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ON THE COVER: Robert Witherspoon tunes the transmission line with a capacitive slider while Joan MacClay adjusts the television receiver. Decorations by John Wanamaker. Miss MacClay's dress by Frances Sider. Kodachrome by Avery Slock.

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The Radio Month

JOHN BALLANTYNE, chairman of the board of Philco Corp., died on June 10th while making a commencement address at Meadowbrook School in Pennsylvania, where his 13-year-old son was a member of the graduating class. Ballantyne was president of Philco from 1943 to 1948, after which

he became chairman of the board of directors, acting only in an advisory capacity. A native of Philadelphia, he was a graduate of the University of Pennsylvania. He became treasurer of Philco in 1940 and vice-president in charge of operations a year later. He was 49 years old at the time of his demise.

DR. WILLIAM W. HANSEN, a professor of physics at Stanford University who helped develop radar, died on May 23 at the age of 39.

As early as 1937 Dr. Hansen was working on the use of radar for military purposes. He was recently elected to the National Academy of Sciences and was awarded the Liebmann Memorial Prize for outstanding work in radio engineering.

LICENSING BILL introduced in the Illinois legislature, requiring all persons servicing radios and TV sets to undergo a training course and examination (see report in this section of July issue) was defeated last month. The Radio Manufacturers Association and the Television Installation Service Association of Chicago were instrumental in having the bill killed in committee.

INTERNATIONAL TV EXHIBIT and convention will be held in September in Milan, Italy, under the auspices of the Italian government. The exhibit, to take place at the Arts Palace in Milan, will show equipment made by European firms; United States companies invited to participate are RCA, Du Mont, Philco, GE, Raytheon, and Westinghouse. The convention will meet at Como, about 45 miles from Milan.

MICROGROOVE reproducing equipment has been installed by 652 AM stations in the U. S., according to a report last month by Robert J. Clarkson, general manager of Columbia Transcriptions, who conducted a survey. Another 185 plan to install the necessary pickups in the next few months. In addition to the standard LP pressings, Columbia offers to program producers a transcription service in which microgroove records take the place of the traditional 16-inch, 33⅓-r.p.m., 15-minute-per-side transcriptions. Because of the close groove spacing, more than 20 minutes can be recorded on each face of a 12-inch record, resulting in a considerable money saving. In addition, technical characteristics are standardized.

LICENSE PLATES with amateur call letters instead of the usual meaningless numbers and letters are now available to automobile-owning Florida hams, due to a bill which took effect on July 1. In recognition of the valuable work done by amateurs in emergencies, State Senator Lloyd F. Boyle, himself a ham, introduced the bill in the legislature; it was signed by the governor on May 12. Each man wanting a call-letter license plate must apply to the Motor Vehicle Commissioner and pay an extra $1 fee.

RADAR STATIONS will be built in the Bahamas by the United States, as part of its Florida-based, 3,000-mile guided missile range, the Defense Department announced last month. The agreement was concluded with Great Britain and the Bahamas governments. The department will conduct extensive tests on guided missiles, beginning, it hopes, in July, 1951. The radar stations will be needed to track the paths of the missiles.

TWENTY-FIFTH ANNIVERSARY of the Radio Manufacturers Association is being celebrated this year. The organization's Silver Anniversary Convention was held in Chicago on May 19, concurrently with the Radio Parts Show.

1949 RADIO FALL MEETING formerly known as the Rochester Fall Meeting, will be held October 31st, November 1st and 2nd at Hotel Syracuse, Syracuse, N. Y. according to an announcement by Virgil M. Graham, chairman of the Radio Fall Meeting Committee and director of technical relations for Sylvania Electric Products Inc. The Meeting will be sponsored by the Engineering Department of Radio Manufacturers Association for its members and members of the Institute of Radio Engineers. Officers of Fall Meeting Committee in addition to Mr. Graham, include R. W. Ferrell of The General Electric Co., vice-chairman and treasurer, and R. A. Hackbush of Stromberg Carlson of Canada, Ltd., secretary.

FCC celebrated the 15th anniversary of its creation on June 19th; on that date 15 years ago the Communication Act was signed On July 1, 1934, the old Federal Radio Commission was abolished and 11 days later the FCC was formally organized. About 125 of the present staff members, including Commissioners Hyde, Walker, and Sterling, were with the Commission when it was organized.

Comparisons of the first annual report and present figures indicate how radio has grown since 1934. At that time there were 51,000 radio stations of all kinds, 600 broadcasters, 45,000 hams, less than 2,000 ship stations, about 700 aeronautical licenses, 250 police transmitters and no fire stations.

In contrast, recent figures show nearly 150,000 total stations (in addition to more than 200,000 associated mobile units), 4,000 broadcast authorizations of all kinds, 80,000 amateur calls, 20,000 shipboard stations, 27,000 air service licenses (and over 100,000 aircraft radio telephone authorizations), more than 4,600 police stations, and 100 municipal fire department systems. Individual licensed operators (holders of commercial tickets) have increased from the 1934 number of 5,500 to almost 375,000.

The grand total of all authorizations outstanding, including both operators and stations, but excluding mobile land stations, has passed the 700,000 mark, testifying to the tremendous importance of radio in present-day America.

TELEVISION PROGRAMS are not worth the phosphor they're projected on, was, in effect, the comment made last month by Lloyd Espenschied, one of the inventors of the co-axial cable which makes large-scale television possible. "I wouldn't give a damn for anything I've seen," commented the 60-year-old inventor, as reported by the *New York Herald Tribune*. "It's the same as sound broadcasting—permeated with commercialism from beginning to end. We in the United States ought to be ashamed. The British have done a far better cultural job in both sound and television broadcasting."

Mr. Espenschied and Herman A. Affel, research engineers in the Bell Telephone Laboratories, devised the co-axial cable in 1929 to satisfy the urgent demand for more telephone circuits.

BRAIN WAVES can be used by an anesthetist during an operation to warn if the patient is approaching death, it was disclosed last month. According to a Mayo Clinic team at the Atlantic City meeting of the AMA, continuous records of the electrical activity of the brain and heart give warning of danger two minutes earlier than the breathing and pulse rates which the anesthetist ordinarily observes. When the regular waves suddenly flatten out almost to a straight line, it is time to stop the anesthetic mixture and turn on the oxygen.

The new life-saving technique was developed by Drs. R. F. Courtin, R. G. Bickford, and A. Flaconer, Jr., of the Mayo Clinic. It has been tried so far on 60 patients. A machine standing at one side of the anesthetist takes continuous records of the patient's heart and brain waveforms. Preliminary trials indicate that the technique is equally useful with any type of anesthetic.

RADAR aided all-weather operations of the Berlin air-lift, Dr. H. R. Skifter, president of Airborne Instrument Laboratory, Inc., revealed last month. A new type of radar made by the company, the Moving Target Indicator (MTI), shows only objects in motion, simplifying the work of the operator. The principal bad-weather flying problem was traffic control, since ships would be likely to collide with each other. The MTI radar permitted the maximum number of aircraft to operate by keeping track of the position of each and telling pilots how to proceed to avoid collisions.

LICENSING of radio service shops is legal in Los Angeles, according to an opinion furnished by City Attorney Ray L. Chesebro last month to the City Council, reported in the *Los Angeles Times*. Radio repair, says Chesebro, falls into the same category as automobile repair shops and used car lots, which already operate under revocable permits issued by the Police Commission. The Council, in asking for the opinion, was seeking to stop general unethical and fraudulent practices in the radio repair business.

NATIONAL NETWORK of radiotelephone stations for mobile service to the general public was announced last month by the National Mobile Radio System. Operators of local systems which handle messages for private automobiles and trucks have banded together in a nation-wide network operating on the same channels. Subscribers in any area served by an affiliate will be able to send messages from their automobiles or trucks to any point in the country. Present stations, many of which are owned by telephone answering services, are experimental and have served subscribers locally for some time. By August the network will be in operation between Boston and Washington, so that a traveler at almost any point along the route will have continuous contact with one or another of the stations. Messages will be transmitted between cities by the station operators, using the stations themselves for relaying, though regular long-distance telephone calls will be made when necessary.

TRANSISTOR TETRODES are the latest development in germanium crystal amplifiers, Rowland W. Haegele of the Physics Laboratories of Sylvania Electric Products, Inc., announced last month to a Princeton conference. The tetrodes, said Haegele, provide a high degree of isolation in mixer service so that signals on one emitter are not picked up by the other.

Heathkit TUBE CHECKER KIT — Heathkit TEST

SHIPPING WT. 15 LBS.

$29.50

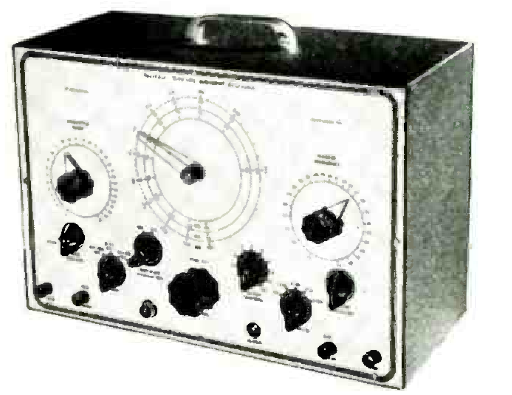
Features

1. Measures each element individually.
2. Has gear driven roller chart.
3. Has lever switching for speed.
4. Complete range of filament voltages.
5. Checks every tube element.
6. Uses latest type lever switches.
7. Uses beautiful shatterproof full view meter.
8. Large size 11"x14"x4" complete.

Check the features and you will realize that this Heathkit has all the features you want. Speed — simplicity — beauty — protection against obsolescence. The most modern type of tester — measures each element — beautiful Bad-Good scale, high quality meter — the best of parts — rugged oversize 110 V. 60 cycle power transformer — finest of Mallory switches — Centralab controls — quality wood cabinet — complete set of sockets for all type tubes including blank spare for future types — fast action gear driven roller chart uses brass gears to quickly locate and set up any type tube. Simplified switching cuts necessary time to minimum and saves valuable service time. Short and open element check. No matter what arrangement of tube elements, the Heathkit flexible switching arrangement easily handles it. Order your Heathkit Tube Checker today. See for yourself that Heath again saves you ⅔ and yet retains all the quality — this tube checker will pay for itself in a few weeks — better build it now.

Complete with detail instructions — all parts — cabinet — roller chart — ready to wire up and operate.

New Heathkit TELEVISION ALIGNMENT GENERATOR KIT



Everything you want in a television alignment generator. A wide band sweep generator covering all FM and TV frequencies — a marker indicator — AM modulation for RF alignment — variable calibrated sweep width 0-30 Mc. — mechanical driven inductive sweep. Husky 110 V. 60 cycle power transformer operated — step type output attenuator with 10,000 to 1 range — high output on all ranges — band switching for each range — vernier driven main calibrated dial with over 45 inches of calibrations — vernier driven calibrated indicator marker tuning. Large grey crackle cabinet 16-1/8" x 10-5/8" x 7-3/16". Phase control for single trace adjustment. Uses four high frequency triodes plus 5Y3 rectifier — split stator tuning condensers for greater efficiency and accuracy at high frequencies — this Heathkit is complete and adequate for every alignment need and is supplied with every part — cabinet — calibrated panel — all coils and condensers wound, calibrated and adjusted. Tubes, transformer, test leads — every part with instruction manual for assembly and use. Actually three instruments in one — TV sweep generator — TV AM generator and TV marker indicator. Also covers FM band.

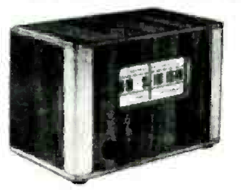
$39.50

Heathkit SINE AND SQUARE WAVE AUDIO GENERATOR KIT

$34.50 *Nothing* ELSE TO BUY

Experimenters and servicemen working with a square wave for the first time invariably wonder why it was not introduced before. The characteristics of an amplifier can be determined in seconds compared to several hours of tedious plotting using older methods. Stage by stage, amplifier testing is as easy as signal tracing. The low distortion (less than 1%) and linear output (± one db.) make this Heathkit equal or superior to factory built equipment selling for three or four times its price. The circuit is the popular RC tuning circuit using a four gang variable condenser. Three ranges 20-200, 200-2,000, 2,000-20,000 cycles are provided by selector switch. Either sine or square waves instantly available at slide switch. All components are of highest quality, cased 110 V. 60 cycle power transformer, Mallory F.P. filter condensers, 5 tubes, calibrated 2 color panel, grey crackle aluminum cabinet. The detailed instructions make assembly an interesting and instructive few hours. Shipping Wt., 13 lbs.

New Heathkit FM TUNER KIT



$14.75 CABINET EXTRA

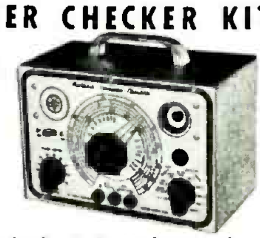
A truly fine FM Tuner with the coils ready wound, all alignment completed — all that is necessary is wiring and it's ready to play — uses super regenerative circuit — 110 V. 60 cycle transformer operated — two gang tuning condenser — slide rule calibrated dial — two tubes — complete instructions including pictorial enable even beginners to build successfully.

The circuit uses twin triode and is extremely powerful — pulls in stations far beyond normal expectations. Shipping Wt., 4 pounds.

Beautiful mahogany cabinet for FM Tuner (shown above) extra $3.75

Heathkit CONDENSER CHECKER KIT

$19.50 *Nothing* ELSE TO BUY



Features

- Bridge type circuit
- Magic eye indicator
- 110 V transformer operated
- All scales on panel
- Power factor scale
- Measures resistance
- Measures leakage
- Checks paper-mica-electrolytics

Checks all types of condensers, paper-mica-electrolytic-ceramic over a range of .00001 MFD to 1000 MFD. All on readable scales that are read direct from the panel. NO CHARTS OR MULTIPLIERS NECESSARY. A condenser checker anyone can read without a college education. A leakage test and polarizing voltage for 20 to 500 volts provided. Measures power factor of electrolytics between 0% and 50%. 110 V. 60 cycle transformer operated complete with rectifier and magic eye tubes, cabinet, calibrated panel, test leads and all other parts. Clear detailed instructions for assembly and use. Why guess at the quality and capacity of a condenser when you can know for less than a twenty dollar bill. Shipping Wt., 7 lbs.

RF Crystal Test Probe Kit

No. 309. Kit to assemble. RF probe extends VTVM range to 100 MC. Complete with IN34 crystal. Shipping weight, 1 lb.... $6.50

New Heathkit TOOL KIT

Now a complete tool kit to assemble your Heathkit. Consists of Krauter diagonal cutters and pointed nose assembly pliers, Xcelite screwdriver, 60 Watt 110 V. soldering iron and supply of solder. Shipping Wt., 2 lbs. Complete kit. $5.95

10,000 V H.V. Test Probe Kit

No. 310. Extends range of any 11 megohm VTVM to 3,000 and 10,000 Volt ranges. A necessity for television. Ship. wt., 1 lb. $4.50

The HEATH COMPANY

★ ★ ★ ... BENTON HARBOR 20, MICHIGAN

The Pacent Engineering Corp. of New York, N. Y., specialists and consultants in electronics, have recently been appointed as consulting engineers by the Plessey International Limited of Ilford Essex, England. This company is one of the largest manufacturers of television, electronic, mechanical and other equipment in the British Isles.

International Telephone & Telegraph Corp. has announced the formation of **Capehart-Farnsworth Corp.** as a wholly-owned subsidiary to acquire the assets of Farnsworth Television & Radio Corp., as approved by Farnsworth stockholders.

At a meeting of directors of **Capehart-Farnsworth Corp.**, ELLERY W. STONE was elected President and DAVID R. HULL, Executive Vice President.

The following officers were also elected: PHILO T. FARNSWORTH, Vice President; HENRY C. ROEMER, Vice President; WILLIAM CLAUSEN, Vice President; P. H. HARTMANN, Treasurer; W. F. HOEPPNER, Comptroller; and CHESTER H. WIGGIN, Secretary and Assistant Treasurer. EDWIN A. NICHOLAS, former President of Farnsworth Television and Radio Corp., will act as Assistant to the President.

Hytron Radio & Electronics Corp. has been producing TV picture tubes since February of this year in steadily increasing quantities. Shipments are now being made to a broadly representative group of leading manufacturers of TV receivers—as well as to Hytron distributors.

Stewart-Warner Corp. of Chicago had a net profit for the first quarter of 1949 of $404,292, equal to 31 cents per share of $5 par value common stock, JAMES S. KNOWLSON, board chairman and president, told the annual meeting of stockholders. The company had a net profit of $902,094, or 70 cents per share for the period ended March 31, 1948. First quarter sales in 1949 were $14,706,155 and in 1948 were $17,338,552.

Philco Corporation, Philadelphia, reports that the sales in the first quarter of 1949 were $53,006,000 as compared with $58,661,000 in the first quarter a year ago.

Net income in the first quarter of this year was $915,000 and was equivalent, after preferred dividends, to 49 cents per common share on the 1,678,779 shares outstanding on March 31, 1949.

In the first quarter a year ago, net income totaled $1,959,000 after tax-paid reserves of $600,000 for inventory and $185,000 for future research and development work. This was equivalent to $1.16 per common share on the 1,607,576 shares outstanding at the end of 1948, after preferred dividends.

The **West Coast Electronic Manufacturers Association,** San Francisco, California, announces the scheduling of the 5th Annual Pacific Electronic Exhibit for August 30, 31, September 1 in San Francisco.

Spokesmen for the West Coast group said the Exhibit will be held in conjunction with the 1949 Western Regional Convention of the I.R.E. Both groups will center their activities in San Francisco's mammoth Civic Auditorium.

The joint meetings of the Electronic Industry and the I.R.E. will follow by four days the Annual National Convention of the American Institute of Electrical Engineers, also scheduled for San Francisco.

Allen B. Du Mont Laboratories, Inc. of Passaic, N. J., announces the publication of a four page "Dealergram," latest dealer aid especially prepared for franchised Du Mont dealers and distributors, according to HENRY R. GEYELIN, advertising manager of the television receiver sales division.

The Dealergram, which consists of four pages of video news items of interest to dealers and distributors, current promotional ideas and sales helps, is profusely illustrated and will be mailed to Du Mont dealers and distributors each month. The first mailing of the Dealergram includes an explanatory letter and an application blank which will enable dealers to have the sales-aid sent to their employees.

Sylvania Electric Products, Inc. announces that a full line of television sets bearing the Sylvania name will be placed on the market this fall, according to DON G. MITCHELL, president of the company.

Sets are expected to be available on October 1. Initially, the line will feature 10-inch and 12½-inch table models, consolettes, and console combinations with three-speed record changer, AM and FM radio, and also a 16-inch consolette.

In making the announcement, Mr. Mitchell stated that Sylvania had delayed entrance into the television set market until an extensive program of field and laboratory engineering research in the direction of simplification, clarity of picture and minimum maintenance, had developed sufficient experience to assure quality performance.

Television Manufacturers Association has started a project aimed at establishing standard service agreements and practises for television sets, according to MICHAEL L. KAPLAN, President of TMA and of Sightmaster Corp. A survey of service organizations and dealers who service sets will be the first action to establish a universal contract for the benefit of the public and the industry.

After this accumulated data has been sifted, TMA expects to be able to formulate a standardized service contract under which service organizations will be expected to meet certain qualifications as to experience, background, technical ability and reputation.

Squeezing the Service Technician

. . . New legislation threatens the television service contractors . . .

By THE EDITORS

THE radio service technician's bed has never been strewn with roses; and of late the situation has been worsening to such an extent that it threatens to get entirely out of hand.

Latest development comes from New York State, where the Attorney General's office may take action which could strike a mortal blow to the independent television installation and maintenance man. The proposition is to declare that television service contracts come under the existing insurance laws, and that *all organizations handling service should therefore be licensed under the State insurance law.* This means that firms taking television service contracts would have to prove they were financially stable, and would have to put a required sum of money into a trust fund to insure that television set owners would get the service they are entitled to under their contracts.

The real cause, of course, is that television maintenance contracts have been set at a price which has made it impossible for the service contractor to carry them out. His costs have been so much higher than the contract fees that he has been forced into bankruptcy, in many cases watching the savings of a lifetime disappear with the funds he received for his television contracts.

Tragic as this has been for the service technician who has been forced to close up his business, the customer has been hurt as well. He has paid his money for a year's service. Three months after the contract is signed, his receiver may develop a fault. He finds that the company with which he signed the contract is no longer in existence. The dealer who sold him the television set and contracted for its installation through an intermediary service firm is not interested in his plight. Neither is the manufacturer of the set, in spite of the fact that one of his models may have been the cause of the customer's dilemma and the contractor's bankruptcy.

As we go to press no final decision has been taken by New York State on this proposal, and it is hoped that no unfavorable decision will be made. New York State is by far the country's biggest television market, and if such an adverse action were taken in that state, many other states would certainly follow the example.

The New York State Insurance Department contacted many of the larger television manufacturers in an endeavor to have the makers themselves guarantee the service contracts. With the exception of several large television set makers who have their own service setups, the manufacturers declined to have anything to do with the proposition. They insisted that maintenance was the dealers' and distributors' job, and felt that if the manufacturers were made responsible they might become involved in lawsuits and other difficulties.

What then is wrong with the entire setup? How can the trouble be cured? The main difficulty is obviously that the rates paid for television installation and maintenance are so low as to drive the service concerns out of business. The cure is obviously to remove this trouble, not to make the present difficulty an excuse to channel television servicing, installation, and maintenance into the hands of large concerns who—given a near-monopoly on the business—can then raise the contract rate to a figure that will assure them a profit under the most unfavorable circumstances. This will react into higher cost to the customer, and eventually the manufacturer and dealer will pay for it in the form of fewer television set sales.

Why are present service contract rates so low? There are three main reasons. First, it is in the dealer's interest to make the price for installation and service as low as possible, since he does not intend to do this work himself. But because of the novelty of the business, would-be contractors had no means of knowing what their costs would be, and in many cases were sold these "suicide" contracts.

Probably the greatest single cause of loss-producing contracts is the "sour" television model. We have had these models since the beginning of broadcast radio. Every manufacturer makes such a set occasionally, and the complications of television render the chances of putting on the market a model with latent defects that much greater. Such a model may call for twice as many service calls as the average televiser, and the maintenance technician who has contracts for a large number of them is slated for certain economic destruction.

The nature of the contract itself it partly to blame. *Only a term of service, with no restriction on the number of calls, is usually specified.* The customer therefore feels it good business to call up the service technician any time if something out of the ordinary appears on the screen. Many maintenance men report that half their calls are of the "nuisance" variety, in which nothing is actually wrong with the set, and the customer requires only an explanation of what he has seen.

How can we remove these causes?

Obviously THE UNLIMITED MAINTENANCE CONTRACT MUST GO! The manufacturer must be responsible for calls due to defects in his receiver. All calls—after the manufacturers' guarantee period—should be paid for by the customer. An ideal installation and maintenance contract would call for a fixed fee for installation and a specified number of calls during the "work-in" period of the receiver. All calls thereafter would be paid for at a stated rate per call. This system would prevent the maintenance technician from going bankrupt.

For—make no mistake about it—the small two- or three-man shop is the most efficient service organization ever devised. We went through this same children's disease in the infancy of broadcast radio in the early '20's. More than one manufacturer wished to assure good repairs by "factory service" and sets were shipped back to the factory when they broke down. But it was soon found that factory repair departments could not break even without charging from three to five times as much as would the local repairman for an equivalent job.

The final answer—for manufacturer, dealer, service technician and set owner—is not a system that will add to the expense of television maintenance by sqeezing the smaller service technicians and installation firms out of business, but common sense that will take the "gimmicks" out of the present setup and thereby make it possible for them to stay on the job.

Far-seeing television manufacturers cannot fail to be impressed with this situation. We are faced with a shrinking economy in this country and *the public cannot be placed in a position where it hesitates to buy television receivers, for fear of having to pay twice for television servicing.* Neither can the manufacturer profit from a system that would result in fewer and fewer technicians being left in the field to service the growing number of sets. It is up to them to help the service technicians stay in business if they do not want to lose money in the end.

Improve Your TELEVISION PICTURE

When you adjust the rear-panel controls, have someone hold a mirror so you can see how adjustments are affecting the picture. Large mirror is best.

Without knowing a thing about radio, you can better your reception. A "how-to-do-it" for non-technical TV set owners

By ALLAN LYTEL

IF YOU drive a car, you probably feel fully capable of telling when the gas tank is empty, of filling your tires with air to the right pressure, and of putting antifreeze in the radiator when winter comes along—even though you're no mechanic. Despite the fact that you may not know a resistor from an inductor, there are certain improvements you can make on your television installation, too.

But wait a minute! Put down that screwdriver and that pair of pliers. It's definitely *not* a good idea to go barging into the set's innards—that's work for your professional television service technician. There are dangerous high voltages inside that back cover. There are also delicate adjustments, disturbing any one of which might put your set out of commission. But there are plenty of improvements you can make *without taking the back cover off the set.*

Your first area of operation might very well be your roof if you have an outdoor antenna. Your regular radio has probably been doing very well with a built-in antenna; but your television set is much more critical for two good reasons.

First, the very short waves used for television transmission won't travel around corners—they travel in straight lines, though they will bounce off flat surfaces. That means that for best reception the antenna should be placed where radiation from the transmitter can reach it directly, without obstructions or detours.

Second, a little noise on your radio doesn't bother the ear much; but on television the noise (interference or static) makes little spots, lines, "rain" and "snow," dance all over the screen, and—as you may know from experience—eyes won't stand much of that without complaining.

If you have put up your own antenna, the first thing to do is find out whether it is in the right place. Moving the antenna a few feet in any direction can make all the difference in the world. So try moving it around, with a friend watching the TV screen to tell you when the picture is best. You may have to turn down the CONTRAST control if you get much of an improvement.

If the installation is a professional one or if the antenna might damage someone or something if it falls down, better not move it. Probably your service technician has installed it right.

Whether or not you relocate the antenna, you may be able to improve reception by turning it a bit. Usually you'll do best by having it broadside to the station, as illustrated in Fig. 1. But that not always being true, try other positions as well.

Eliminating ghosts

There's nothing mysterious about television ghosts. If you get them, it's

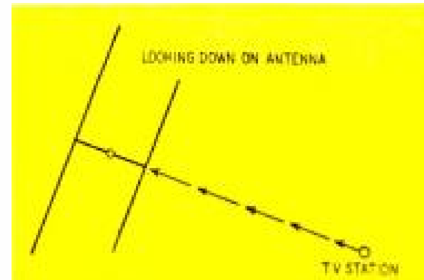


Fig. 1—Antenna is broadside to the station.

because your antenna is picking up *two signals from the same station.* Take a look at Fig. 2. The transmitting antenna squirts out energy in *all* directions. The energy your antenna picks up should be that going along path A—the shortest and most direct route.

But suppose some of the energy going in another direction (path B) hits a building, as the drawing shows. It bounces off the building just as light rays reflect from a mirror. (Angle of incidence is equal to angle of reflection.) The reflected energy also reaches your antenna. But because it has traveled over a longer total distance than the direct ray of path A, *it arrives a little later.* Thus, you have two signals from the same station!

The picture on your screen is "painted" by a spot of light that moves across and up and down the screen very fast. At each point on the screen it varies in brightness to give the right shading to that part of the picture. And the amount of brightness at each instant is dictated by the signal it receives at that instant from the station.

Now, let us say that the signal of

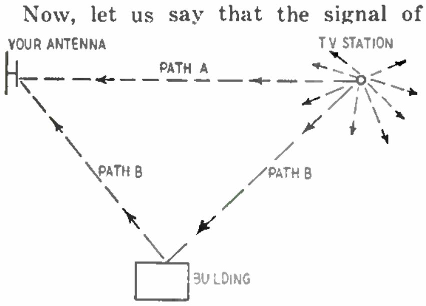


Fig. 2—Dual-path reception can cause ghosts.

path A tells the spot to make your screen black in the center of the picture of a man's vest. Then the signal of path B comes along a fraction of a second later *with the same command.* By that time the spot of light has moved over into the whiteness of a light-colored wall. But the path-B signal tells the spot to go black—and it does. Result: you see two dark areas (two vests) where there should have been only one! The second vest, to the right of the first, is the ghost.

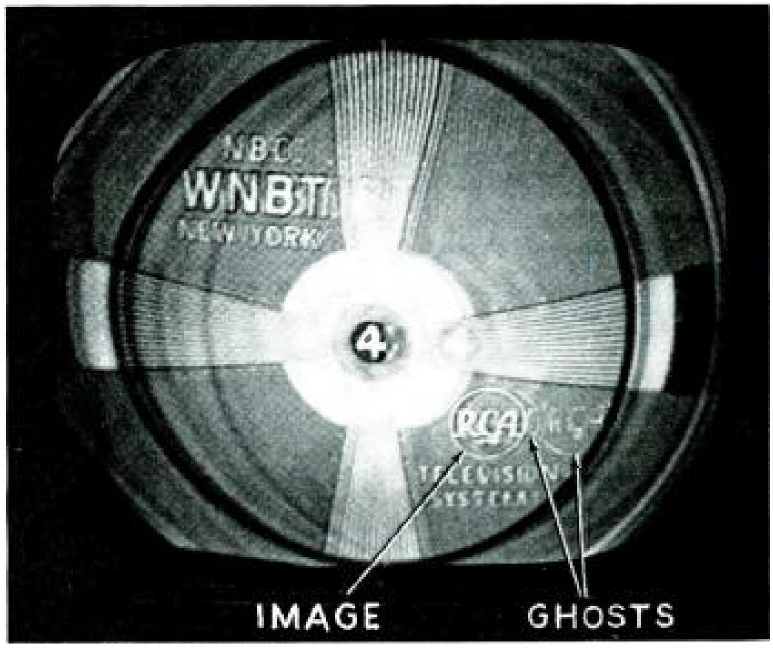
The problem is to eliminate the signal of path B. If your antenna is of a very directional type—that is, it rejects all energy not approaching it directly—you'll probably have little trouble. If you do get ghosts, try revolving the antenna while a friend watches the screen. You'll very likely be able to find one position at which ghosts will be at a minimum for all or most stations. If there is no such position, you'll probably have to get a more directional antenna.

There's no way to predict in advance whether you'll have ghosts; they are *not* caused by the set itself. They are entirely an antenna problem—therefore experiment until you're satisfied.

Better results downstairs

After you've finished with the antenna itself, pay attention to the wire or line connecting it to the set.

The connecting line, usually made of



If your picture is this bad, better get to work! The arrows show the genuine and ghost images.

two parallel wires embedded in a tough, flexible plastic, is known as ribbon line or Twin-Lead or some similar name. It is usually about ⅜ inch wide, and technicians generally call it "300-ohm" line because of its electrical characteristics. If that's what your installation has, it's time to go to work.

Take the tinfoil from a package of cigarettes, tear off about half, and wrap it around the ribbon line a few inches away from your receiver. Keep it in place with a paper clip. The photo will give you the idea.

Slide the foil slowly along the line and *away from the set,* watching the screen. You should have your most difficult-to-receive station tuned in, with the CONTRAST control turned down until you can barely see the picture. You will notice that with the tinfoil at a certain spot, the picture gets worse, and that at another spot it brightens up. Leave the tinfoil at the place at which the picture improved. Check all the other stations to make sure you didn't make them worse. If all is well, you've scored a point!

If reception still isn't good on your worst channel, take the tinfoil off. At your radio store buy 3 or 4 feet of 300-ohm ribbon line. Make sure you have an old razor blade handy.

Strip the plastic away from the first couple of inches of your piece of line, and fasten each wire to one of the antenna posts of the receiver. You'll need a screwdriver because the antenna posts are usually screw terminals, to which the line from the antenna is already attached. When you tighten up the two screws again, you should have *both* the original antenna line and the end of the new piece of the line in place. Fig. 3 illustrates the scheme. Be sure to get one bared wire from each of the two lines securely under the head of each screw.

Now, starting at the free end of the new section of line, hold the razor blade across the plastic ribbon and dig it in until the metal contacts both wires. Watch the screen. The picture may improve or get worse. Try this razor-blade trick at intervals of an inch or so all the way up to the antenna terminals. You will find at least one point where the contact will improve the picture. *Cut the line at that point,* bare the wires, and twist them together to make the improvement permanent.

While this will probably improve only one station, it isn't very likely to make others worse; therefore you will have gained something again. If two stations are bad, go through the procedure sep-

This photo shows the strip of tinfoil wrapped around the line and held in place with a clip.

arately for each one, and then use a switching arrangement like that shown in Fig. 4. You can buy the double-pole, double-throw knife switch at a hardware or ten-cent store. When you want to watch programs on station A, throw the switch to contact the line adjusted for that station; ditto for station B. When watching stations needing no improvement, leave the switch entirely open. You can screw the base of the switch to the back of the receiver cabinet.

There's one more thing to check in the antenna department. Notice how the ribbon line comes down from the roof. Is it securely anchored all the way so it can't whip about in the wind? If not, move it yourself and see

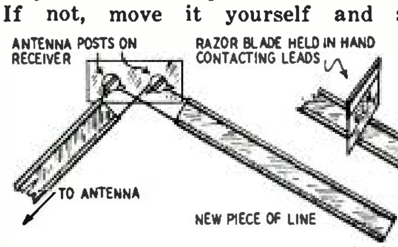


Fig. 3—Add piece of line and test with blade.

whether there's any effect on the picture. If there is, anchor the line firmly at intervals along the way if possible, and at least at top and bottom. Don't use nails or screws; your radio service shop has special insulators.

Adjusting controls

You don't have to be an engineer to adjust a television set's controls correctly, but a few tips will help. You use the front-panel controls more often than those on the rear, and you've probably tamed them so they'll perform as scheduled.

The little, knobless controls on the rear, though, have probably affected you in one of two ways if you're a more or less average set owner. Either you've left them strictly alone or you've become so curious that you twiddled them all and then were unable to do anything but call your repairman. Of the two, the first reaction is the safest, but there's no reason why you can't go around back and adjust at least some of the controls to get a better picture. As your set "breaks in" and the tubes and parts age, some of the adjustments need changing; you can often do it yourself, without bothering the service technician.

But please read on before you touch anything! One wrong move, and the picture may be standing on its ear. Go slowly!

Item No. 1 is to get a good-sized mirror if you have one. A hand mirror will do if you can't find a bigger one. After moving the set out so you can get behind it, prop the mirror on a chair in front of the screen. If you can't do that, get someone to hold the mirror for you, as the personable young lady is doing in the photograph.

If there isn't much light behind the set, use a flashlight to read the control markings. Usually these are stamped in the metal of the chassis and are hard to read; be sure that the control you are adjusting is the one you want.

First adjust the FOCUS control. (It may be either on the rear or the front of your set.) There are just three ways to do it *right*. Take your choice.

If there is a test pattern on (any channel will do, but choose the one that normally gives you the best picture) tune it in and fix the front-panel controls as usual. Now, watching the image carefully in the mirror, slowly rotate the FOCUS control until the black lines near the apex of the bottom vertical wedge are clearest and most sharply defined. Fig. 5 is a photo of a perfect test pattern and the arrow shows you the area to be watched. Make the adjustment very precise—so that your eye can separate the black lines to a point as near the center as possible. This is quite a critical adjustment.

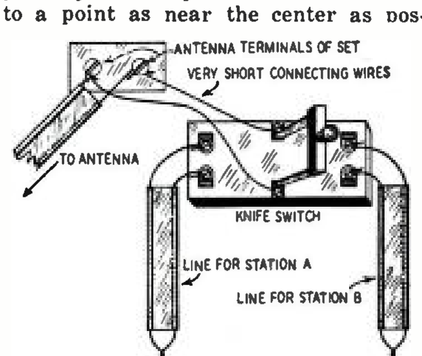


Fig. 4—A switch selects desired tuning line.

Another good way is to try and find a channel with FM or similar interference. Try the channels *not* used by stations in your location. Turn the CONTRAST control up and watch for a "tweed" (as in men's suits) pattern. If you can find one, adjust the FOCUS control until every detail of the tweed pattern is crystal-clear. The optimum adjustment can be found very quickly.

If there aren't any test patterns and you can't find tweeds, tune in a program. Adjust the FOCUS control until you can see individual horizontal lines of light across the screen. You'll have to look closely on most sets, and you may have trouble seeing the lines at all on 7-inch and smaller tubes. Using a test pattern is by far the best method of the three mentioned.

There are two more controls you can adjust *if your set has a 7-inch tube or smaller*. These are VERTICAL CENTERING and HORIZONTAL CENTERING. If the picture is too far over to one side of the mask or too high or low, these controls will move it to the right place. Adjustment is very easy—just watch the image and twirl the control shafts.

Once again a warning: The other controls on the rear of the set interact; that is, *adjusting one affects the functions of another*. One twist of a shaft and you're likely to spend the rest of the evening trying to get a good picture.

Light filters and enlargers

There have been rumors that watching television is bad for the eyes. If your receiver works well and you treat it right, the rumors are—just rumors. For instance, don't locate the set where direct light can fall either on it or on your eyes. If it's under a window or there's a lamp beside it, your eyes will have to withstand quite a change of illumination when you look away from the picture to the comparatively bright sunlight or lamp.

If light falls on the screen, the glass will reflect it, along with the light from the picture itself. Effectively that reduces the contrast—"washes out" the picture. So, for best television viewing, keep the room dark except for a little light that doesn't shine on your face or on the screen.

Keeping the room entirely dark is hard on the eyes, too. When you look away from the screen, your eyes have to adjust from reasonably bright light (the picture) to utter darkness, a change that's too sharp, according to medical men, to be healthy.

Picture-tube filters are sold to "increase contrast"—you've probably seen the ads. Some of them are simply tinted, transparent plastic. The light from the picture itself passes through the filter once and is dimmed to some extent. But any external light reflected from the screen passes through the filter twice—once on its way to the screen and once from the screen to your eye. As you can see, the reflected light is cut down twice as much as that from the picture. As a result, daylight or room lights falling on the screen don't

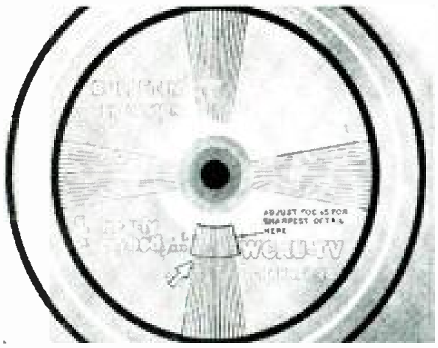


Fig. 5—Watch outlined area when focusing.

tend to wash out the picture so much.

Polaroid filters are a little different. They are tinted, too, and act like the others; but in addition, they have the same properties of cutting down reflected glare as do the Polaroid glasses you may have used while driving a car. Apparently reflected light is polarized much more than direct light; the polarized filter removes most of the polarized reflections.

Some viewers like filters and some don't—it's a matter of individual preference. They undoubtedly do prevent eyestrain to some extent by removing the glare from overly bright screens, but you can do the same thing by turning down the BRIGHTNESS control.

If your set has a 20-inch viewing tube like the Du Mont on this month's cover, you probably aren't worrying about getting a bigger picture. But if you have a smaller one, you may want an enlarging lens. Available in many sizes and styles, most of them are either solid or liquid-filled plastic. Unfortunately, you can't get too far off toward the side without getting picture distortion with a lens; but since a bigger picture will allow you to sit farther away from the screen, you can usually get more or less directly in front of the set all the people who want to watch.

There's an important limitation to the size of your picture. Remember that a television picture is not a solid "photograph" but an optical illusion. It's made up of 485 horizontal lines of light from top to bottom of the picture. If the tube is small, the lines must be crammed in; they are so close together you can hardly see them. With even a very large picture—*the number of lines remains the same;* the lines are now far enough apart to be seen. Whatever the size of your screen, you have to get far enough away from it so that the lines blend together and the eye is fooled into thinking it sees a solid picture. Therefore, with a big screen, be sure your room is large enough to allow you to get back from the set a sufficient distance. The distance will vary according to the condition of your eyes and your preferences. Watch a picture of the size you want at your dealer's store to get the information you need.

You may have heard that American television stations transmit with a definition of 525 lines. What happened to the difference between 525 and the 485 we mentioned above? The answer is that the time that might be occupied by the missing 40 lines is taken up with "sync pulses". These are electronic instructions which tell the receiver what to do to keep the moving light spot in step with that at the transmitter. Without them—no image!

Out in the country

Television stations usually have a maximum useful range of about 40 miles because of the technical characteristics of the wavelengths on which they transmit. Sometimes they'll reach farther, sometimes not the full 40 miles. But if you live more than 25 to 30 miles from a station, you're likely to have a little trouble getting a perfect picture, one without "snow" effect.

The best way to proceed if an ordinary installation doesn't get the results you want is to use a special antenna, one that's very directional. These antennas not only suppress static arriving from directions other than that in which the antenna is pointed, but also provide a gain—they receive energy and send it to your receiver much more efficiently than the simpler antennas.

If you're still not satisfied, try raising the antenna as high as possible. Some owners in outlying districts have even used telephone poles (bought their own, not climbed up existing ones) or tall metal towers. This matter of reception in *fringe areas*, as these locations are called, requires considerable study and is best handled by a professional technician.

If you are located where the signal is weak, but still strong enough to give you some picture, a booster will often help. These are little amplifiers containing one or two vacuum tubes, that any set owner can install himself. Connected between the antenna line and the receiver, they increase the strength of the signal before it reaches the receiver. Even where some stations come in well, there may be others which perform badly; a booster may help with the bad ones and can be switched off when you are watching a strong station.

