# SKYWIRE

Earl Fowler

## THE CANADIAN RADIO AMATEURS' JOURNAL


May, 1951

*20 cents*

*Toronto, Ontario, Canada.*

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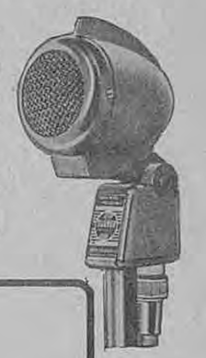

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# SKYWIRE

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*Editor - Fenwick Job, VE3WO*

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May, 1951

SKYWIRE BUSINESS AND EDITORIAL ADDRESS

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# SIDEBANDS

Spring seems to have passed! Day by day, in seemingly ever-increasing quantity, the seasonal rains fell, creating a sea of mire in this relatively new residential district. It created enough of a problem in obtaining supplies of paper and the like, that we were brought up short a few days ago, in starting the May issue of Skywire, with the realization that June will be around in a couple of weeks, and with it, the start of summer activities.

Field Day again will be the most important single item of business during this coming warm weather. Most clubs are already well prepared for the outing having learned, in the past, that equipment must be on hand and well proven in advance, if a good score is the goal. And Field Day is the one big chance for every good operator to show his stuff, whether he's part of the club group, or on his own someplace.

With the announcement that soon we should enjoy reciprocal operating privileges almost anyplace in North America, we can learn the technique of getting out with low power, and operating portable-mobile, on a Field Day type of outing. Once it becomes possible to sign VE3 operating mobile W4 for example, low power experience could be invaluable. If ever there is an emergency, you could be of real assistance, beyond question.

Notice the reference only to low power! Some Field Day operating is in the high power, brute force category, but most is in the low power class where you have to know how to make the most of it, if you want to make a contact, and run up some points. The facts are that the majority of portable-mobilers are low-powered-confined, and some have had trouble getting through the heavy kilowatts.

All of which brings up, as you might suspect, a point. A point which may not meet with your full approval. But an important point nevertheless which today, in view of changed conditions, now definitely needs some altered thinking.

We have portions of bands set aside for the phone men - and CW men - and some for the beginners and the like. Why not grant a very narrow slice of say 10 and 11, 20 and 75 to portable-mobile operation at powers of 50 watts or less. Low powered rigs such as these will be able to buck each other far more effectively this way, and everyone will get out more easily.

Now, before you take gas, and scream in loud protests over this proposed further desecration of our bands, let's look the situation over. First ambition of almost every ham today is to own a car ( to get around to more hamfests and perhaps take the xyl for an outing ) and the second ambition is to have a world beating mobile in that same car.

Once the shoe is on your foot, wouldn't you go along with a meeting place ( frequency-wise ) where you stood a chance?? Sure, and you'd be glad of it when you got down to putting out a CQ.

One tremendous advantage to be gained is in the emergency communications section. A specific piece of each band for mobile or portable operation - even only 15 or 20 kcs in width, could act for us much like the International Distress Frequency of 500 kc. Beyond question, the mobile section would be monitored constantly, and when trouble came along, the ham with it could get it off his hands in the least possible time.

Things have changed a lot in the last fifteen years, and we've had to change with them. It is time we changed again, and gave a fair deal to the ambitious mobilers, who have a lot of QRM to contend with now. Mobile is a must with the military. Let's do something about it ourselves - now. See you mobile - as soon as I can equip the car !!!!!!!

de VE3WO

# MATCHING FEEDER LINES

## Discussing the Use of 300-Ohm Flat-Twin

*We are all concerned with aerial efficiency and making the best use of the available RF. In many cases, this involves the problem of matching at the aerial end and some means of checking on the SWR in the feeder line. This article suggests a practical approach to the business of matching and feeding where 300-ohm line is being used in current-fed systems.—Editor.*

### *By* F. TILLOTSON (G6XT)

THIS article is written in the hope that it will interest and help the many amateurs who are experimenting with aerial systems and methods of feeding them. Perhaps it will induce some to study the various excellent text-books on the subject and start from rock-bottom in radio, that is, AC theory, so that greater advantage can be taken of recent advances in the study of propagation.

Feeder lines with polythene dielectric have come into prominence in recent years and it can be safely said that many present-day amateurs are using this in some form or another, particularly on the higher frequency bands.

The old order changeth and technique has to be adapted to meet the modern innovations. The resonant feeder line with its tuning condensers and lamp indicators is giving way to the so-called Flat Line. Unfortunately, it seems to be taken for granted that this moulded pair feeder can be hitched on anyhow and that matching becomes an automatic certainty.

