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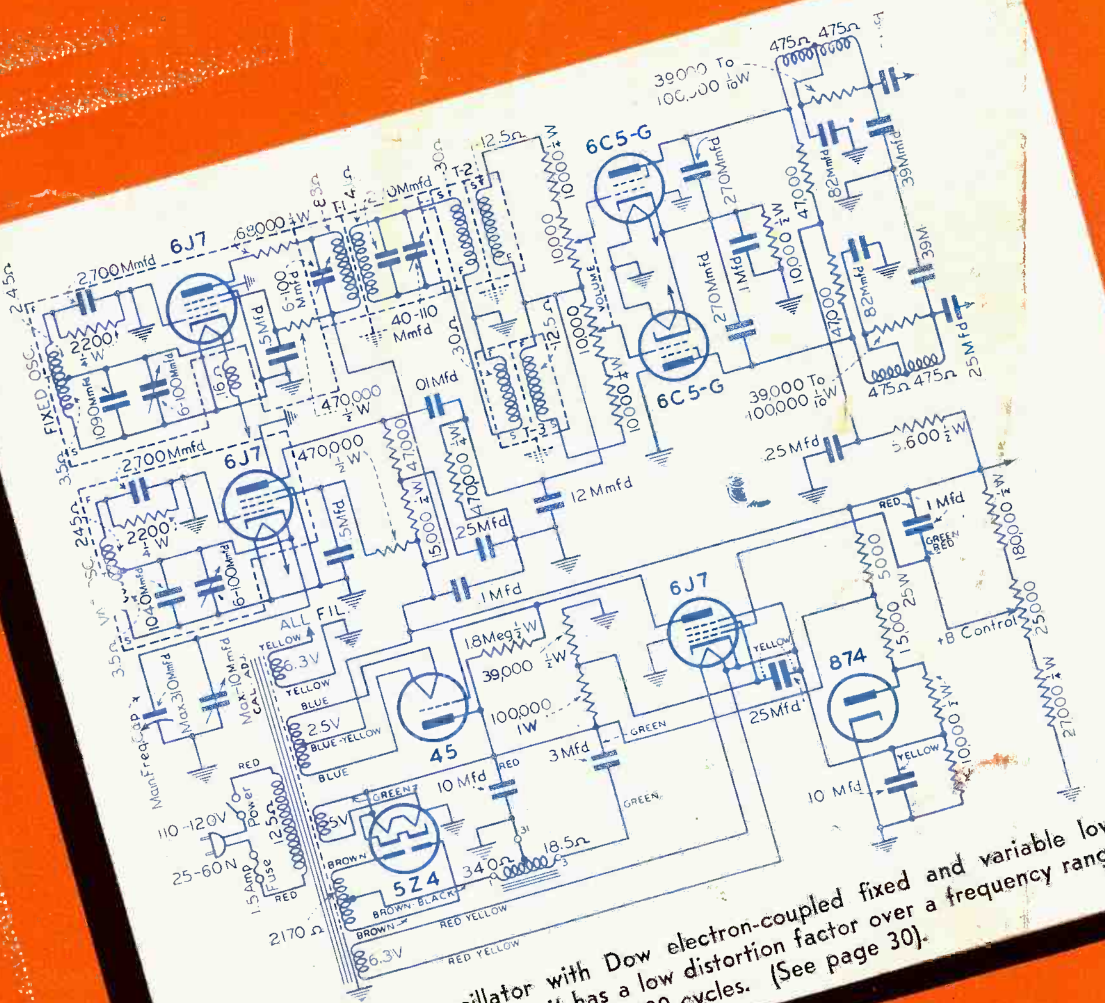

A beat frequency oscillator with Dow electron-coupled fixed and variable low frequency oscillators. The unit has a low distortion factor over a frequency range of from 20 to 17,000 cycles. [See page 30].

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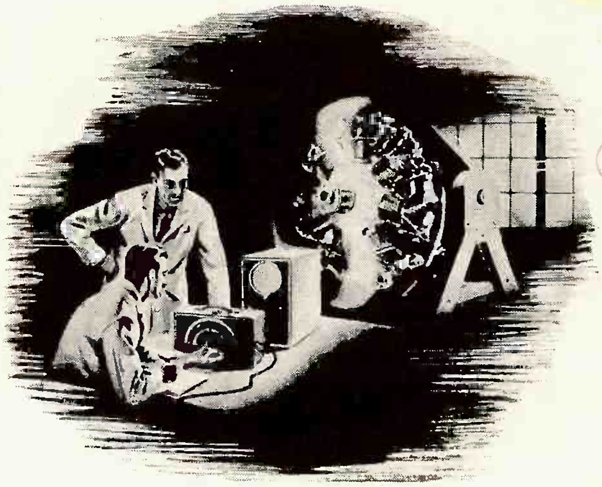
JUNE 1943



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EDITORIAL

AN important amendment to limitation order L-265 has just been issued. It provides for the removal of several restrictions that caused many a worry. It will now be possible, says the amended order, for the dealer to sell such items as loudspeakers and cables, antennae, antenna couplers, power supplies and battery cables for battery type home receivers, auto-radio control assemblies, auto receivers for broadcast reception, standard receivers, phonographs and record players. Such equipment can be transferred or sold, provided it was made on or before April 24. Transfer or sale of these items had been restricted previously.

This new amendment is not an anticipated ruling, but one that is actually in effect now.

THE variety of orders that have come from Washington have puzzled many a Service Man. He has wondered how the rulings would not only affect his business now, but later. To provide authoritative answers to these problems, we asked a group of specialists to give us their views. On page 10 of this issue appear these views . . . views that will be of immeasurable assistance to every Service Man.

EVERY day sees an expanded use of electronic controls, particularly those of the photocontrol type. Their servicing requires a complete knowledge of design and operation. An analysis of this nature appears in this issue on page 12. This paper should be of interest to all Service Men, particularly those with an eye to the future.

AS our contribution towards the conservation of paper, the trim size of SERVICE was reduced last February. And now to further assist in paper conservation, lighter weight paper is being used, for both the covers and inside pages, effective with this issue.

SERVICE

A Monthly Digest of Radio and Allied Maintenance

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FOR SALE OR TRADE—Janette rotary converter type CA-18, 32 volt to 110 volt, 60 cycle A.C. at 1.5 amp. Complete with Belden cords. Make offer. Will trade for good oscillator of recent make. Dell Penman, Hudson, Wisc.

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RIDER'S MANUALS WANTED—Vols. 9 to 13 incl. in good condition at reasonable price. Give full details. All letters answered. Frost Radio Service, 811 21st St., East Moline, Ill.

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TUBES AND EQUIPMENT FOR SALE—RCA Acorn tubes, 9—#954 and 1—#955, $3 each. Also Westinghouse 0-100 microammeter, 4" face, $10; 1940-1 Superior Set Tester model 1180-S, comb. tube and set tester, $15; 1940-1 Superior Inst. Co. signal generator model 1280, $12. All in first class condition. Domestic Appliance Service, Montauk Highway, Bridgehampton, N. Y.

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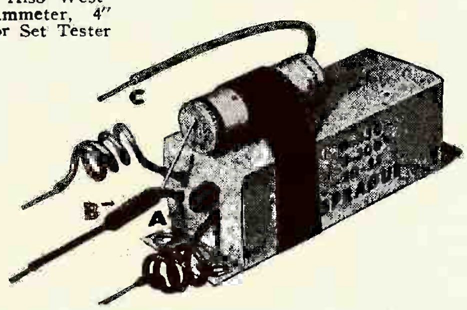

Illustrating how a Sprague Atom Type UT-8 (8 mfd. 450 volt) replaces the 8 mfd. 450 volt section of a 3-section condenser rated at 8 mfd. 450 V.; 8 mfd. 300 V., and 20 mfd. 25 v.:

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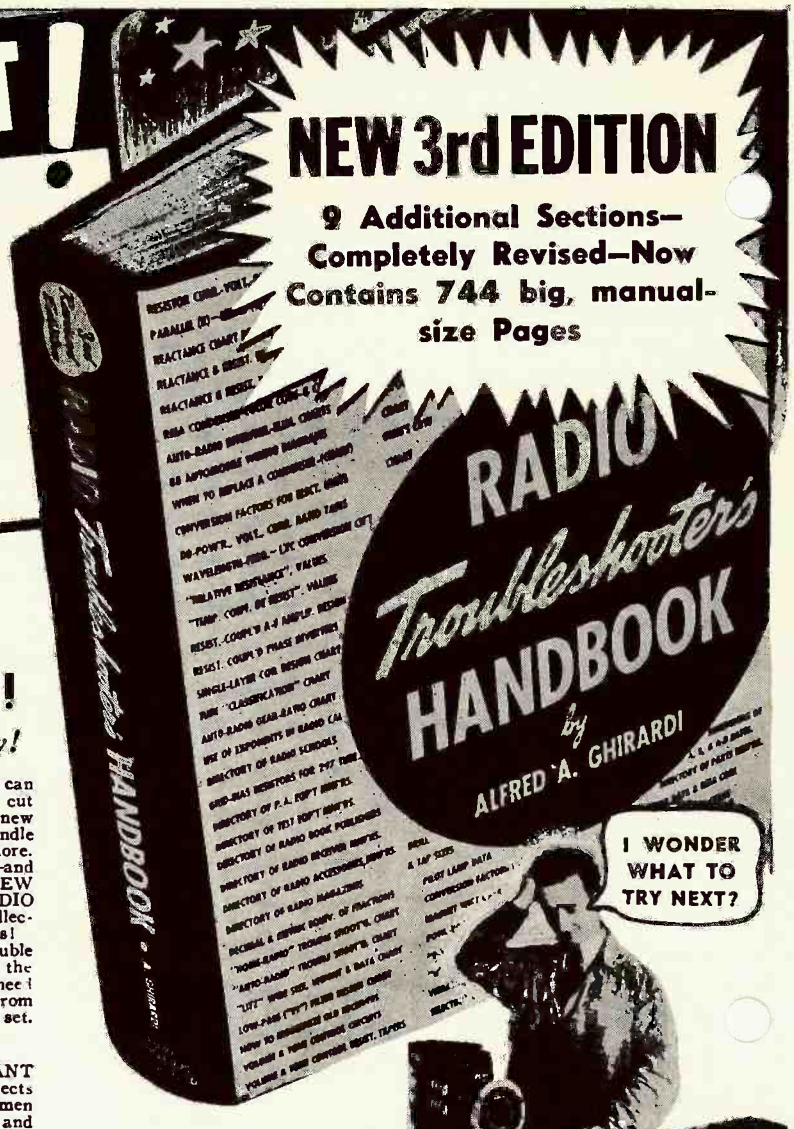

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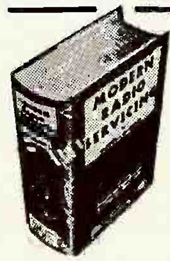

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SERVICE
A Monthly Digest of Radio and Allied Maintenance

AN ANALYSIS OF A-M AND F-M RECEIVERS

By S. J. THOMPSON
Service Manager, Belmont Radio Corp.

ALTHOUGH the underlying principles of frequency modulation are as old as radio, to the Service Man frequency modulation is a relative newcomer in broadcasting. Because its practical use is new, it seem desirable in a discussion of a frequency modulation receiver to review, first, as concisely as possible, the theory of amplitude modulation and then, insofar as possible compare f-m to it.

Harmonics

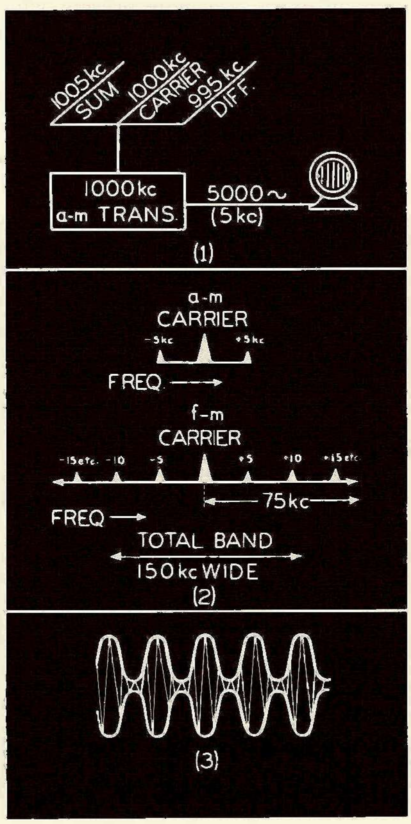
The ability of two violin strings tuned to different frequencies (pitch) to produce new frequencies when the strings are vibrated simultaneously, is a well understood phenomenon of physics. The two important frequencies produced will be the sum of the frequencies of the two strings and the difference in frequency between the two strings.

Amplitude Modulation

The simple principle of vibrating violin strings applies also to transmitter modulation. For example, if a transmitter is radiating an r-f wave at a carrier frequency of 1,000 kc, any new frequency which may be introduced into the carrier will produce the sum and the difference between the carrier and the new frequency introduced. Let us assume that the frequency we wish to introduce is a 5,000 cycle audio note. If this 5 kc note is introduced through speech amplifiers and mixed through the modulators with the 1,000 kc transmitter carrier frequency, two new frequencies are produced—the sum and the difference. An examination of Fig. 1 shows that the sum is 1,005 kc, the carrier frequency is 1,000 kc and the difference frequency 995 kc. The 5 kc audio note is no longer present since low audio frequencies do not radiate. The two new frequencies produced are commonly referred to as the *side bands*. When viewed on a base line plotted in frequency, as shown in Fig. 2, we see that the carrier frequency of 1,000 kc is the station's assigned wave length and the two side frequencies are spaced, in this case, 5 kc either side of the carrier. It is apparent that in order to transmit a 5 kc note, the transmitter must necessarily have a 10 kc channel.

These side bands obviously require power and their power is derived from the carrier. It becomes at once apparent that if the magnitude of the side bands is varied, the magnitude of the carrier that is supplying the power must vary in direct proportion. The degree to which the carrier varies when supplying the side bands determines the intensity of modulation. It is measured in terms of percentage of modulation. This variation in carrier amplitude is illustrated in Fig. 3. For reasons beyond the scope of our discussion the carrier is never completely drained of power for, even at 100% modulation, only 1/3 of the carrier power is in the side bands.

Fig. 1 (top). Sum-difference explanation. Fig. 2 (center). Difference between a-m and f-m carriers. Fig. 3 (bottom). Carrier amplitude.



Amplitude Receiver Theory

We have already seen how modulation by a 5 kc note at the transmitter produces two new frequencies. Now let us examine the receiver and follow the conversion of these two new radio frequencies back to a 5 kc note audible to the ear. Examination of Fig. 4 shows that on the receiving antenna are impressed the three frequencies being emitted by the transmitter, namely, the carrier frequency of 1,000 kc, and the two side band frequencies represented by the sum frequency of 1,005 kc and the difference frequency of 995 kc. Now we shall assume that our receiver is tuned to 1,000 kc. The r-f stage provides gain to the three frequencies being received and, of course, also provides considerable rejection to frequencies above 1,005 kc and below 995 kc. Leaving the r-f stage, the three frequencies are passed into the first detector, often referred to as the *mixer* tube. It is the function of the mixer to combine the three incoming frequencies with the local oscillator frequency. Let us examine the oscillator. We find that we are again using the harmonic theory, by injecting a new frequency. We know that if we mix a new frequency with those already in existence in the tube's input circuit, at least two new frequencies will be produced—the sum and the difference. Keeping this fundamental in mind, we can readily determine the important new frequencies that will exist.

It has become common practice to make the oscillator frequency track above the signal frequency, although it may also be used below the incoming frequency if desired. In Fig. 4, the oscillator frequency is set 465 kc above the incoming signal. Since our incoming signal is 1,000 kc, the oscillator at this particular setting will be 1,465 kc. In the mixer tube there are at least three frequencies from the transmitter which can be mixed with the oscillator. By adding 1,465 kc to the three frequencies of 1,005 kc., 1,000 kc and 995 kc, we arrive at the sum frequencies, as tabulated in Fig. 4. By taking the difference between the oscillator frequency and the three frequencies of 1,005 kc, 1,000 kc, and 995 kc, we obtain the difference frequencies as tabulated. It may be seen that these two groups of new frequencies are about to enter the i-f stages. Now assume that the i-f frequency is 465 kc. Since the i-f band width is designed to be approximately 10 kc wide, it will pass anything from 460 kc to 470 kc, but it will not pass frequencies either above or below this limited band width. It is at once apparent that the three *sum* frequencies, produced by the oscillator in the mixer tube, cannot go through the i-f channel. The three *difference* frequencies, however, pass through the channel readily where they undergo considerable amplification. These three difference frequencies may be seen to leave the i-f channel and enter the second detector, more properly known

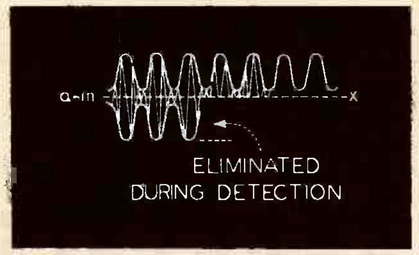


Fig. 5. What happens during a-m detection. Light lines represent r-f carrier. Heavy lines represent sidebands.

as the *demodulator* tube. The 5 kc audio signal has not yet appeared. It is in this demodulator tube that the 5 kc note is recovered and it comes about in the following manner. The three difference frequencies, which were fed into the second detector, combine with each other and through this combination produce the sum and the difference frequencies that always result from the mixing of two unlike frequencies. A close examination of Fig. 4 shows that the sum of $(A + B)$, $(A + C)$, and $(B + C)$ produces three new sum frequencies, and in the same analysis we see that the difference between $(A — B)$, $(A — C)$, and $(B — C)$ produces three new difference frequencies. Thus, we have in the plate circuit of the second detector six entirely new frequencies brought about by self-mixing of the frequencies fed to it by the i-f amplifier. Observe that the 5 kc note is now recovered. Unfortunately, there are a number of higher frequencies, plus an extra 5 kc note present which should be eliminated, leaving only the wanted 5 kc signal.