Improving your television set pays off in better pictures and more satisfying entertainment.

But remember this always: your television receiver is a delicate instrument, and it's immensely complex. *Leave its insides strictly alone;* if something goes wrong that hasn't been wrong before, *call your television service technician!*

TELEVISION TUBES LOSE BRILLIANCE

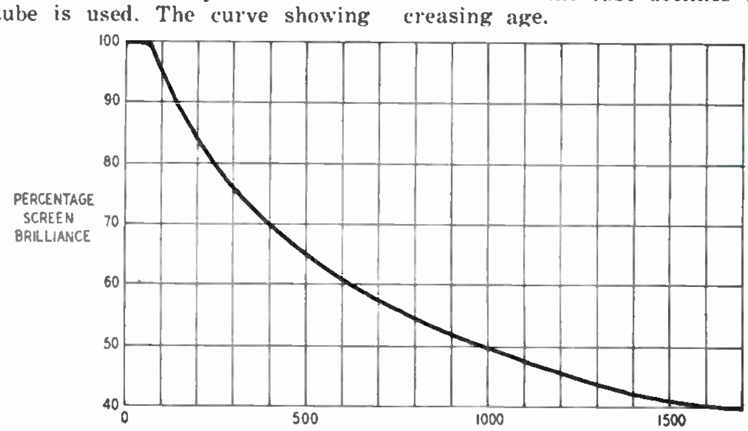
EACH new television set any of our neighbors installed seemed to be better than anything we had seen up to the time. Such bright pictures! But after noting this three or four times, we began to wonder. Television can't be improving that fast! Could it be that new sets give a brighter image, and that the older ones dim down so gradually that one doesn't notice it?

Radio tubes wear out, and the cathode-ray tube should be no exception. But does it lose its brilliancy gradually, drop sharply and then level off, or run at practically full brilliancy through most of its useful life and then drop off sharply?

A letter to H. D. Suesholtz, general manager of Transvision, brought the information:

"The screen efficiency decreases as the tube is used. The curve showing change in brilliancy with age is exponential. After a very short time—approximately 50 to 100 hours—there is a sharp drop in brilliance. The drop is then gradual, usually taking about 1,000 hours to reach 50% efficiency. This means that the light for the same wattage impinging on the screen would decrease as described above. We use the words 'screen burning' to describe this."

The exponential, or "die-away" curve below gives a rough indication of how much brilliance your tube will lose in a given number of hours. It cannot be taken as an exact picture, as other factors affect the tube life, and of course the brightness control will be used to offset the effects of less screen brilliance. But it does give a fair over-all idea of how the tube declines with increasing age.

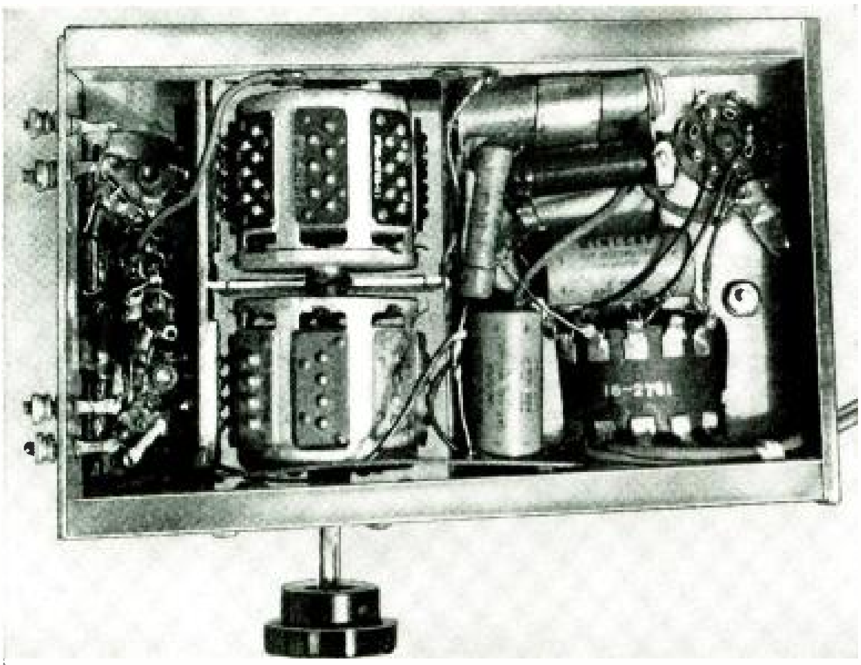


This curve shows how maximum brilliance of the C-R tube decreases with hours of use.

Booster Uses Standard Tuner

Ready-Made Front End Makes For Efficient Operation

By MATTHEW MANDL*



This is the booster made from the Philco front end. Power supply is at right of tuning drum.

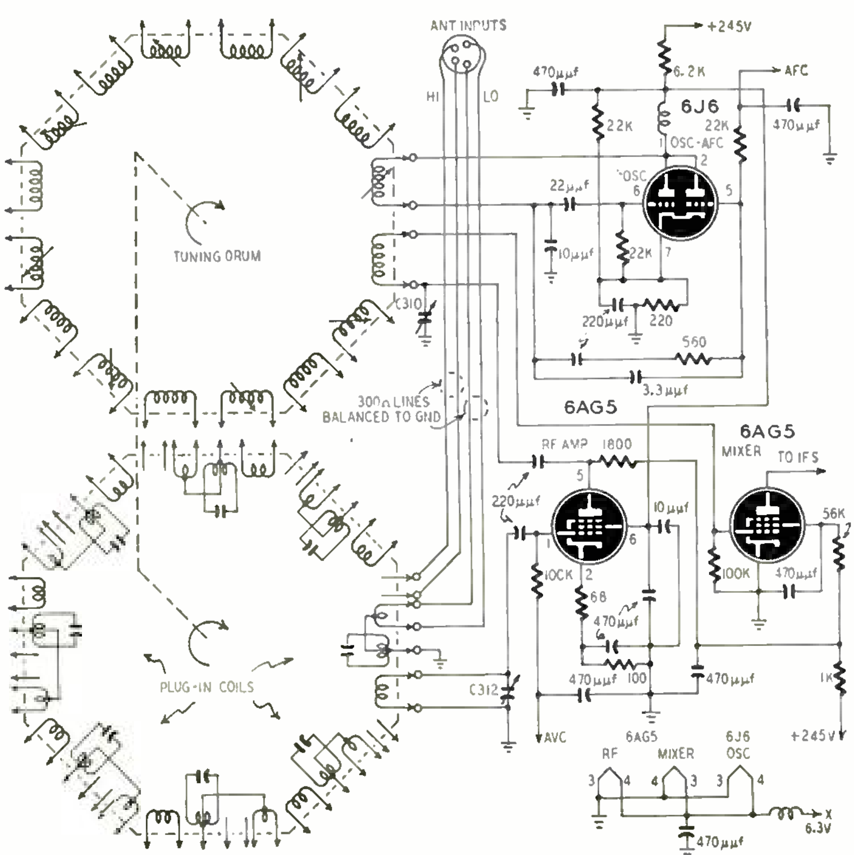


Fig. 1—Original circuit of the Philco television tuner. Coils may be had for any channels.

A TELEVISION booster consists of one or two stages of r.f. amplification with the output so designed that it will match the input of the TV receiver. While it is not difficult to wire an r.f. stage, the wide band of frequencies which must be covered in television makes the tuning system critical. The channel-selector section is the most troublesome because the high frequencies to which it must tune make necessary a number of precautions for even average performance. Assembly and wiring of such a tuning circuit demands constant attention to stray capacitance, lead inductance, and skin effect, for all contribute to high losses and poor efficiency. When, at the same time, a 6-mc bandpass with a good signal-to-noise ratio is required, the problems become even more complex. For these reasons most homemade boosters fail to give satisfactory results—particularly on the higher-frequency channels.

These difficulties can be greatly reduced by using a commercially built tuner as the foundation unit for the booster. Such tuners have been carefully engineered for the TV frequencies, are fairly high in efficiency, and make bandswitching simpler. Any good tuning section can be used, and many types are available from TV kit manufacturers.

Often a defective tuner which has been replaced by a new one during servicing can be salvaged for use. Tuners frequently develop defects in only one or two channels, and thus can be utilized for booster construction, because a booster is not needed for all channels.

Essentially, a commercial tuner consists of three sections: the r.f. amplifier, the mixer, and the local oscillator. These are combined into one unified assembly, small in size, with the tubes mounted on top. Such a device already has all the components, except for the power supply, necessary for constructing a booster. If we eliminate the local oscillator and convert the mixer to an impedance-matching device, we have an excellent r.f. amplifier, pretuned and designed for easy channel selection.

Three things are necessary. First, disconnect from the oscillator the tuning coil which is coupled to the mixer. The oscillator tuning coil need not be removed, but should be open so that it will not affect the tuning of the unit. Second, convert the mixer tube to an impedance-matching device; cathode and plate circuits must be changed slightly as outlined later. The final step

*Television Instructor—Technical Institute Temple University

is assembly of a small power supply for the device.

A booster of this type was built using a Philco turret tuner. The Philco turret has two rotary drums, each with eight slots into which coils are plugged. One drum receives the antenna-r.f.-input coils, and the other the mixer-oscillator coils. Fig. 1 shows the original tuner circuit. Fig. 2 is a schematic of the booster, showing the changes made in the tuner. The power supply is given in Fig. 3. A comparison of the original and modified circuits shows that only two changes were made: the 6J6 oscillater-a.f.c. tube was eliminated, and the 6AG5 mixer was changed to an impedance-matching device for a 300-ohm receiver input.

With the oscillator eliminated, two tuned circuits are still present—the input to the r.f. amplifiers, and the interstage circuit between the two 6AG5 tubes. Plug-in coils for this tuner are available for any TV channels, and eight different stations can be made available by rotating the drum. As with other tuning units, coils are pretuned at the factory and need little adjustment. If coils should be found too far off frequency, adjustments can be made by changing the spacing of the turns slightly. Tracking capacitors, present in all types of tuners, can also be employed when necessary to get peak performance.

The Philco tuner has provisions for high- and low-band antenna inputs, using 300-ohm transmission lines. Two antennas, with separate transmission lines, can be employed. Each will be switched in automatically as the drum is rotated. If the double antenna system is not desired, a single antenna and lead-in can be used by shorting across the two terminals, as indicated by the dotted lines in Fig. 2.

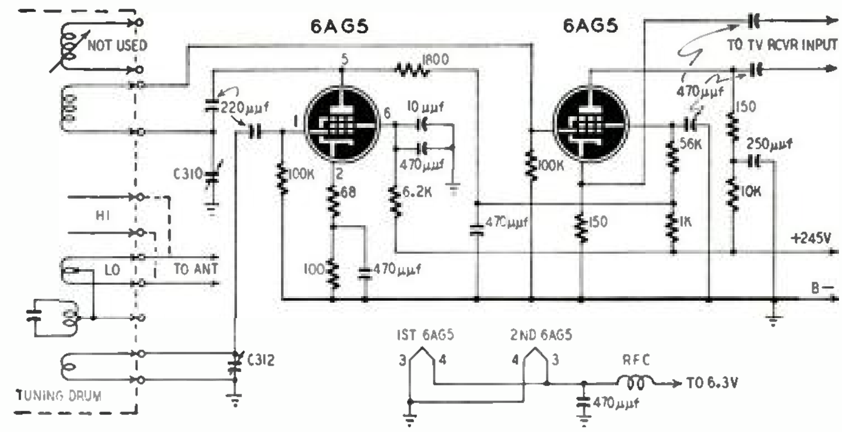


Fig. 2—Circuit of booster. Oscillator-a.f.c. tube was removed and mixer made output stage.

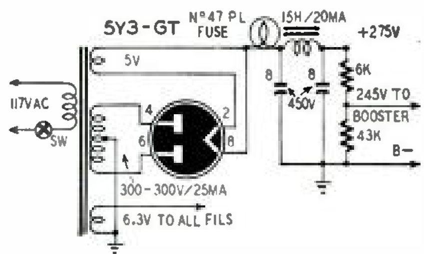
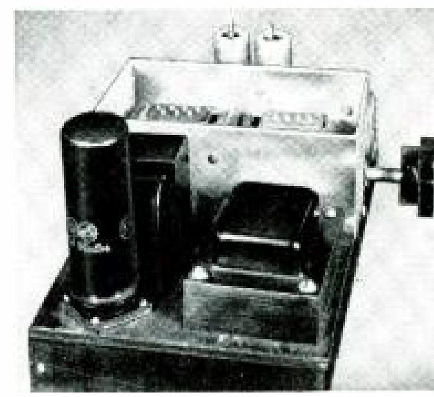


Fig. 3—The booster diagrammed above is powered by the simple supply shown here.

Final construction job appears in the photo.



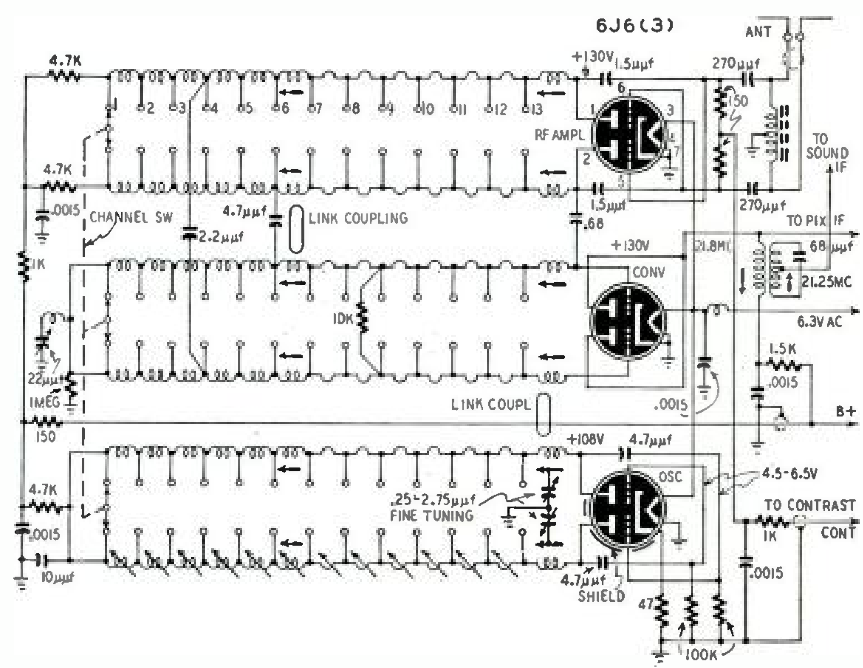


Fig. 4—Circuit of the tuner appearing in RCA, Admiral, Emerson, and other receiver models.

Constructional details

Since the modified tuner comprises the entire booster, additional chassis space is needed for the power supply. With the Philco tuner, the chassis used is 5¾ x 9 x 1 inches. The Philco tuner measures 4½ x 5¾ inches, and this much of the chassis top is left open. The tuner is bolted to the chassis, over the open section, as the photos illustrate. The chassis is made of wood; the tuner framework is metal and provides adequate shielding.

A strip of Plexiglas, Lucite, or other low-loss material should be used for the input and output connections. In the tuner illustrated, bolts and nuts were used for terminal connectors, though low-loss jacks or other plug-in devices can also be employed. Connectors with large surface areas should be avoided, however, because the capacitance effect between them becomes quite pronounced for the upper-channel frequencies.

The power supply is a conventional full-wave rectifier type. A 5T4 was used, but any standard rectifier tube will be satisfactory, including the miniature type 6X4. Almost any small power transformer will do, because the current drain of any commercial r.f. tuner will not exceed 20 ma. The voltage for the booster circuit, however, should be no higher than 245; and if the output of the supply is greater than this under load, a voltage divider system like that shown in Fig. 3 may be used.

The resistance of the bleeder will depend on the particular power transformer used. The type 47 pilot bulb acts as a fuse and protects the rectifier tube and transformer.

With some commercial tuners, the removal of the oscillator tube will suffice, and this should be tried first before disconnecting the oscillator coil. If the unused oscillator coil does not seriously affect tuning, no further changes need be made except to the mixer output. With the booster described, all oscillator wiring was removed to make a

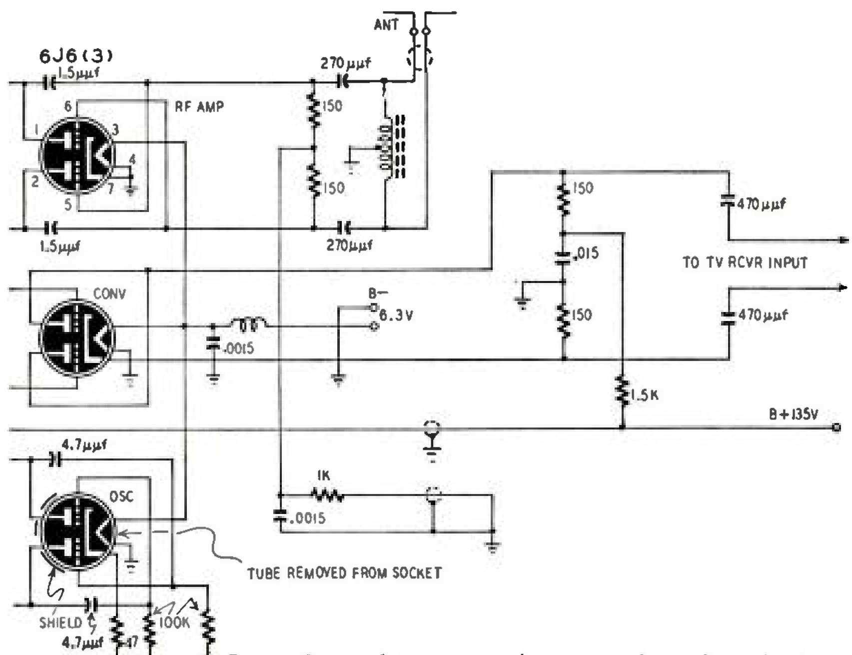


Fig. 5—Tuner of Fig. 4 may be revamped as above for booster.

neater job. Take care not to open circuits unintentionally, because some ground or B-plus returns may be terminated at the oscillator-tube socket.

The mixer tube is used in a circuit whose primary function is to make an impedance match between the booster output and receiver. Balance is attained by using an unbypassed cathode resistor against the plate-load impedance. Since the circuit is degenerative, gain is less than 1. This double-tube booster is much better than a single-tube booster, even though the gain of the second stage is below 1. The reason is that single tube boosters have to match the low receiver impedance (300 ohms) in their plate circuits, substantially reducing gain.

Use a common ground for booster and TV receiver to assure balance throughout. When operating the booster, a 300-ohm transmission line is used from its output to the input terminals of the receiver. It should be as short as possible to avoid stray fields. For the high channels, the antenna transmission line may have to be tuned by shorted stubs attached to the input terminals. Tinfoil, wrapped around the line, can also be used for tuning. Slide it up and down the line until the picture is best.

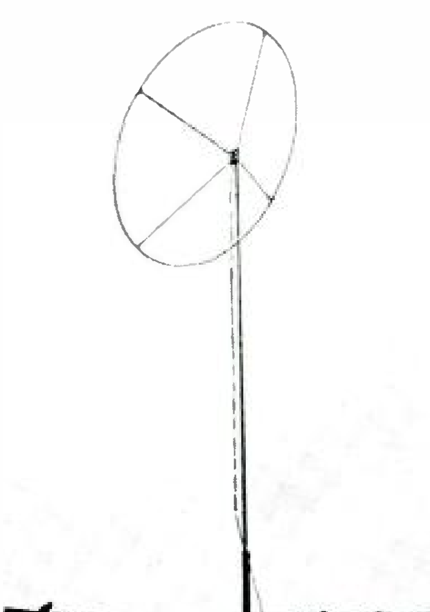
Other tuners lend themselves just as readily to booster construction, with identical changes.

Fig. 4 shows a typical tuner which has been used in several receivers. It was originally the RCA 630TS receiver tuner, and subsequently was used by RCA in 1948 models, 8TS30 series. The Admiral 30A1-B chassis also employed identical tuners, as did Emerson in model 571, and other manufacturers. Removal of the coupling link between the mixer and oscillator and a change in the plate circuit of the mixer, as shown in Fig. 5, converts this tuner into another high-gain booster.

New All-Channel TV Antenna

A TELEVISION receiving antenna of entirely new design was announced recently by Continental Copper & Steel Industries, Inc., New York. Called the Welin Circle X, it consists of a circular tube with four radial rods, the whole forming a shallow cone.

The single antenna is said to be effective over the entire television spectrum with a gain of approximately 1.9 over a half-wave dipole. At the lower-band frequencies, the pattern is wide and bidirectional, about the same as that of a dipole. At the higher frequencies, the rear lobe becomes considerably smaller than the front one.



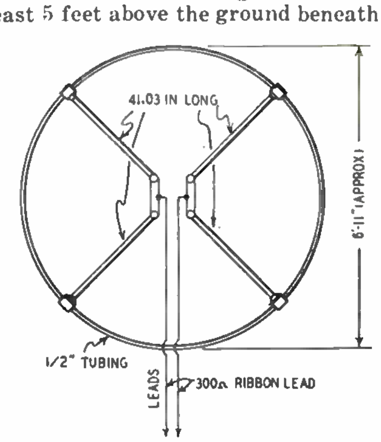
The Circle X resembles shallow skeleton cone.

Because a complete investigation of the validity of the design principles has not been completed at this writing, little can be said of the engineering basis for the antenna. It has been found, however, that despite the broad angle of signal acceptance, it is remarkably effective in suppressing ghosts. A slight reorientation to one side or the other diminishes ghost reception, apparently because of certain phase relations between the direct and reflected signals reaching the circular outer ring; cancellation seems to take place. Interestingly, it has been found that a slight reorientation in the vertical sense—tilting the assembly so that it points upward about 7 degrees—also diminishes ghosts to a large degree in some cases.

The photo and diagram show how the antenna is constructed. The outer circle is composed of four segments, each ¾ wavelength at 135 mc. The 135-mc frequency was chosen as the median of all the television channels. Each of the radial rods is ½ wavelength. The inner ends of the rods are fastened and connected as the diagram indicates, adjacent pairs going to the two ends of the transmission line. The outer ends of the rods are mechanically and electrically connected to the junctions of the circle segments so that they are 90 degrees apart on the ring.

The impedance of the feed point is approximately 150 ohms, though it varies somewhat over the range. In ordinary installations, 300-ohm line is used, with a minimum impedance mismatch (and standing-wave ratio) of 2, though neither is much greater than this at any frequency. For critical installations where signal is low or noise level high, matching stubs and transformers of the ordinary type reduce the mismatch.

For optimum results, the antenna should be placed in a space loop and the bottom of the ring should be at least 5 feet above the ground beneath it.



The drawing shows dimensions and connections.

A standard signal generator with 400-cycle modulation and an output meter are necessities.

Sweep generator and scope are optional.

Trouble-Shooting Television Sets

By IRVING DLUGATCH

MANY an old-timer in radio servicing has turned green with envy on seeing the "complete service laboratory" unveiled by his newest competitor. Yet half the servicing the skilled radio technician does is with no other test equipment than his eyes, ears, nose, and fingers. That's possible because he knows his basic theory and has spent years of postgraduate study in the College of Experience.

Television doesn't differ from sound radio in this respect. It is even simpler to service in some respects because the eyes can be used to better advantage. The kinescope tube is a piece of test equipment wired right into the receiver.

Many may have been frightened away from video work by the ballyhoo over special test equipment supposedly needed. Emphatically, special television test equipment *has* a place in every television shop. The purpose of this article is to demonstrate that a large percentage of television servicing can be done with a good volt-ohm-milliameter and a signal generator.

Servicing any electronic circuit is simplified if we know:

1. What it is designed to do;
2. Whether it is self-excited or receives an external signal;
3. The frequency;
4. How it is supplied with its operating power.

Let's see how the four facts are used in practice. Suppose a device is described as a three-stage amplifier supplying a 15,750-cycle sawtooth wave to its output terminals. It is receiving d.c. potentials from a conventional full-wave rectifier power supply. There is, however, no sawtooth voltage at the output. Now let us proceed to put it into condition.

We know the frequency is 15,750 cycles per second; therefore, we know we need an a.f. voltmeter to trace the signal. Since we are dealing with an amplifier the signal must be coming from some external source. The meter will determine if the signal is arriving at the input terminals. If no signal is present, the amplifier is not at fault. If the signal is coming in, we would next check the power supply. If it is O.K., we need only trace the signal from stage to stage. The trouble can be localized in short order and the defective component found with the ohmmeter or voltmeter.

Required equipment

The foregoing is the general method of solving any servicing problem. Television, even with its multiplicity of circuits, does not introduce any further difficulties. Signal tracing is used in all its possible variations. To do a good job of signal tracing, you need:

1. **Output indicator:** Any a.c. meter with a capacitor in series with the hot lead. Since a high-resistance voltmeter and a wide-range ohmmeter are needed for checking parts, a combination instrument, such as the Superior TV-20, Precision 85, Electronic Measurements 120, or Radio City Products 450C, is recommended.

2. **Signal source:** Should provide modulated r.f. up to at least 30 mc on fundamentals and a 400-cycle audio signal. An attenuator for the 400-cycle note is very desirable. If it can go as high as 200 or 300 mc, it can be used for work in the r.f. sections. The Simpson 340 or Jackson 640 are typical.

Optional equipment

The following test instruments are highly desirable, if available, but are not absolutely required.

1. **Oscilloscope:** Usefulness greatly increased by provision for feeding video signal to grid of cathode-ray tube. Du Mont's 164E or similar instruments can be converted by adding a tip jack as shown in the drawing.

2. **Sweep generator:** Should have variable sweep width and cover a full range of radio and intermediate frequencies. Inclusion of a phaser is also desirable. RCA WR-59A, Hickock 610A, and Triplett 3434 are examples of such an instrument.

3. A number of selected, plainly marked capacitors and resistors for quick substitution.

The true expert soon learns not to trust the calibration of any instrument, regardless of its original cost. The signal generator should be calibrated at regular intervals. This can be done for the sound r.f. and i.f. carriers by using a television receiver that is operating normally. Feed in the signal from the generator while the set is properly tuned. When the 400-cycle note is heard with the television sound, we have the correct frequency to be used for alignment purposes. The picture carriers do not need precise calibration (for reasons to be noted later).

Next, our meters' accuracies are to be questioned. Fortunately, precise resistance and voltage readings are in most cases unnecessary and in many cases foolish. This is obvious when we remember that most parts tolerances are 20%. In addition, we will often be tracing signals that are not sine waves. The results obtained then with most instruments are so mystifying that special interpretation is required. Most a.c. meters used in television servicing are calibrated for r.m.s. measurements of sine waves (the rectifier-type actually reads *average* values but is corrected to read r.m.s.). When, for example, a sawtooth wave—of much lower effective value than a sine wave with the same peak voltage—is measured, the reading is bound to be low. Where a.c. and d.c. are combined, the d.c. component may be measured with a d.c. meter and the combined voltage with an a.c. meter. Subtracting the d.c. from the reading of the a.c. meter will show the amount of a.c. in the circuit.

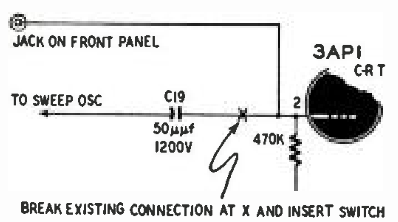
Despite the claims of manufacturers, very few a.c. voltmeters are reasonably accurate above a few thousand cycles. Such things as rectifier characteristics and meter coil inductance limit the frequency range. Only with special probes can these effects be overcome. The probes still can't offset error which follows any attempt to measure anything but a sine wave.

Oscilloscopes are not immune to these faults. At high frequencies, their amplifiers may distort the wave being examined or so attenuate it that the instrument is worthless. Again a special probe will permit the use of an oscilloscope at these frequencies. The oscilloscope makes it possible to measure peak-to-peak values; and, for this reason, it can be used to compare accurately voltages of different wave shapes. This is all we need for signal tracing.

Checking and signal tracing

Our test equipment is assembled. We understand our instruments. Now what? Certainly not an immediate probing into the "innards" of the television receiver. That must wait until we have used our senses to determine the section of the receiver at fault.

So much has been written in the past on the "test-pattern-examination" type of trouble shooting that I shall not take the space to repeat such information. What follows is an outline of the methods to be followed *after* this step in the localizing of troubles within a suspected section of the receiver. (See "Servicing Televisers," page 50, and "Television Trouble Chart," page 54, of the January, 1948, issue; also "Using TV Test Pattern" in the November, 1948, issue.)



A Z-modulation jack added to scope is useful.

Since misalignment of circuits is a very common complaint in television work, let us begin with

Alignment procedure: The serviceman does not need to go through the complete alignment of all circuits in a television receiver. Normally, a receiver brought in for repairs requires only a "touching up" such as might be done with an AM broadcast set. *Because of the broadness of the picture i.f., it rarely requires any realignment.* A satisfactory picture can be received even if the alignment of the individual circuits varies a bit from the normal. The oscillator and sound i.f. may require realignment from time to time to keep the sound with the picture.

Suppose that, using the standard test-pattern-examination and localization methods, we have localized or partially localized a number of troubles. We would then perform the following signal tracing tests:

R.f. amplifier and converter: Signal injection tracing method using modulated sound r.f. carrier frequency with receiver's speaker as an indicator. If the signal generator cannot tune high enough, use a signal tracer with a good v.h.f. probe and high gain to follow received signal from a television station. Don't forget to check oscillator grid voltage and contacts on channel selector.

Sound i.f. amplifiers: Signal tracing with signal generator and output meter. D.c. output meter is connected across detector load. An a.c. meter at the plates of the audio amplifiers or the speaker can be used, also. The signal generator should be tuned to the sound i.f.

In receivers using intercarrier sound (Motorola, Hallicrafters, Videola, new G.E., etc.), the i.f. is always 4.5 mc. Also, tracing should be carried to the video amplifiers where the sound is obtained. A very common complaint with these receivers—a buzzing sound heard with the audio—is due to video getting into the audio system. Provided the fault is not with the transmitter, the trouble can be eliminated by carefully aligning the picture i.f., sound i.f., and sound discriminator. If the discriminator and limiters (if used) are working properly, they will reject the amplitude-modulated video signal. In the picture section, the response curve should be such that the sound carrier is down to about 10% of the level of the picture carrier.

Misalignment of the r.f. circuits or mismatch in the antenna system may cause the buzz by changing the ratio between the level of the sound and picture carriers.

Audio amplifiers and detectors: Inject 400-cycle note using speaker as output indicator. For tracing distortion, use an actual signal and listen with signal tracer or headphones.

Picture i.f. amplifiers: Connect output meter at plate of video output amplifier. Inject modulated picture i.f. signal at the grids of the i.f. tubes, beginning with the last i.f. stage first and moving toward the antenna. The last position for injecting the picture i.f. will be the converter grid. The converter usually being part of a compact tuner, it may be more convenient to feed the i.f. signal directly to the receiver's antenna terminals. Make sure there is no trap at this point to prevent the i.f. from getting through. Incidentally, always remember that the carrier frequency is not passed at maximum gain in the i.f. amplifiers. A lower frequency will give greater output.

If the trouble is due to i.f. oscillation, it will be indicated by decrease in d.c. output at detector load when signal generator is removed and suspected i.f. grid grounded.

Video amplifiers and detectors: Signal tracing by injecting 400-cycle signal. This will give about six dark, horizontal bars on the raster. (See "AM Generator Useful for Television" on page 47 of the July, 1949, issue of RADIO-ELECTRONICS.) The darkness of the bars will depend on the signal amplitude and the gain of the stages being tested. An output meter will also be satisfactory. For distortion, investigate peaking coils and capacitors. Defective coupling capacitors and plate load resistors are also common causes of this complaint.

Sync circuits: Signal tracing by injecting audio-frequency signals. Measure output at grid-leak-biased clipper tubes with d.c. high-resistance voltmeter or note whether raster locks in with injected signal. A high-gain signal tracer may be used. Oscilloscope may be used to compare waveforms with manufacturers' data. (Sync clipper tubes usually have the plates and screens, or both, operating at very low voltages with zero bias.)

Horizontal deflection circuit: Here the signal is being supplied by the horizontal oscillator. The signal can be traced with a tracer, output meter, or oscilloscope. The oscilloscope is best but not absolutely essential. It requires accurate waveform photographs for comparison. With the signal tracer, the 15,750-cycle signal may not be audible to some persons. A good compromise is the output meter giving a relative reading.

A correctly operating discharge tube and multivibrator tubes have a plate potential of approximately 10% of the low-voltage supply. Considerable variation will be found, but if the plate voltage exceeds 30% the waveshape may be incorrect. If it approaches the supply voltage in value, the pulse is not present. Magnetic deflection output tubes are usually operated at cutoff. **Do not attempt to measure the plate voltage of horizontal output tubes and damping tubes in magnetic deflection receivers. A high-voltage pulse is present, making voltage measurement dangerous.**

Miscellaneous: All oscillators, regardless of type, develop a high negative voltage on their grids in normal operation. Sync discriminators can be serviced exactly like any FM detector. Always check the balance of push-pull output tubes, if used. Damping tubes are common causes of distorted pictures.

Vertical deflection circuit: Generally the same as for horizontal deflection circuits.

High voltage supply: For flyback systems, listen for 15,750-cycle whistle audible when horizontal oscillator is operating. Check horizontal sweep circuit as described previously. For r.f. oscillator system, test oscillator tube, measure oscillator grid bias with d.c. high-resistance voltmeter and see if rectifier is lit. Test by measuring resistance of bleeder resistors. Voltage may be measured directly with a d.c. voltmeter having sufficient range or using a special multiplier.

Make sure positioning of ion trap magnet is not the cause of a dark screen. A defective kinescope is also to be suspected. A 10BP4 needs not less than 7,000 volts for adequate brightness. With excessive ripple, make sure deflection yoke is properly grounding outside coating of kinescope. Check filter capacitors by substitution.

Low-voltage supply: Most supplies deliver 300 to 400 volts. The usual voltage and resistance checks will uncover most faults. Capacitors are best tested by substitution. Selenium rectifiers can be tested with an ohmmeter. They should have a minimum back-to-forward resistance ratio of 1,000 to 1.

Now that we have gone completely through the receiver, a review will show that no special test equipment was required in most cases. Obviously, sweep generators, signal calibrators, and other elaborate instruments can do much to speed servicing, and are indispensable in certain jobs.

In conclusion, note that this article is not intended to be a complete servicing manual. It is an outline of the signal-tracing techniques to be used in television trouble shooting, as far as these techniques are applicable. Television theory must be digested so thoroughly that the individual will be able to develop these simple facts into his own streamlined methods.

New French TV Test Pattern

THE NEW French television test pattern illustrated here is more complex than the usual American one. It is designed to produce usable and accurate performance information, regardless of the technical standards of the TV system.

The chessboard edges are suitable for very exact framing. The aspect ratio is almost the same as the American 4 to 3, 4 to 2.91.

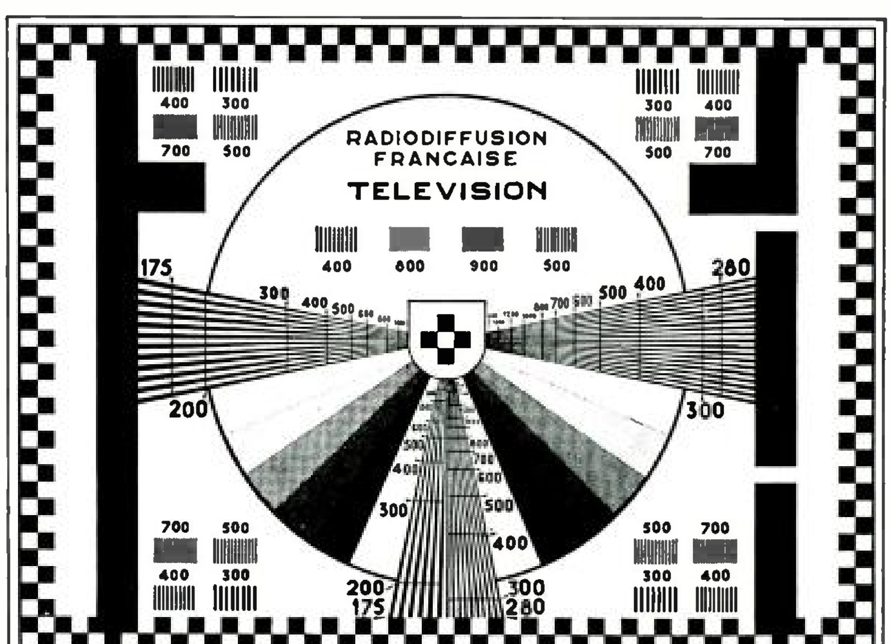
Vertical definition wedges are provided, as on American patterns, but they are calibrated differently. Instead of being marked in terms of the bandwidth necessary for resolution at each point, the figures indicate the number of bars (counting both black and white) which would appear across an entire line. Thus, the bottom of the left vertical wedge is labeled 175, meaning that if the alternate black and white "fence pickets" were extended to fill the entire width of the picture with the same spacing as at the "175" point, 175 of them would appear. This system allows the pattern to be used with TV systems of any standards—specifically (for the purposes of Radiodiffusion Française) with both 440- and 819-line transmissions. Two vertical wedges are provided for a wider range of values, and two horizontal wedges (calibrated in the same manner) are provided, the right one having finer lines for use with the 819-line transmissions.

As with most test patterns, the finer ends of the wedges are at the center of the screen because the cathode-ray-beam spot is always best concentrated (smallest) at the center. The circle encloses the area of best definition, approximately 2/5 of the image height. To observe definition outside this favored area, 16 groups of vertical bars are provided. These are similar in function to the bars of the wedges and are calibrated in the same way.

Modulation percentage may be measured with an oscilloscope. The heavy black bars with white notches provide a signal easily evaluated on the scope. The horizontal extensions on the black bars make lag clearly apparent.

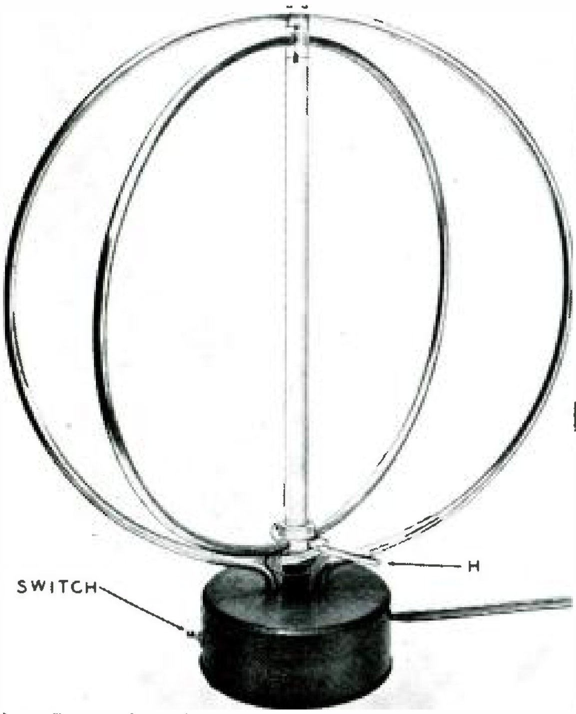
Contrast range may be estimated with the fan-shaped half-tone wedges. The half-tone dots actually are part of the pattern, not added for reproduction purposes in this magazine. The five steps ranging from black to white should be clearly distinguishable on the receiver's screen. Two large half-tone areas were provided in separate places to eliminate errors due to spots on the tube.

Ordinarily the linearity test is the perfection of the large circle. Note that all the wedges are drawn as radii of the circle to eliminate optical illusions which otherwise would make the circle appear imperfect at all times and hinder accurate judgment.



French test pattern is suitable for use with any system. Variety of markings aids testing.

THE TRANSPOLE VARIOTENNA



Final model of the transpole variotenna for TV reception.

. . . An unusual indoor antenna with new features has recently been evolved . . .

By HUGO GERNSBACK

Part 1

TELEVISION has brought in its wake a number of problems which have to do not so much with engineering as with living conditions.

It is admitted that the outdoor antenna is at the present time the most efficient. Unfortunately, it cannot always be used—particularly in our larger cities.

Many landlords of apartment houses do not allow antennas on the roof and frequently even the house owner does not wish to disfigure his roof with an unsightly antenna. That is the reason for window and indoor antennas.

I have had the problem under consideration for a long time during which many indoor antennas were tested. It soon became apparent that on account of the peculiar problems arising from wave reflections indoors, a better device was needed than had been proposed so far. The idea of an inductive coupled antenna soon occurred to me and a number of models were built. The two types shown here are the evolution of this idea. The smaller one which only measures 11 inches across proved quite satisfactory on fairly strong signals. It is composed of four ¾-inch brass or nickel ribbons wound concentrically, with lucite spacers on top and bottom to keep the loops about ¼ inch apart. A strong inductive effect is built up between the convolutions.

Fig. 1 shows the connections of the antenna itself. For better understanding of the connection, a simplified diagram is shown in Fig. 2. Note that connection is made, not in the orthodox manner as in the dipole, *but from opposite ends*. For some reason, not perfectly understood, this arrangement works best in such an inductive loop. I termed this connection "*transpole*," a contraction of the terms *trans*posed and *pole*.