This is *not* so, and if the operator hopes to get the best out of his equipment a little thought and a few hours' work will vastly improve matters. The following method of matching is applicable to moulded pairs and is suitable for beams, doublets or folded dipoles.

**Wave-form on the Feeder Line**

Briefly, the idea is to utilise the Standing Wave Ratio (SWR) as an indication of match or mis-match, so perhaps it will be better to run over, very simply, the production of a standing wave on flat line feeder so that the reader can follow the argument and see what it is all about.

The generation of an RF wave produces a

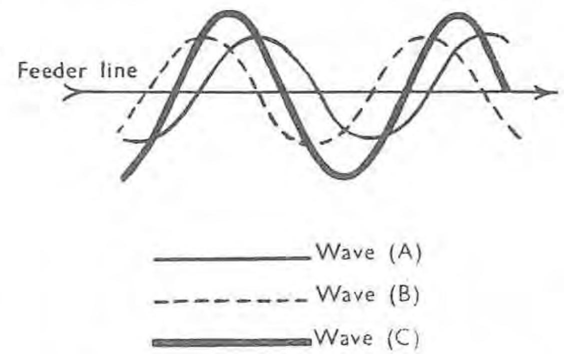



**Fig. 1.** Standing wave produced on one wire of a twin feeder line, assuming low loss material and open wire termination.

current which is alternating in character and is expressed in diagram form as the familiar sine wave. That is, cyclic variation horizontally and amplitude variation vertically.

To simplify matters, only one leg of the feeder will be shown, it being understood that the other feeder leg will have the same waveform, only opposite in phase.

There are three waveforms to consider—all have the same frequency but differ in their amplitude and phase.

(*a*) The generated wave, travelling towards the aerial.

(*b*) The reflected wave, coming back.

(*c*) The standing wave, which is the addition of the first two.

How near the standing wave approaches a "flat" form depends on the amplitude and phase difference of the reflected wave. This phase difference may be anywhere between 0 deg. to 90 deg. and is the result of matching at the impedance of termination. The diagram (Fig. 1) will explain further.

It cannot be stressed too much, and the reader must be clear in his own mind, that the



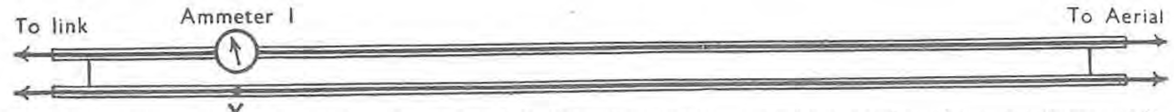



**Fig. 2.** The adjustment is to alter the length of feeder from point X until Ammeter 1 registers maximum reading.

aerial itself or "top" IS a resonant line and carries a standing wave or waves, depending on cut length.

The purpose of this matching of impedance is to put the standing wave on the aerial itself and not on the feeder line, which should be considered as nothing more than an RF pipe. As frequency is involved in impedance formulae and resonance, it is essential that the aerial resonant frequency be known with certainty and that all adjustments and readings be made at that frequency. This will then ensure that a complete waveform or half-wave, as the case may be, will appear on the "top" so that our calculations will not be upset.

A grid dip meter is a useful auxiliary piece of equipment in this respect. Do not rely on the accuracy of formulae for cutting your aerial length; they are very near, but quite easily upset by local conditions and material used for construction. Use these as a starting point, but check after erection and use the resulting figure, for measurement with the grid dip meter, even if the figure is not the frequency you intended. Anyway, it won't be much out.

Reverting to our standing wave—we can now concentrate on reducing this to a minimum on the feeder line and thus produce maximum energy in the aerial, where it is wanted.

Items required are: Two thermo ammeters, preferably same make and type. Scale to be suited to your maximum input, so that the readings will not be confined to a small portion at the front end of the calibration. Another requirement is sufficient excess feeder line to enable you to carry out considerable cut-and-try adjustments. This excess will depend on the frequency you are using, but if you have at least a half-wave spare, this gives you some latitude. A field strength meter is not essential, but is a valuable aid in checking results as you go along and if your aerial is a beam, it is invaluable in lining up. Pencil and paper should be handy so that results of your stage-by-stage matching can be put down in chronological order and you really see, in figures, what you are achieving.

One word about moulded feeder lines before going further with our matching method. Owing to the insulating material separating the two wires not being air, the expression Velocity Factor comes into the picture. This is due to the combination of capacity and inductance and alters the distribution of the waveform on the feeder line as distinct from the aerial line. In order to make our task easier we will base our explanation on 300-ohm flat line which has a VF of 0·85. Therefore, if your half-wave results in a length of, say, 16 ft. for a frequency of approximately 29 mc, then a half-wave of feeder would be 0·85 of that length. So, when you start to "cut and try" this must be borne in mind.