The three sum frequencies are radio frequency and because of this can be eliminated quite readily. This is done by inserting an r-f choke, as shown in Fig. 4, in the plate circuit of the detector tube. In some cases, elimination of these three frequencies may be done merely by the use of a bypass condenser from the plate circuit to ground, in which case the r-f frequencies are given a low reactance bypass to ground. However it may be done, these three sum frequencies are effectively eliminated from the first audio stage. There still remains an extra 5 kc note and a 10 kc note that were not present in the original modulating signal at the transmitter. It is because of its ability to eliminate this extra 5 kc note that the detector tube functions in a manner unlike that of an ordinary amplifier.

Detector Operation

It will be remembered that in modulating the transmitter, the two new frequencies appeared above and below the carrier. At first thought it would be imagined that if these two frequencies are present as separate signals, it should only be necessary to amplify them as such. Unfortunately, harmonic frequencies cannot be separated quite so readily. Complex side band frequencies are part of the carrier frequency until subjected to some form of non-linear rep[illegible]r. How they might appear graphically is shown in Fig. 5, where the light lines represent the r-f carrier, and the two heavy lines represent the upper and lower side bands. It is evident that the side bands have equal instantaneous magnitudes but in opposite directions; that is, they are 180° out of phase. The result of this is that they completely cancel each other out

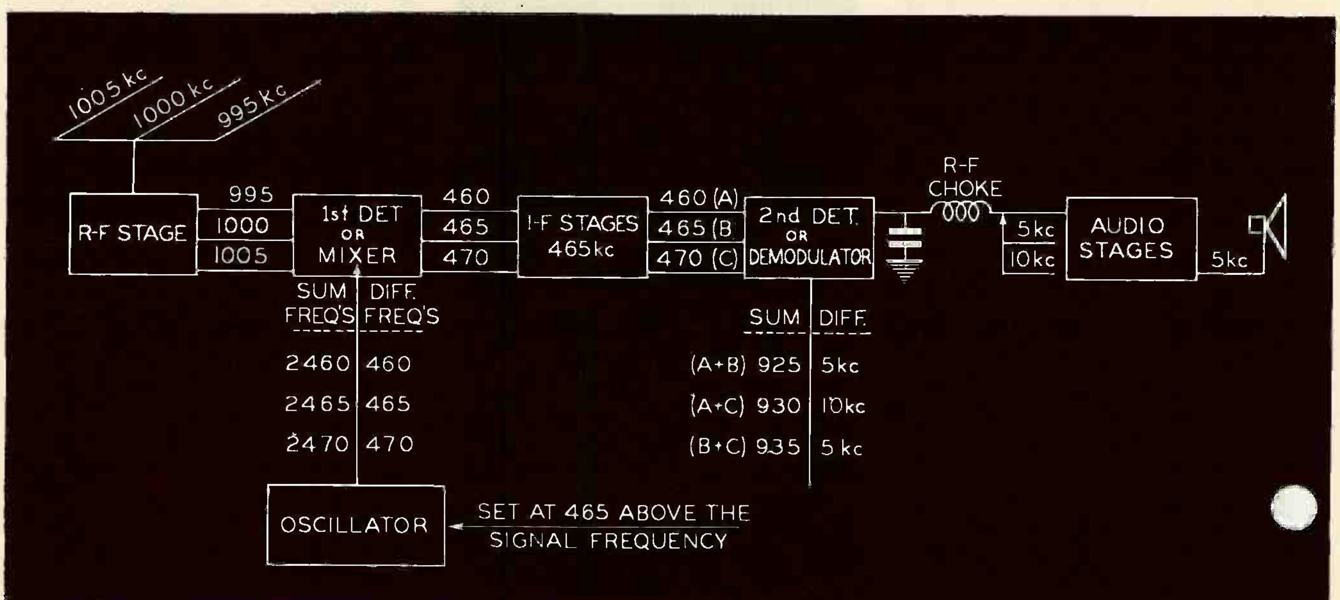


Fig. 4. Sum and difference characteristics of an a-m signal, from antenna to loudspeaker.

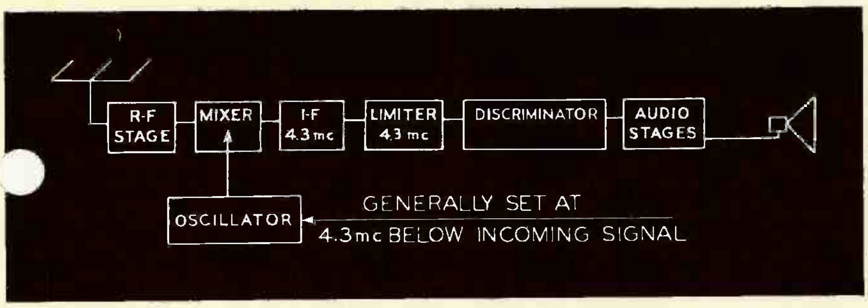


Fig. 7 (top). A block diagram showing the function of the component sections of a f-m receiver. The r-f stage will be required to receive a signal of 75 kc on either side of the frequency to which it is tuned, or a maximum of 150 kc.

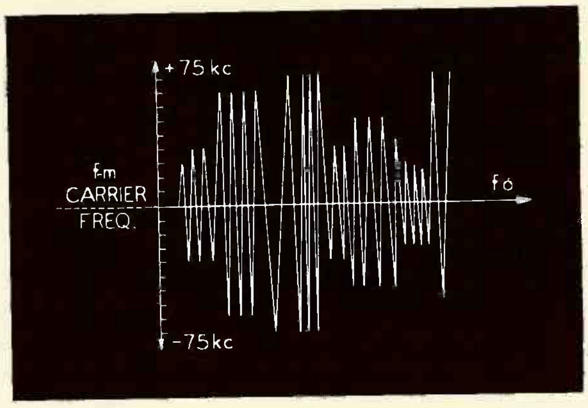


Fig. 6 (right). Deviation in the carrier frequency with varying modulation powers is illustrated here. The carrier frequency f_o is seen to deviate plus and minus 75 kc, with this deviation varying audio input intensities.

inal audio note entering the microphone. A note of sufficient intensity to produce 100% modulation in an a-m transmitter will, in a f-m transmitter, shift the carrier out, with its resulting train of side bands, to the full width allowable by the deviation ratio. The rate or speed at which the carrier is caused to swing above and below its assigned frequency is determined by the audio rate being applied.

in the second detector, unless prevented from doing so.

A detector tube, in whatever form, is essentially a non-linear repeating device, that is to say, it will amplify or repeat one of these harmonic frequencies more than it will the other. Let us take the more simple case in which a diode rectifier is used. In this case, all of the negative r-f peaks below the reference line *X* are removed because of the rectification of the diode, leaving the required audio impulse as seen in Fig. 5.

The other unwanted note of 10 kc is the much-referred to second harmonic. In pushpull amplifiers it is made to cancel itself out in much the same fashion as the two 5 kc notes would cancel themselves before rectification. In the smaller receivers, the 10 kc note is allowed to go through the amplifier, causing some distortion, because it is an audible tone that was not present in the original transmission. Such distortion, however, is usually held to satisfactory commercial levels.

Frequency Modulation

In amplitude modulation we saw that the carrier was varied in amplitude by the audio modulating signal as illustrated in Fig. 3. This variation in carrier amplitude is dependent upon the intensity of the original audio note (or notes) entering the microphone. In Fig. 2 we saw that the modulation produced by the 5 kc note would produce two side bands, spaced 5 kc on either side of the carrier frequency. In frequency modulation we observe that a 5 kc modulating note produces not one, but many side bands on either side of the carrier. This comparison is shown in the bottom portion of Fig. 2 in which the carrier frequency may be anything from 42 mc to 45 mc (these are the frequncies allotted to f-m broadcasting by the FCC), and the side bands may be 5 kc apart, extending out to a total of 75 kc on either side of the carrier frequency. This means that an f-m station occupies a channel of 150 kc and compares with 10 kc for an a-m broadcast station. Since a f-m transmitter is capable of transmitting audio frequencies up to 15,000 cycles or 15 kc, a 15 kc note may produce 5 side bands on each side of the carrier before reaching the maximum width of 75 kc either above or below the carrier frequency. This is seen to produce a deviation ratio of 75/5 or 5 to 1 which is the maximum allowable under present rulings. In an a-m modulated receiver, the carrier is held at the station's assigned frequency, but in an f-m transmitter the carrier is caused to shift its frequency above and below this assigned frequency.

This carrier shift is a function of two factors. The amount that the carrier is made to deviate on either side of this assigned frequency is determined by the intensity of the original audio note entering the microphone...

Since the audio rate is undergoing continual change when broadcasting more than a single audio frequency, it is apparent that the rate of carrier shift is undergoing similar complex rate changes. It should be emphasized that the audio frequency being applied to the transmitter has nothing whatever to do with the band width or the amount of deviation. This is determined entirely by the strength of the applied modulating note (or notes). It is also apparent that the number of side bands present for any single modulating note does not depend in the least upon the audio modulating frequency. This, too, depends only upon the intensity of the applied audio frequency at the transmitter. This deviation in the carrier

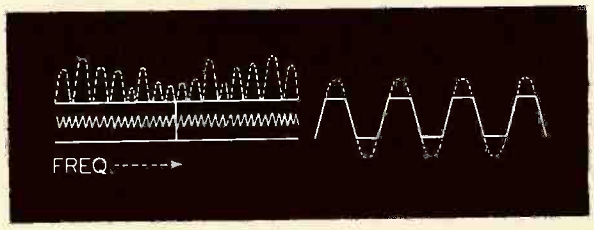


Fig. 8 (left). Illustrating the two components fed to a limiter. Horizontal component is the a-m signal, while the vertical component consists of unwanted amplitude signals which, because of their relative wide voltage swings, drive the limiter tube alternately to cutoff.

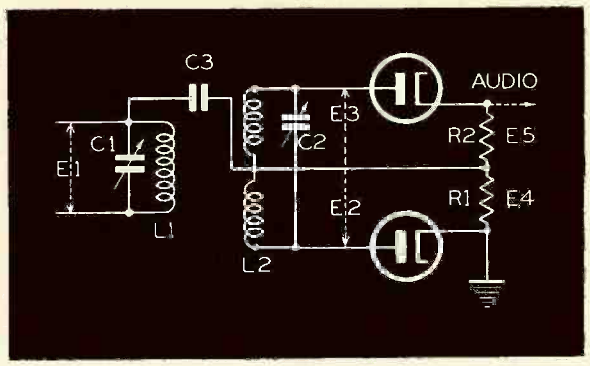


Fig. 9 (right). A f-m discriminator circuit. The discriminator acts as the second detector and converts the frequency deviations received from the limiter into audio frequencies. The circuit shown here is one of the most popular types of discriminator systems employed in commercial receivers. In operation the primary and secondary L_1 and L_2 are tuned to resonate at the same frequency at the preceding i-f-t.

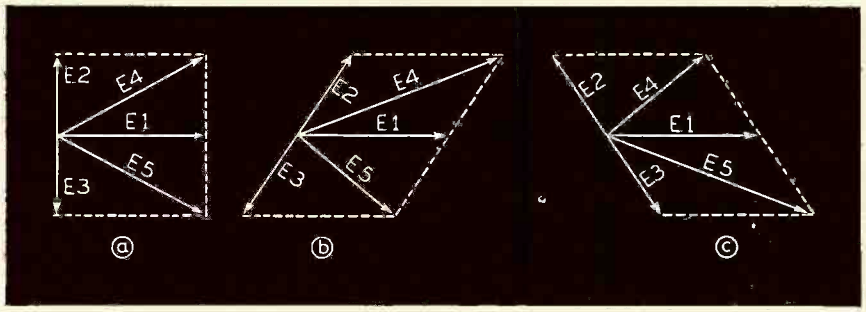


Fig. 10. Vector diagrams, indicating the voltage relationships appearing in the discriminator circuit.

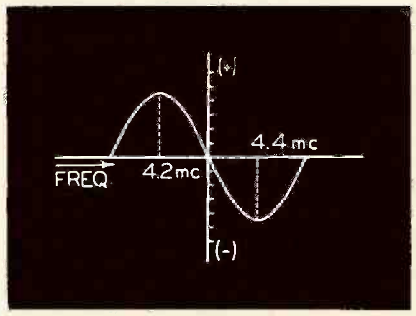


Fig. 11. The resulting output curve of a discriminator.

frequency, with varying modulation powers, can be seen clearly in Fig. 6, in which the carrier frequency, F_0, is seen to deviate plus and minus 75 kc, with this deviation varying with varying audio input intensities

F-M Receiver Operation

We have seen how the carrier is caused to deviate at the transmitter and how, in so doing, it produces not a pair of side bands for each audio frequency as is the case with a-m, but an infinite number of side bands. Now let us concisely compare the practical requirements of the f-m receiver as compared to the a-m. Fig. 7 is a block diagram, showing the function of the component sections of a frequency modulation receiver. The r-f stage will be required to receive a signal of 75 kc on either side of the frequency to which it is tuned, or a maximum of 150 kc. The oscillator frequency in an a-m receiver is usually set above the incoming frequency, but in a f-m receiver it is set below the incoming frequency. This is done to prevent interference with television signals. The accepted i-f frequency is now 4.3 mc; consequently, the oscillator is set at 4.3 mc below the incoming station frequency. Whereas the i-f frequency in an a-m receiver need pass only a 10 kc band, the f-m i-f must pass 150 kc. In order to accomplish this, the i-f transformers are designed in the conventional manner for 4.3 mc, and sometimes have their primaries and secondaries shunted with resistors to broaden them out to the necessary channel width. Except for this wide bandwidth, up to this point the receivers are essentially the same for either a-m or f-m.

Limiter

The next unit shown in our block diagram is the limiter. The limiter plays the important role of removing unwanted amplitude modulation. Because noise impulses, when beating with the oscillator frequency, are amplitude modulated, the limiter effectively reduces noise to a low level. The general requirements for a limiter tube are high mutual conductance and sharp cut-off. The limiter tube is operated at low plate and screen voltages. Sufficient gain is required ahead of the limiter, to drive the plate current to cut-off on the negative swing of the signal voltage, and to plate current saturation on the positive swing. The incoming signal being fed to the limiter can be considered as having two components. The most important is the horizontal component illustrated in Fig. 8. The horizontal component is the amplitude modulated signal and, since its excursion is on either side of the limiter resonant frequency, it is unaffected by the limiter action. The vertical component, however, is made up of unwanted amplitude signals which, because of their relative wide voltage swings, drive the limiter tube alternately to cut-off or saturation. The resulting effect of the limiter action is to clip the peaks of the amplitude impulses while still delivering to the discriminator the complete intelligence of the frequency modulated signal. Since the limiter is essentially an i-f stage, it delivers to the discriminator a signal at the i-f frequency.

Discriminator

It is the purpose of the discriminator to act as the second detector and then to convert the frequency deviations received from the limiter into audio frequencies. Several types of discriminators have been used but, because of its simplicity, the one shown in Fig. 9 is perhaps the most frequently used in the commercial receivers.

Superficially, its action is as follows. The primary and secondary, L_1 and L_2, are tuned to resonate at the same frequency as the preceding i-f transformers—generally 4.3 mc. The tu[illegible] primary, L_1, is connected to the midpoint of the secondary inductance, L_2, through the coupling condenser, C_3. This means that the primary voltage, E_1, will be present at the mid-point of L_2 and is common to both the secondary voltages across each half of the secondary inductance; however, this signal voltage is not in phase with the total induced secondary voltage. The secondary voltage is at right angles to the primary voltage; in other words, voltages E_2 and E_3 are 90° out of phase with voltage E_1. Because of this, the primary and the secondary voltage must be added in vector fashion so as to arrive at the resultant voltages of E_2 and E_3. This relationship is shown at *a*, in Fig. 10. Here the voltages E_2 and E_3 are shown to be at right angles to the primary voltage, E_1. The resultant diode voltages, then, appear as E_4 and E_5. Now, since these voltages are equal in magnitude and polarity, no detected voltages will appear across resistors R_1 and R_2. This is the condition that prevails at the resonant frequency. It implies that no voltage will be de[illegible]veloped by amplitude modulated [illegible]nals at the resonant frequency. Now, if the incoming signals are being frequency modulated, it does not remain at the resonant frequency but is constantly on excursion on both sides of resonance, plus or minus an amount corresponding to the intensity of the original modulating signal.

