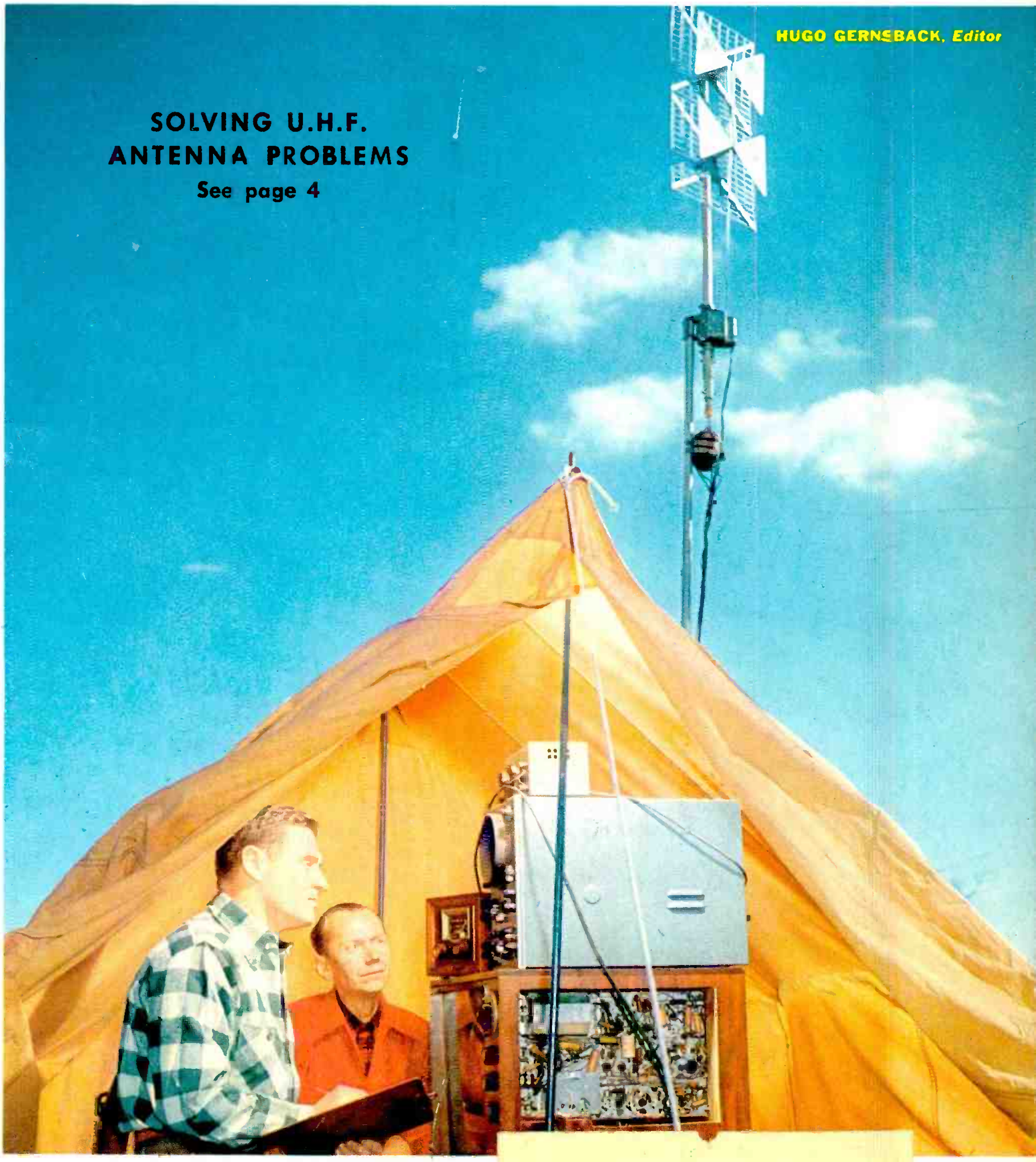
# RADIO-ELECTRONICS

APRIL 1953

LATEST IN TELEVISION • SERVICING • AUDIO




30¢

U. S. and CANADA

*In this issue:* **Long-Distanc**

**TV Signal Tracing •** **-D.C.**

# You'll reap a harvest of sales...

## with these RCA Radio Battery Sales Aids

### RCA Radio Battery Tester and Tester Display Unit

With this RCA Battery Tester displayed on your sales counter, you'll cultivate and close *more* sales of RCA Batteries. You can demonstrate, on a plainly marked scale, the actual playing condition of popular types of radio batteries.

The specially designed Battery Tester WV-37A comes straight from the famous line of RCA Test Equipment.

*Ask your local RCA Radio Battery Distributor how you can obtain the Radio Battery Tester and Counter Display Unit at an amazingly low cost, with your RCA Battery purchases.*


### Counter Merchandiser (3F439)


You'll see plenty of sales action with this RCA Radio Battery point-of-purchase merchandiser on your counter. Three-tier, step-back shelves for battery stock and forceful sales messages remind portable-radio owners to buy batteries—now. Sturdily constructed of steel wire reinforced to support more than 50 pounds of batteries.

### Floor Stand (3F438)

Put this self-selling and supermarket-type floor stand to work on your sales floor and watch RCA Radio Battery sales zoom. It's a self-contained sales department that occupies only 18 inches x 18 inches of floor space, stands 44 inches high. Three-tier, step-back shelves and two lower shelves display batteries and suggest impulse purchases to prospective customers. Constructed of sturdy steel wire reinforced for extra strength.


### Window Display (3F443)


This modern window display unit with hanging sign will tell sidewalk traffic your store is the headquarters for RCA Radio Batteries. Display it in your window and watch radio battery and portable radio sales grow. Size 15 inches wide x 10 inches deep.

### Repeat-Business Stamp and Pad (3F413)

Stamp your name and address on all radio batteries you sell. It will remind customers to come to your store again for radio battery replacements and service. Three-line stamp.

See your local RCA Battery Distributor for the battery line and the battery sales aids that are *geared to radio trade distribution*

**RADIO CORPORATION of AMERICA**

**RADIO BATTERIES** **HARRISON, N. J.**

# TRANSOCEANIC TELEVISION

***. . . Intercontinental TV programs are feasible . . .***

**By HUGO GERNSBACK**

DURING the past year we have heard from time to time about various intercontinental television projects. The idea is not new; indeed when television was in its infancy, Baird, as early as 1928, succeeded a number of times in bridging the ocean between England and the U. S.

It is true that Baird used low radio frequencies to achieve this; nevertheless, he proved that television *could* span distances over 3,000 miles. Of course in those days we had no cathode-ray TV—all transmitters and receivers used the rotating Nipkow disc as a scanner. Nor were the transatlantic transmissions accompanied by simultaneous sound.

Present-day TV transmissions require much higher frequencies, which limit the transmission range. To use these for transoceanic purposes, it is necessary to build many relay stations and skip from island to island—if possible—to reach our distant destination. Technically, this is feasible today. To cross the Atlantic, relay points can be established along the east coast of the North American continent; then jump to Greenland, thence via a chain of other islands to the Northernmost point of Scotland. This completes the chain. A similar arrangement could be worked out in the Pacific via Alaska and the Aleutian Islands, thence to Japan and the Asiatic mainland.

Other more expensive means of spanning the oceans would be via man-made floating, but moored, steel caissons, or "iron islands," carrying the relay towers. We also could use coaxial cables under the ocean. Both of these methods today seem impractical, mainly on account of the very high cost.

There remains another method. Recent researches indicate that long-distance reception of v.h.f. signals is possible without anything more spectacular than high power and directional antenna equipment. Reception at the Washington National Bureau of Standards from Cedar Rapids, Iowa, a distance of 775 miles, was consistent though very weak. It seems that here we have to do with a little-understood upper atmospheric, ionic layer effect. It would seem possible that using new and special antennas and other equipment, reliable long distance TV transmissions could be achieved in the future.

Let us now consider transocean television from an entirely different viewpoint. Let us assume in advance that all technical difficulties have been overcome. Let us also suppose that the economics of the physical transmission have been solved satisfactorily.

Now comes the crux of the problem: *Who will pay for the personnel in charge, cost of the programs, day after day, year after year?* Will these expenses be met by sponsors? That seems hardly likely if you but consider the language obstacle. Admittedly, U. S. programs in English, received in Great Britain would work out satisfactorily. Likewise British programs received in U. S. would no doubt be more than welcome. But again who would bear the program cost?

Evidently the only sensible arrangement would be that most of such programs would of necessity have to be paid for by the various participating governments. These would then be goodwill programs in the main, aimed primarily to promote better understanding between nations. In this respect, International Television is certainly more than worthwhile.

For a number of obvious reasons, such international programs must remain a long-term project—it may be a great many years before even a modest exchange of such programs can become a reality. To begin with, only the U. S. at present has a population-wide television system—over 20 million receivers. By 1960 there will be over 50 million sets, enough to blanket the country effectively. Great Britain at present has a mere 1½ million TV receivers—while the rest of the world together has probably less than 2 million receivers.

It is almost certain that by 1960 the entire world—outside the U. S.—will still have considerably less than 10 million television receivers. Consequently, however much television is talked about in other countries, the fact remains that the U. S. could not hope to bring our programs to several hundred million people of the world for a long time to come.

Yet, it *is* possible to bring such programs to a vast foreign audience by using theater-type television screens, enabling thousands of persons to witness a single program simultaneously. But again we must consider the high cost of such an undertaking. Who would pay for it? Most governments probably might not. Should the U. S. finance such a world-wide project? Would it help in the long run to secure World peace? We do not profess to know the answer—maybe it might be an excellent investment.

International television programs of the future must also cope with the language problems. It is unthinkable to broadcast TV programs *in English* to such countries as France, Germany, Italy, and Spain. Nor would it be realistic to export such programs in foreign languages from a single center in the U. S.

The ideal method naturally would be an electronic language translator. But we must doubt if such a machine can ever be perfected. The voices of no two people are alike. There are vast differences in pitch, overtones, timbre, etc. Then, few people pronounce the same words alike. All this would help to confuse any machine that we could think up today.

The best workable method probably is simultaneous translation by special linguists, expert in such an endeavor. This system has worked exceedingly well at the United Nations, where all talks in any given language are translated with such rapidity that the translator is rarely more than 3 seconds behind the speaker.

In practice, the English sound part of a TV program arriving from the U. S. in France would *not* be broadcast. Instead, the expert French linguist will listen to the sound over his headphones. As fast as the U. S. sound comes in, he translates it and speaks into the microphone before him; his voice—in French—is now combined with the video part of the program and broadcast to the French audience.

*Performance data and characteristics on several popular commercial forms of*

# UHF ANTENNAS and TRANSMISSION LINES

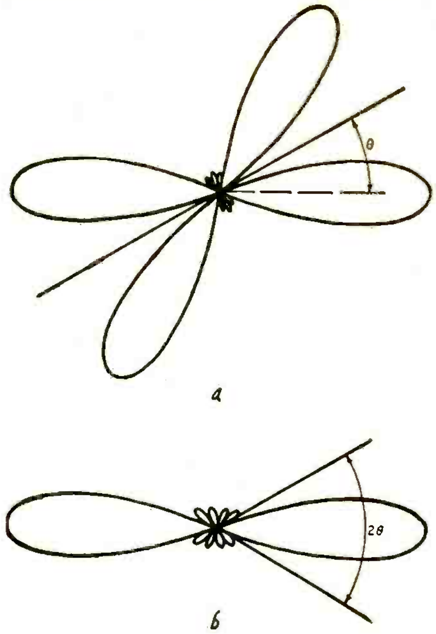



Fig. 1—(a) Directivity pattern of long-wire antenna. (b) The bidirectional directivity pattern when two long-wire antennas are combined to form a V.

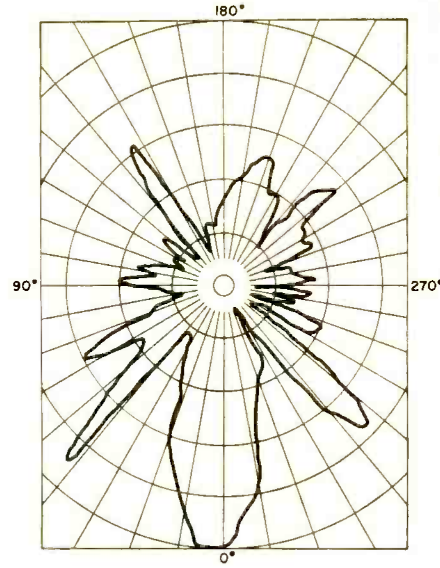



Fig. 3—Directivity pattern of double-V antenna. Note the strong forward lobe, and the relatively narrow minor lobes at intervals of approximately 45°.

**By JOE ROCHE***

U.H.F. antenna installation may be new to most of us, but it's an old story to a picked group of Du Mont engineers and technicians. Long before the end of the freeze they were assigned the job of finding the answers to u.h.f. installation problems. This article describes the antennas and transmission lines that gave the best results in their tests.

U.h.f. antennas fall into two categories: dual-band v.h.f.-u.h.f. types, and those designed to cover only the u.h.f. channels. The ideal antenna for home receivers would be an all-channel unit providing high gain and good directivity in both the v.h.f. and u.h.f. bands. As might be expected, no such antenna has yet been found; however, several types have been developed which have sufficient gain on both bands to meet most requirements.

These antennas are called the "double V," the "stacked V," and the "trombone." They are all based on the familiar V-antenna design shown in Fig. 1. A single-wire antenna more than one-half wavelength long has the directional pattern shown at *a*. When two such long wires are arranged in a V which encloses an angle equal to twice angle $\theta$, the directivity pattern shown in Fig. 1-b is obtained. The V antenna is bidirectional, with maximum gain along the line bisecting the angle formed by the legs of the V. The angle which gives maximum gain and directivity is determined by the lengths of the legs and the operating frequency. When the V is used as a broad-band antenna, a compromise between the angles giving maximum gain at either end of the range over which the antenna is used is selected.

### The double-V antenna

Increased gain and directivity can be obtained by combining two V antennas to form an array, as shown in Fig. 2. Placing one V an *odd number of quarter-waves* behind the other, and exciting them 90 degrees out of phase, gives a unidirectional pattern with maximum sensitivity in the direction of the open ends of the V's. See Fig. 3. This configuration is known as the double V.

The double V is sturdy, light, and easy to assemble and mount. It has sufficient gain on both the u.h.f. and v.h.f. bands to give good results in strong- and medium-signal television areas.

As mentioned previously, the gain and directivity of V antennas are determined to some extent by the angle between the legs. The antenna shown in Fig. 2 has provisions for varying the enclosed angle. Experiment showed that an angle of approximately 60 degrees gives the best results on both the v.h.f. and u.h.f. bands. Increasing the angle to 90 degrees gives better results on v.h.f., but the gain and directivity on u.h.f. channels suffers. Reducing the angle to 45 degrees has the opposite effect. It increases the u.h.f. gain at the expense of v.h.f. performance. The angle actually used is not too critical;

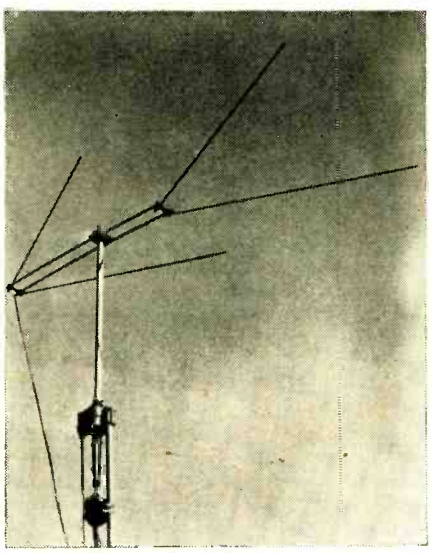


Fig. 2—A commercial double-V antenna.

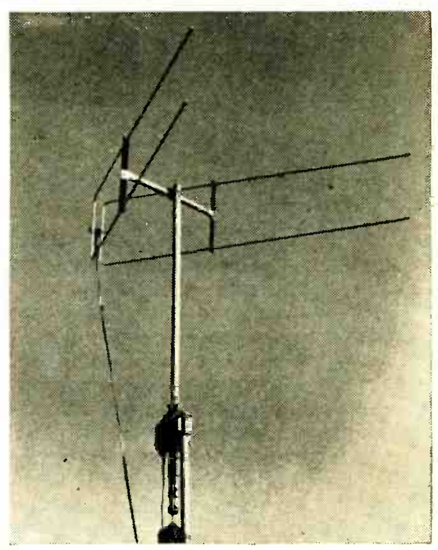


Fig. 4—A vertically-stacked V antenna.

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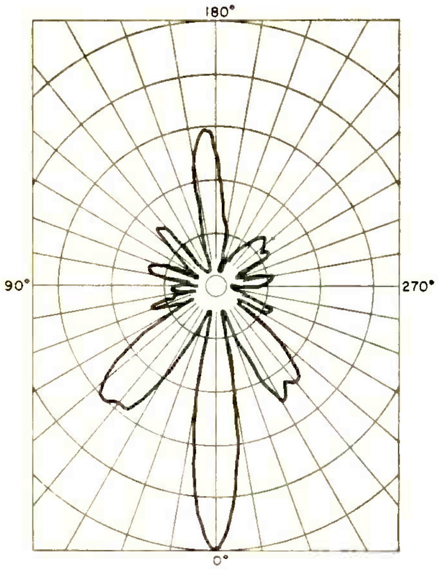



Fig. 5—Higher forward directivity obtained with vertically-stacked V antenna.

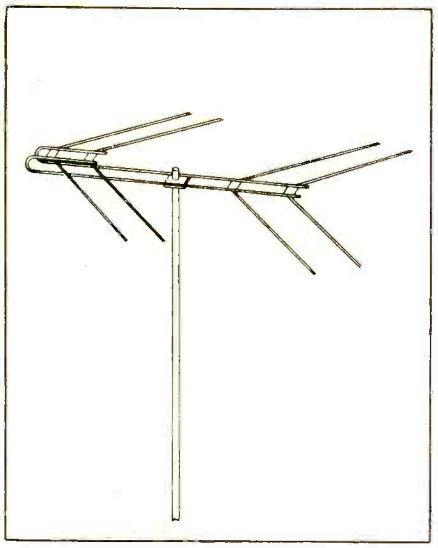


Fig. 6—Four-element "trombone" antenna. Both sets of elements may be adjusted to vary the terminating impedance, and the directivity of the antenna.

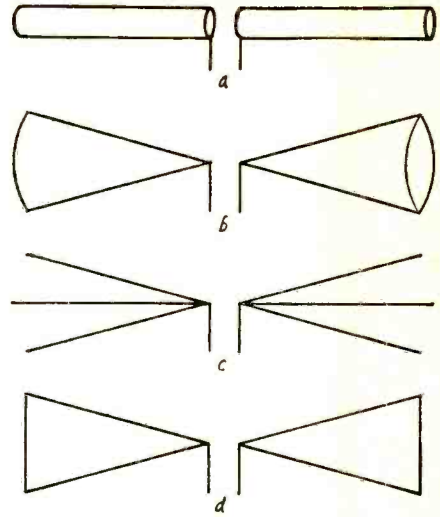



Fig. 7—(a) Increasing diameter of elements increases bandwidth. (b) Biconical dipole covers wide frequency range. (c) Fan-dipole form of conical antenna. (d) "Bow-tie" solid-sheet dipole for u.h.f.

but, wherever possible, it should be determined experimentally for conditions in the area in which the antenna is used. If the u.h.f. channels to be received are at the upper end of the band, an angle of less than 60 degrees will give best results. If only the lower end of the u.h.f. band is in use, the angle may be increased a few degrees.

By this time, you have undoubtedly recognized the double V as an antenna which has been used for v.h.f. reception with considerable success. The v.h.f.-u.h.f. version differs only with respect to the angle between the elements. If you have a double V and can change the angle, you can make yourself a good all-channel antenna.

The comparative voltage gains of the double V and the other antennas to be described are given in Table I. Note that the front-to-back ratio of the antenna is approximately 1.5 to 1. This low front-to-back ratio can be a source of difficulty if ghosts are encountered. As indicated by the directivity pattern shown in Fig. 3, the double V has a number of secondary lobes. If a reflected signal is received on the axis of one of these secondary lobes, there is nothing to prevent it from reaching the receiver and producing a ghost.

There may be occasions when you can use these high-amplitude secondary lobes to advantage. When stations must be received from different directions, it is often possible to orient the antenna so that the weakest signal is picked up by the major lobe, and one or more strong signals by the minor lobes. The major lobe is wide enough to overcome slight differences in the angles between the antenna lobes and the received signals.

## The stacked V

Another way to obtain additional gain from the V antenna is to stack one

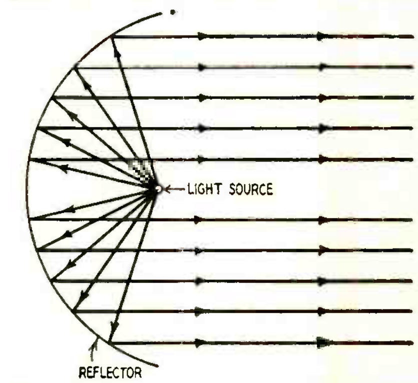



Fig. 10—Parabolic reflector collects light rays emitted by source and radiates them in unidirectional parallel rays.

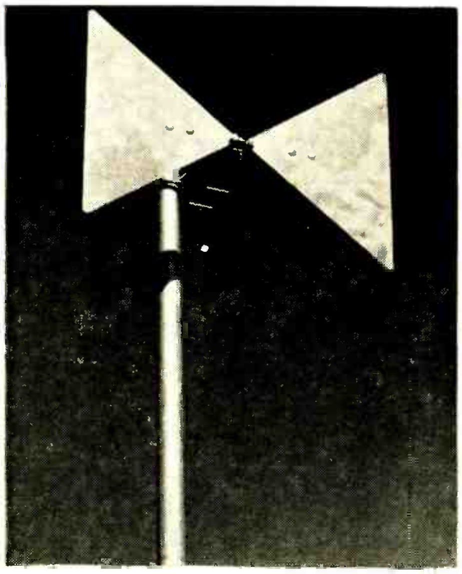


Fig. 8—A "bow-tie" in commercial form.

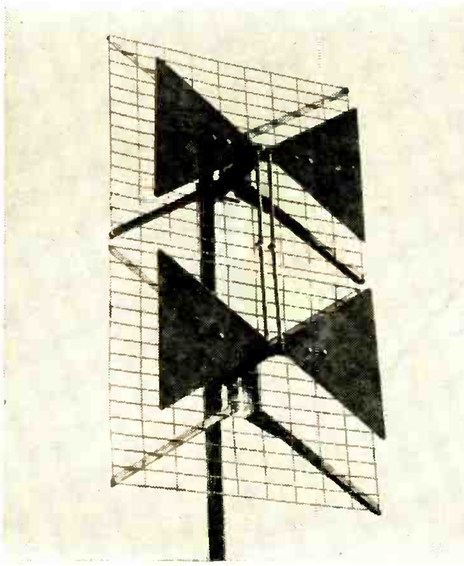


Fig. 9—Stacked "bow-ties" with reflector.

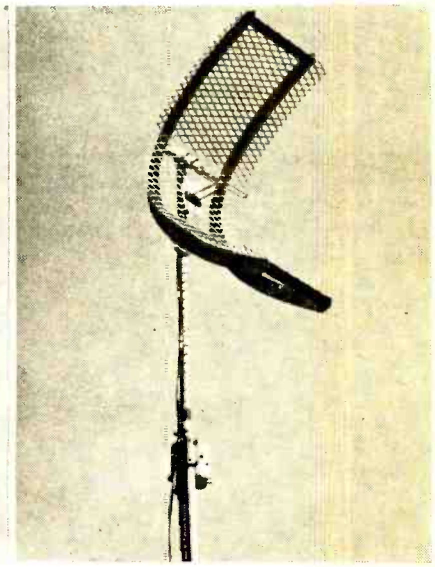


Fig. 11—Folded-dipole u.h.f. antenna with paraboloidal wire-screen reflector.

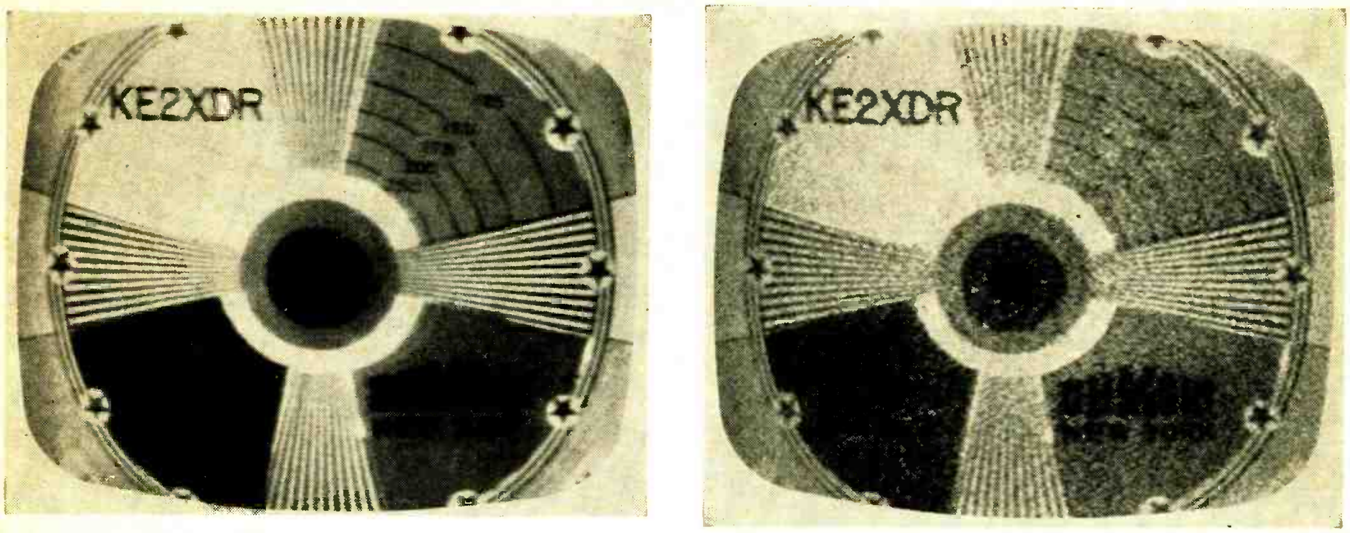



**Fig. 12—(Left) U.h.f. signal received with a short length of low-loss u.h.f. transmission line connected between antenna and receiver. (Right) Effect of substituting a 200-foot lead-in of type RG-59/U coaxial cable on the picture.**

V above another to form the antenna shown in Fig. 4. The stacked-V antenna provided the highest gain and front-to-back ratio of all the dual-band types tested. It is economical, light in weight, and easy to handle. Several commercial models will undoubtedly be available by the time this article is in print.

As indicated by the directivity pattern shown in Fig. 5, the stacked V has a narrower forward lobe than the double V, but also has the multiple minor lobes exhibited by all V antennas, a possible source of difficulty when ghosts are encountered.

A third type of V antenna, called the "trombone," is shown in Fig. 6. It consists of four driven-V antennas. The results obtained with this antenna are roughly equivalent to those obtained with the double V, and there is little preference for one over the other. In fact, any of the V-type arrays described will do an excellent job wherever fairly strong signals are available and ghosts are not a problem.

**Table I**

| Type | Gain | |
|---|---|---|
| | Front | Back |
| Double V | 15 | 9.5 |
| Stacked V | 20 | 11.5 |
| Trombone | 12.5 | 8 |
| Single bow-tie | 6.5 | 5.5 |
| Single bow-tie with reflector | 8 | 2 |
| Stacked bow-tie | 11 | 10 |
| Stacked bow-tie with reflector | 21 | 3 |
| Parabolic | 12.5 | 4.5 |

## U.h.f. antennas

Where the customer already has a v.h.f. antenna or where receiving conditions call for higher gain or better directivity, a separate u.h.f. antenna provides the answer.

Many types of straight u.h.f. antennas were tested, and two were found that met the requirements of all but very weak-signal locations. These are the bow-tie antenna and the parabolic antenna. Commercial versions of both types are now on the market.

An ordinary dipole made of thin wire or tubing behaves like a high-Q resonant circuit. At frequencies slightly above and below its resonant frequency it becomes reactive, its efficiency and gain fall off sharply, and it performs rather poorly as an antenna. The resonant peak can be reduced by increasing the thickness of the conductors, as shown in Fig. 7-a. This lowers the Q of the dipole, providing more uniform response over a wide band of frequencies. Carrying this idea further the conductors can be constructed in cone form (Fig. 7-b), to cover a still greater frequency range. This is the true biconical antenna from which several of the types now in use are derived. The biconical suffers from the major disadvantage of being difficult to construct and mount.

The physical disadvantages of the biconical are overcome in the familiar fan dipole of Fig. 7-c, which is widely used in v.h.f. antennas. The fan antenna, however, does not possess the full bandwidth capabilities of the true biconical. Replacing the multiple conductors with flat metal triangles to form a bow-tie (Fig. 7-d), brings the performance closer to the true biconical.

Several versions of the bow-tie are available. A single version is shown in Fig. 8. Table I shows the comparative voltage gains of the single bow-tie, the stacked bow-tie, and the single and stacked bow-ties with reflectors. The stacked bow-tie with reflector, shown in Fig. 9, gave the best gain and front-to-back ratio of all the u.h.f. antennas tested.

The reflector used with the bow-tie is a flat screen referred to as a "bedspring" or "sheet." This reflector performs very much like a tuned parasitic reflector; however, it overcomes the critical spacing and length requirements of the tuned reflector and is much more efficient. For maximum efficiency the reflector must be somewhat wider than the bow-tie. The size and shape of the openings in the reflector are not critical, but their longest dimension must be kept shorter than 0.2 wavelength.

## The parabolic antenna

At ultra-high frequencies radio waves exhibit many of the qualities of light rays. In a searchlight the light source is located at the focal point of a parabolic mirror, as shown in Fig. 10. The mirror reflects the light which strikes it from the source, forming a beam of parallel rays. The same principle is used in the u.h.f. antenna shown in Fig. 11, in which a folded dipole is mounted at the focal point of a parabolic-shaped metal reflector.

Radio waves striking the reflector are concentrated at the dipole. The reflector is actually a compromise between the flat bedspring type and a true parabola. It produces a very narrow vertical lobe, while the horizontal directivity is approximately equivalent to that obtained with a flat-surface reflector.

Although the parabolic antenna did not give quite as good results as the stacked bow-tie with reflector, it is an excellent antenna and will give satisfactory results in many areas.

## Transmission lines

In the u.h.f. television band special attention must be given to the selection and installation of the transmission line. At ultra-high frequencies transmission-line losses are several times those which we have become accustomed to in the v.h.f. band.

Fig. 12 shows the effect the transmission line can have on u.h.f. reception. The same receiver and antenna were used to obtain both pictures. The pattern on the left was obtained with a short length of low-loss line between the antenna and receiver. The pattern on the right was obtained with 200 feet of RG-59/U connected between the antenna and receiver.

A comparison of the losses of several popular types of transmission line in the v.h.f. and u.h.f. bands is shown in Table II. The losses of each type of line are several times as great in the u.h.f. band (700 mc), as compared to the v.h.f. band.

The figures in the table indicate that

moisture has a drastic effect on 300-ohm ribbon. Its losses when wet are so great that the use of 300-ohm ribbon is not advisable if more than 25 feet of line is required.

The effects of moisture are overcome to a great extent in tubular 300-ohm line. In this line the conductors are attached to the outside of a polythene tube. The construction provides a longer leakage path and keeps moisture out of the space between the conductors. Because of its economy, this type of transmission line will undoubtedly be highly popular for u.h.f. installations.

**Table II**

| Type | Loss in Db per 100 feet | | | |
|---|---|---|---|---|
| | 100 mc | | 700 mc | |
| | Dry | Wet | Dry | Wet |
| 300-ohm ribbon | 1.2 | 7.3 | 3.6 | 26.5 |
| 300-ohm tubular | 1.2 | 2.5 | 3.6 | 8.2 |
| 450-ohm air-spaced | 0.35 | 0.35 | 0.9 | 0.9 |
| RG-59/U coaxial | 3.7 | 3.7 | 11.7 | 11.7 |
| RG-11/U coaxial | 1.9 | 1.9 | 6.2 | 6.2 |

Coaxial lines such as RG-59/U and G-11/U do not suffer from the effects oisture; but the losses of RG-59/U bit its use in weak-signal areas if han 50 feet of line are required.

### tion effects

due to absorption from the ion line can be severe when lines of either the ribbon or pes are used. With a 500- gnal at the antenna, an in- ng 100 feet of 300-ohm rib- an excellent picture when ion line was entirely clear objects. When the line roof of the building the ally disappeared. 300- ffers from absorption to as 300-ohm ribbon. Both kept away from all other lly those containing met- ine at least 6 inches from and other surfaces; and avoid running the line drains, wires, or other structure.

smission line must be ble distance inside a not possible to keep use coaxial line.

for use in u.h.f. -ohm air-spaced, e has the lowest pes available. It bly by moisture, absorption effects away from other weak-signal loca- must be run, but handle. It is not installations re- feet of line.

transmission line t were not checked

ne requirements of an be summed up

ignals are available 30 feet of line are y type of line will

2. When the line is 50 feet or longer, either 300-ohm tubular or coaxial line will usually give best results.

3. If the line is more than 50 feet long and cannot be kept clear of other objects, use coaxial line. If the signals are strong, or if the line is less than 100 feet long, RG-59/U is suitable. With weak signals or longer lines, RG-11/U will give better results.

4. In a weak signal area when a very long line is required, 450-ohm air-spaced line should be considered.

When separate v.h.f. and u.h.f. antennas are used, it is often desirable to use a single transmission line. Several commercial crossover filters are available which permit this to be done. The filter is mounted near the antennas and connected to them by short lines. A single transmission line carries the output of the filter to the receiver.

Many of the u.h.f. converters on the market are intended for use with separate v.h.f. and u.h.f. transmission lines. If the transmission line is connected directly to the v.h.f. and u.h.f. terminals of the converter, a proper match will not be obtained. To provide a correct match, a network is required. Commercial networks are available for this purpose. Some of these networks may be used at either the antenna end of the line to permit the use of a single line as described above, or at the receiver end to match a single line to separate v.h.f. and u.h.f. input terminals.

### Installation problems

You may have noticed when installing v.h.f. antennas that raising an antenna a few feet does not always produce a stronger signal. This effect, called "height cancellation," is much more pronounced in the u.h.f. band. Due to phasing differences between the direct signal and the ground-reflected signal, cancellation and addition occur at various heights above ground. As a result, layers of minimum and maximum signal level are created. When installing u.h.f. antennas, always raise and lower the antenna a few feet to probe for the height which gives maximum signal.

At ultra-high frequencies, the shielding effects of hills, buildings, and other obstructions produces shadow areas in which very little signal is available. Several such areas have been found around Portland, Oregon. In many cases, it was possible to get fair reception with high-gain antennas; in others, nothing could be done.

Most new u.h.f. stations will probably go on the air with effective radiated powers of approximately 20 kw. In most cases, this will give dependable reception within 20 to 30 miles from the transmitter. Future power increases will raise this distance.

Since u.h.f. signals are reflected more efficiently, ghosts are much more common than on v.h.f. This is partially compensated for by the availability of highly directional antennas. Multipath pickup also results in signal cancellation. Moving the antenna a few feet will often greatly increase or decrease the signal pickup. END

## tv dx IN APRIL

APRIL marks a seasonal turning point for the TV dx enthusiast. After a period of several months when TV dx has been seen seldom, if at all, he can now look forward to better times for at least the next three months.

There will not be many dx openings in April, and the observer in the northern states may find little evidence of it at all. Because the dx cycle is associated in a general way with climate, the viewer in the deep south is likely to get the first break in both tropospheric and ionospheric dx.

The last major auroral disturbances of the spring cycle occur in April, and though the magnitude of auroral activity has been generally low in recent months there is always a chance of a marked change in this respect. Auroral effects on TV reception are probably the least understood of any of the principal factors that may account for TV dx. Observers interested in learning more of this will find useful information in the January, 1953, issue of IRE Proceedings, wherein some Cornell University photographs of TV pictures made during an aurora are reproduced.

Ever since the appearance of the summary of 1952 TV dx observations in the January RADIO-ELECTRONICS, reports have been coming in from readers who recorded TV dx reception during the past year, but did not send it in at once. While such reports are valuable for long-term study, they do not get proper acknowledgment in the pages of this magazine, and of course they do not figure in the compilation of the published report for the year.

To be of greatest value, TV dx observations should be sent in soon after the incidents reported. A monthly log is a convenient way to handle it, and useful to us. The time, date, and channel are important, and information on the equipment used is helpful. END

### DEDICATED TO ALL TV KIBITZERS AND DIAL-TWISTERS

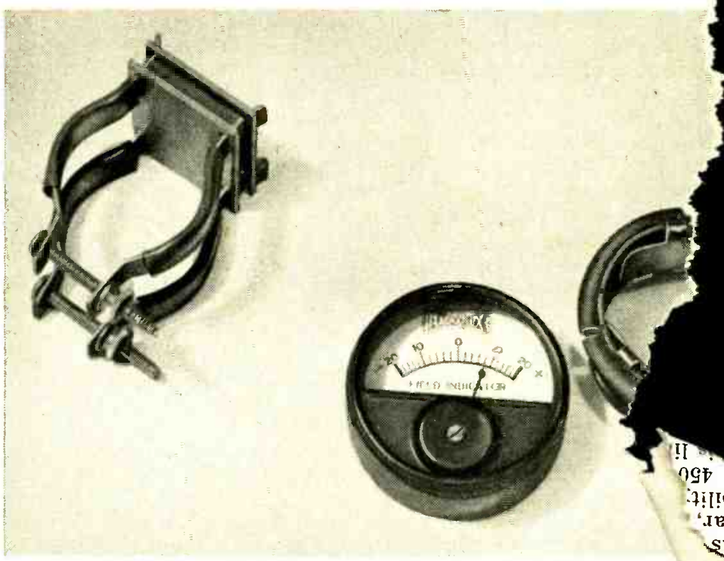
By Caroline J. Beckner

I think that I shall never see
More cause for strong profanity
Than when I twist the TV dial
And others scream: "Your taste is
vile!"
They raise a loud, insistent clamor
For quiz shows or for melodramer.
Or movies old—half-hid in snow—
That give me chills and vertigo.
They take turns at the little knobs
Nor hearken to my tears and sobs.
Radio's made for wrecks like me,
Red's all that I see on TV.

# WHAT ABOUT THE ION TRAP?

By ALVIN B. KAUFMAN

(Above)—The author an ion-trap magn low)—This inexpen strength meter ca to check relative s magnets. Deflectic field of the near-



THE service technician takes the ion-trap magnet and the new PM centering assemblies casually, as a rule. However, measurement of their field strength is an important factor that should not be overlooked when certain types of service trouble are encountered.

Either of these units may be single- or dual-magnet assemblies. The better manufacturers of ion-trap and centering magnets use Alnico V. These magnets have a silvery color, while other materials do not. This choice of material and the importance to the service technician is indicated because both ion-trap and centering magnets operate pretty much under open-circuit conditions and thus are subject to demagnetization due to heat, handling, or vibration. In addition, the centering magnet is close to the deflection yoke with its heavy demagnetizing effect, which may seriously affect its strength.

Appreciable reduction in the field strength of the centering magnet assembly may reduce its ability to center the beam or raster to the point where it has to be discarded. A simple check of its field strength will indicate whether the trouble is in this component or if a breakdown has occurred in the deflection-yoke circuits. Replacement by another unit, off the shelf, may not remedy the trouble if this new unit should be of a type employing magnetic components which also might have a weak field (from one of the causes previously indicated). The centering magnet produces a field which moves the electron beam before it reaches the yoke.

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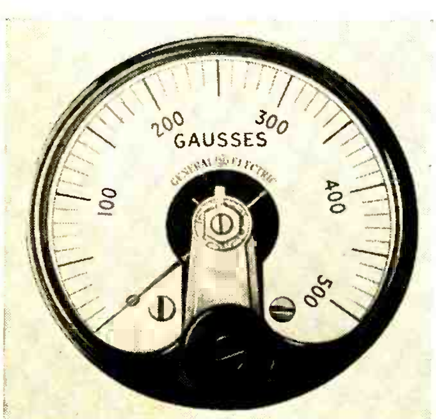
In the electrostatically deflected cathode-ray tube the ions and electrons produced by the cathode of the tube are both deflected equally and the screen is thus bombarded evenly and not burnt. In the electromagnetically deflected tube, due to difference in mass, only the electrons are deflected appreciably, and the ions—hitting the screen at one point in a steady stream—would produce a burnt spot. This was remedied in modern C-R tubes by directing the ions and electrons against some portion of the electron gun, as in the bent gun design. The ion-trap magnet straightens out the electron stream and allows it to go down the tube to the screen. This magnet does *not* affect the ions, which continue in a straight line into the tube structure where they do no harm. As Fig. 1 shows, the magnet is adjusted until the electron beam is just straightened out. Improper adjustment or weak field strength will allow the beam to hit the gun structure (aperture), limiting screen brilliance and producing secondary ion burns due to disintegration of the structure. A discussion of these ion burns was presented very thoroughly in the February, 1952, issue[1].

At this time it is too early to evaluate whether much trouble will be encountered with centering units, for electrostatic and electromagnetic focusing cathode-ray tubes. In checking with a large service organization and numerous dealers not many bad ion-trap magnets have been turned up. But as they were normally unexpected these cases led to many hours of needless trouble shooting before the ion-trap magnets were finally identified as the elements responsible for the difficulties.

### A magnet checker

A simple tester to check the field strength of these magnets may pay for itself even if it just clears the atmosphere by showing that the magnet is not the cause of raster misalignment, loss of brilliance, or ion burns on the picture-tube screen.




**High-grade General Electric Gaussmeter. This instrument is portable and indicates field strength with 5% accuracy.**

The magnetic field strengths employed in these assemblies run between 5 and 40 gausses. Therefore the gauss meter should preferably cover this range as closely as possible. Numerous commercial meters are available, among which General Electric's field meter is particularly adaptable and inexpensive. These field type portable indicators have an accuracy of $\pm 5\%$ and are supplied with standard reference magnets. GE bulletin GEC-777 describes all available models including one of 0–100 gauss range (Cat. No. 416X29) which sells for $72.00. Besides commercial units, home-built designs have been featured in several publications[2,3]. However, for the experimenter or technician who does not wish to either build such a gauss meter, or wants to limit his expenditure to a more modest sum, another meter is available.

Magnaflux Corporation sells a pocket field indicator model No. 2480 for the small sum of $2.60. It is intended for use with the Magnaflux inspection system to allow a check of tested structures or parts to insure that no residual magnetic field has been left after test. As such it was not intended to be a highly accurate instrument, and is not calibrated in gausses. It simply has a scale of plus or minus 20 which corresponds somewhat to the field strength in gauss $\pm 50\%$. Individual units vary by as much as 25% among themselves.

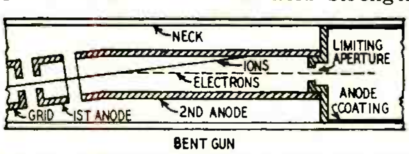



**Fig. 1—Electron and ion paths through gun at correct ion-trap-magnet setting.**

However, this is of little consequence in TV work, as will be indicated shortly.