By providing a switch which is used to short the open ends, as shown in Fig. 2, snow and ghosts usually can be eliminated effectively. When in use, the antenna is oriented by revolving it on its base. Each station has its own best position.

A far more efficient antenna is the double-loop inductive antenna with a revolving inside rotor shown above. This antenna is larger, the inside loop measuring 15⅛ inches diameter; the outside 17 inches diameter. The two loops come to about ½ inch from each other. I call it a *Variotenna*.

The connection diagram of this loop is shown in Fig. 3. It will be noted that it, too, is connected as a transpole.

In this loop, aluminum rod ⅜-inch diameter was used with a center lucite supporting rod and lucite insulation for the bottom of the loops. A simple horizontal splitting of the lucite rod, near the top, makes that section rotatable through a 180-degree arc. The inside rotor loop is controlled by a lucite handle "H". The loop assembly is mounted on a cylindrical wooden base. A shorting switch (see Fig. 3) is mounted on the base, also.

It was found that in actual operation all types of ghosts and snow can easily be eliminated in New York City under

An early model of the antenna had fixed loops.

the most unfavorable conditions in steel apartment houses. All six local channels were well received without any trouble. In some cases it is necessary to revolve the base for best reception, then rotate the inside loop for clearest picture. On some of the channels it may be necessary to use the switch, but this is required only in locations where the reception is particularly poor.

It was found advisable to use one or two lead-in metal sliders to balance the transmission line effectively to the receiver. Once this is done the sliders are no longer touched and are clamped into position.

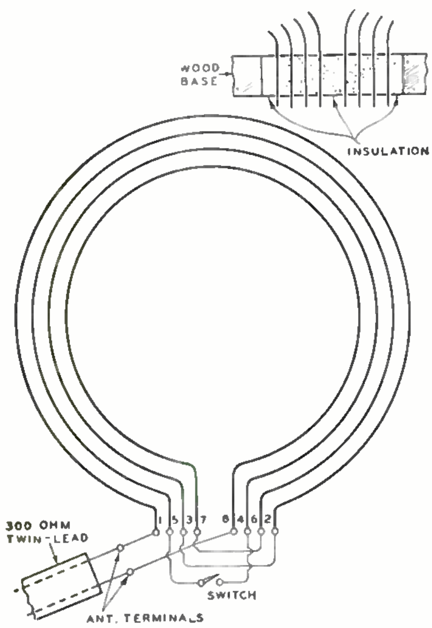


Fig. 1—Connections of the fixed-loop transpole television antenna. Construction inset.

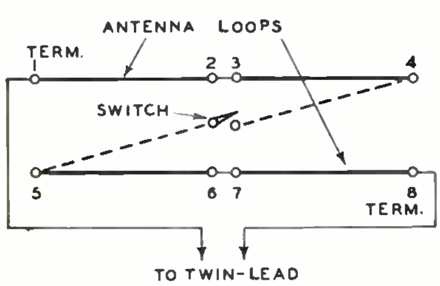


Fig. 2—Simpler diagram explains unit above.

Surprisingly enough, on some stations even the displacement of only ⅛ of an inch of the rotor loop may make the difference between a good and a poor picture. This is not true of all channels, but some stations may prove quite critical, depending upon location.

This antenna is not at the present time made commercially and is presented here merely as a contribution to the art. It is believed that as television receivers evolve, some such antenna, that is, one of the variotenna variety, will probably be incorporated in future television sets.

Early last Spring I dispatched a sample of the two-loop type variotenna to Messrs. Matthew Mandl and Edward M. Noll, television instructors at Temple University, for test.

Here are their findings as reported by Matthew Mandl:

"I tried the antenna out on my Admiral TV receiver in Trenton. Channel 3 from Philadelphia came in fairly well —though with some snow. (My set is, of course, on the ground floor and I had the antenna standing on the receiver.) I found the antenna worked best with the 300 ohm line connected to terminals 1 and 2, with 4 and 3 open, and the two sections at right angles to each other.

"Channel 6 (from Philadelphia) came in with same picture quality as 3, although I found the two loops worked best at about a 45-degree angle, with terminals 3 and 4 open.

"Channel 10 (Philadelphia) came in with same picture quality as channels 3 and 6, with both loops in the same plane. Connecting 3 and 4 seemed to make a slight improvement—though not too pronounced.

"Tentatively, my theory on its operation would be as follows: On the low-frequency channels, inductive (magnetic) linkage evidently occurs between the two loops, effectively giving them the required length for resonance. The fact that each loop can be swung at an angle independent of the other, means that full advantage can be taken of the many reflections existing within a room. Noll and I have found that correct orientation of an indoor antenna rarely corresponds with true orientation such as would be found outdoors.

"On the high frequency channels, the capacitive reactance between the two loops becomes low and affords coupling. This, then, unifies the two loops and they act as a short antenna for the high channels.

"Gain for this antenna seemed to be considerably higher than an ordinary folded dipole—though we would like to check this some more.

"Because of the many reflections indoors, however, we are at a loss when we endeavor to theorize on your particular antenna. Positioning the antenna in different parts of a room, for instance, requires a change in the angle of the two circular elements. As soon as we think we have some answers in one particular location in the room, we must revise theory when we move the antenna—for better reception is usually secured by a complete change of angle between the two loops. As mentioned in my previous letter, the capacity between the two antennas with both in the same plane, and the interacting magnetic fields, probably combine to make the L and C resonant at the low TV channels. Because the C-L ratio is large, the Q of the antenna would be low, resulting in a broad bandwidth and greater coverage.

"I have found that better results on the high channels are procured when the two loops are angled, and it is our belief that in this position the two act more or less independently of each other as two high-band antennas. While it may appear to you that all this is highly conjectural, I believe that it would be difficult for anyone to give a true analysis of the actual performance characteristics because the antenna performance for certain angles of the loops is never the same in any two positions in the room.

"Within a room the reflections would have too short a path to be visible in the form of ghosts on the screen. By rotating the two loops, therefore, a condition can be encountered where each loop picks up (independently) a separate signal from a different reflected angle. If the loops and the antenna position are so regulated that the two reflections are in phase, the antenna would be capable of feeding a signal to the receiver far in excess of a single antenna capable of only one orientation. This factor, combined with the circular configuration of the two elements, means that advantage is also taken of any vertical components present in the room.

"Since, however, so many reflections and polarization changes are encountered indoors, the very versatile arrangement of your antenna is bound to give better performance because it can be adjusted to take advantage of multiple reflections."

Another new type of antenna will be described by the author in an early issue.

Directions for building a simplified Transpole Variotenna will also be given.

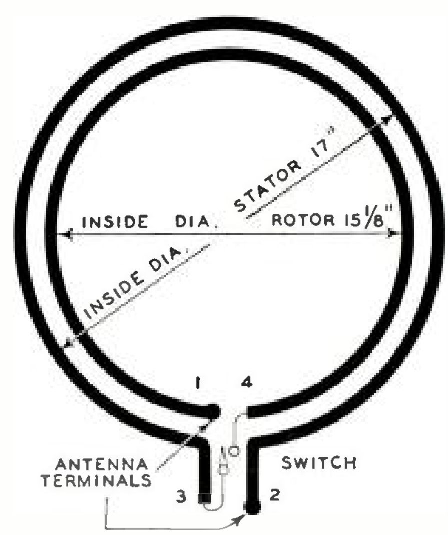


Fig. 3—The antenna with the rotating inside loop is connected as this diagram indicates.

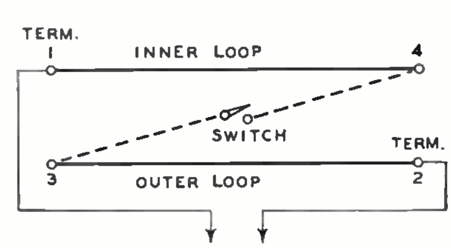


Fig. 4—Diagram of above with loops extended.

Television Queries Answered

IN MY work as a Question Box engineer for RADIO-ELECTRONICS, I have been struck by the broad thinking evidenced in many of the questions about the new subject of television. Unlike queries on other subjects, which are invariably highly practical, many television queries have no immediate practical purpose behind them, but are made in the search for greater knowledge.

As the answers to these questions may help other readers to understand some of the points which occur to many, I am reproducing below a number of them. Though the selections may not be of the greatest general interest yet they seemed most interesting to me.

If RADIO-ELECTRONICS readers have any other points they would like cleared up, let me hear about them. If they are important enough and numerous enough, we will have another article like this one. If not, they will simply be discarded (not returned to the writer). Thus the worst that can happen to your query is that it may remain unanswered.

By DAVE GNESSIN

Ion Traps

? *Two television sets in my town look almost exactly alike; but one has the usual ion trap consisting of two coils on the neck of the cathode-ray tube near the base, while the other doesn't. Yet they both work fine. They are 7-inch tubes. How does the second one work without the ion trap?—L. M., Marion, Ohio.*

A. Up to a diameter of 7 inches, electrostatically deflected tubes work satisfactorily for television. They need no ion traps since ions respond readily to electrostatic deflection and do not burn a brown spot in the center of the screen. Some 7-inch tubes, however, use electromagnetic deflection, as do all the larger sizes. These electromagnetically deflected tubes require ion traps or *beam benders* to prevent the brown spot from forming.

It may also be that the second set you describe uses an ion trap of the newer PM type. Such a trap consists of two small permanent magnets in an assembly which clamps or slides over the base neck of the C-R tube. Fig. 2 shows three common ion traps.

Interlaced Scanning

? *What's the reason for scanning sideways? Couldn't up-and-down scanning have been used as well—or for that matter—inside-out or outside-in or some other scheme?—P.C., New Rochelle, New York.*

A. You're quite correct. We use interlaced scanning of 525 lines. In Europe they use a different number of lines. Nor do they all interlace. But remember that every separate system of scanning needs a receiver constructed for that particular system. We could scan right to left, up-and-down, or even spirally.

The manufacturers have agreed on a uniform system of scanning for all TV transmitters and receivers in use in the United States. This system is embodied in FCC regulations. Thus you may take your receiver with you from coast to coast, sure that everywhere (almost everywhere, anyway!) you can plug into 117-volt a.c. and have your TV receiver working normally.

If you are interested in the possible combinations for scanning other than those now used, note Fig. 1. Then figure out how many different ways the scanning function *might* have operated.

No Raster

? *Maybe it sounds silly, but I was so careful doing it I was sure I couldn't harm anything. I opened up the C-R tube assembly of my new television set to examine it. Then I carefully reassembled it in what I thought was exactly the same manner as it was originally. The tubes light up—I have sound, but the screen is as dead as the proverbial duck. What did I spoil? The set uses a 10BP4.—D.R., Columbus, Ohio.*

A. Don't be alarmed. The symptoms you describe indicate a misadjusted beam-bender element of the ion trap. Loosen the clamp bolts if any, and adjust the beam bender first for raster and then for brightest picture. The element will probably resemble one of the three types shown in the drawings of Fig. 2.

Vertical Black Line

? *I have a Philco TV model 48-1000, diagram of which I enclose. On the face of my picture I get a vertical black line. My adjustments are correct. I've gone over all the component parts of the set without finding a failure. What do I do now to get rid of the black line?—L.M., Baltimore, Maryland.*

A. Checking with the company, I find they've discontinued the 0.1-μf screen-grid bypass capacitor C on the 6BG6-G horizontal output tube, because of complaints such as yours. Simply remove that capacitor and leave it off to clear up your trouble. See Fig. 3 for its exact position in the circuit of the receiver.

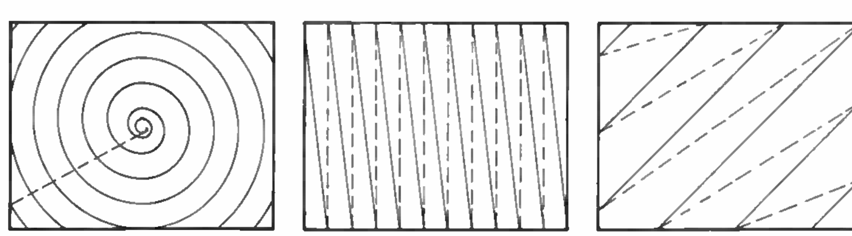


Fig. 1—These examples show three of the many scanning schemes which might have been used.

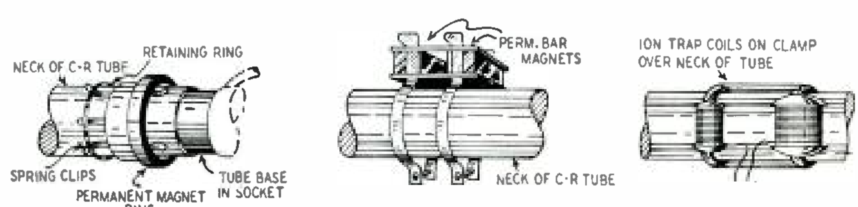


Fig. 2—Three types of beam benders or ion traps. The first two utilize permanent magnets.

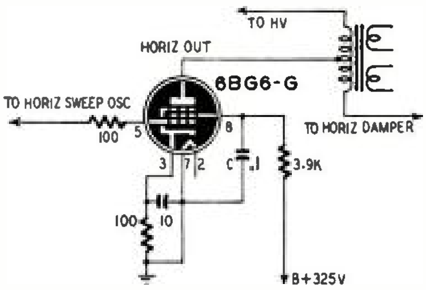


Fig. 3—Remove 0.1-μf screen-grid capacitor.

Replacing Picture Tube

? *Is there some standard, safe, recommended way to remove and replace picture tubes in TV sets? It's the most fragile part of the set and probably requires special care.—A.F., Centralia, Ill.*

A. Reasonable care, avoiding scratching the screen face or abusing the thin glass neck would suffice. However, here is a step-by-step recommended procedure:

CAUTION: First ground H.V. Anode cap to frame of bracket of tube, and B-plus to the chassis ground for double safety.

1. Disconnect the deflection-cable socket, picture-tube socket, and high-voltage connection.
2. Remove beam bender (ion trap) and any other miscellany attached to tube.
3. Prepare in advance crepe or clean newspaper on top of a table to receive the tube.
4. Loosen tube mounting nuts and support brackets, meanwhile supporting tube.

CAUTION: Avoid touching the coating on the outside of tube.

5. Without forcing or applying undue pressure, carefully remove tube, support brackets, and mounting as single unit from cabinet, laying on prepared paper or crepe, tube face down. (Before completing this step first make sure all wiring is disengaged and clear.) Since the face of the tube has the greatest thickness and weight, it is advisable to place the tube face on the palm of the hand while carrying it, for safety. Don't carry by the neck.
6. Loosen picture-tube clamp screw which fits around the rim of the tube face.
7. Finally, lift the entire assembly *off* the tube, leaving the tube face down on the paper.

To replace the tube just reverse the steps described above.

The men who best understand television tubes—the professionals in television stations and assembly men in factories—handle them with *goggles and gloves*. They know exactly what they are doing. In following their example, you will not only be insuring yourself against that day when a tube may implode in your hands; you will be advertising to the set owner that you know what you are doing—and issuing an implied warning against fooling around with viewing tubes!

Dual Power Supply

? *My Philco 49-1278 has a very odd power supply. It uses two low-voltage rectifier tubes, a 5U4-G and a 7Z4. Their outputs are not in parallel, nor do their voltages add. Why this odd combination of rectifiers?—R.F., Zanesville, Ohio.*

A. In the first place, the large current demand of this television set requires more output than one rectifier tube (such as a 5U4) can supply. The reason for making the second rectifier a small cathode-type 7Z4 is a sound one. Examination of the circuit diagram reveals an extensive bypassing system, centered mostly about the screen-grid circuits. In the r.f. and video i.f. sections these capacitors are very critical. A synthetic dielectric was used for the close tolerances required. This performed excellently for the specific application, but had a comparatively low-voltage rating (about 50 volts above working voltage).

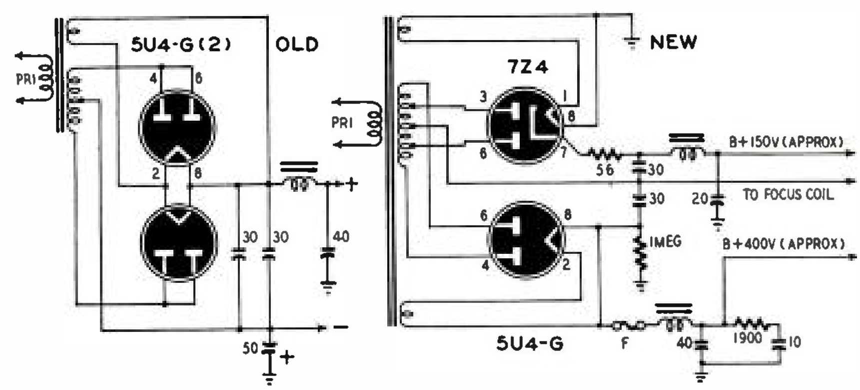


Fig. 4—Old Philco design used two similar rectifier tubes. New circuit appears at right.

In early designs two 5U4's were used as rectifiers. Since they are filament-type tubes, they heat instantly, providing full output voltage throughout the set. The other tubes, being cathode types, were still cold, hence drawing no current yet. This forced the full rectifier voltage to all elements, regardless of resistance step-down. Those valuable TV capacitors, carefully built for this application, popped like so much corn at the overload.

This new technique uses the 7Z4 cathode-type rectifier for the screen circuits. Thus, by the time the 7Z4 produces voltage, the other tubes are heated and ready to receive it. The 5U4 uses its heavy current for the audio and output stages. The division of rectifier output avoids damage to components, and makes for satisfactory steadiness of operation.

See Fig. 4 for comparison between old and new rectifier setups described above.

Folding Over

? *My television set has a very large screen. The picture is fine except that at the left side of the screen the picture is folded; a man walking to the left appears to be walking into himself. I hate to change anything since the rest of the picture is O.K.—L.R., Chicago, Ill.*

A. With a large screen you probably use magnetic deflection. Check your horizontal scanning circuit. If your set uses a horizontal damper tube (probably a diode), your fault is probably there.

Stub Technique

? *I used the stub technique recommended by* RADIO-ELECTRONICS *to eliminate interference from the TV antenna (or lead-in). The open-ended stub required is several feet long and consequently unsightly. Coiling it to get it out of the way disturbs its trap action. What do you recommend that I do to solve the problem?—A.B., New York City.*

A. There is a general rule covering cases of this sort. The open-ended ribbon-line trap stub is cut to half the wavelength of the signal concerned. The identical trap action takes place when the stub is shorted at the end of a *quarter-wave* section. Thus, all you need do is cut your trap stub exactly in half. Then, instead of leaving the end of the stub open, *short* it. You now have the same effect, plus an extra stub of ribbon-line for your trouble. Whatever the unsightly effect of the original stub, you've reduced it by half. This is a 100% improvement in the appearance. If the result is still unsightly, perhaps you'd better formulate another question. See Fig. 5 for a comparison between the two stubs—the open half-wave and the shorted quarter-wave.

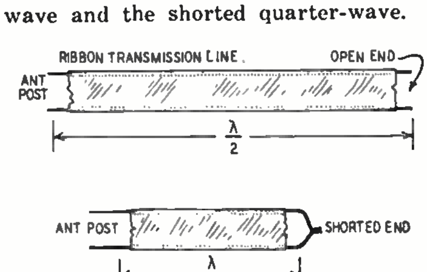
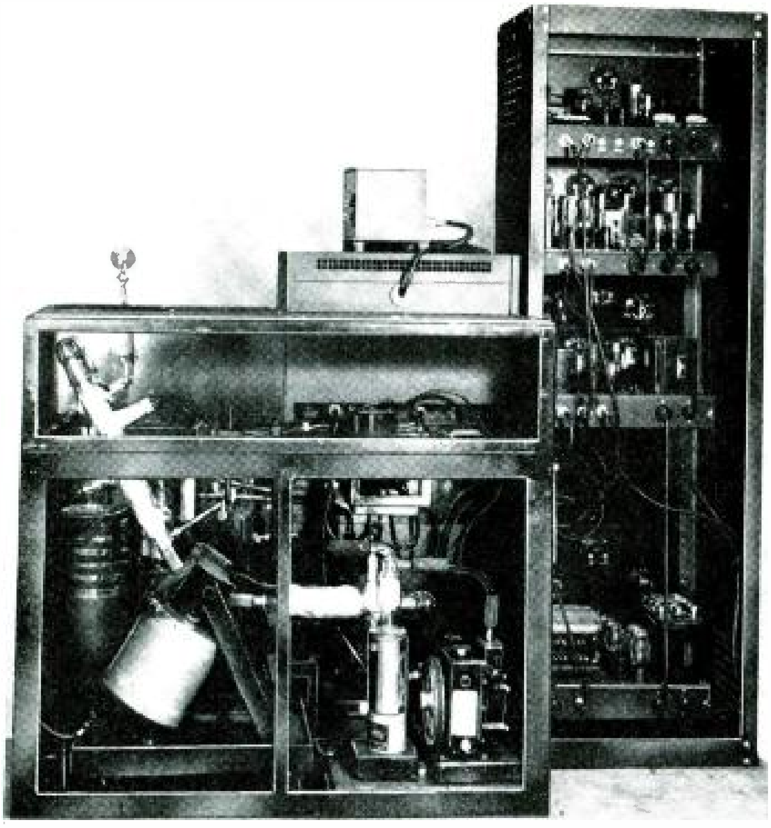


Fig. 5—These two stubs have the same effect.



Photos courtesy Process & Instruments

Rear of commercial mass spectrometer. Note curved tube and vacuum pump.

Liquids and gases with many components may be analyzed accurately by mass spectrometry

Spectrometer Measures Mass of Chemical Ions

By JERRY S. ADAMS

THE mass spectrometer is today one of the most useful electronic tools in the experimental laboratory and in large-scale industrial processing plants. Used to analyze and control the quality of chemical compounds simultaneously, it is especially valuable for detecting very small quantities of impurities and for analyzing very small samples.

The principle of the mass spectrometer is as simple as that of the ordinary vacuum tube. Fig. 1 is a rough and simplified drawing illustrating the process rather than the equipment. The material to be analyzed must be in the form of gas or vapor, and is introduced into the sample bottle at low pressure. The particles of gas are ionized by bombardment from a more or less standard electron gun, and the ions are accelerated in a beam by the field-forming plates.

A magnetic field at right angles to the beam tends to curve the ion path into a semicircle. Ions of less mass are, of course, more easily swayed from their path than those of greater mass. Therefore, after having traveled a short distance, these ions will have separated from the heavier ones. Collected on a photographic plate, as in Fig. 1, a spectrum of ionic weights—similar to that produced by a beam of light in a light spectrometer—is produced. This is the reason for the name mass spectrometer.

A practical model

In actual practice, it is more convenient to collect only one of the deviated beams at a time. A collector with a slotted shield ahead of it is used, rather than the broad plate of Fig. 1. Since the acceleration of the ions can be controlled by varying the electric field (the force causing them to move in a straight line) and their curvature by varying the magnetic field, an adjustment of voltage or magnetic field strength can be made which will permit a particle of any given mass to pass through the slit and to the collector plate.

The practical instrument is shown very well in Fig. 2, a cross section of a spectrometer tube. Gas from the sample bottle circulates in the chamber, where it is ionized by bombardment from the electron gun, electrons from which enter through a hole in one of the field-forming plates. These are maintained by the bleeder at such voltages as to accelerate the particles and start them down the analyzer tube. The magnet, which applies the field to curve the beam, is not shown.

The particles which are of the correct mass to pass through the slit are caught on the collector plate and give up their charges, which are registered on the grid of the electrometer tube and made to give an indication on the recording galvanometer as shown. Field voltage or magnetic intensity, or both, being varied in synchronism with the progress of the record, a continuous spectrum may be obtained. Both the presence of ions of different masses and the relative number of ions in each of such beams may thus be recorded automatically.

Uses of mass spectrometry

Applications of the mass spectrometer fall into the following general fields:

1. Rapid and accurate analysis of liquids and gases which may contain a dozen or more components;

2. Determination of the kinetic forces in and mechanism of chemical reactions;

3. Identification of chemical processes which occur in metabolism.

In the first of these applications, samples of as little as .001 cubic centimeter in volume can be used as test specimens.

The energy of the bombarding electrons is made sufficiently high to ionize and fragmentate the molecules, so that ions of several different masses can be formed and the compound identified in a manner analogous to the fingerprint method of identifying a criminal.

One of the major problems in the chemical industry has been the analysis of small impurities in intermediate products. With the mass spectrometer this work is fairly simple. For example, as little as .003% diethylbenzene has been detected in ethylbenzene during tests that have proved to be of considerable importance to the rubber industry. These tests could not have been made without the mass spectrometer.

In the analyses of hydrocarbons (compounds comprising hydrogen, carbon monoxide, nitrogen, etc., with one to five carbon atoms), the mass spectrometer has been used with particular efficiency because it obviates the need for preliminary fractionation, permitting analyses to be completed in 30 minutes, whereas about 8 hours would otherwise be required. This should facilitate the improvement of numerous petroleum products.

In compounds with as many as six isomeric octanes, the mass spectrometer has analyzed fractionated cuts of alkylates and paved the road leading to improvements in aviation gasoline. In the analysis of gases in thermionic vacuum tubes, samples amounting to only .001 cubic centimeter have been detected.

In pure scientific research, the mass spectrometer has proved of particular value in studies of the kinetics and mechanism of reactions. Its application to this field has followed two different lines: In the first, small samples are withdrawn from the reaction chamber during the reaction and analyzed. In the second, heavy isotope tracer techniques are employed.

The fact that the mass spectrometer is capable of analyzing comparatively small particles permits withdrawal and analysis of samples throughout the course of a chemical reaction at intervals ranging from 2 to 10 minutes, depending on the types of analysis that must be made. In one series of experiments, dimethylether and acetaldehyde were decomposed with heat and continuous analysis was made of the consequent gases—enabling scientists to ascertain the nature of this reaction for the first time.

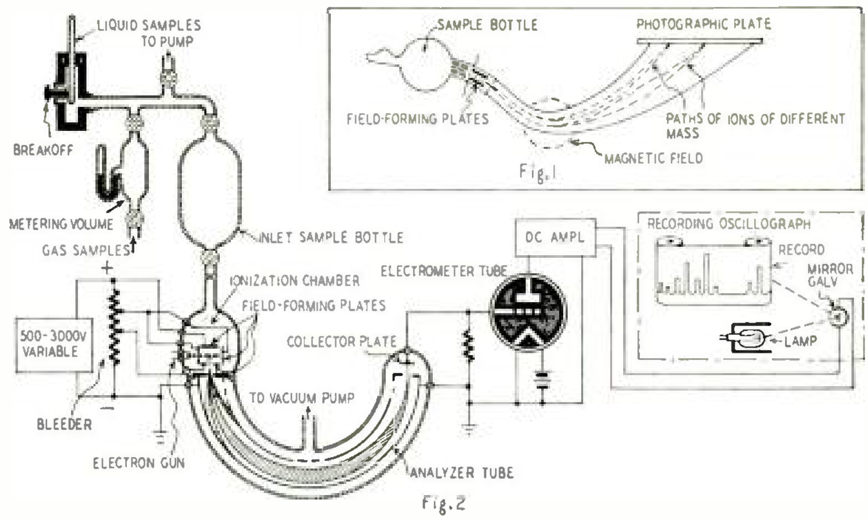
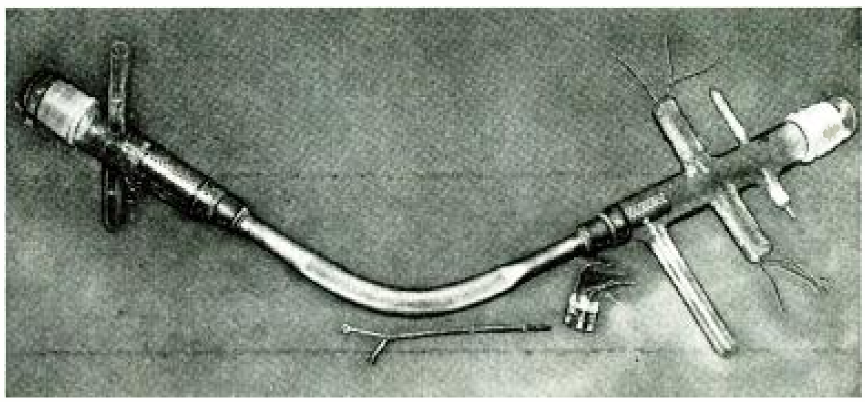


Fig. 1—Diagram shows method by which ions of differing mass are separated in spectrometer. Fig. 2—The complete apparatus consists of the tube plus pumping and recording equipment.

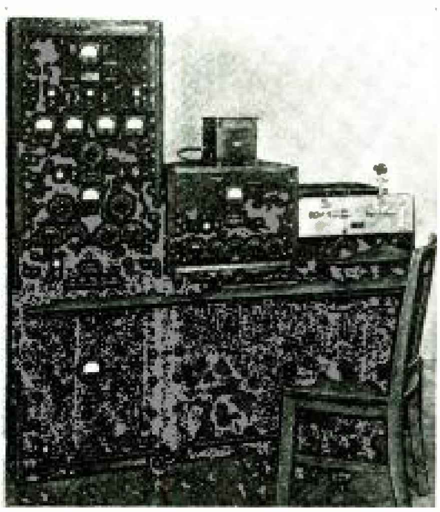


The analysis tube itself. The sample is injected into the transverse tube at the far right.

Tracer methods

Heavy-isotope tracer techniques have also made the mass spectrometer useful in metabolism studies—particularly with regard to intermediary metabolism (that is, the mechanism of the breakdown and synthesis of proteins, fats, and carbohydrates and their introconversion, as well as the effects of vitamins and hormones thereon).

The usual procedure in isotope-tracer work is to submit a *labeled* subtance (one containing easily identified heavy isotopes) to a biological reaction either in an intact animal or in an isolated tissue or extract, then to isolate the products and determine their heavy-isotope content. In one sequence of experiments, rats were fed a labeled amino acid for a period of several days. The acid was labeled by synthesis with an excess of heavy isotope of nitrogen, so that the body components of the rats could be dissected and analyzed for labeled atoms with a mass spectrometer at the end of the test interval. As a result of this unprecedented work, it was learned that the absorption of food products in a living body is a very extensive succession of chemical reactions—not a simple mixing process, as was previously supposed.



Operating position of the mass spectrometer.

NEW LONG-LIFE RECTIFIERS

Rectifier tubes for X-ray service with life expectancy 50 times as long as previously used types was announced by Z. J. Atlee of the Dunlee Corporation, Chicago. The new tubes have filaments made of a thorium-tungsten alloy. They have a possible use in television.

Thorium-tungsten filaments have long life and are commonly used in low-voltage tubes. It was thought, however, up to less than a decade ago, that 5,000 volts was the maximum. During the war 35,000 volts was used and the new tubes raise the ceiling to over 100,000. Because of the much lower work function of thorium on tungsten (2.63 volts) than of pure tungsten (4.52 volts) much more efficient emission is obtained and at a lower temperature.

Electronics in Medicine

Part X—Electron microscopes give a magnification of 100,000 times

By EUGENE J. THOMPSON

THE story is told that the great German physician and bacteriologist, Robert Koch, discouraged and virtually penniless, spent his last remaining funds to buy a microscope. It was indeed a fortunate purchase, both for him and the whole of humanity, because with it he made the discoveries which brought him fame and the everlasting gratitude of his fellow men—discovery of the bacteria that cause tuberculosis, cholera, and other diseases. However, despite the magnificent medical achievements this instrument has made possible, it has many limitations.

For example, a large group of diseases—infantile paralysis, smallpox, influenza, and many others—are caused by viruses, deadly killers so small that they cannot be seen with the finest optical microscope. Hence, there was clearly a need for an instrument which would extend the limits of human vision.

The first steps in this direction were made about 20 years ago when it was discovered that a stream of electrons passing through an axially symmetric electric or magnetic field could be focused much as a glass lens focuses light (Fig. 1).

It was also found that any particulate body (specific minute particle), such as an electron, in motion, had a characteristic wavelength. Thus, if the velocity V of an electron is expressed in electron volts, its wavelength in cm is $\lambda = 10^{-8}\sqrt{150/V}$ A.

Practically speaking, a stream of electrons traveling under a potential difference of 60 kv has a characteristic

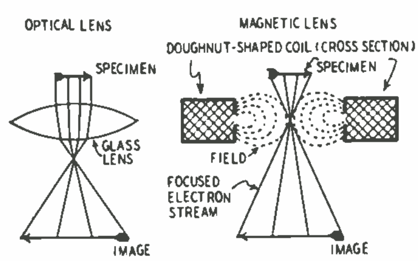


Fig. 1—Magnetic field focuses electron beam.

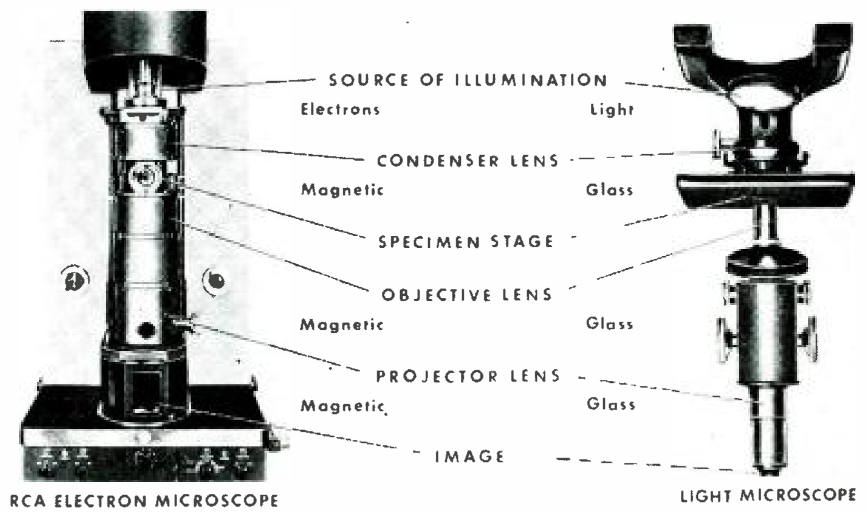
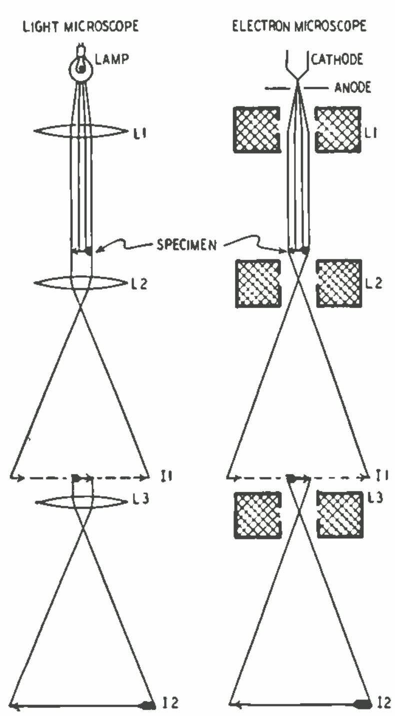


Fig. 2—The electron microscope accomplishes electronically the job of the light microscope.



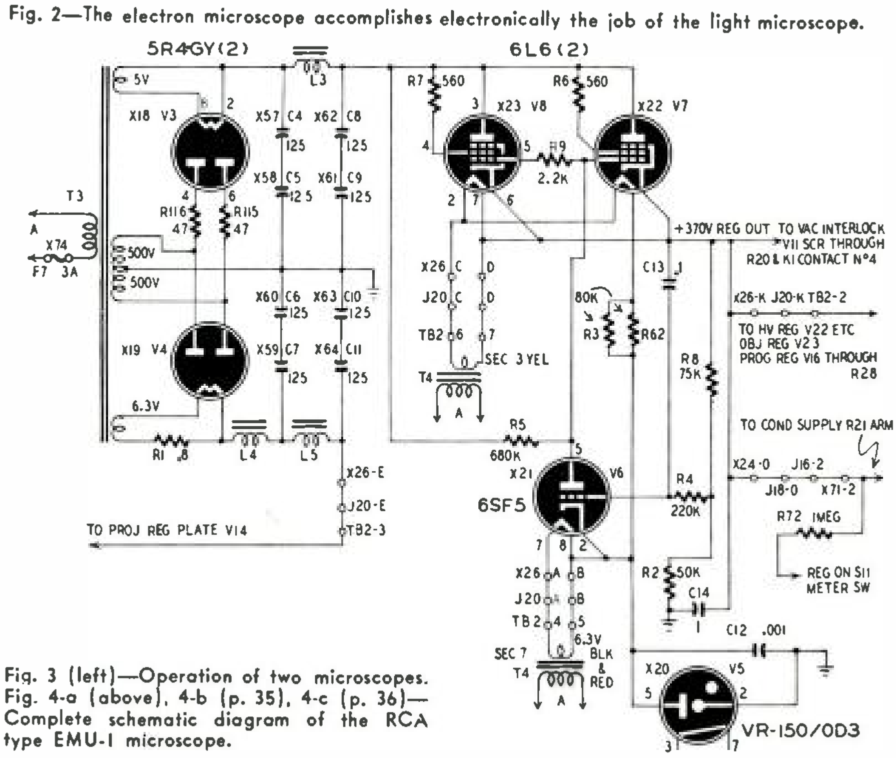
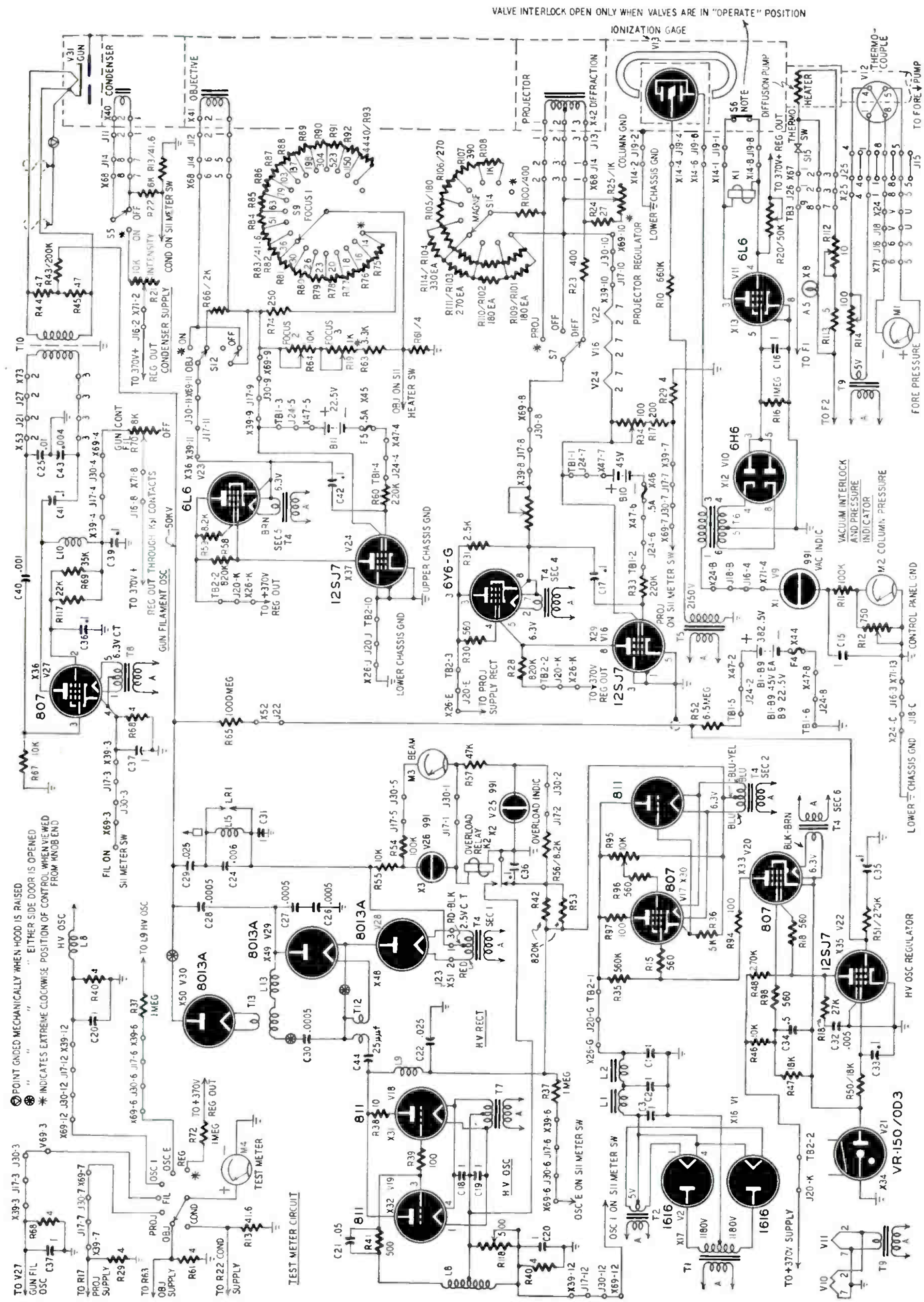


Fig. 3 (left)—Operation of two microscopes. Fig. 4-a (above), 4-b (p. 35), 4-c (p. 36)—Complete schematic diagram of the RCA type EMU-1 microscope.