Suppose now we examine the discriminator action when the signal frequency is shifted above the resonant frequency of the discriminator. Let us assume that the applied frequency is now 4.4 mc, which is 100 kc higher than the 4.3 mc frequency to which the discriminator is resonant. This will have the effect of increasing the reactance (*X-L*) of the secondary coil. Since a condenser decreases its effective reactance as the frequency goes up, C_2 assumes a lower reactance value to the higher applied frequency. As a consequence, the incoming signal views the secondary circuit, L_2 and C_2, as a capacity path, since the capacity has the lower reactance. Because the capacity has the effect of producing a lag in voltage, we have the result shown in Fig. 10*b*. H[illegible] the two vectors, E_2 and E_3, are caus[illegible] to lag the primary voltage, vector E_1. The vectors are consequently rotated clockwise. It can be seen, now, that the resultant vectors, E_4 and E_5, are no longer equal. This means that the voltages across the diode resistors, R_1 and R_2, will no longer be equal. If we assign an arbitrary voltage value to vectors E_4 and E_5 in Fig. 10*a* of 8.0 volts each, we find that vectors E_4 and E_5 in Fig. 10*b* have now assumed voltages of approximately 11.0 volts for E_4 and 6.0 volts for E_5—a difference of 5.0 volts. Since the diode voltage E_4 (the lower diode) is 5.0 volts greater than E_5, this 5.0 volts will appear across the top cathode to ground as an audio voltage. The vector diagram in Fig. 10*c* can be analyzed in the same fashion as the vector in Fig. 10*b*. It will be found to take care of cases when the signal frequency goes to 4.2 mc or 100 kc below the resonant frequency. In this case, the vectors will rotate in an anticlockwise direction and the diode supplying the resistor, E_5, is seen to deliver the greater detected voltage. Thus, we see that if the signal frequency of 4.3 mc is moved back and forth between 4.2 mc and 4.4 mc, an audio voltage will exist between the top cathode and ground, and the resulting output curve of the discriminator will appear as in Fig. 11.

Alignment Procedure

The alignment procedure of frequency modulation receivers is often confusing to the Service Man. This is especially true of the discriminator. Because most present-day f-m receivers are combinations of a-m and fm and frequently have short wave bands, each manufacturer is likely to have his own recommended method of alignment procedure. The f-m alignment, in itself, is not difficult but it is generally advisable to follow the order that the manufacturer recommends for each particular model. It will be remembered that a signal at the resonant frequency of the discriminator will produce no output, while a signal above or below the resonant frequency will produce output. In the absence of a vacuum tube voltmeter or an oscilloscope, this fact may be used to align the discriminator. If an amplitude modulated signal at 4.3 mc is fed into the f-m i-f, the discriminator will have a distinct null point at the resonant frequency of 4.3 mc. In order to use this method, however, it is imperative that the signal generator be extremely accurate, that is, when it is set to 4.3 mc, it *must* be 4.3 mc and not 4.4 mc or 4.2 mc.

Typical 14-Tube F-M Receiver

A typical f-m receiver, with provision for broadcast and short wave reception, is shown in Fig. 12. This receiver has a sensitivity of 10 microvolts average at 500 milliwatts output. Its selectivity at 1000 kc and at 1000 times the signal, is 27 kc.

There are two intermediate frequencies, one for the broadcast band (455 kc), and one for the f-m channel (4300 kc).

In aligning this receiver on the f-m bands a dummy antenna having a capacity of .1 mfd is used for the i-f section. A frequency setting of 4.3 mc is used for four of the bands and two frequencies of 4225 and 4375 kc is used for the fifth band. In aligning the r-f section a frequency setting of 50.5 mc is used with a dummy antenna of 100 ohms.

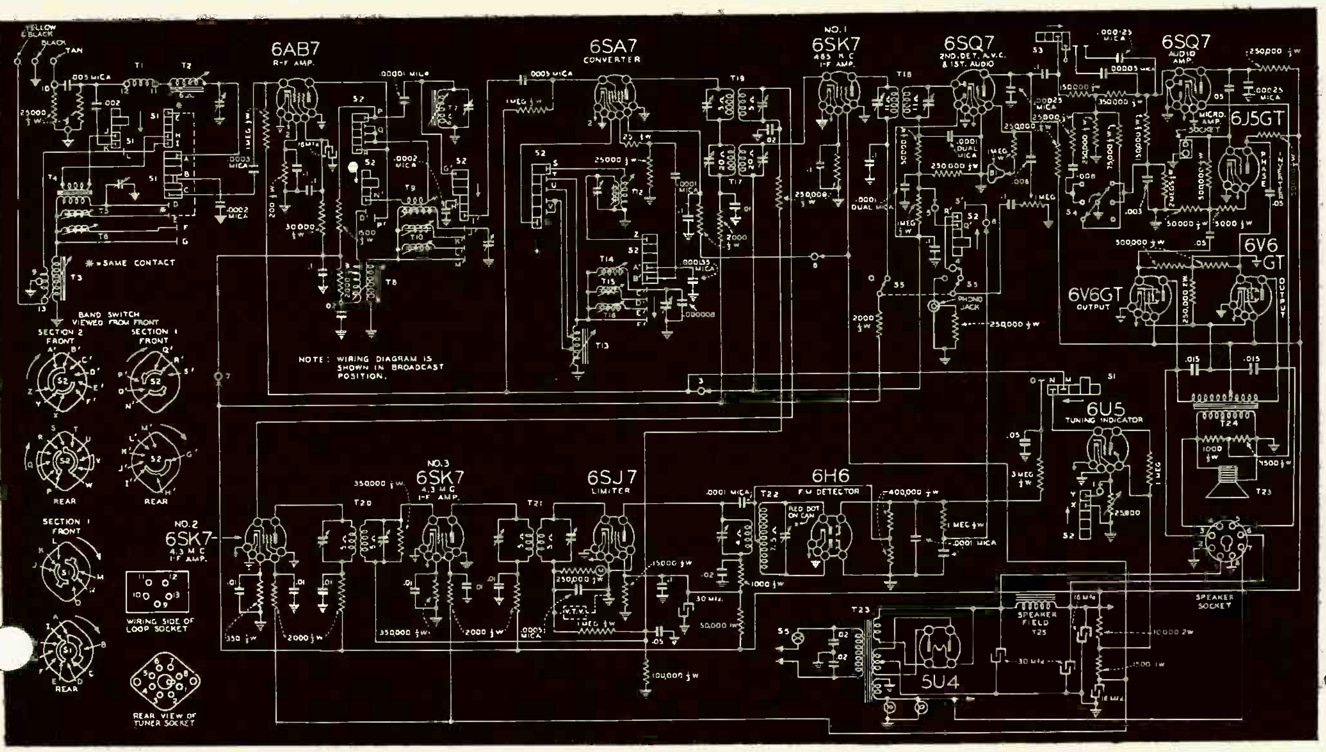
The frequency modulation i-f and r-f band must be aligned before the three standard short-wave bands can be properly aligned. The oscillator and radio-frequency adjustments must be completed simultaneously for each of the short-wave bands. Incidentally the short-wave bands are aligned at 9.6 mc, 11.8 mc, and 15.2 mc. A 400-ohm dummy antenna is used in aligning.

Although the short-wave bands on this receiver are of the bandspread type, the alignment procedure is not difficult. However, because each short wave scale covers only a small portion of the short wave spectrum you must do the work carefully and your oscillator must be accurate.

Do not realign the band spread scales unless you are positive they are out of adjustment.

Coils T17 and T18 are the 455 kc i-f coils. The first and second f-m i-f coils are represented by T19 and T20. The limiter coil is T21 and the discriminator coil is T22.

Fig. 12. A typical 14-tube f-m receiver featuring operation on the broadcast bands, as well as short waves. This receiver also has provision for a record changer. It will be noted that the diagram is shown in broadcast receiving position. Highlights of this receiver are explained on this page.



SERVICING TODAY

An Analysis of the State of the Industry by Leading Specialists

I FEEL quite confident that the Service Men's justifiable complaints due to poor parts deliveries will be answered with some real action through the medium of Limitation Order L-265. Of course the order is new and has to be proved! However, from all previous indications it will be easier for a manufacturer to make available much needed goods for the jobber and, ultimately, for the Service Man.

L-265 means more than a new method for the transferring of parts. It means that the WPB now realizes that the way to *keeping 'em playing* is by facilitating delivery of components.—***G. V. Rockey, Meissner Manufacturing Company.***

THIS is war. Tomorrow it will be peace. In the matter of radio components there is bound to be much disappointment these days for the Service Man. Manufacturers are virtually 100% on war work. Such business is a *must*. If we have any production capacity to spare, after tremendous expansion of our facilities, we may be permitted to consider civilian requirements. However, the war won't last forever, and that's the bright spot for all of us.

The radio parts industry has been stepped up tremendously, in *quality* as well as quantity. Today we are making quality components in unbelievable quantities. What would have been considered an item strictly limited to an instrument-maker's setup, is now made in our factories, in tremendous quantities, at reasonable cost. Much automatic equipment has been introduced of late. We have a veritable army of skilled workers. The *impossible* of yesterday has become the achievement of today, and will be the commonplace of tomorrow.

I hate to predict. However, this is no far-fetched guess: I believe that Service Men will be pleasantly surprised with the components they'll be able to buy when the war is over. These quality components, applied with the tremendous gain in radio knowledge and experience, especially for those who've been in radar and military communications during the war, will usher in that electronic era of radio prosperity we've been talking about so much. At any rate, here's hoping. —***Victor Mucher, Clarostat Mfg. Co., Inc.***

VICTOR MUCHER

REMEMBER the old colored grandpappy who was telling the youngsters about the rabbit and the alligator?

"Yes, suh," he said, warming dramatically to his subject, "ole man alligator was so close dat B'rer Rabbit could feel hot breath on his tail jes like he was in front of a furnace. It seemed like B'rer Rabbit jes wasn't goin' to be able to get away nohow. Den, when ole alligator opened up his jaws to gobble him up de rabbit made one last jump to a tree, got hold of it, clumb up to a branch an' sat dere thumbing his nose."

"But gran'pappy," protested one of the youngsters, "rabbits can't climb trees."

The ole man spat indignantly.

"Well, dis heah rabbit clumb a tree all right," he replied. "By golly, he *had* to."

It's an old story, but it's still a good one to illustrate the situation in which many civilian businesses—including the business of radio servicing—have found themselves during the shortages and difficulties of these war time days. They've got a lot in common with B'rer Rabbit who got out of a tough spot by doing today what seemed impossible yesterday.

If I know radio Service Men—and I think I do—they aren't going to be gobbled up by the difficulties which unavoidably confront them. They aren't going to fall down on the job

HARRY KALKER

of keeping the nation's radios in working order just because test equipment, parts and men are scarce. And they're not going to wilt under the pressure of having many times as much work thrust upon them as they are normally accustomed to handle.

Sometimes it may not seem any more possible for them to overcome all of the difficulties confronting them than it did for B'rer Rabbit to climb a tree—but they'll do it just the s[illegible]

American ingenuity has an amazing knack of being able to work itself out of tough jams—and when it comes to classifying ingenuity, radio Service Men rate high on the list. What's more, they will have the whole-hearted backing of parts manufacturers, who will lose no opportunity to do everything within their power to help as much as they can, and wherever they can.

I am confident, for instance, that the Victory Line of parts will contain sufficient types to enable Service Men, with the manufacturer's whole-hearted cooperation, to keep home receivers in operating condition. I know too, that, like ourselves, leading manufacturers will issue pamphlets and instruction folders as rapidly as possible, showing how to make the best possible use of whatever limited supply of parts or equipment is available. I am also confident that every effort will be made to swap, sell, or loan existing unused equipment to get it into the hands of men who can use it to advantage.

In this connection, I have been particularly impressed by the tremendous response that has come to the f[illegible] classified advertising service for Service Men offered by the *Sprague Trading Post*, a feature sponsored by us in five or six leading radio magazines. Already, we have handled a great many advertisments—all of them from Service Men who either had spare parts or equipment to sell, or who were wanting to buy such materials. Hun[illegible]s of pieces of equipment, and literally thousands of parts have changed hands as a result. All of them have gone where they will do the greatest good under present day conditions.

There are many other examples of splendid cooperation by other manufacturers which might be mentioned—just as there are countless examples of outstanding performance and ingenuity on the part of Service Men themselves.

Actually, I am very optimistic over the future outlook—not because the going will be easy, or conditions entirely satisfactory, but because of the splendid spirit of cooperation and the willingness to work harder and longer than ever before that has been evidenced throughout the trade.

A spirit like this isn't going to be *licked* by future obstacles which may arise. It is simply going to be put on its mettle to overcome them. As the old saying goes, the tough jobs will be done in a hurry. The impossible jobs may take a little longer—but they'll be done nevertheless. And that's what counts!—***Harry Kalker, Sales Manager, Sprague Products Corporation.***

RADIO Service Men will face a big problem in competition when the war is over. They will be bidding against Signal Corps, Air Corps, and Navy trained radio technicians who are being thoroughly grounded in fundamentals, technique and knowledge of the latest radio circuits. In order to meet this competition, radio Service Men must do two things:

1. They must read *technical magazines* and keep posted on all available news about the new developments in radio and electronics.

JACK BERMAN

2. They must make a sincere effort to build good will *today*. They must give better service today than they have ever given before. Parts today are hard to get—customers are easy to find. Tomorrow, parts will be easy to get and customers will be hard to find. Treat your customers fairly today. Explain shortages sympathetically. Inspire their confidence and build a permanent clientele.—***J. A. Berman, Sales Manager, Shure Brothers.***

NOW for the first time the Service Man can really buy those replacements he needs in his work, thanks to the new order L-265. Previous restrictions are swept aside. By submitting the defective part he has removed from radio or similar assembly, or certifying that he needs the replacement, he can walk into his jobber and get that required part. Meanwhile, the jobber in turn should have no hesitancy in giving that part to the Service Man since the jobber can replace his stock on this same part-for-part basis.

CHARLEY GOLENPAUL

I like this new Limitation Order L-265. It's simple. It reduces paper work to a minimum. And yet it safeguards the use of our strategic materials as it should.

This new order should work wonders in wartime servicing. Until now, unfortunately, many jobbers have held up on the release of their merchandise. They have held out for better odds, working under the false impression that they could not replace their stock, although they could have replaced whatever they sold by filing the PD-1X form. However, the present part-for-part routine now clears up all doubts as to stock replenishment within the production scope.

The WPB is certainly proving its intention of keeping American radio sets functioning, to the end that the American people can be kept informed and guided and encouraged at every stage in the winning of the war.—***Charley Golenpaul, Aerovox Corporation.***

SYLVAN A. WOLIN

MUCH has been said recently regarding the necessity for standardization of civilian types of radio parts, so that we can *keep 'em playing.*

Two facts are definitely conceded. First, everyone concerned with Radio—even in the highest Governmental circles—is convinced that home receivers must be kept in proper operating condition for the improvement of civilian morale. Therefore, provision for manufacturing essential repair parts must be made. Secondly, it is obvious, even to the layman, that radio parts manufacturers—already performing miracles in producing vast quantities of war materials—cannot be expected to produce the *variety* of replacement parts which they formerly made available.

The problem therefore reduced itself to one basic question, "How can we provide essential replacement parts for civilian receivers *without unduly disturbing* production of parts for the fighting fronts?"

Obviously, standardization of replacement types could be the only answer, through the consequent reductions in available types, electrical characteristics, mounting arrangements, etc. Such standardization permits increased production, which will at the same time consume the least practical amount of sorely-needed materials and labor.

But one factor—and a very important one—has not as yet been the subject of public comment. That is the fact that a standardization program could not even have been contemplated if the abilities of the men who had to use these parts were on a low level. Standardization demands *ingenuity* on the part of the Service Man who must adapt these new units as replacements for older, and rarely obtainable types of parts. Unquestionably, the talents of American Service Men have aided greatly in the development and adop-

(*Continued on page* 24)

PHOTOCONTROL SERVICING

By S. J. MURCEK

ESSENTIALLY, the electronic photocontrol, often miscalled the light relay or electric eye, consists of a light-responsive element, usually a phototube, and a suitable amplifier tube, together with the ever-necessary power supply and electromagnetic relay. In actual practice, however, it will be found that this basic system has grown into a maze of small components, further complicated by the addition of numerous tubes and relays. Thus, when operation troubles arise, it is often difficult to analyze and localize the cause of the disturbances affecting normal operation. It is, therefore, obvious that a thorough understanding of the principles underlying photocontrol operation is invaluable to the Service Man.

Photocontrols are found in numerous applications. They may be used to control the opening of doors, as in railway stations, or production line package counting, sorting, packaging, in fact any place where the interrupting or dimming of a light beam may be interpreted in terms of relay action. This leads to two general classifications. Photocontrols subjected to a slow change in illumination are known as static photocontrols. Those operated by a sudden, but not continuous change in illumination, are known as dynamic photocontrols.

Various tube types may be employed in the design of photocontrols. The type of phototube selected depends on the service for which it is intended; the amplifier tube or tubes on the method of end operation desired. Use of relays for end operation, such as the control of larger relays, is conventional. At times, photocontrols terminate directly in actuating motors.