The types and forms of ion-trap and centering magnet assemblies vary widely, as does the field strength of the magnets. There are ion-trap units with single bar magnets (mounted either across or parallel to the tube neck), double ring types, bar and ring, and double bar, to mention some of the most common kinds.

The field strengths of these magnets vary widely among the different types. The two-magnet assembly delivers a strong and a weak magnetic field, whether of bar or ring construction. The apparent value of the field strength will also vary with the point at which it is measured. This means that regardless of the type of field strength indicator used, some measurement configuration must be used for each type of assembly if comparative strengths of assemblies are to be measured.

Therefore some position and distance between the magnet assembly and indicator must be selected and noted on a chart along with the value of the flux meter reading for each type of assembly. Use a *known good unit* for the check. From then on it will only take a moment to check an unknown unit of the same type. Absolute values cannot be given in the article, because of the variation in flux meters, and the subject components. A variation of 50% from the selected standard, should allow good units to pass; all other units being eyed with suspicion. END

References:
1. *Ion Burns* RADIO-ELECTRONICS Feb. 1952
2. *Magnetic Phenomenon* RADIO-ELECTRONICS Nov. 1951
3. *Magnetic Flux Comparator* *Radio and Television News Engr. Edition Mar. 50*

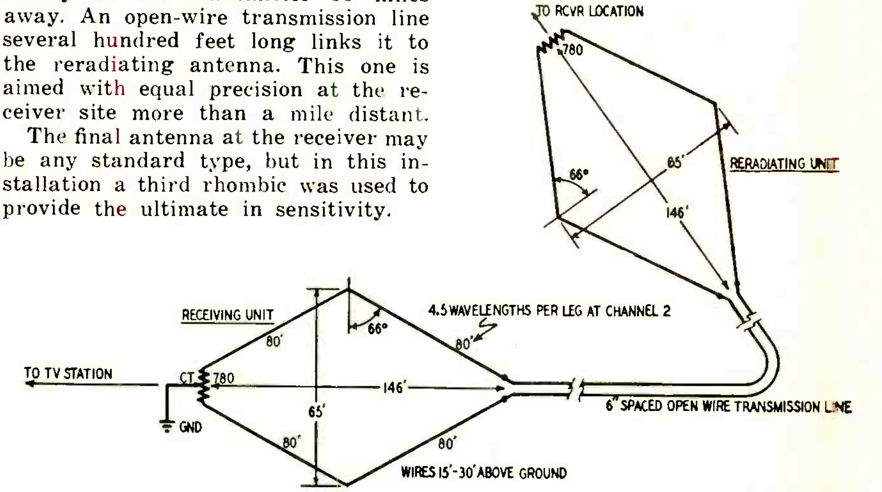
## RELAY RHOMBIC BRINGS TV TO SHADOW AREA

A SIMPLE but sizable twin-rhombic antenna system developed at the University of Denver picks up high-strength TV signals on a mountain top and reradiates them to receivers in a signalless canyon far below.

The pickup rhombic on top of the mountain is beamed with scientific accuracy at the transmitter 55 miles away. An open-wire transmission line several hundred feet long links it to the reradiating antenna. This one is aimed with equal precision at the receiver site more than a mile distant.

The final antenna at the receiver may be any standard type, but in this installation a third rhombic was used to provide the ultimate in sensitivity.

The diagram shows the dimensions of the all-channel rhombics used in the Colorado installation. Increasing the included angle from 66° to 70° improved the response on channels 7-13. END



# Design Data ON VIDEO AMPLIFIERS

*Part II—How to compensate for loss of gain at low frequencies*

By ALLAN G. SORENSEN

IN AN R-C coupled amplifier stage (Fig. 1) the drop in low-frequency response below $F_1$ is a result of the following:

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As a result of these factors not only will the response fall off, but there will be a relatively large phase shift, and oscillation may also occur.

Any appreciable phase distortion in a television receiver will result in a very poor picture. At low frequencies the phase angle will be leading, and only a few degrees shift are required to displace the low-frequency elements of the picture noticeably to the right. The result is the same as a ghost. There will also be smearing of the picture.

Considering C first: C and the grid resistor $R_g$ act as a voltage divider. As shown by the equation for capacitive reactance

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(where f is the frequency in cycles per second and C is the capacitance in µf), the reactance of this capacitor will rise from almost zero at very high frequencies to several hundred thousand ohms at very low frequencies. This results in a substantial reduction of the low-frequency voltage fed to the following tube. When the reactance $X_c$ equals the resistance of $R_g$, the signal voltage on the grid will be down 3 db, or 29.3%. For this reason the grid resistor is made as large as possible.

Even more important than the loss in gain is the shift in signal phase at low frequencies. The amplifier must be capable of flat response down to the lowest frequency that it will be expected to pass. Even a small drop in gain may produce excessive phase shift. As an example, where the amplification drops only to 99.62% of the mid-frequency gain, the phase will shift by 5°. From this it can be seen that a flat response is very important.

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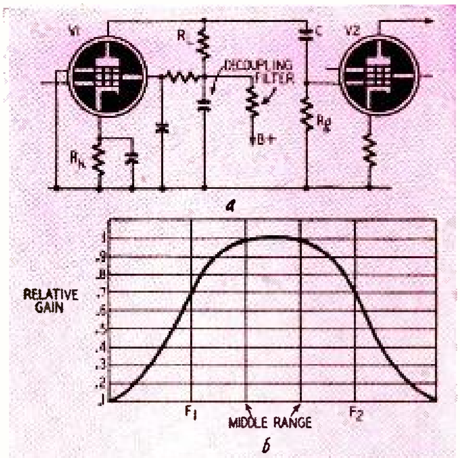


Fig. 1—(a) Basic circuit of two-stage resistance-coupled amplifier. (b) Generalized frequency-response curve of the amplifier. $F_1$ and $F_2$ are points where the frequency response falls noticeably.

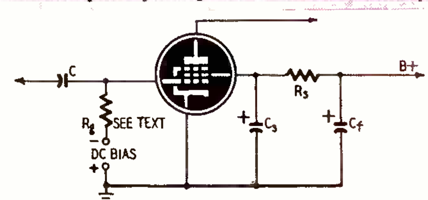


Fig. 2—Grounding the amplifier cathode and supplying grid bias from a fixed d.c. source eliminates cathode degeneration.

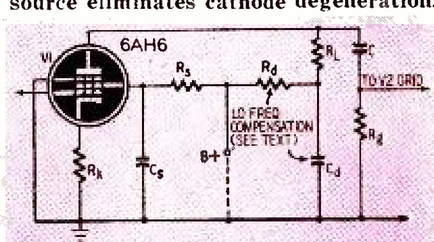


Fig. 3—Part of a two-stage video amplifier with circuit elements affecting the response at low frequencies.

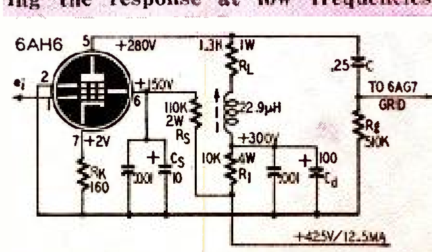


Fig. 4—Video amplifier compensated for flat response from 5 cycles to 4 mc.

moisture has a drastic effect on 300-ohm ribbon. Its losses when wet are so great that the use of 300-ohm ribbon is not advisable if more than 25 feet of line is required.

The effects of moisture are overcome to a great extent in tubular 300-ohm line. In this line the conductors are attached to the outside of a polythene tube. The construction provides a longer leakage path and keeps moisture out of the space between the conductors. Because of its economy, this type of transmission line will undoubtedly be highly popular for u.h.f. installations.

**Table II**

| Type | Loss in Db per 100 feet | | | |
|---|---|---|---|---|
| | 100 mc | | 700 mc | |
| | Dry | Wet | Dry | Wet |
| 300-ohm ribbon... | 1.2 | 7.3 | 3.6 | 26.5 |
| 300-ohm tubular.. | 1.2 | 2.5 | 3.6 | 8.2 |
| 450-ohm air-spaced | 0.35 | 0.35 | 0.9 | 0.9 |
| RG-59/U coaxial.. | 3.7 | 3.7 | 11.7 | 11.7 |
| RG-11/U coaxial.. | 1.9 | 1.9 | 6.2 | 6.2 |

Coaxial lines such as RG-59/U and RG-11/U do not suffer from the effects of moisture; but the losses of RG-59/U prohibit its use in weak-signal areas if more than 50 feet of line are required.

### Absorption effects

Losses due to absorption from the transmission line can be severe when open-wire lines of either the ribbon or tubular types are used. With a 500-microvolt signal at the antenna, an installation using 100 feet of 300-ohm ribbon produced an excellent picture when the transmission line was entirely clear of surrounding objects. When the line was laid on the roof of the building the picture practically disappeared. 300-ohm tubular suffers from absorption to the same extent as 300-ohm ribbon. Both types must be kept away from all other objects, especially those containing metal. Space the line at least 6 inches from all walls, roofs, and other surfaces; and wherever possible avoid running the line parallel to pipes, drains, wires, or other metal parts of a structure.

Where a transmission line must be run a considerable distance inside a building, and it is not possible to keep the line in the clear, use coaxial line.

Another possibility for use in u.h.f. installations is 450-ohm air-spaced, open-wire line. This line has the lowest losses of the various types available. It is not affected appreciably by moisture, but it suffers from absorption effects and must be supported away from other objects. It is ideal for weak-signal locations where long lines must be run, but it is rather difficult to handle. It is not generally needed for installations requiring less than 200 feet of line.

Other types of u.h.f. transmission line are now available, but were not checked in these tests.

The transmission-line requirements of u.h.f. installations can be summed up as follows:

1. If very strong signals are available and less than 25 or 30 feet of line are required, almost any type of line will prove satisfactory.

2. When the line is 50 feet or longer, either 300-ohm tubular or coaxial line will usually give best results.

3. If the line is more than 50 feet long and cannot be kept clear of other objects, use coaxial line. If the signals are strong, or if the line is less than 100 feet long, RG-59/U is suitable. With weak signals or longer lines, RG-11/U will give better results.

4. In a weak signal area when a very long line is required, 450-ohm air-spaced line should be considered.

When separate v.h.f. and u.h.f. antennas are used, it is often desirable to use a single transmission line. Several commercial crossover filters are available which permit this to be done. The filter is mounted near the antennas and connected to them by short lines. A single transmission line carries the output of the filter to the receiver.

Many of the u.h.f. converters on the market are intended for use with separate v.h.f. and u.h.f. transmission lines. If the transmission line is connected directly to the v.h.f. and u.h.f. terminals of the converter, a proper match will not be obtained. To provide a correct match, a network is required. Commercial networks are available for this purpose. Some of these networks may be used at either the antenna end of the line to permit the use of a single line as described above, or at the receiver end to match a single line to separate v.h.f. and u.h.f. input terminals.

### Installation problems

You may have noticed when installing v.h.f. antennas that raising an antenna a few feet does not always produce a stronger signal. This effect, called "height cancellation," is much more pronounced in the u.h.f. band. Due to phasing differences between the direct signal and the ground-reflected signal, cancellation and addition occur at various heights above ground. As a result, layers of minimum and maximum signal level are created. When installing u.h.f. antennas, always raise and lower the antenna a few feet to probe for the height which gives maximum signal.

At ultra-high frequencies, the shielding effects of hills, buildings, and other obstructions produces shadow areas in which very little signal is available. Several such areas have been found around Portland, Oregon. In many cases, it was possible to get fair reception with high-gain antennas; in others, nothing could be done.

Most new u.h.f. stations will probably go on the air with effective radiated powers of approximately 20 kw. In most cases, this will give dependable reception within 20 to 30 miles from the transmitter. Future power increases will raise this distance.

Since u.h.f. signals are reflected more efficiently, ghosts are much more common than on v.h.f. This is partially compensated for by the availability of highly directional antennas. Multipath pickup also results in signal cancellation. Moving the antenna a few feet will often greatly increase or decrease the signal pickup. END

## tv dx IN APRIL

APRIL marks a seasonal turning point for the TV dx enthusiast. After a period of several months when TV dx has been seen seldom, if at all, he can now look forward to better times for at least the next three months.

There will not be many dx openings in April, and the observer in the northern states may find little evidence of it at all. Because the dx cycle is associated in a general way with climate, the viewer in the deep south is likely to get the first break in both tropospheric and ionospheric dx.

The last major auroral disturbances of the spring cycle occur in April, and though the magnitude of auroral activity has been generally low in recent months there is always a chance of a marked change in this respect. Auroral effects on TV reception are probably the least understood of any of the principal factors that may account for TV dx. Observers interested in learning more of this will find useful information in the January, 1953, issue of IRE Proceedings, wherein some Cornell University photographs of TV pictures made during an aurora are reproduced.

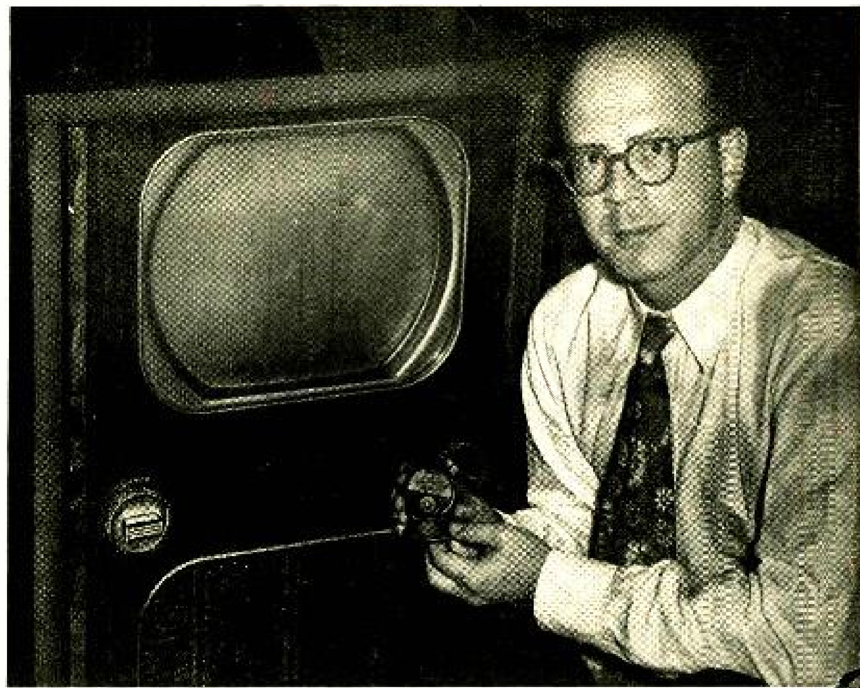
Ever since the appearance of the summary of 1952 TV dx observations in the January RADIO-ELECTRONICS, reports have been coming in from readers who recorded TV dx reception during the past year, but did not send it in at once. While such reports are valuable for long-term study, they do not get proper acknowledgment in the pages of this magazine, and of course they do not figure in the compilation of the published report for the year.

To be of greatest value, TV dx observations should be sent in soon after the incidents reported. A monthly log is a convenient way to handle it, and useful to us. The time, date, and channel are important, and information on the equipment used is helpful. END

### DEDICATED TO ALL TV KIBITZERS AND DIAL-TWISTERS

By Caroline J. Beckner

I think that I shall never see
More cause for strong profanity
Than when I twist the TV dial
And others scream: "Your taste is vile!"
They raise a loud, insistent clamor
For quiz shows or for melodramer.
Or movies old—half-hid in snow—
That give me chills and vertigo.
They take turns at the little knobs
Nor hearken to my tears and sobs.
Radio's made for wrecks like me,
Red's all that I see on TV.



# WHAT ABOUT THE ION TRAP?

By ALVIN B. KAUFMAN

(Above)—The author checks an ion-trap magnet. (Below)—This inexpensive field-strength meter can be used to check relative strength of magnets. Deflection is due to field of the near-by ion trap.

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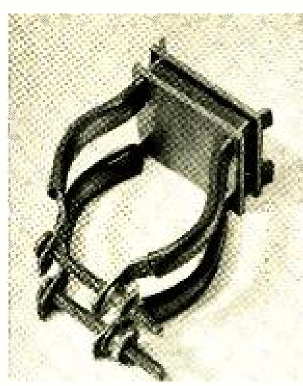

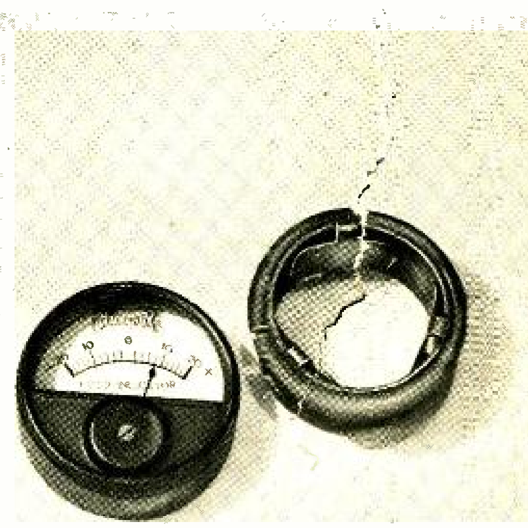

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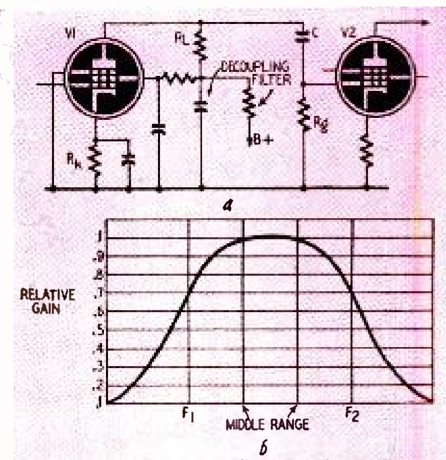


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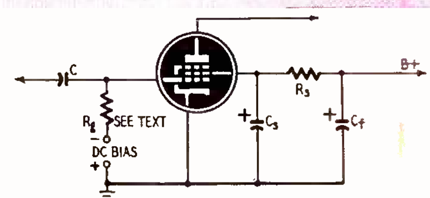



Fig. 2—Grounding the amplifier cathode and supplying grid bias from a fixed d.c. source eliminates cathode degeneration.

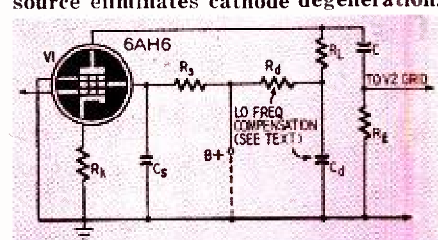



Fig. 3—Part of a two-stage video amplifier with circuit elements affecting the response at low frequencies.

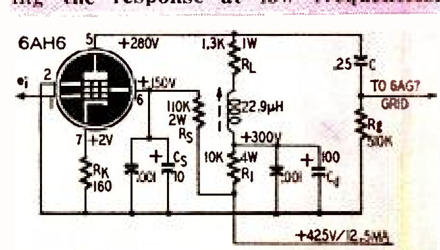



Fig. 4—Video amplifier compensated for flat response from 5 cycles to 4 mc.

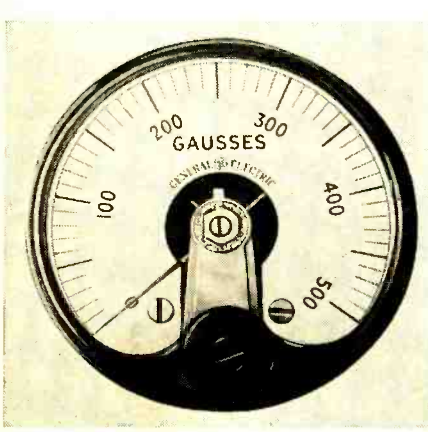
that specified distorts the focused spot, changes the focusing voltage of the tube, and also requires a shift in the position of the magnet on the neck of the tube."—*Editor*)

In the electrostatically deflected cathode-ray tube the ions and electrons produced by the cathode of the tube are both deflected equally and the screen is thus bombarded evenly and not burnt. In the electromagnetically deflected tube, due to difference in mass, only the electrons are deflected appreciably, and the ions—hitting the screen at one point in a steady stream—would produce a burnt spot. This was remedied in modern C-R tubes by directing the ions and electrons against some portion of the electron gun, as in the bent gun design. The ion-trap magnet straightens out the electron stream and allows it to go down the tube to the screen. This magnet does *not* affect the ions, which continue in a straight line into the tube structure where they do no harm. As Fig. 1 shows, the magnet is adjusted until the electron beam is just straightened out. Improper adjustment or weak field strength will allow the beam to hit the gun structure (aperture), limiting screen brilliance and producing secondary ion burns due to disintegration of the structure. A discussion of these ion burns was presented very thoroughly in the February, 1952, issue[1].

At this time it is too early to evaluate whether much trouble will be encountered with centering units, for electrostatic and electromagnetic focusing cathode-ray tubes. In checking with a large service organization and numerous dealers not many bad ion-trap magnets have been turned up. But as they were normally unexpected these cases led to many hours of needless trouble shooting before the ion-trap magnets were finally identified as the elements responsible for the difficulties.

### A magnet checker

A simple tester to check the field strength of these magnets may pay for itself even if it just clears the atmosphere by showing that the magnet is not the cause of raster misalignment, loss of brilliance, or ion burns on the picture-tube screen.




**High-grade General Electric Gaussmeter. This instrument is portable and indicates field strength with 5% accuracy.**

The magnetic field strengths employed in these assemblies run between 5 and 40 gausses. Therefore the gauss meter should preferably cover this range as closely as possible. Numerous commercial meters are available, among which General Electric's field meter is particularly adaptable and inexpensive. These field type portable indicators have an accuracy of ± 5% and are supplied with standard reference magnets. GE bulletin GEC-777 describes all available models including one of 0–100 gauss range (Cat. No. 416X29) which sells for $72.00. Besides commercial units, home-built designs have been featured in several publications[2,3]. However, for the experimenter or technician who does not wish to either build such a gauss meter, or wants to limit his expenditure to a more modest sum, another meter is available.

Magnaflux Corporation sells a pocket field indicator model No. 2480 for the small sum of $2.60. It is intended for use with the Magnaflux inspection system to allow a check of tested structures or parts to insure that no residual magnetic field has been left after test. As such it was not intended to be a highly accurate instrument, and is not calibrated in gausses. It simply has a scale of plus or minus 20 which corresponds somewhat to the field strength

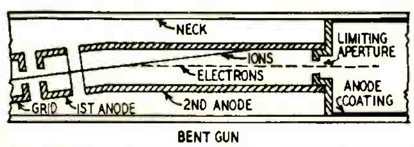



**Fig. 1—Electron and ion paths through gun at correct ion-trap-magnet setting.**

in gauss ± 50%. Individual units vary by as much as 25% among themselves. However, this is of little consequence in TV work, as will be indicated shortly.

The types and forms of ion-trap and centering magnet assemblies vary widely, as does the field strength of the magnets. There are ion-trap units with single bar magnets (mounted either across or parallel to the tube neck), double ring types, bar and ring, and double bar, to mention some of the most common kinds.

The field strengths of these magnets vary widely among the different types. The two-magnet assembly delivers a strong and a weak magnetic field, whether of bar or ring construction. The apparent value of the field strength will also vary with the point at which it is measured. This means that regardless of the type of field strength indicator used, some measurement configuration must be used for each type of assembly if comparative strengths of assemblies are to be measured.

Therefore some position and distance between the magnet assembly and indicator must be selected and noted on a chart along with the value of the flux meter reading for each type of assembly. Use a *known good unit* for the check. From then on it will only take a moment to check an unknown unit of the same type. Absolute values cannot be given in the article, because of the variation in flux meters, and the subject components. A variation of 50% from the selected standard, should allow good units to pass; all other units being eyed with suspicion. END

References:

1. *Ion Burns* Radio-Electronics Feb. 1952
2. *Magnetic Phenomenon* Radio-Electronics Nov. 1951
3. *Magnetic Flux Comparator* Radio and Television News Engr. Edition Mar. 50

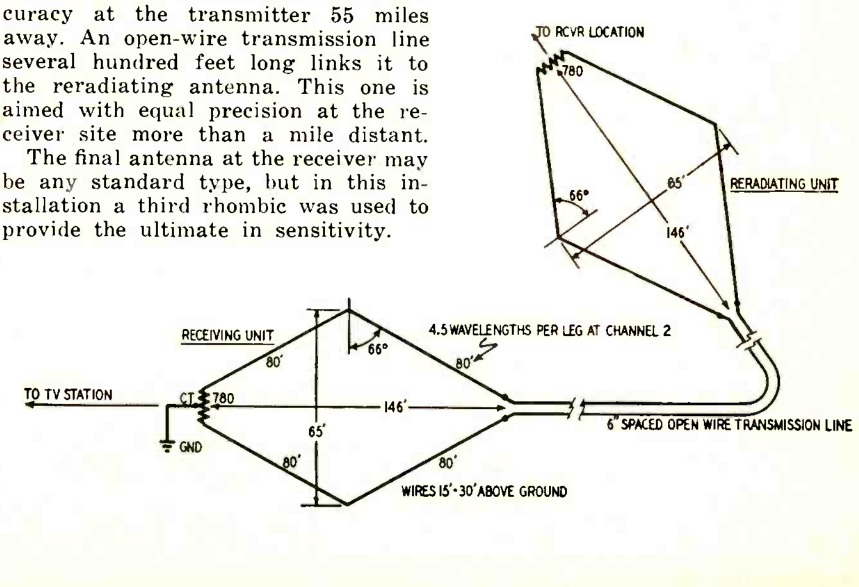
# RELAY RHOMBIC BRINGS TV TO SHADOW AREA

A SIMPLE but sizable twin-rhombic antenna system developed at the University of Denver picks up high-strength TV signals on a mountain top and reradiates them to receivers in a signalless canyon far below.

The pickup rhombic on top of the mountain is beamed with scientific accuracy at the transmitter 55 miles away. An open-wire transmission line several hundred feet long links it to the reradiating antenna. This one is aimed with equal precision at the receiver site more than a mile distant.

The final antenna at the receiver may be any standard type, but in this installation a third rhombic was used to provide the ultimate in sensitivity.

The diagram shows the dimensions of the all-channel rhombics used in the Colorado installation. Increasing the included angle from 66° to 70° improved the response on channels 7-13. END



low-frequency losses and phase shift.

Another method is to use fixed bias. Ground the cathode and apply a negative d.c. voltage to the grid through resistor $R_g$, as shown in Fig. 2. Consult the tube manual for the maximum value of $R_g$ that may be used with fixed bias. The advantage of this method is that there is no reduction in gain from degenerative feedback.

The third approach is to bypass the cathode resistor with a very large capacitor—perhaps 1,000 μf. This value will bypass all but the very lowest frequencies and the gain of the tube will not suffer from degenerative feedback.

Degeneration can also be introduced in the screen-grid circuit. If the screen is not bypassed effectively, the gain of the tube will be reduced and phase shift will result. When a signal voltage is applied to the control grid there will be variations not only in the plate current, but in the screen current as well. This varying screen current will develop a varying voltage across any impedance in the screen circuit. The screen bypass capacitor $C_s$ in Fig. 2 represents an impedance.

For adequate screen bypassing the reactance of $C_s$ must not be more than about 1/10 or 1/20 that of the screen-dropping resistor $R_s$. For example, if the screen resistor is 50,000 ohms, the reactance of $C_s$ should not exceed 5,000 ohms at the lowest frequency to be amplified, and should preferably be even smaller. For most applications a value of 10 μf will be satisfactory.

The final source of difficulty is the power supply. If the reactance of the output filter capacitor $C_f$ rises appreciably at low frequencies, the video-amplifier stages, which are all connected to the common B plus line, will not be decoupled effectively. Signal voltages will circulate on the B plus line. This may cause oscillation at a low frequency and create flickering on the screen of a television set.

For this reason the output filter capacitors in well-designed television sets are always quite large. Electronically regulated power supplies are often used in elaborate equipment to provide the lowest possible internal impedance.

Thus far we have covered the theory behind the R-C-coupled amplifier relating to its low-frequency performance. We have shown how the effects of the cathode and screen and of the power supply can be minimized. The only source of frequency and phase distortion left is the coupling capacitor C. We shall see how the effects of this capacitor can be compensated for.

## Low-frequency compensation

In Part I we found the best values for all the parts that affect the high-frequency response. Now we will find the correct values of the parts contributing to the low-frequency response. See Fig. 3. The cathode resistor $R_k$ is left unbypassed. This gives equal degeneration at all frequencies but reduces the stage gain. With the cathode bypassed, or with fixed-bias operation (Fig. 2) the gain A of the 6AH6 is given by $A = gm \times Z_L$. The gm of a 6AH6 is 9,000 micromhos, and $Z_L$ can be assumed equal to $R_L$, which was fixed at 1,300 ohms for high-frequency compensation. (See Part I, in the March RADIO-ELECTRONICS.) Without degeneration, then $A = .009 \times 1{,}300 = 11.7$. When the cathode of the 6AH6 is left *unbypassed* we use this equation for the gain $A_1$:

$$A_1 = \frac{A}{1 + (gm \times R_k)}$$

where A is the gain without degeneration (11.7). Thus

$$A_1 = \frac{11.7}{1 + (.009 \times 160)} = 4.8.$$

Before we can find the other values it would be well to explain how the $R_d$-$C_d$ compensating circuit enters into the problem. Its basic purpose is to decouple the stage from the common B plus line and eliminate low-frequency oscillations. But with the proper choice of values it can also compensate for the effects of capacitor C.

The theory behind the combination is not at all difficult to understand. It has been explained how the reactance of the coupling capacitor C rises at low frequencies and delivers a smaller voltage to the following grid. At medium and high frequencies the plate-load impedance of V1 is equal to resistor $R_L$, since $C_d$ has negligible reactance at these frequencies. However, when the frequency is lowered, $C_d$ will no longer be an effective short circuit to ground, but may have appreciable reactance.

While the increasing reactance of C reduces the signal voltage at the grid of V2, the reactance of $C_d$ is increasing as well. The parallel combination $R_d$-$C_d$ becomes part of $Z_L$ and raises the gain of V1. The two work together. When the reactance of $C_d$ is equal to the resistance of $R_d$ the total load impedance $Z_L$ will be very nearly equal to $R_L$ plus one-half the resistance of $R_d$. This will greatly increase the gain of V1.

Resistor $R_d$ should be made as large as possible. This will be limited, of course, by the power-supply voltage. The higher this resistance the lower the frequency to which compensation can be carried. A value of 10,000 ohms is a good choice. In our sample problem with the 6AH6 drawing a plate current of 12.5 ma, a 10,000-ohm resistor would create a drop of 125 volts. If a 425-volt supply is available we can use this value of resistor and still got the required 300 volts for the tube. If not, we will have to use a smaller value resistor for $R_d$.

$$E = I \times R = .0125 \times 10{,}000 = 125 \text{ volts.}$$

$$W = E \times I = 125 \times .0125 = 1.56 \text{ watts.}$$

For safety, $R_d$ should have a rating of at least 3 watts. Two 20,000-ohm, 2-watt resistors in parallel will do nicely.

When $R_d$ is very large the system will almost exactly compensate for the effects of C if the time constant $R_LC_d$ exactly equals the time constant $R_gC$.

This time constant should be quite large, somewhere between 0.025 and 0.5 second. As mentioned before, there is a limit to the resistance that may be placed in the grid circuit of V2. For a 6AG7 the maximum resistance is 1 megohm.

Suppose we choose a time-constant $t$ of 130,000 microseconds and a value of 0.25 μf for C.

$$C_d = \frac{t}{R_L} = \frac{130{,}000}{1{,}300} = 100 \ \mu f$$

$$R_g = \frac{t}{C} = \frac{130{,}000}{0.25} = 520{,}000 \text{ ohms}$$

This will give flat response almost all the way down to d.c. and would be fine if the video amplifier is to be used in an oscilloscope for observing frequencies down around 5 cycles.

The requirements are not so severe for television applications, and a time-constant of 52,000 microseconds would be adequate. C could have a value of 0.1 μf. This will give a response well within the required range. Then

$$C_d = \frac{t}{R_L} = \frac{52{,}000}{1{,}300} = 40 \ \mu f$$

$$R_g = \frac{t}{C} = \frac{52{,}000}{0.1} = 520{,}000 \text{ ohms}$$

A 510,000-ohm (standard value) resistor can be used in both cases.

The last item to find is the value of the screen resistor $R_s$. The screen of a 6AH6 requires 150 volts at a current of 2.5 ma. A 10-μf screen bypass capacitor will do nicely. Both $C_s$ and $C_d$ are shunted with .001-μf mica or ceramic capacitors to provide better bypassing at the high frequencies. With a 425-volt supply the drop in $R_s$ is

$$425 - 150 = 275 \text{ volts}$$

$$R_s = \frac{E}{I} = \frac{275}{.0025} = 110{,}000 \text{ ohms}$$

$$W = I \times E = .0025 \times 275 = 0.6875 \text{ watts}$$

A 2-watt resistor should be used for safety. This can be made up of two 220,000-ohm, 1-watt resistors in parallel.

Fig. 4 shows the final circuit with all values derived thus far for high- and low-frequency compensation.

Part III of this series will take up other types of *high-frequency* compensation. So far we have covered only the shunt peaking method (RADIO-ELECTRONICS, February, 1953).

(TO BE CONTINUED)

*Third Conversation—*
*"What Is Electronics" also interests Ken and Will this month. After defining electronics, they discuss the electron gun and C-R tube*


# TELEVISION?


# ...it's a cinch!

**By E. AISBERG**



Will—There's still one thing I can't get. When we were talking last time, you said mechanical TV systems had been abandoned in favor of electronic ones. Well, I think the Nipkow disc is electronic.

Ken—How did you get that idea?

Will—Aren't its atoms made of protons, electrons, and neutrons? What could be more electronic?

Ken—When we say electronic, we are talking about electrons in the pure state, separated from the protons; that is, electrons all by their lonesome. Now, where would you find that kind of electrons?

Will—Why, in vacuum tubes, of course; or at least in the part of the vacuum tube where the electrons make their jump from cathode to anode.

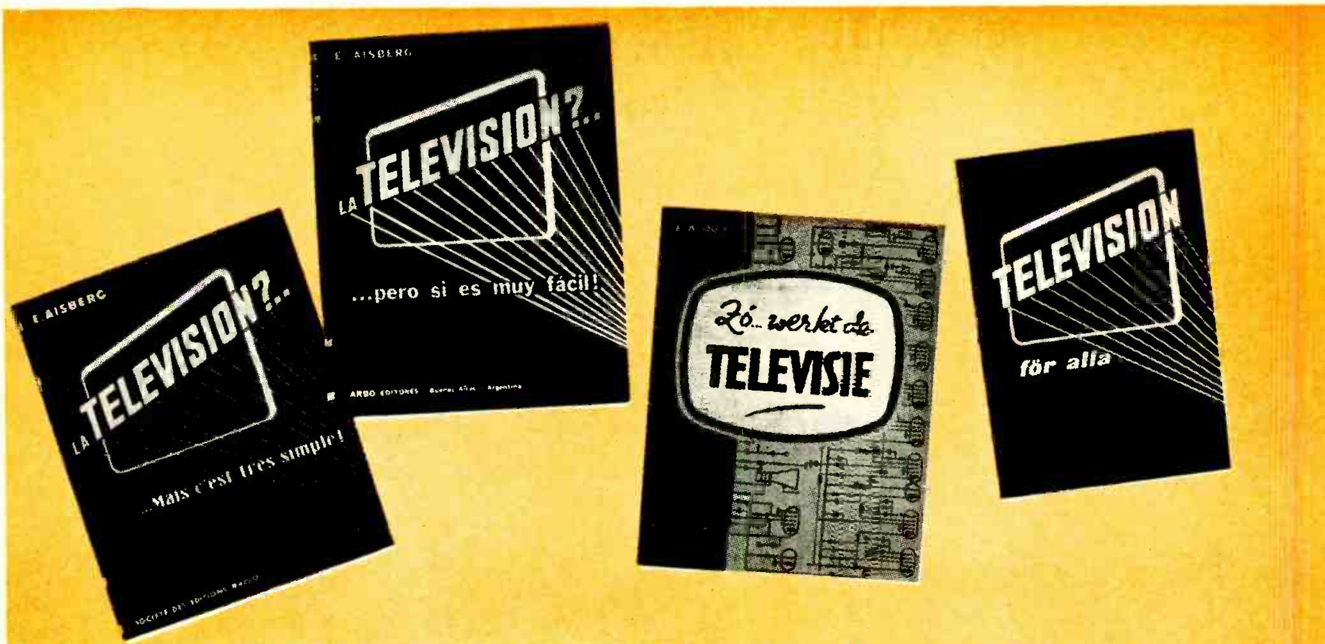
Ken—Correct! And—practically up to the invention of the transistor, every branch of the technique called *electronics* dealt with currents of electrons in vacuum tubes.

Will—Let's stick to television. Just how do they get the electrons that these modern systems use?

Ken—Just as they do in radio—by making them jump off a hot cathode.

Will—And then what do these electrons do?

Ken—Plenty! It's those electrons that turn your image into an electric signal at the transmitter, and then back to light at the receiver. Remember how the beam of light sweeps across the picture in the Nipkow disc? Well, in the electronic system, a *beam* of electrons scans the image, reading the elements line by line.




Will—I can understand electrons flowing from cathode to plate in an ordinary tube. But how can electrons be concentrated into a fine ray or beam, and then be moved across the image like the beam of light from the holes in the scanning disc?

Ken—That's what we're going to find out right now. The *cathode-ray tube* is the device which takes the place of the Nipkow disc and makes all these things possible. And—if it will make you feel more at home—we can start our cathode-ray tube out in life as a triode, much like those in radio. It has its differences, of course. First, it uses a cathode with a very small emitting surface (a so-called "point cathode") to concentrate the electrons.

Will—Get all your electrons together at the start, eh? Then they'll all follow the same path and stay in a tight beam.

Ken—My young friend, remember these electrons all carry the same (negative) charge, so they repel each other every step of the way. They're like those rugged individualists who won't co-operate to do useful labor unless they're compelled to. They try to get as far apart as possible unless some outside force makes them act sociable in spite of their own feelings.

## A peculiar tube

Will—Then where and how do you get these electrons together, if they keep spreading apart?

Ken—We usually start forcing them into a beam just after they've passed the anode.

Will—Say, what kind of a tube is this? You mean the electrons keep on going after they pass the plate?

Ken—That's just what I said. It has a hole in its center, and is kept at a high positive voltage, so it speeds up the electrons quite a bit before they pass through the hole, to finish their course a lot farther on.

Will—Funny kind of a tube!

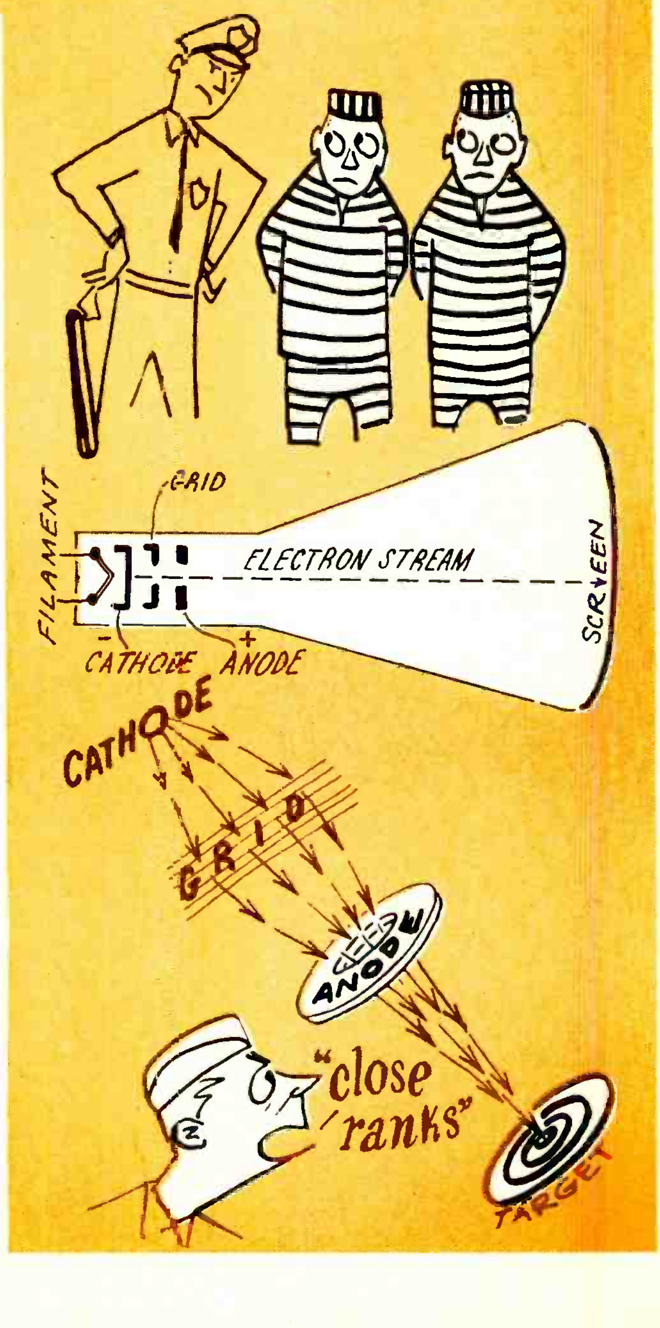
Ken—Funnier than you imagine! If the electrons going through a hole in the plate looks funny to you, what would you say to a *grid* that's really a cylinder around the cathode?

Will—How could a grid like that work?

Ken—Same as any other grid. If it's very negative, it repels the electrons back toward the cathode, so that a very few get by. When it's less negative, most of the electrons from the cathode can get through on their way to—and beyond—the plate.

Will—Is this flow of electrons large?

Ken—No, the current in a television picture tube is a lot smaller than in a receiving triode. It can be in the order of a hundred microamperes. And the cathode-ray tube would be pretty useless as an amplifier, too. Its transconductance



is only a few microamperes per volt, and its internal resistance is likely to be in the order of a hundred megohms!

### Light artillery

Will—So if it won't amplify, what *does* it do?

Ken—It acts like an electronic machine gun. Television needs a device that will produce quantities of electrons and—more important—regulate that quantity. So, in a receiving cathode-ray tube, or *kinescope*, you find this piece of electronic artillery (actually called an *electron gun*) at the rear of the tube, next to the socket.

Will—I take it that these kinescopes are real vacuum tubes—there's no air in them?

Ken—Of course. Otherwise our electrons would collide with heavy molecules of air and lose their speed. You need a vacuum as near perfect as possible in a cathode-ray tube, on account of the long distance the electrons have to travel as compared with ordinary receiving tubes.

Will—I'm like Nature; I "abhor a vacuum." But this one in the picture tube looks worse than most to me. Have you stopped to think that the surface of the tube has to support all the pressure of the atmosphere, or about 15 pounds per square inch?

Ken—I know. Now, surely you remember how to calculate the area of a circle? Suppose you tell me just what the pressure is on the face of, say, a 16-inch tube.