The SWR, expressed as a figure, is the result of comparing two figures. In our case, maximum current and minimum current on the feeder line. If the figures are widely different the SWR is high, such as—14 to 2 is a SWR of 7, while 4 to 2 is a SWR of 2. The perfect result of unity, or SWR of 1, can only be achieved at the resonant frequency. It will be seen that if we have a SWR of 1, the line will be absolutely flat and, acting only as an RF pipe, current indication will be equal at all points up the line. One says indication, because in actual fact our generated wave has still the same amplitude but matching

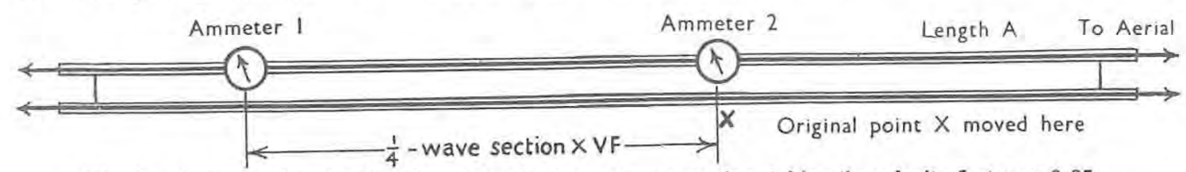



**Fig. 3.** Ammeters 1 and 2 placed at ends of a quarter-wave section, taking the velocity factor as 0·85.

is suitable for beams, doublets or folded addition resulting determines our indication on the meters.

**Points to Watch**

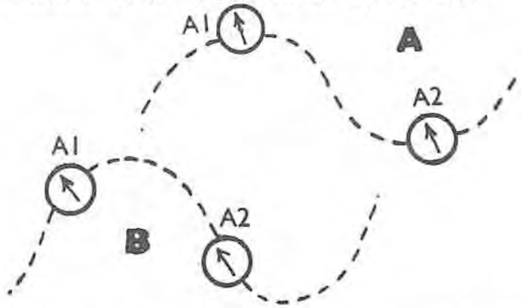
Referring to the diagrams it must be emphasised that accuracy in determining the quarter-wave section separating the two ammeters affects the result. The VF must be considered here, but cut on the long side and then adjust by cut-and-try. This length when accurately worked out remains constant, but only at the resonant frequency. The starting point for all these adjustments is thus the resonant frequency, which indicates the use of a VFO as control.

Set the transmitter on the resonant frequency and tune to your maximum input, that is, in PA plate mA. This is after you have made the set-up as indicated in Fig. 2. The spare feeder line which is attached to point X is now used to obtain the wave shift on the feeder so as to bring the maximum reading on to Ammeter 1. Short lengths are cut off until the maximum reading is obtained, not forgetting to retune each time because the loading will alter. It might be necessary to adjust the link, so that you maintain your maximum input.

You will eventually come to a point where the reading starts to reduce instead of increase. You will have now reached the crest of the waveform and the correct length of feeder to keep the reading at a maximum will be known. As we progress and start to adjust the matching device, slight alterations to this length will have to be made, so bear this in mind.

Now that we have got a maximum point, we can insert our quarter-wave section and second ammeter which has to read a minimum. If this has been too long, we can reduce gradually until the point is reached, remembering that minimum does not mean zero but "lowest figure under the circumstances." The setting of transmitter input need not be altered now, because as the section comes to its proper length we shall see the original readings on the input meter and Ammeter 1. ONLY when these ammeter points are determined correctly can we be sure of accuracy when we commence adjusting the matching device. Fig. 4 may explain more clearly how the SWR can be incorrectly interpreted if our two points are wrongly spaced.

**Fig. 4. (A) Ammeters correctly placed for taking readings. If Ammeter 1 reads 12 and Ammeter 2 reads 4, then the SWR is 12/4, or 3. (B) shows incorrect placing of ammeters from which it is evident that a true indication of the SWR could not be obtained.**




Final matching can now be attempted. If the aerial is a beam, then the lining up for maximum gain should have already been done by means of field strength meter, because alterations in spacing and lengths of elements affect the centre impedance.

If the beam is pointed at the FS meter and a reading taken at the commencement of matching, it will be very clear whether progress is being made, and this is where your paper record begins. Make a record like the one indicated and carefully fill in after each adjustment. The final set of figures will prove that correct matching does pay.