The circuit diagram of Fig. 1 illustrates a photocontrol of static type in elementary form. Here, *1* is the phototube, *2* is a pentode tube of the sharp cut-off type, *3* is the phototube load resistor, *4, 5, 6,* and *7* are battery sources of electrode potential supply, and *8* is a small control relay of the telephone switchboard type.

In this circuit, if the phototube is initially dark, the current through the phototube load resistor is zero, and the voltage across the resistor is also zero. Since the load resistor is connected to the negative terminal of the grid biasing battery *4*, and the voltage across the resistor is zero, it follows that the voltage between the pentode grid and cathode is equal to battery *4*. Further, the pentode grid is negative with respect to its cathode, and the plate current is cut off. Since the pentode plate current, which flows through the operating coil of the end relay *8* is zero, it follows that the armature of the relay will remain open or unsealed.

Now if the phototube is subjected to illumination of a comparatively high level, the conductivity of the phototube rises appreciably, and the phototube plate current flowing through the loading resistor develops a potential across this resistor which is almost equal to the voltage existing across batteries *4* and *5*. This makes the pentode control grid positive with respect to its cathode. As a result, an appreciable current flows through the operating coil of the relay; the relay seals, closing the load circuit.

The element supply batteries *4, 5, 6* and *7* may easily be replaced with an a-c power supply. It can be seen that such a power conversion supply duplicates that of the average radio receiver. Trouble shooting tests for the supply would approximate those used in standard radio repairing.

Returning to the analysis of the circuit in Fig. 1, tube *2* is referred to as a radio pentode, possibly similar to the 6F6. As the grid potential of such a tube is varied, so that the grid is less negative with respect to the cathode, a point is reached where the rise in the plate current is rapid, that is, quite steep for a proportional change in the grid-to-cathode voltage. Thus if the potential across the phototube loading resistor is such that the grid of the pentode is just enough negative with respect to its cathode to permit only a small plate current flow through the coil of the relay, then a small change in the illumination level of the phototube will cause a large increase in the pentode plate current, and the relay will seal. Further, since a small change in the grid-to-cathode voltage of a pentode tube provides a comparatively large change in the plate current of such a tube, one may see that the photocontrol sensitivity is, to a large extent, dependent on the over-all amplification of the photocontrol.

In the previous discussion it was shown that a change in the illumination level on the phototube from a low to a higher value caused the relay to seal. Since the conductivity of the

Fig. 1. An elementary form of static type of photocontrol.

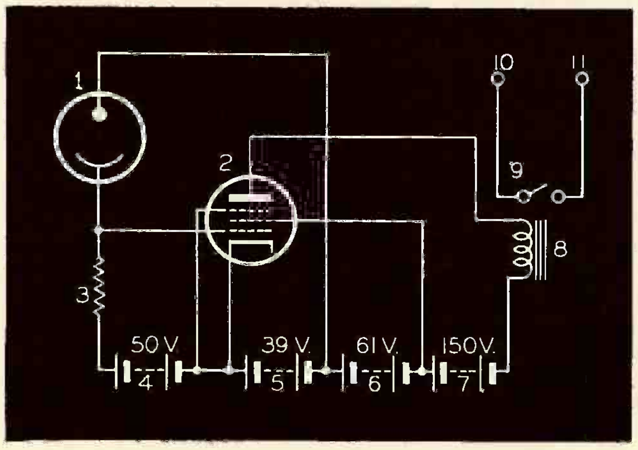
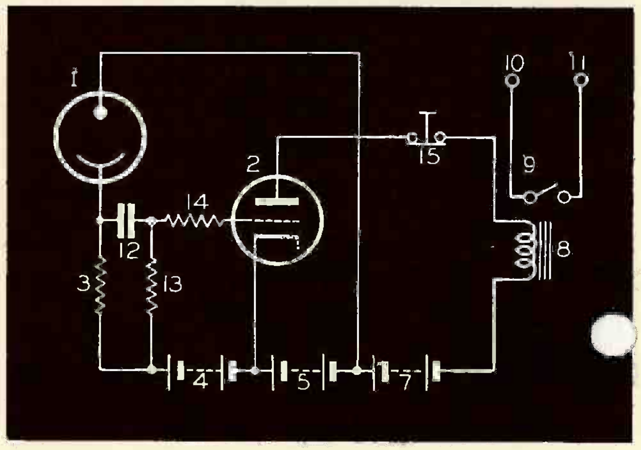


Fig. 2. A photocontrol of the dynamic type is illustrated here.



phototube remains high if the illumination is high, the control grid of the pentode remains positive with respect to the cathode, and the plate current is high. Under these conditions the relay remains in the sealed state. Re-[illegible]ion in the illumination level on the [illegible]otube reduces its conductivity, and the current flow through the loading resistor is reduced proportionately. If the illumination level is reduced to the point where the bias voltage on the pentode grid is allowed to assume a negative value, the plate current cuts off, and the relay unseals. Since the operation of this photocontrol depends on a slow change in illumination level, it is known as a static photocontrol.

A photocontrol of the dynamic type is shown in Fig. 2. This type is often referred to as an *impulse* control, since its action depends on a rapid increase in the light intensity falling on the phototube. Here, the amplifier is a thyratron tube, operating from a d-c power supply consisting of the dry cells *5* and *7*, and the negative bias battery *4*. Since thyratrons are limited to commercial uses, and are rarely seen in receiver circuits, it would be well to review its theory, operation and applications in photocontrol circuits.

The simplest concept of a thyratron is that of a gaseous rectifier tube with a control grid. However, its be-[illegible]or as compared with a triode differs in one important respect. When the control grid of a thyratron tube is maintained negative with respect to its cathode or filament, the tube is nonconductive; that is, no plate current flows. However, once the grid swings positive, the tube begins to conduct quite suddenly, or, simply *fires*. The current passed by the tube in its firing state is large, limited only by the circuit or relay resistance. The full emission of the cathode may be realized with plate voltages as low as 15 or 20 volts. If the grid is now driven negative, it will be found that the tube still conducts, the grid apparently having no further control on the flow of plate current. To stop the plate current, the plate voltage must be reduced to zero. If the grid potential is returned to its negative state before plate voltage is again applied, no current will flow.

Since the thyratron tube is essentially a gaseous rectifier, it is obvious that the tube will rectify an alternating current; that is, current will flow on the positive halves of the cycle, provided the control grid potential is [illegible]tive.

Among applications in photocontrols to which the thyratron tube is placed are those involving the use of the tube as a relay lock-in device, with the plate circuit operated from d-c, such that, once the phototube fires the thyratron, the thyratron plate current closes the relay in the plate circuit and holds it closed until the plate current is interrupted in some manner; use of the tube as a current amplifier to operate a comparatively large relay from phototube currents; and use of the tube as a grid-controlled rectifier for reversal of an actuating motor by means of the change in illumination level on a phototube.

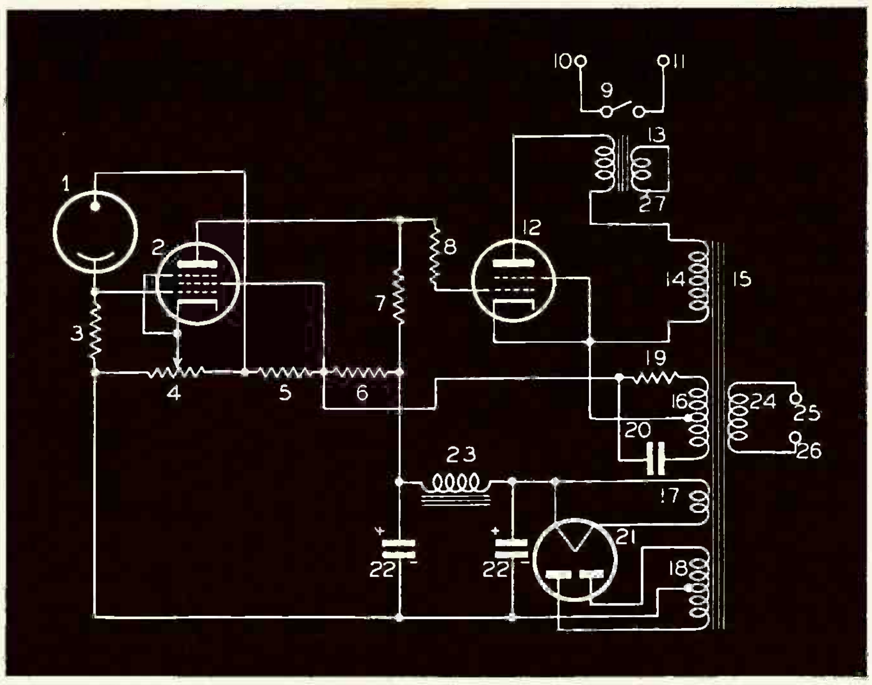


Fig. 3. A static photocontrol system using pre-amplification. The photocontrol here will operate reliably with light levels of one-foot candle or less.

Commercial thyratrons of the small type, passing average plate currents less than 100 milliamperes include such types as the Raytheon 2A4G, RCA 884 and 885, and the Westinghouse types WL 630 and WL 629. Larger thyratrons, passing currents of several amperes, include the Westinghouse types KU 627 and KU 636, also types WL 632 and WL 672.

It is to be observed that the control grid of a thyratron actually is an auxiliary plate, and is quite capable of handling large currents. However, since the driving power available from phototubes and small radio tubes is small, it is conventional to limit the thyratron grid current to a fraction of that carried by the plate control circuits. The method of limiting the grid current merely involves the introduction of a high resistance in series with the grid.

In the circuit of Fig. 2, an increase in the level of light illuminating the phototube increases the conductivity of this tube, and results in an increase in the flow of current through the loading resistor *3*. The resulting increase in the potential across resistor *3* causes the coupling capacitor *12* to charge, the charging current flowing through the grid resistor *13*. Effectively, on the rise of the voltage across resistor *3*, capacitor *12* is a short circuit between grid resistor *13* and the phototube loading resistor, since the charging current taken by this capacitor is initially high. Further, since the terminal of resistor *3* which is connected to the cathode of the phototube, is positive when the phototube conducts, it is readily seen that the grid end of resistor *13* is also positive when the capacitor is charging.

When the capacitor charges to such a value that voltage across it is equal to that across resistor *3*, the charging current ceases and the voltage across resistor *13* falls to zero. Thus, if the illumination on the phototube is increased, a positive voltage pulse will occur across the grid resistor *13*. A decrease in the illumination level on the phototube results in a decrease of the voltage across its load resistor. The coupling capacitor must now discharge to a value such that the voltage across it now equals the voltage appearing across the phototube load resistor. When the capacitor discharges, the discharge current flows through resistor *13*, ceasing when the charge across the capacitor equals the voltage across resistor *3*. Since the fall in potential across resistor *3* is impressed across resistor *13* by means of the initial short circuit caused by the capacitor and the grid end or terminal of the capacitor is now its negative terminal, the voltage appearing across resistor *13* is negative with respect to the voltage across resistor *3*. Thus, a negative voltage impulse appears across resistor *13* when the illumination level on the phototube is decreased.

Resistor *14* of Fig. *2* is a grid current limiting resistor used in conjunction with the manipulation of the control grid in the thyratron tube when its grid is driven positive. It should be observed that the maximum resistance in series with the coupling capacitor is limited by the resistance value of resistor *14*. In order that a maximum voltage pulse be developed across resistor *13*, with a change in phototube illumination level, the resistor (*14*) selected must have resistance as high as possible, without causing unstable operation of the thyraton.

In the circuit arrangement of Fig. *2* we note that the control grid of the thyratron is negative with respect to its cathode when the illuminition on the phototube is stable, since the voltage across resistor *13* under these conditions is zero. However, since a positive voltage pulse appears across this resistor when the illumination on the phototube is increased, the control grid of the thyratron is driven positive with respect to its cathode, and the thyratron *fires*. The resultant current flow through the relay coil *8* seals the relay, closing the relay contacts *9*. The contacts will remain closed until such time as the plate current of the thyratron is interrupted by means of the closed circuit push button *15*. Depressing the push button opens the plate circuit. Since the grid of the thyratron is negative with respect to its cathode, unless the phototube illumination is changed, closing the plate circuit by releasing the push button will not re-establish conduction by the thyratron.

This thyratron-operated photocontrol will operate only with increases, or positive pulses, in the illumination on the phototube, since a decrease in the illumination results in a negative pulse of voltage across the thyratron grid resistor. Since the thyratron is capable of conducting comparatively large plate currents, the control relay may be quite large, often capable of switching the operating currents of a one-horse power motor.

A study of the uses to which these photocontrols are put would indicate that the photocontrol is so placed that the light beam from the integral light source furnished with the photocontrol would fall directly on the phototube, operation occurring when the beam of light is interrupted. Technically, photocontrols of the general type illustrated in Fig. 1 and Fig. 2 are usually applied to operations involving control actuation from direct light. Due to the low overall amplification, or sensitivity of such photocontrols, the level of phototube illumination required is high, being of the order of five to twenty-five-foot candles. As a consequence, in order to insure reliable operation, direct illumination by the light source is resorted to in these instances.

Where the photocontrol is required to operate from reflected light, or from very low illumination levels, the designer applies additional amplification to the variation of phototube load resistor voltages. A static photocontrol utilizing pre-amplification is shown in the schematic diagram of Fig. 3. This photocontrol functions with a decrease in phototube illumination level, and will operate reliably with light levels of the order of one-tenth of a foot candle or less.

The normal illumination level on the phototube *1* of Fig. *3* is so adjusted that the voltage across the resistor *3* exceeds that existing between the slider arm and the negative terminal of potentiometer *4*. This places the control grid of the pre-amplifier pentode *2* positive with respect to its cathode, and the tube draws an appreciable plate current through the plate resistor *7*. The voltage appearing across this resistor then exceeds that across resistor *6*, placing the plate of the pentode negative with respect to its screen grid. Since the control grid of the thyratron *12* is connected to the plate of the pentode in series with the grid current limiting resistor *8*, and the cathode of the thyratron is effectively connected to the pentode screen grid, we see that the grid of the thyratron is negative with respect to its cathode, and the thyratron does not conduct.

A decrease in the illumination on the phototube results in a decrease in the potential appearing across resistor *3*, placing the grid of the pentode negative with respect to its cathode, cutting off its plate current. Since the voltage across resistor *7* is now zero, the plate of the pentode, and therefore the thyratron grid, is positive with respect to the pentode screen grid. Thus the thyratron conducts, causing the relay contacts *9* to close.

Since thyratron plate voltage is secured from winding *14* of the power transformer, the relay coil *13* operates from half-wave rectified a-c. In this case, the relay will be found to be equipped with a short-circuited *shading* coil which lags the collapse of the relay magnet field enough to prevent armature chattering.

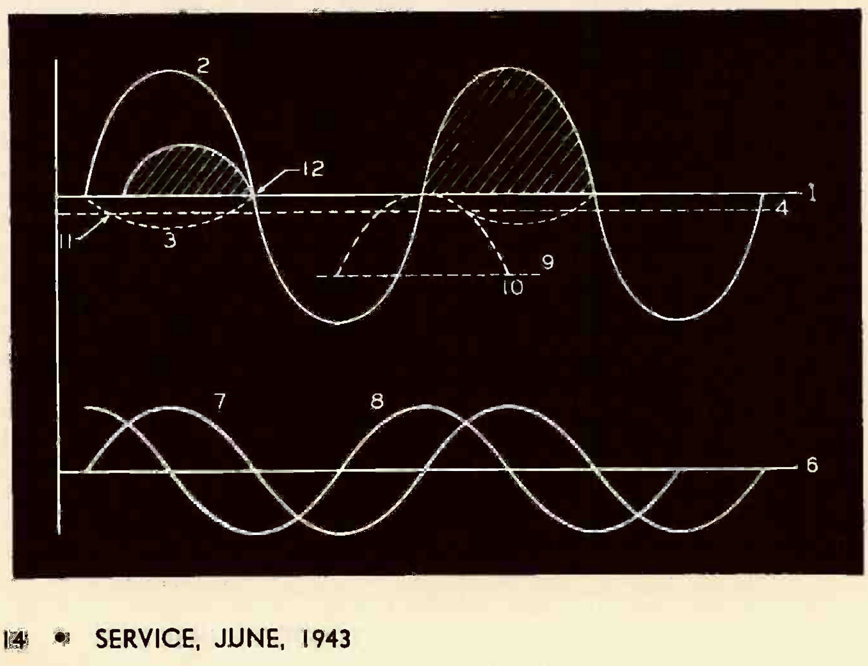
An increase in the illumination on the phototube will obviously cause the control grid of the thryratron to swing negative with respect to its cathode once more. The latter will cease to conduct on the negative half-cycle of the a-c wave succeeding the negative thyratron grid swing.