Will—Let's see. . . . A little more than 200 square inches . . . ! Why, over a ton and a half!

Ken—And if you figure in the sides of the cone and the rest of the tube, you run up about another ton and a half. Altogether, you have the weight of about 40 people pressing in around your tube.

Will—A bus-load of people! A tube like that must have to be fantastically strong!

Ken—Yes. Maybe you've noticed that the face of almost every tube is curved slightly outward for greater strength. And the cone is often made of steel.

Will—In spite of all that, I think I'll do my television experimenting up on a mountain.

Ken—A mountain . . . ? ?

Will—To keep the tube from exploding. The higher up you go, the lower the air pressure.

Ken—That's true, but come back to earth long enough to correct a mistake. The word is "implode," not "explode." And implosions are rare, which is a good thing. It's dangerous to be around when a picture tube comes apart; besides, they cost money!

### The fluorescent screen

Will—What happens to the electrons from the gun when they get to the end of the tube?

Ken—The inside of the tube face is covered with a translucent layer that glows where the electrons hit it.

Will—Is that the same kind of stuff the hands of my watch are painted with?

Ken—No, that material is *luminescent*—a substance that glows by itself without being excited by light or some other radiation. A picture-tube screen is covered with *fluorescent* material—stuff that glows when it's excited by some other (usually invisible) radiation of a shorter wavelength than visible light.

Will—Is that the principle behind fluorescent lighting?

Ken—Yes. In a fluorescent lamp, an electric discharge in the mercury vapor inside the tube produces invisible ultraviolet rays. When they strike the inside of the tube, which is covered with fluorescent material, it glows and produces visible light.

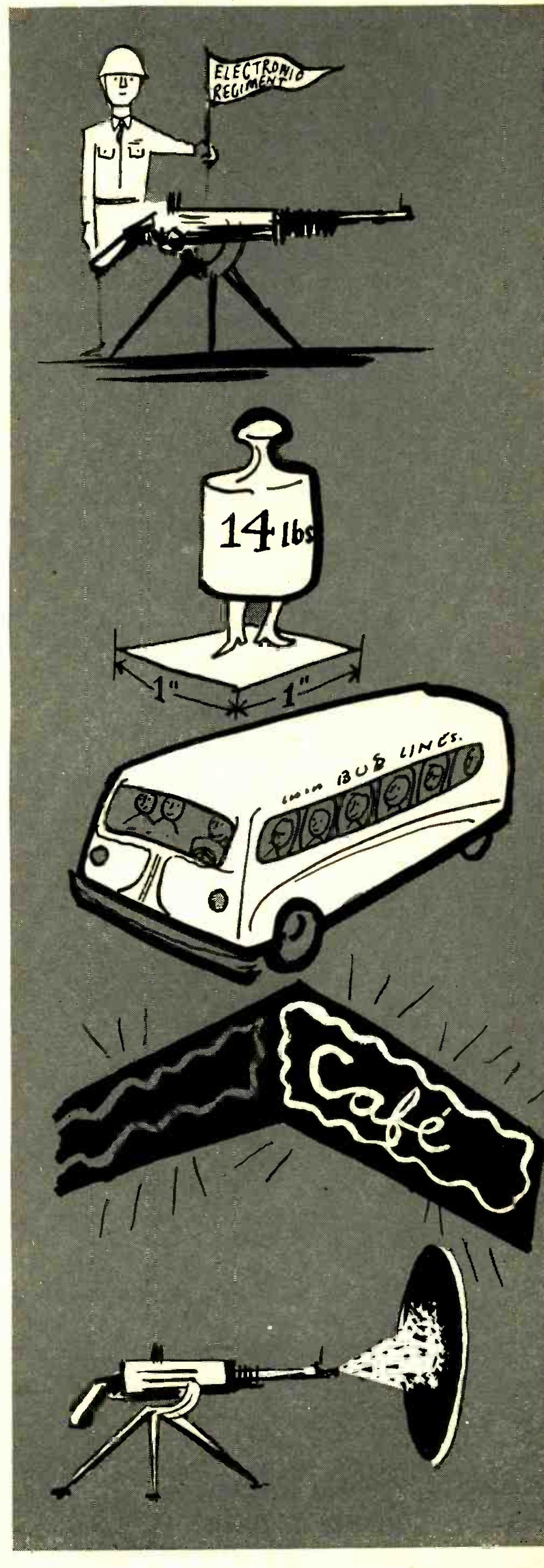
Will—Your fluorescent tube is a sort of superheterodyne, then?

Ken—What?

Will—Doesn't it change the very high frequencies of ultraviolet light to the lower visible frequencies?

Ken—You're right, at that. But let's get back to the job. We have an electron gun that shoots its projectiles to the screen and makes it glow. But because the bullets spread out, we get a large bright spot on the screen. Trying to outline an image with a spot like that would be like trying to paint the fine details of a picture with a whitewash brush.

(TO BE CONTINUED)



# DX PROSPECTS FOR UHF TV

*Hams work u.h.f. dx with negligible power—Why not TV?*

ABOUT twenty-five years ago one of the leading technical journals published a learned article on wave propagation. Based on all that was known of the subject, it tried to predict what we would find when we started to use that portion of the radio-frequency spectrum now known as v.h.f. and u.h.f. It was a masterful job, and it set the pattern of wave propagation reasoning for years to come. There was only one thing wrong: the authors of the article had no way of knowing that there were many factors that would soon rise to complicate their neat picture of a "line-of-sight" world above 30 mc or so.

As soon as amateurs—then invariably the first mass users of new radio frequencies—started to make general use of their 5-meter band, they began to run across things that caused much head-scratching in scientific circles. In one of the finest pieces of original research ever done by an amateur in any field, a 5-meter enthusiast established the basic correlation between weather and v.h.f. propagation, and in the middle '30s first stated the now-accepted theory of air-mass boundary bending of v.h.f. waves.

The amateur discovery of sporadic-E dx on 56 mc followed soon after. Then 5-meter hams found that they could bounce their signals off the aurora to points several hundred miles away. Showing how far off were the early estimates of the potentialities of the v.h.f. region were: reflections from ionized meteor trails; 50-mc dx of world-wide proportions with the passing of a sunspot cycle peak in the years immediately following World War II; several as yet incomplete studies of tropospheric and ionospheric scattering and other forms of v.h.f. dx. *Line-of-sight* indeed!

It was the great error in properly assessing the dx possibilities of the frequencies assigned to v.h.f. television that led to the allocations freeze just recently lifted. V.h.f. assignments have been reshuffled in the light of present-day propagation knowledge, and commercial use of the new u.h.f. band is now getting under way. Will we run into the same confusion with u.h.f., too? Will there be u.h.f. dx, and if so, what will it be like?

Right now it's anybody's guess, though scientific research and amateur operation have combined to give us some clues. The field has been extensively investigated by competent propagation scientists, and much more is known of u.h.f. today than was known of v.h.f. when the first modern TV stations went on the air. Then, too, we have the benefit of several years of use by amateurs of their 420–450-mc band, not far below the low end of the u.h.f. TV band. As they have done many times in the past, hams have been making good use of their u.h.f. assignment, and some of their experiences may be of interest.

Just as with v.h.f. in the early '30s, hams started in on 420 mc with the line-of-sight concept thoroughly accepted. At first everyone thought that the only way to work any distance was to make for the highest mountain-top in the area. We know now that altitude helps, of course, but some of the best distances yet covered in the 420-mc band have been between ordinary home locations at or near sea level. There have been several contacts of more than 250 miles between stations in southern New England and the Washington, D. C., area. In September, a southern New Jersey ham on 435 mc was heard not far from Cleveland, Ohio, nearly 400 miles. Over in Algiers, a North African amateur worked across the Mediterranean to Toulon, France, 500 miles, on 435 mc. Did someone say "line-of-sight"?

It takes something rather special in the way of weather to bring about this sort of thing, but the signs are much the same as with tropospheric dx in the v.h.f. channels. Followers of RADIO-ELECTRONICS' monthly TV dx predictions have come to know these signs well. We know that under normal conditions the u.h.f. signal doesn't get through quite as well as the v.h.f. one, and here we have many amateur comparisons between the 144- and 420-mc bands for evidence; but when there is pronounced tropospheric bending on v.h.f. it is really hot on u.h.f. When we get some good receivers and antennas going, there are some surprises due in u.h.f. TV, especially at distances out to 200 miles or so!

All the evidence points to considerably more variation in signal level at u.h.f. Weather variations, atmospheric turbulence, the summertime coastal inversions, dense fog—all these will affect u.h.f. signal levels to a marked degree. There will be more fading on u.h.f., and it will show up at closer range than on the v.h.f. channels.

On one 210-mile path where two amateurs have run frequent tests on 50, 144, and 435 mc, the strongest signal ever heard over the distance was on 435. Normally the u.h.f. signal doesn't get through at all, although v.h.f. signals are usually reliable. When the 144-mc signal begins to build up markedly, the 435-mc signal gets through too. When things are hot the 435-mc signal is stronger than the lower frequencies.

There are many things we don't yet know. A commercially conducted experiment has demonstrated that u.h.f. signals can be reflected off the moon, raising the possibility of world-wide u.h.f. dx if the technique can be sufficiently improved. Propagation peculiarities as yet not well evaluated may turn up many interesting results.

Amateurs, too, have succeeded in bouncing signals off the moon and recording the results. (See "The Radio Month" in this issue.—*Editor*)

Yes, there will be u.h.f. TV dx, too, and once again the TV dx enthusiast has a chance to contribute to our store of propagation knowledge. Dx observations by thousands of viewers have turned up much useful and interesting information. It goes without saying that history will repeat itself soon in the u.h.f. field. What say, dx-ers—who will send in the first u.h.f. dx report? END

# TV SERVICE CLINIC

**Conducted by MATTHEW MANDL***


Fig. 1—Bending of vertical picture lines may have several causes. See text.

THE television technician must always be prepared for dual troubles when the apparently obvious solution does not solve the problem. Thus, loss of picture and sound with a raster present would normally mean trouble ahead of the sound take-off point. Sometimes, however, this is caused by trouble in *both* the sound and video-amplifier circuits.

Another reason for failure of normal corrective procedures could be manufacturing changes. For instance, Arthur Moreton of Morrisville, Pa., wrote about an Admiral 20B1 combination he took in for servicing. The complaint was a loud hum which was present only when a station was tuned in. Suspecting a cathode-filament short in the local oscillator, Mr. Moreton tried tube substitutions, which did not help. Upon pulling the chassis he found the fine-tuning unit saturated with oil which apparently had leaked to it from too much lubrication between the fine-tuning shaft and the channel-selector shaft.

The excess oil was removed and the receiver now had considerably less hum than before. The fine tuning was able to eliminate most of the hum, where before it had little effect. The hum was still audible, however, and much higher than on similar models.

A check of the supplemental information for this receiver disclosed that tunable hum in some of these models (early runs) could be corrected by connecting a 2,200-ohm, ½-watt resistor and a 0.1-μf, 400-volt capacitor from the a.g.c.-tube anode (pin 5) to ground. Another recommendation was to connect 25 inches of ½-inch bonding braid under the bracket holding the webbing for the picture tube (side nearest the audio lead). The other side of the braid connected under the power supply chassis, at the mounting screw nearest the audio lead.

Another problem which technicians often encounter is an adequate check of coils and transformers. A simple continuity check with an ohmmeter often will not disclose any fault, yet the inductor may act up when the receiver is on and upset normal circuit functions.

Paul Barks of Winfield, Iowa, reports such a condition in a number of Motorola receivers using chassis TS-401, and in earlier production models using similar horizontal sweep circuits. Usual symptoms are picture tearing without complete loss of sync, plus sectional picture tearing which breaks up portions of an actor's face or body.

The first time Mr. Barks encountered this symptom he checked the phase detector and the cathode-coupled multivibrator horizontal-sweep generator. Tubes, voltages, resistors, and capacitors all checked satisfactorily. He disconnected the ringing coil, checked it for continuity, and found nothing wrong. He finally resorted to changing parts in the horizontal oscillator circuit, and when the ringing coil was replaced the trouble disappeared. Subsequently he corrected a number of other similar receivers by replacing the coil. He recommends doing this when such symptoms appear because considerable time can be saved in checking tubes and components needlessly.

## Picture pulling

*In a Hoffman model 637 receiver there is severe picture pull and the vertical lines tend to weave. Intermittently on severe pulling the screen goes black and picture is lost for a while. I have replaced all tubes in the horizontal and vertical sweep circuits and have checked parts. What could cause this trouble?—F. K., Norfolk, Va.*

When the picture bends or weaves as shown in Fig. 1, the trouble could be caused by any one of the following conditions:

- Improper adjustment of horizontal lock system.
- Defective tubes or parts in the horizontal sweep system.
- Defective tubes or parts in the sync-separator stages.
- Improper sync amplitude caused by poor tuner tracking or video-i.f. alignment.
- Signal overload or defective a.g.c.

Video-amplifier tubes sometimes contribute to pulling by clipping a portion of the sync tip. This can happen even in a tube which checks all right in an emission tube checker. Tube cutoff occurs sooner than it should and clips the highest level of the signal (the sync tips).

The intermittent blanking out, however, seems to indicate a.g.c. trouble, and you should try a new 6AU6 a.g.c. rectifier. Insufficient a.g.c. voltage can cause overload by allowing excessive gain, and sufficient overload can blank out the picture.

## Delta-match Yagi

*I am constructing a channel-4 Yagi antenna and want to use a delta match as shown in the sketch (Fig. 2). Are these dimensions all right? What is the gain of this antenna, both single and stacked?—P. T., Ontario, Canada.*

Your specifications are substantially correct for channel 4. The antenna length of 81.2 inches is satisfactory and favors the audio carrier slightly. Some manufacturers use 80 inches, which hits the center of the band more accurately. The extra 1.2 inches will make little difference at the relatively low frequencies of channel 4 as compared with the higher channels.

A single Yagi of this type has a gain of approximately 10 db compared with a matched reference dipole. Stacking

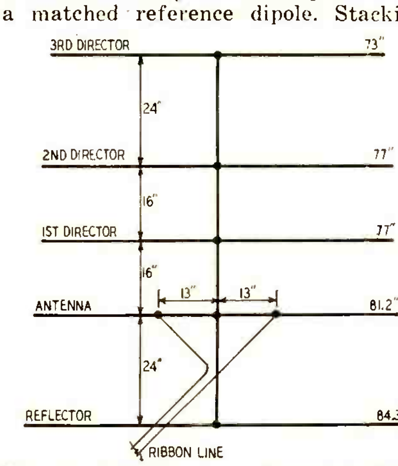



Fig. 2—Details of a channel-4 Yagi.

*Author: Mandl's Television Servicing

increases the gain an additional 3 db.

The delta match permits an impedance match to the transmission line and eliminates the need for an insulator. The impedance is zero where the antenna connects to the mast and rises as the lead-in connection moves away from the center of the antenna. Thus a variety of transmission-line impedances can be matched. The points to which the lead-in connects to the dipole (in the diagram) are approximate for 300-ohm line. Experiment for best results.

### Trailing smears

*In an Emerson 711 receiver there are trailing smears to the right of large objects. Please detail the various causes for this.—R. G., Uniontown, Pa.*

This is usually caused by poor low-frequency response in one or more of the circuits carrying the video signal to the picture tube. Initially, all tubes should be checked from the tuner through the video i.f. stages, detector, and video amplifier. If this doesn't help, check for defective components in the video amplifier and detector circuits. In particular look for leaky coupling capacitors as well as for open capacitors in the R-C networks feeding voltages to the various tubes (the decoupling networks).

Finally, the tuner-tracking and video-i.f. alignment will have to be checked. If the video carrier is too far down on the response curve, the low-frequency video-signal components are not amplified sufficiently, with resulting poor low-frequency response and trailing smears.

### Contrast in RCA 17T160

*In an RCA 17T160 receiver I can't get sufficient contrast. I've tried adjusting the a.g.c. control and also have replaced the a.g.c. tube. The a.g.c. voltage changes with a change of received signal strength. What could cause the poor contrast?—H. P., Olney, Ill.*

In this receiver the 6AV6 first-audio amplifier acts as a bias clamp for the a.g.c. This tube and the a.g.c. amplifier should be checked when trouble symptoms are present. From your description, however, it appears that the a.g.c. system is working all right. First, try new tubes in the tuner, video i.f. stages, and video amplifier. Also check the crystal video detector. Make sure the closed-circuit jack in the cathode of the video amplifier (6AG7) actually connects the .0033-μf capacitor to the cathode, otherwise degeneration will result and the contrast level will decrease. The antenna system should also be checked for possible defects which could reduce signal input to the receiver.

If these measures fail to disclose the trouble, check all supply voltages and alignment.

### TVI in radios

*What can be done to minimize the squeals and whistles which are set up in radios from nearby television receivers? Which television circuits are the cause for such interference?—E. G., St. Albans, N. Y.*

Any television-receiver wires carrying the 30-cycle to 4-megacycle video signal can radiate and cause radio interference. The span of video frequencies falls not only in the broadcast band, but also includes the i.f. of the radio receiver. Another—and much more common—interference source is the high-voltage compartment. This produces 15,750-cycle pulses which are rich in higher-frequency harmonics. (Considerable radiation of these frequencies may take place from the picture tube itself. This is especially true of metal-shell types, in which almost the entire body of the tube is insulated from ground and forms an effective radiator for high-frequency harmonics of 15,750 cycles. In some cases this interference can be reduced by connecting a 500-μμf, 20,000-volt capacitor between the tube-rim contact and the TV-receiver chassis.—*Editor*) In addition, the 75-kilocycle signal established by yoke resonance and the transients developed by the collapsing horizontal-deflection field contribute to radio interference. The latter can be reduced (but not eliminated) by more adequate shielding of the television receiver. Unshielded high-voltage compartments should be covered, and the inside of the cabinet can be lined with aluminum foil grounded to the chassis. The cable from the television receiver chassis to the picture tube can be shielded, but if the shielding is too close to the wires some of the higher-frequency video signals will be shunted. This will decrease fine detail.

Interference can be reduced also by increasing the radio's efficiency. This can be done by peaking up the tuner tracking, i.f. alignment, and replacing old tubes to restore maximum gain. In some cases an outside antenna will increase the signal pickup and reduce the effect of TVI. All these procedures help, but if the radio is moved too close to the television set, interference will still be heard. Owners of table radios should keep them in rooms remote from the television receiver, and change their positions so the loop antennas are oriented for minimum interference pickup. Careful tuning of the radio and adjusting the drive control in the TV receiver for the proper level also help.

### Blooming and focus

*In servicing a Du Mont RA-113 receiver, I am unable to get good focus. An advance of the brilliancy control causes blooming and an additional advance causes picture loss. The focus control starts to clear the picture only at full clockwise rotation. I have checked the focus coil and the focus control with its resistive network. I've also replaced the 6BG6, 6W4, and the two 1X2 tubes but no change. Sound is normal. What other defects could cause this? I've tried a new picture tube, but symptoms were the same.—W. R., Detroit, Mich.*

Blooming indicates insufficient high voltage. This reduces the velocity of the electron beam within the picture tube to the point where it cannot dislodge the space-charge electrons on the phosphor screen. As the brightness control is advanced, more electrons accumulate on the tube face, until eventually the beam cannot penetrate the space charge.

This will result in loss of picture and raster. Focus is usually affected and the range of the focus control is changed. You could, of course, alter the resistance of the focus-control circuit until the control gives best focus at center setting. First, however, correct the blooming.

Make sure the ion-trap magnet is at the setting which gives maximum brilliancy, regardless of corner shadows or its effect on beam position. Corner shadows can be eliminated by adjusting the focus unit (picture positioning).

Check for defective components in the horizontal-output circuit, as well as for low B voltages. Try a new low-voltage rectifier and check the filter capacitors for leakage which might be loading down the low-voltage supply. Also check the horizontal drive. This should be set just below the point where left-hand stretch or center compression occurs.

### Resistor failures

*In a Regal 630-type chassis I am getting repeated burnout of the 1,800- and 270-ohm resistors in the focus-control circuit. Occasionally the focus control also becomes defective.—J. M., Greenwich, Conn.*

These resistors, plus the focus control and focus coil, are part of the network feeding the ion-trap coil and the minus 2- and minus 18-volt circuits. (Fig. 3) An overload in any section of the receiver fed by this network would

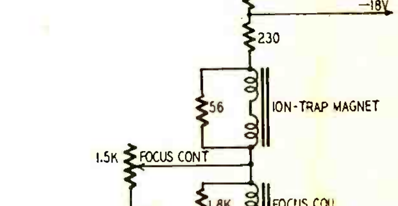



**Fig. 3—Focus-control and negative-d.c. supply circuits in 630-type TV receivers.**

cause excessive current through the focus-control network and the associated resistors. Overloads could be caused by defective filter and bypass capacitors, gassy tubes, or partial shorts. You may have to check a great many parts, for the trouble may be remote from the focus-control circuit. Take resistance readings of the various circuits involved to find where resistance is below normal. END

# TV SIGNAL TRACING

*TV presents other problems and requires different equipment than radio service*

By ENGINEERING STAFF
SCALA RADIO CO.*

SIGNAL tracing in TV receivers differs in several respects from signal tracing in radios. First, the range of frequencies found in TV circuits is very much broader than in radio. Second, the supply and signal voltages in TV chassis cover a much wider range than in radio work. Third, the circuit impedances in TV receivers range from less than one ohm to as high as 10 megohms or more. Fourth, signal tracing in radios is usually concerned with sine-wave signals, while these are the exception rather than the rule in TV. TV circuits often operate with two signals present at the same time, such as the FM sound signal and AM picture signal, or 60-cycle vertical sync signal and 15.75-kc horizontal sync signal.

Other important differences will be developed later in this article.

The operating frequencies in the r.f., i.f., and—under some conditions—in the video amplifier of a TV receiver are too high for the usual service scope to display directly. For this reason, signal tracing in the r.f. and i.f. amplifiers requires *demodulator*, or detector, probes,

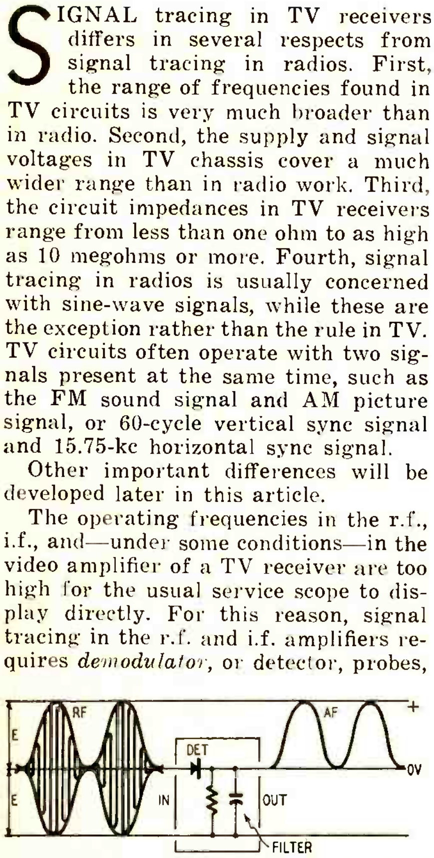
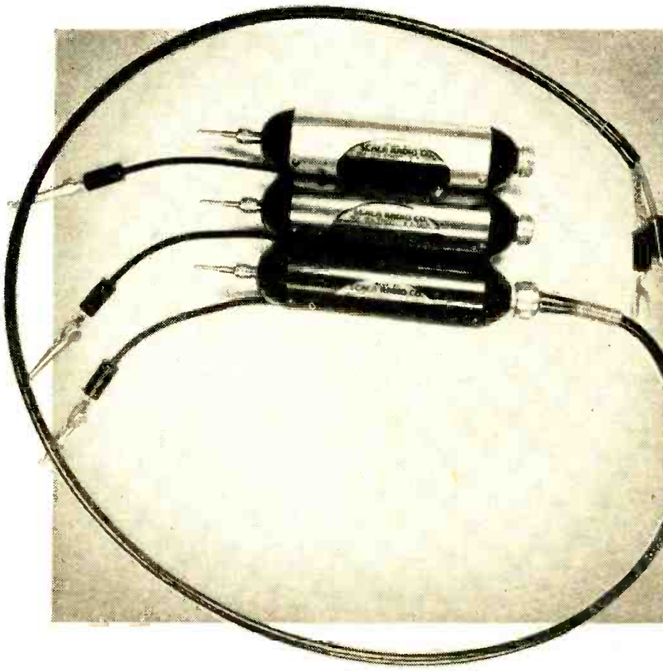



**Fig. 1—Most service-type scopes cannot reproduce a h.f. carrier. If the wave is modulated and rectified by a crystal-detector probe, the low-frequency envelope can be seen on almost any scope.**

which rectify the modulated waveform and recover the modulation envelope. For example, the carrier frequency of a modulated wave may be 30 mc, while the modulation envelope may represent a frequency of perhaps 1,000 cycles. The scope can display the 1,000-cycle output from the demodulator probe, although it cannot reproduce the modulated 30-mc carrier. The average value of a symmetrical sine-wave-modulated carrier is zero, as shown in Fig. 1.

Demodulator probes are usually built around crystal-diode detectors, because these devices are compact, have good frequency response, and do not require a source of heater voltage.

Both series- and shunt-type detectors



**Three types of oscilloscope probes used in TV test work. (Top) Crystal-demodulator signal-tracing probe; (center) low-capacitance high-impedance 10-1 voltage-divider probe; (bottom) 100-1 capacitance-divider high-voltage probe.**

(see Fig. 2) are used in commercial probes, and it will be found that the series type is the more sensitive for signal-tracing purposes. However, it will also be found that the series probe is the least suitable for video-amplifier testing, and will seriously distort the sweep output waveform.

For this reason, practical crystal demodulator probes usually have moderate sensitivity, an input capacitance approximately equal to that of a picture tube, and a time-constant suitable for demodulating carrier frequencies which have been modulated by frequencies as low as 60 cycles.

Shunt-type probes are generally found most suitable for signal tracing as well as for video-amplifier checking.

## Testing video amplifiers

There are two general methods of

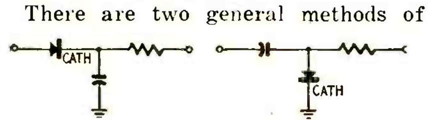



**Fig. 2—Series (left) and shunt detectors. The series resistors prevent the scope input capacitance from shunting the detector and reducing the output.**

testing a video amplifier. One technique is to apply a sweep signal to the input of the amplifier, and to display the amplifier output on the scope screen. Most service scopes will not respond to frequencies of 4.5 or 5 mc, and a demodulator probe must be used to develop the visual-response curve. The video sweep signal used in such tests varies from a low frequency of about 100 kc to 5 or 6 mc, 60 times a second.

A demodulator probe which is satisfactory for i.f. signal tracing may be quite useless for video-amplifier testing. The reason is that the response of the video amplifier depends in great part on the *shunt capacitance* across the output. If this shunt capacitance is greater than the input capacitance of the picture tube, the high-frequency response will appear to be very poor. On the other hand, if the shunt capacitance of the test circuit is less than the input capacitance of the picture tube, the frequency response will appear to be better than it really is.

Obviously, the input impedance of the demodulator probe must equal the picture-tube input impedance. The probe must also have good response to 60-cycle square waves, because the demodulated sweep output is of the same general form as a 60-cycle square wave, and if the time-constant of the probe is too long, the scope will indicate a true rise but a false fall of the response curve.

## Square-wave testing

The square-wave test is more informative than the sweep-frequency test, because it shows up phase distortion as well as frequency distortion in the video amplifier. Phase distortion is just another way of expressing abnormal time delay, which means that small picture elements may arrive slightly later or slightly earlier than large picture

*San Francisco, California

elements regardless of their positions in the original picture. Accordingly, phase distortion causes the small picture elements to be displaced horizontally with respect to the larger picture elements, and the observer describes the picture as "smeary."

For accurate square-wave tests on video amplifiers, the vertical-deflection

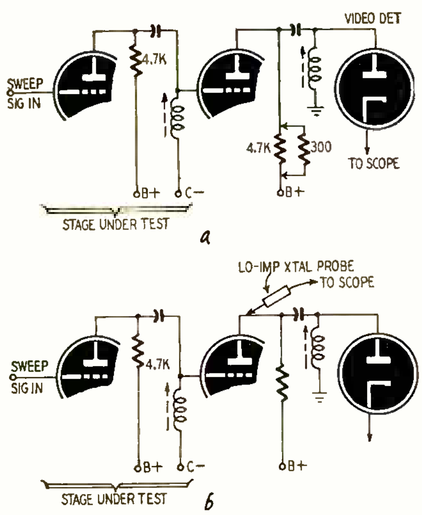



**Fig. 3—(a) In stage-by-stage alignment using the video-detector output to feed the scope, intermediate stages must be shunted as shown to prevent their resonant peaks from affecting the scope trace. (b) A *low-impedance* demodulator probe automatically shunts the following stage and feeds the scope.**

amplifier in the scope must have better frequency and phase characteristics than the TV receiver. Otherwise, the output from the video amplifier must be applied directly to the vertical-deflection plates of the scope. (This gives the best possible frequency and phase re-

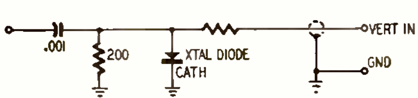



**Fig. 4—Low-impedance probe circuit.**

sponse from the scope, but has the disadvantage of providing only 3/8-inch to 5/8-inch deflection on the scope screen.)

Never feed the output of the video amplifier directly through a cable to the input of the scope. Any usable length of cable will have very much greater capacitance than the grid-cathode circuit of the picture tube, and the square-wave response on the scope screen will be grossly misleading.

To avoid such distortion, a low-capacitance probe must be used, and this probe should have the same input capacitance as the picture tube.

If the output of the video amplifier is applied directly to the deflection plates of the scope, the connection must be made with a short, *unshielded* test lead.

Of course, the socket is removed from the base of the picture tube in all such tests, because the input capacitance of the scope setup is substituting for the input capacitance of the picture tube.

## Stage-by-stage response

The reader no doubt will point out that he requires another important application from his crystal probe—namely, the ability to reproduce stage-by-stage i.f. response curves. Some TV receiver manufacturers suggest this method of i.f. alignment.

There are two general methods of making such a stage-by-stage alignment, one of which requires a crystal probe. These two methods are indicated in Fig. 3. In the first method (*a*), the picture detector serves as a demodulator for the alignment of any one stage. In *b* the demodulator probe serves this purpose, and the use of a number of shunting resistors is avoided.

A low-impedance probe is usually considered necessary for this sort of work, as illustrated in Fig. 4. However, if a 300-ohm resistor is shunted temporarily across the plate load of the circuit to which the crystal probe is applied, the usual crystal probe will serve quite well. The shunt resistor swamps out the unwanted resonance of the plate load, and the crystal probe demodulates the sweep output from the stage under test.

Accordingly, a low-impedance crystal probe is not necessarily required, and a probe that is satisfactory for video-amplifier work also serves satisfactorily for stage-by-stage i.f. work.

## Sweep-circuit testing

Unlike radio testing, TV testing is concerned with *shapes* of waves in very many cases, and with various *types* of voltages. For example, a normally operating TV receiver may produce the typical waveforms indicated in Fig. 5, while a "sick" receiver may produce the variants shown in Fig. 6. And every little variant has a meaning all its own; the problem of the technician is to learn to read this new language, and to be able to spot the receiver component responsible for the waveform distortion.

These waveforms also represent different kinds of voltages. The TV technician hardly ever speaks of r.m.s. voltages used so widely in radio work. Instead, he speaks of peak-to-peak voltages, positive-peak voltages, and negative-peak voltages. These relations are shown in Fig. 7.

The probes used to apply these waveforms to the input of the scope must also attenuate their voltages by known factors, so that their peak-to-peak (or other) values can be read from the scope screen. It is customary in probe design to make the attenuation factor either 10-to-1, or 100-to-1. That is, if we apply a 100-volt wave to the input of a 10-to-1 probe, 10 volts will be applied to the input of the scope. Then, if the scope screen has been calibrated for a sensitivity of 1 volt per square, the 100-volt wave will produce 10 squares of deflection of the screen.

The technician does not want to recalibrate his scope every time he plugs in a probe, and he does not have to—provided he uses such a *decimal* probe—that is, a 10-to-1, or 100-to-1 probe;

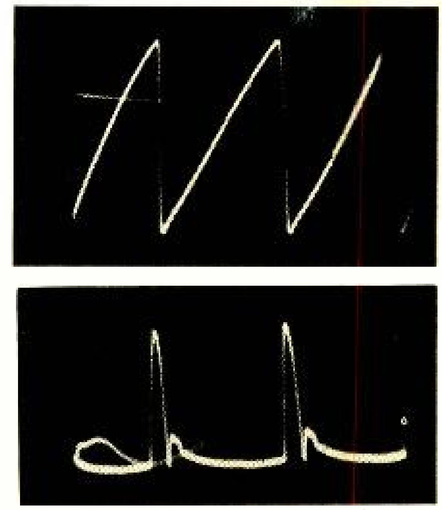


**Fig. 5—(Top) Normal current trace in horizontal yoke windings. There is only slight non-linearity, and a trace of ringing at the start of each sawtooth. (Bottom) The 15,750-cycle ripple component in the high-voltage d.c. output. (Both waveforms were fed to the scope vertical-input circuit through capacitive voltage-divider probes.)**

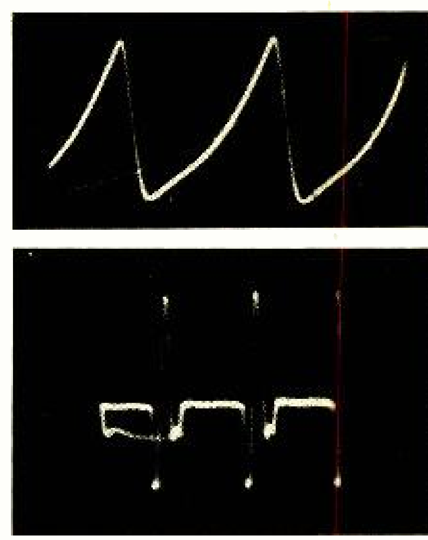


**Fig. 6—(Top) Distortion in horizontal yoke current. Nonlinearity shown would compress left side of picture. (Bottom) Negative undershoot in high-voltage waveform drives the plate of the horizontal-output amplifier negative. This may generate Barkhausen oscillations, causing vertical bars on screen.**

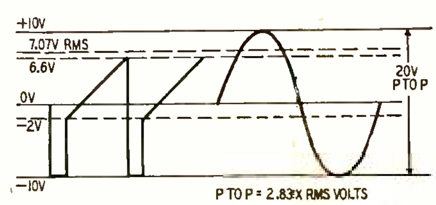



**Fig. 7—Effective (r.m.s.) voltages can be applied accurately only to the measurement of symmetrical sine waves. The amplitudes of trapezoids, pulses, and other irregular waveforms are generally expressed in terms of peak-to-peak, positive-peak, or negative-peak voltages, which can be read on a scope.**

he merely adds *one zero* to his original calibrating factor.

When checking the waveform across the horizontal-deflection coils, the low-capacitance probe, which is also an attenuating probe (usually 10-to-1), can be utilized to advantage, not to provide increased input impedance, but to attenuate the source voltage to a point at which the scope amplifier is not overloaded.

Another important consideration concerns checking the waveform at the grid of the vertical blocking oscillator. In this circuit the oscillator grid leak is sometimes as high as 10 megohms.

The technician who attempts to test such a circuit will find that the input impedance of a direct cable to the scope is *far too low* for this application. Its capacitance will shunt the oscillator tank circuit, will cause a loss of signal voltage, and may seriously disturb circuit operation.

To avoid this difficulty, the technician may try a low-capacitance probe. Although the probe will eliminate the first difficulty, it usually will introduce another: The *input resistance* of the probe, being less than 10 megohms, will drain away too much of the d.c. bias voltage, again seriously disturbing circuit operation. When this difficulty is encountered, the technician must use a blocking capacitor in series with the low-capacitance probe.

Special low-capacitance probes are available which do not offer a d.c. path to ground, and thus eliminate grid-bias disturbances.

### Checking high-voltage circuits

High voltage can do harm in these ways: It may *overload* the scope amplifier and distort the displayed waveform, without doing actual physical damage to the scope. It may puncture blocking capacitors, and char or burn out attenuator resistors. It may arc through insulating washers and carbonize terminal strips.

The plate of the horizontal output tube represents a typical circuit point that is potentially dangerous to the scope input system.

The voltage at the plate of the horizontal output tube, or at the plate of the high-voltage rectifier tube is always "high" as far as conventional scopes are concerned. To protect the scope against physical damage in such tests, a high-voltage a.c. probe is required. Such probes are constructed as capacitance dividers.

### Looking ahead

The reader has now been introduced to some of the fundamental properties of special scope probes which are useful in TV service applications. In the next article he will be taken on a tour through a practical servicing situation. He will learn what various distortions mean in TV waveforms, how to calibrate a scope, and how to obtain true waveforms.

We'll be seeing you.

(TO BE CONTINUED)

# PEAK-TO-PEAK CALIBRATOR

## By GEORGE E. ROW

THE ability to measure *peak-to-peak voltages* of sweep and video-signal waveforms can help the service technician save considerable time in trouble-shooting TV receivers. Some late-model v.t.v.m.'s read peak-to-peak voltages directly, but generally the most convenient method is to use a calibrated oscilloscope, as this allows you to check waveform and voltage in one operation. Expensive laboratory-type scopes have built-in voltage calibrators, but the average service instrument requires an external calibrating unit.

The circuit selected (Fig. 1) combines simplicity with adequate accuracy for service applications. Sine-wave voltage from the power line (adjustable over a range of about 20 to 100 volts) is stepped up in the transformer and applied to a tapped voltage-divider network. At full input (with the 100-ohm resistor shorted out), the *effective* secondary voltage is 400. With a perfect sine wave this is equivalent to 1,120 volts *peak-to-peak* (2.8 × 400). The powerline waveform is so nearly sinusoidal that there is no appreciable error. By reducing the input with the 100-ohm resistor we can make the maximum peak-to-peak output exactly 1,000 volts. (This is equivalent to an *effective* voltage of 350, which will push 10 ma through the meter circuit.) Thus 10 on the meter corresponds exactly to 1,000 volts peak-to-peak, and lower readings represent proportional voltages.

The voltage divider allows you to tap off fixed fractions of the output, so that any peak-to-peak voltage from 1 to 1,000 can be obtained by adjusting the divider switch and the 500-ohm potentiometer.

The a.c. milliammeter is a *moving-iron* type, *not* a rectifier-type d.c. instrument. This simplifies the circuit, and gives maximum accuracy, since the circuit operates only on the 60-cycle frequency for which the meter is designed. The values of the resistors in the meter multiplier and bleeder are such that the maximum error introduced by the shunting effect of a 1-megohm oscilloscope input is limited to 2%. The total resistance of the meter and multiplier is 35,200 ohms.

The entire assembly fits conveniently into a standard 4 x 6 x 9-inch steel cabinet. An old booster chassis was used for mounting the transformer and bleeder network. The transformer

**The completed oscilloscope calibrator.**

was mounted in the center of the chassis to concentrate the weight in the middle of the completed instrument. The potentiometer and high-wattage section of the bleeder were mounted in the upper left-hand corner of the cabinet to avoid overheating the meter.

**Materials for Calibrator**

**Resistors:** 1—23,333 ohms, 1—100 ohms, 5 watts; 1—6,666 ohms, 1—2,333 ohms, 1—666.6 ohms, 1—233.3 ohms, 1—66.6 ohms, 1—23.33 ohms, 1—6.66 ohms, 1—2.33 ohms, 1—1 ohm, 1 watt. 1—35,000 ohms approx., 10 watts (see text); 1—500-ohm, 25-watt potentiometer; 1—100 ohms, 5 watts, adjustable.
**Miscellaneous:** 1 power transformer, 400 volts c.t. at 20 ma; 1—single-pole, 10-position selector switch; 1—0-10 a.c. milliammeter (Triplett type 3375 or equivalent); 1 s.p.s.t. toggle switch; 1—117-volt pilot light and socket; 1—chassis; 1—4 x 6 x 9-inch steel cabinet; 1 TV-type interlock line cord and receptacle; terminals; knobs; wire; solder; hardware.

Ventilating holes 1½ inches in diameter were made in each end of the cabinet and in the bottom and covered by copper mesh. The output terminals are two banana jacks on the panel. A TV "cheater" receptacle was installed on the rear panel in preference to an ordinary line cord which would dangle and drag when the instrument would be moved from place to place.

The calibrator is easy to use. Feed the voltage to be measured into your oscilloscope and adjust the vertical gain to give a trace about one inch high. Note the exact spread and without disturbing the oscilloscope gain control move the probe to the output of the calibrator. Adjust the range switch and potentiometer to give a sine wave of exactly the same height on the scope. The meter reading multiplied by the range factor is the peak-to-peak value of the wave. END

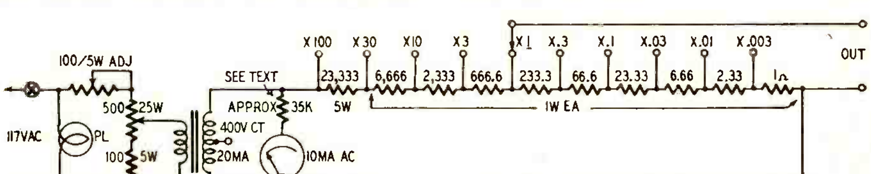
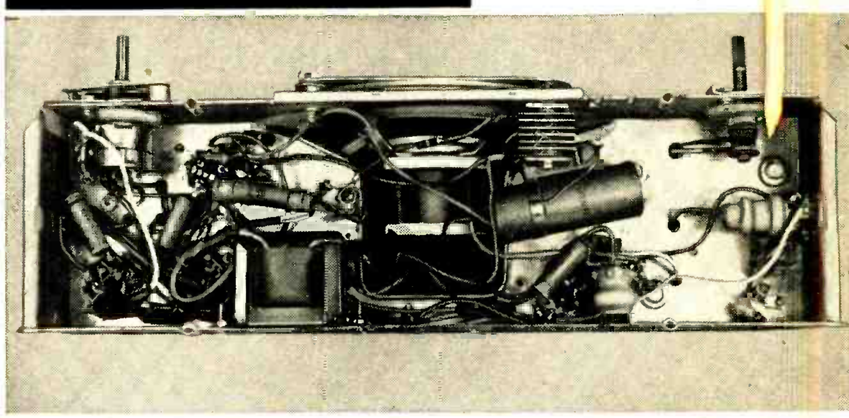



**Fig. 1—Schematic diagram of the peak-to-peak voltage oscilloscope calibrator.**

# REWIRING BATTERY SETS FOR AC DC OPERATION

By RICHARD LAURENCE



Philco 46-131 battery receiver after conversion to power-line operation.

OVER the past ten years the Rural Electrification Administration (REA) has brought power to the vast majority of farm homes. This has opened an entirely new market for the sale of electrical appliances and has brought radio technicians opportunities for additional profit by converting battery radios to line operation.

Most battery sets now in use utilize 1.4-volt tubes and the familiar 1.5-volt and 90-volt battery pack. A good battery set designed for reception in location as far from broadcast stations will have excellent sensitivity and selectivity, far above the average a.c.-d.c. table model. The owner is used to good reception and has a considerable investment in the set. If the set is reasonably new he can be usually sold on the idea of converting it.