The height of a beam does not affect the matching to a great extent, so place it at a convenient height for reaching the matching device. Assuming this is a "T" match, this should be opened out about 2 in. either side and the reading of the two ammeters checked with the reading you commenced with. If you are moving in the correct direction the readings will be nearer (lower SWR) and your input lower. If the readings indicate higher SWR it will be obvious that your matching space wants decreasing and not increasing. So up the ladder again and reduce by 4 in., taking further readings and recording them. Once started in the proper direction the amount moved each time should not be large because you may pass the point of correct match. When you approach this point it will be shown quite clearly in your figures because your two ammeters will get nearer together in readings.

When you get to this point, your table should indicate lower input, lower SWR, but increased field strength.

**General Observations**

If there was considerable mis-match to commence with, the length of feeder will have to be readjusted, because the waveform will have moved on the feeder line and our maximum position will have been displaced. It may mean an extra length to be inserted or a small portion taken out. Following the same procedure as before, bring Ammeter 1 to the correct place on the feeder line and take readings. Make a final adjustment to the "T" match and record the results.

Depending on how far you were originally mis-matched, your table of figures will be a revelation, especially if you have the F/S readings as well. It must be emphasised again that accurate results can only be obtained if the ammeters are correctly placed. This means ALL the adjustments at the resonant frequency and correct length of quarter-wave section between ammeters.

If you take readings either side of the resonant frequency and record the apparent SWR your readings will become more and more faulty because of the distribution of waveform on the feeder and consequent wrong placing of the two ammeters. This will be easily seen if you compare the feeder length at 28 mc and 29 mc, taking into account the VF and your overall length of feeder, which may contain a number of half waves.

It is recommended that the ammeters be permanently included in the feeder line so that you can see when mis-match occurs due to any displacement of elements during bad weather. The losses that may occur in the metered portions cannot be great at amateur frequencies and they will prove their worth.

| INPUT mA | A1 | A2 | FIELD STRENGTH READING | REMARKS |
|---|---|---|---|---|
| 150 | 1·2 | ·2 | 80 | Commencement of adjustment, "T" match 24 in. |
| 160 | 1·3 | ·18 | 70 | "T" opened to 28 in. |
| 145 | 1·1 | ·3 | 95 | "T" closed to 22 in. |
| 130 | 1·0 | ·45 | 150 | "T" closed to 21 in. evidently correct direction of movement. |
| 120 | ·9 | ·6 | 200 | Nearing match. Space now 20 in. |
| 110 | ·85 | ·75 | 250 | Space now 19 in.* |
| 115 | ·87 | ·7 | 220 | Now going back. Point * seems nearest. |

Note: These figures are for guidance only. Having obtained the correct adjustment for matching, alter length "A" to regain maximum current reading in Ammeter 1, and then re-check the SWR.

# Feeding the Aerial

## Coupling Adjustments and Circuit Loading

*By* V. J. COPLEY-MAY

An interesting practical discussion on the problem of matching and feeding between PA tank and aerial tuning circuits. The author shows that there is a good deal more in it than simply slapping on the load and tuning for a rise in PA plate current.—Ed.

THIS article is directed mainly to those amateurs whose knowledge of the transference of power from the PA tank circuit to the aerial is a little hazy. It is quite a complex business and space will not permit a complete and detailed account of the theory involved.

When considering the problem with pencil and paper it may appear to be fairly straightforward, as we can take for granted that such factors as aerial length, PA tank Q, and so on are all correct and "ideal." But it seldom occurs that the coupling system behaves as anticipated when power is fed to the aerial. Many inter-dependent variables are introduced, some unknown, which may have considerable bearing on the problem. Mathematical prediction of results to a good order of accuracy becomes a virtual impossibility. In such a case it is quite justifiable to make an approximate mathematical computation of the factors involved and then to make final adjustments so that the system is operated with maximum efficiency.

### Impedance Matching

First of all, we can investigate the properties of the two parties before committing them to unhappy matrimony. To ensure maximum transfer of power to the PA tank circuit, the latter must present the correct load to the valve used. (The same applies to an audio output stage.) Also, to ensure that power in the PA tank circuit is transferred most efficiently to the transmission line that is feeding the aerial circuit, it is necessary for the input impedance of the line to be "transformed" to a value that will load the transmitter to its correct rating.

The manufacturers supply us with this value of PA load, in most cases; however, if the line is coupled to the tank circuit so that at resonance the valve draws the prescribed plate current at its correct operating voltage, the PA is loaded correctly anyway. So we can forget about the ohmic value of the load.