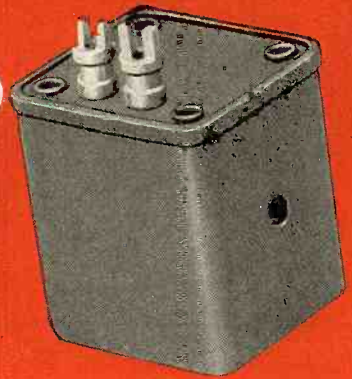
The phase-shifting circuit consisting of resistor *19* and capacitor *20*, operating from the center-tapped winding *16* of the power transformer is a peculiarly advantageous feature found in Westinghouse photocontrols. The function of this circuit is interesting and in the case of the more sensitive photocontrols, will be found to be of great importance.

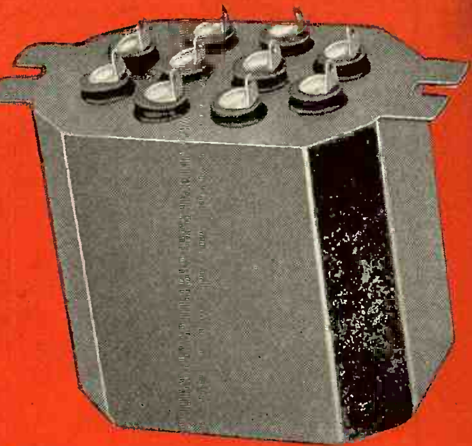
Since windings *14* and *16* of Fig. 3

(*Continued on page* 20)

Fig. 4. An explanation of voltage phases when using the thyratron. (See page 20.)







DRAWN . . . . .
DIE CAST . . . .
FORMED . . . . .
MOLDED . . . .
EXTRUDED . . . ?

No one type of housing structure is suitable for all transformer applications. UTC units are housed in structures ranging from heavy sand castings to bakelite cases made in 30 cavity molds. A few structures, with their relative advantages for specific functions, are illustrated below.

This unit is a tunable inductor in a die cast housing. The casting itself incorporates facilities for the internal mounting of the unit, mounting of the terminal board, tapped mounting facilities, and tapped set screw hole. The only screw used in this entire item is that for setting the inductance.

Drawn round cans are ideal for many applications. The type illustrated effects small base dimensions with screw mounting. The cylindrical shape lends itself ideally to hermetic sealed units.

Drawn octagonal cans are simple in construction, and effect a minimum of volume. The two hole flange type mounting permits the construction of a unit poured with compound, having the same overall and mounting dimensions as an equivalent open channel mounting unit. Four hole mounting octagonal cases are used where additional mounting strength is required.

The extruded can used on the now famous UTC Ouncer unit affords submersion test construction a minimum of weight, and sufficient metal thickness in the base opposite the terminal board for tapped mounting holes. Pioneered by UTC, the Ouncer unit is probably the most popular item in aircraft communication equipment.

May we design a unit to your war application?

UNITED TRANSFORMER CO.

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SER-CUITS

By HENRY HOWARD

PORTABLE receivers designed for a-c or d-c line operation are receiving the major portion of interest this year, now that batteries for many portables are unavailable. The line-powered receivers feature many unusual circuit elements.

The battery tube filaments in the Knight B-17109, Fig. 1, for instance, are operated in parallel from a 1.5 volt A battery and are switched in series in the cathode circuit of the 50L6GT for line operation. The 3Q5GT battery power tube is not used in line operation. The output transformer primary is tapped to match impedances of both power tubes, the 3Q5 feeding the entire primary and the 50L6 being tapped down.

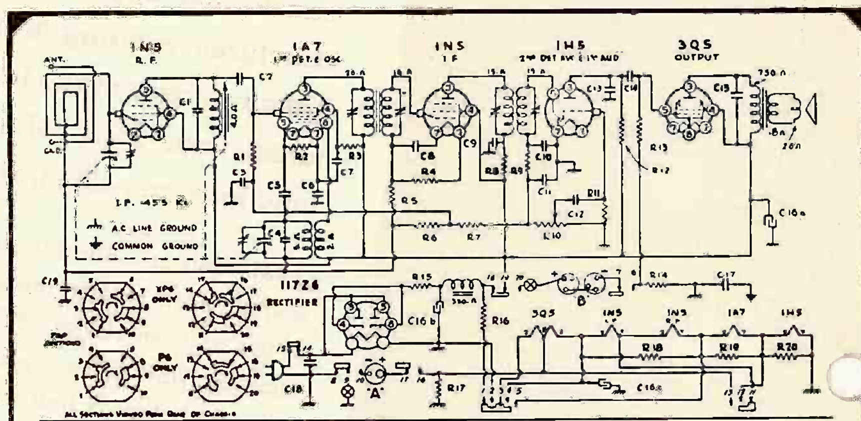
The receiver has a genuine tuned t-r-f stage with a 3-gang condenser. A tuned-plate oscillator circuit is employed, with the grid coil functioning as a tickler.

Admiral P6-XP6

Fig. 2, Admiral P6-XP6, shows a well designed single band 3-gang portable with a t-r-f stage. Only two condensers are used, however. The third element is a variable inductance coil in the plate of the r-f stage for first detector tuning. This shunts a fixed silver .000367 mfd mica of close tolerance.

The avc circuit is exceptionally well filtered, separate decoupling circuits being used in each of the three stages fed by the avc bus. This is insurance against oscillation or other instability due to coupling from a common impedance element. A 117Z6 rectifier with both diodes in parallel feeds the series filament string through a filter choke and surge suppressor resistor of 22 ohms, and a 2,150-ohm voltage dropping resistor.

Fig. 2. Admiral P-6-XP6, with an exceptionally well-filtered avc circuit.



Late Model. In model P6 only, switch points 6, 7, 16, and 17 are not used. Power switch in line position. Common ground is chassis ground

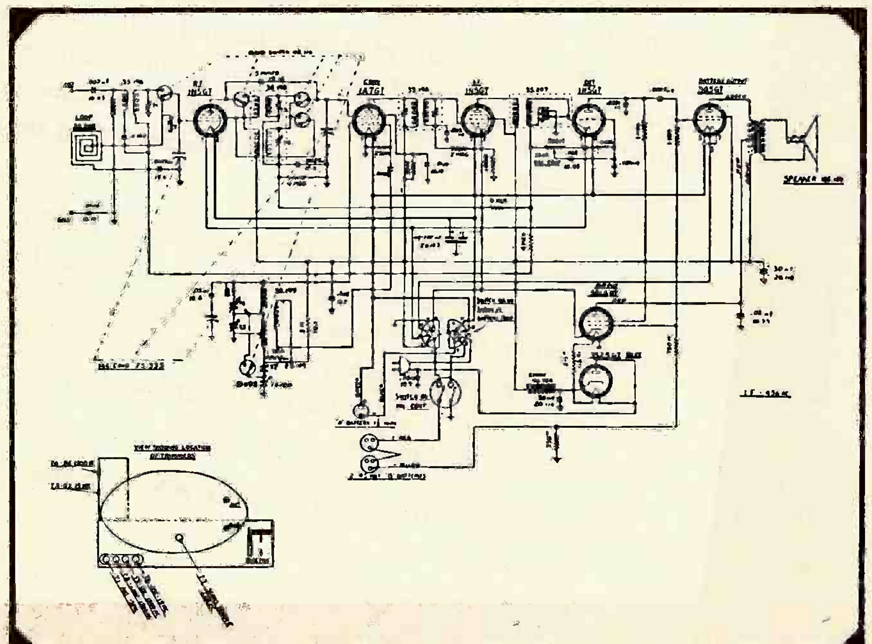
CONDENSERS

No.	Ohms	Watts	No.	Ohms	Watts
R1	100,000	½	R11	15,000,000	½
R2	200,000	½	R12	1,000,000	½
R3	5,000,000	½	R13	2,000,000	½
R4	5,000,000	½	R14	400	½
R5	5,000,000	½	R15	22	½
R6	5,000,000	½	R16	2,150	5
R7	3,000,000	½	R17	3,000	½
R8	5,000	½	R18	500	½
R9	70,000	½	R19	200	½
R10	1,000,000	V.C.	R20	110	½

RESISTORS

No.	Capacity (Mfd.)	Volts	No.	Capacity (Mfd.)	Volts
C1	.000367	Silver Mica	C11	.0001	Mica
C2	.00025	Mica	C12	.01	400
C3	.01	400	C13	.00025	Mica
C4	.000015	Mica	C14	.01	400
C5	.00005	Mica	C15	.002	600
C6	.25	200	C16a	40.	150
C7	.01	400	C16b	30	150
C8	.01	400	C16c	100	125
C9	.05	400	C17	.1	400
C10	.00005	In I.F. Can	C18	.05	400
			C19	.05	200

Fig. 1. Knight B-17109, with its battery tube filaments operated in parallel from a 1.5-volt A battery.



Farnsworth CT-60

Another 3-gang portable, Farnsworth CT-60, is shown in Fig. 3. In this set only two stages, the r-f and converter, are fed avc. The r-f stage has a decoupling filter. The i-f stage uses a 5-megohm grid leak. In addition it receives a fixed bias from the tube below it, in the series. This receiver also uses the 117Z6, in a circuit similar to the Admiral P6-XP6.

Airline 14WG-575

One battery set that has no dry battery worries in this batteryless year is the Airline 14WG-575, Fig. 4, designed for 6-volt storage battery and a-c operation. This is a 5-tube table model unit with a battery consumption of 2.2 amperes at 6.3 volts. It is rated at 32 watts at 117 volts a-c. Power output is from 0.5 watt with 1.0 watt maximum. All tubes, including the power tube (6G6G) are of the low drain 150 milliampere class for battery economy. An external antenna and good ground are required, the ground being especially helpful in reducing noise when battery operated.

Knight 6CH5

An interesting auto set, Knight 6CH5, is shown in Fig. 5. Provision is made for coupling either a high capacity antenna or a low capacity one in an efficient manner, at points marked *HC* and *LC* respectively. The high capacity aerial has a lower impedance and therefore is tapped down on the primary, whereas the low capacity, high impedance aerial uses the full primary. A 30 mmfd condenser between the primary tap and secondary tap provides additional capacity coupling.

High capacity antennas are here considered to have a capacity of around 200 mmfd to ground. This is approximately the value of a typical 60-inch shielded cable lead-in, plus one of the following types of aerials . . . running board, built-in roof aerial in fabric top, or above-the-roof antennas close to a metal top. Low capacity antennas have a capacity of around 70 mmfd, which includes a 30-inch cable and a low capacity aerial of the fish pole, door hinge or top-of-roof type, running well away from the top. Several 1936 cars built by Chrysler have a steel roof insulated from the car body which, when used as an antenna, has a capacity of about 1,500 mmfd. This is too high for satisfac-

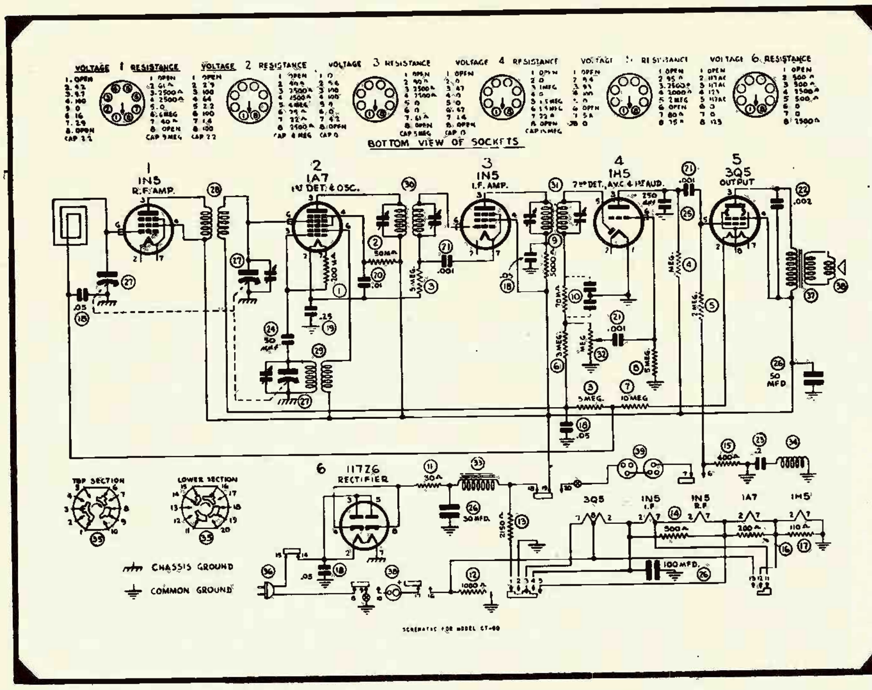


Fig. 3. Farnsworth CT-60 portable with a 117Z6 rectifier feeding a series filament string.

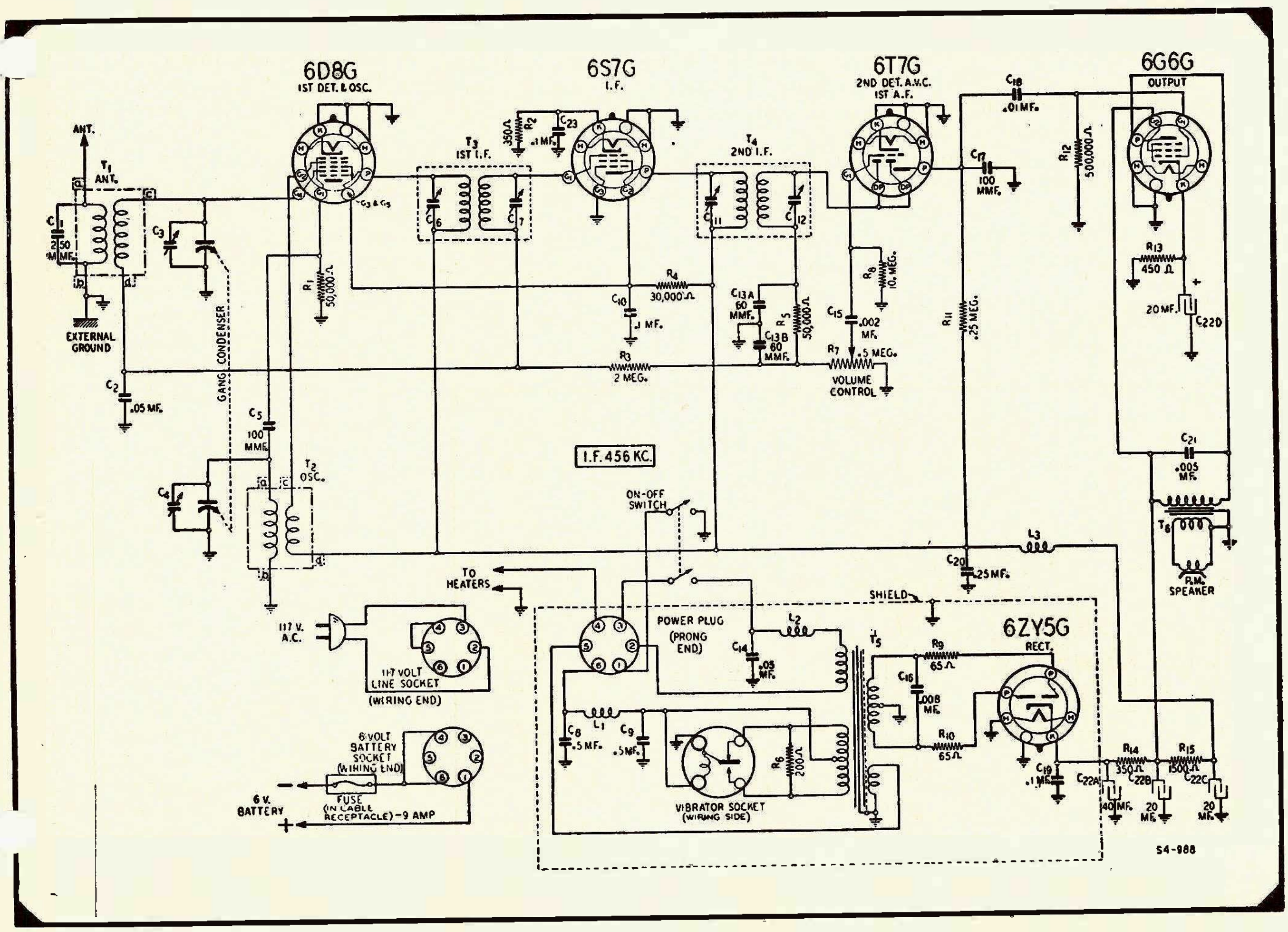


Fig. 4. Airline 14 WG-575 designed for 6-volt storage battery and a-c operation.