If your locality has steady line voltage, a converter can be substituted for the battery pack; this is a very simple installation. In many locations, however, the REA voltage drops greatly under load conditions, and the converter will not furnish enough filament power. If you step up the filament voltage, it will be excessive when the line voltage returns to normal and will soon burn out the tubes. Under such circumstances, the most satisfactory way to convert is to rewire the set for power-line operation.

A typical battery set that I converted is the Philco 46-131, using 1LA6, 1LN5, 1LH4, and 1A5 tubes. To replace these I chose a 7A8 converter, 14A7 i.f. amplifier, 14B6 detector-audio amplifier, and 50L6 power-output tube, since these have socket connections nearly identical to the original tubes. It was necessary to change the parallel filament wiring to a series hookup, using a 250-ohm, 10-watt resistor in the string to drop the extra voltage that would ordinarily be taken up by a rectifier tube (See Fig. 1). The resistor is first in line, and prolongs tube life by absorbing part of the initial current surge through the cold heaters. The battery *on-off* switch is a double-pole single-throw type; I disconnected the A plus

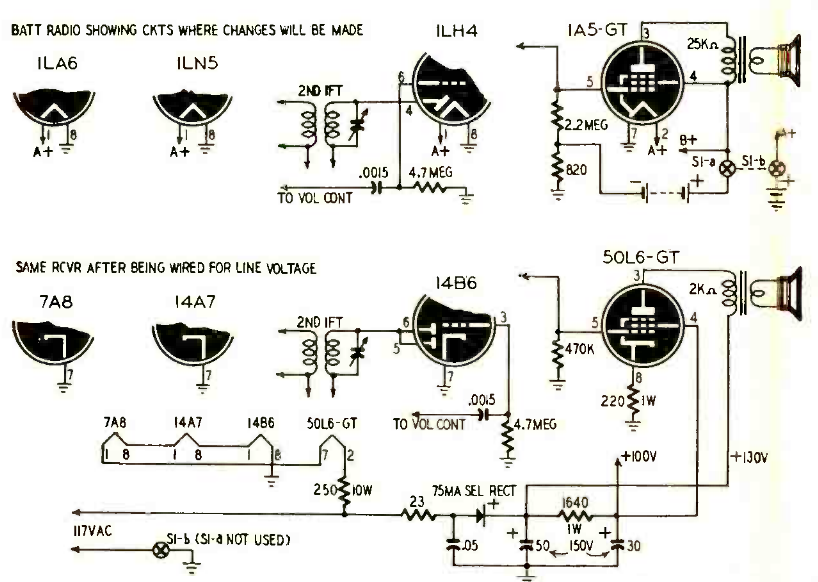



Fig. 1—(Top) Tube lineup of Philco model 46-131 battery-operated receiver, showing only socket connections and components that must be changed for conversion to power-line operation. (Bottom) New tubes and required circuit changes.

wires from one side and used it as a line switch, this side of the line connecting directly to the chassis. This is the only bad feature of this type of conversion, but a power transformer would make the expense prohibitive. The line-connected chassis is standard with many manufacturers, and will give no trouble so long as a ground connection is not attempted. I always clip the ground wire and stick a piece of adhesive tape on the back of the radio, with a warning in red letters *not to attempt a ground connection.*

Incidentally, the set should be in top-notch playing condition before conversion is attempted. It's a little embarrassing to quote a set price and then find that the volume control or speaker will have to be replaced before the completed job is acceptable.

Ground the cathodes on the 7A8, 14B6, and 14A7 tubes. The No. 7 pins on the battery-tube sockets were used as tie-points for a.v.c. and B plus circuits, so you will have to disconnect these wires and float the connections (taping them thoroughly), or anchor them to terminal strips. The cathode of the 50L6 is connected to chassis through a 220-ohm bias resistor. (This value may seem a little high to most service technicians. The usual value is 150 to 180 ohms—*Editor*). The original B minus circuit was returned to ground through an 820-ohm resistor to provide bias for the 1A5 tube, with the 2.2-megohm grid resistor returned to the high side of this bias resistor. Both these units should be removed, and a 470,000-ohm grid resistor should be connected between pin 5 of the 50L6 socket and the chassis.

More extensive changes are necessary on the 14B6, since its socket connections differ considerably from the original 1LH4. The control-grid connection must be changed from pin 6 to pin 3; the diode plate is pin 4 on the 1LH4, and this connection must be transferred to pins 5 and 6, which are now tied together. Note that the 14B6 has *two* cathode pins—4 and 7—and both of these should be grounded.

I used a 75-ma selenium rectifier, since this is much easier than cutting a hole for another tube socket. A 27-ohm resistor is connected between the rectifier plate and line, and a .05-µf, 600-volt capacitor from the a.c. side of the rectifier is connected to chassis to eliminate modulation hum. The filter capacitors are a 50-µf (input) and a 30-µf (output), both rated at 150 volts. The filter resistor is a 1,640-ohm unit, but any value between 1,500 and 2,200 ohms (1 watt) will do. All B plus lines are taken from pin 4 of the output tube.

The original output transformer had a primary impedance of 25,000 ohms. This must be changed to a 2,000-ohm unit, returning the B plus side directly to the rectifier cathode.

The oscillator grid resistor in the battery circuit has a value of 220,000 ohms, and theoretically this should be changed to about 50,000 ohms. In practice, the original resistor works perfectly with the 7A8 tube, and shows absolutely no tendency to block, so I left it in. After careful realignment this set really works well; with a 30-foot antenna I logged stations at nearly every division across the dial, with even the more distant ones completely free of converter noise. On practically all stations a quarter turn of the volume control drives the speaker to full power. There is none of the tendency to oscillate at the low and of the dial such as is so common to many small radios, and the selectivity is very good. END

# "WHAT IS ELECTRONICS?" CONTEST

## ANNOUNCEMENT OF AWARDS

**First Prize ................................ $100**

**John D. Goodell, The Minnesota Electronics Corp., St. Paul, Minn.**

**Second Prize ................................ $50**

**Lt. Sheldon Jones, Valley Forge Army Hospital, Phoenixville, Penna.**

**Third Prize ................................ $25**

**Richard H. Dorf, 255 West 84th St., New York 24, N. Y.**

**Fourth Prize............(Two $10 prizes awarded)**

**ET3 Stanley H. Dinsmore, U.S.S. *Eversole*, c/o FPO San Francisco, Calif.**

**Robert K. Rickard, Warnerville, N. Y.**

Our prize contest "What Is Electronics?" was initiated (RADIO-ELECTRONICS, Nov. 1952, P. 45) to discover a better definition of the science than any heretofore offered. The perfect definition of electronics is in our opinion still to be written, however. Though some of the definitions are excellent, readers will note that important points that appear in one are played down in another. Definitions might have been improved by inserting phrases from other ones, but of course this is a contest, and the definitions had to be presented exactly as received.

The most complete and best worded definition was—in the opinion of our Board of Editors—that of John D. Goodell of the Minnesota Electronics Corp., printed below:

> **ELECTRONICS: The science that deals with phenomena produced by electrons, and techniques for controlling electrons to generate, change, combine, program, display, apply or transmit energy or information.**

The second prize went to Signal Corps Lieutenant Sheldon Jones, a patient at Valley Forge Army Hospital, Phoenixville, Penna., for a very broad and well worded definition:

> Electronics is the science and technology of the transfer of information or energy by electron emission, electromagnetic radiation, or devices employing the principle of semi-conduction in solids.

The third prize was awarded to Richard H. Dorf, audio and television consultant of New York City, well known to many readers of this magazine through his articles on electronic music. Though it lacks the scope of the first two definitions, it refers to the important feature: ". . . electron flow or potential in one circuit controls electron flow or potential in another. . . .":

> Science and technology in which electron flow or potential in one circuit controls electron flow or potential in another, or in which emission or radiation of electrical energy is utilized.

The fourth place had four contestants running almost neck and neck. It was impossible to select one outstanding entry here, so two fourth prizes were awarded. One of these was to Electronics Technician Third Class Stanley H. Dinsmore, U.S.S. *Eversole*, apparently somewhere in the Pacific:

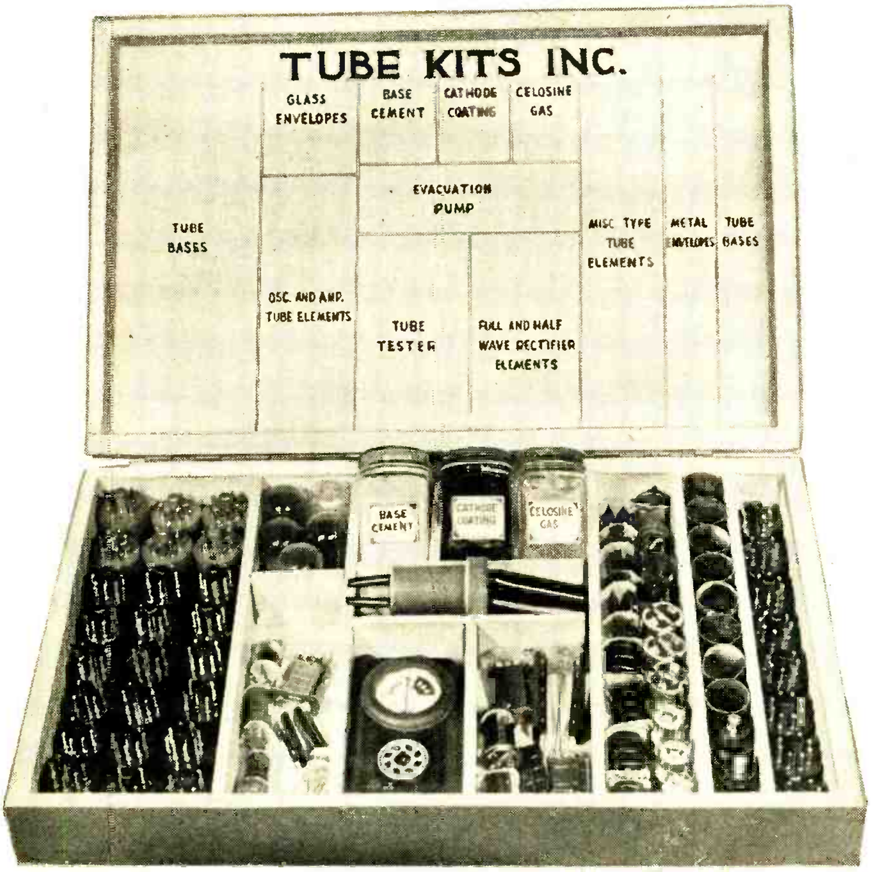
> Electronics is the utilization of free electrons, ionized particles, and electromagnetic waves for control, generation, reception, amplification, dissemination, and display of all types of physical information.

The other fourth prize goes to Robert K. Rickard of Warnerville, N. Y. for the definition:

> Electronics is the scientific art of controlling the motion of electrons and associated electromagnetic fields, photoelectric effects, and ionization, so that information is processed, transmitted, and presented in usable forms.

Honorable mention is due Charles M. Dougherty of Los Angeles, and Howard J. Waters, Silver Spring, Md., who were runners-up for the fourth prize.

While we do not believe that any of the above definitions is perfect, we are sure that among them they contain the essentials for a workable definition of electronics. Readers may amuse themselves by putting it together—or we may hire a staff of experts and combine the best features of each into an "official" RADIO-ELECTRONICS definition of electronics!




# NEW KIT SOLVES TUBE PROBLEMS

**By PROF. ADOLPH GLOCKENSPIEL***

THIS tube kit is capable of producing fifty tubes for $1.00! Miniature, octal or Loktal types can be produced in your own shop at a cost of little more than two cents each, including the heavier television tubes that cause so much customer ill-will and unhappiness when they have to be replaced. Because of the cost of the meter, pump and other equipment, the first few dozen tubes will be a little more expensive, but after that, it will be necessary only to order replacements of tube envelopes, small elements, and the occasional bottle of gas or cement, bringing the cost down to a laughable figure.

Any intelligent service technician with a minimum amount of experience can make his own tubes after reading the simple instructions that come with the kit. The vacuum pump, hitherto the almost insuperable obstacle to tube-making on a small scale, has been made unnecessary by the newly discovered *Celosine* gas. This wonderful substance comes in a solid form. When placed inside a tube, it explodes as soon as the filament is heated and consumes all the gases in the tube, creating a very high vacuum.

Everyone knows how tubes are constructed. All the service technician needs to know is what tube he desires to make. Then, with the help of the latest tube manual, which contains all the graphs and characteristics of the tubes, he can assemble and employ any variable characteristics and mutual transconductance. Tubes not exactly like any now in commercial production can easily be made.

The filaments are all supplied with the kit. Some of these are already fabricated, as they are too delicate to handle. A spool of filament wire is also furnished. This wire and other components of the kit can be used to repair tubes with burnt-out filaments. By doubling the wire for greater carrying power, the larger and more expensive television tubes can easily be restored to use. The marvelous Celosine gas—invented by Woufhausen—makes this possible.

The author has long been impressed with the need for a good vacuum-tube kit. There are radio and television receiver kits, amplifier kits, and test equipment kits on the market, but no tube kits. The complexity and expense of the equipment made such kits seem unfeasible. Fortunately, skilled design—and Celosine—have changed all that.

The various tube manufacturers have tried to keep this kit off the market, but the inventor—seeing the great need for such equipment—wouldn't let the radio technicians down. In spite of favorable offers, pressure, and even threats, he went ahead with production and sale of the kits.

The equipment contains bases, envelopes, filaments, grids, cathodes and plates. Extra parts can be ordered at a low cost when the items supplied with the kits are exhausted. The base cement is a new discovery almost as important to the new equipment as the Celosine gas. Heat has no effect on it, and it dries immediately. Soldering the pins is of course no problem to the service technician.

After assembly and insertion of the Celosine gas the tube is inserted in the tester supplied with the kit. It is first set at "flash" and the filament heated. This fires the gas and evacuates the tube. The meter is set at "test" and the tube checked. If the needle (normally in neutral position) does not move, the tube can be assumed to be good. If it is poorly constructed or shorted the needle will drop back to indicate "Bad." If it swings up to "Good" the tube is better than average and can be used in critical circuit positions.

The tube evacuation pump is used only for rectifier tubes. It is self-contained with air which when squeezed, has a vacuum pulling power of 30.6; therefore no getter is used.

Fusing the glass envelopes to bases is very simple. The base cement furnished with the kit softens the glass like putty and adheres very well. Metal tubes are sweated together by using both cathode coating and base cement, which combined create a heat of 1,800 thermal units, making the materials very pliable.

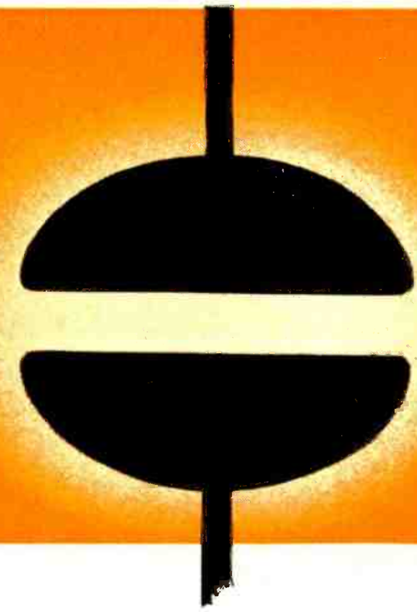
Tube Kits, Inc., is at present overloaded, but is expanding its factory, and hopes to reduce its long waiting list in the near future. It will take considerable time for this product to reach the general market, so you will be well advised to order and wait. If estimated production is reached, you will probably receive your kit by next APRIL FIRST END

*Professor of Electroniker and Noisivelet Engineering, Krausekopf-on-Rhine (Germany).

# THE VERSATILE Neon Tube

**By R. P. HAVILAND**

***Voltage regulator—generator—protector—and circuit tester***



ONE of the most useful components in electronics is the glow tube, also known as the glow lamp or neon lamp. One reason for this usefulness is the fact that it provides a link between electrical and visual phenomena; another lies in the electrical characteristics of the discharge.

Basically a glow tube contains two electrodes separated by a small gap and surrounded by a gas under reduced pressure. The gas is usually neon, although in some cases it may be argon or a mixture of these plus other rare gases. When a voltage of sufficient magnitude is impressed across the electrodes, the gas ionizes and current flows through the tube. This is accompanied by a visible discharge, which occurs as a glow covering part or all of the *negative electrode* or cathode.

The voltage-current relation in the tube does not follow Ohm's law. Instead, within limits, the voltage across the tube is almost independent of the current. A typical voltage-current relation is shown in Fig. 1. No discharge occurs until the voltage reaches a certain value, known as the *striking voltage*. Once the discharge has started, the voltage across the tube drops to the operating value. As current through the tube increases, the voltage rises very slightly until a point is reached at which the discharge changes from a glow to an arc. At this point the voltage rises rapidly. However, since the arc discharge damages the electrodes, tubes are normally not operated above the arc point. If the current through the tube is reduced, the voltage between the electrodes will drop below the operating value, and at a certain critical value the glow will disappear. This value is known as the *extinction voltage* of the tube.

Because of this nonlinear voltage-current characteristic, the glow tube must be supplied from a current-limited source if excessive currents are to be avoided. In the simplest case this is obtained by a series resistor. The tube must always be operated from a source having higher voltage than the striking potential.

The color of the glow depends on the nature of the gas and the current. For neon the normal glow is a reddish orange, which becomes more yellow at high current. The color of the glow is also affected to some extent by the frequency of the currents, being more reddish for high-frequency currents. For argon the glow is a weak blue-violet, with an appreciable amount of ultraviolet radiation present. However, all but the lowest u-v frequencies (near violet) are filtered out by the glass of the bulb.

## Available designs

Two general types of glow tubes are available at present. One of these is designed primarily for illumination and the other primarily for electrical applications (especially voltage regulation). These two types are electrically similar, although generally the illumination type shows considerably greater variation in characteristics. In general, the illumination type uses the same bulbs and bases as conventional lamps, while the electrical types use bulbs and bases similar to those used in radio tubes.

The illumination types are available in ratings from $\frac{1}{25}$ watt to 3 watts, and are supplied unbased and with four types of bases, which vary with the size of the bulb and the type of application. The electrical types are rated by *current*, which ranges from 2 to 40 milliamperes, and are available in three types of bases.

Important characteristics of commercial bulbs are given in Table I, and regulator tubes are shown in Table II. These show the type of base, the wattage rating, operating current, and voltage, the approximate striking voltage, value of built-in resistor if used, and the regulation where important. Note that only those tubes with screw-type bases have built-in resistors.

## Circuit applications

One of the major applications of the glow tube arises out of its relatively constant voltage drop. The tubes are therefore useful for holding a voltage relatively constant regardless of load-current variations—within limits. This type of regulation is normally used for d.c., but may be used on a.c. voltages with some wave-form distortion.

Typical regulator circuits are shown in Fig. 2, together with design information for selecting the series-dropping resistor. In applying these circuits note that there must not be too great a variation in output current, since if the load current becomes too great, the drop in the series resistor will reduce the load voltage below the striking potential, and the discharge will stop. If the load current becomes too low there may be danger of tube damage due to an arc discharge.

In regulator service there is appreciable variation in output voltage from tube to tube. The output voltage is also affected by the past history of operation, external illumination, operating current, temperature, and age. For these reasons, gaseous regulator tubes should not be depended on to hold the voltage closer than within about 5% of the rated operating value. The only exception to this is the special high-stability 5651, which is rated at a stability of ±0.1 volt. This stability is maintained only with constant current through the tube, and special circuits have been developed to meet this requirement.

The glow-tube a.c. regulator is not widely used, primarily because of low power-handling ability, and the poor waveform that it yields. It is useful wherever constant voltage is more important than these other factors. This regulator must use two tubes connected back-to-back if the tubes have different-size anode and cathode electrodes. Certain glow tubes have symmetrical electrodes, as shown in Table I, and therefore any single tube of this type may be used for a.c. regulation.

Since the glow tube has some of the characteristics of a resistor, it may be used in many places to replace a resistor. Some of these applications are shown in Fig. 3.

The voltage divider at *a* is constructed by operating glow tubes in series. With available types, voltage steps from about 50 up to 2,000 volts can be obtained. Care must be taken in design to keep the current through the top tube within the allowable operating limits. The requirements for this section are the same as for the simple voltage regulator shown in Fig. 2.

The characteristics of the glow tube also make it useful as a cathode-bias device (Fig. 3-b). The major limit on such use is the relatively large minimum-bias voltage of at least 60 volts which results.

A very useful circuit element may be constructed from a pair of glow tubes and a pair of resistors, connected in a bridge. See Fig. 3-c. This circuit will function as a discriminator, giving zero output for a certain voltage, *negative output* for input voltages less than this, and *positive output* for inputs greater than this. The input voltage for zero output is equal to the sum of the voltage drops across the two tubes, and can thus vary from 100 volts minimum up to several hundred volts or more if several tubes are connected in series in each leg. This circuit is useful for control applications.

The glow tube can also be used to couple the plate and grid circuits of an amplifier (Fig. 4), replacing the usual coupling capacitor or coupling resistor. In this application the gain of the amplifier may be made to approach the gain achieved with capacitor coupling. This method is often used in d.c. amplifiers.

Glow tubes are used widely as indicators, because of their high visibility, low power requirements, and low heat output. The types with internal resistors may be used directly on normal 110- and 220-volt power circuits exactly as conventional light bulbs are used. The other types require an external limiting resistance when used on power-line voltages, but may not require this on other circuits. For example, the tiny 1/25-watt tubes are widely used in binary and decade counters to indicate the count at the end of a counting cycle. Numerous applications of this type will be found in the literature.

Under some conditions it may be desirable to have an intermittent or flashing indication rather than a continuous glow. This can be obtained by connecting a small capacitor across the tube. The design of flashing circuits is discussed below under "Glow-tube Test Equipment."

A special application of glow-tube indicators is to show component failure. Small glow lamps are sometimes bridged across fuses to show when these are open. This is a considerable

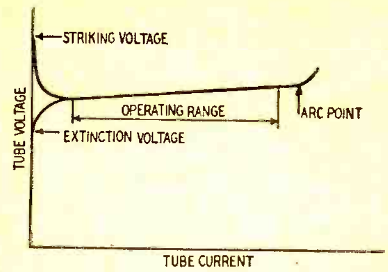



Fig. 1—Neon-lamp operating characteristic. Striking and extinction voltages vary widely for lamps of the same type.

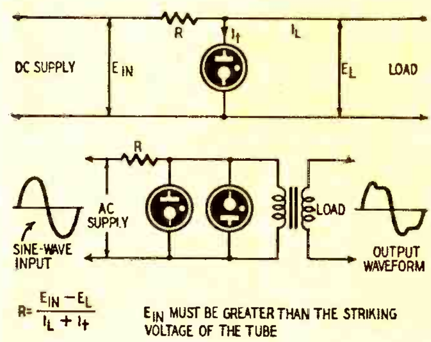



Fig. 2—Basic circuits for regulating d.c. and a.c. voltages with glow tubes.

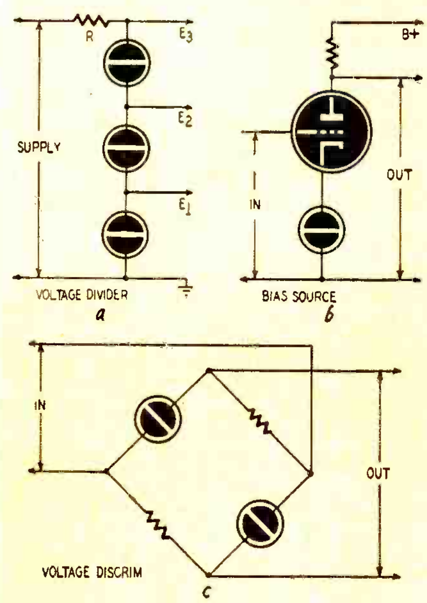



Fig. 3—(a) Neon-lamp voltage divider. (b) A neon lamp as a cathode-bias resistor. (c) Voltage-discriminator circuit.

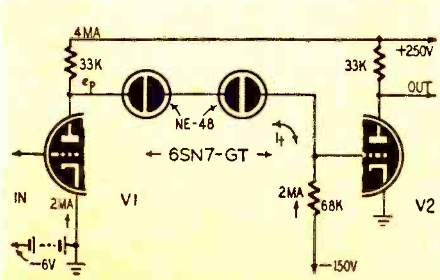



Fig. 4—Neon-lamp interstage coupling circuit for audio and d.c. amplifiers.

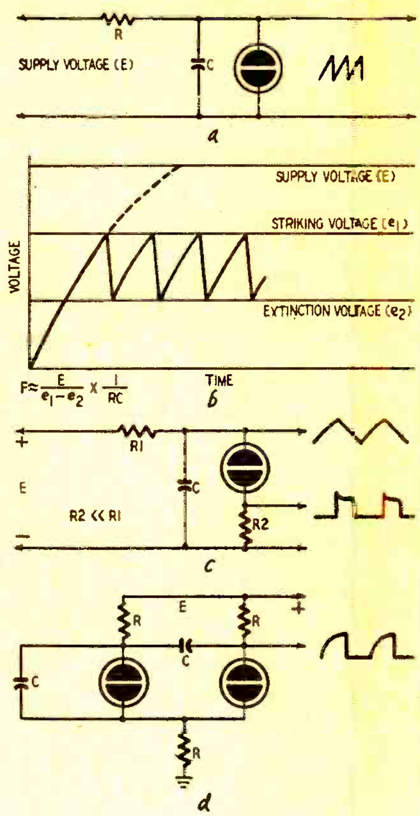



Fig. 5—(a) Neon-lamp relaxation oscillator. (b) Derivation of sawtooth waveform. (c) Dual-output oscillator yields pyramidal waves and trigger pulses. (d) Circuit for producing quasi-square waves.

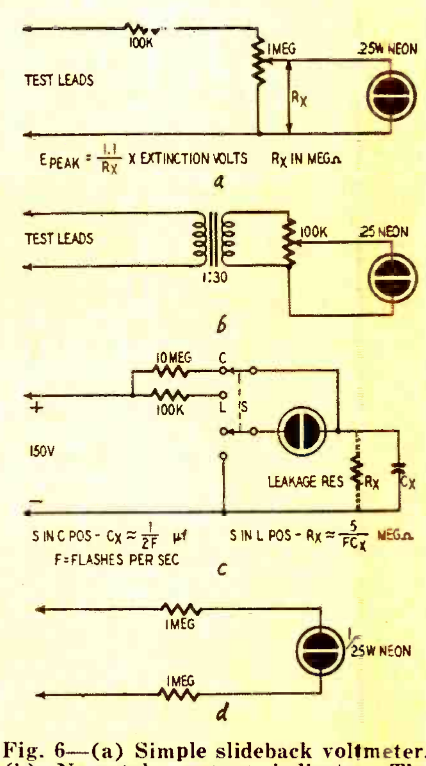



Fig. 6—(a) Simple slideback voltmeter. (b) Neon-tube output indicator. The transformer steps up low voice-coil voltages to the striking potential of the tube. (c) Combination capacitance-leakage-resistance checker. (d) Circuit tester.

## Table I—Glow lamps for lighting and indicator service.

| Type | Base | Wattage | Max. Current (ma) | Approx. Striking Voltage | Internal Resistor | Electrodes | Remarks |
|---|---|---|---|---|---|---|---|
| NE-2 | Leads | 1/25 | 0.5 | 90 | None | RR | |
| NE-51 | SC | 1/25 | 0.5 | 90 | None | RR | |
| NE-15 | SC | 1/25 | 0.5 | 90 | None | RR | |
| NE-20 | SC | 1/25 | 0.5 | 80 | None | RR | |
| NE-21 | SC | ¼ | 5 | 70 | None | | |
| NE-48 | DC | ¼ | 5 | 90 | None | PP | |
| NE-45 | Cand. | ¼ | 5 | 90 | 30,000 | PP | 110 volts |
| NE-16 | DC | ¼ | 5 | 87 | None | PP | d.c. only |
| NE-17 | DC | ¼ | 5 | 70 | None | PP | |
| NE-57 | Cand. | ¼ | 5 | 70 | 30,000 | CW | 110 volts |
| NE-58 | Cand. | ½ | 10 | 90 | 100,000 | PP | 220 volts |
| NE-29 | DC | ½ | 10 | 105 | None | CW | a.c. only |
| NE-32 | DC | 1 | 20 | 85 | None | CW | |
| NE-30 | Edison | 1 | 20 | 85 | 7,500 | CW | 110 volts |
| NE-31 | Cand. | 1 | 20 | 85 | 7,500 | | 110 volts |
| NE-56 | Edison | 1 | 20 | 85 | 33,000 | CW | 220 volts |
| NE-36 | DC | 2 | 40 | 85 | None | PP | |
| NE-34 | Edison | 2 | 40 | 85 | 3,500 | PP | 110 volts |
| NE-40 | Edison | 3 | 60 | 85 | 2,200 | PP | 110 volts |
| NE-42 | DC | 3 | 60 | 85 | None | PP | |
| AR-1 | Edison | 2 | 40 | 90 | 3,500 | PP | Argon |
| AR-2 | DC | 2 | 40 | 90 | None | PP | Argon |
| AR-3 | Cand. | ¼ | 10 | 115 | 15,000 | PP | Argon |
| AR-4 | DC | ¼ | 10 | 115 | None | PP | Argon |

SC—Single-contact minature bayonet base.
DC—Double-contact candelabra bayonet base.
Cand.—Candelabra screw-base.
Edison—Edison screw-base.
RR—Both electrodes are rods.
PP—Both electrodes are plates.
CW—One electrode is cylinder and the other is wire.

## Table II—Voltage-regulator and protective glow-lamps

| Type | Base | Current (ma) | Operating Voltage | Supply Voltage | Regulation Volts | Remarks |
|---|---|---|---|---|---|---|
| 0A2 | 7 pin button | 5–30 | 150 | 185 | 2 | 6073 similar |
| 0B2 | 7 pin button | 5–30 | 108 | 133 | 2 | 6074 similar |
| 1B47 | 7 pin button | 1–2 | 82 | 225 | | |
| 874 | 4 pin medium | 10–50 | 90 | 125 | 7 | |
| 991 | DC bayonet | 1–3 | 48–67 | 87 | 11 | |
| 1265 | Octal | 5–30 | 90 | 130 | | |
| 1266 | Octal | 5–40 | 70 | | | |
| 5651 | 7 pin button | 1.5–3.5 | 82–92 | 115 | | Stability 0.1 volt |
| 6073 | 7 pin button | 5–30 | 150 | 185 | 2 | Premium type |
| 6074 | 7 pin button | 5–30 | 108 | 133 | 2 | Premium type |
| 0A3/VR-75 | Octal | 5–40 | 75 | 105 | 5 | |
| 0B3/VR-90 | Octal | 5–30 | 90 | 125 | 6 | |
| 0C3/VR-105 | Octal | 5–40 | 105 | 135 | 4 | |
| 0D3/VR-150 | Octal | 5–40 | 150 | 185 | 5 | |
| VXR-130 | Leads | 1–2.5 | 130 | 160 | 5 | Subminiature |
| 5841 | Leads | 2–50 | 900 | 930 | | Corona type |
| 5950 | Leads | 2–50 | 700 | 730 | | Corona type |
| 5962 | 7 pin button | 5–55 | 700 | 730 | | Corona type |
| 6143 | Leads | 2–100 | 1,200 | 1,230 | | Corona type |
| 6119 | Leads | 2–50 | 2,000 | 2,100 | | Corona type |

Note: While these data have been checked for accuracy, it is recommended that manufacturers' literature be consulted for data in critical applications.

time saver in trouble-shooting. Other applications are possible: For example, it would be possible, by judicious design, to have a single glow tube associated with each vacuum tube in a circuit.

These could be arranged to show no glow if the tube fails to draw current, a normal glow if the tube draws normal current, and a more intense (or even a flashing) glow if the tube draws excessive current. A very great and almost untouched field in the design of electronic equipment exists in this type of application.

### Special glow tubes

A number of glow tubes of special design have been made in the past, although most of these have gone off the market due to improvements in other techniques. An example is a voltage regulator-potential divider combination which has been used in Europe for quite a number of years. This multielectrode tube was designed to have a drop of approximately 60 volts between each adjacent pair of electrodes. Thus a single tube replaced the conventional resistance voltage divider, with improved regulation characteristics.

Another type, since discontinued, was used as a tuning indicator in a number of early radio-receiver designs. In this tube one electrode was considerably longer than normal. Increasing current caused the glow to extend further along this electrode, furnishing a visual indication of the amount of current flowing, and thus indicating relative signal strength. This same tube was also used as a simple oscilloscope, with the time base furnished by a rotating mirror. This design became obsolete as the cathode-ray oscilloscope was improved.

Other special designs are widely used for photoflash units. These tubes are designed to carry very large peak currents and to give a high light output. Photographically these are quite useful because of the short flash duration possible.

The argon tube, which yields a small amount of near ultraviolet light, also has special applications. One of these is in photo printing, where a number of argon tubes are mounted in a grid under a contact printer. These are generally arranged so they can be switched on and off individually for "dodging". The ultraviolet radiation from argon tubes is also used to excite fluorescence in mineral specimens.

### Glow-tube test equipment

The factors that make the glow tube useful as a circuit component also make it useful as a test element. A number of designs based on these factors are shown in Figs. 5 and 6.

When connected as shown in Fig. 5-a, the glow tube makes a useful oscillator. As shown in Fig. 5-b, the output is a sawtooth wave, which will be almost perfectly linear if high supply voltages are used. The oscillation frequency may be computed from the equation given in the figure. The exact frequency will vary considerably, due to the relatively poor regulation of the tube and normal differences in commercial glow-tube characteristics.

The sawtooth output may be modified by introducing additional elements. For example the circuit of Fig. 5-c will yield a pyramidal wave at the top terminal and a trigger pulse at the lower terminal. The circuit shown in Fig. 5-d will give an output approximating a square wave. Other connections are possible which will yield a variety of waveforms.

When connected as shown in Fig. 6-a the glow tube may be used as a voltmeter. The potentiometer is adjusted until the tube just ceases to glow. The potentiometer may be equipped with a calibrated scale showing the multiplication factor by which the extinction potential of the tube must be multiplied to give the unknown voltage. This circuit is reasonably accurate, being almost as good as a pocket voltmeter, and is usable and safe over the range of about 50 to 500 volts a.c. or d.c. This circuit is also a polarity indicator, since only the negative electrode will glow on d.c., while both electrodes will glow on a.c.

This same circuit may be used as an output meter for aligning radio receivers. For this application the potentiometer would be set to give a small glow which would then increase or decrease in intensity with the aligning adjustments. When used across speaker terminals, a step-up transformer will be necessary, as shown in Fig. 6-b, to raise the output voltage to a value greater than the striking potential of the tube.

The glow tube is also widely used as a test device to show the presence of r.f. current. If the r.f. field is strong enough, it is not necessary to have a continuous path through the tube. Thus it may be used to show the presence of power on an antenna; to check the standing wave pattern on a transmission line; or as an indication of proper neutralization by coupling the neon tube to the output circuit of the stage being neutralized *with the plate supply disconnected*, and adjusting the neutralizing controls for *minimum* output.

When connected as shown in Fig. 6-c —with the switch in C position—the glow tube becomes a useful capacitor checker. The value of the capacitor can be determined by counting the number of flashes per second. With the switch in position L the lamp indicates leakage resistance.

Finally, if provided with an internal resistor and a pair of test probes (Fig. 6-d), the glow tube becomes a very useful universal tester. With a little experience it is possible to estimate the voltage reasonably well, to determine polarity, and to determine whether the voltage is a.c. or d.c. (See "Quick Capacitor Checker," by George Kelly, in RADIO-ELECTRONICS, January, 1953.) END

# HIGH-SPEED SERVICING

## *Checking Tubes and Capacitors First Saves Trouble-Shooting Time*

### By FAIRBANKS TRYON

FOR the past 12 years I have used a system of radio servicing which has enabled me to repair 95 of every 100 sets in an average of one hour. The paramount rule is: **Do not plug the set in—fix it first.** The system is simple. Master it and you can work faster and more efficiently with a minimum of equipment. Follow these rules and see how simple most servicing jobs can be:

1. **Do not plug the set in. Fix it first.** A.c.-d.c. sets having 150-ma tubes are the most common. If the set is new, the customer may be right when he says that the set has a loose wire or a burned-out tube.
   a. Without removing the chassis, turn the switch on, set your ohmmeter to its lowest range, and measure the resistance between prongs of the line plug. No reading indicates an open line cord or a burned-out tube. If the set has a 117-volt pilot lamp, a reading of 250 to 300 ohms indicates an open heater.
   b. Don't stop to check the tubes. Save 20 minutes. Pull the rectifier tube. Check continuity between pins 2, 3, and 7 on a 35Z5-GT; 3, 4, and 6 on a 35W4; 1 and 6 on a 25Z5, or 2 and 7 on a 25Z6. Replace the tube if there is an open circuit between any two points. If the rectifier is good, check heaters of the remaining tubes until you find the open one. Replace the bad tube.
   c. Check the resistance across the line plug. Plug in the set if the meter shows approximately 150 ohms (70 to 100 ohms with a 117-volt pilot) or 250 to 300 ohms in sets having 6- and 25-volt tubes of the 300-ma variety.
   d. If it works and sounds O.K., bounce it twice on the bench. If you don't hear microphonics or noise, return the set to the customer.
2. The procedure for a.c. sets is slightly different.
   a. If the set is new, check all tubes on the checker. On an old set, check only the rectifier. Use the ohmmeter on the other tubes. If any tube is burned out in a new set, that may be the only trouble.
   b. If the rectifier shows little or no emission, the chances are 10 to 1 that something else is wrong.
   c. While the rectifier is out of its socket, set the ohmmeter to the 20,000-ohm range and measure resistance between the filament (cathode on heater-type tubes) and ground. A low reading indicates leaky or shorted bypass or filter capacitors.
   d. If the resistance between rectifier filament and ground is reasonably high, you can check the set on the a.c. line. Hang onto the plug and be ready to yank it if the rectifier tube shows anything except the usual orange glow from the filament. This saves the rectifier tube if anything is wrong.
3. This step applies to any type of set in which the trouble was not located in steps 1 and 2.
   a. Remove the chassis.
   b. Check all tubes which were not checked previously. Check all filters.
   c. Use the ohmmeter to measure resistance between each plate and ground.
   d. Look for burned resistors, loose or shorted wires, solder shorts, etc. Use a flashlight to look at all connections.

It takes only a few minutes to perform these three steps on most sets. In this time you will have repaired about half of the sets coming in. If you are still stuck with the set, don't reach for the aspirin bottle.

4. Set the ohmmeter on the 20-megohm range (the 30-megohm is better).
   a. Start taking capacitors loose at one end and applying the ohmmeter. If there is no deflection, look closely, reverse the prods, and try again. No deflection—except on very small capacitors—indicates the possibility of an open capacitor. If the meter reads below 20 megohms, the capacitor is leaky and must be replaced. You will find most of the leaky capacitors in the circuits of tubes which checked weak.
   b. If the speaker has a field coil, check it for an open or short to ground.
   c. Check the speaker socket for loose contacts.

By now you will have removed and replaced all shorted or leaky capacitors so you can check the set on the line without fear of damaging any tubes which you may have replaced. Any set which has not been repaired by following these four steps will probably be a hard nut to crack. Look for smoke, feel overheated resistors, smell, check voltages, and measure resistances. Drag out the signal generator, scope, signal tracer, or what have you. Keep up the fight with no holds barred. END

# NARROW GAUGE Motion Pictures

*present a new field for the versatile electronic technician and service dealer*

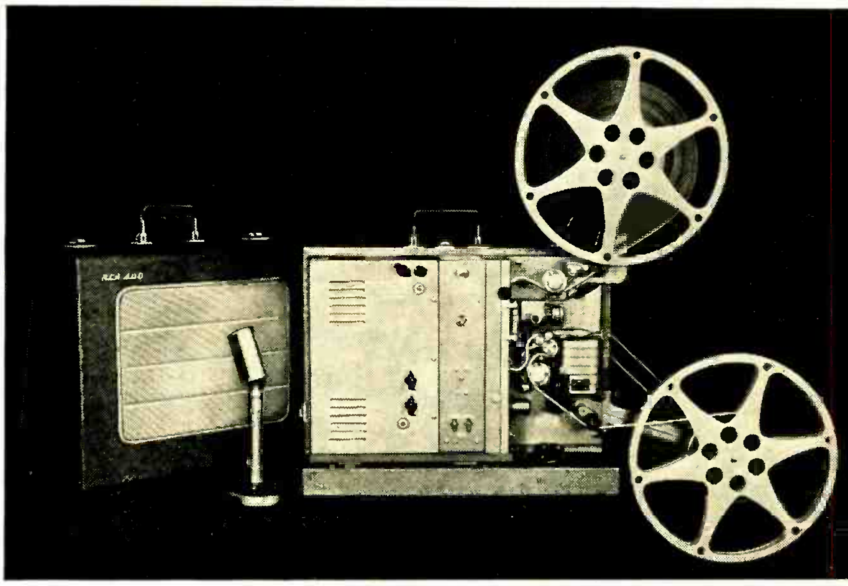


Fig. 1—RCA 400, a standard home-type moving-picture projector of the kind described in this article.

By RONALD A. LANE

OPPORTUNITIES for the technical and business skills of radio technicians are expanding rapidly in the field of narrow-gauge motion pictures. This field has extended enormously in the past year, largely because of the introduction of magnetic soundtracks. These give the narrow-gauge film a versatility and flexibility not possible with the optical tracks previously used. This dramatic increase in the value of the medium was naturally accompanied by an increase in the demand for it. That demand is still growing.

The opportunities for radio technicians include servicing, especially electronic servicing. Every narrow-gauge sound-film projector contains an audio-frequency amplifier. This is excited by the soundtrack. Optical soundtracks are reproduced by a photoelectric cell, the output of which becomes the amplifier input signal; magnetic tracks are similarly reproduced by a magnetic "head". All *magnetic* sound projectors embody provisions for erasing an existing soundtrack and recording a new one. Because of this, microphones are now normally associated with narrow-gauge projectors. A loudspeaker (or speakers) completes the electronic equipment. All of them need more or less servicing and maintenance, and the electronic technician is qualified for this work.

Circuit schematics are always available in the manufacturer's instruction book. Tubes, resistors, and the like are standard; only the magnetic erase and playback heads are apt to be specific products of the projector manufacturer.

Aside from electronic circuits, narrow-gauge film projectors always incorporate simple electrical wiring for the projection lamp, the drive motor, switching, and appliances. These also must be serviced occasionally.

Other opportunities include owning equipment and renting or leasing it out for use; and acting as agent both for the equipment and for the narrow-gauge film.

Fig. 1 shows a standard 16-mm projector. There are two general types of narrow-gauge motion picture film, 16-mm and 8-mm. The former is by far the more important at present. These film widths, 16 and 8 millimeters, were chosen originally to avoid arithmetical relationship with the 35-mm film, which is the standard commercial type used in motion picture theaters. This was done for a very important reason.