VALVE INTERLOCK OPEN ONLY WHEN VALVES ARE IN "OPERATE" POSITION
IONIZATION GAGE
POINT GNDED MECHANICALLY WHEN HOOD IS RAISED
" " " EITHER SIDE DOOR IS OPENED
INDICATES EXTREME CLOCKWISE POSITION OF CONTROL WHEN VIEWED FROM KNOB END
TEST METER CIRCUIT
TEST METER
GUN FILAMENT OSC
CONDENSER SUPPLY
PROJECTOR REGULATOR
HV OSC REGULATOR
HV RECT
H V OSC
VACUUM INTERLOCK AND PRESSURE INDICATOR
COLUMN PRESSURE
FORE PRESSURE
CONTROL PANEL GND
LOWER CHASSIS GND
UPPER CHASSIS GND
DIFFUSION PUMP
THERMOCOUPLE
TO FORE PUMP

wavelength of 5 × 10^{-10} cm, which is about .00001 times that of light.

It is not possible to detect objects or details whose dimensions are much smaller than the wavelength of the illumination used, so the magnification obtainable with optical microscopes is relatively slight (about 2,000 times). Because the wavelength of high-speed electrons is only a hundred-thousandth that of light waves, it should be possible, theoretically, to get electronic magnification up to 200,000,000 times. In practice, the maximum enlargement is 100,000 times, which is still 50 times that of any light microscope.

The electron microscope operates much like a transmission-type light microscope. As shown in Figs. 2 and 3, in the light microscope the source of illumination is a lamp (and mirror), the light rays from which are formed into a parallel beam and directed on the specimen to be magnified by the condenser lens, L1. The image of the specimen then falls on the objective lens L2, which focuses and magnifies it, producing an enlarged image, I1. Part of this enlarged image is further magnified by the projector lens, L3.

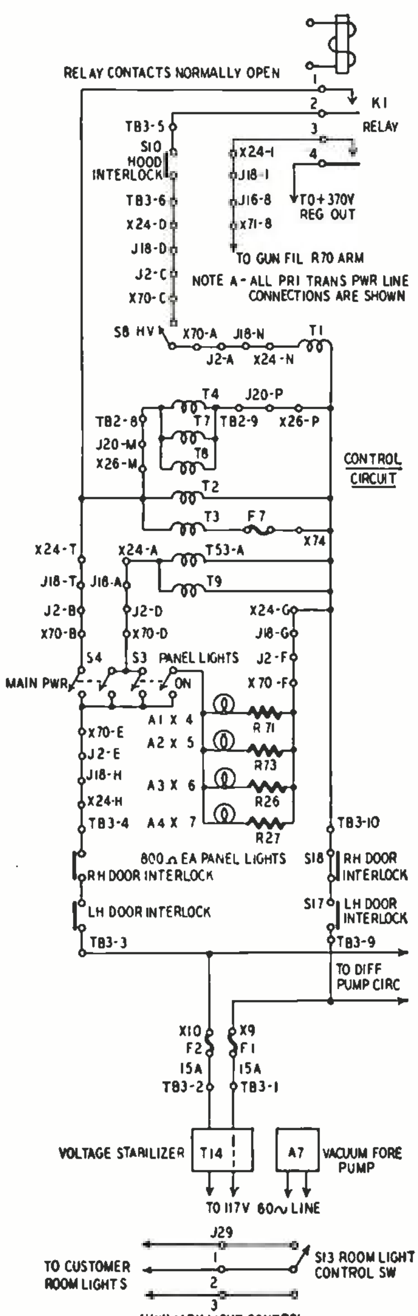


Fig. 4-c—The microscope control circuits.

In the electron microscope the source of illumination is a hot cathode which emits electrons. An anode with a small hole in the center gives these electrons a high velocity, and a doughnut-shaped coil L1 produces a field which bends the paths of the electrons into a parallel beam directed on the specimen. The electron rays pass through the specimen and are affected in varying degree depending on the composition of the specimen. Those which pass through are brought to a focus by the field of the coil L2 and form an enlarged image I1. The electron rays which form a section of this image are in turn magnified by the field of coil L3, and caused to form a further enlarged image I2. It will be noted that the coils L1, L2, and L3 act like the lenses in the optical microscope, and are referred to as *magnetic lenses*.

The image I2 in the electron microscope is formed by an electron beam which itself is not, of course, visible. A fluorescent screen, therefore, is placed so that the beam falling on it produces a visible image. Photographs are made by allowing the electron beam to fall directly on a photographic plate.

Four basic systems comprise the electron microscope. The schematic diagram is shown at Fig. 4. The optical system has already been described, and the control system is essentially a switching and metering network. The vacuum system consists of an oil diffusion pump, a forepump, and an electronic valving arrangement. Its purpose is to pump the air out of the area through which the electron stream must pass, so that an electron leaving the filament will travel the length of the instrument with a minimum likelihood of striking a molecule of air. This requires a vacuum of about .00001 mm of mercury.

The chief electronic features of interest are contained in the power system. Two power supplies are used. A high-voltage, 60-kv unit is used to accelerate the electron stream. Its high side is attached to the anode and run at ground potential, while the negative leg is connected to the cathode, at —60 kv with respect to ground. A low-voltage supply is used to power the tubes and the magnetic-lens coils. Because the speed of the electron stream and the current flowing through the lens coils are the critical factors in focusing the instrument, both supplies must be *very stable*. For satisfactory operation, regulation must be:

Over-all microscope voltage	.015%
Objective lens coil current	.005%
Projection lens coil current	.068%
Condenser lens coil current	0.1%

The problem of getting a highly regulated 60-kv power supply in a small space was solved by using an r.f. rather than a 60-cycle design. This feature makes it possible to use a relatively small, low-loss resonance coil which requires very little power to excite it. Also, for a given permissible ripple value, smaller capacitors can be employed. The speed of regulation at r.f. frequencies is not the problem it is with a regulator operating on the low-voltage side of a slow 60-cycle rectifier. In addition to this, it is a simple matter to shield stray r.f. fields.

The actual circuit is shown in Fig. 4. and a block diagram in Fig. 5. Referring to the latter, the high-voltage rectifier is essentially a high-Q resonant network consisting of Lx and Cx which is in series resonance with respect to the driving oscillator, but parallel-resonant when viewed from the high-voltage rectifiers. Cx represents the sum of the rectifier and stray capacitances. The resonant impedance of the high-voltage coil and the Q of the circuit determine the amount of exciting power required from the oscillator because of the small load.

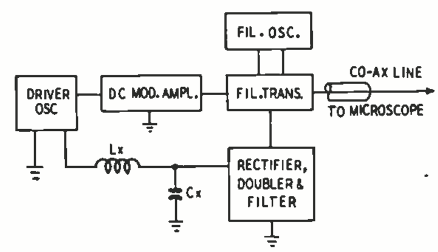


Fig. 5—Block diagram of 60-kv power supply.

The requirements of high Q and maximum impedance demand careful coil design and frequency selection. The Q of the circuit is about 200 and the operating frequency 32 kc. Under these conditions the required exciting power is around 150 watts; the maximum load is approximately 30 watts.

The high-frequency oscillator is controlled by the resonant circuit to maintain the proper driving frequency, and the amplitude of the current from the oscillator controls the power-supply output voltage. The oscillator current is dependent on the screen voltage applied to the oscillator output tubes. Thus, controlling the screen voltage governs both the amplitude and constancy of the output voltage.

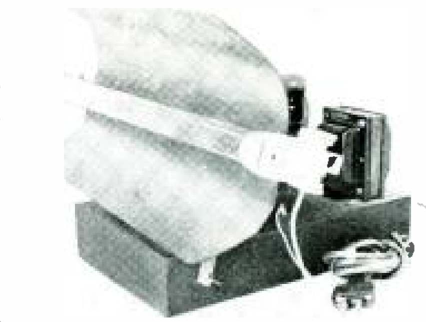
The rectifier employed is a voltage doubler which does not require a tuned transformer, because the circuit is such that one side of the high-voltage coil can be grounded. For this reason a simple resonant circuit is permissible.

A tuned filter is used to eliminate high-frequency ripple from the high-voltage output. The low-frequency disturbances are corrected by comparing a portion of the input voltage with a standard voltage and regulating the oscillator screen with a d.c. amplifier. The voltage regulation is better than .002%.

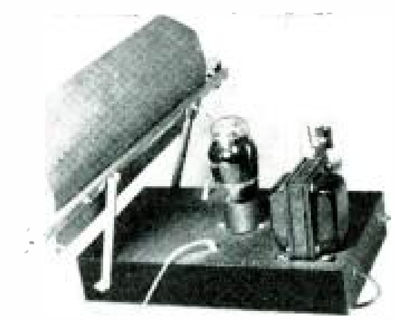
The lens-coil current is also regulated. The current variation is less than .002% for the objective lens coil, .004% for the projector-lens coil, and .02% for the condenser lens coil.

Experimenting with Ultra-Violet Rays

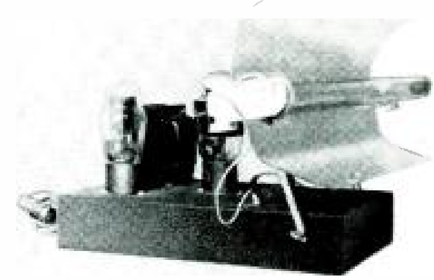
By ERNEST J. SCHULTZ



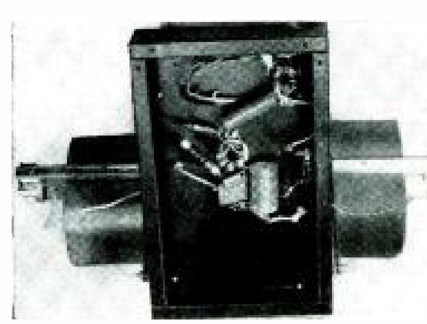
These pictures show how the ultra-violet-ray



tube and its reflector are fitted to the met-



al chassis. Though parts are few (see under



chassis) large base has mechanical solidity.

MANY interesting experiments can be performed with the powerful ultra-violet rays obtainable with the simple apparatus described here. One use of the device is a "heatless" suntan which can be realized with short exposures of only 2 or 3 minutes daily for several days. Study of the weird characteristic colors of fluorescent materials and examination of stamps and documents under "black" light are other very interesting applications of the ultra-violet ray.

There are many other intriguing uses. For instance the germ-killing effect of the rays can be employed in sterilizing materials or areas. Goods that would normally perish rapidly maintain their freshness under the protective glare of the ultra-violet generator.

The circuit employed is an adaptation of the "Furedy" circuit and utilizes r.f. energy to power the ultra-violet-ray tube. In operation it parallels a commercially available lamp, but is more powerful. The tube used is a 15-watt G-E fluorescent *Germicidal* bulb. The tube life (barring breakage) is almost endless as the filaments are not used, and there is no chance of burnout with the r.f. supply. The r.f. oscillator is a 6B4-G, and the rectifier an 80. Other tubes, such as a triode-connected 6L6, can of course be substituted with equally good results.

The oscillator is an ultraudion operating in the 11-meter diathermy band with a coil L1 of 11 turns of No. 20 bare tinned wire, wound on a 1-inch polystyrene form, the turns being spread to cover 1⅛ inches. The tube is capacitively coupled to the ends of this coil, with the two leads shown in the schematic. One is wound tightly round the glass at one end (L2). About three turns will be sufficient. The other lead is simply attached to a filament prong at the other end of the tube. Blocking capacitors of 250-μμf capacitance are installed to keep d.c. off the leads for safety's sake.

The two r.f. chokes are standard 2.5-mh chokes. Shortwave types could be used but apparently are not necessary. The tube UV is a G-E 15-watt Germicidal lamp, as stated before.

The ultra-violet tube is mounted with two conventional fluorescent sockets screwed to a metal mount made slightly longer than the tube. The reflector is made from part of a discarded photographic ferrotype plate. For best results a reflector is essential to avoid wasting the rays. A highly polished chrome reflector is the most effective. The reflector is mounted, with adjustable brackets, on the 11 x 7 x 2-inch chassis. If desired, the actual lamp assembly may be made independent of the power and oscillator chassis, provided the leads are kept to a reasonable length. No particular precautions need be observed in the wiring, and the layout is not critical. A variety of construction methods could be employed for the job.

The germicidal lamp gives rich output throughout the violet end of the spectrum and up. Peaks of output occur between 2,500 and 3,000 Angstrom units. The lower peaks have the germ-killing powers, whereas the rays of frequencies about 2,900Å tan and burn the skin.

Be very careful when using ultra-violet rays. Overexposure causes painful burns of eyes and skin.

No heat accompanies the ultra-violet rays; therefore, you cannot depend on your sense of feeling to warn you when you are getting an overdose.

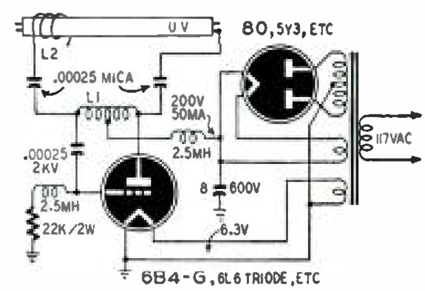
Determine your sensitivity by making trial exposures starting at not more than 1 or two minutes daily and increasing the exposure gradually till you get the desired tan.

The exposure, of course, varies inversely as the square of the distance from the source.

Goggles are indispensable when experimenting with ultra-violet rays.

Almost any glass (colored or clear) will serve to protect the eyes. The rays will not penetrate ordinary glass without great loss in intensity. The rays will not penetrate clothing, so the experimenter need protect only uncovered parts of his body, such as his eyes, face, and hands, if working under the lights for long periods.

The ultra-violet generator produces profuse amounts of ozone, and the lamp can be used where deodorizing as well as germ killing is required. For the experimentally inclined constructor, making one of these generators will open up new fields of adventure in invisible radiation with moderate expenditure and not a great deal of work.



Be sure to adjust oscillator to 11-meter band.

A High-Fidelity Tuner-Amplifier

Part II—Amplifier has two types of equalization, three feedback loops.

By M. HARVEY GERNSBACK

THOSE of you who last month read Part I of this story probably commented to yourselves, after looking at the photos and schematic, "He's using two tubes and two germanium diodes for the r.f. end, but the photos show an awful lot of other tubes and parts. What is he using them for?" A glance at Fig. 1 should answer that question. It shows the wide-range audio amplifier.

Let's leave the two-stage phono preamplifier (the 6SL7-GT) until later and discuss the main amplifier first. As Fig. 1 shows, it consists of six triode stages, resistance-coupled. The first three stages (the two 7A4's, and half of the first 6SN7-GT) are single-ended. The two sections of the first 6SN7-GT are direct-coupled. The second section is a kangaroo phase splitter feeding the push-pull second 6SN7-GT. This in turn drives the 10.5-watt output push-pull stage of triode-connected, class-A 807's.

Negative Feedback Loops

The colored lines in Fig. 1 indicate two separate negative feedback loops in the main amplifier (there's a third one in the phono preamplifier). Loop 1, around the two 7A4's, is for bass boosting. The .02-μf capacitor and the 68,000-ohm resistor in this loop determine the maximum amount of boost and the frequency at which it starts. Potentiometer R1 in shunt with the .02-μf capacitor controls the amount of bass boost. Although this bass-boost circuit alone will give considerable boost, it is augmented by a second bass-boost circuit at the grid of the first 7A4. This is made up of the 22,000-ohm resistor, the .04-μf capacitor, and R2 between the 200,000-ohm tap on the volume control and ground. The fixed resistor-capacitor combination determines the frequency at which boost starts. R2 determines the amount of boost and it is ganged with R1. The use of a potentiometer gives a smooth, stepless adjustment of bass boost.

For bass cutting (useful when listening to speech on stations having a tendency to boominess) S1, an ordinary power switch on the back of the dual control R1-R2, opens when the bass-boost control is turned off. With S1 open, a .01-μf capacitor is placed in series with the 0.1-μf unit, coupling the plate of the second 7A4 to the following 6SN7-GT grid circuit. This provides effective bass cutting.

Reduce the size of the .01-μf capacitor for greater bass cut. Likewise, decrease the values of the .02- and .04-μf bass-boost capacitors to start the boost at a higher frequency, giving greater boost at the low frequencies. The values we use are the result of listening tests with a wide-range loudspeaker (a Stephens P52-HF). We found that raising the frequency at which the boost starts caused tubby reproduction like that of a juke box. If you like that, fine; but then there's no sense building yourself a wide-range system like this.

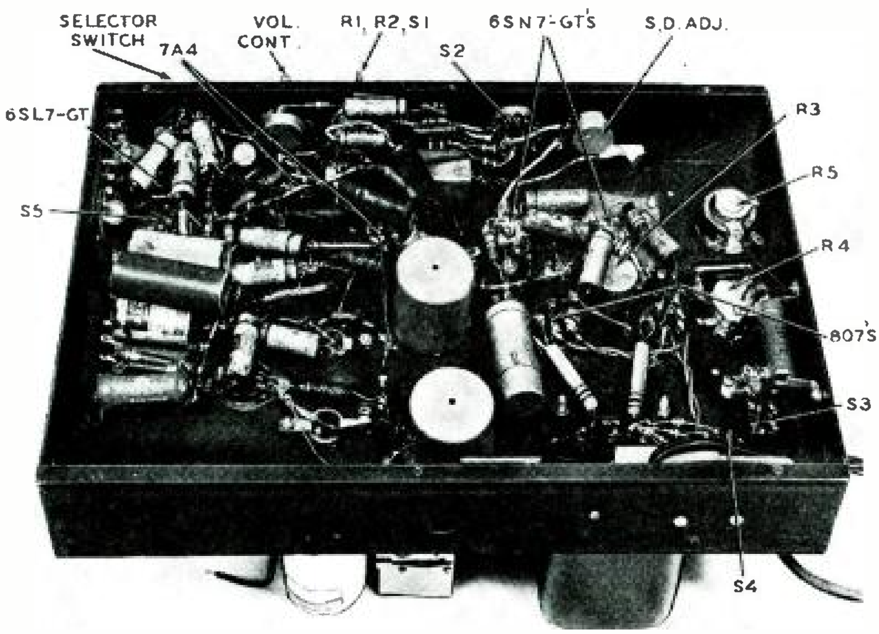
Fig. 2 shows the maximum value of bass boost obtainable and the bass cut obtained with S1 open. Adjustment of R1-R2 will give intermediate amounts of bass boost. As the curve shows, boost starts at about 800 cycles but doesn't really begin to climb until about 250 cycles. Below this frequency the rise is at the rate of about 6.5 per octave. Maximum boost occurs at 20 cycles where it is 21.4 db. Bass cut starts at about 350 cycles and reaches a maximum of 14 db at 20 cycles.

Treble boosting is handled by shunting small capacitors of .025 and .015 μf across the 2,200-ohm cathode resistor of the first 7A4, thus bypassing the negative feedback in loop 1 at high frequencies. The treble switch S2-b does this in positions 1 and 2. Treble cutting is accomplished in positions 4, 5, and 6 of S2. A two-section, resistance-capacitance network from the plate circuit of the second 7A4 to ground causes the high-frequency rolloff to have a steeper slope than with a single section. The two sections can be traced from the two 4,700-ohm resistors in series in the output of the 7A4. The bypassing capacitors are connected to contacts 5 and 6 of the two-gang switch S2.

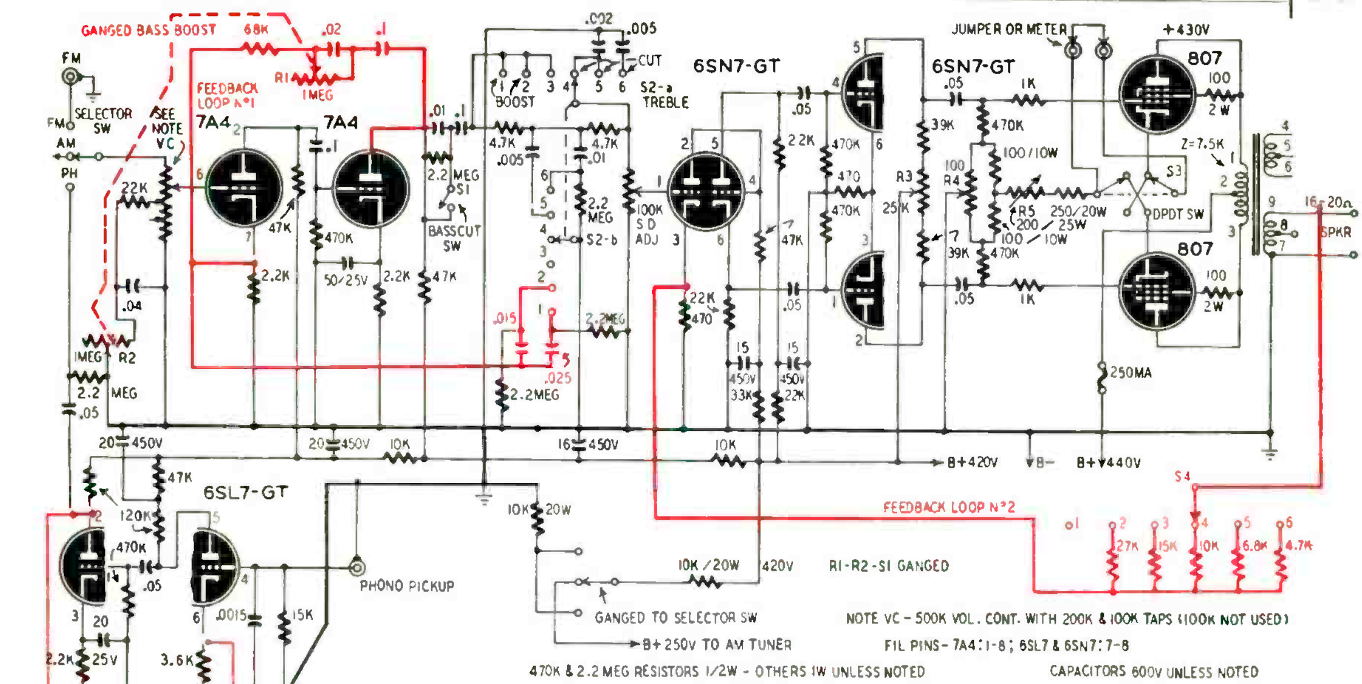
Fig. 2 shows the amount of treble boost and cut which this arrangement gives. The boost position is used only on broadcasts where the program material lacks highs. It is very effective. The tone-control stages are based on the design used by Lincoln Walsh in the Brook amplifier.

Following the tone-control stages there is a 100,000-ohm screwdriver-adjusted potentiometer to set the over-all maximum gain. The following four stages are included in negative feedback loop 2.

You have probably noted the absence of cathode-bypass capacitors within loop 2. This is deliberate. Because of the large amount of negative feedback used (20 db), phase shift at very low and very high frequencies (which could cause negative feedback to turn



Same photo as last month—but minus veil—shows placement of parts in the amplifier section.



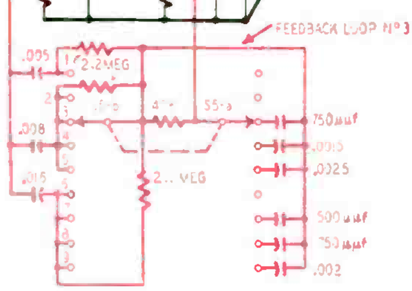


Fig. 1—Complete schematic of the amplifier. The three feedback loops are shown in color.

into positive feedback) must be kept as small as possible. Cathode capacitors could cause too much phase shift at low frequencies. The loss of gain is of no importance.

The first stage in the loop is merely a voltage amplifier (one half of a 6SN7-GT) feeding the phase splitter (the other half 6SN7-GT). Direct coupling is used to eliminate one more source of phase shift. With direct coupling and low-value load resistors in the phase-splitting circuit, balance is good within less than 1 db over the whole audible range.

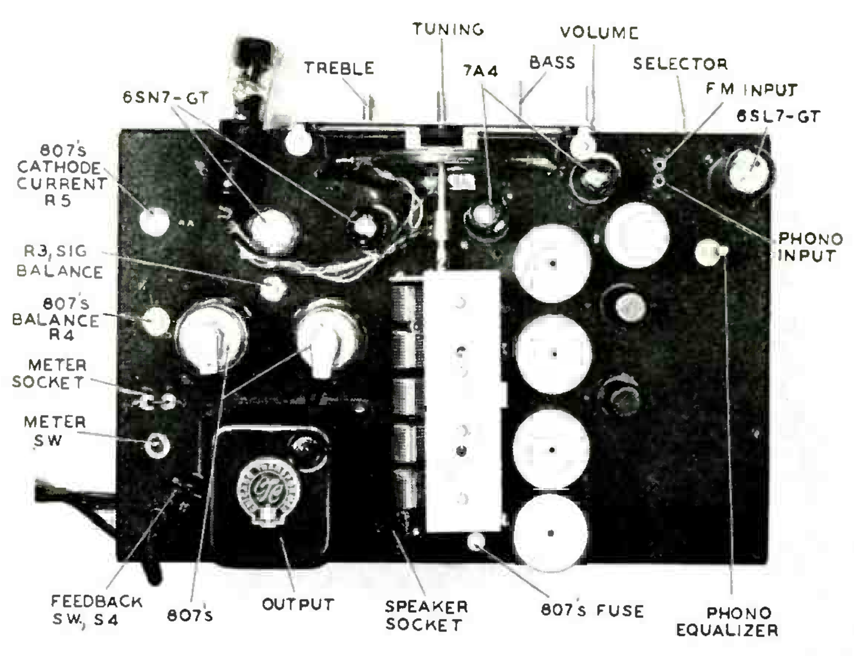
The second 6SN7-GT is a conventional push-pull stage feeding the push-pull 807's. R3 in the plate circuit of this 6SN7-GT is a balance control to equalize the signal voltages on the 807's. To adjust, disconnect the negative feedback, feed an audio tone of about 1,000 cycles to the amplifier, and adjust for equal signal level at the grids of the two 807's. Use a scope or v.t.v.m.

The output stage is unusual in the use of 807's as triodes. With the plate voltage specified, output at the secondary of the output transformer is about 10.5 watts at the grid-current point. We used 807's because they are available at low cost in the surplus market and, more important, being cathode-type tubes they generate little hum. We gave up 6B4-G's because of this; 2A3's cause less hum trouble than 6B4-G's but require a separate 2.5-volt filament transformer. If 6A5-G's are available, they can be used, with proper adjustment of plate and grid voltages. We tried using a 6AS7-G but gave it up because of the difficulty of driving it to full output with a resistance-coupled driver stage. It just requires too much input.

The two 100-ohm resistors and R4 in the grid circuit of the 807's are for bias balance. R5 adjusts the total plate current on the 807's (about 96 ma with no signal). A 100-ma meter is connected in place of the meter jumper in the cathode circuit to measure individual 807 plate current. S3 switches the meter from one 807 to the other so that plate current can be accurately balanced by R4 at 48 ma on each output tube.

The 100-ohm units in series with the screens limit screen dissipation to a safe value.

The output transformer is a critical component. It must be good or you will get into oscillation trouble with the large amount of negative feedback employed. It must be a true high-fidelity unit with less than 1-db variation from 20-20,000 cycles. Primary inductance must be high and leakage reactance low. There are a number of transformers on the market which will meet these specifications. Cheaper trans-



The 11 x 17 x 3-inch chassis holds the push-pull 807 amplifier in addition to t.r.f. tuner.

formers may be used only if the amount of feedback is appreciably reduced. Quality will of course suffer in that case. The transformer we used (Chicago Transformer Co. BO-6) has a tertiary winding (terminals 4-5-6) for use if feedback is applied directly to the cathodes of the power tubes. Don't use this winding.

The output winding is 16-20 ohms, with an 8-ohm tap. Feedback is taken off the 16-20-ohm terminal and goes back to one cathode of the first 6SN7-GT, through S4 and one of five resistors selected by S4. This switch varies the amount of feedback from none (position 1) to 20 db (position 6) in six steps. The amounts of feedback in positions 2 through 5 are 2, 8.6 db; 3, 12.4 db; 4, 14.9 db; 5, 17.7 db. These measurements were made at 1000 cycles with the P52-HF speaker as load. The whole circuit within feedback loop 2 is based on a design by D. T. N. Williamson in *Wireless World* (London).

You may be surprised at the use of feedback with triode class-A output tubes. The difference between triodes with and without the feedback has to be heard to be appreciated. We have checked input-output linearity at various output levels with no feedback and with varying amounts of feedback up to 20 db, using an oscilloscope and a.f. oscillator. The linearity curve is practically a straight line with full feedback and bends rapidly as feedback is reduced.

Another advantage of the large amount of feedback (even with triodes) is greatly increased loudspeaker damping. Electrical output measured at the speaker terminals is flat within 0.5 db from 20-20,000 cycles. This is with a *speaker* load.

With feedback there is no difference in frequency response when measured with resistive or speaker load. Take away the feedback and response with the resistive load is still good; but with a speaker load, it varies as much as 5 db over the range. The peaks coincide with speaker resonance points. The measured internal impedance of the amplifier at the 16-ohm output (with 20-db feedback) is 0.66 ohm. The net result of all this is very fine response to transients, which shows up particularly well with music.

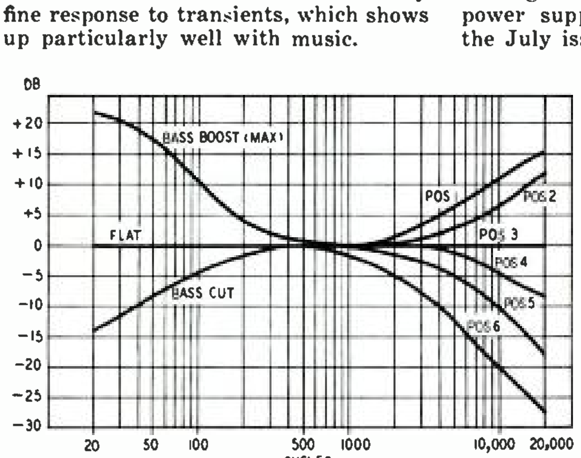


Fig. 2—Responses obtained with the main equalizer controls.

The phonograph preamplifier need not be included if the builder has no use for it. Just omit everything on the lower level of Fig. 1 and use a two-position (FM-AM) selector switch. The 6SL7-GT preamplifier circuit will equalize a low-level, wide-range magnetic pickup for varied recording characteristics.

Fig. 3 shows the response for different positions of S5 when using a Pickering 120M cartridge. The nine positions provide proper equalization for practically all U.S. and foreign records manufactured since electrical recording was adopted. The bass and treble tone controls in the main amplifier augment these nine positions.

Feedback loop 3 provides the preamplifier equalization. The three capacitors selected by S5-b are in series with the feedback line and, with the 47,000-ohm series resistor, set the crossover frequency at which bass boost starts.

The six capacitors which are bridged across the 47,000-ohm resistor by S5-a increase the amount of negative feedback at the higher frequencies, effectively causing high-frequency rolloff. S5-a selects the proper capacitor for the desired rolloff. In positions 1, 2, and 6 there is no rolloff. The 2.2-megohm resistors connected to various switch points in the amplifier are switch-click suppressors. S5 is mounted on the chassis deck. A flexible shaft connects it to the front panel.

Construction

The layout of stages is shown in the two photos. The unsymmetrical arrangement was dictated by the tuning capacitor and coils for the AM tuner and by a desire to keep leads to the front-panel controls as short as possible.

All ground returns are brought to a common bus rather than to chassis. The bus is grounded to chassis at a point near the first audio stage. The outside foil of paper capacitors (curved plates on schematic) should be connected as the schematic shows to keep stray-capacitance effects low. The cable connecting the chassis to the separate power supply chassis (see Part I in the July issue) should have heavy filament wire—No. 12 at least. We used parallel pairs of No. 16.

After the amplifier is completed, it may be necessary to reverse the plate leads to the output transformer if you are getting positive, instead of negative, feedback in loop 2. If it is easier, it is also effective to reverse the secondary leads at the transformer terminals. Use shorting-type switch sections for S2, S4, and S5.

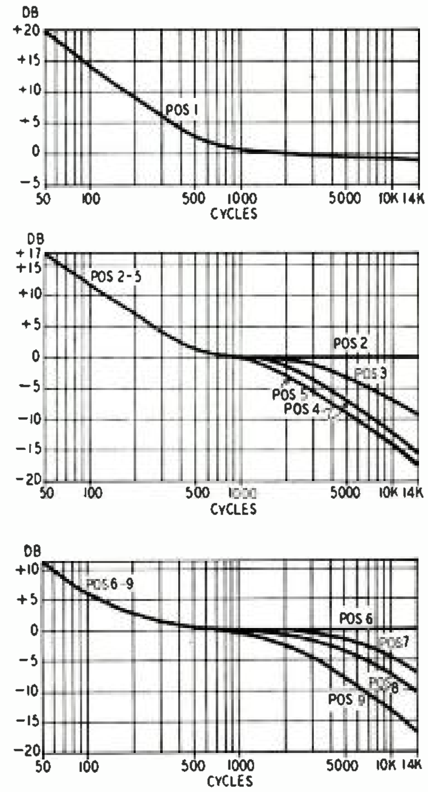


Fig. 3—Phono curves suit almost any record.

Adjustments

An amplifier employing a large amount of feedback (such as in loop 2) is a tricky thing to get working properly. If you plan to use the full 20-db feedback, a scope (or v.t.v.m.) and a.f. oscillator covering the full audio range is almost a necessity. Without these aids you may have unsuspected positive feedback at a supersonic frequency, which will cause baffling distortion and even birdies in nearby broadcast receivers.

In our amplifier, for example, with a resistor load on the output the amplifier is perfectly stable at all settings of the screwdriver-adjusted potentiometer. But with the Stephens speaker connected, and the speaker's tweeter volume control full on, oscillation results unless the screwdriver-adjusted potentiometer is set at least 15,000 ohms away from full on or off. Different output transformers and speakers will have distinct effects. If you don't have the necessary test equipment available, plan to use less feedback.

Adjustment of R3, R4, and R5 has been covered. The screwdriver-adjusted potentiometer is set at about 50% of full rotation (note the caution about this control mentioned above). The feedhack-control switch S4 is set for the level of feedback desired and left alone. In fact it may be omitted entirely by wiring in permanently one of the feedback resistors. Note that the values of these resistors must be changed experimentally when a different output transformer is used or feedhack is taken off a winding having an impedance other than 16-20 ohms.

New Devices Exhibited at Chicago Parts Show

EVERY year the radio parts distributors of the nation, manufacturers' representatives, and others intimately interested in radio components gather at the Stevens Hotel in Chicago for the National Radio Parts Show, at which practically all the important manufacturers of radio components exhibit their latest and newest items to prospective customers.

Unlike some of the displays occasionally seen at the IRE show, almost everything exhibited is practical, down-to-earth stuff ready for sale and delivery to the distributor of repair parts or to the manufacturer of radio and television receivers and other electronic devices. Yet products of great technical interest often do appear. Some of these are new items, kept carefully under wraps to get the jump on a competitor. Others may be components which have been in use for some months, but whose technical importance has escaped both the manufacturer's own publicity department and the reporters of the radio press.

Sprague bypass capacitor resonates at 456 kc.

The Chicago show this year was no exception. There were several outstanding items, including a rotating television antenna that doesn't rotate and a bypass capacitor with an inductance deliberately inserted in series with it.

The paradoxical antenna is known as the Square Root Quad-loop. Once seen, its principle is recognized as that used long ago in the Bellini-Tosi direction finder. One wonders (without detracting from the genius of the designer) why somebody didn't think of it sooner!

Two special dipoles are mounted crosswise to each other (one, for example, is directional north-south; the other, east-west). Leads from each of these antennas are brought into a phasing box, from which a single 300-ohm line goes to the set. A knob on the box is turned to bring in the best picture from any given direction.

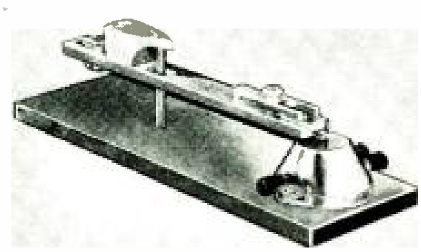
While the manufacturer is reticent about the contents of his box, he admits freely that it contains a pair of crossed coils with a revolving pickup loop between them. One admires the ingenuity that adapted the Bellini-Tosi idea to frequencies in the 200-mc range and sympathizes with the designer's decision not to tell anybody how he did it—until, at least, a few of his competitors have paid for the privilege of taking the little box apart.

The Square-Root was by no means the only antenna at the show. It was the Show of the Antenna, with even a rumor that one manufacturer had been refused admission because he had no antennas in his intended display.

The other startling innovation was exhibited by Sprague. Since the dawn of the art, capacitor makers have battled the inductive effects involuntarily introduced into their products, especially where rolled foil is used.

Yet there is a sound reason for the capacitor-with-added-inductance. For any given frequency, there is a series combination of inductance and capacitance which has a much lower impedance than the capacitance alone. Modern radio receivers require a great deal of bypassing of the 455-kc i.f. signal. A capacitor-inductor combination *tuned* to 455 kc is much more effective than an untuned capacitor of the same value. The Sprague 0.2-μf resonant capacitor has only $\frac{1}{10}$ the impedance of an ordinary 0.2-μf capacitor at 455 kc. Therefore this 0.2-μf resonant unit is as effective as a standard 2.0-μf capacitor at its correct working frequency.

In the sound field, Electro-Voice has produced an interesting *compliance meter* for measuring the stiffness of phonograph styli. Higher fidelity and less record wear result from the use of high-compliance styli, and this instrument measures them for that quality.

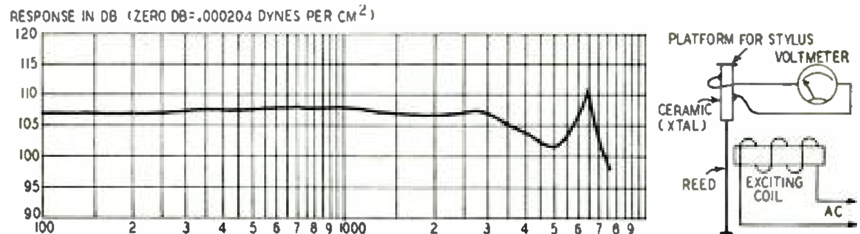

Electro-Voice compliance meter rates pickups.

A vertical reed (see drawing) is subjected to an alternating magnetic field from a coil surrounding it; the field makes the reed vibrate. A piezoelectric ceramic element is mounted at the free end of the reed. Its inertia causes it to be distorted (and thus to produce a voltage) in direct proportion to the amplitude of the reed's swing. Placing a pickup on the little platform at the top of the assembly naturally cramps its style, and the voltage drops according to the stiffness of the stylus. Thus the output as read on the meter indicates the *compliance* or bendability of the stylus assembly being tested. A chart (individually calibrated for each instrument) interprets the meter readings in microcentimeters per dyne of applied pressure.

The compliance meter was a working model for practical use and was not one of the items exhibited for sale at the Electro-Voice booth. It is nonetheless a valuable contribution to the art of recording and reproducing sound.

An important development in the printed-circuit field was signaled by Centralab engineers, who told of the increasing tendency to *combine* printed and ordinary wired components in standard radios or televisers. The Centralab Couplate and similar units are well known, and a new unit, an integrating device for television receivers which replaces six standard components, was exhibited. People have an unfortunate habit of thinking in terms of pure printed or pure wired circuits, it appears. The future may show that in many cases it will be more efficient and economical to use both printed *and* wired components in the same piece of equipment.

Users of the glorious but extinct Baldwin phones will be interested in the new dynamic headphones exhibited by Permoflux. The phone is built with a voice coil and pot magnet like a small loudspeaker. Developed for applications where flat frequency response is essential, the new phones are still a bit expensive for general use, but might be interesting to a high-fidelity enthusiast. The acoustic frequency-response curve shown was made in a 6-cubic-centimeter coupler with 1 mw of power available.



Frequency response curve of the Permoflux phones, left, and diagram of compliance meter.

Improved Phono Amplifier

A design for a cheap, yet good amplifier for a table-model phonograph

By JOHN S. CARROLL

THE amplifier described here is the final one of a series designed to determine how much table-model record players can be improved without excessive increase in cost.

The simplest amplifier used in such phonographs consists of a rectifier and a small beam-power tube, occasionally combined as in a 70L7 or 117N7, sometimes as individual tubes such as the 35Z5 or 35W4 and 50B5 or 50L6. These "one-lungers" are capable of power outputs between 1 and 2 watts, but require high output from the phono pickup.

These small beam tubes actually require a peak signal of 7.5 volts to develop full output. The average high-output crystal pickup generates an average signal of 3 to 4 volts, and reaches a peak value of 7.5 volts only on very high-level passages in the usual record. In general, then, such record players suffer from inadequate power output and excessive distortion, the latter running as high as 11% of the total harmonics.

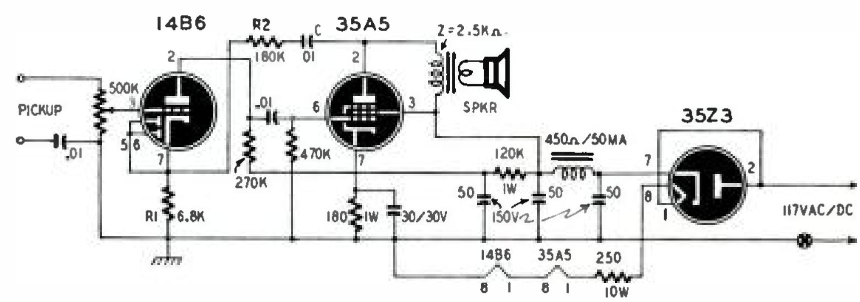
The logical solution is inverse feedback: this would reduce distortion without loss of output power. But the cost of feedback is higher signal voltage, which is not available in these single-tube record-player amplifiers. A driver stage is a necessity if feedback is to be applied.