Many readers may have realised that in the foregoing assumptions nothing has been said about the effect of the dynamic impedance of the tank circuit. In all but academic cases it is reasonable to forget about this effect, as any usual value of LC ratio will result in the dynamic impedance

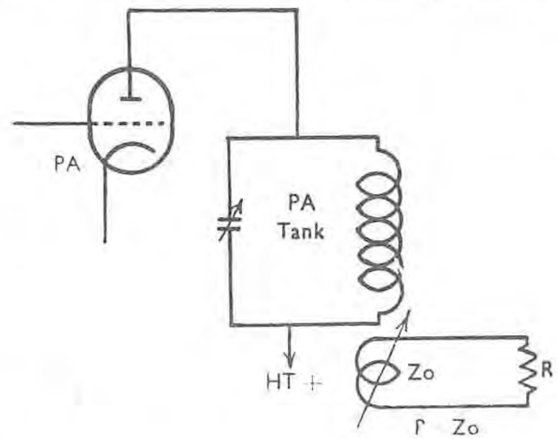



Fig. 1. Resistance R is equal to the characteristic impedance (Zo) of the transmission line.

of the tank circuit being considerably higher than the load-line input resistance or the resistance of the valve to which the circuit is connected.

In all but exceptional cases the value of the load-line impedance is lower than the PA load impedance. Many factors become associated with this problem and the issue can be extremely confusing.



At the end of a couple of feet of this transmission line, say we connect a resistance R equal to the characteristic impedance (Zo) of the transmission line (see Fig. 1). Then we shall be dissipating most of the power generated by the valve in this resistance. Now, if we can substitute the aerial for this resistance, so that the PA tank circuit notices no difference whatsoever, then the maximum possible power will be transferred to the aerial. All very obvious! Even more obvious—the feeder to the aerial connected where the resistance had been must also look just the same, with no reactance.

In the case of a half-wave aerial of correct length for the operating frequency, with 80-ohm cable connected at its electrical centre and 80-ohm cable used right up to the link at the PA tank, the above conditions are easily satisfied. With the link pushed into the tank circuit so that the PA is correctly loaded, we have a very efficient system for transferring power to the aerial.

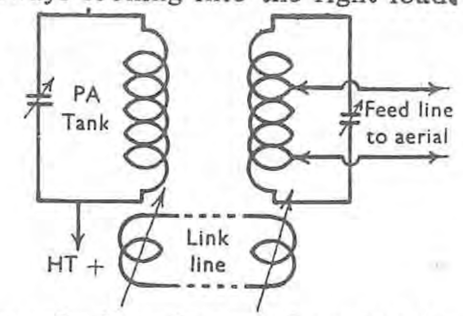
### Other Conditions

Unfortunately, all problems of coupling the PA to the aerial are not as simple as this. It may be required to end-feed an aerial; or, more probably, it may be necessary to operate the aerial on more than one frequency. Therefore, some system has to be devised whereby it is possible to maintain an efficient match between the two circuits. Looking at it from the point of view of the PA—in order to give his best all he asks is that the system of carrying away the power loads him to correct value and does not reflect into his tank circuit undesired reactances. Unless we oblige him in this respect, the coupling will cause him to go off tune and *then* the dynamic impedance of the tank circuit may have a considerable effect and maximum output will not be possible.

Remember that retuning of the PA only compensates for the reflected reactance and, although it will increase the efficiency, it does not eliminate the trouble as losses increase in the feeder.

In the interests of harmonic suppression it is desirable to transfer the power from the PA tank to an aerial tank circuit so as to reduce capacity couplings. This is fortunate as it enables one to isolate the high DC voltages associated with the PA and also to place the aerial tank circuit in an accessible position for adjustment. These factors are, however, unimportant compared with the prime advantage of being able so to arrange things that the PA is always looking into the right load.

Fig. 2.




The transferring of power from one to the other can be accomplished with a link line (see Fig. 2). The degree of mutual coupling will depend upon how far the links are pushed into the tank. If the coupling line is short it is satisfactory to couple one end tightly and leave the other for adjustment of loading of the PA. There will be standing waves on the feeder, but in view of the short length the losses will be negligible. If we wish to couple two circuits together where the feeder length is significant in terms of wavelength the link at the aerial end is adjusted so that the feeder is looking into a value of load resistance that is equal to its characteristic impedance. The link at the PA is then treated as a load adjustment. With both ends so adjusted, standing waves on the line will be almost eliminated and the loss will be low.