### A safety measure

Commercial film was (and to some extent still is) a very dangerous and almost explosive product. Its base is cellulose nitrate, not nitrated far enough to be as unstable as guncotton, but far enough so that if it catches fire, water can't put it out. Neither can the fire be smothered by depriving it of air. The material supplies all the oxygen needed. Highly poisonous fumes are given off when the stuff burns—nitric acid fumes that rot the lungs. For these reasons, many legal precautions surround the use of commercial film in theaters.

Narrow-gauge film has always been made of "safety" stock. This base, cellulose acetate, is no more dangerous than paper. At first, a narrow-gauge width of 17½ millimeters was proposed, but this would have left an opportunity for unscrupulous characters to split 35-mm nitrate film in half and offer it as safety film. Therefore 16-mm was chosen as the first narrow-gauge standard. Later, when invention and improvement made still smaller and still less expensive film practicable, 8-mm film was chosen. This was conveniently obtained from 16-mm, and no harm could result since no dangerous 16-mm stock has—to the writer's knowledge—ever been manufactured.

At present, as said, by far the greater opportunities in the narrow-gauge field lie with 16-mm. Fig. 2 illustrates two of the general types of film now used. They differ as to soundtrack, not otherwise. Those shown here have either magnetic track alone, or both magnetic and optical track, either of which can be played at will. Other 16-mm types, not pictured here, have only optical soundtrack or no sound at all. These last, relics of the nearly forgotten days of silent pictures, can now be modernized by processors who "strip on" a blank magnetic ribbon. The owner then magnetically records any sound he wants.

### Scope of usefulness

The field of 16-mm activity ranges from near-theatrical equipment and audiences down to living-room and amateur scale. Users include business firms, schools, churches, small theaters, private individuals, and television studios.

Most of these users benefit greatly by the fact that magnetic recording now permits them to add their own sound accompaniment. A business firm may need one soundtrack for an audience of potential customers and an entirely different track when showing the same film to a convention of its own salesmen. Teachers in school or Sunday school often want to use the identical film with a different narration suited to the age level of each class. A foreign-

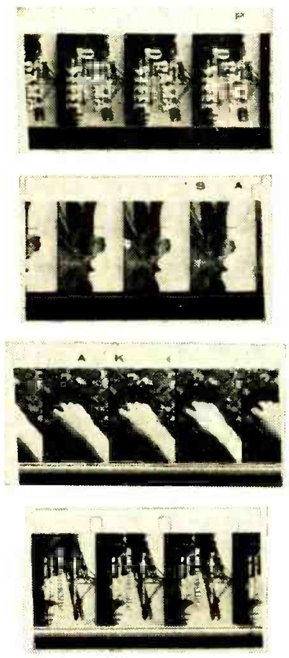


**Fig. 2—Magnetic sound is a broad dark strip; optical, a jagged white line.**

made film, with its own language optical track, may be given an additional (magnetic) recording in English, either of which can be played at will; both may be played alternately in a foreign-language class.

A radio technician who contemplates entering the 16-mm field may want first of all to inquire if there are enough users of such equipment in his vicinity to justify the step. Following is a somewhat detailed list of those who use this apparatus and for what purposes. These institutions and persons may be checked by questionnaire or direct approach:

**Industrial and business firms** use 16-mm for several purposes, such as training employes in manufacturing operations, training foremen and supervisors, and entertaining employes during lunch hours and other rest periods. Sales and advertising use of 16-mm motion pictures has already been mentioned. In addition to motion pictures, film strips—which are sequences of still pictures shown one after another and accompanied by explanatory sound from a record player or tape player—are also used for sales and advertising purposes.

**Schools** use 16-mm motion pictures extensively for instruction. The advantages of placing before the student a vivid, moving presentation of a foreign country or historical occurrence are obvious. Cartoon films teach abstract concepts: for example, the physics class may learn the action of a vacuum tube by seeing "electrons" move through space and rush ahead or slow down or turn back, in response to changing accumulations of electrons in a grid wire. Schools also use film strips in addition to motion pictures.

**Churches** use films for religious instruction and the same equipment with a different film for entertainment at "socials," gatherings and festivals.

**Stores** and other places of business sometimes use 16-mm to entertain or attract customers, especially if they consider available TV programs not attractive enough to their particular clientele.

**Individuals** use 16-mm for home movies, for their own amusement, or to entertain guests. Perhaps the most attractive home use is at children's parties, for the youngsters seem delighted and thrilled to have movies at home instead of in a theater; most small fry feel that this is something ultra-special.

## Operating the equipment

Operating 16-mm apparatus is basically simple. Detailed instructions are always given in the manufacturer's instruction book which accompanies every unit sold. There are three general processes: projecting the film, picture and sound; then rewinding the film back on the original reel so it can be projected again; and using the projector as a recorder to make a new magnetic recording.

Putting the film into the machine is called *threading*. Manufacturers simplify this as much as possible. In the equipment of Fig. 1, the path the film must follow is indicated by a curving rib on the main-frame casting. The user threads the film through the various parts in exact parallel to that rib. In other common equipment the film path is shown on a diagram inside the projector door. The details of engaging the film sprocket holes in the sprocket-wheel teeth, and of opening and relocking the *gate*, *shoes*, and other items that restrain the film from leaving its proper path, differ with each make of machine, but are thoroughly explained in each manufacturer's instruction book, usually with the help of many pictures.

## Functional details

How the electronic portions of the equipment operate will be obvious to every radio technician, but the optical and mechanical details may be less familiar. They are not very complex.

A motion picture film consists of a series of photographs of progressive stages of action. When these are exposed to the eye in rapid succession the illusion of motion is produced. In a projector, they are exposed by passing them, one at a time, through a strong beam of light. Each is thus presented as an appropriate pattern on a viewing screen.

The film unwinds from an upper reel, passes through the mechanism, and is taken up on a lower or *takeup* reel. A row of holes, called *sprocket holes*, runs along one side of the film—the side opposite to the soundtracks. In the mechanism are toothed wheels called *sprockets* which engage the sprocket holes and thus move the film along.

The film is pulled down from the upper reel by a *pull-down sprocket*. Thence it proceeds to the *gate*. It slides downward through the gate, rigidly positioned by guides. But it must not move continuously through the gate, because this is the place where light shines through it to project the picture. It must remain motionless in the gate while one picture is projected, then move downward, and again remain motionless while the next is projected; its motion through the gate is therefore *intermittent*. This motion is created by one of two devices: either there is a shuttle-action "*claw*" with sprocket-teeth on it, or an intermittently moving sprocket wheel just below the gate. The claw is more common than the intermittent sprocket. A projector has either one or the other, never both.

After film has passed through the gate the intermittency must be filtered out of its motion, for if permitted to remain it would produce frequency modulation in the sound. Therefore the film is looped around one or more sprockets or other mechanical damping devices. A steady, unvarying motion is necessary where it passes the photoelectric cell or magnetic reproducer.

The takeup reel is driven by a slipping clutch of some kind, usually of felt or leather, for its speed of rotation must vary in accordance with the amount of film wound up on its hub at any given moment.

One additional part that every projector must have, not yet mentioned, is the shutter. The film must be pulled downward 24 times in each second, and the light must be cut off while this happens. A rotating shutter intercepts the light during the pull-down interval. However, a 24-cycle-per-second light frequency would be plainly visible as a highly annoying flicker. Therefore most shutters are provided with two blades, and intercept the light a second time halfway through each period of exposure. The resultant 48-cycle flicker is not annoying and is practically invisible. One make projector uses a single-blade shutter revolving at double speed to achieve the same optical effect by projecting 48 separate images every second.

Finally there is always a *framing* device. (A single picture is called a *frame*.) The film is always so threaded that one frame fits squarely opposite the aperture through which the projection light shines. Otherwise the screen would show the top part of one image and the bottom part of the next one. In spite of careful threading, the picture may "get out of frame" during the showing because of faults in either the mechanism or the film. Mechanical means for correcting the condition without stopping the show are built into every projector.

The service technician will find these machines—intended for the unskilled operator—easy to understand and work on. The second part of this article will deal with their servicing, both electronic and electro-mechanical.

(TO BE CONTINUED)

# R-E'S ASSOCIATE EDITOR REPORTS ON PENNA. U.H.F.

F. D. Coslett (center) and Milan J. Krupa (right) interview editor.

MAINTAINING its policy of bringing its readers first-hand information on new developments, RADIO-ELECTRONICS sent its Associate Editor Mort Bernstein on a second visit in January to new u.h.f. TV areas in Pennsylvania. Besides studying u.h.f. problems, he was invited to speak at meetings of local service organizations in Wilkes-Barre and Scranton.

The success of the visit to Wilkes-Barre was largely due to the enthusiastic co-operation of Milan J. Krupa, Secretary of the Radio Servicemen's Association of Luzerne County, and Chief Engineer of WBAX. Mr. Krupa not only handled all the details of the meeting, but made it possible to study operating problems at Wilkes-Barre's new u.h.f.-TV station WBRE-TV, and arranged to have Bernstein interviewed on WBRE-TV's main evening news program. He even got us excellent hotel accommodations in spite of a shortage due to exceptional local business activity.

As a result of the interview—which was held at about 6:30 p.m., with 100% potential audience coverage—the meeting was attended by a much larger number of Association members than expected, as well as by several non-members whose interest had been aroused by the telecast.

After the meeting Messrs. Krupa and Bernstein prepared a press release to be published the following day (January 21) in final editions of the Times-Leader, Wilkes-Barre's evening paper with the largest circulation.

On the morning following the meeting R-E's Associate Editor visited WBRE-TV's transmitter and learned about the difficulties the station has been having with equipment (see technical report, column 3). Later that day the TV interview was restaged for still photographs. These were taken by Dick Paul, of the Wilkes-Barre Junior Chamber of Commerce.

In spite of hazardous weather conditions on January 21, which prevented many members (including Secretary Leon Helk) from attending, and a last-minute change in location due to a "Scranton Home Industries" show which had taken over the original meeting hall, the Scranton meeting of the Lackawanna Radio Service Engineers was exceptionally well attended. As in Wilkes-Barre, Bernstein spoke on business methods and ethics, and u.h.f.-TV service problems. After the formal session, he explained the operation and characteristics of transistors and described some of the recent developments in transistor-operated equipment. (The audience was particularly enthusiastic about this.)

In both Wilkes-Barre and Scranton, technicians attending the meetings were eager to get the speaker's attitude toward licensing. Open discussions brought out the fact that they were unanimously for it.

In any event, both organizations did their best to indicate that they had got a good deal out of the talks.

## U.h.f.-TV Problems

The impression gleaned from this trip and recent visits to York and Williamsport, Pa. (P. 102, RADIO-ELECTRONICS, March, 1953) is that u.h.f.-TV troubles are divided about equally between the transmitters and the receivers.

In York, just at the height of the critical period when harassed service technicians were struggling to install and check a tremendous number of u.h.f. converters and new u.h.f.-v.h.f. receivers on the one local station, the transmitter's sound carrier went haywire. A defective crystal oven sent the oscillator frequency down to the point where it was modulating the video carrier, and sound herringbones were all over the received picture. No sound could be heard at all in intercarrier sets. (The difference between the sound and picture carriers was no longer exactly 4.5 mc.) Of course, once this transmitter trouble was cleared up conditions returned to normal, but there was a period of several days that had technicians frantic.

In Wilkes-Barre, transmitter troubles were far more numerous and serious. Many units of brand new studio equipment were defective when received from the factory. Weak and burned-out tubes, unsoldered and incorrect connections, shorted or leaky capacitors—were found in cameras, monoscope, sync generator, and other units. Even after returning these to the factory they came back with some of the original defects still in them. Instruction books and schematics for many of the units were missing.

One main terminal block forming a junction between several pieces of control equipment was wired painstakingly according to the diagram. Over 50 separate leads from multiconductor cables had to be cut to exact length, trimmed, laced, dressed, and soldered. When the job was completed, checked, and double-checked, the units failed to work. Finally, after the station engineers made a trip to the factory in desperation, it was discovered that the identifying numbers on the terminal block had been stencilled incorrectly—completely reversed, in fact.

Of course, all these problems were solved—had to be—before the station went on the air. Even bigger headaches showed up after transmissions started. WBRE-TV's u.h.f. transmitter uses lighthouse-type triodes in the final amplifier. These are tuned by cavity resonators which are pretuned and sealed at the factory and labeled "Do not adjust!" Tubes failed to load up properly, ran red hot, and cavities began popping. Even after more than three weeks' operation and testing by the manufacturer's own engineers, the solution had not been found. The only way to keep the station on the air was to operate at less than one-fourth normal power. They were down to one spare tube—the last one in the country.

Other troubles showed up in the transmitting antenna. The designer failed to include de-icing equipment,

# VOLTAGE AMPLIFIERS in CONTROL CIRCUITS

By RONALD L. IVES

MORE than one owner of an all-wave or communications receiver has wanted to operate auxiliary equipment with the band-switch, but has been stymied by the lack of room for an additional switch wafer. Some have tried to operate a.c. relays in parallel with the band-indicator lights, only to find that the heater winding which supplies the lights had insufficient spare capacity, or that the leads from the lamp circuit to the relay introduced hum into the system.

Zero-drain a.c. relays are in about the same category as d.c. transformers, so some other method is needed if we are going to operate from the band-indicator light system. It should draw negligible current and introduce no hum. The method of Fig. 1 meets these specifications and (with voltage-multiplying circuits where necessary) will operate satisfactorily in a number of applications where it is necessary to actuate a relay from a low-voltage, low-current source. A triode with a suitable relay in its plate circuit controls the external auxiliary equipment. The plate relay can be any convenient standard type, such as a 10,000-ohm Potter and Brumfield LM-11 or equivalent.

Rectifier circuits shunted across the band-indicator lights are shown in Fig. 2. Commonly called voltage doublers, they are actually voltage multipliers, with a theoretical output of approximately 1.4 times the line voltage times the number of sections employed. Because of circuit losses the voltage obtainable is always less than the theoretical value; and voltage gain per section declines as the number of sections is increased, all other factors remaining the same. Voltages shown in Fig. 2 are those actually obtained in a 60-cycle circuit.

For circuit simplicity, these control circuits are designed to cut off the relay tube when the circuit is "live." This also—in many instances—equalizes the power drain on the supply of the auxiliary device. Reverse operation, so that the relay pulls in when the control circuit is live, is entirely practicable, but usually requires more complicated relay-tube circuitry.

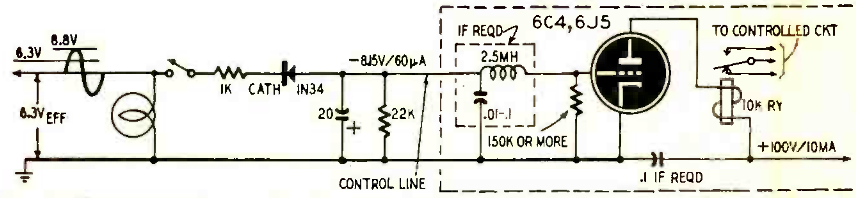



Fig. 1—Remote-control circuit uses low-voltage d.c. obtained from 6.3.-volt band-indicator-lamp circuit.

When the same device must be operated from more than one band-indicator light, the rectifier can be fed from the center tap of a high-resistance jumper between the hot terminals of the lights, as in Fig. 3. Output voltage will be approximately half that of the same rectifier fed from a single light. The same principle can be extended to any number of lights, with a corresponding reduction in output voltage.

Additional filtering is usually not necessary, but when needed must be isolated from the voltage multiplier by a high impedance. A large capacitor directly across the output of a tripler, for example, acts as an a.c. shunt, as shown in Fig. 4, and reduces the output voltage greatly. Because of low current drain, isolation with a high resistance is entirely satisfactory.

Circuit constants of rectifiers of this general type are not critical, and components have a long service life. Two triplers have been in service for more than 2,000 hours with no component failures. Rectifier bulk is small, a tripler with standard components occupying about as much space as a pack of cigarettes. All components need not be in the same place, provided they are kept away from low-level audio circuits. END

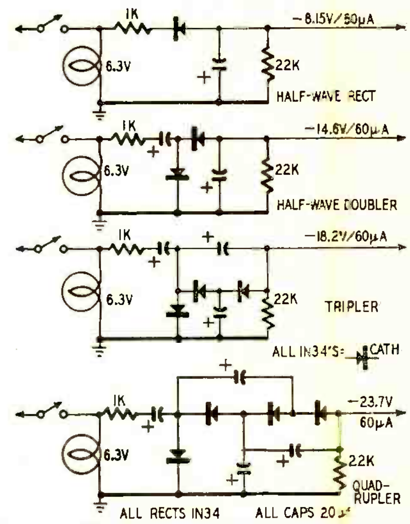



Fig. 2—Basic circuit and multipliers.

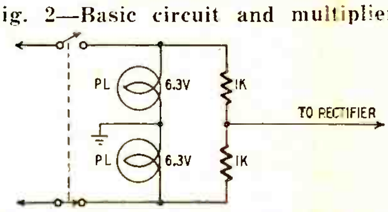



Fig. 3—Circuit for two-band control.

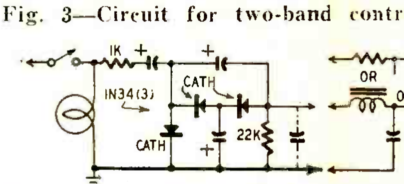



Fig. 4—Extra filter capacitance must be isolated as shown to reduce loading.

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and the first sleet storm put the station off the air. (Apparently there is a considerable difference in winter weather conditions between Wilkes-Barre and York, although these two cities are only about 100 miles apart. The Wilkes-Barre antenna is about 2,000 feet above sea level, and much more subject to freezing.)

Still more troubles had developed in the microwave pickup units. WBRE-TV has been able to bypass these successfully when necessary with the aid of a v.h.f. standby receiver and a super-duper rhombic antenna beamed at New York, and picking up signals directly from the Empire State Building.

## Receivers and their troubles

The chief problem has been oscillator radiation from u.h.f. converters. When one of the units goes on the air (literally) it can blank out *v.h.f.* reception over an entire neighborhood.

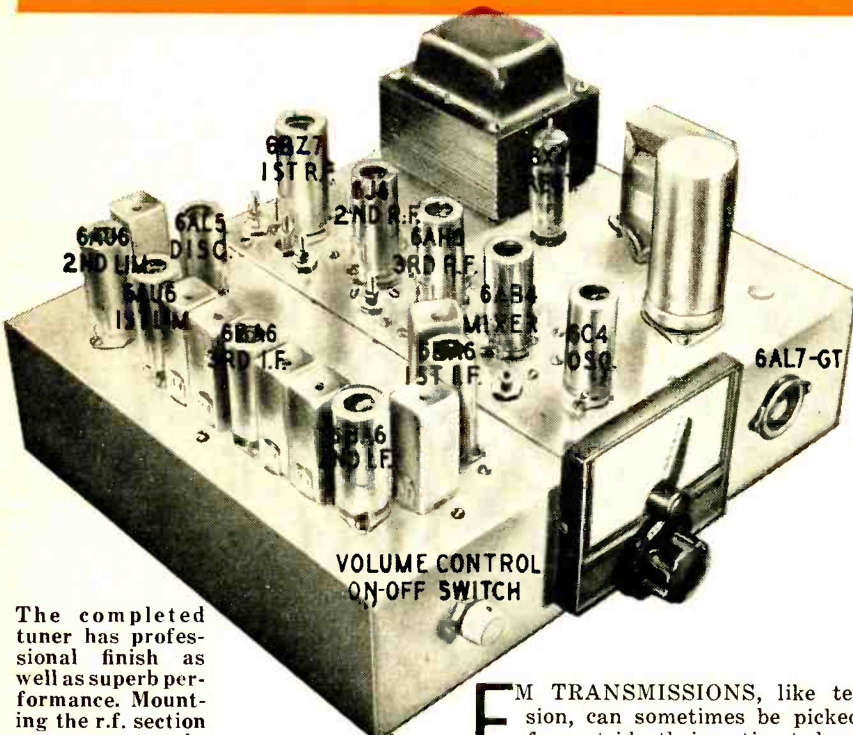
Since there are no tubes available commercially at the present time which can amplify effectively over the frequency range 470-890 mc, these converters have no r.f. stage between mixer and antenna. As a result, a large part of the oscillator output goes up the flue—and spreads a pall of interference over a wide area when the converter oscillator operates in the v.h.f. TV band.

As an illustration: The oscillator in a u.h.f. converter with output on channel 6 will tune from about 97 mc to about 200 mc in covering the entire u.h.f. band. (The fourth harmonic of the oscillator—roughly 388 to 800 mc—beats with the incoming signal to produce the channel-6 difference frequency.) At the low end of the u.h.f. band the second harmonic of the oscillator (194 mc and up) falls right on v.h.f. channels 10 to 13. At the high end of the u.h.f. band the oscillator's fundamental will do the same thing on v.h.f. channels 7 to 10. Some one-channel converters and turret-tuner u.h.f. strips cause similar troubles. END

# LONG DISTANCE FM RECEIVER

*Three low-noise r.f. stages and bandpass-coupled i.f.'s solve a receiving problem*

By WILLIAM H. KUMM

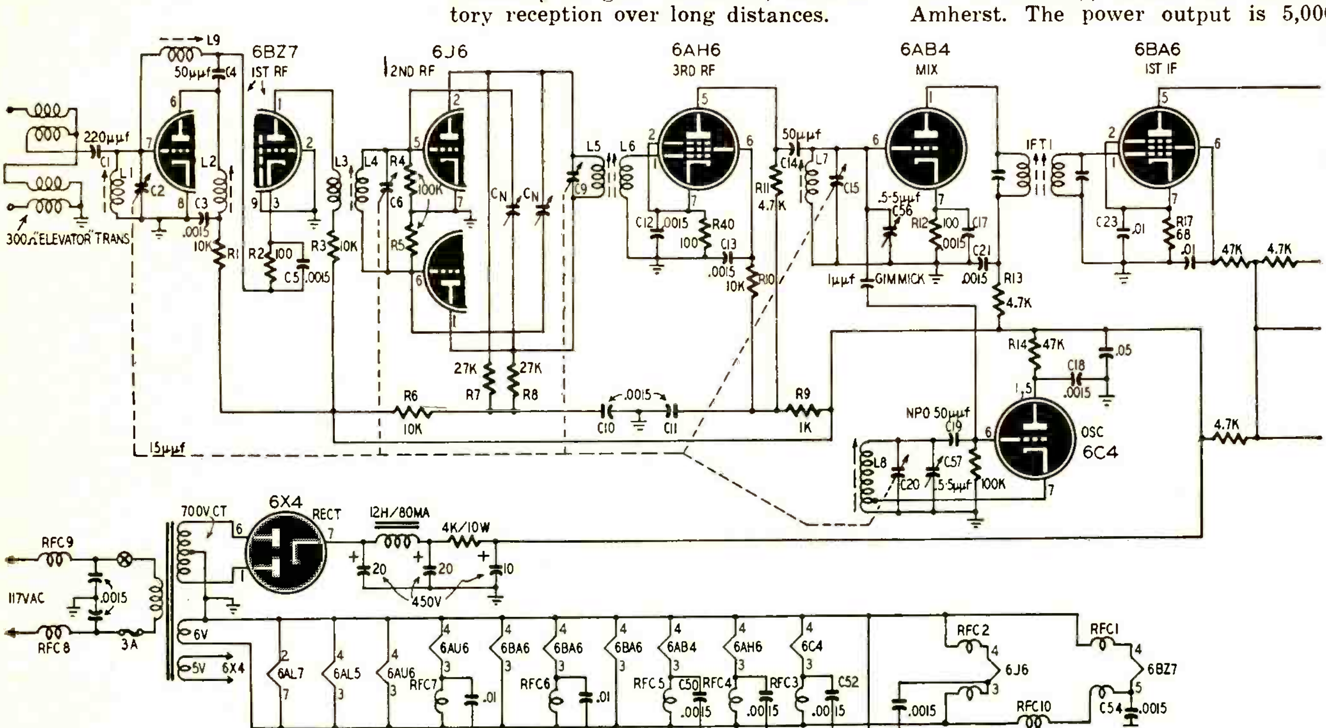


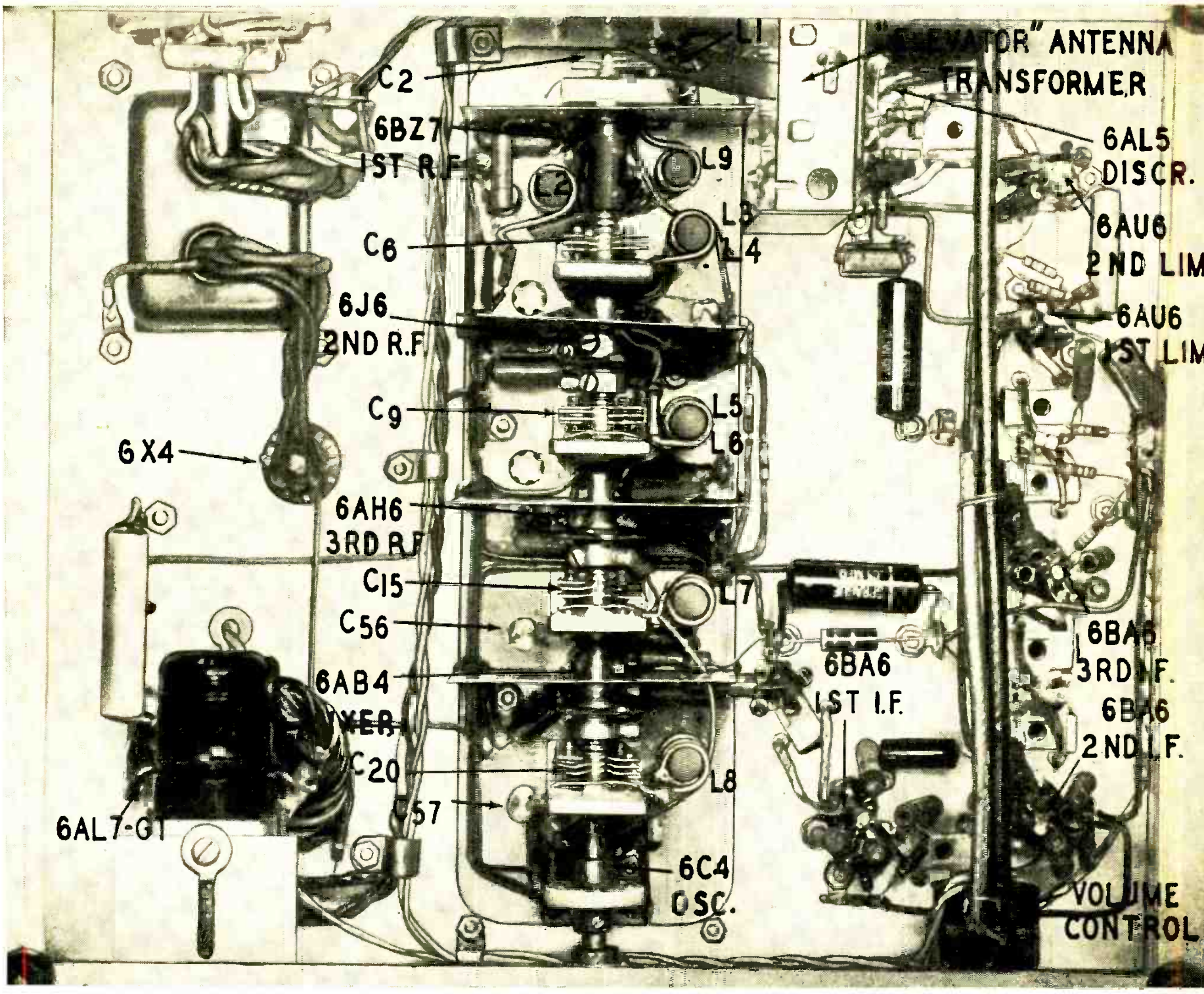

The completed tuner has professional finish as well as superb performance. Mounting the r.f. section on a separate subchassis simplifies construction and makes future modifications easy.

FM TRANSMISSIONS, like television, can sometimes be picked up far outside their estimated useful service areas. Today, thanks to recent developments widely used in television receivers, it is possible to build an FM receiver which has the high sensitivity and extremely low noise level necessary to give consistent, satisfactory reception over long distances.

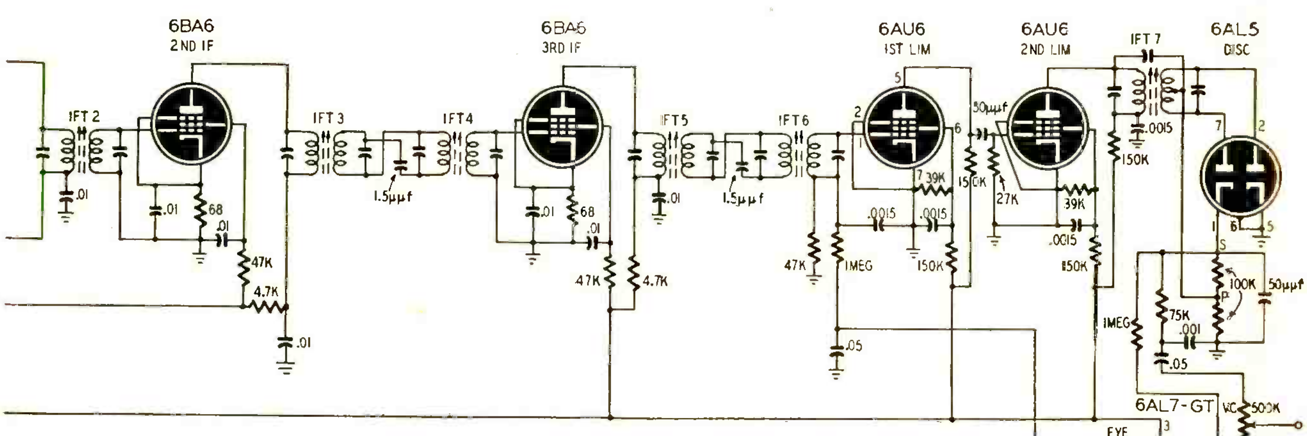
These advances are the cascode circuit, the neutralized push-pull-triode r.f. amplifier, and the "elevator" transformer. By incorporating these in the front end—plus an unusual band-pass-coupled i.f. amplifier—the receiver gain and selectivity can be raised to such a high level that a station 85 miles away can be brought in day after day without the slightest interference from either of two "local" stations on adjacent channels.

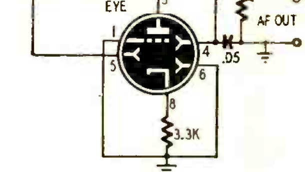
Receiving conditions at Amherst, Mass., will illustrate the problem and show how—after much experiment—very satisfactory results were obtained. The desired transmission on 95.9 mc originates in Woburn, Mass. (just outside of Boston), almost due east of Amherst. The power output is 5,000






Tube and component layout under the tuner chassis. Note the copper interstage shields installed directly across the r.f.-amplifier and mixer sockets. Placement and wiring in the front end should follow the original as closely as possible.






watts. The line-of-sight distance to the station is 85 miles over hilly terrain. About 30 miles south of Amherst, in Springfield, Mass., is another transmitter on 96.1 mc with an output of 1,000 watts. There is a third station in Hartford, Conn., about 60 miles south of Amherst. This one is on 95.7 mc, and has an output of 50 kw.

The problem is that the weak, distant, desired signal is directly between two powerful ones which are relatively close to the receiver. This calls for a tuner with high sensitivity and low noise to pick up the signal; and sufficient selectivity to eliminate cross-talk from the nearby adjacent-channel stations.

The tuner described in this article is the third of a series of tuners built in an effort to solve the problem.

The first tuner had two pentode r.f.

**Fig. 1—Circuit diagram of the high-sensitivity, low-noise FM tuner. Exceptional selectivity without clipping off modulation peaks is provided by two dual-transformer-coupled i.f. stages.**

stages—a 6AH6 followed by a 6AK5—and a 6AK5 pentode converter with a 6C4 oscillator. There were two 6BA6 i.f. stages, two 6AU6 limiters, and a 6AL5 discriminator. It had pretty good sensitivity, but the noise level with the pentode r.f. stages and the pentode converter was too high, so the entire front end was rebuilt. The second model had two 6AB4 grounded-grid-triode r.f. amplifiers followed by a 6AH6 pentode r.f. stage; a 6AB4 triode converter; and a 6C4 oscillator. The i.f. system was the same one used in the original model. This set had a low noise level, by virtue of the grounded-grid-triode r.f. stages and the triode converter; but it lacked the sensitivity of the first tuner, so it was scrapped too.

The present set is the result of an attempt to combine sensitivity with low noise level and a higher degree of selectivity than previously.

## Circuit analysis

Fig. 1 is the schematic of the final model. The tuner has 13 tubes which perform the following functions: First radio frequency amplifier, a 6BZ7 double triode in a cascode circuit. Following this is a neutralized 6J6 push-pull-triode r.f. stage. The third r.f. stage is a 6AH6 pentode. The converter is a 6AB4 triode, and the local oscillator is a 6C4 triode. Following the converter are three 6BA6 i.f. stages operating at 10.7 mc, with dual-transformer bandpass coupling. Two 6AU6 limiters in cascade are next, and the discriminator is a 6AL5 double diode. There is a 6AL7 tuning eye operating from the a.v.c. line, and the power-supply rectifier is a 6X4.

A convenient and efficient coupling method for matching 300-ohm lead-in to the input grid was borrowed from TV practice. One of the so-called "elevator coils" gives us relatively light input loading, which allows us to tune the input grid circuit with one section of the five-gang tuning capacitor. The plate circuit of the first triode (half of the 6BZ7) is not tuned because it is not critical at all. The grounded-grid half of the 6BZ7 has a slug-tuned neutralizing coil (L9) to the grid of the first triode through which the cathode current of the second triode passes. Its plate circuit (L3) has untuned link coupling to the 6J6 push-pull grid circuit. Both the grid circuit (L4) and the plate circuit (L5) of this push-pull stage are tuned by sections of the gang. A link from the 6J6 output goes into the untuned grid of the 6AH6 third r.f. amplifier (L6), whose plate circuit is impedance-coupled to the grid of the 6AB4 mixer (L7). This is also tuned by one of the ganged capacitors. The oscillator is a 6C4 in a conventional Hartley circuit, tuned by the fifth gang of the tuning capacitor.

The plates of the converter and all r.f. tubes operate at about 150 volts, and the oscillator has about 100 volts on its plate.

Two of the 3 i.f. stages are bandpass-coupled by "back-to-back" i.f. transformers. This arrangement steepens the sides of the i.f. response curve, to give the desired selectivity. The i.f. stages are operated at relatively low voltages—approximately 90 on the plates and 60 on the screens—to reduce any tendency to regenerate. The cascaded 6AU6 limiters operate at even lower voltages than the i.f. stages. They have about 40 volts on the plates and 30 volts on the screens for good limiting even on extremely weak signals.

The 6AL5 discriminator circuit has a 75-microsecond de-emphasis filter in its output. This feeds the volume control, which also incorporates the power switch for the tuner.

Bifilar-wound r.f. chokes were inserted in the filaments of the first two r.f. stages, with single chokes in the hot sides of the remaining r.f. tube filaments, and in the filaments of alternate i.f. and limiter tubes. The slug-tuned interstage coils in the r.f., mixer, and oscillator stages are all self-supporting. They were tuned with iron cores taken from National XR50 coil forms, but any high-frequency iron cores available may be used. The five-gang tuning capacitor was made up of National UM-15 15-μμf miniature sections linked with insulated couplings.

Tubular trimmer capacitors were used in the converter grid circuit and the oscillator grid circuit, but the other tuned circuits tracked satisfactorily with the slugs only. The number of turns given in the table for each coil is only approximate, and it is advisable to use a grid-dip meter to find the correct number of turns for each coil. The tuner covers 86 to 110 mc, which takes in TV-channel 6 sound at one end and aircraft signals at the other.

The 6J6 push-pull triodes are cross-neutralized by two 1/16-inch inside diameter copper tubes about 1/2 inch long ($C_N$). These are soldered to the terminals of the plate tuning capacitor and an insulated wire from the *opposite* grid terminal of the 6J6 is inserted in each tube. This is a very handy way of neutralizing, takes up little space, and fits the physical layout very well. One of these neutralizing tubes can be seen in the underchassis photo at the right of tuning capacitor C9.

## Construction

Parts placement, orientation of tube sockets, and lead dress are highly critical, especially in the r.f.-mixer-oscillator section. To reduce the possibility of regeneration, and to insure satisfactory alignment, follow the layout given in Fig. 2 as closely as possible—*especially the socket keying.*

Copper shields were mounted across the converter socket and all r.f. tube sockets to isolate their grid circuits from their plate circuits as much as possible. These shields are drilled to pass the tuning shaft.

There is a bit of backlash in the last section of the tuning gang. For this reason, the antenna circuit, which is not critical at all, is placed at this end; the highly critical oscillator circuit is closest to the dial, where there is minimum backlash.

The bandpass coupling in the i.f. stages very definitely helps to narrow the bandwidth, but it does reduce the gain. Where the tuner is to be used for long-distance reception with no selectivity problems, single-transformer coupling is preferable.

The 6AL7-GT twin-beam tuning eye is an added refinement and operates off the discriminator output and the grid

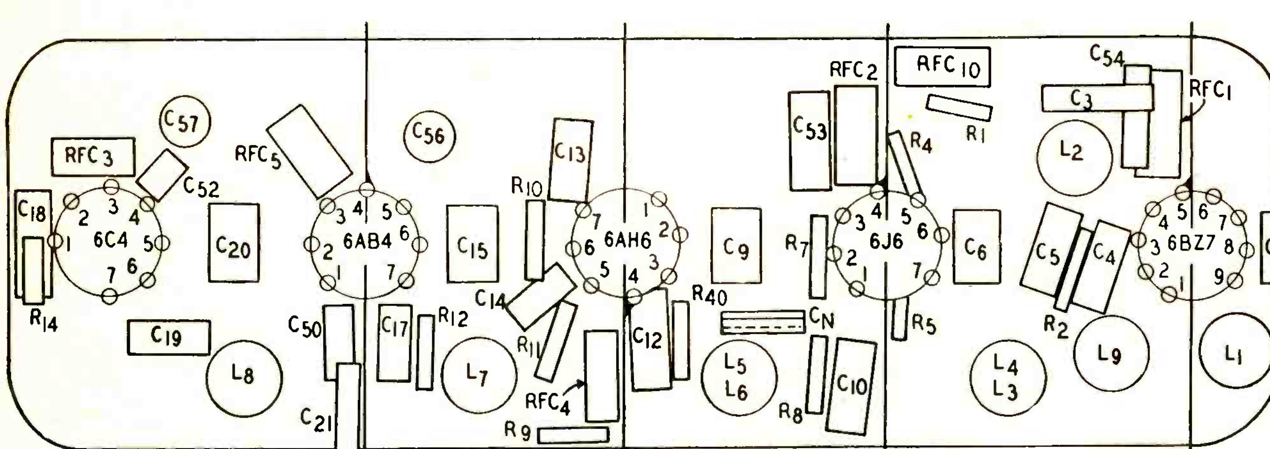



**Fig. 2—Layout diagram of r.f., mixer, and oscillator stages. Component numbers refer to circuit elements shown in Fig. 1. Note the positions of the terminals on the tube sockets, and the connections between interstage shields and heater pins.**

circuit of the first limiter. A microammeter in series with the first limiter grid return would give a more accurate indication of signal strength, but is a good deal more expensive.

## Alignment and tracking

For i.f. alignment, connect a vacuum-tube voltmeter from pin 5 of the tuning-eye socket to ground. Remove the 6C4 oscillator tube from its socket so there will be no conversion of unwanted signals. With a 10.7-mc signal fed into the converter grid tune the i.f. transformers for maximum reading on the lowest voltage scale of the v.t.v.m. If the transformers are very far out of alignment it may be necessary to introduce a strong signal at the first-limiter grid and work back stage by stage to the converter grid, introducing the signal in the stage just ahead of the one being aligned.

In aligning the quadruple-tuned band-pass circuits for optimum bandwidth connect an oscilloscope to the plate of the first limiter and feed the output of a sweep-signal generator to the converter grid. Set the generator for a total sweep width of 450 kc with 10.7 as the center frequency. Adjust the various i.f.-transformer slugs to give a tall, flat-topped response curve with sides as steep as possible. With single-transformer i.f. coupling the oscilloscope and sweep-generator alignment is unnecessary; v.t.v.m. maximum readings on 10.7 mc are sufficient.

The discriminator primary is adjusted for a *maximum* reading with the v.t.v.m. connected between the load center-point (P) and ground. The secondary is then adjusted for *zero* voltage reading with the v.t.v.m. between point S and ground. Now plug the oscillator tube back in.

To align the front end, connect the v.t.v.m. between pin 5 of the 6AL7-GT socket and ground, as in the i.f. alignment procedure. The oscillator should be aligned first just above the high end of the FM band—at approximately 109 mc—by opening the main tuning gang all the way, running the oscillator-coil (L8) slug *halfway* in, and adjusting trimmer capacitor C57 for maximum output. To track the oscillator at the low end of the band, set the generator at 87 mc, close the main tuning capacitor completely, and adjust the oscillator-coil slug for maximum output.

Adjust the mixer grid circuit (C56 and L7) next in exactly the same way. The interstage r.f. coils are peaked at the high end of the band by stretching or compressing the windings with the slugs halfway in. Then the low end is peaked by adjusting the slugs for maximum output. If desired, the second r.f. stage can be peaked in the middle of the FM band instead of at the ends, for more uniform over-all response.

## Neutralizing procedure

The r.f. stages are neutralized after they have been aligned. The v.t.v.m. is left in the position for r.f. alignment. Disconnect one side of the 6J6 heater and feed a signal to the antenna terminals at the high end of the tuning range. Adjust the neutralizing capacitors ($C_N$) *in equal steps* for *minimum* reading on the v.t.v.m.

Reconnect the 6J6 heater and disconnect one of the heater leads on the 6BZ7. With the same high-end signal fed in at the antenna terminals, adjust the slug in the neutralizing coil (L9) for *minimum* output. L9 may have to be stretched or compressed to obtain this minimum.

With the antenna terminals open, an interesting way of indicating the benefit of low-noise neutralized triodes can be tried. When the 6J6 and 6BZ7 are properly neutralized, the noise level will *decrease* if they are plugged in after the rest of the set has warmed up. The noise level will *increase* when the 6AH6 is plugged in and warms up because it is a pentode and hence noisy.

The "elevator-transformer" antenna-input system is not absolutely necessary, but if one can be obtained or homewound it will decrease the input grid loading and allow us to gang-tune this circuit.