The better-quality crystal pickups put out about 1 volt of signal; since 7.5 volts will drive the output tube under normal conditions, a low-mu triode would seem to be adequate for the input tube. However, large amounts of feedback may increase this requirement by as much as 5 to 10 times, making a high-mu tube necessary.

In the past, such feedback amplifiers have used a resistor between the plates of the input and output tubes as feedback path. This places the feedback voltage on the grid of the output tube by way of the coupling capacitor. While that system reduces distortion in the output stage greatly, it fails to take into account conditions in the input stage.

Given a plate supply of 100 volts, a typical high-mu triode will put out 7.25 volts of signal with an input of 0.13 volt. This, however, is the *maximum-signal* condition for the tube, and is accompanied by 4.6% harmonic distortion. If there is a great deal of feedback in the output stage, it will be necessary to start with signals as high as 1 volt to secure sufficient driving voltage on the grid of the output tube. Then the distortion developed in the driver stage will be intolerable. This is the reason why so many small a.c.-d.c. amplifiers have such poor tonal quality, even with feedback.

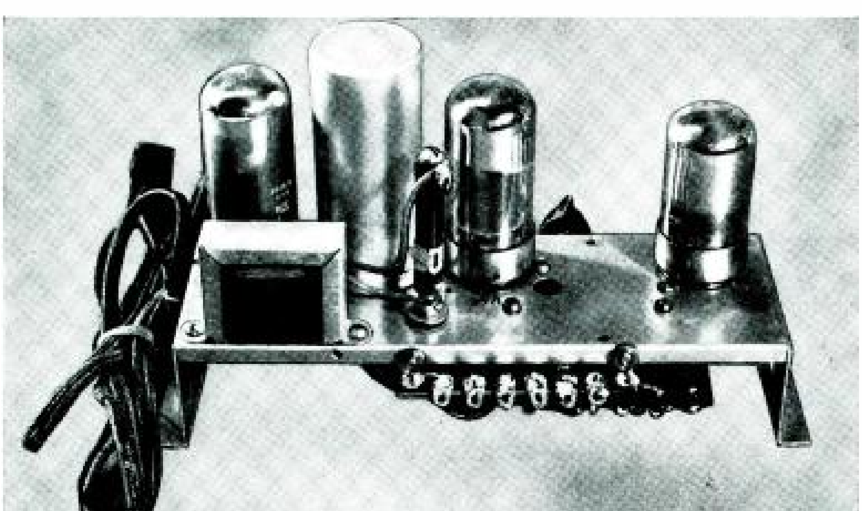
The solution shown in the schematic is to run the feedback loop to the input of the *first* stage. It then reduces distortion and flattens the frequency response in the input stage as well as the power tube. Polarity of the feedback is such that the connection is made to the cathode of the input tube; obviously, to develop any a.f. feedback voltage at this point, the bias resistor must *not* be bypassed. Thus, some additional degeneration is introduced in the input stage, further improving its characteristics.



Feedback is applied from plate of the second stage to cathode of first through C and R2.

In addition, the polarity of the feedback voltage is such that it adds to the bias of the tube on positive signal peaks, and subtracts from the bias on negative peaks. Thus, it acts as an automatic bias control, avoiding grid current on positive peaks, and cutoff on negative peaks.

The effect of the feedback on the characteristics of the power stage is unchanged; it lowers the effective plate resistance of the output tube, avoiding high-frequency peaks and improving the speaker damping.



The chassis looks typical of those in inexpensive instruments but performance is excellent.

Constructional details

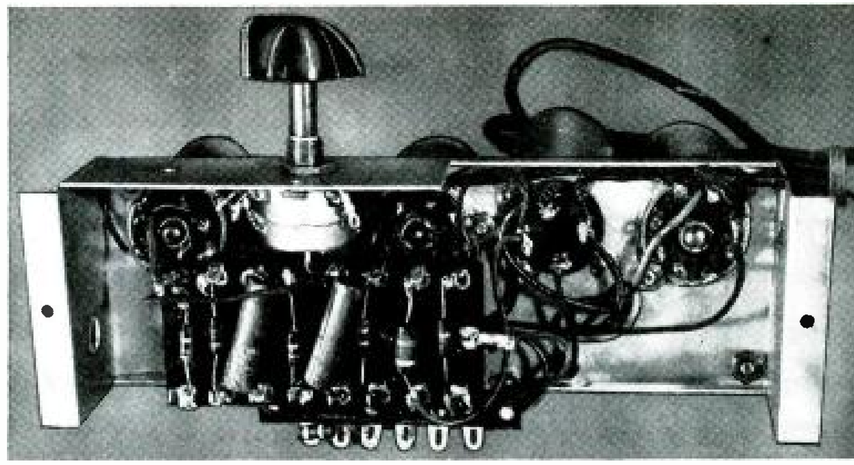
The photographs show the prototype amplifier as constructed for test purposes. Lock-in tubes were used in this model, but either octal or miniature types will serve as well. No high-mu single triode was available in the 0.150-amp series with lock-in base. The 14B6

—a duo-diode, high-mu triode—was chosen instead, and the diode plates connected to cathode at the socket.

The feedback loop consists of R1, R2, and C. The latter is simply a blocking capacitor, intended to keep the d.c. plate voltage of the 35A5 off the cathode of the 14B6. Having no other function, its size is not critical, except that it should not be reduced below the value given. If it is too small, feedback will be reduced at the lower frequencies, causing an over-all bass boost which may overload the speaker.

R1 and R2 act as a voltage divider and put a specified percentage of the output signal voltage on the cathode of the 14B6 (essentially the same as putting it on the grid with reversed polarity). The value of R1 is set by the bias requirements of the 14B6, leaving R2 the only variable to be determined. The calculated value (180,000 ohms) proved satisfactory. However, the over-all gain of the amplifier can be adjusted at this point. Increasing the value of R2 increases the gain, and vice versa. It is easy to determine a value for this resistor by trial and error.

Since the over-all feedback results in a considerably flatter and wider frequency response, plate-supply filtering is made considerably better than usual. This is more for the sake of improved transient response than for hum reduction (feedback reduces the hum to a large extent). Remarkably low hum level is attained without such usual gimmicks as hum-bucking speaker fields or hum-cancelling networks.



The few components, if wired point to point as in commercial models, make unit inexpensive.

The amplifier was constructed on an odd chassis which happened to be available. Circuits were simplified considerably with an FP type of tubular capacitor containing all filter condensers and the cathode bypass in one can. All other resistors and capacitors are mounted on a terminal board. Commercially, this probably would not be done; the point-to-point method, using the pigtails of the components as wiring, is probably cheaper and just as good if not better.

Since this unit was entirely experimental, the chassis was used as ground, and a capacitor was inserted in the chassis side of the input circuit to keep the pickup arm isolated from the a.c. line. In commercial construction, all ground points would be brought to a central tie lug, and grounded to chassis through a .01-μf capacitor. The grounded side of the pickup could then be connected directly to chassis, and the capacitor eliminated. It would be necessary to mount the can-type electrolytic condensers on an insulating wafer, to avoid grounding to the chassis through the can.

Notes on Sound Recording

By RICHARD H. DORF

THE other night I went to a meeting of the New York Section of the IRE to hear two lectures on tape recording. One of the speakers was Dr. D. G. C. Hare, a physicist who has spent some time developing a new broadcast-quality tape recorder.

Dr. Hare's talk on the subject of noise contained some highly interesting information for those interested in magnetic recording from any standpoint.

One of the problems is keeping noise a reasonable number of db below program level. Apparently no one is quite sure of all the causes of noise; but through the cut-and-try procedure, which every radioman has developed since his radio infancy, certain information has been obtained.

Probably the prime difficulty arises from magnetization of the recording, playback, or erase head. How many owners of tape machines can honestly say they have never had a slightly magnetized screwdriver somewhere near one of the heads? Most screwdrivers become magnetized at some time during their careers; working on a tape recorder with one may raise the noise level by as much as 15 db!

The bias-erase oscillator is another prime factor. If it hasn't a perfect sine-wave output, the distortion will result in a d.c. component which will magnetize the heads. The frequency of the oscillator and its amplitude—within limits—don't seem to be too important. In fact, if they are critical, you can be pretty sure the waveform is bad. So take a look at yours on a good oscilloscope.

There isn't much you can do about it, but turning off the audio at the peak of a wave will also leave the recording head "permed"—permanently magnetized. Funny thing, though, that speech waves, which are mostly either positive or negative, not equally both, have no effect. Why? Dunno.

One more tip. Dr. Hare said he has taken a brand-new tape and carefully kept it clear of everything before making the first recording. Then he found that running it once through the erase head before making a recording lessened noise.

Demagnetizing a head is quite a chore, it appears. Air-wound coils with 60-cycle a.c. running through them are used in about the same method as for demagnetizing a watch. Details weren't given, but you place the coil around the head, then lift it off. The number of times you have to do it will vary with the quantity of perm the head has; but if there's much magnetism, it may take all day! Shoot as much 60-cycle current through the coil as you can without burning it up. According to Dr. Hare, it's about right when you spit on it and it sizzles. If you take this literally, be sure you have a couple of extra fuses and a tube of Unguentine handy . . . but anything for better sound quality!

New discs arrive

Having become an enthusiastic microgroove fan since the long-playing records bowed in, I jumped at the chance to try some of the new RCA 7-inch, 45-r.p.m. discs when samples arrived. I have a Garrard 201V motor which is governor-controlled from 78 right down to 33, so setting it at 45 was simple. If you want to try it, just count revolutions until you get a little over 11 in 15 seconds, then trim up the adjustment while matching the music to a piano.

The center-hole problem was solved for about \$2.00. A machinist made up an aluminum washer approximately 5/16 inch thick. The outer diameter equals the inner diameter of the disc hole (about 1½ inches), and there is a center hole in the washer to fit the standard turntable center pin (about ¼ inch). Furnishing the machinist with a sample disc and a turntable is a good way to get the dimensions accurate.

Frequency Bridge For Audio

Theory, construction, and calibration data for a Wien frequency-measuring bridge

By K. E. FORSBERG

BUILDING an audio oscillator is not a difficult feat—many excellent designs have been published in RADIO-ELECTRONICS and other magazines. But calibration, once the unit is built, is quite another matter, especially if no one in the vicinity has a well-calibrated generator and an oscilloscope.

The solution may well be an audio-frequency meter. Such a frequency meter is valuable for other purposes as well—for instance, as an interpolation device for heterodyne radio-frequency meters or for harmonic-distortion measurements on audio amplifiers.

For an a.f. meter to be really valuable, it must be accurate; to be economical it should be made from standard parts. The one described here contains only 10 parts—no vacuum tubes. The principal investment required is a bit of headwork. No standard component is 100% accurate; therefore, to make the frequency meter tell the real truth, values and calibration must be obtained by experiments and calculations.

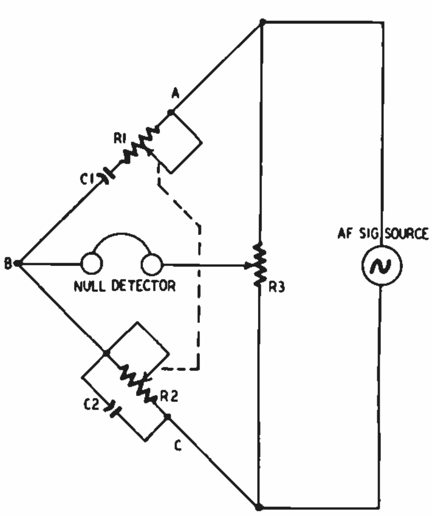


Fig. 1—Basic Wien frequency bridge circuit.

The instrument is a Wien bridge, of which Fig. 1 is the basic circuit. A variable-frequency signal source is connected to a bridge, two arms of which (the two sections of R3) are purely resistive, and two resistive and capacitive.

The phase shift in an R-C circuit varies with the proportion of R to X_C. Since X_C varies with frequency for any value of capacitance, phase shift varies with frequency for any given combination of R and C. And in the Wien bridge of Fig. 1, R in the reactive arms is variable. As a result, R1-C1 and R2-C2 can be made to give any desired degree of phase shift at any frequency.

R1 and R2, two potentiometers of the same resistance mounted on a single shaft, vary approximately in unison. But because R1-C1 is a series network and R2-C2 a parallel, the phase shifts of the two vary oppositely when the potentiometer shaft is turned. With both R1 and R2 fully shorted, for example, arm AB is wholly capacitive, giving maximum phase shift, while arm BC is shorted out, causing no phase shift. On the other hand, with all resistance in the circuit, phase shift in the AB arm is minimum (because there is a maximum of resistance), while that in arm BC is maximum (because most of the impedance between B and C is capacitive reactance).

The voltage of the signal source is impressed across the series combination of R1-C1 and R2-C2. Because the net impedance from A to C is always at least somewhat capacitive, the current I_{AC} leads the applied voltage E_{AC} by some angle between zero and 90 degrees.

Fig. 2-a is a vector diagram showing this. E_{AC} is represented by the line at zero degrees. Since vectors revolve counterclockwise, the I_{AC} line represents the current, leading E_{AC} by an amount $\theta 1$.

The current passing through R2-C2 is I_{AC}, leading the generator voltage by $\theta 1$. This current causes a voltage drop E_{BC} across R2-C2. Since arm BC is capacitive, the voltage drop E_{BC} lags the current I_{AC} which caused it by a certain number of degrees, depending on the values of R2, C2, and the frequency (assumed to be constant throughout this explanation). The lag of the voltage drop E_{BC} behind the current I_{AC} which caused it is shown in Fig. 2-a as $\theta 2$. Because of the component values and the frequency, it is, in this case, equal to $\theta 1$.

Observe the result. E_{BC} is now in phase with E_{AC}, the generator voltage. Since the voltage across any section of R3 is always in phase with the signal source, headphones connected between point B and the arm of R3 will have in-phase voltages at its terminals. All that is necessary to obtain a perfect null is to adjust the arm of R3 so that the *amount* of voltage appearing between it and point C is the same as that between B and C.

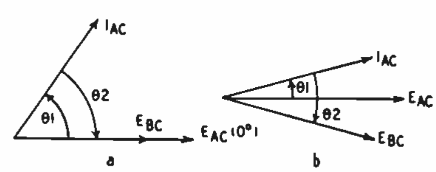


Fig. 2—Vectors show how the null is reached.

Suppose now that the frequency is raised, but R1 and R2 are left at their present settings. The net reactance between A and C is changed, and so is the reactance between B and C. As a result, the phase shifts in AC and BC are reduced, as Fig. 2-b indicates. I_{AC} still leads E_{AC} (though not as much), but the shift in BC is too great. E_{BC} now falls behind E_{AC} (lags it) because of the new values of $\theta 1$ and $\theta 2$. The voltage across the headphones now has an in-phase and an out-of-phase component; while the in-phase voltage can be balanced out by adjustment of R3, there is no way of nulling the out-of-phase voltage and a signal will be heard.

The basic formulas for the phase shifts will be found in many textbooks, although this explanation is very hard to find. The null frequency is

$$f_n = \frac{1}{6.28\sqrt{R1 \times R2 \times C1 \times C2}}$$

Construction

Fig. 3 is a schematic of a practical Wien bridge having three frequency ranges: 20-200; 200-2,000; and 2,000-20,000 cycles. R1 and R2 are the sections of a dual potentiometer with logarithmic taper. Wire the potentiometers so that the resistance-rotation curve will be like that of Fig. 4-a, which will give a frequency curve as

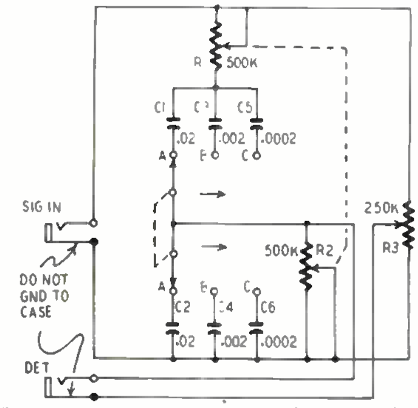


Fig. 3—Schematic of a practical Wien bridge.

shown. If wired backward, as in Fig. 4-b, the frequency calibrations will be very crowded at one end of the scale.

The capacitors should be mica or high-quality paper units. A metal case is useful for preventing stray capacitance, but don't ground the jack frames to it. The dial scale should provide for 270 degrees of rotation; a piece of polar graph paper will provide equally spaced divisions.

Calibration

The easiest way to calibrate the bridge is to feed a signal into it from

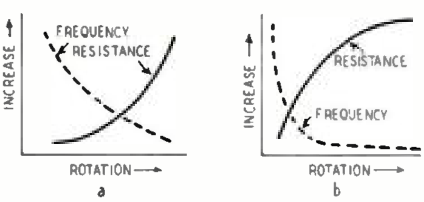


Fig. 4—Correct curve for R1, R2 is as above.

a calibrated generator. But, if the bridge is to be used to calibrate a generator, that is impossible. Some calculations and measurements will then do the trick.

With the capacitors given in Fig. 3 for each range, null frequency depends only on the resistances of R1 and R2. If these two resistances and the capacitances of each pair of capacitors (C1-C2, C3-C4, C5-C6) were equal and as stated, a simple table of resistance vs. frequency could be given. In the actual unit, they will not be equal nor will they be known exactly.

The procedure is as follows:

1. With a good capacitance bridge, measure the capacitance (including strays) actually in the circuit between the switch arm and the other end of each capacitor; note the results. Then solve the following formula for K (the range multiplying factor) for range A (20-200 cycles):

$$K_A = 1/6.28\sqrt{C1 \times C2}.$$

If, for example, the measured capacitances of C1 and C2 are exactly .02 µf each (an unlikely case), then

$$K_A = 1/6.28\sqrt{.02 \times 10^{-6} \times .02 \times 10^{-6}} = 7{,}950{,}000.$$

Solve also for K_B and K_C, using the values of capacitance in the circuit when the switch is on bands B and C.

2. Decide on the first frequency for which the bridge is to be calibrated, then substitute it for f in the formula

$$\sqrt{R1 \times R2} = \frac{K}{f}.$$

The K to be used is that for the band being calibrated.

If the frequency is 20 cycles, for example, and K_A is 7,950,000,

$$\sqrt{R1 \times R2} = 7{,}950{,}000/20 = 397{,}500.$$

3. Find a setting for R1-R2 at which

$$\sqrt{R1 \times R2} = 397{,}500.$$

If both sections of the potentiometer varied exactly equally and the resistances at any setting were the same, the value of either would be sufficient. Since commercial dual units do vary somewhat, this geometric mean (square root of the product) is necessary, as it was with the capacitors. Using a good ohmmeter, find a setting at which one resistance is slightly above and the other a little below the desired value of 397,500 ohms; then make trial calculations and vary the settings slightly until the last equation above is satisfied. Mark the dial scale with the frequency at the setting found.

4. Go through steps 2 and 3 for each frequency to be used on each band.

It is possible to find the values for K without having a capacitance bridge. Apply 60-cycle line voltage to the input terminals of the bridge through a step-down isolation transformer. Adjust R1-R2 and R3 for sharpest null, and mark the scale. Measure the resistance of R1 and R2. Then

$$K_A = \sqrt{R1 \times R2}.$$

Calibrate range A as in steps 2 and 3, extending the calibration to as high a frequency (above 200 cycles) as possible.

Connect an audio oscillator (it need not be calibrated) to the bridge and adjust it so that a null is secured *above 200 cycles*. Note the frequency from the calibration just made, then switch to band B. Readjust the bridge for null on this frequency, mark the dial, and measure R1 and R2. Then

$$K_B = f\sqrt{R1 \times R2},$$

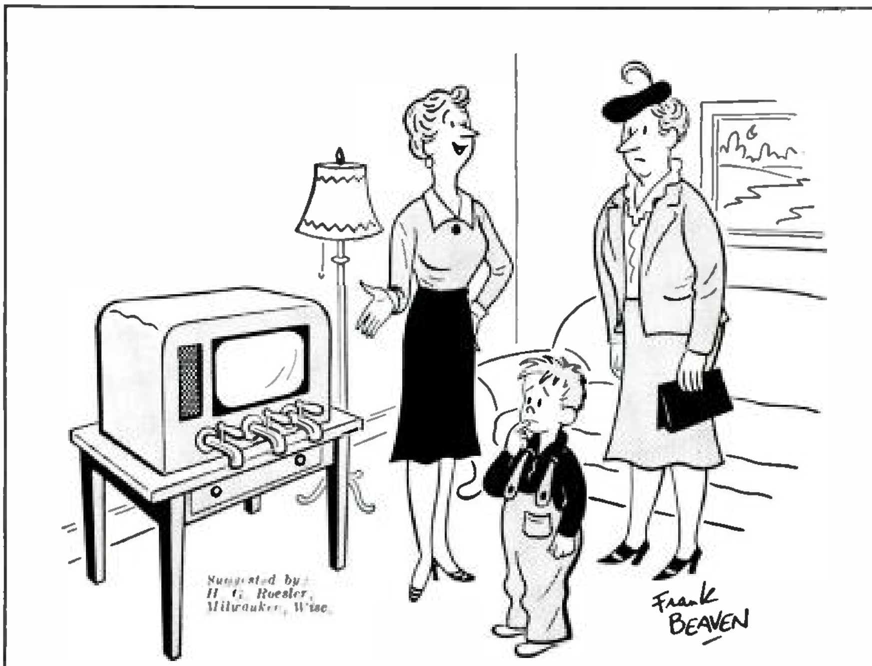
where f is the frequency to which the oscillator is set. Calibrate range B as before, to a point above 2,000 cycles. Then follow the same procedure to find K_C.

To use the bridge, feed in a signal and adjust first R1-R2 and then R3 for sharpest null. Readjust both controls as often as necessary to get a complete null. Then read the frequency directly from the dial.

While headphones are usually satisfactory, a sensitive a.c. v.t.v.m. gives more exact null indications. Depending on the voltage fed to the bridge, an ordinary a.c. voltmeter might also be used.

If well calibrated and carefully handled, this Wien bridge is an extremely accurate frequency-measuring device.

One useful application not concerned with measurements is in receiving c.w. signals on crowded amateur bands. It is very difficult to copy when a strong interfering note is very close to the desired one in frequency. The bridge may be connected to the output of the receiver and the headphones used as the "detector." Adjusting the two controls will then balance out the interfering note while allowing the desired one to come through. A single-frequency a.f. amplifier may be constructed by inserting the bridge in a feedback loop so that all frequencies but one are fed back 100%. Many other uses will occur to the experimenter.

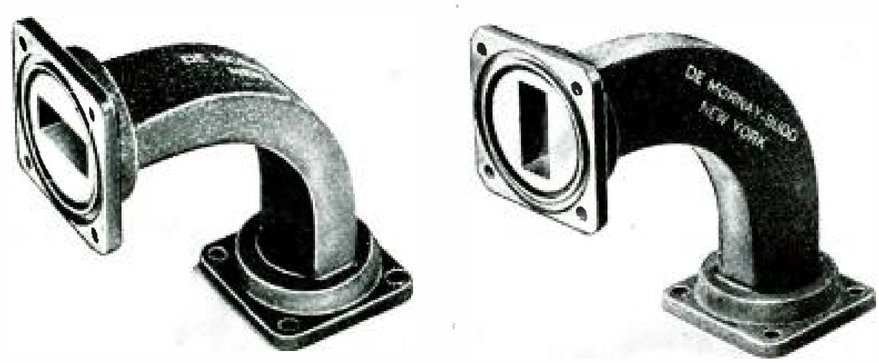


"Junior won't monkey with those knobs—he hates baths!"

MICROWAVES

Part IV—How waveguides are joined and tuned for lowest possible loss

By C. W. PALMER



DeMornay Budd Photo

Fig. 1—In bending waveguides, use is made of either the E or the H bend. Both appear here.

SO far we have learned how waveguides are used to transfer microwave radio power from an oscillator or transmitter to an antenna, and from the antenna to the receiver's amplifying and detecting circuits.

We have learned that the familiar radio quantities — inductance, capacitance, impedance, reactance, and resistance—are found in r.f. plumbing, but that their appearance is entirely new. And since we are dealing with *wave propagation* instead of *conduction of r.f. currents* as in low-frequency radio, we must learn a new set of rules.

In this part of the microwave series we will attempt to express those rules in a form that will help the radio man to understand better the do's and don'ts of r.f. plumbing.

One of the most important things to learn in using waveguides is to avoid discontinuities or changes in the internal mechanical shape of the guide from one section or piece of apparatus to another when joining them together in a "circuit."

Look at Fig. 1 as an example. It shows two types of L bends used extensively in r.f. plumbing. The first is known as an E bend, and the second is called an H bend. It is easy to remember which is the E and which the H bend if you think of the E as the "easy" and the H as the "hard" bend (if it were possible just to bend a piece of straight guide to make a right-angle turn, which it isn't).

In manufacturing these bends, deviation from the inside dimensions of the straight section by even a few thousandths of an inch in the bent portion will increase the loss from a nominal .02 decibel for such a section to several decibels, with a corresponding increase in the standing-wave ratio.

Fortunately such discontinuities can be taken care of by introducing into the guide obstacles that produce reflections which cancel the unwanted ones.

The matching devices most commonly used are *diaphragms* and *tuning screws*. The diaphragm, or *window* as it is sometimes called, is an aperture of thin metal placed across the waveguide. Such a window introduces either inductive or capacitive reactance depending on the direction of the slit.

Fig. 2 shows inductive and capacitive windows. For an inductive window the edges of the slit are parallel to, and for the capacitive window perpendicular to, the electric field. Usually these windows are soldered in place and are not variable. Where large amounts of power are to be carried in the waveguides, inductive windows are preferred because the capacitance type breaks down, causing arcing and loss of power.

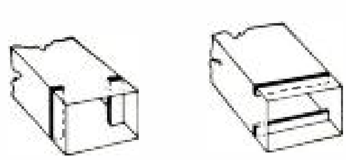


Fig. 2—The inductive and capacitive windows.

Several examples of the use of fixed windows in waveguide circuits are shown in Fig. 3, which shows E and H tees used for branching or splitting the waves into two paths. The windows in these tees balance out reflections that would otherwise be introduced by the branch line and would introduce losses in the main waveguide path.

Sometimes it is desirable to have a variable reactance in a waveguide setup to permit balancing out undesired reflections. In such cases tuning screws —small cylindrical posts projecting into the broad face of the guide as shown in Fig. 4—are used. These screws provide capacitive reactance which varies with the penetration of the post into the guide. A single screw may be sufficient, but usually three screws are provided at quarter-wavelength intervals along the guide.

Sometimes it is desired to insert in a waveguide a device that will either *pass* a desired mode (modes of propagation were discussed in Part I) and no other, or *reflect* completely the power in a certain mode. Resonant diaphragms or windows are used for this purpose. A thin rectangular ring of the proper dimensions placed across the inside of the rectangular waveguide and separated from it by insulation will *reflect*, for example, all the T $E_{0,1}$ mode transmitted through the guide.

If a thin metal diaphragm across the guide is provided with an opening of the proper size, all the power in the T $E_{0,1}$ mode will be *transmitted*.

Resonant slits in the waveguide diaphragms are also useful for passing waves of low power and rejecting those of higher power. The slit is so narrow that breakdowns occur, and the resonant condition is temporarily removed. A device of this sort is useful for preventing the direct power of a transmitter from reaching and damaging a receiver connected to the same antenna system, during transmit periods, while allowing incoming radio waves to be received normally. In a radar system a special form of such a device is called a TR or ATR box, and will be discussed in detail later.

A microwave primer

It is frequently necessary to use long stretches of waveguides, and it is very unusual for them to proceed in a straight line. Bent and twisted sections with the bends in both E and H planes, tees for branch lines, etc., must be used to fit the needs of the individual installation.

In using these lengths with tee's, L's, etc., certain rules must be observed to obtain the desired results. These are summarized here in the following eight items.

1. A shorted end of waveguide (as the side arm of a tee or a stub) an odd number of *quarter wavelengths* long reflects an "opening" where it joins another waveguide. Waves in the main arm would travel into such a side arm as well as traveling through the main arm.

2. A shorted end of waveguide any number of *half wavelengths* long reflects a "solid wall" where it joins another waveguide. Waves in the main arm of a tee would travel through without entering such a side arm for this reason.

3. A quarter-wave section of waveguide has opposite impedances at its ends (if impedance is high at one end, it is low at the other) just as in ordinary types of co-axial and parallel transmission line. (This summarizes rules 1 and 2.)

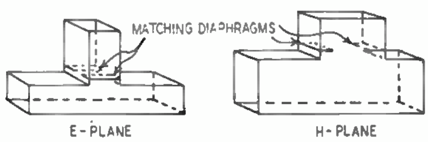


Fig. 3—Windows used in waveguide branch.

4. The Q of a waveguide is a function of frequency and also depends on the ratio of volume to inside area of the guide. Q's of 25,000 are not uncommon in waveguides and resonant cavities.

5. The characteristic impedance differs with different modes of operation. In a rectangular waveguide the impedance is proportional to the narrow or b dimension of the guide. It varies from about 475 ohms to zero as the b dimension is reduced.

6. The wavelength in a hollow waveguide (as measured in a slotted waveguide section) is always greater than the wavelength of the same wave in air, due to the multiple reflections from the walls of the guide.

7. Sections of open and closed waveguides may be used as switching circuits by applying the principles of Rules 1 and 2 above.

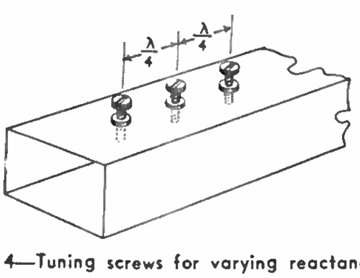


Fig. 4—Tuning screws for varying reactance.

8. Standing waves in waveguides are checked in a manner similar to that used for co-axial lines. A section of waveguide with a narrow slot parallel to the axis of the guide is used. A probe with a crystal detector or a small fuse (1/200 ampere) heated to almost the blowing point by direct current is used to detect the presence of standing waves as with a slotted co-axial line at lower frequencies.

Joints in waveguides

Sections of waveguide may be soldered together end to end. If the sections line up and touch, losses and reflections introduced by the joints are negligible.

However, for maintenance purposes and to make waveguide apparatus useable in more than one installation, it has become common usage to terminate waveguides with flanges on the ends which are soldered to the guide and machined flat on the ends. These flanges are bolted together. Experience has shown that this type of joint can be made better than even the average soldered guide-to-guide joint if care is taken to make uniform contact.

To reduce further the possibility of losses due to waveguide joints, it is considered good practice to use the "choke flange" joint, butting a choke flange *always* against a flat one.

The principle on which this choke flange works can be readily understood from waveguide Rule No. 2 above. See Fig. 5. This shows a cross-section view of a choke-to-flat joint. The slot left by the junction of the two waveguide sections is a half wavelength long at the optimum frequency of operation of the waveguide, which means that the side cavity A reflects a "solid wall" to the

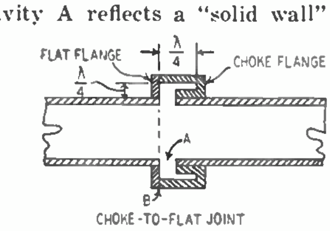


Fig. 5—The choke flange, perfect connector.

main guide so that there can be neither leakage of r.f. nor dicontinuity to cause reflections in the main guide path.

In addition to the above, the point B where contact is actually made between the two waveguide sections is at a point of zero current, and perfect electrical contact need not be made between the two sections as is necessary in joining two flat flanges.

Such choke couplings are frequently used as "wobbly" or nonrigid connections between waveguide sections. They are used, for example, at the junction of an antenna where it is desired to shift or rotate the final section of guide to orient the antenna for peak response.

As a rigid connection the loss in a choke-flange joint is in the order of .02 db, compared to about .05 db for a well-made contact joint. The nonrigid connection mentioned, with a gap of about 1/16 wavelength between the choke and flat flange, has a leakage of about .3 db.

Plungers for shorting bars

In terminating side arms as described in the rules above, it is sometimes desirable to make movable *shorting plates* or *plungers* so that the lines can be tuned exactly to a desired quarter- or half-wavelength point.

Plungers can be either solid blocks, cup terminations, or choke terminations. The solid blocks must make good electrical contact at all points around the edge with the inside of the guide, or behavior will be erratic as the plunger is moved and power may leak past the termination.

Better results are obtained with a *cup contact* as shown in Fig. 6. Contact is

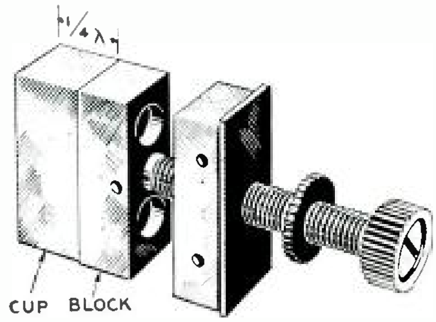


Fig. 6—The cup-type plunger reduces losses.

made with the inside walls of the guide a quarter wavelength from the plunger, where the flow of current in the walls of the guide is zero. Losses in this type of termination can be held to as little .08 db.

An improved termination is the *choke plunger* which uses the same principle as the choke coupling. As shown in Fig. 7, no mechanical contact with the inside walls of the waveguide is made at the front surface of the plunger. Contact is made at B where the current is zero. Choke plungers have losses in the neighborhood of .02 db.

Dielectric in waveguides

The fact that the introduction of a dielectric inside waveguide will decrease the "cutoff" wavelength has been used practically in a so-called "line stretcher." This device introduces controlled amounts of dielectric into the guide to tune it.

The effect of an ideal dielectric in a waveguide is to increase its apparent

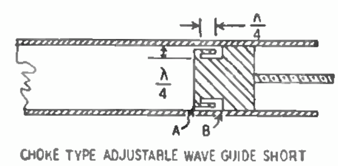


Fig. 7—Improved plunger uses choke circuit.

size. It also lowers the impedance in all but one TM (transverse magnetic) mode. The losses of a guide filled with solid or liquid dielectric are higher than for an air-filled or gas-filled guide. However, the effect is slight.

An exception to the above and a point of caution to the experimenter in microwaves is the effect of water. Small amounts of water condensed on the inside of a waveguide may introduce losses up to ½ decibel per foot of waveguide. This is caused, not only by the large dielectric loss characteristic of water at high frequencies, but also by the high dielectric constant of water. This is why some waveguide installations are pressurized or charged with an inert gas.

Receptacle at left is for PE-103 dynamotor.

Mobile 10-Meter Rig Puts Out 20 Watts on Phone

By ALVIN B. KAUFMAN, W6YOV

WHEN vacation time comes along, why leave ham radio at home? Plenty of fun may be had and some excellent contacts made while mobiling in the high Sierras or other vacation spots.

The low-power, 10-meter, mobile transmitter described was designed and built with this in mind. With all bands open for mobile operation, 10 meters was still selected over all other available bands, with 75 meters the only other one considered. Both bands are good for dx, but 75 is much more crowded than 10. Seventy-five-meter mobile, if really mobile, would require a loading coil to resonate the short whip antennas available, causing low radiation efficiency. But where short skip or ground-wave range is a necessity, 75 meters wins. The other bands, such as 6 meters, were not considered, as their range with low-power equipment is insufficient for the tourist ham.

The first major decision in design was whether to go FM or AM. The choice of FM meant far less drain on the power supply. At the same time, more tubes might be required for modulation. Then, too, where AM receivers were being used on the receiving end, QRM would knock the lower-power signal out easily. Therefore, AM was selected.

Frequency control was the next major issue. Crystal control was preferable from several viewpoints. A major disadvantage was inability to shift frequency to avoid QRM. A v.f.o. would have allowed this, but was impractical because of the cost and the problems of insuring drift-free operation under mobile conditions. The solution was the use of a variable-frequency or "rubber" crystal. It gives some of the best features of both methods of frequency control.

The transmitter requires four tubes, and only two tuning controls. The crystal-buffer-stage tuning control may be set to the mid-frequency of the "rubber" crystal and left there. It is necessary only to touch up the tuning on the final tank when shifting frequency.

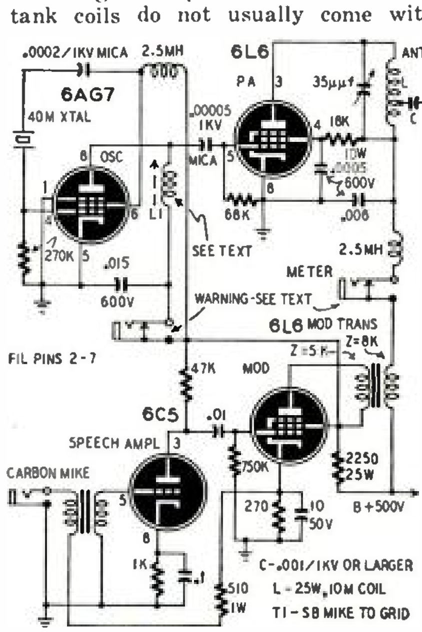
The r.f. section of the transmitter is unusually simple in design, as the schematic shows. The crystal and buffer stages are combined in one tube. A 40-meter crystal is connected as a Pierce oscillator, using the screen grid of the 6AG7. The plate circuit of the 6AG7 is tuned to 20 meters. The r.f. is coupled to the final grid capacitively.

An unusual feature here is the use of variable-inductance tuning. Taking advantage of the already high distributed wire and output capacitance, *no capacitor*, fixed or variable, is required across the buffer tank coil L1. Instead, using a National XR-50 coil form, a coil was wound which resonates in the correct range and whose resonance can be varied by moving the iron core in or out. This occurred with a winding of No. 29 enamel close-wound to a length of ¼ inch. This gives an excellent L-C ratio and very good doubling efficiency. Mechanically and electrically it simplifies the transmitter. Despite the high L-C ratio, at these frequencies the tuning of the stage is not sharp.

The final stage consists of a conventional r.f. amplifier which doubles to 10 meters. It receives all its bias from a grid-leak. As a doubling operation takes place in this stage, it is desirable to have as high a bias as possible to facilitate harmonic generation. The grid leak selected was 68,000 ohms, but a value of 50,000 to 100,000 ohms is acceptable. No protective bias was included as this was thought unnecessary for the low-power tubes involved.

Depending upon the power supply used with the transmitter, it is possible to overload heavily and burn out the final tube if its plate circuit is not in resonance. The use of protective cathode bias, however, would lower the over-all efficiency, which on this low-power job is not desirable. Momentary overloads will not cause tube failure, and 6L6's are comparatively cheap.

The antenna may be link-coupled to the 25-watt commercial tank coil, or it may be directly tapped on the coil (as in the diagram) where a quarter-wavelength whip is used. As 25-watt tank coils do not usually come with



Doubler coil L1 is wound on slug-tuned form.

variable links, and because there are constructional difficulties in making a link hold still under mobile conditions, directly feeding the antenna may be advisable. When this is done, *always* place a mica coupling capacitor in series with the antenna lead. Failure to do this places the power-supply high d.c. voltage on the antenna, and a dangerous shock may occur to an innocent bystander. FCC regulations forbid direct coupling.

Both methods of coupling have disadvantages. A varying link will amplitude-modulate the carrier. With the tapped antenna connection, harmonics may be radiated, and a swaying whip, due to its change of capacitance, may cause detuning of the transmitter and consequent amplitude modulation. The choice is yours!

There is one important mechanical detail in the final stage. The tuning capacitor must have both rotor and stator above ground.

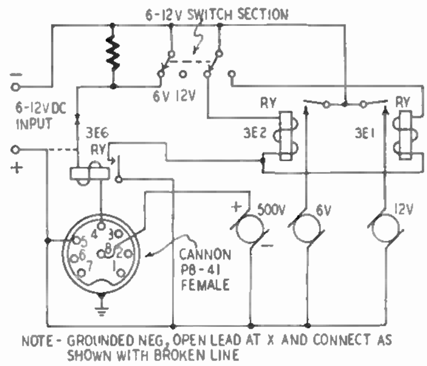
To keep the transmitter compact, jack-and-plug metering with an external meter is used. The plates of the buffer and final must be monitored when the transmitter is tuned. The meter jacks have been put in the plate leads. This places high voltage on the jack frames, which must be isolated from the chassis with fiber washers. Here the meter will indicate true plate current. For safety it may be advisable to place the jacks in the cathode circuits as per conventional design. Of course, grid and screen current must be subtracted for a true plate-current indication in this case.

(Mr. Kaufman's last communication to us was fairly recent, which indicates that he is still alive, even with two jack frames and a capacitor shaft, both 500 volts above ground, on his front panel. Despite the author's apparent good luck in never having accidentally brushed his hand across any of these gadgets while his feet were firmly planted on the ground, we cannot recommend that readers depend on the same good fortune. Mount the final tuning capacitor on the chassis with standoff insulators and use an insulated shaft. Place the metering jacks between the cathode of each tube and ground, with the frame of each jack grounded. You will have a better chance of remaining healthy enough to read the meters.—*Editor*)

Plate power should never be applied until the tube filaments have come up to operating temperature, primarily to protect the capacitors. Where a dynamotor power supply is used, regulation is poor and excessive voltage may be applied to the capacitors until the transmitter loads up the supply and lowers its output voltage.