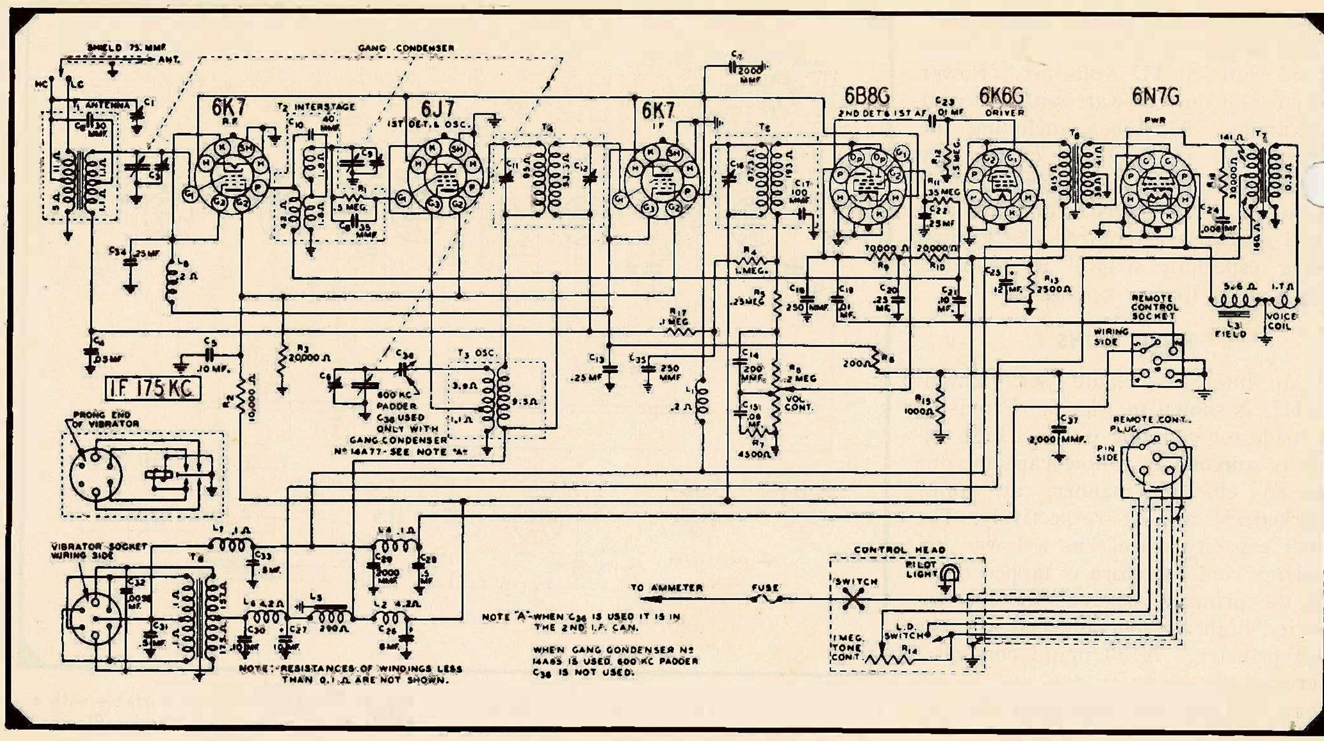


Fig. 5. Knight 6CH5, with provision for coupling a high or low capacity antenna.

tory results. Short aerials of these types can be considered as generators. They have internal impedances equal to their capacity reactance, with the lead-in cables acting as a shunt capacitance. The cables therefore shunt plenty of signal to ground. It is therefore important to keep them as short as possible. A flat top added to a vertical section of an aerial lowers the effective internal impedance and, therefore, reduces the shunting effect of a given cable capacity. This provides more signal for the receiver.

For door hinge and top-of-roof antennas, the lead-in must be shielded for the entire distance, from the receiver to the point where the lead penetrates the car body. Since, for running board antennas, the shielding must run all the way to the antenna, the performance is never too satisfactory.

Inductive-Capacitive Coupling Used

In the Knight 6CH5 receiver the local-distance switch shunts a 1,000-ohm resistor in the r-f and i-f cathode return, thereby decreasing the grid bias and providing greater gain. This switch is operated by a special wing knob behind the tuning knob. The r-f to detector interstage coupling has a combined inductive and capacitive system similar to that in the antenna transformer, or from r-f plate to center tap of the secondary. This arrangement produces a sharply tuned circuit. The i-f amplifier uses 175 kc which feeds a 6B8G diode-pentode, 6K6G driver and 6N7G power stage.

Farnsworth CT-63

Fig. 6 shows a dual band a-c d-c receiver, Farnsworth CT-63 and 64, using 6-volt, 150-ma 6SS7 tubes for r-f and i-f amplifiers. A low impedance short-wave loop is provided in addition to the usual broadcast loop. External antenna coupling is obtained with a separate aerial input transformer. The detector stage is untuned, but a peaking coil is utilized in the r-f plate and an i-f wave trap is connected between the signal grid and oscillator grid. The trap consists of two coils and the capacity between them, acting as a series circuit.

Philco 42-350

A f-m/a-m combination receiver, with many features, is shown in Fig. 7. It is the Philco 42-350, 7-tube, 3-band job. Two XXL triodes are used for converter and oscillator; two 7V7 pentodes for the two i-f stages, and an XXFM double diode-triode is used for the detector and first audio. A low impedance loop is connected to a tap on an iron-core antenna autotransformer. The first and second i-f transformers have a single primary and two secondaries, one for 455 kc and the other for 4.3 mc for f-m. The third i-f transformer has two primaries and really two entirely separate detector circuits, one f-m and one, the usual diode a-m.

Knight 390

A strange array of tubes is employed in the Knight 390, 8-tube recorder

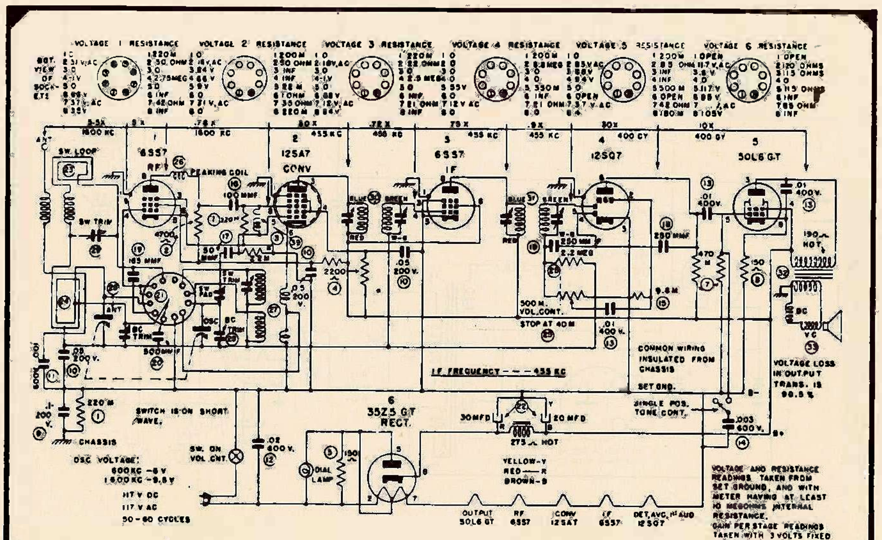
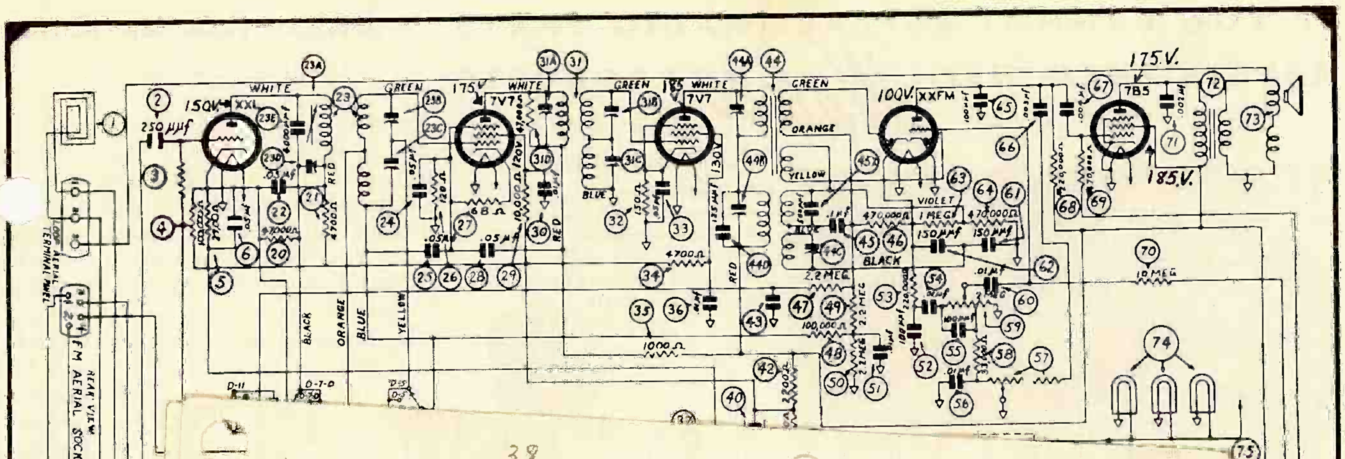


Fig. 6. Farnsworth CT-63 and 64 dual band a-c/d-c receiver using 6-volt 150-ma tubes.



42-350

op	Sig gen.	set	dial	Rec cont set	Comp. adj	Sp. inst
1	2 IF FM in	4.3 MC	580	Vol. max FM	44C note D 44A " E	
2	1st IF FM in	4.3 MC	580	B5 FM	31A 31B note F	
3	High side to #1 grid to #2 of FM sock.	4.3 M.	580	"	23D 23C " "	
4	test loop & dipole	48.5	85 note G	"	15 note G	roll TC on 15C (B)
5	" "	48.5	85	"	15C " H 15 sec.	

D - min sig on 44C

E - Sig gen 125 KC belo 4.3 MC (4.17) then 125 KC above (4.42) Sig. peaks equal in reading equally spaced in freq. each side of 4.3. If unequal 44A is readjusted. O reading on O.P. if OK. Sig shows readj 44C to zero then readj 44A as per above.

F - Adj 31A 31B 23C 23D for equal sig & equal freq. each side of 4.3 Mc.

G - Dial scale Nos. in 1/100 of Mc. less 1st digit ie 49 Mc is 90, 48.5 is 85. set dial pt. 690 on scale (FM) Adj 15 for min sig.

H - To adj. 15C set sig gen. 125 KC above or below 49 Mc (48.875 Mc or 49.125 Mc) adj 15C to max as per note B

ant Sw4
10
FM

In schematic
15A should be 11
11B " " 15A
11 " " 11B

12 mf. filt in p in place of 4 mf

V4 B5 44A 44C 44B
2n IF. FM in 31C 31A 31B V7
1 IF FM in 23D 23A 23B 23C V7
15C 15B 15A 15
11B HA 11

270 27
7B5 10 Meg XXFM
FM
FRONT - TOP

oper	Sig gen	set		Rec	adj in ord	op. inst
1	high side to #1 on loop panel .1a	455	580	Vol max. Brdcst	44B 31C 23A 23B	
2	wire loop	1500	1500	"	15A 11B	note A
3	" "	580	580	"	11	Roll (B) turn end.
4	" "			same as op. #2		
5	" "	15 Mc	15 Mc	SW	15B HA	C

A - Set point at extr. l. index line (cond closed)

B - 1st osc comp. vary TC for max again vary comp for max vary TC again

C - Adj 15B to 2nd peak from closed. 11A on 1st peak as per B

Fig. 7. Phi... tion receive... connected ...

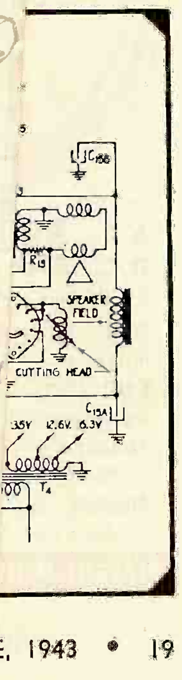
...ny existing ...ould never be ...r.

model, sho... transformer... 35-volt fila... taps at 12... switched ... 6U5 eye ... indicator. ... accomplish... series wit... necessary ... recording ... back from ... prevent a...

A low ... ing coil, ... former d... layed avc ... ceiver. ... contact p... which su...

Extre... or more ... is rece... caution ... safety. ... while i...

...rder-receiver, ...ilament wind- ...6.3 volts. To ...cording head, ...om speaker to ...vent acoustic ... has been in- ... voice coil.



PHOTOCONTROL SERVICING

(*Continued from page* 14)

are wound on the same core and in the same direction, the upper terminals of each of these windings will be of the same a-c polarity at any gi[illegible] instant. Thus, the voltages across these windings are in phase, (Fig. 4), *2* being the voltage across winding *14* and *8* the voltage across winding *16*. Since the current through capacitor *20* leads the voltage across it by 90°, the voltage across the junction of resistor *19* and capacitor *20*, and the center-tap of winding *16* lags the voltage across the lower half of winding *16* by 90°. The voltage appearing between the condenser-resistor junction and center-tap of winding *16* is shown as voltage *7* in Fig. 4. It may be seen that this voltage leads the winding *16* voltage, and therefore winding *14* voltage by 90°.

This factor assumes importance when the characteristics of a-c thyratron operation are considered. As the plate-to-cathode voltage of the thyratron rises, the negative bias required to prevent conduction by the tube also rises. This is termed the critical grid characteristic of the thyratron, and is shown as voltage *3* in Fig. 4.

If, in Fig. 4, *1* is the cathode voltage level of the thyratron, and *4* is a steady-state d-c biasing voltage on its grid, the tube will *fire* at point [illegible] since the grid voltage at this point is too small to hold the tube non-conductive. The portion of the half-cycle conducted by the thyratron may then be measured as a function of the time elapsing between points *11* and *12*, which is less than a full half-cycle. It follows that such current flow may be insufficient to hold the control relay in series wtih the thyratron plate in the sealed position, resulting in relay chattering.

Introduction of the phase-shifted voltage *7* in series with the negative grid biasing voltage, insures the conduction of a full half-cycle by the thyratron, indicated by the position of the voltage wave *10* in Fig. 4. Here, it is seen that the thyratron may not conduct at any other position than the beginning of the half-cycle, since the grid voltage swings negative at any point other than the start of the half-cycle, thus insuring delivery of full half-waves with the approach of the zero grid-to-cathode voltage state.

Service and repair of photocontrols will present something of a problem to the Service Man. Phototube loading resistors, such as resistor *3* [illegible] Fig. 1, may range between one and fifty-megohms, which places the measurements of these circuits far beyond the scope of the average vacuum tube voltmeter. A simple expedient for arriving at the condition of the phototube circut involves the voltage across battery *4* of Fig. 1. If this voltage is replaced with a convenient-ly variable d-c voltage source, it is possible to vary this voltage so that the difference in two positions of this voltage, with respect to two different phototube illumination levels as read with a photographic light meter, may be taken as an indication of the voltage change across resistor *3* with change in phototube light level. This holds true, since the point at which the control grid of the amplifier tube swings positive is a fixed value. The quotient of this voltage difference to lumen difference on the phototube establishes the phototube current. If this current does not agree with the characteristics of the tube as given in the tube manufacturer's data, then the phototube is defective, or its anode-to-cathode voltage is incorrect.

Dust Films

A particular bugaboo of photocontrol operation lies in dust films collecting inside the apparatus across the components. Due to the very high resistance of the phototube loading resistor, the conduction paths offered by dust films may result in such a low phototube loading resistance that insufficient voltage to swing the control grid of the pentode follows. Again, dust film between the cathode of the phototube and one of the highly positive voltage terminals may be of sufficient conductivity to maintain the control grid of the amplifier pentode positive with respect to its cathode. Under these conditions, the photocontrol would be completely inoperative. In the first case, it would be impossible to cause the photocontrol relay to seal. In the second, it would be impossible to cause the photocontrol relay to unseal. The remedy lies in a thorough cleaning of the phototube system. Suction removal of the dust accumulation is most highly recommended, to be followed with a thorough cleaning with a brush having stiff bristles. Use of liquid cleaners results, usually, in the sealing of a thin dust layer beneath a coating of the cleaner.

Where accumulation of dust in the photocontrol is prone to be rapid, the unit should be thoroughly dustproofed. Better still, the manufacturer of the unit should be contacted for a suitable dust-proof housing.

Numerous photocontrols are installed in industrial locations, where vibration conditions may be severe. Examples of such installations include units functioning to count the passing packages on a production conveyor, observation of boiler gauge water lev-

TO HIT 'EM H-A-R-D-E-R

THE year 1943 promises to be the grimmest, hardest year this country has ever faced. Every effort, and every dollar of national income not absolutely needed for existence, should go into war work and War Bonds.

In the Pay Roll Savings Plan, America finds a potent weapon for the winning of the war—and one of the soundest guarantees of the preservation of the American way of life!

Today about 30,000,000 wage earners, in 175,000 plants, are buying War Bonds at the rate of nearly half a billion dollars a month. *Great as this sum is, it is not enough!* For the more dollars made available now, the fewer the lives laid down on the bloody roads to Berlin and Tokio!

You've undoubtedly got a Pay Roll Savings Plan in your own plant. But how long is it since you last checked up on its progress? *If it now shows only about 10% of the gross payroll going into War Bonds, it needs jacking up!*

This is a *continuing* effort—and it needs *continual* attention and *continual* stimulation to get fullest results.

You can well afford to give this matter your close personal attention! The actual case histories of thousands of plants prove that the successful working out of a Pay Roll Savings Plan gives labor and management a common interest that almost inevitably results in better mutual understanding and better labor relations.

Minor misunderstandings and wage disputes become fewer. Production usually increases, and company spirit soars. And it goes without saying that workers with substantial savings are usually far more satisfied and more dependable.