### Materials for tuner

**Resistors:** 2—1 megohm, 4—150,000 ohms, 5—100,000 ohms, 1—75,000 ohms, 5—47,000 ohms, 2—39,000 ohms, 3—27,000 oms, 4—10,000 ohms, 5—4,700 ohms, 1—3,300 ohms, 1—1,000 ohms, 3—100 ohms, 3—68 ohms, ½ watt; 1—4,700 ohms, 1 watt; 1—4,000 ohms, 10 watts; 1—500,000-ohm audio-taper potentiometer.
**Capacitors:** (Electrolytic) 2—20, 1—10 µf, 450 v. (Paper) 4—.05 µf, 600 v. (Ceramic) 1—.01, 20—.0015 µf, 1—220, 4—50 µµf. (Zero temp. coeff. ceramic), 1—50 µµf 500 v. (Mica) 1—.001 µf, 500 v. (Silver mica) 2—1.5 µµf, 500 v. (Variable) 5—15 µµf (National type UM 15 or equiv.); 2—0.5–5-µµf ceramic tubular trimmers (Erie type 532 or equiv.); 2 neutralizing capacitors (see text); 1—1-µµf gimmick.
**Transformers:** 1 power transformer, 700 v./c.t., at 200 ma, 6.3 v. at 6 amp, 5 v. at 3 amp (Thordarson type T22R07 or equiv.); 6—10.7-mc i.f. transformers, (Miller type 1463 or equiv.); 1—10.7-mc discriminator (Miller type 1464 or equiv.); 1—antenna matching transformer (Philco No. 324432-1, RCA No. 73591, or equiv.); 1—150-200-ma filter choke.
**Miscellaneous:** 1—6BZ7, 1—6J6, 1—6AH6, 1—6AB4, 1—6C4, 3—6BA6, 2—6AU6, 1—6AL5, 1—6X4, 1—6AL7-GT; 1—9-pin miniature, 11—7-pin miniature, 1 octal sockets; 5—insulated flexible couplings; 1 dial (Millen type 10039 or equiv.); 7 h.f. powdered-iron tuning slugs (see text); 1—s.p.s.t. on-off switch; chassis; socket shield; 3-amp fuse and holder; terminals; hardwore; wire; solder.

When the tuner was completed it was compared with one of the better table-model commercial sets. The results were conclusive. With the commercial receiver, the desired signal could barely be made out in the cross-talk of the nearby stations. There was no entertainment value here. The tuner, by comparison, gave a strong, relatively hiss-free signal with no cross-talk. Over almost two years it has given fairly consistent daytime and evening reception of New York City and Philadelphia stations, from the Amherst receiver location. The distances to these two cities are about 170 and 225 air miles respectively. Troy, N. Y.; Binghamton, N. Y.; Providence, R. I.; Lawrence, Mass.—in fact nearly every FM broadcast station within 200 miles—has been heard at least once. The antenna is a folded dipole with reflector and director mounted about 10 feet above the roof of the house and rotated manually by a homemade mechanism.

### COIL TABLE

| | |
|---|---|
| L1, 2, 4, 5, 7 | 3½ turns No. 16 bare tinned wire, ⅜ inch dia., ¾ inch long. |
| L3 | 2½ turns No. 20 insulated wire interwound with L4. |
| L6 | 2½ turns No. 20 insulated wire interwound with L5. |
| L8 | 3½ turns No. 16 bare tinned wire, ⅜ inch dia., 1 inch long; tapped 1 turn from ground. |
| L9 | Approx. 12 turns No. 20 enameled copper wire, ⅜ inch dia., ¾ inch long. Number of turns adjusted to neutralize 6BZ7 (see text). |
| RFC1, 2 | Bifilar winding—15 turns No. 26 enameled wire close-wound on ¼-inch diameter form. |
| RFC3, 4, 5, 6, 7, 8, 9, 10. | 20 turns No. 26 enameled wire close-wound on 47,000-ohm or higher. 1-watt insulated resistor form. |

Long-distance FM reception is fascinating, especially when freak conditions occur. In the summer of 1951 the receiver was taken to the White Mountains of New Hampshire. In one evening 18 stations were heard, ranging from Ohio to as far west as Minnesota, over distances of as much as 1,100 miles. END


*Suggested by N. Radicone, Brooklyn, N. Y.*

"Howdy Doody heck! I'm the repair man. This set isn't fixed yet!"

# AMPLIFYING the REED ORGAN

**By B. FRANKLYN SHINN**

***Great improvement results with little labor and expense.***

Fig. 2—The completed contact microphone, with four rubber support blocks mounted on the face of the earpiece cover.

THE writer, who has been a church organist for many years, recently had occasion to play one of the reed-type organs that are still found in many churches. Finding that the instrument was not adequate for the size and acoustics of the building, I decided to experiment with electrical amplification. The results were so far above expectation that the solution may provide a new source of revenue for service technicians in designing and setting up similar installations.

In "reed" organs the tones are generated by brass reeds vibrated by air drawn past them by a foot-operated bellows or a motor-driven blower. The tones generated by the reeds are rich in harmonic content but rather weak. Efforts to reinforce the output by direct microphone pickup and amplification were not very successful. At high output levels the sound was unpleasant and the problems of acoustic feedback were not easy to solve. The speakers must be placed so that the organist can hear the result, but the microphone can "hear" it too! In seeking a solution I reasoned that the top of the reed chest would in all probability vibrate as a sounding board, and would reproduce the tones of the reeds. I mounted a contact microphone at the center of the reed chest on the SWELL organ. The result was so good that I decided to carry the experiment further.

The instrument was a two-manual and pedal-clavier organ with 20 stops. As each manual had distinctive tone characteristics which I wanted to maintain, I decided to use a separate pickup for each manual. The pedal-clavier tones could not be picked up without excessive background noise, but in any case the bass response was more than adequate, since enough of the pedal tones reached the two pickups provided for the manuals without the complication of a separate input. Each pickup had to be provided with a foot-operated volume-control, and as the leads involved were very long, the problem of hum had to be kept in mind. It was decided to try to develop low impedance devices for the purpose.

Two contact mikes were made from a pair of war-surplus 50-ohm dynamic headphones. I carefully loosened the cap from one headphone and cut a circular hole about one-half inch in

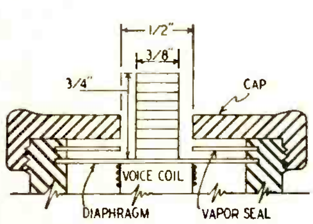



**Fig. 1—Section through a modified dynamic headphone, showing the cork contact pile at the center of the diaphragm.**

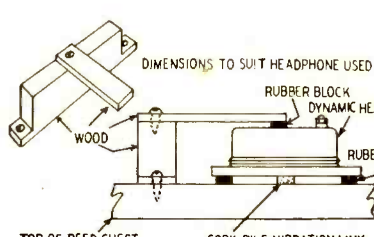



**Fig. 3—Microphone clamping method.**

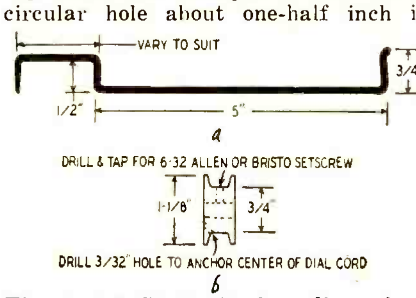



**Fig. 4—(a) Steel-wire bow dimensions. (b) Driving pulley for volume control.**

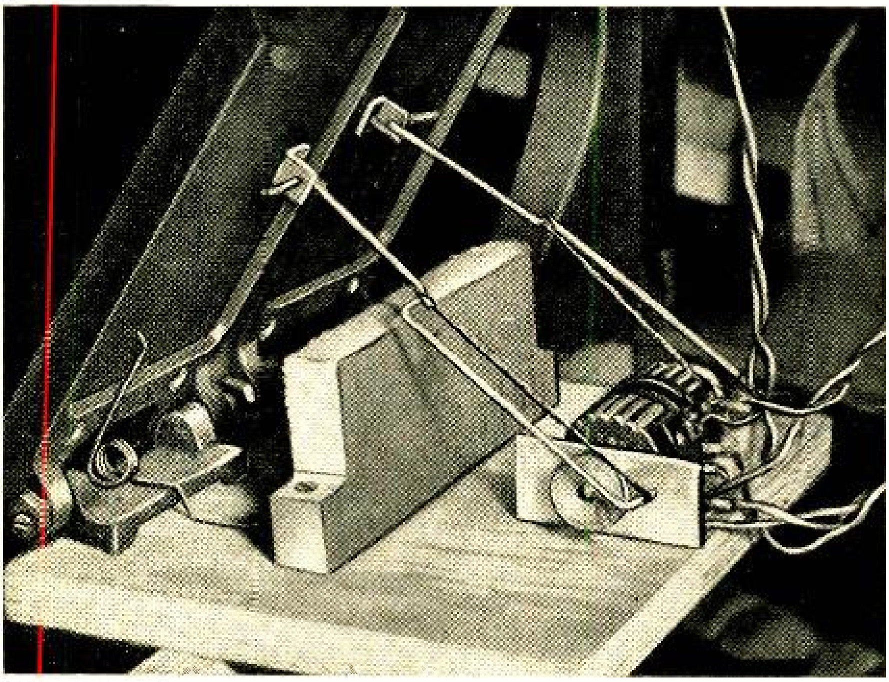


Fig. 5—Foot-operated gain-control assembly. Vertical block is pedal stop.

diameter through the center of the cap, and also through the oiled-silk moisture seal that covers the conical diaphragm. With a card punch I cut enough discs —⅜-inch in diameter—from cork gasket material to make a stack about ¾ inch high. I cemented these together with Glyptal, and cemented the entire stack to the center of the diaphragm so that it projected through the hole in the oiled-silk vapor seal. Then I replaced the cap. See Fig. 1. As the next step I cut eight sections about ⅜-inch square by ¼ inch thick from a rubber eraser, and cemented these to the face of the cap as shown in Fig. 2. The tip of the cork pillar protrudes just far enough that when the rubber feet are held firmly against a flat surface, the end of the cork pillar rests squarely on the same surface.

The microphone was then clamped to the soundboard of the organ at the desired point by screwing a block of wood to the soundboard, and providing a small clamping piece projecting over the body of the mike. Another block of rubber between the body of the microphone and the clamping piece assures that the vibrations of the soundboard will be transmitted to the diaphragm through the cork pillar, but flexible mounting of the heavier body of the microphone will damp out transmission through the mounting blocks.

A pair of 175-ohm, heavy-duty wire-wound potentiometers—also war surplus—made effective gain controls for the microphones, and they stand vigorous and continuous operation much better than ordinary radio-type controls. A method of mounting and operating these by foot then had to be devised.

The instrument had a pair of pedals that had orginally operated the bellows. With the installation of an electric blower, these pedals were no longer needed, and they were taken over for the job.

To convert the reciprocating motion of the pedals into rotary motion for the controls in the simplest way possible, we went back through ancient history to what was probably the earliest system known to man: winding the string of a bow around a shaft, and making the shaft revolve by sawing back and forth with the bow. Angle brackets were fastened to the backs of the pedals to serve as bearings for the bows. The bows were bent from steel wire to the dimensions given in Fig. 4. (This steel wire can be taken from an ordinary coat hanger.)

The controls were mounted back-to-back on a U-shaped chassis with the vertical sides of the U in line with the bow-bearing brackets on the backs of the pedals. The controls were wired so that the ground side of the one control is nearest the pedals, and the ground side of the other is away from the pedals, because one pedal will produce clockwise rotation and the other counter-clockwise rotation. See Fig. 5.

With the pivots for the bows about 4½ inches above the pedal hinges, the bows will have a straight-line travel of approximately 2 inches. To convert this into an equivalent rotation, turn a couple of drums out of brass or other suitable material to a diameter of ¾ inch at the bottom of the groove. See Fig. 4-b. Drill the centers for the volume control shafts (¼ inch) and drill and tap the drums for No. 6-32 Allen or Bristo setscrews. Also drill a hole at an angle through the rim of the drum to provide an anchor for the bowstring.

Use only the best grade of dial cord. Anchor the center of the cord to the drum. Fasten the drum to the volume-control shaft and turn the control to the OFF position. Tie one end of the cord to the bow where the bend occurs next the pedal as shown in Fig. 5, holding the pedal in the raised position. Wrap one complete turn of the cord around the drum and tie the other end to the tip of the bow. Any service technician who can thread up a dial can do this with his teeth while his helper holds his hands behind his back!

It may be desirable to provide stiffness in the hinges of the pedals so that they will remain in any desired position. We took over the pedals from an old player piano whose hinges were of the pin-ended shaft operating in a socket-ended screw. Tightening the screws was sufficient to provide the desired feel for the writer. The vertical block of wood between the pedals and the controls prevents the pedals from being depressed too far.

The mixer circuit is given in Fig. 6. An electronic engineer could no doubt improve it, but it worked. The main amplifier was a 6C5 feeding a 6SL7 phase-inverter driving push-pull 6V6's with negative feedback around the final stages.

Experiment to find the best speaker location. It goes without saying that the largest speaker obtainable should be used, and that adequate baffling must be provided. Tweeters were tried, but added nothing to the output. The use of at least two speakers is recommended, as the final tone frequently resembles a pipe organ to a surprising degree, and the essence of such tone is that it seems diverse and not located at a single source. Direct the speakers at a plaster wall, or better yet, at the corners of several plaster walls.

Experiment to find the best locations for the pickups too. The center of the back of the wind-chest is probably the best location, as far as possible from outside or internal supports so that it is free to vibrate. It may be desirable to try a location toward the treble end of the instrument to balance the result. Consult the organist. END

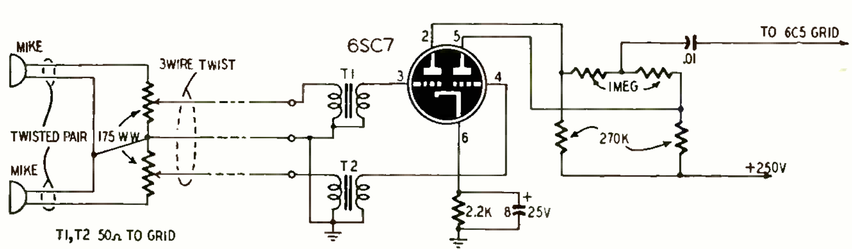



Fig. 6—Inputs are mixed through a simple and effective circuit using one 6SC7.

*How practical filter sections differ from the mathematicians' loss-free ideal*

# MORE ABOUT

By NORMAN H. CROWHURST

FROM correspondence I have received since the publication of "Loudspeaker Crossover Design" in the July, 1952, issue of RADIO-ELECTRONICS, it is evident that many—even engineers—have more vague ideas about filters than might have been expected. Articles have appeared from time to time, giving various details of filter design, complete with circuits and values, or with charts or formulas from which values can be calculated to suit individual applications. This information has included idealized response characteristics, and a general impression seems to exist that filters are special circuits possessed of some magical properties which can be achieved simply by applying the charts or formulas.

Mathematicians may be more fortunate than the rest of us in being able to understand the *derivation* of the wonderful circuits presented in textbooks, but whether or not they understand fully the practical implications of their handiwork, they generally fail to convey this information in terms the technician who is not a mathematical genius can understand. The truth is that, even to the mathematician, complete analysis of circuits containing a number of reactance elements is highly involved. Even our mathematical friends look for short cuts. As anyone who has tried taking a short cut knows, it can be very useful *when it can be certain that the short cut really does lead to the same place* as the regular route.

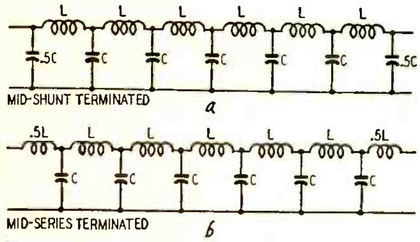



**Fig. 1—Artificial lines built up from two types of low-pass filter sections.**

## Travelling up the line

Most filter designs are based on transmission-line theory. To understand this let us first look at the properties of transmission lines. They consist essentially of two conductors spaced apart by dielectric material. The conductors may be similar or different, concentric or parallel wire—in all cases the conductors possess resistance and inductance distributed uniformly along their length, and the dielectric between them will introduce capacitance and insulation leakage (conductance) also distributed uniformly along the length of the line.

The theory of transmission lines deduces that attenuation along the line is due to conductor resistance and insulation conductance. Time delay and other effects are created by inductance and capacitance. When these four quantities are in a simple proportional relationship the line is "distortionless"; this means uniform attenuation and time delay for all frequencies. As all frequencies suffer the same *time* delay, this means the *phase* delay of individual frequencies will be proportional to frequency. Such a distortionless line does not occur naturally; insulation conductance is usually too low (or insulation resistance too high), to satisfy the proportional relationship required. Increasing insulation conductance by deliberately making the line more leaky is obviously undesirable because this will increase the attenuation along the line.

Long lines are usually loaded to make them distortionless. This consists of artificially increasing inductance so that correct proportional relationship is obtained. There are two kinds of loading: distributed and lumped. Distributed loading is introduced by inserting magnetic material along the conductors to increase the inductance uniformly all along the line. Lumped loading is achieved by inserting chokes—or *loading coils*—at regular intervals along the line, so the average inductance value satisfies the proportional relationship required.

Theoretical analysis of lines with distributed loading is quite simple, but the mathematics for lumped loading become formidable, and approximations have to be made to obtain workable formulas. These apply only over a limited range of frequencies; beyond this range the approximations are not good enough. It is obvious that a line with lumped loading cannot achieve the distortionless condition in the same way as one using distributed loading; but it does produce an approximation to the distortionless condition nearer than the unloaded line, within the range of frequencies for which it is designed.

## . . . and back again

But we did not start out to discuss transmission lines—the real subject of this article is *filters*. The transmission line is merely a short cut to conventional filter design. Enough has been said to show that a distortionless transmission line is somewhat a "castle in the air". Filter design is based on another approximation in transmission-line theory, called the "loss-free line." In this approach, conductor resistance and insulation conductance are both assumed to be zero, so the line possesses only inductance and capacitance.

## Characteristic impedance

A loss-free line would be distortionless, and would possess what is called a *characteristic impedance*. If the line is terminated with a resistance equal to the characteristic impedance, the voltage and current in this terminating resistance will naturally follow the usual Ohm's law relationship; but the signal voltage and current at any point along the line will be identical in value with that in the terminating resistance. Progressive phase delay takes place along the line, but this will not affect either the values of voltage and current or the phase relationship between them at any one point.

Now suppose the line is terminated, not by a resistance equal to its characteristic impedance, but by some other value—either a different resistance, or a reactance. The usual explanation of what happens states that when the line is terminated by its characteristic resistance all the energy transmitted along the line is dissipated in this termination; but when some different value is used, some of the energy arriving at the termination is reflected back along the line. The varying phase relations between the reflected components of voltage and current and the original forward-going components, cause the effective impedance of the line measured at different points to vary. The net result: with wrong resistance termination, the impedance varies above and below the characteristic value, having maximum values at half-wave intervals, and minimum values also at half-wave intervals, but spaced mid-way between the maximum values; with re-

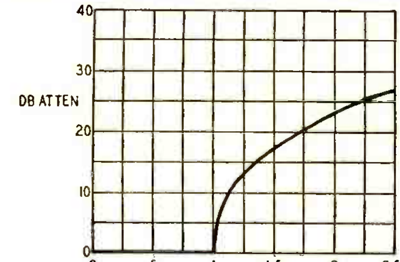



**Fig. 2—Attenuation curve of a typical low-pass filter section that is terminated in its image impedance. See text.**

# FILTERS

actance termination the impedance of the line varies so as to produce alternately positive and negative reactance components at similar half-wave intervals.

This brief consideration shows that even the comparatively simple loss-free line, wholly theoretical as it is, can produce some quite complicated results if the operating conditions are not exactly as planned, especially when it is remembered that the wavelengths of different signals along the same line will vary in inverse proportion to frequency; so the impedance at the sending end of a line mismatched at the receiving end will vary in a very complicated way over a wide frequency band. However, in our short cut to filter theory, lines are always *assumed* to be correctly terminated to avoid these complications.

The simplest form of filter derived directly from this imaginary loss-free line is the *low-pass* type. A number of sections of this type of filter are called an *artificial line*. Fig. 1 shows such an artificial line. (A high-pass filter merely has the positions of L and C reversed.) The basic difference from the theoretical loss-free line is that the inductance and capacitance of the line are uniformly distributed along its length, so each little bit of inductance is between two little bits of capacitance, so finely divided that a true equivalent would contain an infinite number of both inductances and capacitances. The artificial line has a restricted, or finite, number of elements.

## Image impedance

The practical effect of this fact is that the artificial line has a definite cutoff frequency (it may be "high-pass" or "low-pass"). The loss-free line had no cutoff frequency, remember (provided we do not take into consideration the effect of transverse propagation between conductors. This enters the picture only when we get to waveguides). The term *image impedance* is used to

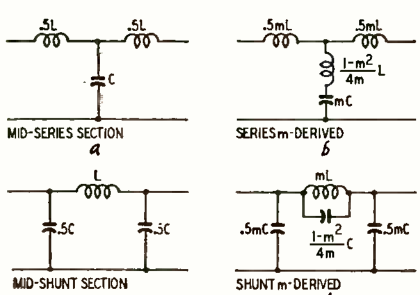



**Fig. 3—Basic low-pass filter sections, with corresponding *m*-derived types.**

replace what was called *characteristic impedance* for the transmission line; it signifies that if this image impedance is applied as termination to the output end, the impedance measured at the input will be identical. What is often overlooked about the artificial line is that, besides having a cutoff frequency, its image impedance also has a frequency characteristic. *Image impedance* is thus quite different from the *characteristic impedance* of the loss-free transmission line.

If the artificial line is terminated at what are termed mid-shunt points, represented at Fig. 1-a, the theoretical image impedance rises to infinity (or open circuit) at the cutoff frequency. Below cutoff this image impedance is resistive and starts from a value identical with the characteristic impedance of the equivalent transmission line. Above the cutoff frequency the theoretical image impedance becomes reactive.

If the artificial line is terminated at a mid-series point, as represented at Fig. 1-b, the image impedance at cutoff falls to zero (short-circuit). Below cutoff the image impedance is always a resistance and likewise starts from the characteristic impedance of the equivalent transmission line. Above cutoff, the image impedance again becomes a reactance.

The usual way of showing the transmission (or attenuation) characteristic of such an artificial line is represented in Fig. 2. Note that the attenuation is zero right up to the cutoff frequency, and from there it suddenly starts to rise steeply. In curves of this kind the filter is assumed to be terminated by its image impedance, something which is not always clearly stated.

Before considering the implications of this fact on practical circuits, let us turn to the next stage in filter derivation—what are called *m*-derived filters.

The idea is that one of the elements, series or shunt, in a basic section of the artificial line, is modified by a factor *m* (modification) and then the other one is also modified and another element (of opposite kind of reactance) is introduced in such a way that the image impedance in the pass range, i.e. well away from cutoff frequency, retains its original value. In practice, the factor *m* is a fraction of 1.

Fig. 3 shows basic mid-series and mid-shunt sections of artificial line together with the *m*-derived filter obtained from each. Fig. 4 shows the attenuation characteristic for one of these *m*-derived filters. Comparing this with Fig. 2, the advantages gained are that the cutoff slope is much steeper, and at one frequency beyond the pass range (indicated by the dotted line) the attenuation becomes theoretically infinite. (In practice this attenuation is limited by losses). This attenuation characteristic is also plotted on the assumption that the filter is terminated by its image impedance.

## What an image!

Now to see what this assumption of image impedance termination really means. Fig. 5 shows how mid-series image impedance varies with frequency for a low-pass filter or artificial line of the simple type (given by $m = 1$), and for different values of *m* in series *m*-derived types. Books on filters recommend using, as termination for a com-

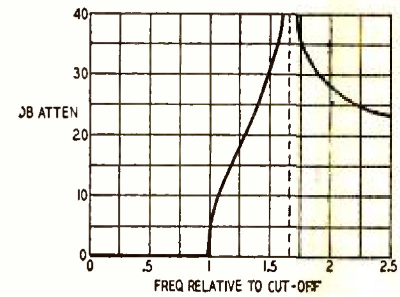



**Fig. 4—Attenuation of *m*-derived low-pass filter. In this example $m = 0.8$.**

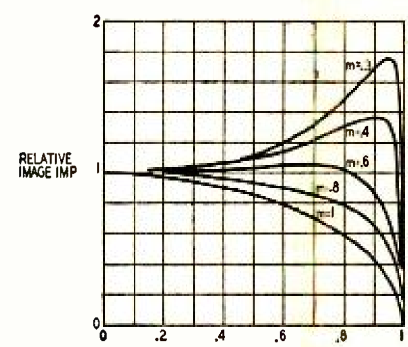



**Fig. 5—How image impedance of low-pass filters varies with different *m* values.**

posite filter, an *m*-derived section with a value of $m = 0.6$, because this value of *m* gives an image impedance that adheres most closely to characteristic impedance up to cutoff frequency. But, even then, to get the idealized performance characteristic given in Figs. 2 and 4, the output load (loudspeaker) impedance must look like one of the curves of Fig. 5. Even if, and when, the speaker manufacturer obliges, who wants to load the amplifier with such an impedance—since it will also "appear" at the input terminals? Every type of filter has an image impedance that either rises to open circuit or falls to short circuit at cutoff frequency: *but the practical terminating impedance never does this.*

However, it is possible to design "constant resistance" types which approach very closely to the idealized characteristic. The second and concluding installment of this article will describe such filters and their design.

(TO BE CONTINUED)

# ELECTROSTATIC SPEAKER

*An old type of speaker starts out a new life under better auspices*

## By WERNER W. DIEFENBACH

PRACTICALLY every home radio now sold in Western Germany is equipped to receive FM broadcasting in the 87.5–100-mc band (RADIO-ELECTRONICS, March, 1953, P. 63). The majority of German listeners attach great importance to high-quality reproduction, and insist on good audio response from 40 to 12,000 cycles, and even higher. Their demands have compelled German radio manufacturers to develop low-cost wide-range speaker systems. One of the most interesting features of these new systems is the trend to electrostatic speakers for the high-frequency units.

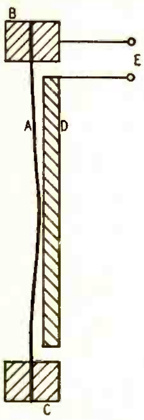



Fig. 1—Cross-section through an electrostatic speaker. The d.c. polarizing voltage E prevents "doubling" due to inertia of diaphragm. See text.

Electrostatic speakers in themselves are not new. A number of types have been designed and manufactured in the past for general use, but their large size and the high polarizing voltages required prevented them from being very successful. (Older readers will remember the *Kylectron*, sold in the United States in the late '20's.—*Editor*) However, the electrostatic speaker has distinct advantages as the h.f. element in a two- or three-way system, where its size and voltage requirements are both small. It costs much less to manufacture than the dynamic type, and has no pronounced resonant peaks between 7 kc and 20 kc.

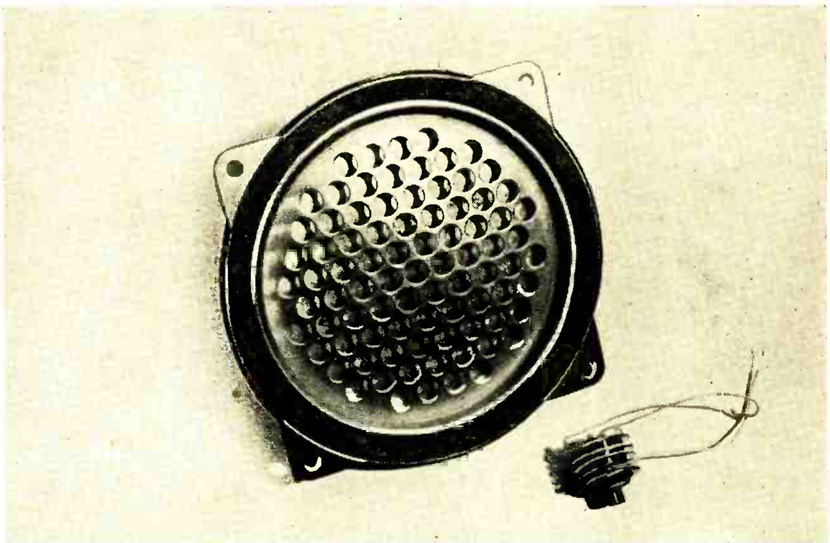


Fig. 2—*Isophon* electrostatic tweeter. Coil is part of the high-pass filter.

In principle, the electrostatic speaker is nothing but a two-plate capacitor (see Fig. 1). The diaphragm A—usually made of thin metal or metallized plastic foil—forms one of the plates, and is clamped at the edges (B and C). The heavy back plate D, representing the other plate of the capacitor, is spaced a small distance from diaphragm A. A d.c. polarizing voltage applied between A and D creates an electrostatic attraction which tends to pull the plates together. Since only A is flexible enough to move, it bends in at the center, but is prevented from actually touching D by the mechanical design of the speaker.

Now, if an a.c. signal is superimposed on the d.c., diaphragm A will move in and out in accordance with the a.c. variations. (Without the d.c. bias pulling it toward D, the diaphragm would swing almost *twice as far* in the opposite direction on the second half-cycle—its inertia alone would carry it an equal distance back past the original position, and the driving force of the second half-cycle of the signal would be added to this movement. This is known as "doubling," and is the reason why the d.c. polarizing voltage is essential.) Good efficiency requires high d.c. bias voltage or very small normal clearance between A and D.

Fig. 2 shows a typical modern electrostatic tweeter (Isophon). The diaphragm is 3⁹⁄₁₆ inches in diameter, and the speaker is only ¾ inch deep overall. The coil at the right is part of the high-pass filter that prevents the tweeter from being damaged by low frequencies. The circuit for feeding the tweeter is given in Fig. 3.

In this arrangement the speaker is fed with about 250 volts polarizing bias through R1. C1 and L1 form a high-pass filter between the impedance-matching tap on the output transformer and the speaker. The low-frequency cutoff (turnover) of the filter can be varied by adjusting the powdered-iron core of the coil. L1 has a maximum inductance of about 40 mh and a d.c. resistance of about 125 ohms. Higher values of inductance develop excessive voltage at the turnover frequency.

The filter is adjusted for a turnover

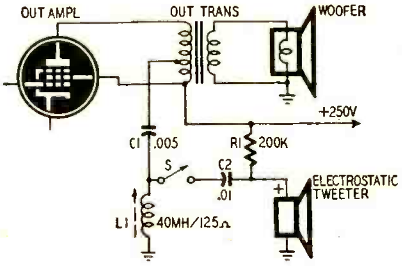



Fig. 3—Schematic of two-way speaker system with *Isophon* electrostatic unit.

between 7 and 8 kc. The remarkably flat acoustic-pressure curve between 7 kc and 20 kc is shown in Fig. 4.

The speaker is coupled to the filter network through C2, and can be disconnected from the circuit if desired by opening switch S.

### Directivity

High-frequency speakers are notoriously directive, so that listeners sitting off the main axis of a tweeter without

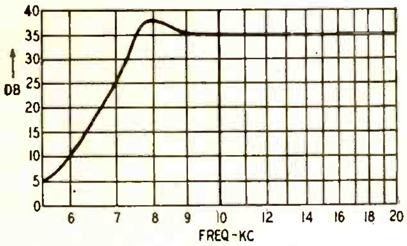



Fig. 4—Response of *Isophon* tweeter is remarkably flat above turnover.

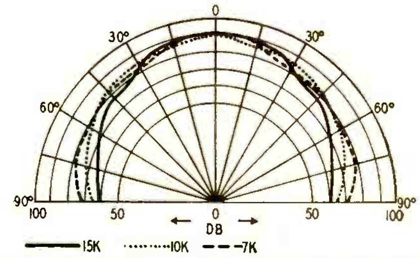



Fig. 6—Horizontal distribution pattern of the *Koerting* electrostatic tweeter.

a special wide-angle distribution horn may not hear much of the high-frequency radiation. This disadvantage is overcome in one electrostatic tweeter (Koerting) by giving the diaphragm and back plate an outward curvature. See Fig. 5. The success of this design can be seen in the horizontal-distribution pattern of the Koerting tweeter (Fig. 6).

A three-way speaker system made by Koerting for high-quality receivers is shown in Fig. 7. The characteristics and mounting of the individual speakers are designed to distribute all frequencies uniformly throughout the room. Extensive tests indicate that these units have good service life as well as excellent frequency response, even at high relative humidity. END

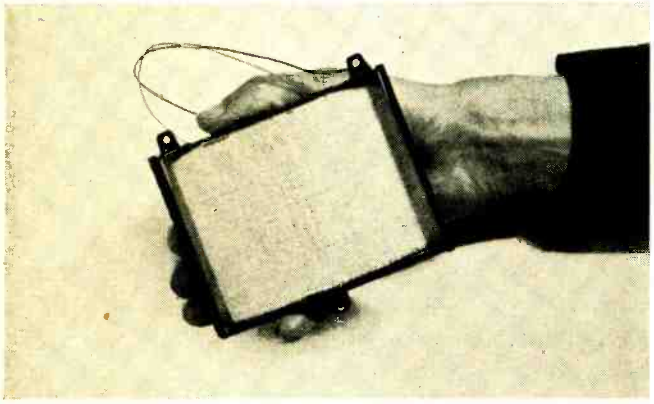


Fig. 5—*Koerting* curved-plate electrostatic tweeter has wide-angle distribution.

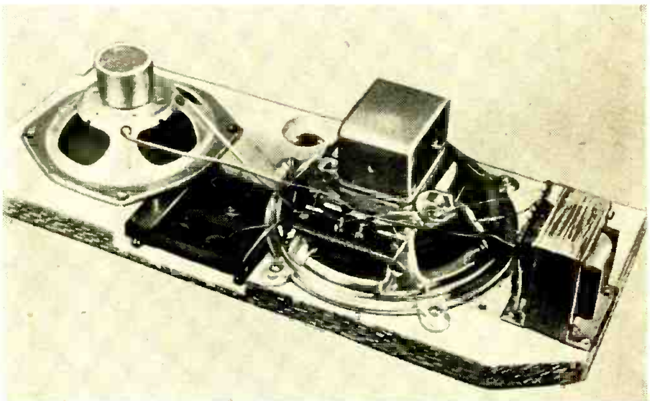


Fig. 7—Three-way speaker system used in high-quality German radios. The electrostatic unit is in the center.

# RELIABLE WIDE-RANGE AUDIO OSCILLATOR

WIDE-RANGE audio oscillators featuring low distortion and a high degree of stability are rapidly becoming a necessity. This capacitance-tuned Wien bridge audio oscillator is described through the courtesy of Cornell-Dubilier.

The unit covers from 20 to 20,000 cycles in three ranges. The lowest range tunes from 20 to 200 cycles when the 20-megohm resistors are in the bridge. The bands are tuned with a standard 2-section, 365-μμf tuning capacitor (C2 and C3) instead of the 4-section, 500-μμf unit often specified for use in these instruments. C1, C4, and C5 are 50-μμf APC-type air trimmers. C1 compensates for the stray capacitance across C3. C4 and C5 raise the capacitance range to 40–400 μμf. The tuning capacitor is mounted on a plastic plate supported above the chassis on standoff insulators. The portion of the chassis immediately below the tuning capacitor is cut out to minimize stray capacitance. An insulated shaft connects the shaft to the tuning dial.

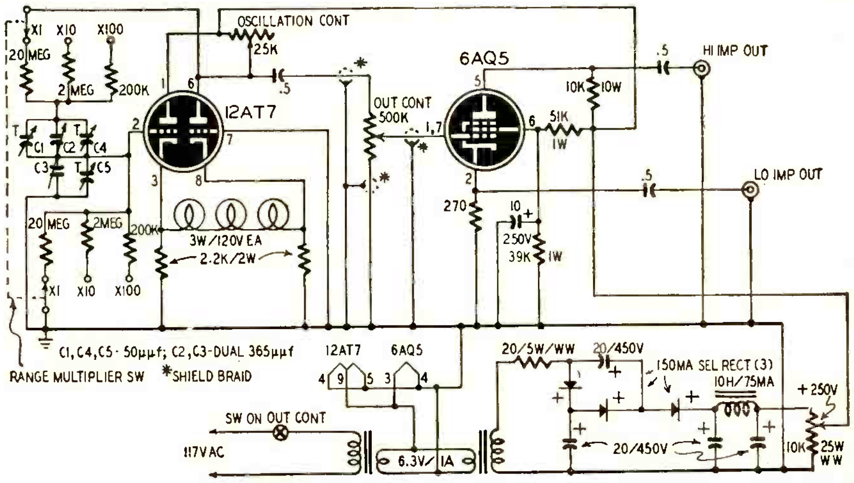
The resistors used in the bridge should be accurate to 1%, so we recommend precision resistors unless you select them on an accurate bridge from a supply of ½-watt units. The range switch is a 2-pole, 3-position rotary type with ceramic insulation.

The power supply is mounted below the chassis with a partition shield to isolate it from the hum-sensitive parts of the circuit. Heater leads are twisted and dressed close to the chassis. All grounds for the 12AT7 return to one point on the chassis.

Use the following procedure in preparing the oscillator for calibration:

1. Set the slider on the 10,000-ohm bleeder resistor about one-fourth the way up from the grounded end.
2. Set the range switch to ×1.
3. Set the OSCILLATION CONTROL to maximum resistance, connect a pair of high-resistance phones to the low-impedance output jack, then set the OUTPUT CONTROL to the middle of its range.
4. Set C1, C4, and C5 to about three-fourths of maximum capacitance and set the tuning capacitor C2-C3 to maximum capacitance (fully closed).
5. Turn on the power and let the tubes warm up. Listen for a tone in the phones. If you don't hear one, advance the OUTPUT CONTROL and turn the tuning capacitor to minimum-capacitance position. Advance the OSCILLATION CONTROL until a tone is heard.
6. Use a high-resistance voltmeter to set the slider on the voltage divider to exactly 250 volts, then repeat step 5.

The instrument is now ready for calibration. Follow the procedure outlined in the article "Calibrating Audio Oscillators" in the October, 1948, issue of RADIO-ELECTRONICS. END



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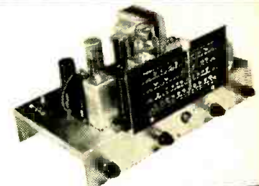

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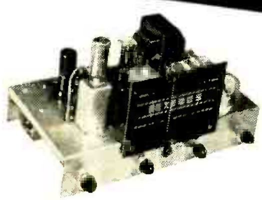

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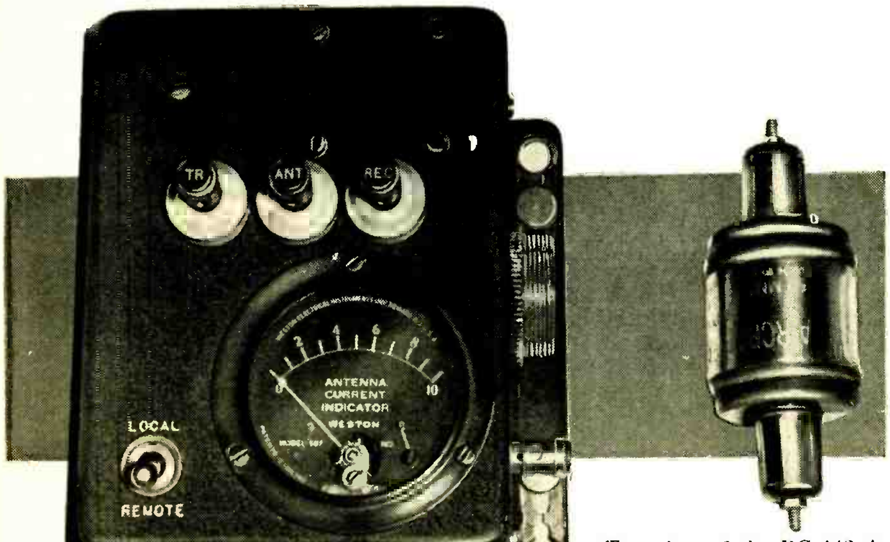
# THE LOW DOWN ON THE BC-442-A

***Piece-by-piece or "as is"—this antenna relay unit is a real surplus goldmine for transmitting amateurs***

By JOHN T. FRYE




Top view of the BC-442-A. The vacuum capacitor fits cavity in bottom cover.

THE supply of worth-while war surplus electronic equipment has virtually disappeared from the market. Faced with this hard fact, we should re-examine the equipment we have already bought and "stashed" away against some vague possible future need. The antenna relay unit for the 274-N and ARC-5 command transmitters, known variously as the BC-442-A or by the Navy model number CBY-29125, was purchased by thousands of amateurs and experimenters; but many who bought these compact little units still do not realize what a treasure they have. The aim of this article is to tell them. The diagram of the BC-442-A is shown in Fig. 1. The LOCAL-REMOTE switch and the connections shown in dashed lines were provided in earlier models of the BC-442-A. Lead A is omitted in units using the LOCAL-REMOTE switch.

The 2-inch G-E or Weston antenna current indicator has specially shaped pole pieces which produce a nonlinear d.c. characteristic which partially compensates for the nonlinearity of the r.f. thermocouple used with it. The dial scale is calibrated from 0 to 10 in purely arbitrary linear units. Table I shows the current *versus* scale readings of the meter.

The unusually low resistance of the movement (3 ohms ± 20%) makes the instrument very voltage sensitive. To demonstrate this fact, I constructed a simple voltaic cell by placing a quarter and a copper penny on opposite sides of a piece of note paper that had been moistened with the tongue. This cell deflected the meter pointer a full two divisions. You will note that while the full-scale current is around 5 ma, 1 ma drives the pointer to half-scale. This makes the meter very useful in any application where a substantial indication of very low current is desired and yet where considerable peaks of current —peaks that would damage a microammeter—must be anticipated. A typical use is contained in the article "S-Meter From Surplus" on page 47 of the June, 1952, issue of RADIO-ELECTRONICS.

The meter is designed, however, to be used with the thermocouple located inside the case of the BC-442-A. This thermocouple develops its rated 19.5 mv of d.c. across the meter terminals when approximately 0.75 amperes of r.f. current flows through the LINE terminals located at the ends of the unit. Table II shows the relationship between r.f. current through the thermocouple and the scale reading of the meter. The improved linearity shown by the indications listed in Table II is the result of using the special meter pole pieces mentioned previously.

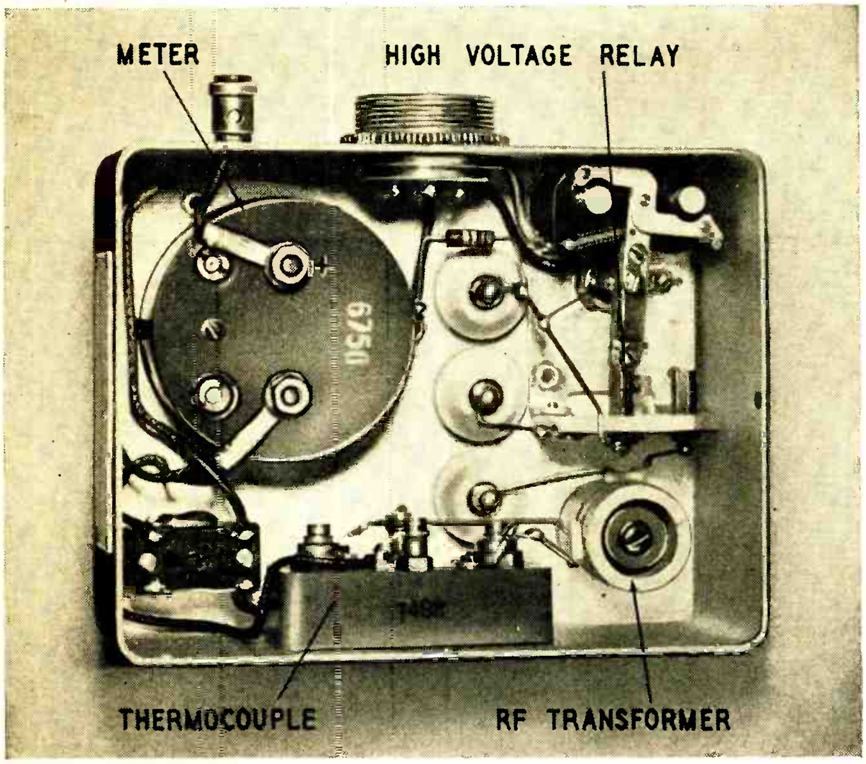
You will note that a substantial meter indication is had with as low as 100 ma of r.f. current. The sensitivity cannot be further increased by substituting a microammeter for the meter in the unit. A thermocouple is a very low-impedance limited-voltage-generating device, and it cannot push any significant amount of current through the high resistance—usually several hundred ohms—of a microammeter coil.

