RCA Kinescopes, as well as with RCA Receiving Tubes, TOP-QUALITY CONTROL makes the difference.

RADIO CORPORATION of AMERICA

ELECTRON TUBES **HARRISON, N. J.**

TMKS. ®