The modulator

The speech amplifier and modulator are of standard design, a 6L6 driven by a 6C5. Rather than use the 6-volt car-battery circuit (too much hash) or a dry-cell supply for the carbon microphone, a special circuit was employed. The bias resistor of the 6L6 was increased to a high value which, in parallel with the microphone button and transformer, supplies the correct bias to the tube and current to the microphone. This has several desirable features besides simplicity. It makes possible a.c. operation of the transmitter for portable or home operation. The modulator 6L6 is automatically biased to very low plate current when the microphone is off, conserving the power supply. Of course, where a push-to-talk microphone also controls the power input to all stages, this is of little advantage.



Simplified schematic of the PE-103 dynamotor.

The power supply

An excellent power supply is an Army surplus PE-103 dynamotor, obtainable for less than $10, which has built-in circuit-breaker protection and will operate from either a 6- or 12-volt battery. The output is rated at 500 volts at 160 ma. The unloaded voltage may reach 650, so it should not be operated until the transmitter filaments are warm. This will save the 600-volt bypass capacitors.

It is also possible to operate the dynamotor while connected for 12 volts input, on a 6-volt supply. In this case the output is 250-300 volts and may be used directly on all of the transmitter tubes with the 2,250-ohm protective dropping resistor for the modulator and crystal stages removed.

Cathode-type tubes are used, so their heaters must be on as long as the rig is on standby. The transmitter is then put on the air by applying voltage to the dynamotor. A simplified schematic of the PE-103 dynamotor is shown. The control and output leads terminate in a Cannon type P8-41 connector. (A Cannon type P8-24 plug fits this connector.)

The dynamotor starts when the circuit through pin No. 4 is grounded through a push-to-talk switch on the microphone. The PE-103 may be used without modification if the positive side of the vehicular storage battery is grounded. If the negative side of the battery is grounded, the 6-volt control circuit must be altered. Disconnect the hot side of the control relay, 3E6, from the negative side of the low-voltage input circuit and connect it to the positive side as shown by the broken line on the diagram.

In most of these units, the high-voltage lead terminates at pin No. 8 and 6 volts for controlling an antenna change-over relay at pin No. 3 on the connector. However, PE-103's bearing serial numbers between 4711 and 9500 may have connections to pins 3 and 8 reversed. Be sure to check your dynamotor before connecting it.

At 500 volts input and 60 ma final plate current, input power is 30 watts. Assuming 70% efficiency, power output is 21 watts. The input power may be varied from 15 to a maximum of about 40 watts. With the modulator shown, input power should run approximately 15 to 20 watts to allow a high degree of modulation.

Construction details are not too important, and each amateur will have his own ideas, depending upon available chassis and boxes.

MATERIALS FOR TRANSMITTER

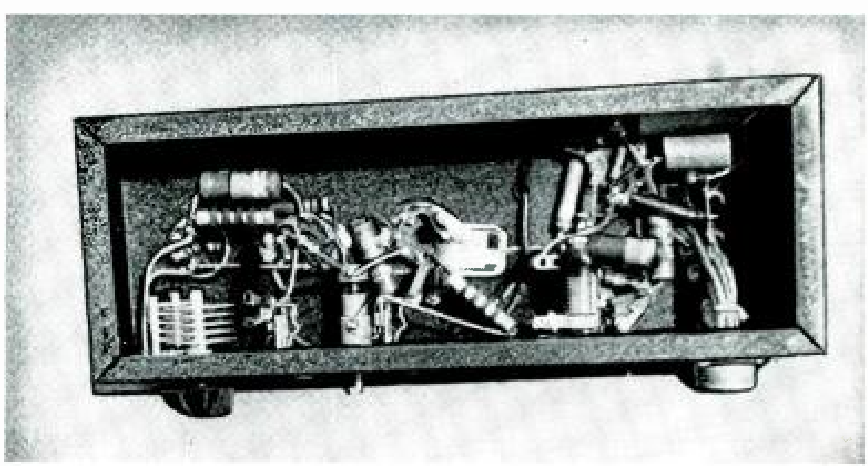
Resistors: 1—270, 1—1,000, 1—47,000, 1—68,000, 1—270,000 ohms, ½ watt; 1—510 ohms, 1 watt; 1—4,000 ohms, 10 watts; 1—2,250 ohms, 25 watts.

Capacitors: 1—50, 1—200 μμf, mica; 1—.006, 1—.015, 1—.01, 1—0.1 μf, 600 volts, paper; 1—10 μf, 50 volts, electrolytic; 1—35 μμf, variable.

Transformers: 1—single-button carbon microphone to grid; 1—modulation, 5,000-ohm primary, 8,000-ohm secondary.

Tubes: 1—5AG7, 1—6C5, 2—6L6.

Miscellaneous: 1—40-meter crystal (variable-frequency); 1—National XR-50 coil form; 2—shorting, 1—non-shorting phone jacks; 1—PE-103 Dynamotor; cabinet, chassis, hardware.


This is the underside of the transmitter chassis. Final tank tuning capacitor is at left.

Manufacturers Versus Service Technicians

By HUGO GERNSBACK

IT has been a matter of growing concern to us that for over two decades now the radio service technician has not been recognized by the radio set industry. During this period thousands of letters from radio technicians have passed across my desk complaining of the lack of recognition by the manufacturers.

It is true, perhaps, that during the first decade the old so-called "radio servicemen" had only themselves to blame for this treatment because their business methods left much to be desired.

During the last decade, however, this condition changed for the better, yet recognition was not forthcoming. Even at this moment—although a number of forward-looking manufacturers are beginning to work intensely with the radio technicians—more than half of the industry is not only indifferent toward them, but actually hostile.

Recognizing this condition—as this magazine has done for over 20 years—I recently took it upon myself to do something about this state of affairs.

Several months ago I began to address a series of ten weekly letters to the heads of the entire radio-television set manufacturing industry. In these letters I set forth, in no uncertain terms, the service technician's case. This correspondence resulted in a great deal of attention in the trade; I received many letters from the manufacturers—large and small.

The ten letters are much too lengthy to reproduce in full here, so I will limit myself and give certain highlights as follows:

From Letter #1. . . .We think it would be a big surprise to many manufacturers, if it were generally known, how many buyers are actually influenced by the advice of a radio technician, the serviceman. After all, he is supposed to "know," and the family which is in the market to buy a TV set will listen to him. . .

From Letter #2. . . .The great trouble today with set manufacturers, both television and radio, is that there is practically no cooperation with the technician. Letters by the independent technician addressed to manufacturers for servicing information, for information on various parts, etc., meet with little cooperation. He is frequently not even answered.

From Letter #3—Parts of a reader's letter to Radio-Electronics.

". . . The other day when I visited one of my customers he showed me a full-page advertisement from a local newspaper, advertising a new television model by the . . . . Radio Company. The customer asked me what I knew about the set. I had, of course, seen the ad in the paper that same day, but I was forced to admit I knew nothing about the new receiver and could give no information . . ."

. . . The radio service technician is still at odds with the radio set industry . . .

. . *Instead of taking the trade, and particularly the technicians in the field, into their confidence, the manufacturers are doing everything to antagonize these men, thus losing not only good will but actual sales*. . .

From Letter #4. . . .FROM NOW ON EVERY YEAR WILL REQUIRE MORE AND MORE SERVICING OF TELEVISERS. Television sets—being far more complex than sound radio sets—are bound to get out of order quicker than the average radio. During the next few years—unless the number of new service technicians coming into the industry increases greatly—it is easy to foresee that *there will be chaos due to the inability of maintenance technicians to make repairs and do servicing in a reasonable time*. If present conditions prevail in 1952, conceivably it may take *months* before a customer's television set can be repaired. The set manufacturers fully realize the situation, but so far they have made no effective attempt to remedy it. . .

From Letter #6—Taken from a television set manufacturer's letter to us.

". . . I think that you could take another look at the extent to which the servicemen are being penalized due to the fact that they are not receiving technical information on new models in advance. This particular point could be the subject of long discussion; but, generally speaking, the average, first-class serviceman in this industry can readily absorb the features of any new model within a short time, provided he has the technical data which is released along with any new model . . ."

. . . .Today's common habit of many set manufacturers is to publicize the new receiver to the home set buyer while instruction and alignment manuals for the service technician are still on the press. Put yourself in the position of the radio technician when this happens—and it happens nearly all the time. *It causes bitter resentment*. . .

From Letter #8. . . .*Remember, it is one thing to manufacture a set, but a totally different thing to service it.* Why not tell radio service technicians that they will be paid for every worthwhile suggestion submitted? . . .

But no radio technician will put himself out to send in sugestions to a manufacturer, knowing that he will not be paid for his necessary labor—indeed he does not know whether his suggestions will be welcome or not. However, his experience is invaluable, and should not be lost to the manufacturer.

My final letter to the manufacturers (Letter #10) was sent to the radio-television manufacturers early in June. I thought it worthwhile to reprint, here, the entire substance of that letter:

. . .For a period of over ten weeks we have addressed to you a series of letters stating the service technician's viewpoint in his relations with the radio set manufacturer. *This is our final letter.*

Sample Advertisement Suggested by Author

We believe we are well qualified to represent the service technician, since, for over 20 years, a major portion of our magazine has been devoted to the radio servicing field. Here is a short resumé of the highlights contained in the previous nine letters.

1. Over 75,000 service technicians—who routinely go into the homes of your set users—can create either good will or ill will for you and your product.
2. For nearly 20 years the radio receiver industry—and now the television industry—has done practically nothing to obtain the good will and *full* cooperation of the service technician.
3. You have not taken the service technician into your confidence.
4. You have continuously made the serious mistake of placing the service technician in the same position as the buying public. *No TECHNICAL information on your new sets reaches these technicians until long after it has been announced to the public.* This has caused justifiable resentment and increasing ill will.
5. You have never thought it worthwhile to sell the service technician on your new product—*before* advertising it to the public—so that when a prospect asks him about it he can discuss it *intelligently*. (*Continued on page 52*)

TO THE SERVICE TECHNICIAN

MEMO:

Dear Service Technician:

We have just placed the Model OXOOY on the market. This receiver, we believe, has several new technical features that warrant your consideration. For your benefit, and the benefit of those customers of yours who may ask you for information on this new model, we will supply technical data on these features.

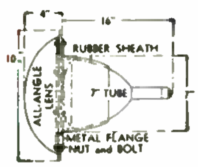
For more detailed data and complete service manuals, please fill out and mail the coupon in the lower right hand corner.

Yours very truly,
Videon Corporation

BUILT-IN MAGNIFIER

The 10-inch tube of the Model OXOOY is equipped with a lens actually sealed on at the factory. Experience has shown that a large number of television users use and approve the imperfect magnifiers that are mounted *ahead* of the lens, and which cannot give optimum results, due to light losses from the rear surface, astigmatism, etc.

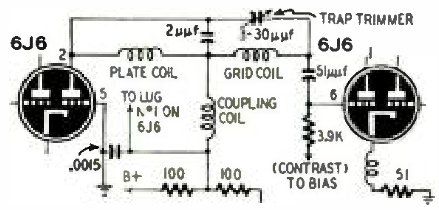
The OXOOY magnifier lens brings the picture up larger than that obtainable from a standard 15-inch tube, yet gives full picture visibility over more than 135 degrees without distortion. Light loss is small. That is because the lens is factory sealed to the front of the tube, which actually forms its rear face. Thus there is no intersurface to reflect the light. The close mounting, plus design factors engineered by the VIDEON research department, is responsible for the wide angle view. This feature alone is a tremendously important selling point. Reception on the nominally 10-inch OXOOY is practically indistinguishable from that on a standard 15-inch television. Yet the OXOOY is definitely priced in the 10-inch class.

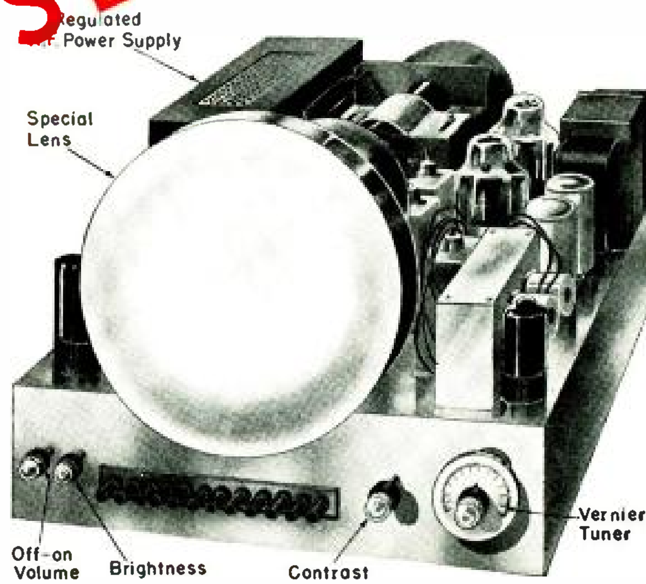


GENERAL CHARACTERISTICS
Number tubes: 28
C-R Tube: 10-inch
Loudspeaker: 12-inch
Video bandwidth: 4.5 mc
Overall gain: See Service Manual
Frequency range: All television channels; standard FM band

BRIDGED-T I. F. AMPLIFIER

Most revolutionary feature of the Model OXOOY is the Bridged-T video i. f. section. This section employs 6J6 dual triodes in the well-known grounded-grid amplifier (the cathode varies in voltage at the signal frequency, and the second grid is grounded). Thus we have the low noise characteristic of the triode, and—due to the grounded grid—the excellent isolation between input and output circuits that characterize the pentode. Stability is even better than that of a pentode stage. Instead of the more common two-coil i. f. transformer between stages, the Bridged-T circuit shown below is used. This provides a wide bandpass of 4.25 mc, and eliminates a number of technical difficulties hitherto experienced with two-coil coupled circuits. Briefly, a straighter-sided curve with less loss of gain is possible with this circuit. A total gain of 55 is realized over the whole video i. f. amplifier.





TUNING SYSTEM

Technicians have reported some instability in the push-button circuits of the OXOOU and OXOOV which tended to drift after some months of use. New-type ceramic capacitors reduce this possibility to a minimum in the OXOOY, and any traces of it are eliminated entirely by a vernier capacitor which may be adjusted by the user to bring in each station perfectly after it is tuned with the pushbutton. This vernier may be used on all channels, though in practice it is likely to be used only to "sharpen up" the weakest stations.

For complete servicing information, mail coupon to:
THE VIDEON CORPORATION
Radioland, U. S. A.

VIDEON CORPORATION
00000 Tele-Boulevard, Radioland, U. S. A.

☐ Please send service data on your Model OXOOY.
☐ Also please send advertising information on Model OXOOY.
☐ I am interested in receiving further information on your models..

Name..

Company Name.....................................

Address...

City........................Zone........State.........

Material for the above ad courtesy Snaider Television, Television Assembly Co., The Hallicrafters Co. and Transvision, Inc.

Why Pick on Radio Technicians?

By LYMAN E. GREENLEE

RECENTLY another wave of "investigations" sponsored by individuals and sundry organizations of various kinds has been supposedly producing statistics to prove conclusively that most radio repairmen are out to "gyp" the public. Two things about these investigations should make all legitimate radio repairmen fighting mad. First, the methods used have been decidedly unfair. Second, why pick on the radioman? What about refrigeration service, auto mechanics, watch repairmen, washing machine servicemen and others who do repairing for the public?

Most of the surveys are based on the planted "fault" in an otherwise normal radio. So the repairman slaves for a couple of hours on some screwy job planted just to test him out. He charges maybe as much as $5.00 for his time and is classed immediately as a thief and chiseler and gyp artist! Maybe a 14-year-old kid *could* fix it in five minutes—if he was lucky, was a smart kid, and *if he knew there was a planted "gimmick."* So could the service technician, IF he were lucky. If he finds the fault immediately in one of the doctored sets and charges 75¢ he is a good guy. Tomorrow he may spend two hours on the same type of set cooked up in a different way. Is he going to charge 75¢ for that two hours of labor?

A fundamental point overlooked or ignored by the unfair survey is: **Is the radioman entitled to pay for his time?** Is he entitled to a fair hourly wage for time spent in checking a set in addition to the actual time spent fixing it? If he is not (and the surveys seem to assume just that) **it's just about time we all quit servicing radios**

We all remember several sets from past experience. One was an a.c.-d.c. midget that could have been fixed in five minutes, *if* you knew just what to do, but it took four or five hours to find the trouble. Acid solder had been used and was causing enough high-resistance leakage to ground to make the receiver go dead in damp weather. Probably some other repairman *had* used acid solder, but that didn't help the matter.

You can seldom charge full price for your time on these tough jobs; but you certainly can't do them "for free" if you want to keep on eating occasionally.

License regulations will not make an honest man out of a dishonest one, and in many cases will make it easier for the chiseler to operate and harder for the honest newcomer to get a start. Check with any service where licensing is required. Radio repairing has always been a pretty tough racket and some of the boys have been driven to practices which are actually unethical though they were not gypping or overcharging. I refer to "installing" imaginary components instead of itemizing the charge for labor, where it belongs. Strange as it may seem, the public has some radiomen educated into believing their labor *isn't* worth anything!

Organizations of repairmen can help clean up the situation wherever and whenever it is necessary. Maybe they could also help to clean up the situation in other fields!

But the best way is to clean up your own situation—to watch your own reputation and improve it by your manner of dealing with the customers. Every repairman should have a standard schedule of charges and an open and aboveboard method of doing business. This will do more than any other one thing to defeat the charges of racketeering hurled against the industry.

1. Be frank and honest with every customer. Tell him what was wrong, what you had to do, and how long it took, whenever such an explanation is necessary or desirable. If it took two hours to locate an obscure fault, say so and justify your charge.

2. **Always make out an itemized bill** listing labor and parts separately plus any special charges such as sales tax. Give the customer a copy **and keep one for your file.** Have established list prices for everything you sell, including your time. Stick to your schedule, but if you make a mistake, admit it *and don't charge the customer for it.*

3. Give a standard guarantee, and if a job goes wrong within the guarantee period, fix it without quibble or question. **Keep accurate records of what was found wrong with each job**, but remember that sometimes it pays to fix a set free even if the customer is wrong.

4. Don't advertise "free" service. There is no such thing, never was and never will be!

5. Avoid repair estimates if possible. They cost you time and money. Handle these situations by saying: "Mrs. Jones, if this job runs more than $5.00, I will call you and give you an estimate." **It takes more of your time to fool with repair estimates than it does to repair radios.**

MANUFACTURERS VERSUS SERVICE TECHNICIANS

(*Continued from page* 50)

WHAT'S THE REMEDY?

We have gone to considerable expense through industry research, surveys and personal interviews, to provide manufacturers with the necessary data and information to remedy the above situation. The answer is simple in principle. To us it is amazing that it has not been done before. In our opinion there is only one way to obtain the good will and confidence of the service technician, *namely by talking to him in the language which he understands* through the proper media—the technical trade press.

We are attaching a sample advertisement designed to sell your product in an intelligent manner to service technicians. The advertisement which we have prepared is merely a suggestion of what should and must be done to get the technicians on your side.

An advertisement of the type shown, when placed in the *technical* trade press BEFORE the new receiver or allied product is introduced to the public, will do wonders for you. The cost is small and wholly out of proportion to the good will of the more than 75,000 service technicians that you will earn with this message. Remember please, that the advertisement should always appear *before* the receiver is introduced to the public through newspaper or magazine advertising.

If you will read the sample advertisement carefully, you will note that it gives all the salient *technical* points of the new product. YOU ARE NOW TAKING THE SERVICE TECHNICIAN INTO YOUR CONFIDENCE. Consequently, you will immediately have over 75,000 experienced technical salesmen rooting for you, instead of openly expressing their ignorance—and even their disapproval of your product—when the prospect asks questions about it. There is no reason why this plan should not be adopted by every manufacturer of radio and television receivers. It is bound to earn big dividends for you and the respect of the service technician. . . . (End of letter).

We have here reproduced for our readers the sample advertisement. No advertisement of this type has ever appeared in the technical press in this country.

We would very much like to have the service technician's reaction to this article. As many of your letters probably will be submitted to the manufacturers. I trust that all of you will find the time to comment fully on the above.

Training For Radio

A training program of real value is possible only when the student possesses the necessary qualifications

By JULES L. HORNUNG*

Jules L. Hornung, well-known author of books on radio communications, was educated at Columbia, Bowdoin, and the Massachusetts Institute of Technology. He is an educator of long standing, having been a radio instructor at New York University from 1929 to 1932 and chief instructor of the radio division of the New York YMCA Trade & Technical Schools from 1916 to 1941. During the war he was Commandant, Naval Training School (Radar) at M.I.T., where he received special commendations from the Chief of Naval Personnel and the Secretary of the Navy, as well as an honorary professorship of electrical engineering from M.I.T. He now holds a commission as commander, USNR.

On the practical side, Mr. Hornung was chief engineer of WGBS from 1926 to 1928. His best known books are *Practical Radio Communication* and *Radio Operating Questions and Answers* (both written in collaboration with Arthur R. Nilson), and his latest work *Radar Primer*. At present he is head of the radio-electronics department, Walter Hervey Junior College, New York City, a YMCA affiliate. He presents here an idea of what the radio school graduate may expect to find after his course is finished, and the requirements for a radio trainee.

WITH all expectations of a high-paying job, John Doe graduates from the Ready Radio & Television School. He is really amazed at his own knowledge of the field! Just six months ago, he had never seen the inside of a radio or television set. . . .

Armed with his diploma, he begins a tour of service shops and manufacturing plants. In the first two places he is turned down cold. At a third place, the owner tells him frankly that he doesn't know enough; at the fourth place, he is hired, only to be fired two weeks later. It is quite natural for John Doe to register bitterness. There is no greater disappointment for the graduate student in any trade than to find that he is not equipped to take a job in the profession he has chosen, or that he cannot live up to the requirements of the job.

The first reaction of John Doe is usually to blast the training program of the school. On this point, he might be right. Following World War II, a horde of radio and television schools opened to take advantage of the GI Bill of Rights. Many of these schools have not survived simply because the various John Does awoke to the sad truth that they had acquired little training and a vast number of promises. Their unsatisfactory training programs have in many cases damaged the quality of their work in radio and television servicing.

However, John Doe might consider the fact that his failure to succeed in radio-electronics may have been due, not to the specialized schooling he has received, but mostly to his own shortcomings. Perhaps he did not study himself and his possibilities prior to entering school. Coupled with the weakness of the Ready School training, the lack of proper self-analysis may be the downfall of John Doe.

In analyzing the progress of a student in a radio-electronics school and later on the job, it has been found that many of the problems encountered are a direct result of failure to consider interests and aptitudes prior to training. If a student is more interested in tinkering with automobiles than radio and electricity, no school in the world can turn him into a successful radio craftsman.

The young man who plans to be a technician and later run his own repair shop should ask himself these questions:

A. Do I have a definite interest or flair for radio-electronics and allied mechanical work?

B. Do I have the background in elementary mathematics and general science to understand properly the elements with which I will be working in electronics?

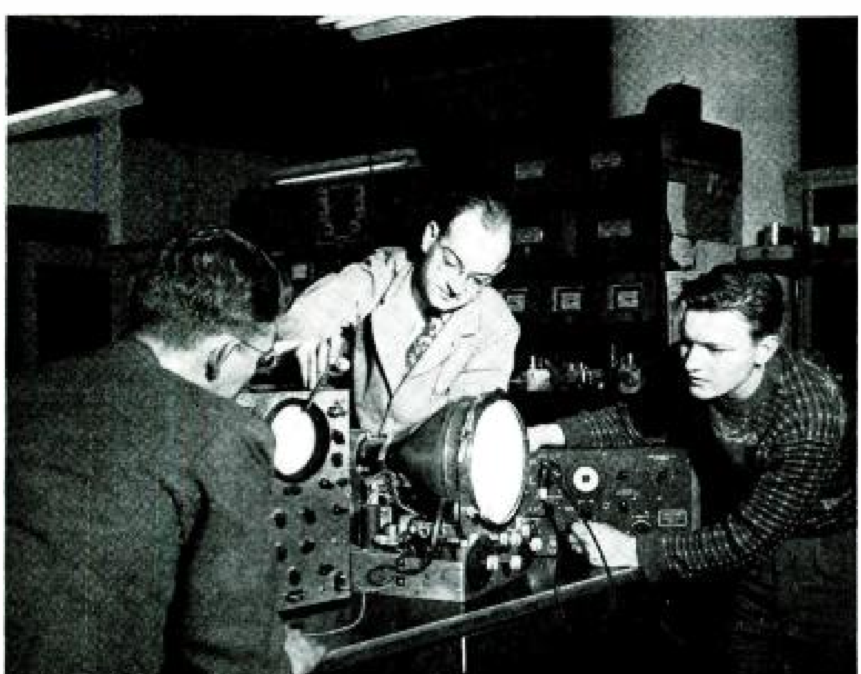
C. Do I have a reasonable degree of mechanical aptitude or "feel" for handling tools?

D. Do I have the personality to cope with the general public?

E. Am I willing to enter the business from the bottom floor, as a learner, upon graduation from school rather than expecting a top-paying job at once?

If the service-technician-to-be cannot

*Chairman, Radio-Electronics Division, Walter Hervey Junior College, New York, N. Y.



Small groups allow individual instruction in complex procedures such as TV-set alignment.

answer these questions affirmatively, he should immediately cross radio-electronics off his list. No amount of training can fit him for a successful and useful career in the servicing end of the business. There are always exceptions to this rule, but in general the above pattern represents a fairly accurate cross section of the requirements.

It will be easy to arrive at the answers to A and E. However, B, C, and D call for some amount of further explanation.

Requirements of B would include the mathematics and general science necessary to obtain a high school diploma. That means at least one year of general mathematics and one year of general science, or its direct equivalent. Many high schools also require a year of algebra. The prospective technician should not tackle the present field without a high school education, or its equivalent in science, physics, and mathematics, at least.

The requirements of C are comparatively easy to analyze. If the student finds himself at loss in making small mechanical repairs at home (light sockets, wiring, etc.), or if he dislikes working with tools, he had better steer away from radio-electronics. The same reasoning would apply if he had considerable trouble figuring out the circuit of the family electric iron.

The answer to D is harder. Personality poses a great problem in all phases of business and industry. However, the technician will many times deal directly with the consumer of his product. That means facing an occasional irate and altogether unreasonable customer. If the technician cannot damper his temper, keep smiling, and admit that he isn't infallible, he will not only antagonize his trade but may eventually lose his business. He must have the patience to cope with people who know little of his repair problems; he must be willing to offer service even at an occasional personal sacrifice of time. If he has the type of personality that will let him treat each customer as a friend and not a dollar-mark, he has little to worry about.

The prospective engineer

For the young man who plans to become an engineer, the same prerequisites hold true but their scope increases tremendously. An engineering student embarking on a career in radio-electronics must have particular capabilities to face the rigid requirements of the field.

To be successful, the engineering student must possess an inherent liking for and aptitude in mathematics, physics, and English. These subjects are the building blocks for a good engineer. One might question the necessity of English, but it must be remembered that an engineer must be able to put his thoughts and ideas into clear and concise written words and to read written explanations.

Perhaps an even more important requirement than the pure academic prerequisites and accomplishments is generally overlooked. How well is the student suited in terms of personal character? He must view his temperament, personality, integrity, ethics-in-essence, and ability to get along with people. These are of vital importance to the employer. They are also qualities which ensure the young engineer the maximum opportunity for success. These factors are of such major importance that many leaders in industry consider academic ability and mechanical accomplishments only a fraction of the engineer's required characteristics.

After the young man has analyzed himself properly and affirmed his desire to enter the field, the next problem lies in the selection of a school. The student interested in servicing would be wise to carefully consider at least six well-known schools before making a decision. *A school is best judged by its reputation within the industry.* If the industry has received an unusually large number of poorly trained students from a certain school, it will not be any secret. The school will be blackballed by the people who are its greatest asset.

The student may obtain information from various sources—a vocational guidance counselor, a Veteran's Administration counselor, or someone already employed in a responsible position in the industry. He should examine the school's curriculum and test its offerings against what he desires to learn.

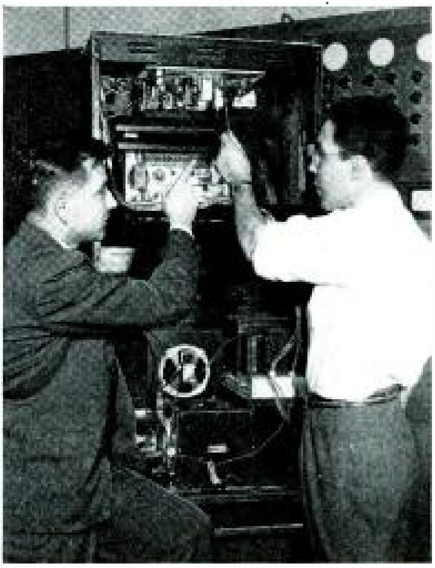
On the engineering level, the student must realize that it will be a long haul, financially and scholastically. Choosing a college which will offer the necessary elements to fit him for a career will not be an easy task. Once again, counseling, reputation within industry, and curriculum of study must be considered at length.

In the selection of the radio-electronics educational program, certain basic factors should be observed. The student might well consider the following before making up his mind:

1. Reputation of school,
2. Curriculum,
3. Admission policies,
4. Cost of training against values to be obtained from it,
5. Reputation of faculty,
6. Guidance and counseling program available,
7. Placement bureau,
8. Absence of mass-production tactics; comparative individuality in instruction.

The would-be engineer's high school background should definitely include algebra, chemistry, physics, and if possible, calculus. In other words, he should purposely load his course electives with as much science and math as he can carry. His college work in these subjects will be increasingly easier in direct comparison to the amount of preparation which he took in high school.

Once the student has entered a reputable institution, the onus lies on the faculty and administration. In the case of the "mismatched" student, it poses a problem which is not easy. When it is clear that the student cannot achieve his goal, it is obligatory for the school to advise that he drop the course. However, there are degrees of mismatch. Some of these can be cleared up by extra effort on the part of the student and the faculty. If the engineering student cannot meet the necessary mathematical requirements because of lack of previous training, he should be coached or advised to undertake separate courses in his work. For the clearly mismatched student there is no better solution than frank advice and ultimate dropping from the rolls of the school.



Photos courtesy YMCA Trade & Technical Schools, New York

Instructor points out final set adjustments.

The greatest test of any training program in radio-electronics and associated fields begins when the student is employed on his first job. This is where all his study and training meet the acid test. If it has been good, the student can cope adequately with the problems his job presents. If it has been bad, he will find himself in the predicament of John Doe.

In choosing a school or program of study, the young man planning to enter the field of radio-electronics must realize that the entire industry is developing at a breath-taking speed. All phases are becoming more complex in mechanical operation, and the demands of industry are increasing daily. It is no longer enough to be able to tinker with a radio or television set; anyone in the field must be able to know how it works, why it works, and what will make it work better. He must be prepared to keep up with new developments in the field and increase his knowledge continuously from year to year. This new era of electronics is one full of demand and great promise. The right young man, properly trained and well qualified, will go far.

Fundamentals of Radio Servicing

Part VI—Reactance, impedance, and phase

By JOHN T. FRYE

WE ARE now nearly ready to splice inductance and capacitance together into that blissful state known as "the tuned circuit." But before the actual wedding takes place, we ought to make sure that the union can withstand any and all strains that may be placed upon it. It is true that we have observed how both an inductance and a capacitance behave under the influence of a direct current, but do we know what they will do when an a.c. voltage starts pushing and tugging at them? Perhaps it would be well to investigate this angle before we bestow our blessing on the marriage.

You cannot penetrate very far into the a.c. woods without having a clear understanding of *phase;* so we may as well get that straight right now. Phase simply means *comparative time of occurrence* as applied to actions, changes, or events. If two things happen together, we say they are *in phase.* If one happens first, we say that it has a *leading phase.* The thing that happens second is said to have a *lagging phase* with respect to the first.

Consider the case of you and your one-and-only doing a dance step. If the feet of both are in phase, her foot moves back at the same instant your foot moves forward. If your foot has a leading phase, it will move forward before hers is out of the way, and you will probably step on her toes and be told you are a poor dancer. If your foot has a lagging phase, she is doing the leading, and you are going to be a henpecked man!

As applied to electricity, phase usually means a comparison between similar changes in two or more different voltages or between a single voltage and its accompanying current. For example, Fig. 1 shows what happens when an a.c. voltage is applied across a pure resistance. Don't be surprised if you don't see it; Fig. 1 has probably balled up more students than any other diagram in the science of radio! It's supposed to show the life history of a cycle of alternating current. In our figure, having chosen the standard 60-cycle current, our base line is laid off in fractions of a 1/60 second. This makes it a time chart, just like the rolls that record the temperature for a day, with a thermometer-controlled pen making a continuous track. Any point on the voltage curve on the chart will tell you just what the voltage is at that instant —the curve is simply a combination of all those instantaneous voltages.

No, alternating current really does not wiggle as the chart might lead you to believe. What happens is that current from the alternator starts to flow through the resistor, starting with very low (zero, to be exact) voltage and current. Both current and voltage rise until, at the end of 1/240 second, we have maximums of 170 volts (dashed line) and 2½ amperes (solid line).

Chief actors—inductor, capacitor, resistor.

(The exact quantities are unimportant; in many radio circuits we have alternating currents of some hundreds of volts at only a few milliamperes, and in some welding circuits there may be hundreds of amperes with only a few volts. In most a.c. diagrams, voltage and current curves are arbitrarily drawn the same height—see Figs. 2 and 3. The only reason we didn't do it here is that the two curves would then be on top of each other, and you couldn't tell them apart. Neither is the frequency important; we have used 60 cycles because it's common, but the story would be equally true at radio frequencies.)

But now—because of the way an alternator is built—our voltage and current start to drop, and at the end of 1/120 second there is no voltage across the resistor and no current flowing through it. Then the current starts to flow through the resistor *in the opposite direction.* Our clever mathematicians represent these volts and amps in the reverse direction by just drawing the voltage and amperage curves in the opposite direction to the first ones. Neat, eh?

Following the chart, we find that voltage and current in this direction again rise to a maximum in 1/240 second from the time they started, and in another 1/240 second are also back to zero. Total time 1/60 second, and we are back at the end of the circle (or cycle—it's the Greek word for circle) and ready to start all over again.

This is all to tell you what you probably don't need to be convinced of— that the voltage across the resistor and the current through it are exactly in phase, and that when the voltage is maximum or minimum, so is the current; and both reverse precisely in step. But when the resistor is replaced by either an inductor or capacitor, this harmonious state of affairs no longer prevails. A *phase shift* takes place, and the current reaches a maximum value at a different time from that at which the voltage is highest. Let us see why.

Fig. 2 shows what happens when an inductance is placed across the output of an a.c. generator. The dashed line shows the voltage applied to the coil. You will recall from our discussion of self-induction (read it again if you don't) that the changing current through the coil produces a counter-e.m.f. (voltage) very nearly equal to the applied voltage but directly opposed to it. This induced voltage is shown by the dotted line. Notice that when the applied voltage is positive (or for a.c. it might be better to say "in one direction") this induced voltage is negative ("in the other direction") and *vice versa.*

Remember that this induced e.m.f. is produced by the expanding or contracting lines of force cutting the turns of the inductor. Further recall (or re-read) that these lines of force are in motion *only when the current is changing value.* Still further, the induced voltage is highest when the movement of the lines of force—and consequently the *rate of change* of current—is fastest. Keeping all of this in mind (yes, I know it's a neat trick), where would you say the rate of change of current on Fig. 2 is the greatest? the least?

The solid line represents the current flow. The rate of change is highest when this line is most nearest vertical; least, when it is horizontal. As you suspected all along—but can now see on the diagram—the rate of current change is least when the current itself is maximum. It is at these maximum-current points that the induced voltage —sustained *only* by a *changing* current —is zero. On the other hand, the *rate of change* is greatest at the point where the current is just starting to reverse its direction or cross the zero line; and this is the point of maximum induced voltage.

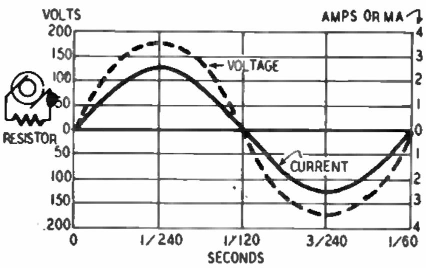


Fig. 1—E and I in a resistance are in phase.

In experimenting with an induction coil, we found that the current reached a steady value a split second *after* the voltage was applied. We can see from our diagram that the current peaks are separated from both the induced and the applied voltage peaks by a quarter of a cycle. Since we know that we must apply the voltage first, we can see that in a pure inductance the current lags the applied voltage by a quarter of a cycle.

The armature of an a.c. generator has to make one complete revolution or turn through 360 degrees to produce one complete cycle of voltage. The angle through which this armature has turned from the starting point is indicated in degrees along the time axis. This is all there is to "degrees," as applied to phase lead or lag or other a.c. terms. It is convenient to divide the cycle (remember, it's a circle) into 360 degrees and refer to fractions of a cycle in degrees instead of saying—as we did, clumsily—1/240 second, etc. Every quarter of a cycle is seen to occupy 90 degrees. Do you see why we say that, *in a pure inductance, changes in current lag changes in applied voltage by 90 electrical degrees?*

Fig. 3 shows what happens when an a.c. generator is connected across a capacitor. The dashed line again represents the value and polarity of the applied e.m.f. with respect to time. As the voltage first starts to rise in the "positive" direction, the electrons are easily pushed onto one of the plates of the capacitor and rush on at their maximum rate, for they encounter little resistance. But as this plate acquires more charge, its voltage rises (note dashed line) and begins to repel the electrons the generator is trying to force upon it. The movement of electrons, which makes up the current in wire circuits, slows down and finally stops when the applied e.m.f. and the electron charge have reached their maximum values (at 90°, or one-quarter of a cycle). Then, as the applied voltage starts to decrease, *the packed electrons begin to flow back into the wire,* against the applied voltage, through the generator, and on to the other plate. They keep right on flowing in increasing number while the applied voltage falls to zero and starts to build up in the opposite direction; but the current again begins to droop as the other plate nears its maximum charge. Thus we see that the current through the circuit is maximum when the applied voltage is minimum and is at its minimum when the applied voltage is highest. Since the electrons have to flow onto the plate of the condenser *before* its voltage can rise, it is easy to see why *the current through a pure capacitance leads the applied e.m.f. by 90 electrical degrees.*

You have noticed that a capacitor, which says a firm "No!" to the passage of d.c. after it has once become charged, seems to murmur a coy "Maybe" or even "Yes" to the knocking of a.c.? While the electrons do not actually pass through the dielectric material, their rushing back and forth through the connecting circuit from one plate to another creates an alternating current in that circuit just as if the capacitor were replaced by a resistor.

We say "resistor" instead of "short circuit," for the capacitor does offer some opposition, depending on its ca-

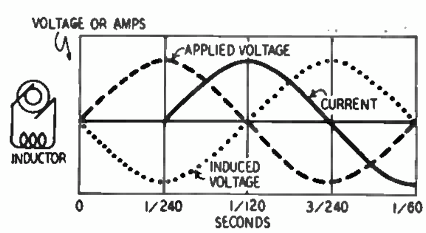


Fig. 2—Phase relations in inductive circuit.

pacitance and the frequency of the applied a.c., to the passage of current. As the capacitance is increased, more electrons must be moved to charge it each time; therefore, the current that is composed of the movement of these electrons is increased just as if the equivalent resistance represented by the capacitor were lowered. If the frequency of the applied voltage is increased, the electrons have to make more trips back and forth between the plates in a given length of time, and more electron trips mean more total current just as if the equivalent resistance were lowered again.

This "equivalent resistance" offered by a capacitor to the passage of a.c. is called *capacitive reactance*, has the symbol X_c, is measured in ohms just like resistance, and for any given capacitor can be found by the formula:

$$X_c = \frac{1}{6.28\ f\ C},$$

in which f is the frequency in cycles, C is the capacitance in *farads*, and 6.28 is 2π (your old friend of grammar-school days, 3.1416). If you want to know the reactance of a 1-μf capacitor at 60 cycles, you simply substitute in the formula, not forgetting to change microfarads to farads. Or if you want to work with microfarads, simply multiply the numerator by a million, thus:

$$X_c = \frac{1{,}000{,}000}{(6.28)\ (60)\ (1)},$$

and you find that the answer is approximately 2,654 ohms.

When you recall that an inductance is stubbornly opposed to any change in the amount of current flowing through it, and also remember that the current in an a.c. circuit is changing almost continuously, it should be easy to see that an inductance, too, is going to offer more than a little opposition to the flow of a.c.

The amount of this opposition increases when either the inductance or the frequency of the applied voltage is increased. Since the induced or opposing voltage increases with the amount of inductance encountered, it is not hard to understand why a greater inductance will offer more opposition to the flow of current. The induced voltage also depends on the speed with which the expanding and contracting lines of force cut the wire; and since an increase in frequency means that the lines have to speed up in order to go through their expanding-contracting routine more often in the same space of time, no great brain is required to grasp why an increase in frequency stirs up more opposition to current flow.

This resistance which an inductance presents to the flow of a.c. is called *inductive reactance*. It has the symbol X_l, is measured in ohms, and is found by the formula:

$$X_l = 6.28\ f\ L,$$

in which f is again the frequency in cycles per second, L is the inductance in henries, and the 6.28 is 2π, the same ancient mathematical pastry we had served up in capacitive reactance. If we want to know the reactance of a 10-henry choke to a 60-cycle voltage, simply substitute in the formula:

$X_l = (2) \times (3.1416) \times (60) \times (10)$.

and we find the answer: just under 3,770 ohms.