## Applications

The amateur or experimenter can find dozens of important uses for this sensitive r.f. thermocouple and meter. For example, when very short leads were used to connect the LINE terminals of the thermocouple between the bottom of a center-loaded 75-meter whip antenna and the car body, shock excitation from a BC-696-A transmitter running 40 watts input and feeding an antenna several feet from the car was sufficient to produce a half-scale reading on the meter. You can easily tune a whip antenna by tuning the transmitter to the desired frequency and then trimming the loading coil for maximum shock-excited current.

The man who likes to experiment with antennas can place the thermocouple directly across the center of a receiving dipole cut to the frequency and placed several wavelengths away from the transmitting antenna. A twisted pair or shielded leads can be run from the thermocouple back to the meter at the operating position. Varying the spacing or length of elements in the transmitting antenna, will result in a change in current of the receiving dipole.

If it is desired to measure the antenna current produced by any except the smallest transmitters, the .75-ampere maximum reading of the thermocouple-and-meter combination will not




**Underside of the antenna relay unit, with cover removed to show components. The resistor between ground and the REC terminal is not used in all models.**

be adequate. However, if the built-in r.f. transformer is used ahead of the thermocouple, the current-measuring capacity is roughly increased by a multiplier of 10 to a maximum capacity of 7.5 amperes of r.f. current. This special transformer can be seen in the picture and is shown in the wiring diagram of Fig. 1. If it is to be used, the parts should be left mounted in the case exactly as they are, for changing the lead lengths from the transformer to the thermocouple will change the readings.

The spring carrying the moving contact points of the high-voltage relay can be shifted so that instead of pressing against the inside of the fixed contact point farthest from the end of the case it presses against the outside of the fixed contact nearest the side of the case. Then, if the switch is thrown to the LOCAL position, the r.f. current can be read when applied to the TR and ANT terminals.

Table III shows the relation between measured r.f. current applied to these terminals and the meter reading. The last two figures on this chart were estimated because the r.f. meter used for calibrating went only to 5 amp.

The relay is a nice little item. It consists of a set of s.p.d.t. contacts with excellent high-voltage insulation and exceptional spacing that provide very low capacitance and good arc-stopping characteristics. In addition, there is another pair of s.p.s.t. normally-open contacts. As can be seen from the bottom-view photo, the action of the relay armature is a torque affair instead of the usual straight up-and-down pull. Two coils connected in series produce this torque. Each has a resistance of 90 ohms, making a total of 180 ohms. The relay was designed to work on 28 volts d.c. with a current of 155 ma. A 30-volt stepdown transformer, a 200-ma selenium rectifier, and a 50-µf filter capacitor can be used to make a power supply (see Fig. 2) for operating this and other 24–28-volt relays.

This particular relay can be used for send-receive switching of single-wire antennas. The extra set of contacts can be employed to ground the receiver antenna lead-in while transmitting, just as was done in the original setup. The relay can also be used for switching r.f. inside the transmitter or for switching connections carrying very high voltages. You need not worry about the relay wearing out. It originally operated with each closing of the key on the 274-N transmitters!

The final valuable item of the unit is the 50-µµf, 5,000-volt vacuum capacitor originally mounted beneath the tuning unit but pictured beside it in the top-view photograph. It features a high voltage rating, excellent stability, and low inductance. The first and third features make it very useful in eliminating TVI. When connected between the plate and filament or grid and filament of a transmitter final amplifier, it provides a low-impedance bypass for high-frequency harmonics that otherwise would have to return through the tank circuit and so could reach the antenna and be radiated. Phil Rand, in his booklet on TVI prevention, gives excellent suggestions on how this identical capacitor can be used to good advantage. It can also be used to pad a high-frequency final tank circuit for operating on a lower band.

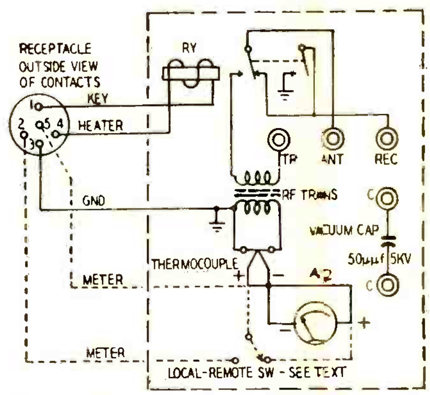



**Fig. 1—Diagram of the BC-442-A unit.**

The stability and low inductance of the capacitor also make it an excellent one to be used with a grid-dip meter for measuring the inductance of small coils. The coil is connected directly across the capacitor with very short, heavy leads, and then the resonant frequency is determined with the grid-dip meter. The inductance of the coil in microhenries equals

$$\frac{25,330}{C \times f^2}$$

where C is the capacitance in µµf (50 in this case) and f is the resonant frequency in megacycles.

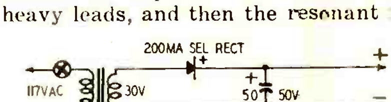



**Fig. 2—Diagram of an inexpensive 28-volt d.c. supply for surplus relays.**

It is obviously impossible to point out all of the various uses of the BC-442-A and its components. It is hoped, though, that this discussion of the characteristics of these several items will enable you to use them more intelligently and confidently than you otherwise could have done. END

**TABLE I** (Meter alone)

| D.C. ma. | Scale |
|---|---|
| .1 | .5 |
| .2 | 1 |
| .3 | 1.75 |
| .4 | 2.5 |
| 1 | 5.2 |
| 2 | 7.5 |
| 3 | 9 |
| 4 | 9.6 |
| 5 | 10.2 |

**TABLE II** (Thermocouple and Meter)

| R.F. amps. | Scale |
|---|---|
| .1 | 1 |
| .2 | 2 |
| .3 | 4 |
| .4 | 5.5 |
| .6 | 8.25 |
| .75 | 10 |

**TABLE III** (Using r.f. transformer)

| R.F. amps | Scale |
|---|---|
| 1 | .5 |
| 1.5 | 1.25 |
| 2 | 2.5 |
| 2.5 | 3 |
| 3 | 4 |
| 6 (Approx.) | 8 |
| 7.5 (Approx.) | 10 |

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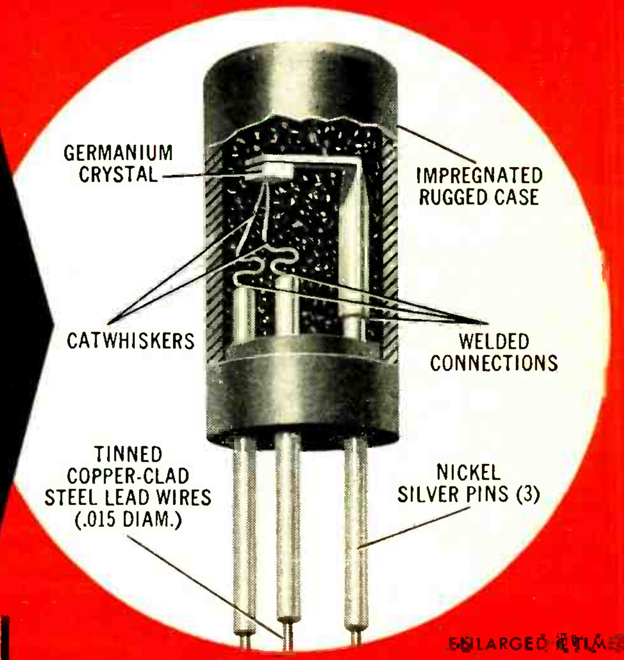


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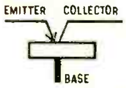
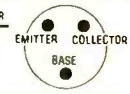


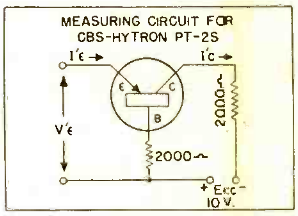

Transistor Symbol

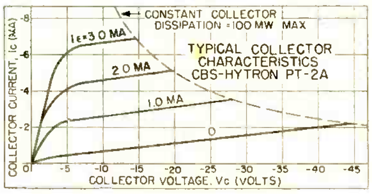


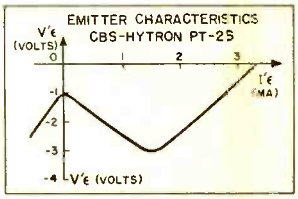

Basing Diagram (bottom view)

CBS-Hytron T-2 socket

Note similarity of pin layout to that of transistor symbol. CBS-Hytron type T-2 transistor socket features groove to guide pins into socket. Also anti-burn-out design to insure that base connection of transistor will always be made first.



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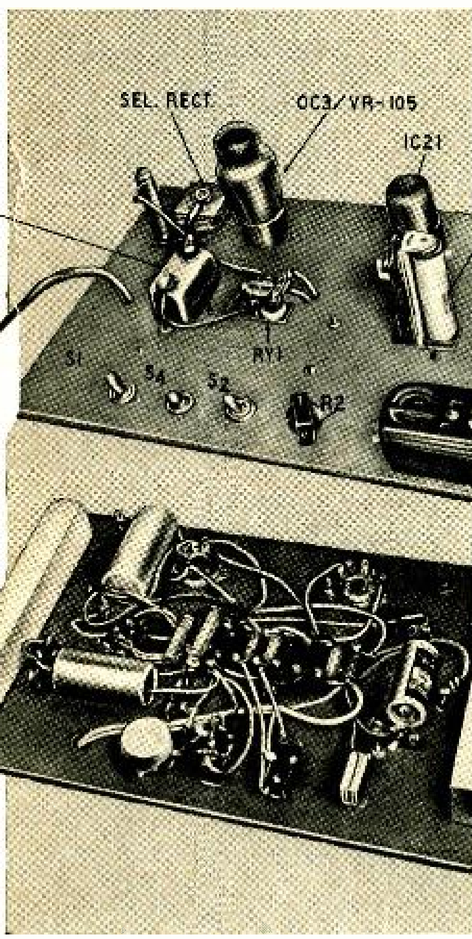
# ELECTRONIC INTERVAL TIMER

***Turns equipment on or off after any time period from 6 seconds to 15 hours or more***

**By JOHN L. HARNED**




IT IS often convenient and sometimes necessary to have a means of turning various types of electrical equipment on or off automatically, after a predetermined time interval. This electronic interval timer does just that, and combines versatility, dependability, and ease of operation with low cost, simple construction, and minimum operating power.

The design of the electronic interval timer is based on the characteristics of an R-C circuit when connected to a d.c. voltage supply. See Fig. 1. The time the capacitor will take to charge to the applied voltage E can be computed from the circuit constants. Such time $t$ is represented by the formula

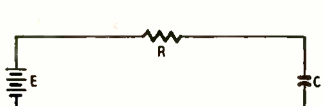
$$t = -RC \left( \log_\varepsilon \frac{EC - q}{EC} \right)$$

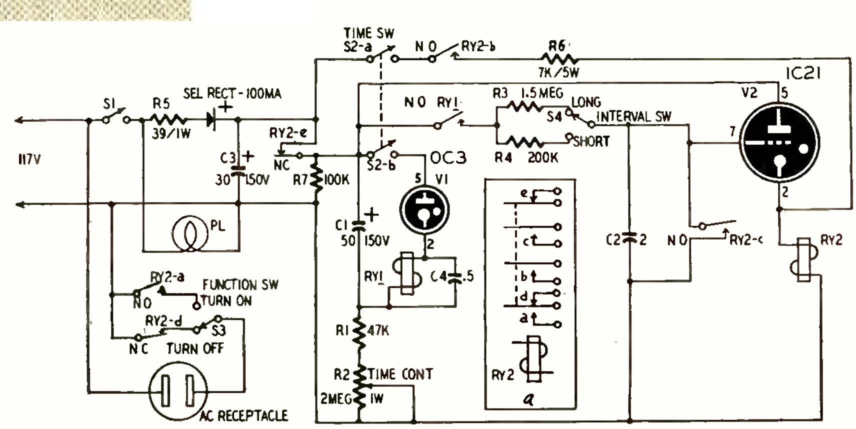
where R is the resistance in ohms, C is the capacitance in farads, $\log_\varepsilon$ is the *natural* logarithm, E is the supply voltage, $q$ is the required charge in coulombs, and $t$ is the time required in seconds. The charge is equal to the product of the capacitance in farads and the voltage across the capacitor. Thus the time it takes for the voltage across a capacitor to build up to a predetermined value is directly proportional to the resistance in series with the capacitor. Any time desired to bring the capacitor up to a certain charge $q$ can be obtained by changing R while maintaining C and E constant. The design of the electronic interval timer has been based on this relationship.

## Circuit operation

The operation of the timer circuit (Fig. 2) is relatively simple. When the power switch S1 and the timer switch S2 are closed, C1 begins to charge through R1 and R2. When C1 has charged to the breakdown potential of V1, V1 conducts and energizes relay RY1. This closes RY1's relay contacts which in turn causes C2 to charge through R3 or R4, depending on the position of S4. When V1 conducts, C1 discharges rapidly through the low resistance of RY1 and V1 until the extinguishing potential of V1 is reached. When this happens relay RY1 is de-energized and RY1's contacts open again.

(Above) Timer layout and wiring. Fig. 1 (below)—Basic time-constant circuit. Fig. 2 (right)—Schematic of the timer. Type 1C21 is a cold-cathode thyratron triode.

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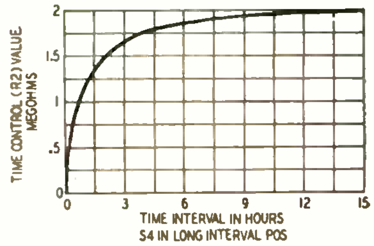
This cycle repeats itself until the charge on C2 reaches the potential necessary to break down V2. When V2 conducts, the control relay RY2 is energized; this closes contacts RY2-a, RY2-b, and RY2-c, and opens contacts RY2-d and RY2-e. RY2-a can turn *on* an external electrical appliance; RY2-d can turn *off* an external electrical appliance; RY2-e turns off the timing circuit when relay RY2 is energized; contacts RY2-b are holding contacts to keep relay RY2 energized; and contacts RY2-c discharge C2 after relay RY2 has been energized.

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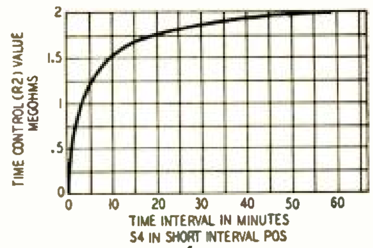


b

**Fig. 3—Approximate long- and short-interval calibration curves for use with a linear timing-control potentiometer.**

Resistors R3, R4, and the potentiometer R2 determine the time interval before relay RY2 is energized after the timer switch S2 has been closed. R2 determines the time it takes to charge C1 to the breakdown voltage of V1 and resistors R3 and R4 determine the number of times relay RY1 must energize before C2 charges to the breakdown potential of V2. (R3 is for long intervals and R4 is for short intervals.)

Since C1 is an electrolytic capacitor, there is some leakage through it, which causes the time required to charge C1 to a predetermined voltage to vary *nonuniformly* with uniform changes in the resistance of R2. This leakage is generally constant as long as the capacitor does not deteriorate, and thus does not affect the operation of the circuit. R1 is the critical resistance needed to make the circuit operate.

R5 and R6 are current-limiting resistors and R7 is a bleeder. C3 is the filter capacitor. C4 smooths out the current pulses passing through RY1. The pilot lamp PL was added to the circuit to provide a constant light source for V1. Gas-filled V-R tubes can be partially ionized by light, and this lamp helps maintain the breakdown potential of V1 at a constant value.

## Using the timer

To operate the electronic interval timer, plug the timer line cord into any convenient a.c. outlet. Plug the electrical appliance to be controlled into the a.c. receptacle on the timer. Throw control switch S3 to the position desired

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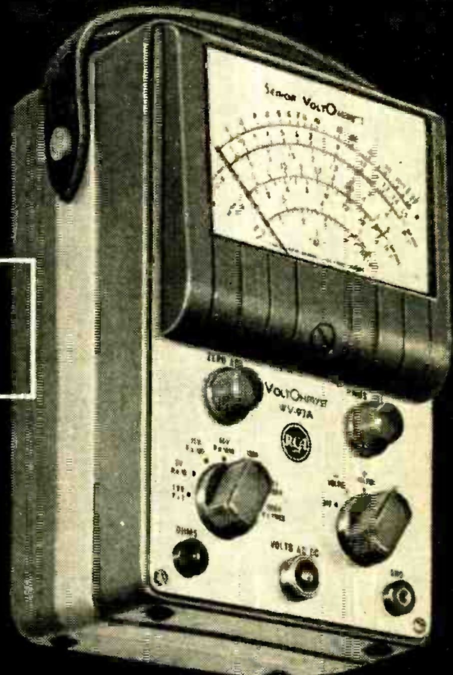

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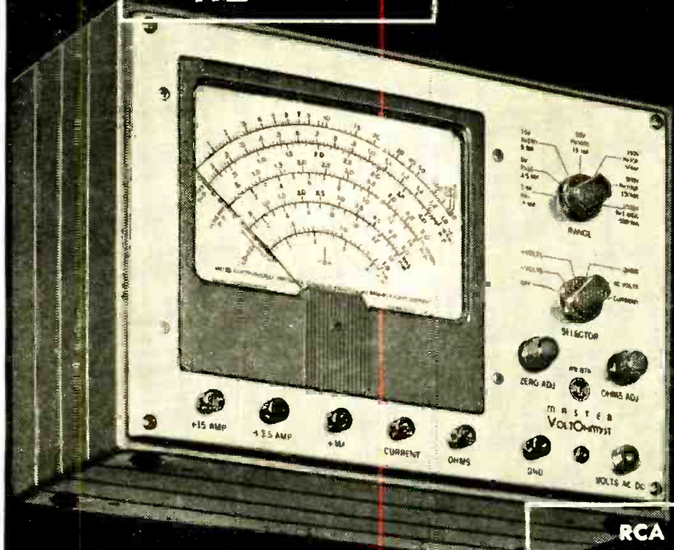


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(TURN ON or TURN OFF). Then set the timing control R2 for minimum time, turn on the switch S1 and allow a warmup period of 30 seconds. After this, set the time control R2 and the interval switch S4 for the time interval desired. The timer can then be thrown into operation at any time by simply throwing S2 to its ON position.

The time intervals for which the timer can be set cover a large range. The shortest interval is 6 seconds and the longest is 15.5 hours. However, the longest time interval can be increased easily to cover a period of several days by replacing R3 with a larger resistor (20 to 40 megohms).

**Materials for Timer:**

**Resistors:** 1—7,000 ohms, 5 watts; 1—39 ohms, 1 watt; 1—1.5 megohms, 1—200,000 ohms, 1—100,000 ohms, 1—47,000 ohms, ½ watt; 1—2-megohm, 1-watt potentiometer, linear or logarithmic taper (see text). **Capacitors:** (Electrolytic) 1—50 μf, 1—30 μf, 150 volts. (Paper) 1—2 μf, 1—0.5 μf, 600 volts, oil-filled. **Miscellaneous:** 1—OC3/VR-105, 1—1C21; 1—100-ma selenium rectifier; 1—s.p.s.t. relay (normally-open contacts), coil resistance 1,280 ohms, Leach type P-3 or equivalent; 1—5-pole, s.t. relay (three contacts normally open; 2 contacts normally closed), coil resistance 350 ohms; 2 octal sockets; 1—117-volt pilot lamp and socket (see text); 1 s.p.s.t. toggle switch; 2 s.p.d.t. toggle switches; 1 d.p.s.t. toggle switch; 1 dual power-outlet receptacle; line cord and plug; terminals, hardware, wire, solder.

## Applications

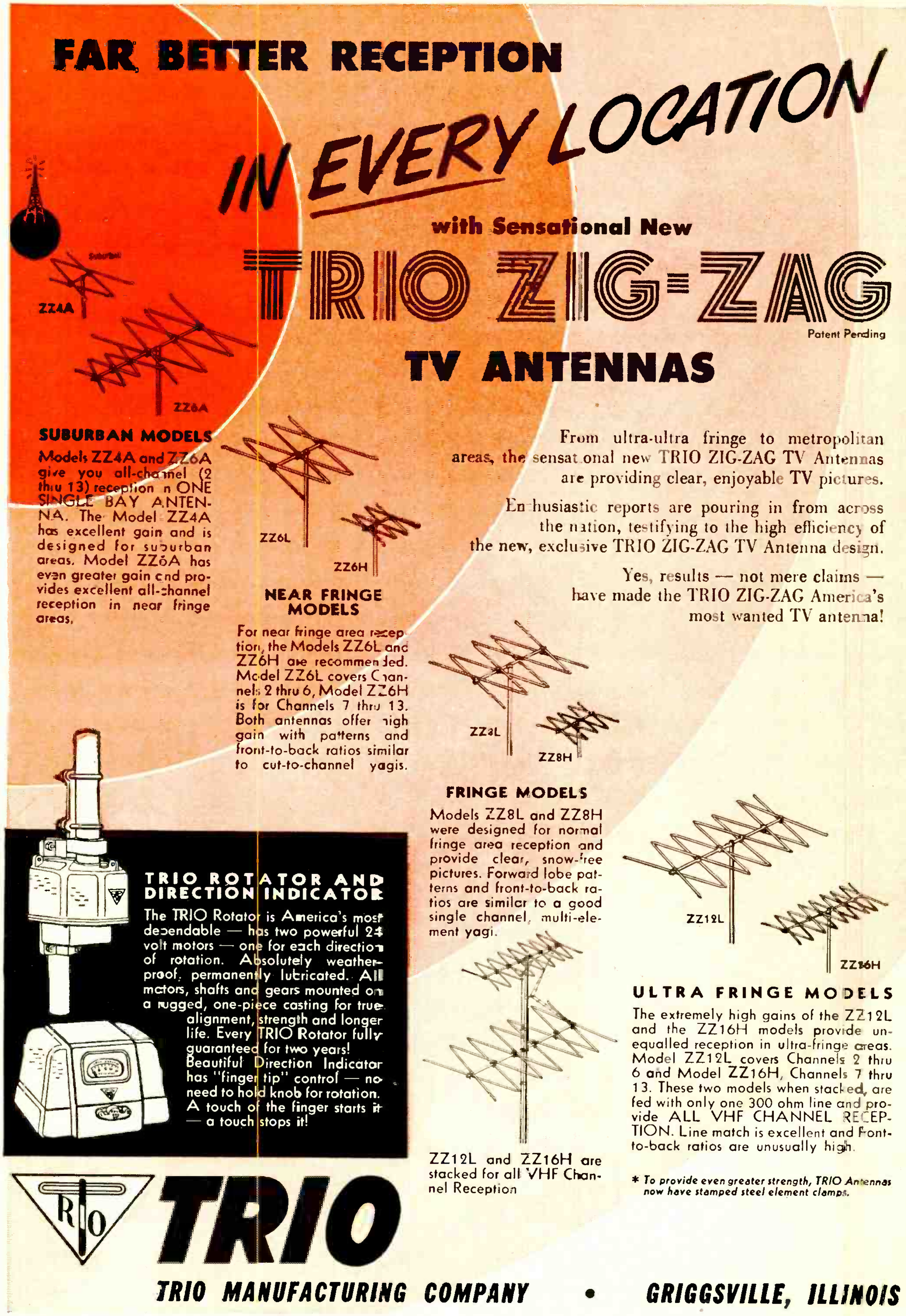
The electronic interval timer can be put to many uses. Around the home it can turn the radio or TV set off at night, or turn it on in the morning; turn a washing machine off after a certain time interval; or turn various lights on or off.

Usefulness can be greatly increased by using two timers at once. This makes it possible to turn an electrical appliance on after a predetermined time interval and off after another interval.

## Construction details

Surplus parts were used throughout the electronic interval timer so that the total cost was less than $10. A transformerless circuit was used, to reduce cost, weight, and size. Relays RY1 and RY2 were purchased from surplus stores for 25 cents each. Relay RY1 requires 12 ma to energize it and relay RY2 requires 23 ma. This relay may have four double-throw switch sections or it may have one set of s.p.d.t. contacts, two s.p.s.t. normally open contacts, and one s.p.s.t. normally closed contact. A schematic of RY2 is shown in Fig. 2-a. The lamp PL, used to illuminate V1, is not critical. Any small 117-volt lamp will do.

In installing relay RY2 it is very important to make sure that contact RY2-b close *before* contact RY2-c, otherwise sparking will occur when the relay is energized. The original time-control potentiometer R4 was a good-quality volume control with a linear taper. Since the time interval does not vary uniformly with the time-control setting, you can get better adjustment and a more linear calibration scale by using a control with a *logarithmic* taper. The graphs in Fig. 3 provide approximate calibration curves as a starting point. END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Appearance of the vest-pocket receiver.

# TWO-TUBE POCKET SET USES FAMOUS CIRCUIT

## By NICHOLAS A. TAX

IT was my ambition to build for myself a true vest-pocket radio set—one that would tune in all the local stations with good selectivity. Much time and many experiments resulted in the one described below.

The circuit I use is the old "three-circuit tuner," which dates back to the beginning of radio itself. Years ago it was considered highly sensitive and capable of reaching great distances, but was a bulky thing. The "variocoupler" itself was about 3 inches in diameter and 4 inches long, and the set required a good antenna and ground.

### The tuned circuit

What I did here was to re-create the variocoupler in miniature and in a different form. The antenna and grid coils are wound on a rectangular plastic form $2\frac{1}{4}$ x $4\frac{7}{16}$ x $\frac{3}{4}$ inches. This form is actually part of the tiny chassis. The antenna winding, L2, consists of 7 feet of No. 26 enameled wire. The grid winding, L3, has 25 feet 6 inches of the same wire. The two coils are spaced about $\frac{3}{16}$-inch apart. This spacing allows a shaft to run through to L1, the tickler coil. I worked with this coil for about two months, trying to figure a way to control regeneration without enlarging the size of the set. Finally I hit on the idea of winding the tickler coil on a tiny triangular form fitted in one corner of the grid coil. When its windings are brought parallel to the grid coil, regeneration is at its highest point. This worked beautifully. The tickler coil is 18 feet of Belden 5-44 Litz wire, wound on a triangular form $\frac{5}{8}$ x $1\frac{1}{4}$ x $1\frac{1}{4}$ inches. This form is made from cardboard dipped in liquid plastic. The shaft was made from an

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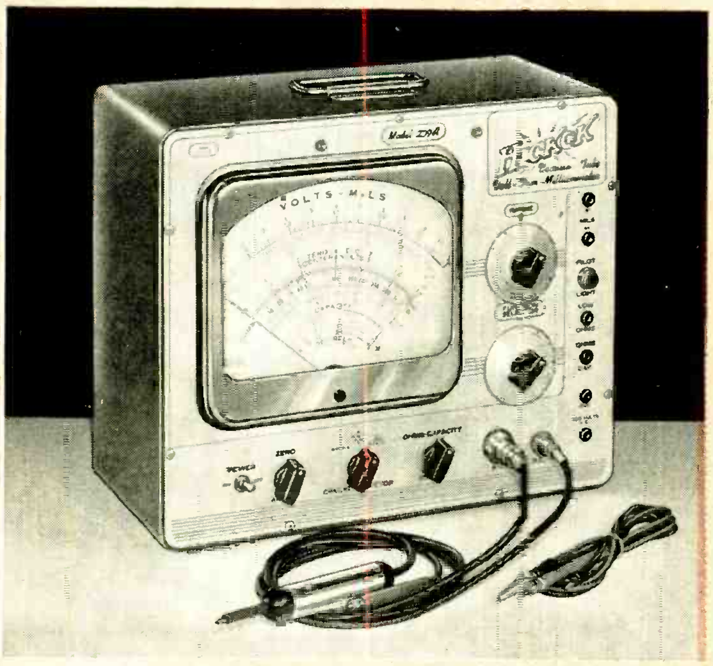

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- **Built-in power supply permits high accuracy even with wide line-voltage fluctuation.**

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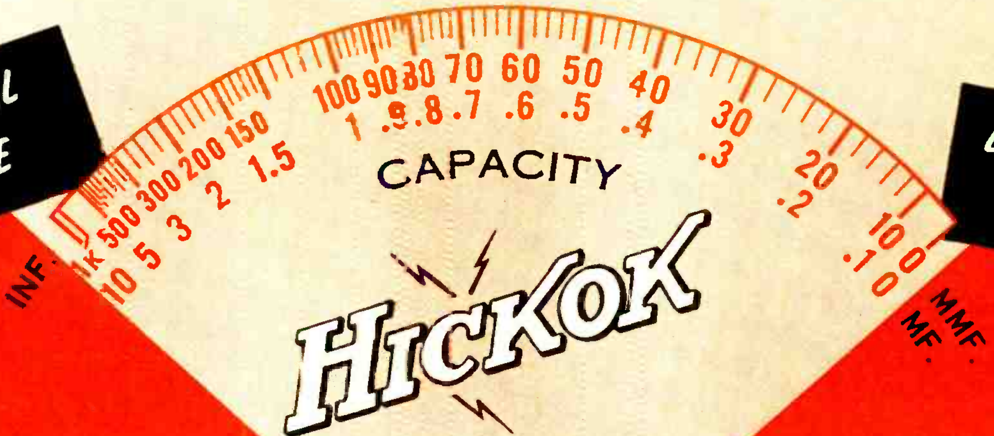


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8-penny nail. One end was ground down to about 1/16 inch diameter and forced through the bottom of the form. A small piece of brass shim stock was soldered to the nail and clipped into the cardboard to strengthen it. Just above the shaft the fine wire was wound in three layers, one on top of the other, approximately 6 feet to the layer, with hot paraffin wax between each layer. This was done to prevent the following layer from displacing the other.

The tuning capacitor will be of special interest. I made a frame from 1-inch angle iron (dressed down considerably) and bent down a third side. To this I fitted a 100–580-μμf trimmer capacitor, removed the set-screw, placed a small block of brass on the blade, and made a shaft with an eccentric that moves the brass block, thus opening and closing the blade of the trimmer capacitor. There is less than a 180° turn with the knob which covers from 740 to 1600 kc. I tried various amounts of wire in the grid coil trying to get it to tune down to 550 kc, but gave up. Evidently a bigger trimmer capacitor is needed to do this. I did try a 45–380-μμf trimmer capacitor but had no luck.

The end of the tuning capacitor shaft is ground flat to prevent the knob from slipping.

### Hand-made components

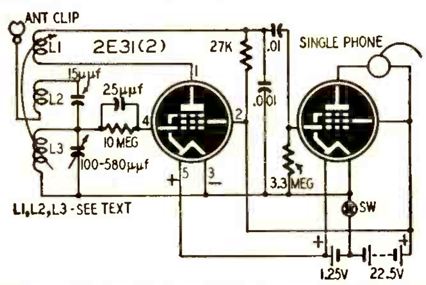
The switch was made from brass shim stock, as were the battery clips. The shim stock I was using was brittle and it was necessary to anneal it with a blowtorch so that it could be bent without breaking. All brass and metal parts were tinned with solder to give them a nice appearance and to prevent corrosion.

The plastic chassis was made from a refrigerator dish. Pieces were cut from it and cemented together with liquid plastic. It looks almost as if it had been molded in one piece.

Thin-head rivets were not available, so I used galvanized screen-wire tacks with the heads ground down almost paper thin.

To prevent the heat of the soldering iron from melting the plastic chassis under small brass parts, wires were soldered to them before they were riveted in place. This may not have been necessary, as I soldered one connection (A plus on battery clip) and immediately applied a damp cloth to it, with no harm to the chassis.

The set uses two 2E31 subminiature tubes, a hearing aid A cell, a 22½-volt B battery, small ceramic capacitors, and ⅓-watt resistors.




The vest-pocket receiver uses the ancient but excellent 3-circuit tuner.

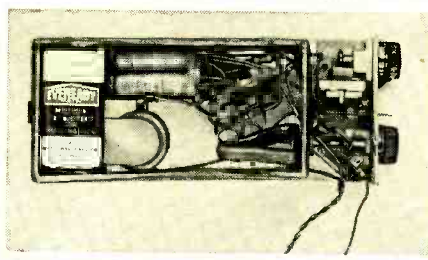
The audio is delivered by *one* headphone from a standard, inexpensive 2,000-ohm pair of phones. A small metal head-band was cut from galvanized metal and fitted to the phone.

The two tubes were mounted in rubber, cemented to the chassis to prevent damage from shock and also to secure them nicely.

Very small terminal strips were used as tie-points. These were riveted in place on the chassis.

The case that houses the little set was made from cardboard and then given three coats of liquid plastic and two coats of enamel. The plastic gives it a smooth finish and stiffens it, rendering it unbreakable.

As you will note on the circuit, I have a 15-μμf ceramic capacitor at the start of the antenna winding. This was installed after much experimenting and completely eliminates the use of a ground wire which is almost always necessary with the old variocoupler. Also note that the antenna lead is connected to the end of the winding nearest the grid coil. This gave the best results, and greater distance was obtained.



Triangle at lower right is the tickler; the other coils are wound on the case.

This little set requires fine adjustment with both knobs to bring in distant stations, and with such adjustment, they can be brought in clear and loud. I find the best way to tune is to place the set in your shirt pocket so that your hands are free to adjust both knobs at the same time. I have brought in stations 1,300 miles away at night when conditions are good.

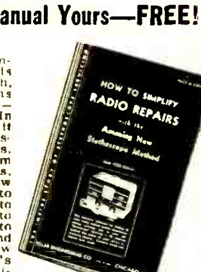
The finger-stop on a dial telephone seems to serve very well for the antenna, for local stations, also metal parts of table or floor lamps.

**Materials for vest-pocket receiver**

**Resistors:** 1—10 megohms, 1—3.3 megohms; 1—27,000 ohms, 1/3 watt.
**Capacitors:** 1—15, 1—25, 1—100-μμf, ceramic or mica; 1—.01 μf, paper; 1—100-580-μμf trimmer (see text).
**Tubes:** 2—2E31
**Miscellaneous:** 1 s.p.s.t. miniature switch, 1 single phone, A and B batteries, case, wiring, coils, hardware, etc. Many of these items are described in the text.

To give this set a fair test it should be tried in a wood-frame building. I have had very little luck in steel structures. It may work differently in other localities.

The cost of the set was about $8.50, including batteries, tubes, and headphone. This does not include all the small parts made by hand. These would probably run the cost up pretty high, as I spent six months of my spare time building it. (I enjoyed every minute of it.) END

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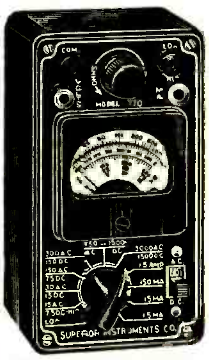
Superior's New Model 770

## VOLT-OHM MILLIAMMETER

*Sensitivity—1000 ohms per volt*



Uses latest design 2% accurate 1 Mil. D'Arsonval type meter. • Same zero adjustment holds for both resistance ranges. It is not necessary to readjust when switching from one resistance range to another. This is an important time-saving feature never before included in a V.O.M. in this price range. • Housed in round-cornered, molded case. • Beautiful black etched panel. Depressed letters filled with permanent white, insures long-life even with constant use.

**SPECIFICATIONS:**

6 A.C. VOLTAGE RANGES: 0-15/30/150/300/1500/3000 Volts.
6 D.C. VOLTAGE RANGES: 0-7.5/15/75/150/750/1500 Volts.
4 D.C. CURRENT RANGES: 0-1.5/15/150 MA. 0-1.5 Amps.
2 RESISTANCE RANGES: 0-500 Ohms 0-1 Megohm.

Model 770 is an accurate pocket-size V.O.M. Measures only 3⅛" x 5⅞" x 2¼".

**$14.90 NET**

The Model 770 comes complete with self-contained batteries, test leads and all operating instructions.

Superior's New Model TV-11

## TUBE TESTER

• Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TV-11 as any of the pins may be placed in the neutral position when necessary. • Uses no combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket. • Free-moving built-in roll chart provides complete data for all tubes. • Phono jack on front panel for plugging in either phones or external amplifier detects microphonic tubes or noise due to faulty elements and loose external connections.

Operates on 105-130 Volt 60 Cycles A.C. Hand-rubbed oak cabinet complete with portable cover

**$47.50 NET**

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## SUPER-METER

*A combination volt-ohm milliammeter plus capacity reactance inductance and decibel measurements*

**SPECIFICATIONS:**

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,000 Volts
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
OUTPUT VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes
RESISTANCE: 0 to 1,000/100,000 Ohms 0 to 10 Megohms
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd. (Quality test for electrolytics)
REACTANCE: 50 to 2,500 Ohms 2,500 Ohms to 2.5 Megohms
INDUCTANCE: .15 to 7 Henries 7 to 7,000 Henries
DECIBELS: —6 to +18 +14 to +38 +34 to +58

Comes housed in rugged, crackle-finished steel cabinet complete with test leads and operating instructions. Size 6¼" x 9½" x 4½".

**$28.40 NET**

**ADDED FEATURE**

The Model 670-A includes a special GOOD-BAD scale for checking the quality of electrolytic condensers at a test potential of 150 Volts.

Superior's New

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CONNECTS DIRECT TO ANTENNA POST

NO CONNECTION INSIDE RECEIVER

**Features—**

Can be used when no stations are on the air. • Provides linear patterns to adjust vertical and horizontal linearity • Provides vertical and horizontal sweep signals • Provides signal for testing video amplifiers.

TV Bar Generator comes complete with shielded leads and detailed operating instructions. Only ..........

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Superior's Model 660-A—A NEW A.C. OPERATED

## SIGNAL GENERATOR

*Provides Complete Coverage for A.M.—F.M. and TV Alignment*

• Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 220 Megacycles on powerful harmonics. • Accuracy and stability are assured by the use of permeability trimmed Hi-Q coils. • R. F. available separately or modulated by the internal audio oscillator. Built in 400 cycle sine wave audio oscillator used to modulate the R. F. signal also available separately for audio testing of receivers, amplifiers, hard of hearing aids, etc. • R. F. Oscillator Circuit: A high transconductance heptode is used as an R. F. oscillator, mixer and amplifier. Modulation is effected by electron coupling in the mixer section thus isolating the oscillator from load changes and affording high stability. • A. F. Oscillator Circuit: A high transconductance heptode connected as a high-mu triode is used as an audio oscillator in a high-C Colpitts Circuit. The output (over 1 Volt) is nearly pure sine wave. • Attenuator: A 5 step ladder type of attenuator is used.

• Tubes used: 1—6BE6 as R. F. Oscillator, mixer and amplifier. 1—6BE6 as Audio Oscillator. 1—6H6 as Power Rectifier.

The Model 660-A comes complete with coaxial cable, test lead and instructions ..........

**$42.95 NET**

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$2.90 down payment. Balance $2.00 monthly for 6 months.
☐ MODEL TV-11 .......... Total Price $47.50
$11.50 down payment. Balance $6.00 monthly for 6 months.
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$7.40 down payment. Balance $3.50 monthly for 6 months.
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# BRIDGED-T NETWORK MAKES IDEAL PHASE SHIFTER

THE bridged-T network, familiar as an audio attenuator and oscillator feedback circuit, has found another important application. It can be used as an effective phase shifter at a.f. or at r.f., while maintaining constant attenuation. Phase shifters are used to control servos and test networks, and for circuit measurements. The bridged-T phase shifter can vary phase angle over a wide range; it has a common input and output ground; it is relatively easy to construct and operate.

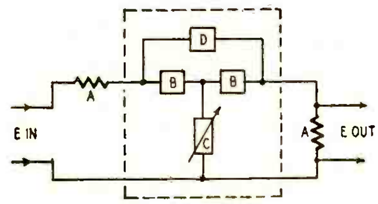



**Fig. 1—Basic bridged-T filter network.**

The new circuit is described by Myron G. Pawley in the *Journal of Research of the National Bureau of Standards*, Sept., 1950, page 193. Mr. Pawley has also obtained a patent* which covers several practical forms of his idea.

Fig. 1 is the basic bridged-T. Input and output load impedances are designated A. (These may be equivalent impedances reflected by transformer windings.) The network is shown within dotted lines, C being the variable shunt element. When correctly designed, this network provides constant attenuation, but the phase of the output signal will be shifted as C varies.

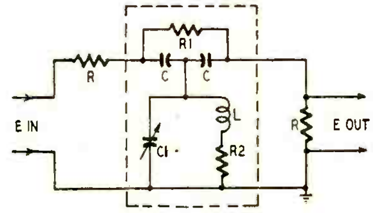



**Fig. 2—Pawley bridged-T phase shifter.**

One form of the invention appears in Fig. 2. The shunt element is shown here as a combination of resistance, capacitance, and inductance. The capacitor is the variable element. The following relationships must be maintained.

$R1 = 2R + 8R2;$

$X_L = \frac{X_c}{2};$

$X_c$ must be much greater than R1; $X_{c1}$ must be much greater than $X_L$, which gives C1 a value of about 100 μμf at 4.17 kc, and about 2 μμf at 29.1 mc.

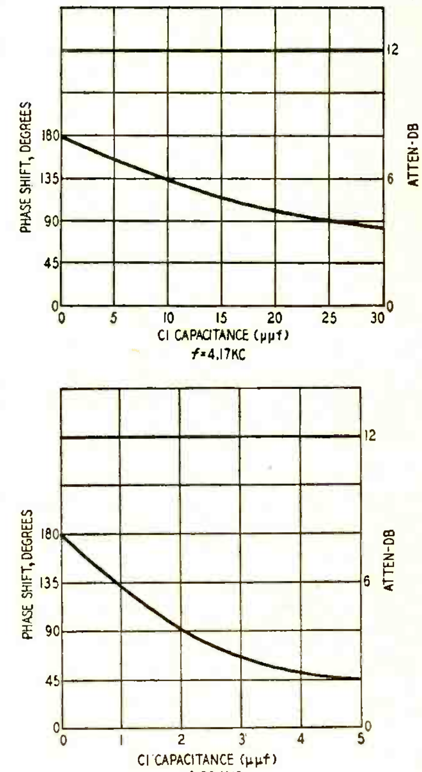



**Fig. 3—Phase-shift *versus* capacitance curves for Pawley bridged-T networks at frequencies of 4.17 kc and 29.1 mc.**

Typical circuit constants are listed in Table I for a frequency of 4.17 kc. Table II shows values for 29.1 mc. The corresponding graphs appear above in Fig. 3. In each case the attenuation remains constant at 12 db.