And one thing more, these War Bonds are not only going to help win the war, they are also going to do much to close the dangerous inflationary gap, and help prevent post-war depression. The time and effort *you* now put in in selling War Bonds and teaching your workers to save, rather than to spend, will be richly repaid many times over—now and when the war is won.

You've done your bit ★ Now do your best!

This space is a contribution to victory today and sound business tomorrow by SERVICE els, and positioning of wrapper label impressions on candy wrapping machines. Since pentode amplifier tubes are numerous in photocontrol applications, these often present a source of trouble. In the circuit of Fig. 3, a noisy pentode will cause the thyratron to fire spuriously, due to the voltage impulses appearing across the resistor 7. Such a condition would be tantamount to a catastrophe in candy wrapping machine operation. Procedure for location of the trouble in such an instance is rather simple. A high resistance a-c voltmeter or output meter is clipped across resistor 7 of Fig. 3, and the phototube removed from its socket. Tapping the pentode envelope, if the tube is noisy, results in swings of the output meter indicator hand. A confusing condition appearing similar to amplifier tube noise results if the phototube excited lamp is microphonic. Here, noise voltage impulses do not occur if the phototube illumination is cut off, or if the phototube is removed from its socket. Tapping the light source housing will immediately reveal the trouble, however. Proper procedure in this case indicates lamp replacement, or, if vibration is severe, the mounting of the light source on a shock-absorbing housing.

A word of caution with respect to phototubes should be of value here. Vacuum phototubes will be found operating from plate voltage supplies as high as 500 volts, and little electrical trouble will be encountered with this type, with the possible exception of dust film troubles. However, in the case of gas-filled phototubes, extreme care should be taken to see that the voltage across the phototube does not exceed ninety volts. Rise of the phototube supply voltage in the case of a gas phototube, above the ninety-volt level causes the gas to ionize, and the sensitive cathode coating is destroyed.

Other aids to the radio Service Man in connection with electronic equipment service include a thorough study of a-c and d-c power circuit wiring. This is especially true of motor circut connections, since photocontrols are sometimes installed and so connected as to operate an integral power motor, which performs the final operation, such as the automatic opening of a surgical room door. Study in the proper placing of limit and repositioning switches will result in increased revenues.

In concluson, since the servicing of electronic equipment in general leads to the handling of power wiring and circuit layout, an intensive study of the National Wiring Code will not be amiss, often saving return calls which are due to objections of insurance company wiring inspectors. Customer good will and resultant increased revenue will often result, too, if the client is reminded of requirements anent installations in the proximity of explosive gases and vapors, and ever-present paraffin pots.

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Our country is at war. On the home-front, it is your obligation, small enough surely, to keep your industry functioning smoothly "for the duration".

NEWS OF THE REPRESENTATIVES

At the last meeting of the MidLantic chapter, announcement of the retirement of the Philadelphia area *Rep* Milton Shapp for the duration to enter the armed forces was made.

The MidLantic chapter also reports the acquisition of a new member, J. H. Benge, 6710 Hollis St., Philadelphia, Pa.

Verner O. Jensen, Seattle, Wash., is now doing business under the name of Verner O. Jensen Co. with offices at 2607 Second Ave., Seattle.

The June meeting of the Mid-Lantic Chapter of *The Representatives* was held June 1 at the Engineer's Club, 1317 Spruce St., Philadelphia. The following new members were elected. . . . Charles Fryburg, 402 Cherry St., I. R. Blair, 1418 Walnut St., Robert Williams, Lincoln-Liberty Bldg., all of Philadelphia.

SERVICING TODAY

(*Continued from page* 11)

tion of standardized types. This is evidenced by a recent letter which, in brief, states . . . "We have always been adversaries of endless duplications. Give us enough *standardized* parts and we're good enough to make our own way from there!"

Since standardization offers the only answer to the problem of maintaining civilian receivers without further complicating production of already hard-pressed manufacturers, the contribution of *real ability* on the part of our Service Men is most welcome. Without it, any attempt to standardize would be doomed to failure. With it, there is a definite contribution to the war effort.—***Sylvan A. Wolin, Sales Manager, Solar Capacitor Sales Corporation.***

QUITE aside from the functions of bringing news and entertainment, civilian radio has proved to be one of our most effective weapons in carrying on the war. Recruiting, conservation, defense bonds, and many other campaigns of national importance lean heavily on radio for their success. Beset by shortages in manpower and materials the radio service industry has done an amazing job.

It is true that the manufacturing facilities of suppliers of radio components are devoted largely to war work. As a result, deliveries of component parts for civilian use have been limited. However, certain parts are now available in reasonable quantities. Some parts are still on the critical list and the situation with respect to radio tubes is extremely serious.

The civilian tube capacity of the several manufacturers is limited by the volume of war business which takes precedence and is beyond the control of the manufacturers. Yet it seems reasonable to believe that there will be a growing recognition on the part of the Government of the importance of civilian radio and that, in cooperation with the military plans, every effort will be made to improve the present situation.—***R. P. Almy, Manager, Distributor Sales, Sylvania Electric Products, Inc.***

ELECTRONICS, the new art of harnessing what you have known up to this time as the *radio* tube to *new applications,* means everything to your servicing future!

Big as the radio and communications industry has been, it is only *one phase* of electronics. Hitherto your opportunities have been practically limited to that one phase—transmission of sound. At the start of the war, television—transmission of sight—was just opening up.

When the war is over and television comes along, *it won't be alone.* Electron tubes will be put to work on thousands of *new jobs.*

In the future, RCA electron tubes may be destined not only to hear and see, but to taste, smell, touch, count, measure, calculate, analyze . . . prevent accidents, control machines, traffic, diagnose disease, sooth pain, heal injuries, kill germs, catch criminals, simplify and increase production in an endless variety of industrial applications. There will be profitable work for electron tubes to do in every plant, shop and office in your community.

No matter where or how these RCA electron tubes are used—or in what devices—their operation will all be basically dependent upon radio-electronic circuits, governed by radio principles familiar to *YOU* as a Service Man.—***L. W. Teegarden, Radio Corporation of America.***

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BUY UNITED STATES WAR SAVINGS BONDS AND STAMPS EVERY PAY DAY

REDUCING AUTO-RADIO NOISE

By BARRY KASSIN

Assistant Editor

MOTOR noise in cars has always been a problem. And today with new cars and equipment, not available so readily, the problem becomes quite a major one.

To reduce motor noise to a satisfactory level in most cars, the following procedure is recommended:[1]

Generator Condenser

A generator condenser is required in all cases. The condenser lead should be connected to the battery terminal of the generator. The case and the mounting strap should be connected to the other side of the condenser to ground. This unit must, therefore, be well grounded at its mounting.

In cars with automatic regulators, it is important not to connect the condenser across the field terminal. Most manufacturers have a recommendation for the proper post at which to connect the condenser.

Distributor Suppressor

A distributor suppressor will be required in most cases. The high tension lead to the distributor should be removed. A distributor suppressor should then be inserted and the wire connected to the other end of the suppressor. If this is not practical, the high tension lead should be cut close to the distributor and a wood screw, end type distributor suppressor, used in this line.

If motor noise is heard, with the antenna cable plug withdrawn, first try grounding to the fire wall, all cables and tubing which pass through it, such as oil lines, gas lines, etc. By means of a file, contact can be established between any of the lines and the fire wall in order to determine whether such a ground will reduce the noise. To bond the cables to the fire wall, the point of contact should be cleaned and a length of braided shielding wrapped around the cable. This connection should be soldered. Then the end of the shielding should be soldered to the fire wall or grounded under a screw head, if one is convenient.

Bonding Shielding

Sufficient play should be left in the bonding shielding so that movement of the cables or tubing will not loosen the shielding from the fire wall.

It is possible for the steering column, foot pedals, and brake lever to carry interference to the back of the fire wall at which point it may affect the radio. See if each of these items is well grounded to the frame of the car. By means of a file or braided shielding jumper, contact can be established between any of these items and the frame to determine whether or not such a ground will reduce the noise. A piece of one-inch braided shielding should be used if such a ground is necessary. This shielding may be grounded under a screw head, nut or may be soldered into position.

If motor noise is heard when the antenna cable is reconnected, additional noise reduction steps can be taken. For instance, noise due to radiation from the dome light lead is generally experienced only when a roof antenna is being used. The dome light lead connection at the back of the instrument panel should be disconnected and grounded. If this is found to reduce the noise considerably, interference is being radiated by the dome light lead. Reconnect the dome

(Continued on page 29)

NEWS

NEW UTAH VICE-PRESIDENTS

Oden F. Jester, Austin Ellmore and Remy Hudson were elected vice presidents of Utah Radio Products Company, Chicago, Ill.

Mr. Jester, now vice president in

charge of sales, has been with Utah for the past six years as general sales manager.

Mr. Ellmore, now vice president in charge of engineering, has been chief engineer of Utah since 1938.

Mr. Hudson will be in charge of post-war planning.

* * *

MUSIC AND MANPOWER

An exhaustive and authentic study of music as a production factor appears in a 24-page book on *Music and Manpower,* released by Operadio Manufacturing Company, St. Charles, Illinois.

Treating the subject historically and currently, the book presents data that will be extremely useful to production executives.

Although only a limited edition has been printed, a copy will be sent gladly to any executive.

* * *

NATIONAL UNION WARTIME TUBE SUBSTITUTION CHART

A wartime tube substitution chart compiled by the sales engineering department of National Union Radio Corporation, Newark, New Jersey, has just been released.

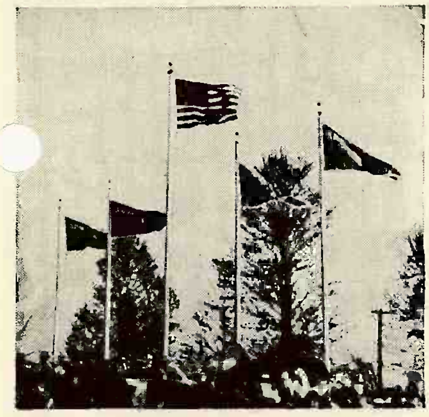
The compilation indicates substitutions of approved Government types for 288 types available prior to the Government limitation order.

Preferred substitutions are shown in each instance and types are coded to indicate necessity of changes such as changing sockets, changing bias, using external shield, using filament shunt, rewiring sockets, etc.

In addition to the interchangeability listing, a functional cross index shows replacement with regard to functional considerations vs. heater considerations.

A copy of the chart may be obtained by recognized Service Men and technicians on request to National Union distributors in local areas.

FOUR RAYTHEON PLANTS WIN "E"



The power-tube, small-tube, radar and equipment division of Raytheon Manufacturing Company of Newton and Waltham, Mass., were each awarded with the Army-Navy "E" recently.

* * *

HIPERSIL CORE BOOKLET

A 12-page booklet describing Hipersil cores has been issued by Westinghouse Electric and Manufacturing Company.

Contained in the booklet are charts of recommended Hipersil applications, performance curves which compare Hipersil and ordinary silicon steels, tables showing complete range of core sizes available, and diagrams of the type C core assembly.

A copy of this new booklet, B-3223, may be secured from the main office in East Pittsburgh, Pennsylvania, or from the nearest Westinghouse office.

* * *

L. G. THOMAS ELECTED IRC V-P

Leslie G. Thomas has been elected vice president in charge of production at International Resistance Company, Philadelphia, Penn.

* * *

LAFAYETTE TRAINING KITS BOOKLET

To aid schools in their government training courses, a booklet describing a variety of kits has been prepared by the Lafayette Radio Corporation, 901 West Jackson Blvd., Chicago, Ill.

Starting with fundamentals and progressing to basic receiver and transmitter operation, a progressive training program may be built up around these kits.

GHIRARDI TROUBLESHOOTER HANDBOOK FOLDER

The expanded 3rd edition of Ghirardi's *Radio Troubleshooter's Handbook* containing 744 manual-size pages of service work data is described in a new 4-page folder just issued by the Radio & Technical Publishing Co., 45 Astor Place, New York City. A listing of the 75 sections in the book also appears in the folder.

Copies of this new folder are available from local radio supply houses, radio dealers and bookshops, or direct from the publishers. Dealers not already supplied can obtain desired quantities, with space for their imprint, free upon request to the publisher.

DR. POWER WINS ARMY PROMOTION

Dr. Ralph L. Power, who formerly operated his own radio advertising agency in Los Angeles, and who became an Army Signal Corps Inspector last year, has been promoted to the grade of Senior Inspector.

* * *

LT. COMDR. RALPH BRENGLE IN NEW NAVAL POST

Lt. Comdr. Ralph T. Brengle, formerly Head of Radio Procurement Section, Bureau of Ships, has been appointed Assistant Head of Radio Division, Bureau of Ships.

Before entering the services Lt. Comdr. Brengle was head of the Ralph T. Brengle Sales Company of Chicago.

(*Continued on page* 31)

Which comes first — Your second helping? or our second front?

YOU WANT TO SEE THIS WAR WON — and won quickly. You want to see it carried to the enemy with a vengeance. Okay—so do all of us. But just remember...

A second front takes food... food to feed our allies *in addition to* our own men.

Which do you want — more meat for you, or enough meat for them? An extra cup of coffee on your breakfast table, or a full tin cup of coffee for a fighting soldier?

Just remember that the meat you don't get—and the coffee and sugar that you don't get—are up at the front lines—fighting for you.

Would you have it otherwise?

Cheerfully co-operating with rationing is one way we can help to win this war. But there are scores of others. Many of them are described in a new free booklet called "You and the War," available from this magazine. Send for your copy today! Learn about the many opportunities for doing an important service to your country.

Read about the Citizens Defense Corps, organized as part of Local Defense Councils. Choose the job you're best at, and start doing it! You're *needed*—now!

Contributed by the Magazine Publishers of America

EVERY CIVILIAN A FIGHTER

MOTOR NOISE

(*Continued from page* 25)

light lead and then connect a .5 mfd bypass condenser between the point at which this lead leaves the pillar post and ground.

Use of .5 Mfd Condenser

Try a .5 mfd bypass condenser from the ammeter to ground. If there is an improvement, this condenser should be installed permanently.

In like manner, you should try a .5 mfd condenser from car fuse to ground, switch to ground, tail light and stop light connections to ground, windshield wiper and other 6-volt connections to ground, noting the effect of these condensers on the noise pick up. A .5 mfd condenser from the "hot" side of the coil primary to ground can be tried also.

Check Electric Gauges

The electric gauges used for oil, water and gas are often a source of interference. Bypass condensers should be tried here.

In some cases the high and low tension leads between the coil and distributor are run close together. In some cars they are in the same conduit. If this is the case, the low tension lead from this conduit should be removed. In any event, the high and low tension leads should be kept as far apart as possible. If separating the two leads is insufficient, the ground of the low tension lead should be shielded.

Grounding Motor

In every case, the motor must be well grounded to the frame of the car. If it is not, a very heavy braided lead should be used for this purpose, similar to a storage battery ground lead. In like manner, it may be necessary to check the grounding of the metal fire wall, instrument panel, transmission, radiator, hood and muffler to the frame of the automobile. To obtain a good electrical connection, it may be necessary to scrape off the paint at the point where ground contact is made.

Peening Distibutor Arm

In extreme cases of motor noise, it is advisable to peen the distributor rotor arm; that is, increase the length of the arm by using a small machinist hammer. This will lessen the gap between the rotor arm and the stationary contacts thus reducing the spark. Be sure, after peening the arm, that it does not strike the stationary contacts.

If motor noise persists, spark plug suppressors must be installed. One suppressor is put on each plug.

Care should be taken that a good mechanical and electrical connection is made between the spark plugs, suppressors and plug wires.

Noise in Wheels

Noise from the wheels or brake is generally experienced only when an undercar antenna is being used. To determine if noise is being caused from this source, the car should be set in motion. Then with the motor shut off and the clutch disengaged, the brakes should be applied. If the noise stops, the source of the static is in the wheels. The use of a front or rear wheel static eliminator will generally end the trouble.

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[1]Knight Radio Notes.

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BUY UNITED STATES WAR SAVINGS STAMPS AND BONDS FOR VICTORY

BEAT-FREQUENCY OSCILLATOR

(*See Front Cover*)

A BEAT-FREQUENCY oscillator is one of the most fascinating, as well as one of the most useful pieces of test equipment. Their circuits are unique, too.

The RCA 68-B unit, for instance, has some very interesting characteristics, including very low distortion over the entire frequency range of 20 to 17,000 cycles, an output voltage independent of frequency up to 25 volts and 125 milliwatts, and three output impedances from a balanced secondary (center-tapped).

The heart of the equipment is the 6J7 fixed and variable low frequency oscillators. Both are of the Dow electron-coupled type, with hot cathode and grounded (at r-f) screen grid and suppressor. The fixer generator is set at 180 kc. It has a tuned-plate circuit and tuned tank circuit which delivers a high signal voltage to the 6C5G push-pull detector. The 68,000-ohm plate circuit resistor provides extra stability. The filament choke also serves in this way.