To review a little while we catch our breath: *Resistance* is the opposition

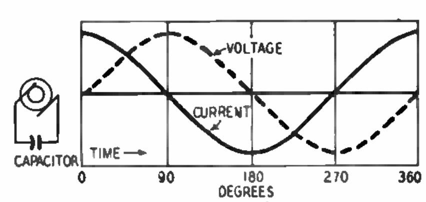


Fig. 3—Current leads in capacitive circuit.

offered to the flow of a steady direct current; *Reactance* is a specialized form of opposition that a.c. runs into. Reactance comes in two flavors: *capacitive or inductive*, according to whether the current leads or lags the voltage. While all three impede the flow of current, they are not at all alike. Resistance uses up power and dissipates it in the form of heat. Reactance transforms electric current into a magnetic field in an inductance or an

electrostatic field in a capacitor for a portion of a cycle and then returns this stored energy as an electric current during the remainder of the cycle. With pure reactance in the circuit—never actually found in practice—the energy is just swapped back and forth from one form to another without any loss of power. In a purely reactive circuit, there is a 90-degree phase shift in one direction or the other from the in-phase condition of a purely resistive circuit. The more resistance we have in comparison to the reactance, the fewer are the degrees of phase shift (the closer together are current and voltage maximums or minimums).

Capacitive and inductive reactances have exactly the opposite effect on phase, and can be combined just like positive and negative numbers. In a circuit containing both, the effective reactance is found simply by subtracting the smaller reactance from the larger and giving it the name of the larger. For example, in a circuit containing 15 ohms of capacitive reactance and 10 ohms of inductive reactance, we just take 10 from 15 and say that the circuit has 5 ohms of capacitive reactance.

In addition to reactance, all actual circuits have some resistance; and we have a special word to describe this total opposition to a.c. That word is *impedance*, represented by the symbol Z, and it means "reactance and resistance." The two are somewhat like fractions and decimals in that you cannot add them directly. You have to extract the square root of the sum of their squares, which gives us the formula for finding impedance:

$$Z = \sqrt{R^2 + (X_c - X_L)^2}.$$

Suppose, for example, we have a circuit containing 4 ohms of resistance, 10 ohms of capacitive reactance, and 7 ohms of inductive reactance (total reactance 10 — 7, or 3 ohms capacitive). Substituting these values in the formula:

$$Z = \sqrt{4^2 + (10 - 7)^2} = \sqrt{16 + 9} = \sqrt{25} = 5 \text{ ohms.}$$

But here it is the end of the chapter, and the union of capacitance and inductance into a tuned circuit—like the marriage of Little Abner and Daisy Mae—has been repeatedly postponed. These nuptials will take place in the very next chapter!

European Report

By Major Ralph W. Hallows

RADIO-ELECTRONICS LONDON CORRESPONDENT

IN Roumania they're talking seriously of loudspeaker reception from a plain crystal set. No tubes, no transistors; in fact no amplification at all. Just a straightforward, common crystal detector of the fixed type, connected on one side to the antenna and on the other to the loudspeaker. When I said talking seriously I meant that no less formidable a publication than the *Bulletin of the Roumanian National Technological Research Institute* has published an article in which Mr. Matei Marinesco gives accounts of both his investigation of the theory of electromagnetic and other reproducing instruments and of the promising results claimed to have been obtained already in his efforts to evolve a practical crystal-detector-loudspeaker receiver.

It all began like this. Feeling that the radio receiver incorporating tubes and needing "juice" either from electric mains or from relatively expensive batteries could never become really popular in its country districts, where there is little money to spare, the Roumanian Radio Company announced a competition, with large money prizes, for genuine "people's receivers". The conditions were, briefly, that sets should contain no tubes, that they should operate loudspeakers and that they should provide a sound intensity of 30 phons in a room with a content of 50 cubic meters for an input of 100 millivolts.

Getting down to the job, Mr. Marinesco decided that the big snag was not the crystal detector, but the loudspeaker. Those which most of us use are, he finds, sadly inefficient devices, since the ratio of power output to power input works out at between 2 and 6%. Devise a loudspeaker with an output-input ratio of 80% or a bit more and the trick should be done. Mr. Marinesco claims to have evolved loudspeakers with efficiencies up to 85% over fairly wide bands of frequencies, in conjunction with which a simple crystal set fulfils most of the conditions laid down for the competition. Well, here's hoping! What with the transistor and the super-efficient loudspeaker, the amplifying tube may have to look to its laurels.

What the televiewer wants

I was very interested in the data produced not long ago by the American firm, Audience Research, Inc., on what Americans want in the way of televisers and in comparing these with the yearnings, the earnings, the likes, and the dislikes of potential televiewers in Britain. There's no doubt at all about what our ordinary man and woman regard as essential in a televiser. First and foremost, they simply won't have any set which gives a picture with an area less than 65 square inches. And that means a 10-inch C-R tube. At one time or another this manufacturer or that has tried to popularize a low-priced set using a 4-inch, 6-inch, or 8-inch C-R tube and the result has invariably been something very like a complete flop. Even if a televiser gives the clearest of images of smaller size than about 65 square inches, the ordinary viewer just won't have it in the house.

Next, our folk won't buy the televiser that does not also reproduce the accompanying sounds. The main reason for this is that few indeed of our domestic radio receivers can tune in the sound channel of the television broadcasts.

Price seems to be a secondary consideration. So long as its cost is not outrageously high, a good televiser sells rather more quickly than its makers can produce it. That is due to some extent to prevailing conditions. We are still on short commons as regards food and our shops (owing to the urgent necessity of exporting all we can in order to pay our way) are still not too well stocked with consumer goods. Hence, there aren't many things on which people can spend what money they have left after paying living expenses and taxes. Televisers can be bought on the installment system and, provided the installments are within their means, people buy them in large quantities.

From the A. R. I. report I see that televiser prices are, on the average, round about the $400 mark in the U.S. (The A. R. I. report is based on U.S. TV prices in effect last fall.—*Editor*) Now, that does surprise me. On ordinary broadcast radios American prices are far below British. A small 4-tube radio receiver costs at least twice as much here as it does in the States. (I'm leaving purchase tax out of consideration, since it varies from time to time and has, in any event, nothing to do with the efficiency or otherwise of mass-production methods). But British prices for televisers—remember I'm speaking of sound-and-vision sets with at least 10-inch C-R tubes—seem to be a great deal less than yours. Were I intending to go out to-morrow to buy a TV receiver of the kind mentioned, I'd find two or three types below the $200 mark and quite a wide selection at under $300. For $750 I could buy a good-looking combination all-wave radio-phonograph-televiser with a 12-inch-diameter cathode-ray viewing tube and all the trimmings.

The war on interference

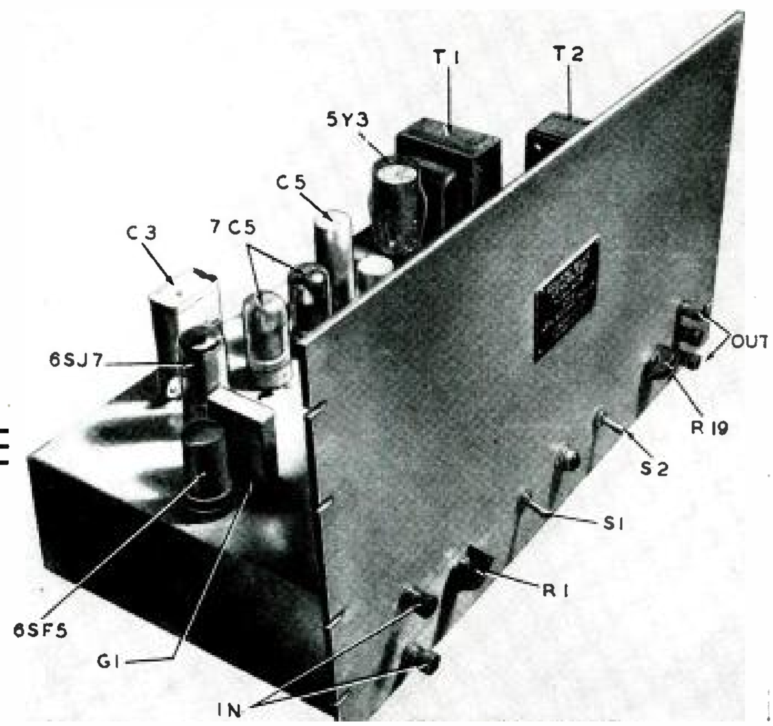
You may recall that I've told you already how we in Britain are tackling the problem of man-made interference with radio and television reception by making it illegal to operate an unsuppressed factory machine, domestic electrical appliance, or automobile. In Switzerland they're dealing with some of the main causes of interference in another way. Switzerland is, in proportion to its size and its population, perhaps the most completely electrified country in the world today. Thanks to its vast resources of waterpower, even small villages and outlying farms have electric mains supplies. No steam locomotive runs on its railways and it has a vast mileage of electric street-car systems. Some of the street cars operate over interurban systems of considerable extent. With cheap electric power available everywhere you can imagine that radio listeners (there are no televiewers yet) complain bitterly of the effects of man-made static. They have to pay for licenses to use radios and they're not a bit pleased when a fine selection of "noises offstage" makes a classical concert sound like a feature program concerning a large boiler factory.

The license fees are collected by the government Posts and Telegraphs Department, which has recently decided to spend a considerable percentage of this income on static suppression at source. To accomplish this will certainly cost a tidy sum, for, to take transport alone, both the railways and the street car systems use overhead conducting wires with spring-loaded sweep contactors on locomotives and cars. At every joint in the overhead wires the travelling contactors are liable to jump, producing sparks and radiation of the kind which shock-excites antennas over a considerable area. The problem is a pretty big one, you'll agree, and the Swiss are to be congratulated on getting down to it in this practical way.

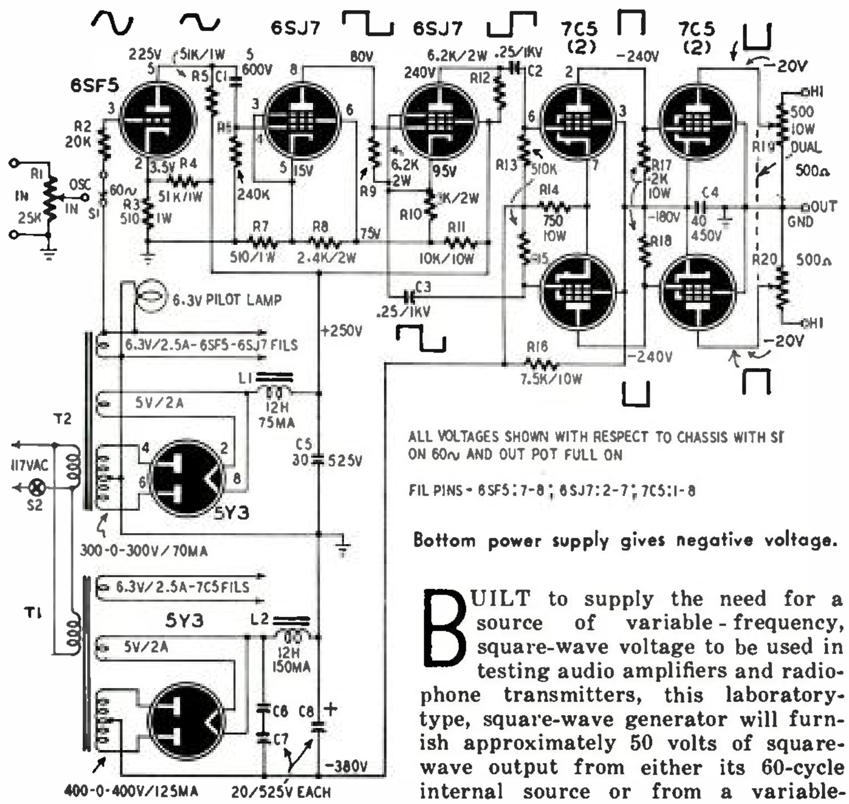
Laboratory Square-Wave Generator

Square waves at frequencies up to 50 kc may be produced with this instrument plus an a.f. generator

By JOHN E. PITTS



Quarter-view photo shows where the principal parts and controls are placed.



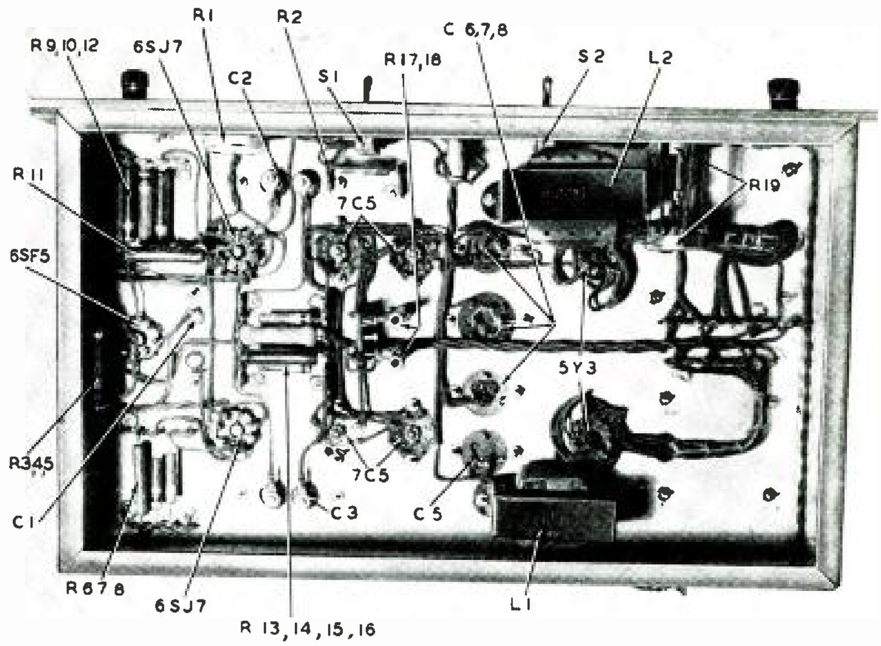
Bottom power supply gives negative voltage.

BUILT to supply the need for a source of variable-frequency, square-wave voltage to be used in testing audio amplifiers and radiophone transmitters, this laboratory-type, square-wave generator will furnish approximately 50 volts of square-wave output from either its 60-cycle internal source or from a variable-frequency audio oscillator which may be coupled to the IN terminals to produce square waves as high as 50 kc. The voltage available from the OUT terminals may be varied by the OUT potentiometer when using 60-cycle input or from the IN or OUT potentiometers, or both, when using an external audio oscillator as the signal source.

The instrument was designed for mounting in a relay rack, but it can readily be modified for portable use by building it in one of the amplifier-type covered chassis.

The generator was built on a 10 x 17-inch chassis with a 10½ x 19-inch panel. It begins with one voltage amplifier, a 6SF5, acting as a partial limiter. The 6SF5 is capacitance-coupled to a 6SJ7—in whose plate circuit the square wave appears. This tube is direct-coupled to another 6SJ7 amplifier, which in turn is capacitance-coupled to push-pull 7C5's, which are direct-coupled to the push-pull 7C5 output stage.

The output of a variable audio oscillator may be connected to the IN terminals and the input to the square-wave generator varied by potentiometer R1 when the input selector switch is thrown to OSC. With the switch thrown to the 60-CYCLE position, the input is connected internally to one of the 6.3-volt filament windings. The input from



The 10 × 17-inch chassis provides plenty of space for the components, allows neat wiring.

either of these two sources goes to the grid of the 6SF5 through R2, a limiting resistor in the tube's grid circuit. This produces partial clipping at the input. The output produces a wave of the shape shown above the 6SF5 plate lead in the schematic diagram.

The 6SF5 output voltage is capacitance-coupled to the first 6SJ7 which further limits and squares off the wave tops. The mutual coupling resistor R9 in the first 6SJ7 plate and second 6SJ7 grid direct couples the two tubes for minimum frequency discrimination. The second 6SJ7 is used as a phase inverter of a modified cathode-follower type to provide the proper drive for a push-pull stage. The phase inverter is capacitance-coupled through C2 and C3 to push-pull 7C5's which are direct-coupled to another pair of push-pull 7C5's in the output stage.

To present a relatively constant voltage drop across the first stage of the direct-coupled 7C5's, the stage is shunted by R16 so the voltage applied to the output stage will not depend wholly on the plate resistance of the driving stage. In order that the output stage may have its plate circuit returned directly to ground potential, the last two stages are operated from a power supply whose positive terminal is grounded, thus putting the grid circuit of the first 7C5's approximately 390 volts negative with respect to the chassis.

A 40-μf capacitor C4 is connected between the output cathodes and ground. It must be mounted on an insulated mounting plate. Since one of the power supplies is operated in an inverted manner, *the cans of capacitors C4, C6, C7, and C8 are all hot with respect to chassis*, and, if exposed, must be adequately protected from accidental contact.

Capacitors C2 and C3 should be *at least* of the voltage rating (1,000) specified, as they have the combined voltages (about 640) of both power supplies and the peak plate voltage of the 6SJ7 cathode follower stage across their terminals.

It was felt best *not* to ground one of the 6.3-volt heater windings, since the cathodes of all the 7C5's are at a high d.c. potential above ground. Were one of the tubes to develop a cathode-to-heater leak with the heater circuit at ground potential, one of the rectifier tubes would be destroyed if the primary fuse should not blow.

One of the photos shows a front quarter view of the completed instrument and the other, an underneath view, shows placement of parts. In the latter photo the input circuit is at the right and the output stage in the middle with all electrolytics and the power supplies toward the left.

Though the frequency response of an amplifier may measure up to snuff, the waveform of the input voltage may not be reproduced accurately in the output. This is due to non-uniform phase shift between stages; different frequencies are shifted by different amounts.

A square wave may be fed to the input of the amplifier. Since it is rich in (odd) harmonics, the output waveform as observed on a scope will be square only if the phase shift in the amplifier is uniform and if the frequency response is wide. It tests both at once.

The instrument has proved itself extremely useful in adjusting and testing various types of amplifiers, and also as the timing base for an electronic switch. The time and money spent in its construction have been more than repaid by the usefulness of the equipment.

SOLDERING PLIERS

Durst Mfg. Co.,
North Hollywood, Calif.

A new method of soldering radio parts is introduced by these pliers. The two arms of the tool are insulated from each other and connected to a low-voltage, high-current transformer. The wires or parts to be joined are held by the pliers, and the foot switch is pressed for an instant. The components and the solder are heated enough by the high current to melt the solder and form a solid joint.

The pliers remain cool at all times as does the work, except at the point of contact. Less solder is used and surrounding parts—capacitor wax, plastic spaghetti, and so on—are not damaged. The pliers may also be used as an ordinary tool, saving time ordinarily needed for changing tools for soldering.

CIRCUIT-BREAKER PLUG

Hopax Electric, Inc.,
New York, N. Y.

Providing protection to electrical devices and to power wiring, this plug contains an interesting circuit breaker. The power cord from an electric motor or other device is connected to it, and it is then inserted in a line socket as is

an ordinary a.c. plug. When the device shorts or overloads and draws too much current, a small lever, which ordinarily rests between the prongs, springs up and pushes the plug out of the socket. The breaker is reset by lifting the lever, pushing it back between the prongs, and re-inserting the plug in the socket.

Designed primarily for fractional-horsepower motors, the unit should be usable for electronic equipment as well. Ratings up to 10 amperes are available.

VERSATILE BINDING POST

Superior Electric Co.,
Bristol, Conn.

The 5-Way binding post is intended for general radio use. It should be especially suitable for test and measuring equipment. Five different methods of connection to it are possible: spade lugs, wire (size up to No. 12) through

the center hole, wire looped around shaft, clip leads (there is enough shaft for this when head is turned to end position), and standard ¾-inch banana plugs.

The hexagonal-shaped head being captive, it cannot get lost. The posts are furnished in red and black, with 30-ampere capacity and a 1,000-working-volt rating.

V.H.F. VOLTMETER

Sylvania Electric Products, Inc.
New York, N. Y.

The Polymeter Type 221 is a vacuum-tube voltmeter with essentially flat response from 20 cycles to 300 mc and usable up to 500 mc. A special subminiature tube used in the r.f. probe provides high input impedance and very low capacitance. Vacuum-tube rectification is used throughout. Six scales give d.c. ranges of 3 and 1,000 volts, which can be multiplied by 10 with a 10-kv accessory probe. A.c. voltage ranges are the same as those for d.c.; r.f. up to 300 volts may be measured. Resistance and current ranges are included.

ANTI-STATIC COMPOUND

Merix Chemical Co.
Chicago, Ill.

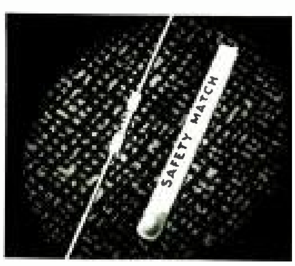
Plastic phonograph records, such as the vinylite long-playing discs, accumulate a static electric charge which attracts dust and lint, making the playback noisy. Anti-Static Compound No. 79 is a liquid chemical which eliminates the charge. Applied in small quantities with a lintless cloth to either side of a vinylite disc, it dries quickly and (as confirmed in tests by the editors) does not harm the record. After application of the liquid, the discs have no apparent charge; they remain unusually clean and noiseless.

The liquid should be applied with a dampened cloth, using a circular motion following the grooves. About 150 records can be treated (one side each) with a 4-ounce bottle of Anti-Static.

MINIATURE RESISTORS

Wilkor Products, Inc.,
Cleveland, Ohio

Carbofilm resistors are available in sizes from ¼ to 1 watt and resistances from 20 ohms to 5 megohms. The smallest resistor is 1/16 inch in diameter and only ⅜ inch long. Insulated units may be had.



TUBULAR TWIN-LEAD

American Phenolic Corp.,
Chicago, Ill.

Amphenol's Twin-Lead was one of the first of the ribbon-type dual transmission lines. The flat line undergoes changes in characteristics, however, when moisture or dirt collects on the surface of the insulating material, since all the plastic lies directly between the

conductors. The new tubular 300-ohm Twin-Lead made especially for reception (like the tubular transmitting lines introduced by the company last year) has the conductors separated mainly by the enclosed air space within the tube. Thus dirt collecting on the outside of the tube does not lie between the conductors and has little effect on electrical characteristics. Additional features are lower wind resistance and greater strength.

PORTABLE METERS

Weston Electrical Instrument Corp.,
Newark 5, N. J.

The model 901 series of a.c. and d.c. voltmeters, ammeters, milliammeters, and microammeters features instruments with easily seen scales and efficient shielding. Unbreakable windows extend the full width of the meter and curve around each side to reduce shadows. The units have hand-calibrated mirror scales and knife-edge pointers. Basic accuracy is within 0.5%. Instruments using rectifiers for reading a.c. have an accuracy of 1.5% of full scale.

CAPACITANCE COMPARATOR

Clippard Instrument Laboratory, Inc.,
Cincinnati, Ohio

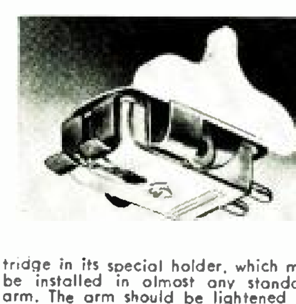
Model PC-4 capacitance comparator is an accurate production-line test instrument designed to aid in selecting

and grading capacitors. It may be used by non-technical personnel to obtain results within 0.2%. The range of the reading is 10 μμf to 1,000 μf. The meter is a 4-inch direct-current D'Arsonval type.

DUAL-POINT PICKUP

Electro-Voice, Inc.,
Buchanan, Mich.

The Twilt is a torque-drive crystal phonograph pickup with two tips on the stylus shank. One has a 1-mil radius for microgroove records and the other 3 mils for standard discs. Either is placed in position by tilting the car-



tridge in its special holder, which may be installed in almost any standard arm. The arm should be lightened for a 6-gram stylus force. Output is 1 volt at 1,000 cycles from the RD90 test record.

SWEEP GENERATOR KIT

Radio Kits Co.,
New York, N. Y.

Model SWS is a kit of parts for building a 2-226-mc test generator for serv-

icing AM, FM, or TV sets. Either AM or FM output is available, with a maximum FM sweep width of 10 mc. Sweep and phasing are variable; a sweep-sync output is provided for an oscilloscope.

ABOVE-CHASSIS RESISTOR

Clarostat Mfg. Co., Inc.
Dover, N. H.

The Standee is a new-type vertical power resistor for above-chassis mounting.

Basically, the Standee comprises a wire winding on Fiberglas core, bent in hairpin form with a mica separator between the legs, placed in a ceramic tube filled with cold-setting inorganic

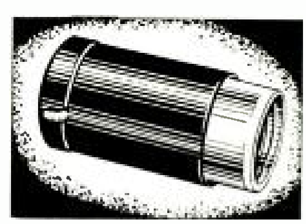
cement, and provided with bottom terminals and mounting bracket. The lugs are locked into the tube wall in addition to being sealed in cement. By having this power resistor mounted above the chassis, the problem of heat dissipation is neatly solved.

Standees are available in the standard 19/32-inch diameter, in heights of 1½, 2, 2½, and 3 inches, with power ratings of 10, 15, 20, and 25 watts, respectively. Maximum resistance values are 6,000, 9,000, 12,000, and 15,000 ohms, respectively.

SCOPE LENS

Allen B. Du Mont Laboratories, Inc.,
Clifton, N. J.

The new Type 2542 oscillographic projection lens, is a two-element, symmetrical, objective lens with a relative aperture of f/3.3 and a focal length of

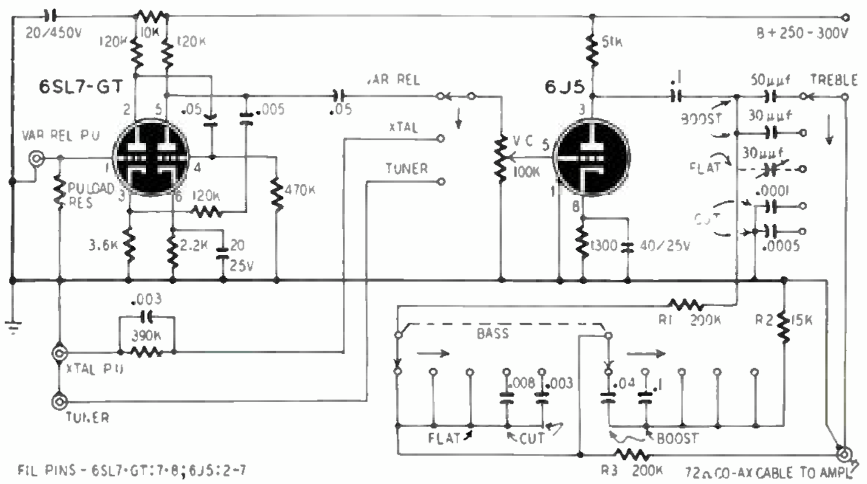


7.7 inches. It projects an oscilloscope pattern up to 3 inches square from 8 to 30 feet, resulting in a picture as large as 12 feet square. Axial light transmission of the system is about 85%.

An advantage of the lens is the simplicity with which it may be mounted on any oscilloscope equipped with a bezel similar to that supplied with Du Mont instruments. (This bezel may be had separately.) The lens is slipped into the bezel and a clamp knob on the lens is rotated. The lens is designed primarily for use in lectures and demonstrations.

AMPLIFIER CONTROL UNIT

Many lovers of high-fidelity recorded music go to considerable trouble and expense to develop reproducing equipment meeting their needs. All too frequently, the joy of owning and operating such equipment is marred by the fact that the amplifier chassis just doesn't harmonize with most household furnishings and is too bulky to be hidden in a convenient bookcase or radio cabinet. An amplifier is seldom mounted in a closet or an attic because the operator wants it close at hand where he can control the volume and tone at will.



This amplifier control unit, with its volume and equalizer controls, is on a 10 x 4 x 2¾-inch chassis that can be mounted in the cabinet of a large record player. Suggested by a circuit in *Radio and Hobbies* (Australia), it consists of a 6SL7-GT compensated preamplifier for variable-reluctance magnetic pickups and a straight 6J5 amplifier designed with a gain of approximately 14 to compensate for the losses in its plate equalizer circuits.

Separate high-level input channels are provided for crystal pickup (with compensation) and radio tuner.

The BASS control is a two-circuit, five-position switch. When this is in the middle position, the low-frequency response of the equalizer is flat. Low, middle, and high frequencies appear across R1 and R2 in series. Approximately $\frac{1}{14}$ of the available voltage is taken from the junction of the two resistors and applied to the 72-ohm co-axial output cable through a 200,000-ohm resistor. The output and input voltage are approximately equal because the loss in the voltage divider compensates for the gain in the 6J5.

When the BASS control is in either of the two BOOST positions, a capacitor is inserted in series with the 15,000-ohm resistor, making the output impedance of the smaller leg of the voltage divider (and therefore the output voltage) increase as the frequency decreases. In either CUT position, a capacitor is inserted in series with R1, increasing the impedance of the larger section of the voltage divider as the frequency decreases. The output voltage available across the smaller section decreases as well.

The TREBLE control is a single-section, five-position wafer switch. When this control is in any BOOST position, a small capacitor shunts the highs directly to the output terminal rather than going through the R1-R2 voltage divider. In the CUT position, highs are attenuated by a 100- or 500-µµf capacitor across the output terminal.

The apparent input capacitance of the 6J5 (due to Miller effect) might be sufficiently high to cause high-frequency losses when the treble control is in the center or flat position. This can be compensated by connecting a 30-µµf air trimmer to the center position and adjusting it to about half capacitance to give just enough high boost to flatten the response curve. The 200,000-ohm resistor R3 prevents interaction between the equalizer sections.

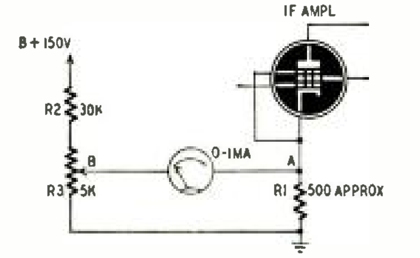
Operating voltages may be taken from the amplifier, from a tuner, or from a small power supply.

The control unit is connected to the amplifier through the shortest possible length of 72-ohm co-axial cable terminated with a 1-megohm resistor. This 1-megohm resistor is the grid resistor or volume control at the input of the amplifier.

LINEAR S-METER

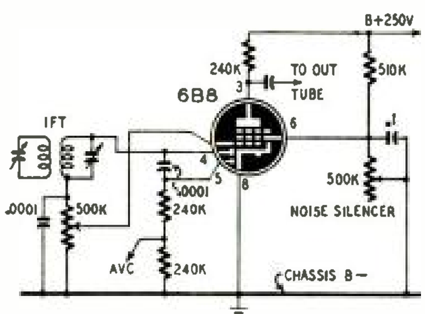
A number of communications receivers lack S-meters, making it practically impossible for the operator to give accurate comparative signal-strength reports. A simple linear S-meter that can be added to almost any superheterodyne receiver having one or more i.f. stages on the a.v.c. line was described in *Short Wave Magazine*.

Only two resistors and a 1-ma meter are required for the S-meter circuit shown. R1 is the normal cathode resistor in a typical i.f. amplifier controlled by a.v.c. voltage. R2 and R3 are the resistors which must be added to the circuit. Measure the voltage drop across R1 when no signal is being received. Adjust the potentiometer so the voltage between its arm and ground is equal to that across R1. When this adjustment is made, the meter will read zero. An incoming signal will reduce the cathode current, thereby decreasing the drop across R1. This makes A negative with respect to B, and some current will flow through the meter, making it read upward. Sensitivity can be controlled by adjusting the arm of the potentiometer. Values on the diagram are for an i.f. stage using a 6K7, 6SK7, or similar tube. The voltage for the bleeder should be taken from a 150-volt point in the receiver.



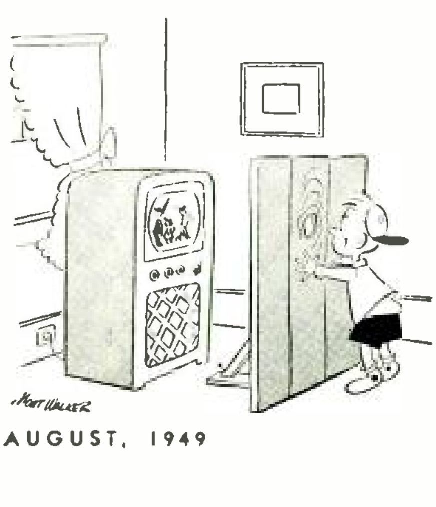
UNUSUAL NOISE LIMITER

The plate current and the maximum signal level of a pentode are controlled by the screen-grid voltage. This action is used in a novel noise limiter described in *The Short Wave Listener* (London). The circuit shows a 6B8 as a combination second detector, a.v.c. source, and first a.f. amplifier.



The screen voltage is supplied by a voltage divider consisting of a 240,000-ohm resistor and a 500,000-ohm potentiometer. This control can be adjusted to a point at which noise cannot exceed the signal level.

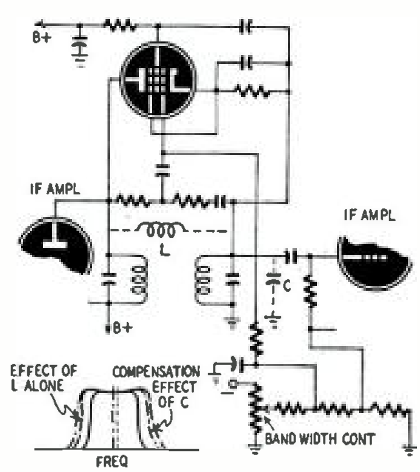
This circuit can be applied to other tubes similar to the 6B8 and to sets with a pentode first a.f. amplifier.



BANDWIDTH CONTROL

Patent No. 2,464,125
Harold G. Fisher and Eugene O. Keizer, Princeton, N. J.
(assigned to Radio Corp. of America)

Described here in connection with an i.f. amplifier, this electronic control varies bandwidth of an amplifier while maintaining a flat response. The reactance tube is connected as an artificial inductance to couple two i.f. stages.



When the bandwidth control (see figure) is set near the grounded end, the gm of the reactance tube is high. This results in a higher I_p for a given E_g and is equivalent to a lower effective L and more loading across this effective inductance. The lower inductance increases the coupling between stages, but the double-hump response does not appear because of the added loading.

The bandwidth variation is also accompanied by a change in mid-frequency. As the value of L is decreased, more of the higher frequencies are passed, making the center frequency higher.

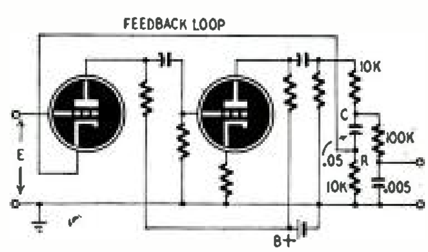
To compensate for this undesired condition, the gm of the following i.f. tube (of which the grid is shown) is also controlled. As the bandwidth potentiometer is set near the grounded end, the gm of the i.f. tube is increased. Due to Miller effect, the input capacitance C of the tube rises thus restoring the mid-band frequency to normal.

As the potentiometer is rotated to the negative terminal, bandwidth is decreased, loading reduced (to maintain the flat response), and the input capacitance to the following tube is less, thus maintaining the center-frequency value.

INTEGRATING CIRCUIT

Patent No. 2,463,553
Raymond C. Olesen, Altadena, Calif.
(assigned to Consolidated Engineering Corp.)

Integrating systems are pulse-shapers used in television receivers and various pulse circuits. In this circuit one is used to convert a voltage proportional to velocity into one that is proportional to amplitude.



Sound or seismic waves are conveniently detected by a magnetic type of instrument which may consist of a fixed electromagnet with a winding at the poles. The coil support is made so heavy that it cannot follow the motion of the electromagnet. Therefore a sound or seismic wave will cause the electromagnet to vibrate, but the coil remains relatively stationary. This results in an induced voltage in the coil. Its output is proportional to the velocity of the wave.

Often the required response must be proportional to the amplitude instead of velocity. An integrating system can also be used for this purpose. The circuit shown here gives faithful integration and far more output thar is possible with the more simple R-C networks.

Because of a relatively large value for R, the output current through capacitor C is nearly E/R, that is, practically independent of frequency and output impedance. The voltage across C is the integrated response of the input voltage. A resistance-capacitance network is added at the output. This makes possible a grounded output which is convenient as well as extending the range of the integration.

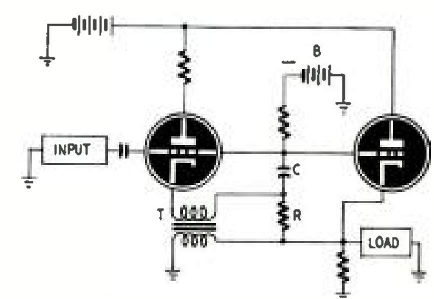
HIGH-EFFICIENCY MULTIVIBRATOR

Patent No. 2,465,249
Cyril E. McClellan, Catonsville, Md.
(assigned to Westinghouse Elec. Corp.)

A conventional multivibrator is a very inefficient device. An input signal causes one tube to conduct and . . . blocks the other. At the end of the short pulse the first tube returns to cutoff, and the second passes current until the next pulse is applied. Usually this interval is much greater than the duration of the signal. The second tube contributes no useful power; yet it conducts almost continuously.

This patented improved multivibrator also uses two tubes, but both conduct only during the existence of the input signal. Then both go back to their normally blocked condition.

Battery B biases both tubes to cutoff. A positive input pulse unblocks the left-hand tube, allowing current to flow through the windings of T to the cathode. As the abrupt flow passes through R, the



voltage drop is transmitted through C to both control grids. This voltage being positive, both tubes are saturated. When this condition is reached, capacitor C begins to charge; a negative charge collects on the grid and both tubes are quickly blocked, ending the cycle until the next signal arrives.

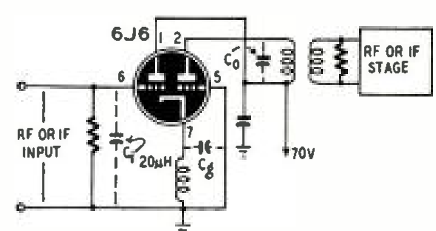
Transformer T accentuates and sharpens the pulse currents.

WIDE-BAND AMPLIFIER

Patent No. 2,460,907
Alfred C. Schroeder, Feasterville, Pa.
(assigned to Radio Corp. of America)

An excellent i.f. or r.f. amplifier, this 6J6 amplifier is especially effective as a first stage because of its low noise factor.

The first triode is a cathode follower. The second triode is used as a grounded grid stage. This arrangement is slightly different from the "cascode" which has the first stage connected with its *cathode* grounded (RADIO-ELECTRONICS, October, 1948). The advantage of the cathode follower is that the input capacitance (C_i in dotted lines) is reduced by feedback. This increases the gain bandwidth product of the amplifier. An r.f. choke couples the stages. This choke, with the distributed cathode-to-ground capacitance (C_g), forms a resonant circuit, thereby improving gain and signal-to-noise ratio. The out-



put transformer, tuned by Co to the center of the passband, is shunted by a resistor to lower its Q for wider band response.

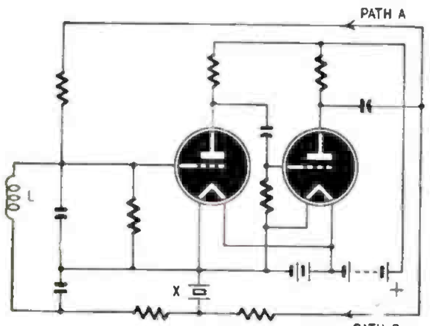
The total amplification is nearly equal to that of a high-gain pentode stage. Stability, band-width, and noise factor are better.

CRYSTAL OSCILLATOR

Patent No. 2,459,842
George T. Royden, S. Orange, N. J.
(assigned to Federal Tel. & Radio Corp.)

In this two-stage oscillator the plate of the second tube feeds back to the tank L along two paths (A and B). A feeds to the first grid. This is positive feedback because the second plate and the first grid are in phase. Path B feeds back voltage which is out of phase. The negative feed-back is made greater to keep the circuit from oscillating.

A crystal is connected in the negative-feedback path to form the equivalent of a high-Q series resonant circuit which bypasses the negative-



feedback voltage to the cathode. Therefore, at the crystal frequency, there is no negative feed-back and the circuit oscillates only at this frequency.

The crystal stabilizes the circuit and compensates for temperature and load variations. Tank L is tuned approximately to the crystal frequency.

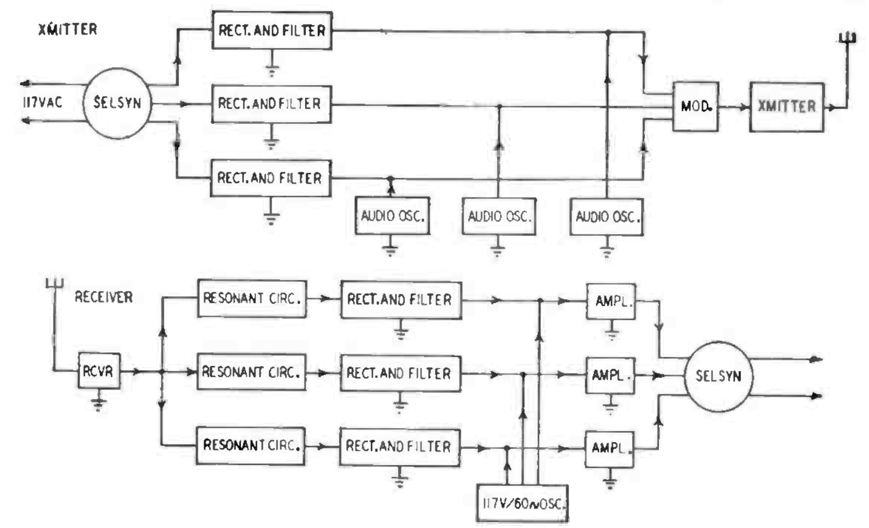
REMOTE-CONTROLLED SELSYN

Patent No. 2,462,117
Ward C. Mikkelsan and Jacob Anthes,
United States Army
(may be used by the U.S. Government without royalty payment)

This is a telemetering system for transmitting data by radio from one Selsyn to another.