Another circuit for operation at 4.17 kc is shown in Fig. 4. Here a variable

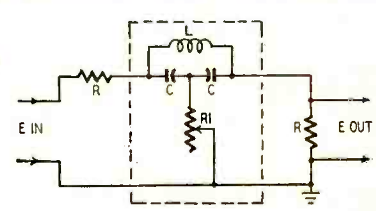



**Fig. 4—Resistance controlled shifter.**

resistor R1 controls the phase shift. For this circuit, the Q of L must be much greater than unity, and $X_c$ must be much greater than

$$\frac{R}{2}$$

In addition we must choose $X_L = 4X_c$. These requirements are met by the circuit values listed in Table III. END

**Table I**

| | |
|---|---|
| R | 1,000 ohms |
| R1 | 5,120 ohms |
| R2 | 390 ohms |
| C | 520 μμf |
| L | 1.4 h |

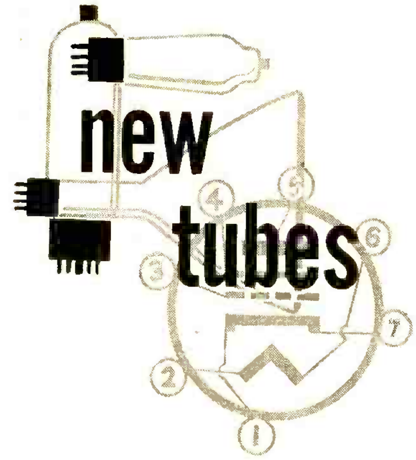
**Table II**

| | |
|---|---|
| R | 50 ohms |
| R1 | 114 ohms |
| R2 | 1.75 ohms |
| C | 10.5 μμf |
| L | 1.44 μh |

**Table III**

| | |
|---|---|
| R1 | 1,000 ohms |
| C | .004 μf |
| L | 1.4 h |
| Q of L | 94 |

*Pat. No. 2,606,966 assigned to the United States Government.




THE trend in large-screen picture tubes seems to be toward reviving the spherical faceplate—apparently to increase the effective picture area. Rauland has announced two new 21-inch rectangular all-glass tubes of this type, with an effective screen area of 252 square inches, compared with 245 square inches for 21-inch rectangulars with cylindrical faceplates.

Type 21YP4 has low-voltage electrostatic focus and magnetic deflection; type 21ZP4 has both magnetic focus and deflection. Both tubes have gray filter faceplates, external conductive coatings, and the Rauland indicator-type ion trap, which glows when the ion-trap magnet is not positioned correctly.

### New cathode-ray tubes

A British-made 1-inch all-glass cathode-ray tube is now available on the American market.

The *Cossor* 1CP1 has a standard Loktal base, electrostatic deflection, and fixed electrostatic focus, all of which simplify its application to compact test and monitoring equipment. The 1CP1 operates at anode voltages of 500 to 800 (maximum), with spot diameter ranging from 0.3 mm (.012 inch) at the lower voltage, to 0.2 mm (.008 inch) at 800 volts.

At maximum anode voltage the deflection sensitivity of the plates nearest the anode is approximately 72 volts per inch; the plates farthest from the anode have a sensitivity of 88 volts per inch. The heater-cathode insulation will withstand a voltage difference of 250 volts maximum.

Bias for the 1CP1 can be obtained from a 10,000-ohm cathode resistor. The maximum circuit resistance between control grid and cathode is 1 megohm; maximum resistance between any deflecting plate and anode is 5 megohms.

The electrical characteristics and the application of the 1CP1 are similar to those of the 1-inch metal-shell RCA cathode-ray tube, type 913.

## NEW DESIGN

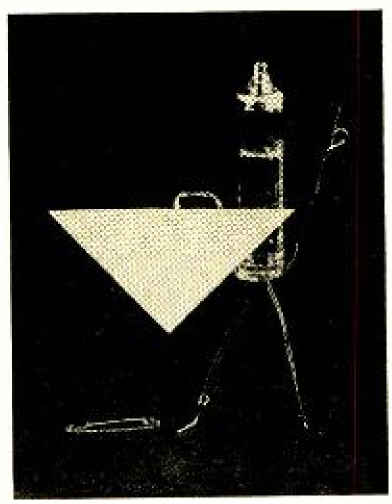
Du Mont has announced two new electrostatic focus and deflection cathode-ray tubes for oscilloscope use. They have exceptionally high deflection sensitivity, obtained by using extra-long deflection plates and limiting the useful display area to less than the full screen diameter. The right-angle relation between horizontal and vertical traces is accurate to 1°.

Type 3WP– is a 3-inch tube with an accelerator (ultor) rating of 2,500 volts maximum. Representative operating conditions for the 3WP– are: Accelerator voltage—1,500; focusing voltage—247 to 465; grid 1 voltage for visual extinction of undeflected spot—minus 45 to minus 75; grid-circuit resistance—1.5 megohms max.; grid 1 modulating voltage—50 volts max.; line width—.026 inch max.; light output (P1 phosphor) 7 foot lamberts *minimum;* deflection factors: D1-D2—62-76 volts per inch; D3-D4—43-52 volts per inch; useful scan: D1-D2—2.5 inches; D3-D4—2.25 inches.

Du Mont type 5ADP– is a 5-inch tube with similar high deflection-sensitivity characteristics, and the addition of a post-accelerator anode with a 6,000-volt maximum rating. With 3,000 volts on the post-accelerator, and 1,500 volts on the accelerator anode, the 5ADP– has a deflection sensitivity of 40-50 volts per inch for D1 and D2, and 31.5-38.5 volts per inch for D3 and D4.

Two other new Du Mont cathode-ray tubes are designed for observing high-frequency phenomena. These are the 5XP-A and 5XP-AM. Both types have electrostatic focus and deflection, and are equipped with post-accelerator anodes that may be operated as high as 25,500 volts. The 5XP-AM has a metal-backed screen which provides twice the light output of the 5XP-A. Vertical-deflection sensitivity is down only 10% at 200 mc. END

## A NEW FORM OF PARASITIC



**Workers at Sylvania's Emporium, Penna., plant create new tube types that speak for themselves. Here a campaign orator offers us a three-point program.**

ciation, according to George Morton, chairman of the policy committee, is a city ordinance to license and bond TV service technicians. Meetings have already been arranged with the city's mayor and electrical inspector, for the purpose of drawing up such an ordinance.

## NATESA MEETS IN KANSAS CITY

NATESA's Spring Convention—its first national convention for TV-service dealers, managers, and technicians—will be held Friday through Sunday, April 10, 11, and 12, in Kansas City. *Television Service Engineers, Inc.* of Greater Kansas City will play host to the more than 500 member guests expected to attend from all parts of the United States.

Exhibits of about 50 manufacturers—with emphasis on u.h.f. TV equipment—will fill 1½ floors in the Continental Hotel.

The convention will open Friday afternoon with registration and a cocktail party. Business sessions will be held Saturday, with addresses by NATESA President Frank Moch and manufacturers' representatives. These will be followed by a banquet and floor show, and the presentation of awards.

The Sunday session will feature an optional ranch-style breakfast and round-table discussions.

## FRSAP ELECTS NEW OFFICERS

Milan S. Krupa, of the Associated Radio Servicemen of Luzerne County, was elected president of the Federation of Radio Servicemen's Associations of Pennsylvania. He succeeds Dave Krantz, who, after 6 years of continuous service, declined to continue as president of FRSAP. Mr. Krantz will head a new advisory council to be made up of the heads of all member chapters.

Other officers elected for one-year terms were Bertram Bregenzer, of the Radio Servicemen's Association of Pittsburgh, vice president; Fred Schmidt, of the Mid-State Radio Servicemen's Association (Harrisburg), treasurer; and Leon Helk, Lackawanna County Radio Servicemen's Association (Scranton), secretary.

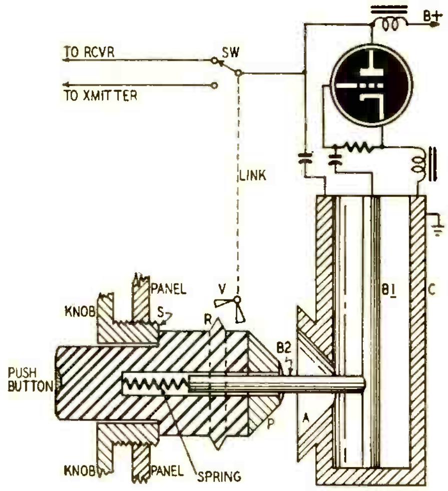
A special committee under vice-president Bregenzer will aid the formation of new chapters. Requests for membership in FRSAP have already been received from servicemen's groups in Lancaster, Butler, Johnstown, Erie, and Sunbury. END

## NEW PATENTS

### U.H.F. OSCILLATOR TUNING

Patent No. 2,618,705
John E. Allen, Lansdale, Pa.
(Assigned to Philco Corporation, Phila, Pa.)

This device overcomes the difficulty of u.h.f. switching. It generates two distinct frequencies from a single oscillator. One of these frequencies is fixed; the other is adjustable over a narrow range. A push-button switches from one to the other. The fixed frequency is suitable to control a transmitter. The other frequency may be the local oscillation for receiving. Both are stable because they are cavity-controlled.




The figure shows a coaxial-line cavity. C is the grounded outer conductor. B1 is the inner line which has an extended portion B2 passing through a flared aperture in C. A metallic, tapered plug P fits snugly into this aperture A, when the push-button is depressed. When desired, a catch (not shown) is set to hold the plug in this position. When P is inserted into A, the oscillator frequency is the natural frequency of the cavity.

When its catch is released, P is forcibly withdrawn from A by a spring. The plug comes to rest against the stop S. Due to capacitance between C and P, the frequency is now changed. This second frequency is adjustable by turning the threaded knob shown. Rotating it clockwise, for example, moves it deeper behind the panel so P cannot come out of A quite so far.

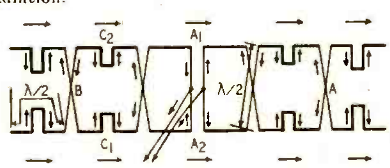
Note the annular ring R around the push-button. When the button is depressed, R acts against the pivoted vane V. V is moved counter-clockwise. A mechanical link forces switch SW to its lower contact. Therefore the fixed frequency is fed to the transmitting circuits. When the button is released, V is moved clockwise by R. SW is now forced upward and makes contact with the receiver lead.

### IMPROVED BROADSIDE ARRAY

Patent No. 2,622,198
Richard G. Clapp, Haverford, and Samuel H. Colodny and Bernard Wise, Philadelphia, Pa.
(Assigned to Philco Corporation, Phila, Pa.)

A simple dipole radiates in only two directions. As the antenna is lengthened, minor lobes appear in its directional pattern. These undesirable lobes can be eliminated by proper control of the radiation. The antenna should radiate maximum power from its center. Radiation should fall off progressively as we pass to the ends. This principle is applied to a broadside array in this invention.

The diagram shows a 10-element array. It has 5 elements in each of 2 rows. Arrows show the instantaneous direction of current flow. By transposing the elements, current flows in the *same direction* in each horizontal element. Therefore the radiation is strengthened. The vertical elements cannot radiate. This is because each such pair carries opposing currents which cancel the radiation.



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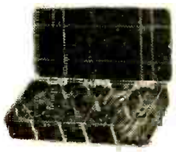

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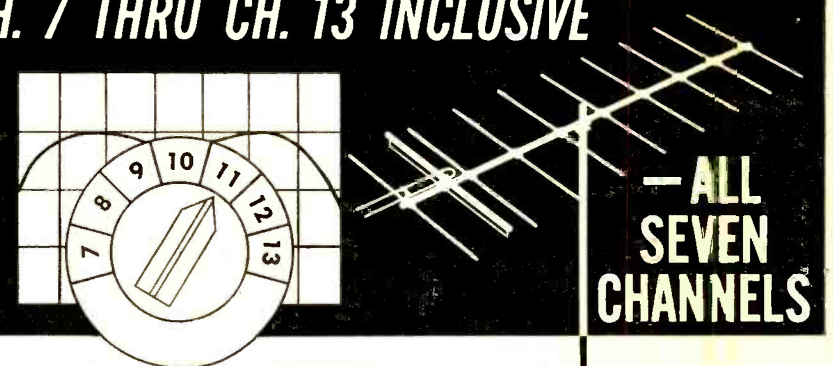


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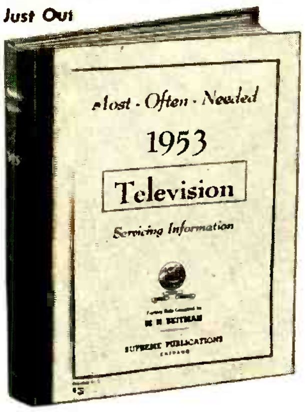


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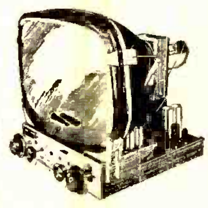

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To reduce minor lobes, folds are introduced in some of the elements. These folds cannot radiate because the re-entrant parts carry opposite currents. However, these folds decrease the effective lengths of the horizontal radiators in the figure, the end elements have the greatest folds so they have least radiation. The next adjacent elements are folded to a lesser extent so they have greater radiation. The center elements have no folded stubs. Their radiation is maximum as desired. This variation in folding is the feature that is patented.

For maximum efficiency, the elements should radiate in accordance with the binominal expansion, a mathematical formula. For a 5-element row (as in this array) the horizontal elements should radiate in the following proportion: 1, 4, 6, 4, 1.

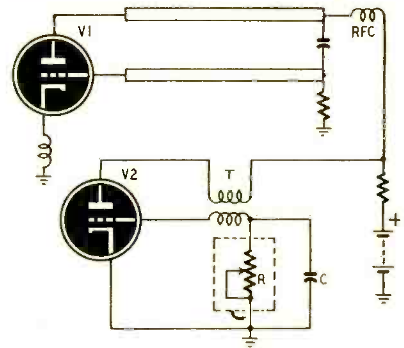
### FM RADIOSONDE SYSTEM

Patent 2,613,347

William Todd, Neptune City, N. J.
(Assigned to United States of America as represented by the Secretary of War)

Generally speaking, FM communication requires an elaborate receiver and a simple transmitter. Therefore FM is suitable for radiosonde systems where the transmitter must be light and compact. This inventor points out other FM advantages and suggests its use in radiosonde work.

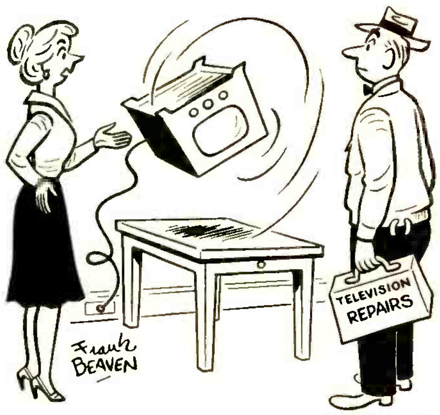
The figure shows the transmitter circuit. V1 is an oscillator tuned to about 400 mc. V2 is the modulator which conducts intermittently. When current flows, feedback impresses a large negative pulse on its grid. Then the tube is blocked




until C can discharge its negative voltage through R. This resistor is shown as a variable element. If, for example, it is reduced, the blocked interval becomes less. Then the average current through V2 is increased. Since V1 and V2 are coupled through a common dropping resistor, the r.f. tube gets less plate potential. As in any self-excited oscillator this means a change in carrier frequency.

Actually, R may be a thermistor or other element whose resistance depends upon temperature, humidity, pressure, etc. Any change in the resistance of R makes a corresponding variation in carrier frequency, which is interpreted at the receiver.

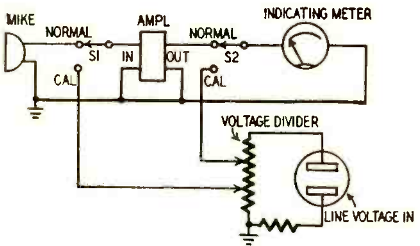
In FM, the carrier amplitude remains constant. This makes it easier to track the radiosonde transmitter. Also, a small change in frequency can be detected easier than can a small change in amplitude. END




"I'm afraid my set is troubled with Flop-Over!"

## AMPLIFIER CALIBRATION

Most radio and PA amplifiers do not need extra high stability. A slight change in amplifier gain from time to time does not matter. On the other hand, if the amplifier is part of a precision instrument, constant gain is of the utmost importance. For this reason, the General Radio sound-level meter includes an internal checking circuit. A gain test may be made quickly and at any time.



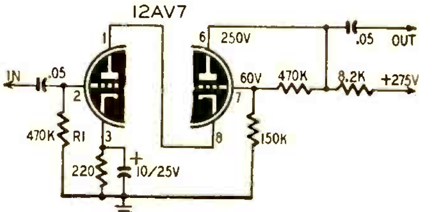

With switches S1 and S2 in positions shown, the amplifier is ready for normal use. To test its gain, S2 is thrown to CAL. The meter measures a relatively high voltage from the line voltage divider. This reading is noted. Now S2 is returned to NORMAL and S1 is switched to CAL. This feeds a small a.c. signal to the amplifier. If the amplifier gain is correct, the meter will show the same reading as before.

This is how the calibration circuit operates. Before leaving the factory, the voltage divider taps are adjusted and fixed so the voltage ratio between taps equals the amplifier gain. When the calibration is checked, the attenuation of the potentiometer is balanced by the amplifier gain. Since these are equal, the meter will give identical readings as described above. The actual meter deflection is not important.

## AUDIO PREAMPLIFIER

Most modern audio amplifiers use some form of microphone or phono preamplifier to amplify the low-level signal to a point where it can be fed into the main amplifier. The input signal is usually very low so preamplifier designers try all sorts of tricks to minimize noise and hum.

I suppose that you would call this a cascode amplifier, but it differs from the cascode in that the grid of the second triode is not grounded at the signal frequency and some of the output signal from the second triode section is fed back into the grid through the 470,000-ohm resistor. The grid is 60 volts positive. I varied the positive grid voltage but it works better with the value shown. From ordinary observations, it would appear that this circuit is impossible but such is not the case.



The preamplifier was used to drive a 6F6 output tube with a radio and low output phono pickup and as far as I can determine with any other test, it has excellent low- and high-frequency response. The combined gain of both sections is just about equal to a 6J5 but the audio quality is far better. I had no difficulty with any hum even though no part of the circuit was shielded. A 500,000-ohm volume control can be used in place of R1, if desired.—*Wilbur J. Hantz.*

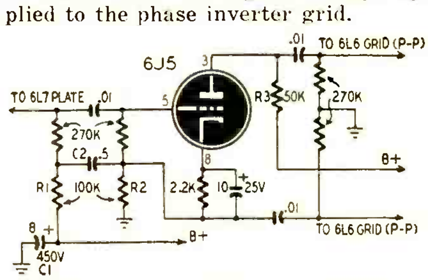
**Materials for audio preamplifier**

**Resistors:** 2—470,000, 1—150,000, 1—8,200, 1—220 ohms, ½ watt.
**Capacitors:** 2—.05 μf, 600 volts, paper; 1—10 μf, 25 volts, electrolytic.
**Miscellaneous:** 1—12AV7 tube; 1—nine-contact miniature socket. Chassis, hook-up wire, terminal lugs, hardware.

## PHASE INVERTER CIRCUIT

I don't recall when or where I saw this phase inverter described, but I do feel that you will like its performance in your favorite amplifier. I've used it for several years in a 25-watt amplifier and do not hesitate to recommend it to others.

If we disregard the presence of C2 and R1 and make R2 equal to R3, we have the popular hot-cathode or *kangaroo* inverter, which has a gain of about 0.9 from its grid to the grid of one of the push-pull tubes. The total gain is about 1.8. This low gain is the result of 50% negative feedback developed across the cathode load resistor, in series with the signal voltage applied to the phase inverter grid.



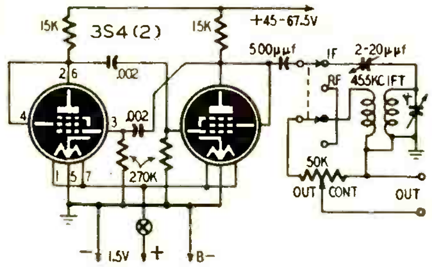

Adding R1 and C2 to the circuit increases the gain tremendously. (See pages 98 and 100, January, 1953, for the theory of this circuit.—*Editor*) The reactances of C1 and C2 are so low at audio frequencies that R1 and R2 are effectively in parallel. For balanced output from both halves of the inverter, the effective resistance of R1 and R2 in parallel should equal the resistance of R3. So we make R1 and R2 each twice the value of R3.

This inverter should be used with a pentode or other multigrid tube with a high plate resistance. I use a 6L7 with a plate resistance of about 800,000 ohms.—*G. R. Anglado*

## SIMPLE SIGNAL GENERATOR

With low-cost r.f. type signal generators generally available, many service technicians and experimenters overlook the multivibrator as a signal generator suitable for accurate alignment of receiver r.f. and i.f. circuits. The average owner of a multivibrator-type signal generator uses it only for shooting trouble in sets that are dead or badly out of alignment. The major disadvantage of the usual multivibrator signal generator is that its output signal is too broad for accurate alignment of i.f. circuits. This obstacle was overcome in a battery-operated multivibrator type signal generator described in *Radio and Electronics* (Wellington, New Zealand).

The diagram shows a pair of triode-connected 3S4's in a 400-cycle multivibrator circuit. When the output switch is in the I.F. position, the 400-cycle signal is applied to the tuned winding of a 455-kc i.f. transformer. This circuit is shocked into damped oscillations at a rate of 400 times per second. This, in effect, produces a 455-kc signal modulated by a rough 400-cycle note. With the switch in the R.F. position, the harmonics of the multivibrator fundamental blanket the spectrum up to about 30 mc.




The author describes the use of the unit for aligning superhets. Connect the output of the generator to the mixer circuit and peak the i.f. transformer trimmers for maximum output. Tune the set to the high-frequency end of the band, adjust the oscillator trimmer to about two-thirds capacitance, and feed the i.f. output of the generator to the antenna terminals of the set. Peak the antenna and r.f. trimmers for maximum output. Tune the set to the low end of the band and adjust the oscillator padder for maximum output.

Disconnect the generator, connect an antenna, and tune in a station on the high end of the band. Identify the station and check its frequency against the dial setting. If the dial setting is incorrect, set the dial correctly and retune the station with the oscillator trimmer. Use the generator to peak the antenna and r.f. trimmers. Tune in a station on the low end of the band and recheck the dial calibration. Readjust the oscillator padder to bring in the station at the correct dial setting. Repeat the process several times. Touch up the oscillator trimmer on the high end of the band and the padder at the low end so the dial calibration is correct at both ends of the dial. This procedure is particularly useful in lining up a newly constructed receiver.

(Before you sneer at the idea of using a battery-powered signal generator, just stop and think how handy it will be for touching-up the alignment of auto radios and for simple servicing jobs at summer camps and in areas where a.c. is not available.—*Editor*)

**Parts for signal generator**

**Resistors:** 2—15,000, 2—270,000 ohms, ½ watt; 1—50,000-ohm potentiometer.
**Capacitors:** (Mica): 2—.002 μf, 1—500 μμf; 1—2-20-μμf mica or ceramic trimmer.
**Miscellaneous:** 2—7-pin miniature sockets; 2—3S4 tubes; 1—s.p.s.t., 1—d.p.d.t. toggle or rotary switch; 1—455-kc i.f. transformer. Batteries, hardware, hookup wire.

END

## DRILL SIZE REMINDER

The average radio service technician uses wood, machine, and sheet-metal screws so rarely that he usually has to waste a lot of time looking up data on the drill size for the holes. One way of having the desired data on hand when needed is to write it on the cover of the screw container.

For sheet-metal screws, record the size of the drill used for the pilot hole. On wood screws, write the drill size and depth of the starter hole. For machine screws, write the size of the smallest drill which will allow the screw to pass without binding or damaging the threads. Recording this data on the screw containers takes only a few moments and will save lots more time before a box of screws is exhausted.—*Ken Maxwell*

## OSCILLOSCOPE BLANKING

Many TV sweep generators do not provide a means for blanking out the retrace curve on the scope when sweeping an i.f. or discriminator response curve. Since the sweep is a 60-cycle sine wave, it is possible to blank out the return trace by connecting one side of the scope's 6.3-volt heater winding to the intensity-modulation input terminal in the scope. With this connection, the single trace is easier to read and inspect.—*Bedrich Hrachovina*

## SOLDERING TIPS

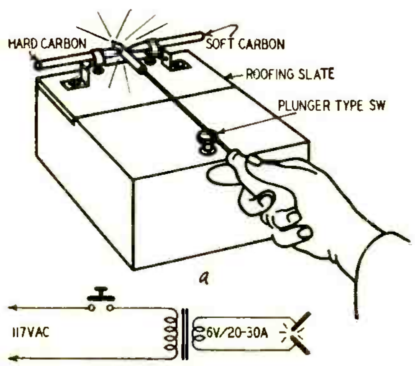
Before screwing in a new soldering iron tip, apply a coating of graphite to its threads. This prevents freezing and makes the tip easy to remove when it has worn out.—*Leonard Pfeiffer*

## TV FOCUSING TRICK

Here is a trick to facilitate focusing a TV set: I use a strong reading glass to magnify the scanning lines. Then I adjust the focus control until the scanning lines are as sharp and distinct as possible.—*John A. Comstock*

## QUICK IRON HEATER

This type of soldering-iron heater is rugged, safe, dependable, and unusually fast heating. The iron is heated by placing its tip in an arc between two carbon rods connected across the secondary of a 6-volt, 20–30-ampere filament transformer. The construction of the unit is shown in the illustration at *a*. The schematic is shown at *b*.



## TRY THIS ONE

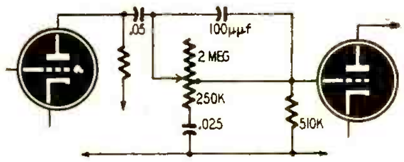
The heater is turned on by a micro-switch mounted inside the box with its plunger protruding on the outside. The hard carbon rod is the type used in arc lamps and movie projectors. The other is a soft type which may be taken from a discarded flashlight cell. Clamps for holding the carbons can be made from sheet metal or can be purchased from electrical supply dealers.

I find that this is the fastest practical method of heating large soldering irons. Long ice-picks (or lengths of drill rod) can be threaded and fitted into small, specially shaped copper tips used for getting into those tight places.

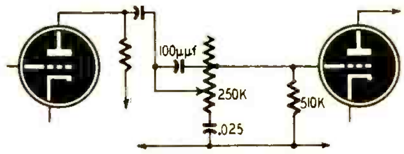
This heater develops a very high heat, so it takes a little practice to get the iron to the right temperature without burning it. A clock or watch with a sweep second hand is useful in timing the heating operation until you get the hang of it.—*J. Perkinson, Jr.*

### NOVEL TONE CONTROL

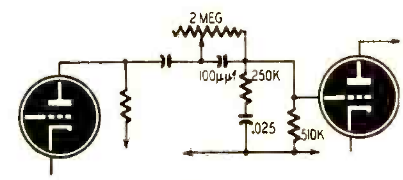
While rebuilding a phono amplifier I found myself with just enough space on the control panel for one tone control while I wanted two separate controls for bass and treble boost. I considered using concentric controls, but abandoned the idea in favor of this single-control circuit which provides normal response or bass or treble cut, simply by turning the control toward opposite ends of its range.




*a*




*b*




*c*

The control circuit consists of a 2.5-megohm potentiometer tapped at 250,000 ohms and two capacitors. The control network is used between two high-mu triodes.

Response is normal when the arm of the control is opposite the tapped point as in drawing *a* in the illustration. The arm of the control is moved toward the low-resistance end for bass boost and toward the open end to boost the highs. Diagrams *b* and *c* show the equivalent circuits for treble and bass cut, respectively.—*Dr. Leon Greenberg.*

END

## REMOTE FM TUNER

? *Is there any way to adapt an FM tuner for remote control? Push-button tuning is desirable, but if this is not feasible, can the dial and control portion of the tuner be mounted at a distance from the rest of the tuner?—E. E. W., Burlingame, Calif.*

A. For push-button tuning, replace each section of the tuning-capacitor gang with a multiposition rotary switch and small ceramic trimmer capacitors. The switch must have as many sections as there are tuning capacitor sections. There should be one capacitor and one switch position for each FM channel that you wish to receive. Wire the switch so it switches a different capacitor across the coil in each position. Adjust the capacitors—4-30-μμf units—for proper tuning of each channel.

If the distance between the tuning head and the main chassis of the tuner is limited to a few feet, you may be able to use flexible control shafts like those used in some automobile radios and military communications equipment. Cables longer than three or four feet are likely to cause backlash which will make tuning difficult. If the tuner has a.f.c., it will compensate for a small amount of backlash.

Another method of providing remote control for the FM tuner is to separate the tuning control, dial, and the r.f. amplifier, converter, and oscillator circuits from the i.f. circuits. The latter may be on the remote chassis with the power supply. The remainder of the components would then be installed on a small chassis to be placed at the operating position. The first i.f. transformer would be on the chassis with the i.f. strip and connected to the mixer plate through low-capacitance coaxial cable.

The capacitance of the cable will shunt the transformer primary, making it difficult to resonate the i.f. input circuit. If the transformer is slug-tuned, you may have to replace the fixed tuning capacitor with a smaller one or remove it entirely. If the circuit still doesn't tune to the i.f., try replacing the powdered-iron slug with a brass one.

## IMPEDANCE MEASUREMENTS

? *How can I measure the impedance of ribbon-type transmission lines without using involved formulas? I want to spot-check the impedance of ribbon line as it is being extruded in a plastics plant.—M. D., Brooklyn, N. Y.*

A. We would suggest using an r.f. impedance bridge or a standing-wave ratio indicator and a grid-dip oscillator or any convenient source of low-power r.f. voltage. Take a sample of the line and terminate it in a noninductive resistor having a resistance equal to the nominal characteristic impedance of the line. Feed in the r.f. signal and measure the standing-wave ratio on the bridge. When the impedance of the line equals the resistance of the load, the load absorbs all the power and there are no standing waves on the line. This indicates that the load resistance and line impedance are equal.

These measurements can be made with the *Antennascope* made by Eldico of New York, Inc., 44-31 Douglaston Parkway, Douglaston, N. Y., and the *Micro-Match* made by The M. C. Jones Electronics Co. of Bristol, Conn.

## 2-TUBE, 360-WATT RIG

? *About 10 years ago, one of the tube manufacturers published details on the construction of a 2-tube, 3-band, 360-watt transmitter for 160, 80, and 40 meters. It used a 6V6 crystal oscillator and an 813 final amplifier. The screen of the 813 was in series with the cathode return of the oscillator. If you are familiar with this transmitter, I would apprecaite having its circuit printed in an early issue. I want to use the rig for c.w. traffic nets—R. O. W., Camden, N. J.*

**A.** We hope that this diagram is the one you want. It appeared originally in data supplied by RCA. The 6V6-GT oscillator operates straight through with 160-, 80-, and 40-meter crystals. The plate-cathode resistance of the oscillator tube is used as a part of the voltage divider supplying the 813 screen grid. A glass (G or GT) tube must be used in this application. If a metal tube should be used, its shell would be 400 volts above ground and would present a serious shock hazard.

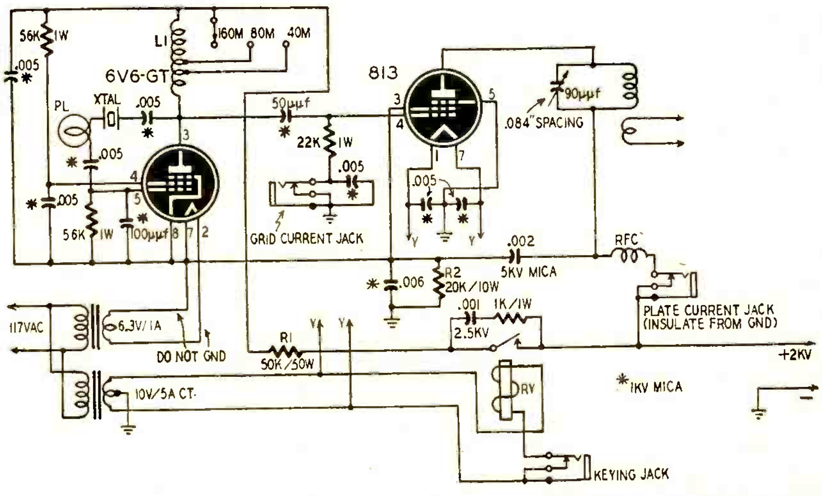
The tapped, untuned oscillator coil, L1, consists of 155 turns of No. 28 enameled wire close-wound on a 1⅛-inch form. Taps for 40 and 80 meters are placed at 21 and 65 turns respectively. If the inductance of L1 or the position of the taps is just right, minimum r.f. crystal current will occur simultaneously with maximum oscillator output. Crystal current is indicated by a glow in the 60-ma pilot lamp in series with the crystal. Oscillator output is indicated by the 813 grid current. Slight variations in wire and coil diameter may cause excessive crystal current or sluggish oscillation, and make it necessary to adjust the position of the taps. If crystal current causes the lamp to light, the inductance of the part of the coil in use is probably too large. If the crystal is hard to start, not enough coil is being used. The final tank coils are 500-watt units for 160, 80, and 40 meters.

Preliminary oscillator adjustments should be made with the 813 plate lead disconnected and the supply voltage reduced to about 1,000 by inserting a 50,000–100,000-ohm resistor in series with R1. The oscillator should supply 3 to 7 ma of grid current to the 813 without the crystal pilot lamp showing any color. If the circuit performs satisfactorily, connect the 813 plate, tune the output tank to resonance, and raise the supply voltage to 2,000. The 813 can then be loaded to 180 ma for c.w. operation. Grid current will be 7 to 10 ma; power output will be approximately 275 watts. If the supply voltage is 1,600 or less, R2 should be disconnected so the 813 will have correct screen voltage.

Plate modulation may be employed by reducing the supply voltage to 1,600 and disconnecting R2. Approximately 135 watts of audio is required for 100% modulation. This can be supplied by class-B 809's operating from a separate 1,000-volt supply or by class-B 811's with 1,500 volts on the plates. The 811's and the 813 can be operated from a common 1,500-volt supply.

(The 811 has recently been superseded by the 811-A, which has the same electrical characteristics with improved internal construction. At 1,500 volts—the maximum for *intermittent service*—the 811-A's draw a peak-signal plate current of 313 ma, with a recommended plate-to-plate load of 12,400 ohms.—*Editor*)

The 813 plate-current jack and the rotor of the final tuning capacitor are hot. To minimize the danger of shock, the jack should be mounted on a bakelite strip recessed about 1½ inch behind the front chassis apron, and the tuning capacitor shaft should be fitted with an insulated coupling and extension shaft. Plate spacing of the final tank capacitor should be .07 inch or more for c.w. and .084 inch for phone operation. END



### PHILCO 8-200

This set had a 60-cycle hum on all stations when the volume was turned up. It was found to be originating in the 14C6 circuit. All components checked good. The trouble was cleared up by resoldering all connections on the 14C6 socket.—*Manuel Silva*

### BELMONT 12AX26 TV SET

In this model, sound bars may appear in the picture when the set is jarred or when the volume control is advanced. This trouble is usually caused by a microphonic tube in the i.f. strip.

To determine which tube is causing the trouble, gently tap each of the i.f. tubes while watching the picture. The bad tube will produce sound bars when you tap it. Replacing the tube will eliminate the difficulty.—*John A. Comstock*

### ADMIRAL 20X1, 20Y1, 20Z1

Field reports and laboratory tests indicate that about 80% of the complaints of vertical foldover with high line voltage can be cleared up by replacing the 12AU7 vertical output tube. Try several 12AU7 tubes of brands other than Sylvania before replacing the vertical output transformer.—*Admiral Service Bulletin*

### ZENITH 5-S-127

The complaint was severe motorboating. The trouble was caused by a short between the B plus lead from the second i.f. transformer and one end of the white a.v.c. resistor.

The set was restored to normal operation by replacing the B plus lead with one having heavier insulation.—*Gordon V. Weeks*

### SPARTON TV RECEIVERS

Insufficient width in Sparton rectangular-tube TV receivers may be caused by variations in the characteristics of the 6BQ6-GT horizontal output tubes. A 30,000-ohm resistor may be added across R110 and R111 (33,000 and 39,000 ohms, respectively) in series with the screen-grid lead. This increases the screen voltage and provides greater width.

If the 30,000-ohm resistor is already in the circuit and width is greater than necessary, the screen voltage and width may be reduced by removing the resistor.—*Sparton Service Division Bulletin*

### TELE-KING 516M TV SETS

These models and others using the TVC chassis may have complaints of a constant buzzing in the audio with the volume turned down. If realigning the sound i.f.'s does not cure the trouble, shield the lead between the plate of the 6T8 (triode section) and the control grid of the 6AQ5 audio output tube. This lead is very long (about 18 inches) and picks up radiation from the vertical output transformer.—*Dock B. Gerald*

### WESTINGHOUSE H-210, H-211

Sticking dial pointer is cured by lubricating two dial pulleys and increasing cord tension.—*Westinghouse Service Hints*

### UNUSUAL BRIGHTNESS PROBLEM

An Emerson model 585 was brought in with the complaint that the brightness control did not function properly. It was impossible to get uniform darkness over the screen.

When the brightness control was backed down, dark bars appeared at the sides of the screen. Continued rotation of the control resulted in the bars widening until they met in the center to black out the screen.

A Du Mont RA-112 came in with the same complaint. However, in this case, the picture got black on only one side.

In both cases the trouble was caused by an open filter capacitor on the B plus line to the first anode of the picture tube.—*J. V. Caraseno*

### 60-CYCLE HUM IN RCA KCS38 CHASSIS

Complaints of 60-cycle hum in extremely strong signal areas can be cleared up by referring to Figs. 1 and 2 and making the following modifications:

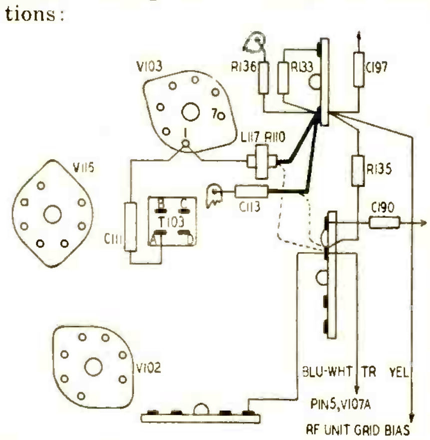



Fig. 1—Wiring changes in RCA KCS38.

Disconnect R110-L117 and C113 from their present tie-point at the junction of R135 and C190 and reconnect them to the adjacent tie-point at the junction of C197, R135, R136, and R133. The original wiring which is removed is shown in dashed lines on the pictorial diagram in Fig. 1 and on the schematic in Fig. 2.

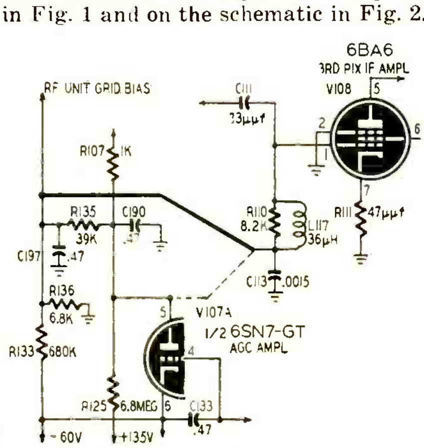



Fig. 2—Schematic of circuit changes.

The heavy lines indicate new wiring. These changes, which produce a greater a.g.c. voltage at the r.f. stage and first picture i.f. amplifier, have been made in late production models of the KCS38 chassis.—*RCA Radio Phono TV Tips*

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### So Simple

"A child could fix a TV set,"
They tell us, as we work and sweat.

"A child could do it," we reply,
"But *children* are too smart to try."

—JEANNE DEGOOD

### CORRECTION

Clear Beam Television Antennas, Burbank, California, was omitted from our annual Antenna Directory (January) because of difficulties in mail service. The company manufactures v.h.f., u.h.f., and special u.h.f. lead-in, antennas and accessories.

## Radio Thirty-Five Years Ago
### In Gernsback Publications

**HUGO GERNSBACK**
*Founder*

| | |
|---|---|
| Modern Electrics | 1908 |
| Wireless Association of America | 1908 |
| Electrical Experimenter | 1913 |
| Radio News | 1919 |
| Science & Invention | 1920 |
| Television | 1927 |
| Radio-Craft | 1929 |
| Short-Wave Craft | 1930 |
| Television News | 1931 |

Some of the larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

### APRIL 1919
### ELECTRICAL EXPERIMENTER

Grand Opera in Your Home, by H. Gernsback.
Guiding Airships with the "Radio Barrage", by Lee de Forest.
The Moon's Rotation, by Nikola Tesla.
How to Make a Direct-Reading Wave-meter and Decremeter, by H. Winfield Secor.
German Radio Apparatus Used at Metz.
Radiotelephony to Airplanes a Great Success.

END

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

### AUDIO CATALOG

Califone's 1953 line of phonographs, transcription players, and sound systems is described in an 8-page, 2-color, illustrated catalog.

*Free of charge from Califone Corp., 1041 N. Sycamore Ave., Hollywood 38, Calif.*

### MAGNETIC MATERIALS

A range of 20 high-permeability materials and 22 permanent magnet alloys are described in the 12-page booklet, *A Review of Magnetic Materials.* Typical properties are given in table form, and comparative information is discussed in the text and illustrated by 15 charts. Applications are drawn primarily from the communications field and illustrate typical uses for the various alloys.

*Available gratis from the International Nickel Co., Dept. EZ, 67 Wall St., New York 5, N. Y.*

### TRANSFORMER CATALOG

Catalog No. T-100 is a cross-reference transformer catalog which matches Utah transformers to manufacturers' parts. Reference charts are supplemented by electrical and physical data for each item, together with tube applications for output transformers.

*Copies free on request from Utah Radio Products Co., Inc., Huntington, Ind.*

### TRANSFORMER CATALOG

A new 14-page Stancor Transformer Catalog and Replacement Guide, listing replacement information on over 4,400 TV models and chassis is now available. Manufacturers' part numbers, listed in numerical order by type of transformer have Stancor replacements listed next to them. The guide also lists the electrical and physical specifications of Stancor transformers.

*Copies on request from Standard Transformer Corp., 3580 Elston Ave., Chicago 18, Ill.*

### TEST EQUIPMENT

The 1953 Heathkit *Test Equipment* catalog is a 31-page booklet listing data and prices on all the kits the company now manufactures. Included are amplifiers, an a.f. meter, audio oscillator, FM tuner, grid dip meter, oscilloscope, signal generator, signal tracer, and v.t.v.m.

*Copies gratis on request from the Heath Co., Benton Harbor 20, Mich.*

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*for*
*Approved Precision Quality*

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Once she's seen the familiar RCA trademark on those tube cartons, you have her complete confidence. She's sure now that her set is in good hands.

And it is . . . because you've learned from experience, that the superior quality of RCA Tubes and Kinescopes is your best measure of protection against the costliness and inconvenience of premature tube failures. It's good to know you can fix a receiver and forget about call-backs.

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