The variable oscillator tunes from 180 to 163 kc. Unlike the fixed oscillator, the plate load is resistive with no tuning whatsoever. Being variable in frequency, there must be no frequency discriminating circuits to interfere with the desired flat frequency characteristic. A comparatively low signal voltage is fed to the high side of the dual volume control of the detectors. A fixed resistor equal in value to the volume control is placed in each detector circuit to prevent overloading of the oscillators. The detector output is fed through a two-section r-f filter to a push-pull, parallel 6C5 output stage. In order to keep even harmonics at a minimum this stage must be balanced. Thus a milliammeter and switch is provided for checking the cathode currents of each side.

To maintain stability, a beat-frequency oscillator must have a steady plate supply. This unit has a high degree of voltage regulation, provided by a 6J7 d-c amplifier which controls the plate resistance of a 45, which is in series with the positive B bus. A 5Z4 with a choke-input filter supplies the d-c. An 874 90-volt gaseous regulator establishes the cathode and suppressor potentials of the 6J7, while its grid potential is determined from a voltage divider across the d-c output As the potential of the grid changes, the change is amplified and fed to the 45 grid. This produces the proper change in its plate resistance to compensate for the change in output voltage. A 5000-ohm resistor shunts the 45 enabling more current to be controlled. Two 45 tubes in parallel would accomplish the same result, but at a greater cost. A potentiometer in the voltage divider connected to the 6J7 allows a certain amount of adjustment in plate voltage.

A voltage regulated supply such as this has other virtues. Its output impedance is very low. This minimizes coupling between the various stages thus increasing stability. In addition the filtering action is greatly improved, affording a very low level of hum.

The power supply frequency of 25-60 cycles may be used with no change in performance whatsoever. A 6E5 indicator makes use of the supply frequency for calibrating the oscillator, and a 10-mmfd trimmer is provided for calibration adjustment.

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WHEN YOU CHANGE YOUR ADDRESS

Be sure to notify the Subscription Department of SERVICE at 19 E. Forty-seventh St., New York City, giving the old as well as the new address, and do this at least four weeks in advance. The Post Office Department does not forward magazines unless you pay additional postage, and we cannot duplicate copies mailed to the old address. We ask your cooperation.

NEW PRODUCTS

G. E. AIRCRAFT NOISE FILTERS

A new line of radio-noise filters designed for use on aircraft with attenuation characteristics from 200 to 20,000 kilocycles, have been announced by G. E.

The 100-ampere unit weighs approximately only 2 1/5 lb., and measures 5" by 4" by 2½". They can be mount-

ed in any position, and will operate over a temperature range of ±50 C. They are available in ratings of 20, 50, 100 and 200 amperes, d-c, at 50 volts.

Complete information on the filters is contained in bulletin GEA-4098, available on request from General Electric, Schenectady, N. Y.

* * *

LIGHTWEIGHT AIRCRAFT CONTACTOR

A contactor designed for aircraft applications for controlling solenoids and small motors in aircraft has been developed by G. E.

The contactor is furnished in two sizes; 50 amperes and 100 amperes. The 50-amp type is 2 5/16" by 2" and weighs 4¾ ounces. The 100-amp type is 2¾" by 2⅝" and weighs 11 ounces. The unusual lightweight of this contactor is due largely to its balanced armature construction.

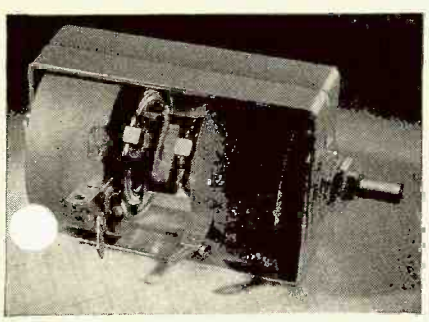
The new contactor is said to be suitable for use at altitudes from sea level to 40,000 feet. In addition, it can be mounted in any position on either a metal or nonmetallic base.

* * *

CLAROSTAT TANDEM POWER RHEOSTATS

Tandem power rheostat assemblies of two or more sections have been announced by Clarostat Mfg. Co., Inc., 285-7 N. 6th St., Brooklyn, N. Y.

These assemblies are made up of two 25-watt or two 50-watt rheostats coupled together and held in a metal cradle. The usual one-hole mounting and locking-projection features are retained. Individual rheostats can be of any standard resistance value, taper, tap and hop-off, and all units go through the same degree



of rotation as the single shaft is turned. The units are fully insulated from each other and from ground.

Because of the wide choice of resistance values and other factors, the assemblies can be made only on special order.

* * *

NEWS

(*Continued from page 27*)

AMERICAN STEEL EXPORT TO HANDLE ZENITH

American Steel Export Co., Inc., has been appointed exclusive export sales representative for Zenith Radio Corporation, Chicago. H. W. McAteer, president of American Steel Export Company, New York, has announced his resignation from the board of directors of Philco International Corporation.

GLASS STRING CARRIES RADIO ANTENNA

A kite string of glass yarn is now being used with a box kite that carries aloft the antenna of a portable, hand-generator, radio transmitter developed by the Army Air Forces to summon help for fliers forced to make crash landings at sea.

The box kite has an ordinary cloth and wood frame with an antenna consisting of very fine copper wire wound around the glass kite string.

Glass yarn can be used as the kite string because of its strength in proportion to its weight, and because it does not rot or otherwise deteriorate from the effects of salt water, tropic sunlight, rain, or dampness. The yarn is twisted and plied from continuous filament glass filters which can be drawn to indefinite length, measurable in miles.

JOTS & FLASHES

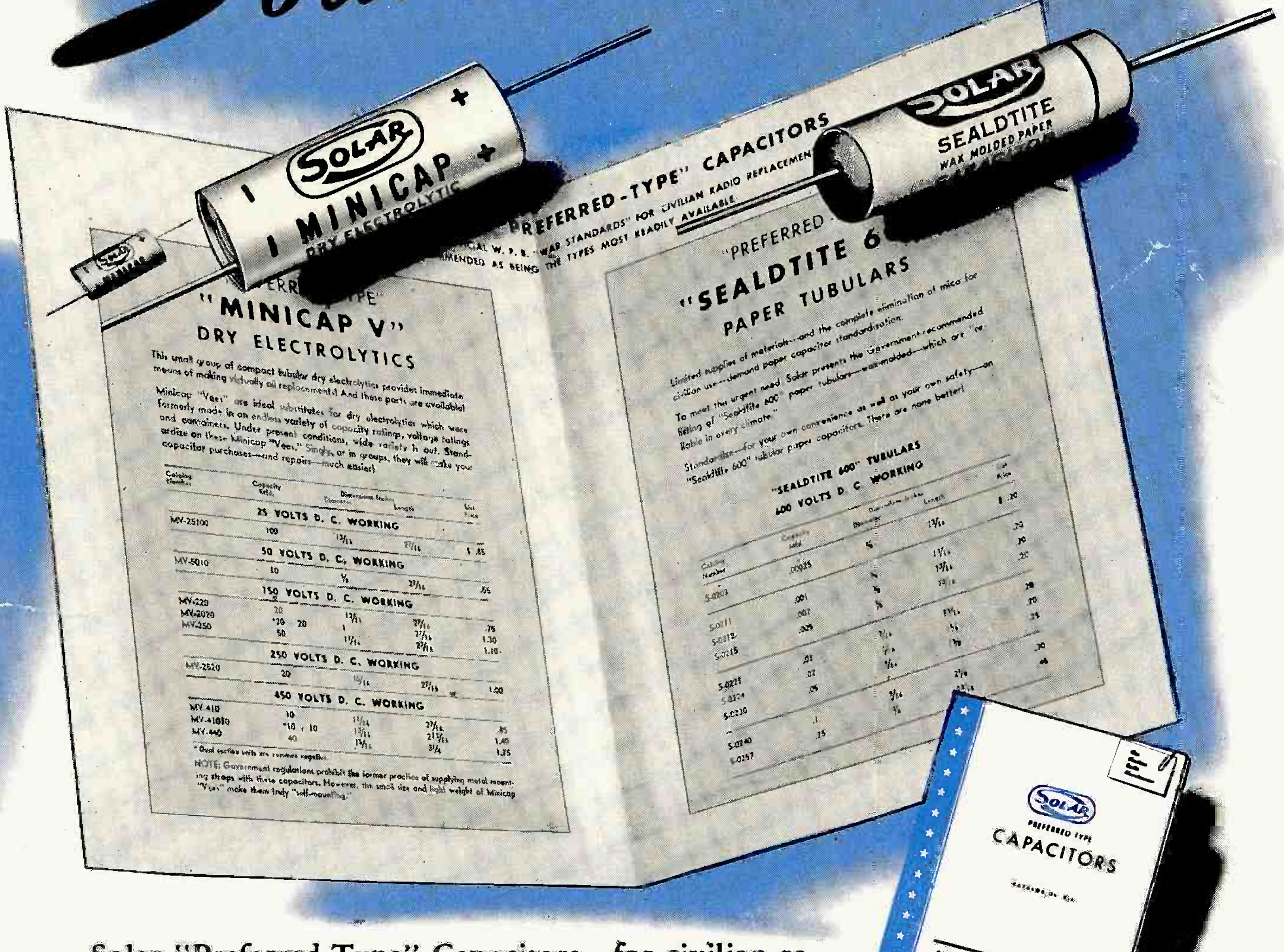
GRIEVED to hear of death of Captain Wm. Sparks, president of Sparton . . . one of radio's pioneers. . . . Lt. Alexander Norden, Jr., vice-president of L. S. Brach Mfg. Corp., appointed executive officer of a squadron in the Civil Air Patrol . . . congratulations, Alex. . . . Dr. Wm. D. Coolidge, vice-president and Director of Research of General Electric awarded *Order del Merito* by the Republic of Chile for his *many services to civilization*. . . . George Barbey re-elected head of NEDA at annual meeting early this month in Chicago. . . . George deserves this honor and more . . . he has done an outstanding job. . . . RMA Annual Convention, a one-day streamlined gathering, a huge success . . . practically all radio manufacturers represented . . . plenty consideration being given to post-war planning . . . we like General Electric's current advertising in national magazines. . . . Solar opens large modern capacitor plant in Midwest . . . that's their third factory. . . . Neville Robinson joins Universal Microphone Co. as production expediter. . . . Bill Giraldin joins cost accounting dept. of same company. . . . *The Hallicrafters Tuner*, a swell morale stimulator for all employees. . . . Zenith Radio wins White Star to add to their Army-Navy "E" pennant. . . . Frederick S. Rowe appointed tube production manager by Westinghouse Lamp Division. . . . Stackpole Carbon advances Henry Dressel to Supervisor of Electronic Components Engineering. . . . Stewart-Warner earns coveted Army-Navy "E" for second time . . . four Army-Navy "E" awards simultaneously given to Raytheon plants in Newton and Waltham, Mass. . . . Lou Shappe and Jesse Wilkes, New York advertising men specializing in radio, form Shappe-Wilkes, Inc. . . . Frank Shipper new supervisor war production division at Universal Microphone. . . . Paul Galvin reelected president RMA. . . . A. S. Wells appointed chairman RMA Planning Board to study industry problems . . . our thanks to all you radio Service Men now with the armed forces for your interesting letters . . . keep sending 'em . . . here's hoping you'll all be back on the job again in the near future . . . and you fellows at home . . . keep buying bonds and contributing all your scrap for the war program . . . the boys at the front need your help.

BUY BONDS
SAVE SCRAP

ADVERTISERS IN THIS ISSUE

SERVICE—JUNE, 1943

Solar "PREFERRED-TYPE" CAPACITORS



Solar "Preferred-Type" Capacitors—for civilian replacements—are available promptly!

"MINICAP V" DRYS: Minicap "Vees" are ideal replacements for dry electrolytics formerly made in an endless variety of ratings and containers.

A *minimum* number of Minicap "Vees" will make a *maximum* number of replacements.

"SEALDTITE 600" TUBULARS: These are the only *wax-molded* tubular paper capacitors available! Wax-molding guarantees reliability in every climate.

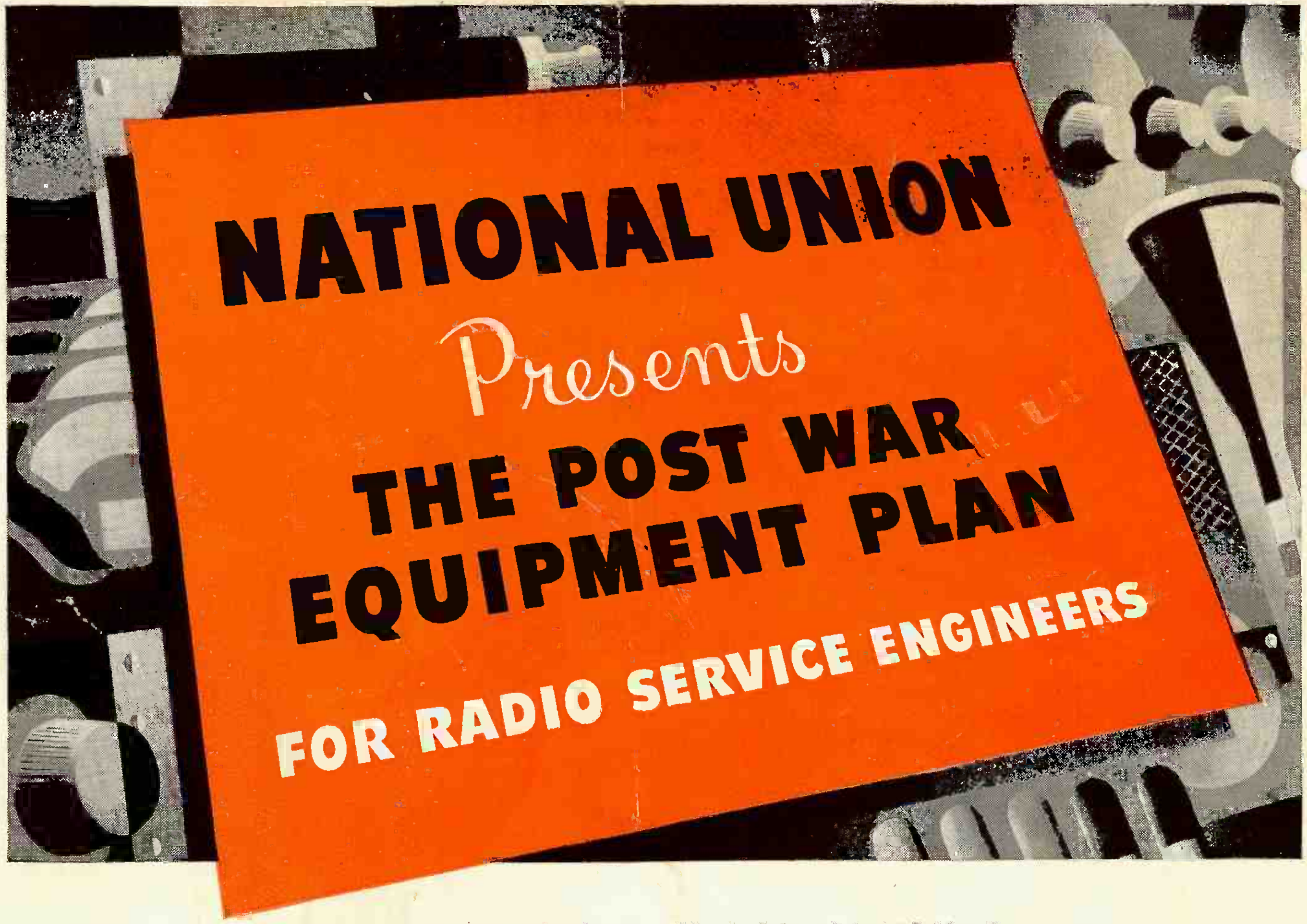
Standardize on these 600 volt working units—for your purchasing convenience—and your safety!

Write for Catalogs V-1 and V-2

Solar SOLAR CAPACITORS

SOLAR CAPACITOR SALES CORP., BAYONNE, N. J.

MAKERS OF CAPACITORS: • ELECTROLYTIC • MICA • PAPER



READY FOR YOU NOW!

IN WAR AS IN PEACE, National Union assists radio servicemen in meeting their problems.

And here's the evidence—a Post-War Equipment Plan—ready *now* to go to work for servicemen.

Here too, is an example of the post-war leadership you can expect of the new and greater National Union being built today to meet the demands of war.

How National Union has doubled and redoubled its production of "fighting" tubes for our Country's fighting men is, in itself, a notable story of war service. New facilities had to be created; new methods had to be developed; new materials had to be employed. At Lansdale, Pa., a quiet country pasture was overnight transformed by National Union into the Tube Industry's most modern plant. And National Union has long contributed a full share to the production of tubes for such secret weapons as RADAR.

In the midst of these war activities, National Union puts into action Radio's first post-war merchandising plan for servicemen—fully explained in a printed folder we will gladly send on request.

Write for this N. U. Post-War Plan today, so you can put it to work immediately. Find out about the advantages you gain from it every day the war lasts.

NATIONAL UNION RADIO CORPORATION

NEWARK, NEW JERSEY — LANSDALE, PENNSYLVANIA

NATIONAL UNION

RADIO AND ELECTRONIC TUBES

Transmitting Tubes • Cathode Ray Tubes • Receiving Tubes • Special Purpose Tubes • Condensers • Volume Controls • Photo Electric Cells • Exciter Lamps • Panel Lamps • Flashlight Bulbs