To elaborate this point: The insertion of a micro-match in this line with the aerial end tightly coupled will enable one to calculate the loss caused by the standing waves (standing-wave ratio indicated on the meter) and thereby decide whether such loss is acceptable in view of the greater convenience in having only one adjustable link. Knowing the length of cable in feet and the attenuation in dB per foot for the frequency used, the product is the total attenuation in dB. Convert this to the power ratio, and assuming a given input, you now know what to expect in watts in the load to which the line is connected. This assumes *no* standing waves. The difference between the two voltage figures is the power loss in the line; this is seldom more than a watt or two in a good line operated "flat."

But if there is a standing-wave ratio of 10 (it quite often exists) then the loss in the line is increased five times and 5 to 10 watts RF are lost in the line. Now, if the link line is long (one or two wave-lengths at 28 mc) attenuation in even a good quality line may rise to 1 dB and it is possible to lose as much as 25 to 50 watts in the line from a transmitter loaded to 100 watts, assuming your standing-wave ratio is in the region of 10.

Of course, this is a very bad case—but far from being impossible—and judging by occasional remarks heard over the air, it seems that many operators are warming up the feeder line unnecessarily.

**Balancing the Line**

What it boils down to is that if the coupling line is long, then play safe and have an adjustable link at both ends. If you have no micro-match, you can get some idea of how serious the situation is by observing how much you have to retune the PA when you load up ; though this is a crude method. Standing waves can be high without calling for PA retuning as the adjustment of a heavily loaded PA is pretty broad, anyway. With the two links, the best you can do is to adjust the one at the aerial end until a condition is found where the swinging of the link at the PA end has the minimum effect on the PA tank tuning. You will never arrive at an adjustment where *no* retuning is required, due to the leakage reactance of the coupling coil on the tank circuit, but the minimum is the point to aim for, thus indicating a virtually flat line. It will be found in practice that an adjustment can be found where retuning appears to be unnecessary.

**Aerial Coupling**

The only thing now remaining is to transfer the power away from the aerial tank to the aerial proper and any of the many recommended arrangements can be used, depending on the type of aerial. The pi-section coupler is possibly the most versatile, as it will match almost any link line to any aerial feed line—flat or resonant—within all reasonable limits. Using large variable inductances on ceramic forms, this type of coupler makes a very practical piece of equipment.

Whatever type of aerial tuning unit is used, the only requirement is to adjust the coupling between the tuning unit and the aerial so that maximum power is transferred to the latter. This may call for a further adjustment of the link line at the aerial tuning unit end (dependent variables again !) as the dynamic impedance of the aerial tuned circuit may be reduced.

It is worth while to remember, especially with the more complex aerial systems, that the performance of an aerial on reception is not necessarily the same as its performance on transmission as, should standing waves appear on the line during transmission, the actual polar diagrams on transmission and reception may differ considerably. With a beam, there may be a very good front-to-back ratio on receive and a poor one on transmit, or *vice versa.* In fact, the gain of a system may be greater on transmit than on receive, due to a mismatch at the receiver but a good match at the transmitter. Unless both sides are correctly matched it is a fallacy to assume that you can work anything you can hear, propagation conditions permitting.

A sound generalisation for the beginner is that the most important factor governing the efficient operation of a combined transmit-receive aerial system is a good match at the receiver front end and also between feeder and aerial when on transmit. These adjustments control more than 50 per cent. of the efficiency.



# Single Sideband Working

## Some Practical Considerations

*By* H. C. WOODHEAD

THERE is no need to stress here the advantages of Single Sideband Suppressed Carrier working over the more normal DSB methods as used in Amateur Radio. These have been covered adequately and it is not proposed to recapitulate them here, though it may presently appear that it is possible to eliminate some of the disadvantages which are normally held to weigh in the balance against SSB systems.

It would, perhaps, be as well at the outset to make clear the distinction between Single Sideband Suppressed Carrier and Double Sideband Suppressed Carrier. The present article will be concerned entirely with the former.

In the case of DSBSC, as distinct from SSBSC, the carrier must be reinserted at the receiving end *at the correct frequency and phase* or the resulting speech will be so distorted as to be unrecognisable.

For this reason alone, therefore, it is extremely unlikely that the system suggested by G3VG, as a simplified system of SSBSC but being in fact DSBSC, would be adopted as suitable for amateur operation.

In Fig. 1 are shown diagrammatically the four different conditions to which it will be necessary to refer in the course of this discussion. At (*a*) is the Double Sideband system normally employed by the amateur. In this example the carrier is shown situated at 50 kc and the sidebands extent from 47 kc to 53 kc, occupying a space in the high frequency spectrum of 6 kc but having an audio transmission band of 3 kc. In (*b*) the case is much the same, except that no carrier is transmitted and this must be reinserted at the receiving end correct both in frequency and phase.