The output of any Selsyn is composed of three a.c. voltages, the amplitudes of which vary with the instantaneous position of the stator. In this to the modulator of a standard radiotelephone transmitter.

At the receiving end, the audio signals are separated by resonant circuits and are rectified and filtered. The respective d.c. signals control sepa-



system the Selsyn output voltages are rectified, filtered, and used to control separate audio oscillators. As an example, these may generate 60, 120, and 240 cycles, respectively. The amplitude of each will depend upon the Selsyn output which controls it. Each of these audio voltages is fed

rate outputs from a 60-cycle oscillator. These three a.c. voltages are proportional to those obtained from the Selsyn at the transmitter. After amplification, they are fed to the second Selsyn which will assume the same angular position as the first.

Try This One

INDOOR FM-TV ANTENNA

An adjustable indoor antenna for TV and FM reception can be constructed, as shown in the photographs, from a pair of surplus collapsible antennas and two brass ball-and-socket fittings. Each half of the dipole is made from an antenna adjustable from 10 to 39 inches. The dipole is 81 inches overall when extended; 24 inches when telescoped. It can be adjusted to cover all frequencies between channels 4 and 13. Fully extended, it gives good results on all low-band TV channels.

The antennas used are commonly available on the surplus market. However, if these are not obtainable, collapsible automobile antennas can be used. The ball-and-socket fittings, purchased from a hardware supply house, are similar to those used on some types of casement windows. We used hardwood for the base. Any insulating material will work just as well. The underside of the base should be covered with a layer of felt or fitted with small rubber feet.

EUGENE JACONETTI,
Brooklyn, N. Y.

TV-FM INSTALLATION NOTE

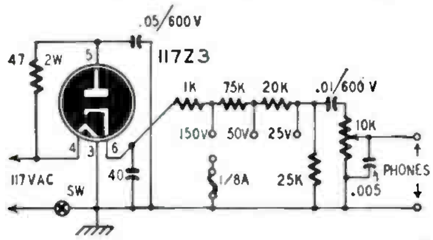
It is not always possible to provide adequate support for ribbon-type transmission line running to FM and TV antennas. Consequently, the line whips in the wind and causes a type of flutter interference that affects TV pictures and weak FM signals. Furthermore, the continued strain on the transmission line is likely to cause it to snap off at the antenna. These troubles are particularly common in installations where the unsupported line crosses wide areas or hangs from the roof of a tall building.

You can minimize trouble from this source by stretching a heavy cord across the area and wrapping the line around it. The cord prevents the line from swaying and takes the strain that would normally be placed on it.

JACK ROTHSTEIN,
Eatontown, N. J.

ELECTROLYTIC TESTER

A foolproof method of testing electrolytic capacitors for hum-dissipating qualities is provided by this circuit. The 117Z3 supplies the necessary power to check electrolytics at voltage ratings of 150, 50, and 25. Because the 40-μf input filter capacitor does not supply sufficient filtering action, a hum will be heard in the phones. To check the electrolytic in question, place it from the correct voltage point to the top of the fuse and plug in the phones. Keep the



volume control all the way down until the electrolytic connections are made or else an annoying click jars your eardrums. If the hum diminishes the capacitor is good; if not, discard it. All ground returns for the electrolytics under test are made through ⅛ ampere fuse for protection against completely shorted capacitors.

JOSEPH SCIORTINO,
Waterbury, Conn.

SOLDERING RIBBON LINE

The polyethylene insulation on ribbon-type transmission line melts easily making it difficult to solder joints. You won't have this trouble if you wrap several layers of Scotch tape around the insulation where the connection is to be made. The tape prevents the insulation from breaking down or creeping.

WM. GAMBONEY,
Chicago, Ill.

TV ANTENNA MATCHING STUB

A 300-ohm TV transmission line can be matched easily with this method. Cut a 48-inch length of 300-ohm line and short one end. Attach the open end to the receiver antenna terminals across the transmission line from the antenna. Roll up the stub until the picture brightens, then hold the coil in place with tape or a rubber band. Run your hand along the antenna lead-in while watching the picture. If the picture is affected while so doing, add or subtract turns from the coiled stub until the picture remains unchanged.

MILTON M. SCHUMAN,
Baltimore, Md.

PISTOL GRIP

Several of the "instant-heating" soldering irons are equipped with pistol grips. Any ordinary iron can be fitted with one.

Cut the grip from a block of wood to fit the hand. Use a coping saw and a file. Curve the top to fit the iron, then bend a strip of light metal to fit over the original handle.

The metal strip and a few bolts are used to clamp the pistol grip to the iron.

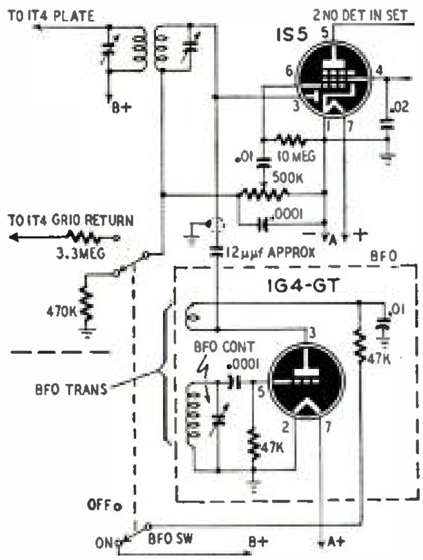
ROBERT L. HYMAN,
Kansas City, Mo.

Question Box inquiries are answered by mail. Those of general interest are printed on this page. A fee of $1.00 is charged for questions requiring no research or schematics. Write for estimates on questions requiring research or schematics. Be sure to give full specifications and details. Due to nominal fees charged for this work, it must be handled as a part-time proposition. Therefore rapid service is impossible. Six to eight weeks is required to draw up answers involving large drawings or research.

ALL-WAVE RECEIVER

? *Do you have a circuit of a small, portable, all-wave superheterodyne receiver suitable for phone and c.w. reception? I do not want one with a loop antenna if it can be avoided.—E.P.J., East Peoria, Ill.*

A. A four-tube, all-wave superhet was used in the battery-powered interference locator described on page 46 of the September, 1947, issue of RADIO-CRAFT. Commercial coils are used in this set that tunes from 560 kc to 18 mc. Additional coils can be added to



increase the tuning range to 36 mc if you desire 10-meter reception. A two-gang, 35-μμf capacitor can be connected across the main tuning capacitor to provide bandspread tuning.

For reliable c.w. reception, a b.f.o. is needed, a circuit of a suitable one being shown. A standard 455-kc b.f.o. transformer can be used, or one can be made from a standard 455-kc i.f. transformer tuned about 8 kc higher or lower than the i.f. in the set. Note that a switch inserted in the a.v.c. line keeps it open when the b.f.o. is turned on. This prevents the b.f.o. from overloading the detector and reducing the sensitivity of the set.

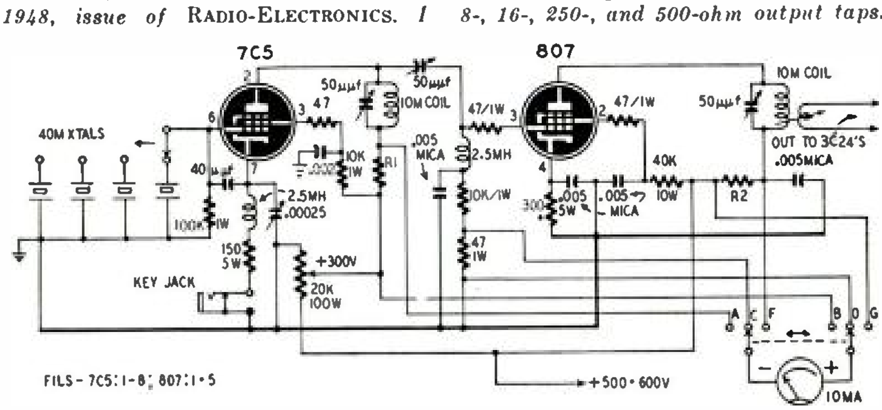
EXCITER FOR TU-10-B FINAL

? *Please print a circuit of an exciter for driving the TU-10-B 10-meter transmitter described in the November, 1948, issue of* RADIO-ELECTRONICS. *I would like to be able to use several 40-meter crystals that I have.—E.W.F., Berkeley, Calif.*

A. More than enough drive for the push-pull 3C24's will be supplied by this exciter. A 10-ma meter is used to meter each stage. R1 and R2 are shunts to increase the range of the meter to 100 and 200 ma, respectively. Connect the meter in series with a 1½-volt battery and a 200-ohm wire-wound rheostat. Adjust the rheostat for full-scale deflection. Connect different lengths of No. 28 or 30 enamel wire across the meter terminals until it reads 1 ma for R1 and 0.5 ma for R2. When the correct lengths of wire have been found, wind them around a pair of 1-watt resistors having a value of 5,000 ohms or more.

Grid current for the 807 should not exceed 4 ma; therefore vary the setting of the 50-μμf variable coupling capacitor so the 807 is not overdriven. Drive for the 3C24's is controlled with the variable link in the exciter output.

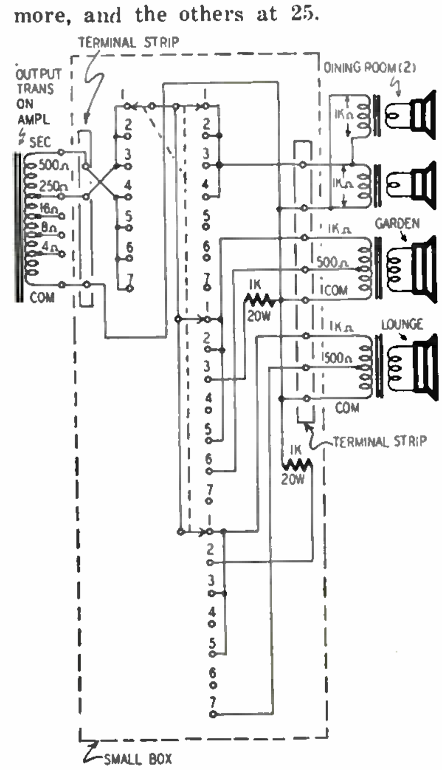
The oscillator plate coil has about six turns of No. 18 enamel wire spaced to 1½ inches on a 1½-inch plug-in form. A 50-watt coil with variable link is used in the plate circuit of the 807. If a coil of this type is not available, then use a center-tapped coil with swinging link in the grid circuit of the final amplifier.



SPEAKER CONTROL SYSTEM

? *A 25-watt amplifier is to be installed in a hotel. Two speakers are to be used in a dining room, one in the lounge, and another in a garden about 600 feet away. Please show a foolproof method of switching the speakers to use any or all of them at will. Both dining-room speakers are to be used simultaneously. The amplifier has 4-, 8-, 16-, 250-, and 500-ohm output taps. What size speakers are required, and how shall I connect them?—J.M., Ely, Minn.*

A. Maintaining a perfect match between the amplifier and speakers at all times, this speaker control system is designed around a heavy-duty, four-gang, seven-position wafer switch. This switch and the two 1,000-ohm resistors can be mounted in a small box that can be attached to the amplifier. The speaker transformers are the line-to-voice coil type with 500- and 1,000-ohm primary taps and with secondary taps to match the impedance of the voice coils. The speakers in the dining room should each be rated at 15 watts or more, and the others at 25.



The switch positions are:

1—All ON;

2—Lounge OFF, garden and dining room ON;

3—Garden OFF, lounge and dining room ON;

4—Dining room ON, garden and lounge OFF;

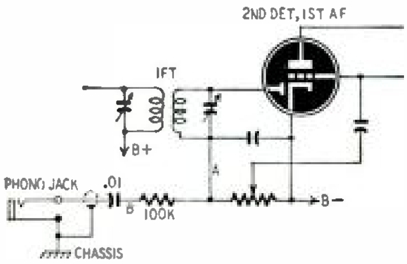
5—Garden and lounge ON, dining room OFF;

6—Garden ON; lounge and dining room OFF;

7—Lounge ON; garden and dining room OFF.

.... PHONO FOR 3-WAY SETS

The conventional method of connecting a record player consists of providing a switch to transfer the high end of the volume control from the i.f. output to the phono jack, while, at the same time, an extra set of contacts grounds the i.f. output. However, when this method is used with three-way portables, hum and oscillation often result, particularly when the receiver is used on a.c. This effect, caused by lengthening of critical leads, is especially bad when the chassis is isolated from the common negative in the a.c. position.



The circuit shown has been used successfully to overcome this difficulty. No switch is used, and the radio is tuned off stations when records are being played. The phono jack is permanently connected to the high end of the volume control through an isolating network, which consists of a 100,000-ohm resistor and a .01-μf capacitor in series. Leads marked A and B should be as short as possible. The output of a crystal pickup is sufficient to override completely interstation noise in these receivers.

As there is seldom sufficient room to mount the phono jack on the chassis, it may be soldered to the end of a short length of insulated shielded wire such as lapel mike cable. This may be folded inside the case when not in use; all metal parts of the jack should then be covered with an insulating material.

K. R. KNOWLTON,
Toronto, Ont.

.... CABINET REPAIR

Plastic radio cabinets are sometimes marred by the chemical action of carbon tetrachloride and other chemicals which fall on them. They can usually be restored to good condition by rubbing the marred surface with fine steel wool soaked in light machine oil.

PETER WALTNER,
Hollywood, Calif.

.... BYPASSING BAD TUBE

Every once in a while a customer brings in a set with a bad r.f. tube for which I have no replacement on hand. When the customer is in a hurry for his receiver, I remove the tube and connect a 500-μμf capacitor between the grid and plate connections on the socket, bypassing the tube. As soon as I can get a replacement tube, of course, I install it and remove the capacitor. Most receivers will work nearly as well without the r.f. tube as with it, at least in my location.

P. J. LOMBARD, JR.
Winnebago, Nebr.

BOOKLET FOR SET OWNERS

POSSIBLY the first effective effort by a manufacturer to cooperate with the service technician in building up good will with his customers appears in the form of a booklet entitled *Your Money's Worth in Good Radio and Television Service*, issued by the Sprague Products Company, North Adams, Mass.

The 5 x 7½-inch pamphlet of 16 pages has a beautifully designed cover which impels the recipient to look inside, where the story of modern radio repair is told in language admirably suited to the intelligent, but nontechnical, set owner. Beginning with an illustration of a 1924 radio, it shows on the next two pages an all-band receiver and a televiser, and describes the high degree of technical skill and large amount of precision equipment needed to maintain and repair such complex modern home electronic equipment.

A picture of a large test bench, captioned "The Modern Service Shop Needs This Sort of Equipment," covers the two center pages; the next two detail and itemize the manuals, test apparatus, tools, and other equipment required in a modern repair shop.

The extensive and thorough training necessary to today's service technician is pointed out clearly, and the low comparative cost of his services is driven home at various points throughout the book.

The booklet, published by Sprague for free distribution by the radio service technician to his customers, is available to any bona-fide service shop through all Sprague distributors. Space is provided on the back cover for the technician's own imprint, thereby making it a valuable advertising piece for the individual service shop. The radioman would be well advised to mail one of these booklets to each of his customers. It is the best piece of publicity he has received since the advent of broadcasting.

FCC AMATEUR PROPOSALS

ON April 21st, the FCC released a document outlining *proposed* amendments to the rules governing amateur radio service. The amendments are based on proposals submitted by the American Radio Relay League, the National Amateur Radio Council, Inc., and the Society of American Radio Amateurs of Washington, D. C.

Radio constructors and experimenters who are not amateur operators will be interested in the proposals for new novice and technician amateur licenses.

To be eligible for a **Novice Class** license, the applicant must be a citizen of the United States whose actual residence, address and proposed station are more than 125 miles air line from the nearest point where amateur radio operators' examinations are given at intervals of not more than 3 months; or who, according to a physician's certificate, has a disability which prevents him from appearing for examination; or a member of the Army, Navy, Air Force, or Coast Guard whose duties make it impossible to appear for examination at the appointed time and place.

The applicant would be granted a Novice Class license upon passing a code test and written examination. The code test will consist of receiving and sending plain language messages in International Morse Code at a speed of not less than 5 words per minute. Each character will be formed at a speed of 7.8 w.p.m. and spacing between then increased so the overall speed is 5 w.p.m. The written examination will include questions on rules and regulations essential to the beginners' operation and elementary radio theory necessary for understanding these rules.

The license would permit the holder to operate c.w. in the 3,700-3,750, 14,100-14,150 28,000-28,500-kc bands and phone and c.w. in the 145-147-mc band. Plate power input to the final amplifier is limited to 75 watts. This license would not be available to holders or former holders of commercial licenses issued on the basis of a technical examination.

The **Technician Class** license would entitle the holder to all amateur privileges in amateur bands above 220 mc. The examination for this license will consist of a code test (same as for Novice Class) and examinations on radiotelephone and radiotelegraph theory and amateur rules and regulations.

The present Class A, B, and C licenses would be called **Advanced Class, General Class,** and **Conditional Class respectively.** Under the proposed amendments, **Advanced Class** (Class A) licenses would not be issued after December 31, 1950. Commencing January 1, 1951, valid **Advanced Class** licenses would be renewed only as **General Class** (Class B) licenses. The present Class A privileges would be granted only to amateurs qualifying for the new proposed **Amateur Extra Class** license. Qualifications for this new license include a 20-w.p.m. code test and a written examination in advanced radiotelephone theory including techniques for operating in bands assigned for narrow-band emissions.

Many amateurs will no doubt welcome adoption of the proposals for limiting bandwidth of phone signals because they will put an end to the splatter and spill-over all too common on some of the bands. Phone operators will gain 50 kc (3,800 to 3,850) in the 75-meter band; provided that the maximum bandwidth does not exceed 3 kc. A 6-kc bandwidth limitation will be effective on the 3,800 to 4.000 and 14,200 to 14,300-kc bands and in the 29,650 to 29,700 kc sector of the 10-meter band. Ten and 20-kc bandwidths are permitted in the 28,500 to 28 650-kc and 50.1 to 54.0-mc bands respectively.

Metal Ladders Dangerous

By W. OTIS FITCHETT*

IN ADDITION to the best-known hazards of using extension ladders, a new one has been added. It is the danger of possible electrocution while using one of those postwar, all-metal extension ladders. Newspaper dispatches recently described the accidental death in New York of two television mechanics when their metal extension ladder came in contact with a 13,200-volt overhead electric transmission wire. This is direct evidence of the extreme danger of handling metal ladders, flagpoles, or awning brackets in the vicinity of exposed electric wires. Metal gutters and downspouts are also rightly approached with suspicion if adjacent to electrical conductors. In the past, most ladder accidents have been due to loose rungs—with the superstitious souls, of course, maintaining that the greatest ladder hazard of all is to walk carelessly under one.

Three kinds of extension ladders are generally available at the present time, aluminum, magnesium, and kiln-dried wood. Since aluminum is an excellent electrical conductor, its danger when used in close proximity to electric power lines will readily be recognized. However, magnesium is a relatively poor conductor of electricity, and might, therefore, be thought safer. Actually, the resistivities of the two metals are as shown below at 20° C, expressed in ohms per cubic centimeter (copper being the standard, its figure is included for comparison):

Copper: 1.724×10^{-6}
Aluminum: 2.828×10^{-6}
Magnesium: 4.6×10^{-6}

From these figures it will be seen that magnesium definitely has not sufficient current-carrying ability to qualify as a useful electric conductor; but, having less than twice the resistivity of aluminum, it can be equally dangerous as a "short-circuiting" material. Electricity rushes to ground at every opportunity, and always seeks the best available conductor when doing so.

A wooden ladder made of, say, dried poplar, has a resistivity in ohms per cubic centimeter of 5×10^{11}. This is approximately 1.8 million trillion times the value listed for aluminum, *in the direction of safety.*

The time of greatest shock danger comes when, while standing on the ground, a human being permits a metal ladder to come into contact with a high-voltage conductor (any voltage above 50 may be considered "high" in this discussion). At such a time the exact specific resistivity of the metal would be of no importance. A thoroughly wet wooden ladder might prove equally hazardous.

Now, here are two rules for ladder safety:

1. *If there are live high-voltage wires around do not use any kind of metal ladder.*

2. *Where wooden ladders are employed, store them indoors so they don't get wet.*

*General Electric Co.

Radio Thirty-Five Years Ago

In Gernsback Publications

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Founder

Modern Electrics	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931
Wireless Association of America	1908

Some of the larger libraries in the country still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

AUGUST 1915 ELECTRICAL EXPERIMENTER

Television, or the Projection of Pictures over a Wire, by H. Winfield Secor
Submarine "Wireless" Signaling
An Interview with Guglielmo Marconi, by Samuel Cohen
How to Build an Electric Writing Machine or Telautograph, by Homer Vanderbilt
A New 100-Watt Wireless Telephone
New 1½-2 KW. Radiophone Arc Generator
Up-to-date Wireless Set of the SS. "*Olympic*"
A Novel Idea for Wireless Telephones
Wireless Relays and Amplifiers
An Improved Electrolytic Detector, by Isaiah Rosin
Anti-Hum Stunt for Radio Receivers, by Urban McMiller
A Cheap but Efficient Carborundum Detector, by H. J. Andrews
A Simple Galena Detector, by Harold Pruden
An Alloy for Radio Crystals, by Lloyd Stratton

Herbert Bayard Swope has joined the *Radio Corporation of America* as adviser and consultant. His work will not require his full time, and he will continue his independent practice with other organizations. Mr. Swope recently resigned from the Columbia Broadcasting System, Inc., of which he had been a director and member of the executive committee, since 1932.

Drs. C. H. Townes and P. Kusch of Columbia University have been appointed consultants to the Microwave Standards Laboratory of the *National Bureau of Standards*, where they will be available for consultation on microwave absorption spectroscopy and atomic beam equipment for use as frequency and time standards.

Fred R. Lack of New York, vice-president of *Western Electric Company*, has been elected president of the *Armed Forces Communications Association*. Mr. Lack, a member of the Industry Advisory Committee for the Armed Services during and since World War II, succeeds Brigadier General David Sarnoff, chairman of the board of *Radio Corporation of America*, who has served as president of the Association since its formation in 1946.

Dr. Elmer C. Larsen has been appointed chief engineer of the Tungsten and Chemical Division of *Sylvania Electric Products, Inc.*, it was announced by John B. Merrill, division manager. Dr. Larsen will assume direction of the engineering and scientific program for improved production and process control of tungsten and chemical products.

J. Gilman Reid has been appointed chief of the Engineering Electronics Laboratory of the *National Bureau of Standards*, where he will direct research on electronic instrumentation, miniaturization, printed-circuit processes and techniques, electronic circuit components, and electronic standards.

One of the senior scientists in the Bureau's radio proximity fuze program during World War II, Mr. Reid has conducted research on electronic instruments, special controls for isotope separation, auxiliary instruments for mass spectrographs, heat transfer, and thermal conductivity.

Paul W. Erickson has been appointed manufacturing superintendent for the Electronics Division of *Sylvania Electric Products, Inc.*, Boston, Mass., according to an announcement by J. J. Sutherland, general manager. He was formerly supervisor of production engineering and then general foreman in charge of microwave tubes.

Leonard C. Welling has joined the JEWEL RADIO AND TELEVISION CORP., New York, as General Sales Manager. Mr. Welling is backed by over 20 years of experience in the industry. Formerly associated with Emerson, Mr. Welling was also one of the principal owners of the French Sonora Radio company in Paris.

Emil J. Maginot has been appointed sales manager in charge of Distributor Sales for the NATIONAL UNION RADIO CORP. of Newark, N. J. as announced by Kenneth C. Meinken, President.

Maginot has served National Union successively as Director of Sales Engineering and Manager of Advertising and Sales Promotion.

Louis G. Pacent, President and Technical Director of Pacent Engineering Corp., New York City, has been appointed a member of the AMERICAN STANDARDS ASSOCIATION'S Sectional Committee on Acoustical Measurements and Terminology, Z24, as a representative of the American Institute of Electrical Engineers. He is a Fellow of the American Institute of Electrical Engineers, a member of its Board of Examiners and the Committee on Communications; Fellow of the Institute of Radio Engineers; Fellow and past President of the Radio Club of America; and Member of the Acoustical Society.

Harry F. Dart, Westinghouse engineer who pioneered in radio, has been elected Chairman of the New York section, INSTITUTE OF RADIO ENGINEERS. Dart, office manager of Westinghouse electronics department, Bloomfield, N. J., was secretary-treasurer of the section in 1943.

Raymond C. Cosgrove, executive vice-president of Avco Manufacturing Corporation, Cincinnati, Ohio, has been elected President of the RADIO MANUFACTURERS ASSOCIATION, succeeding Max F. Balcom, vice-president of Sylvania Electric Products, Inc., Emporium, Pa., who declined to be a candidate for re-election following two years as RMA president.

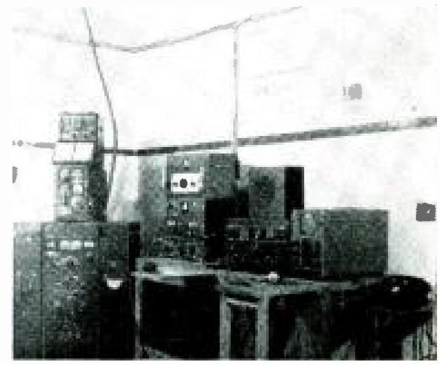
Sidney Jurin has been named sales manager of TELEKING CORP., television Manufacturer. Mr. Jurin was formerly with the Pilot Radio Corporation.

Herb Young's appointment as Sales Manager for the NIELSEN TELEVISION CORP. Norwalk, Connecticut, has been announced by Harold V. Nielsen, President of the firm. He is nationally known throughout the radio appliance and television industry. He was sales manager for the original Majestic Radio, at which time he was Vice-President in charge of sales for the Grigsby-Grunow Company.

INDIA STARTS RADIO CLUBS

Dear Editor:

We are pleased to announce the formation of the Amateur Radio Club of India and the Short-Wave League of India, with headquarters at Mhow in Central India and a QSL bureau at Bombay—P. O. Box No. 6666.



This is the first time in the history of our country that an organization of this kind has been established. The ARCI looks after the interests of all transmitting amateurs, and the SWL takes care of shortwave listeners. A combined journal for members of both organizations, *QRZ*, is published monthly.

The headquarters stations are believed to be the best-equipped amateur stations in Southeast Asia. The calls of the ARCI and SWL stations are VU2ARCI and VU2SWL, respectively. Both are very active on 7, 14, and 28 mc.

We are enclosing a photograph of the main operating position of VU2ARCI.

MAJ. B. M. CHAKRAVARTI, PRESIDENT,
Mhow, Central India

HAM LIKES U.H.F. ARTICLE

Dear Editor:

I have just finished reading Part I of "Microwaves" by C. W. Palmer in the April issue of your magazine. This is a very fine article. By using the elementary and practical approach as Mr. Palmer has done, more interest will be awakened in the u.h.f., especially among hams. Most hams are not graduate engineers; but armed with some knowledge of microwaves and with their natural enthusiasm for radio, they will proceed to make history in the upper bands, just as they have from 200 meters down.

PETER N. SAVESKIE, W2JFE
Staten Island, N. Y.

CENTRAL ORGANIZATION

Dear Editor:

Much had been said and printed pro and con about licensing radio, television and electronics technicians. I think everybody will agree that organization is better than licensing.

The main difficulty is that existing organizations are few and mostly of a local nature. What is needed is a nationwide organization that will be recognized the country over. This will give rural and small-town technicians a chance to benefit from such an organization.

Here is a solution to the problem. What organization has more influence and contact with the service technicians than RADIO-ELECTRONICS? Who has been pioneering on the advantages of organizing more than your publication? You have a golden opportunity to further the industry this way:

Set up an organizing committee and print application blanks in every issue of RADIO-ELECTRONICS, requiring applicants to be engaged in some form of electronic servicing. As soon as there is a sufficient enrollment elect officers and make RADIO-ELECTRONICS official headquarters and communications center. Set the membership dues high enough to cover the cost of expenses, such as wall plaque and membership cards. Print questionnaires regarding fair hourly wages or service charges on the various repair jobs. Have members submit their opinions on the subject and the other problems we are confronted with.

I believe a step like this must be taken to secure a large enough organization to gain recognition from the manufacturers and the public.

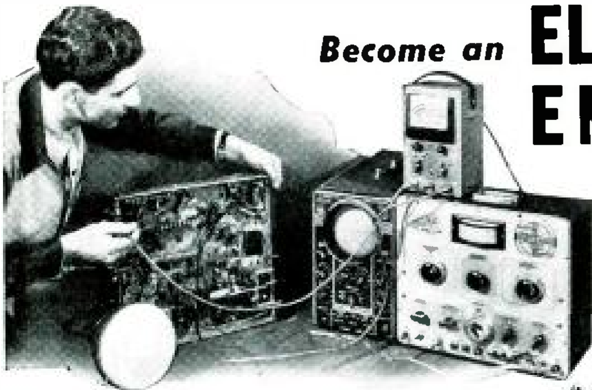
James M. Pelley
(No address given)

We would be inclined to agree with you—had we not already tried it! During 1931 we organized the Official Radio Service Men's Association (ORSMA). Despite considerable work and a large amount of money spent on organization, publicity, certificates, booklets, lapel buttons, etc., it did not prove a success.

But we learned one thing. An organi-

(*Continued on page* 79)

RADIO SCHOOL DIRECTORY



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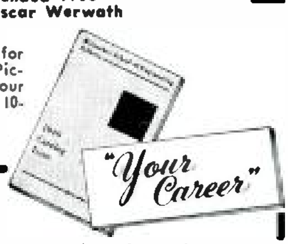

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CITY .... STATE .... ( ) Veteran of World War II

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zation of this type cannot be run by mail order. Seventy-five percent of the radio technician's problems are local. Take the matter of fair charges for instance. It would be impossible to set these on a national scale, for a technician in one area would starve to death on what would be exorbitant charges for another part of the country.

Besides the difference in problems, a national organization finds it hard to keep in contact with the members and promote local activity. As a result, he finds himself merely a name on a membership roll. Such an organization gets no recognition from the manufacturers nor the public. It just adds another wall plaque to the display of certificates, bonds and diplomas many radiomen already have on their walls, and to which few people pay any attention.

The only organization worth anything is one in which radio technicians join to *work together* for objectives they could not easily obtain separately. For this the local organization is ideal. If you have a local problem, talk it over with other local men and form a group of five men or more to *do* something about it. No town is too small. In some Western organizations, members come 30 miles to meetings. Draw a 30-circle around your shop and count the radio technicians inside it!

If your problem is low returns, agree not to cut rates—or each other's throats. If bad publicity, send your chairman and secretary round to the local paper—or broadcast station, if you have one. Do people complain of dishonest repair? Offer the services of your organization to investigate such cases, and to testify where dishonest work is found and the customer is willing to prosecute. Arrange technical meetings with outside talent. Increase business with educational campaigns to the public. Your organization will be a success as long as *you* work and *keep it working.*

Some things cannot be well done by a local organization. Top-notch speakers of the radio field are willing to address you if *a series* of meetings can be arranged. State laws come up—such as the proposed one to permit erection of roof antennas for television—at which the radio technician should be heard. For these purposes the State Federation is perfectly adapted. Both Pennsylvania and New York now have such federations, and other states will follow as radio technicians' organizations increase in number.

A national federation to handle interstate problems will be the next step. Such a national federation—built up the democratic way through local and state associations, and handling only the business they cannot—can be successful.

Remember, no organization can "do something for you," but *you can often do more for yourself through an organization than without it.* We hope to hear in your next letter that you and your colleagues have formed a local Electronic Technicians Association.—*Editor*

UNITED'S SUMMER VALUES!!!!

BC-454 RECEIVER. 3 to 6 Mc. Like new—$4.50.

BC-458 TRANSMITTER. 5.3 to 7 Mc. Used, good condition—$7.95.

274-N TRANSMITTER RACKS. Single (FT-234-A). Double (FT-226A) New, either type—89c.

ARR-1 RECEIVER. A beautifully built T.R.F. job. in the 234 to 258 Mc. band. A "natural" for conversion to 1¼ meters!!!! Excellent condition, with tubes and antenna relay box. Approx. shpg. wt. 8 lbs.—$7.95.

V.H.F. TRANS.-REC. Similar to BC-966 I.F.F. 14 tubes. with dynamotor, gear train, relays and many other useful parts. Operates in the vicinity of 200 Mc. Shpg. wt. approx. 40 Lbs. Express only. Like new—$9.75.

BC-702A RADAR TRANSMITTER. Airborne. Uses 2—R.E.L. #7 tubes in coaxial line R.F. system. 4—2X2 rectifiers in power supply. For 115 V. @ 400 Cyc. Exceptional experimenters item or parts buy! Shpg. wt. approx. 60 Lbs. Express only. New—$12.95. Used. good condition—$9.95.

ASB-5 RADAR TRANSMITTER. Navy. Operates in the 500 Mc. region. Uses 4 type 15-E tubes in P.P. parallel long line R.F. 1-15R Rectifier. Completely shielded in black wrinkled case. High quality parts. 115 V. 800 Cyc. Shpg. wt. approx. 40 Lbs. Express only. Like New—$12.50.

RELAY SELECTOR UNIT. BC-685A. Consists of two individual band-pass filters. 450 cycles and 700 cycles. each uses 3 25L6GT and 1—12H6 tubes. Components include 14 telephone type relays. 200 and 500 ohm coils. one 25 position 4 circuit rotary relay with 12 ohm coil. band-pass transformers. networks. resistors. condensers. etc., etc. Panel controls are missing. Heavy gauge chassis and panel. size: 8¾" X 11¾" X 19". Metal hood encloses entire unit. Shpg. wt. approx. 55 Lbs. Express only. Like new. less tubes. including diagram—$14.95.

TRANSCEIVER TRANSFORMERS. Input for single button mike and single plate, to single grid. Shielded. Lug terminals. New—79c.

BK-22 ROTARY RELAYS. As used with 269 series compass units. Like new condition—$1.95.

M-299 MICROPHONE ADAPTER, for SCR-522—79c.

VOLUME CONTROL ASSORTMENT. A selection of various types of carbon and wirewound controls. All new and clean. A SUPER VALUE!!!! DON'T MISS IT!!!! 15 for 98c.

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40 + 40 Mfd. 250 V.D.C. Round upright can—55c.

1 Mfd. 1000 V.D.C. Small Rect. can. 6 for $1.00.

2 Mfd. 600 V.D.C. Round can. 6 for $1.00.

500 Mfd. 200 V.D.C. Sealed round can. with mounting bracket—$1.05.

OUNCER TRANSFORMER W-226262-4

AF Output. Pri. Impedance: 10,000 Ohms. Sec. Impedance: 4000 Ohms, tapped at 250 Ohms. Metal can: 1⅞" Lg. X 1" O.D. Overall. 10% at 75 Mw. 400 Cyc. 20% at 75 Mw. @ 250 Cyc. Response: 250 to 2500 Cyc. ± 3 DB Glass sealed. New—95c. ea.

OUNCER TRANSFORMER #7254502

Pri. Impedance: 5000 Ohms. Sec. Impedance: 250 Ohms. Size: 1⅜" Lg. X 1" Overall. Diagram on case. Hermatically sealed. New—89c. ea.

POWER AMPLIFIER AND POWER SUPPLY

For console radio-phono combination. Tubes: 1—6SQ7; 1—6J5; P.P. 6V6; 1—5Y3 or 5Z4 Rect. 12 Watts output. Power supply delivers 350 V.D.C. at 150 Ma. Size: 9" X 7". 6-8 Ohms to spkr. All outlets built-in. for phono motor, pick-up, speaker and input. Beautifully built. Brand new. Less tubes. Shpg. Wt. Approx 17 Lbs. Express only. A GREAT BUY!! Only $7.95.

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Only a few of these popular sets are left at this attractive price. Our units are clean and in good overall condition. DON'T WAIT!! ORDER NOW!! Shpg. Wt. Approx. 60 Lbs. Express only. With tubes. $39.95.

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Resistors. Assorted Values.

No. 1 Carbon. Non-Ins. ¼W. to 2W. 100 for 65c.

No. 2 Carbon. Ins. ¼ W. to 2 W. 100 for $1.69.

No. 3 W.W. Enameled 5 W. to 50 W. 25 for $1.95.

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No. 4 Paper Tube. .0003 Mfd. to .1 Mfd. 100 for $1.95.

No. 5 Oil paper. .002 Mfd. to 1 Mfd. 50 for $2.19.

No. 6 Auto. Gen. and Distr. types. 50 for $1.69.

No. 7 Mica, ins. 37 Mmf. to .1 Mfd. 100 for $1.95.

No. 8 Mica Xmtg. .0002 Mfd. to .01 Mfd. 10 for $1.19.

No. 9 Ceramics. 1.0 to 1000 Mmf. 100 for $1.95.

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No. 12 Air Pad. All types. Ceramic ins. 10 for $1.19.

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No. 16 4 to 8 Pin, inc. min. 25 ass't 89c.

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No. 21 Studs, Spacers, Feed-thrus, etc. 50 for $1.79.

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- (a) Gruen, 0-150, $1.49.
- (b) Wstghse., 2 scales 0-3.5. 0-140, $1.85.

Amps., D.C.
- (c) Gruen, 0-1.5, $1.59.
- (d) G.E., F.S.—5 Ma. 0-50 scale. Less Sht., $1.49.
- (e) Trip. F.S.—10 Ma. 0-50 scale. $1.49.

Amps. R.F.
- (f) G.E. 0-6 With Thermocouple. $1.69.
- (g) G.E. 0-8 With Thermocouple, $1.69.

Milliamps.
- (h) Weston, #507. F.S.—1.2 D.C. 0-100 scale, $1.69.
- (i) Readrite, sq. 0-10 Volts DC. Black Fin., $0.59.

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S-17. 115 V. 10 Amps. Set at 275 degrees. ⅝" D. X 4¼" L. Asbestos covered shielded leads. Variable from —100° to +400° F. at 90° per turn. New 95c.
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THE A.R.R.L. ANTENNA BOOK (5th Edition—1949), by the Headquarters Staff of the American Radio Relay League. Published by The American Radio Relay League, Inc., West Hartford, Conn. 6¼ x 9¼ inches, 266 pages plus index and catalog section. Price $1.00.

Though written especially for radio amateurs, this edition can be considered a textbook on antennas and be used by students, experimenters, and professional engineers.

Its first five chapters are devoted entirely to antenna theory and design problems, and sufficient data is provided to permit the reader to design an antenna to his own specifications. Chapters six through ten give full details on constructing specific types of antennas for the various amateur bands. By following the directions in these chapters, the reader can erect many different antenna systems without resorting to the design data in the foregoing chapters.

The remaining chapters cover the mechanics of antennas and include details on constructing and raising masts, rotary beam mechanisms, and orienting antennas.—R.F.S.

AUTOMATIC RECORD CHANGER SERVICE MANUAL, VOL. 2, published by Howard W. Sams, Inc., Indianapolis, Ind. 8½ x 11 inches. Price $6.75.

This manual describes 45 record changers and magnetic recorders, and a certificate accompanying the book entitles the buyer to a supplement on the RCA 45-r.p.m. unit when it is issued. The data on each changer or recorder includes operating instructions, a detailed explantion of how it works, lubricating procedure, and a list of usual troubles and their solutions. As in all the Photofact publications, photos and drawings are plentiful. In this manual, each mechanism is pictured at least once in operating position; and at least two under-chassis photos, with numbered arrows for every part, are furnished. An exploded-view drawing shows in detail how each unit is constructed. Parts lists are furnished.—*R.H.D.*

INTRODUCTORY RADIO THEORY AND SERVICING by H. J. Hicks. Published by McGraw-Hill Book Co., Inc., New York. 6¼ x 9¼ inches, 393 pages. Price $4.

No electronic knowledge on the part of the reader, nor any mathematical training other than the ability to add, subtract, multiply, divide, and square is assumed by this text.

As an introduction to radio—and that is the expressed purpose, according to the title—it turns in a creditable job. The explanations are certainly easy to follow, as far as they go. There are very many diagrams of practical circuits and a large quantity of do-it projects. Servicing is definitely stressed, the author pointing out possible troubles at every opportunity. Separate chapters on FM and television are provided.

All in all, a good introduction for the novice—easy to read and as informative as befits its purpose—a well calculated encourager for more advanced study.—*R.H.D.*

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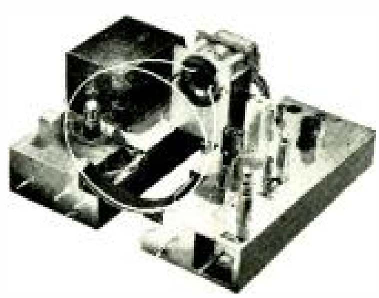

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