In (*c*) both the carrier and upper sideband have been removed and for reception the carrier must be reinserted, but there is some latitude regarding the frequency and an error of perhaps 100 cycles may not render the speech unintelligible, though, of course, the speech frequencies will all be translated up or down by the amount of the error and the quality will suffer accordingly. For example, a transmitted audio frequency of 1,500 cycles would be received as 1,600 or 1,400, depending on which side of the correct frequency the reinserted carrier erred by 100 cycles. In (*d*) is shown a single sideband complete with normal carrier. This can be taken on a normal receiver and is barely distinguishable from (*a*).

In actual practice combinations of these four conditions are often encountered, which

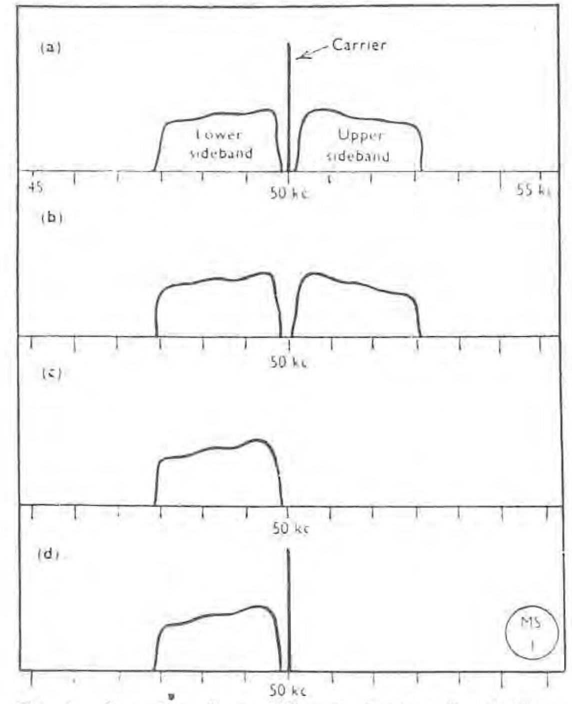



**Fig. 1. Showing four different types of telephony transmission. (*a*) Double sideband, with carrier ; (*b*) Double sideband, carrier suppressed (DSBSC) ; (*c*) Single sideband, carrier suppressed (SSBSC) ; (*d*) Single sideband, with carrier.**

are so close to one of them as to be barely distinguishable from it. Such a case, for example, is the Single Sideband Pilot Carrier, which is between (*c*) and (*d*) but more nearly resembles (*c*). On the other hand, Asymmetric Sideband, shown diagrammatically in Fig. 2, is a combination of (*a*) and (*d*), and must be considered as a separate case.

Now the methods of producing the condition shown in Fig. 1 (*c*) so far adopted have been :

(1) **By removing the unwanted carrier by balancing and the unwanted sideband by filtering ;**

(2) **By removing the unwanted carrier by balancing and the unwanted sideband by phasing.**

Method (1), as far as the author is aware, has not yet been adopted for amateur use because of the difficulty encountered in constructing a suitably narrow filter to remove the unwanted sideband.

Method (2) appears to be meeting with some success in the United States, though the author has never yet worked a W using this system, nor has any other amateur of his acquaintance. It does not appear to have met with much support on this side of the Atlantic due, presumably, to its complexity. It depends for its operation on a network capable of producing a 90-deg. phase change equally in all frequencies in the audio range of, say, 100 to 3,000 cycles. Such a network is quite possible of construction, though it is difficult to maintain the output in exact quadrature over the entire audio band.

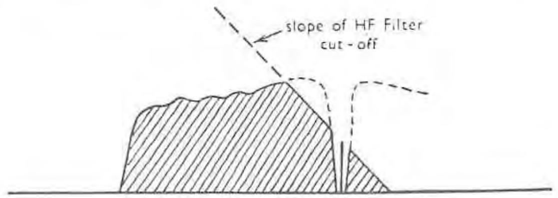



**Fig. 2. Showing how the form of an asymmetric sideband signal may be determined by the shape of the HF filter response.**

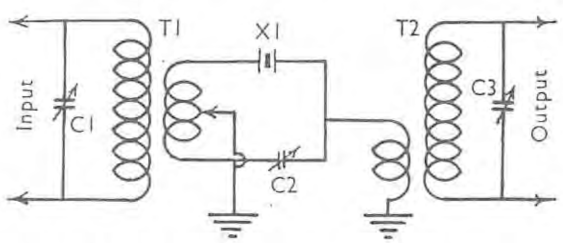



**Fig. 3. Crystal filter as used in a communications receiver. T1, input transformer tuned to pass-frequency ; T2, output transformer tuned to pass-frequency ; C1, tuning capacity for T1 ; C2, Balance or phasing condenser ; C3, tuning capacity for T2.**

## The Crystal Gate

It is proposed to explore further the possibilities of Method (1) for amateur use by consideration of a crystal filter of the type used in the average communications receiver for so-called "single-signal" reception.

The arrangement for such a filter is shown in Fig. 3, where both the input and output circuits are tuned to the resonance frequency of the crystal and the condenser C2 is adjusted to have the same value as the inherent capacity of the crystal in its holder. Thus, for any frequency except the narrow pass-band of the crystal, the circuit is balanced and no output results. In the pass-band the reactance of the crystal branch of the circuit is very much reduced and so the bridge is unbalanced. The response of such a filter is shown in Fig. 4, from which it will be seen that the band width which may be expected from a 465-kc filter may be of the order of 300 cycles. This figure can be varied to some extent by adjustment of the impedances of the input and output circuits, but it is obviously too small to be of any use as a sideband filter. If, however, such a filter is constructed with a crystal of ten times the frequency, the pass-band would be about ten times as great. So a 5-mc filter would give a pass-band of the order of 3 kc, which is something like the required figure, but the sides of the curve are still not sufficiently steep to cut off one sideband and leave the other intact.

There is, included in the average communications receiver, a "phasing" control which is none other than the condenser C2 of Fig. 3 ; this has the effect of modifying the response as shown in Fig. 5 or of tilting it the other way, according to whether C2 is increased or decreased on the central balance position. One of these curves (No. 7) for a 5 mc crystal, has been plotted to a larger frequency scale in Fig. 6 and it will be seen that a circuit so adjusted offers a discrimination of some 20 dB for 400 cycles on its steep side and the band width on top is at least 3 kc.

Such a filter can be used to produce an asymmetric sideband, as shown in Fig. 2, from which the carrier can be balanced out. The further inclusion of an audio filter to remove all frequencies below, say, 200 cycles would leave only a single sideband as shown in Fig. 7.

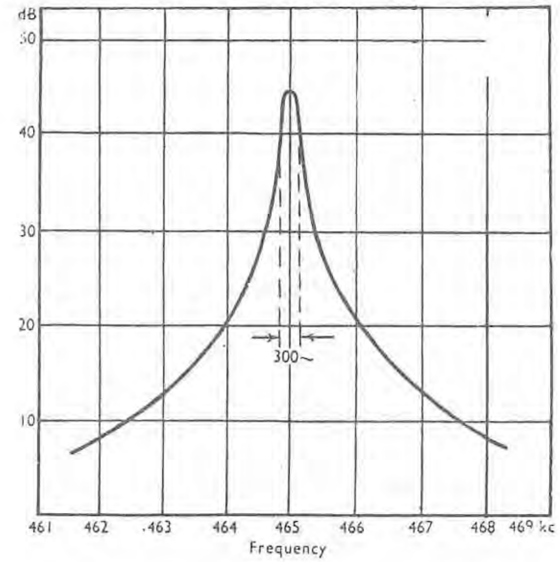



**Fig. 4. Typical response curve for circuit shown in Fig. 3.**

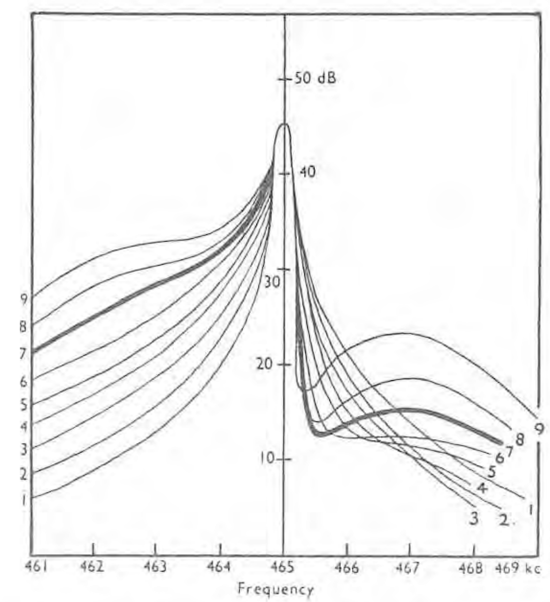



**Fig. 5. Curves 1-9 obtained by decreasing the value of C2 in Fig. 3 from the balance condition.**

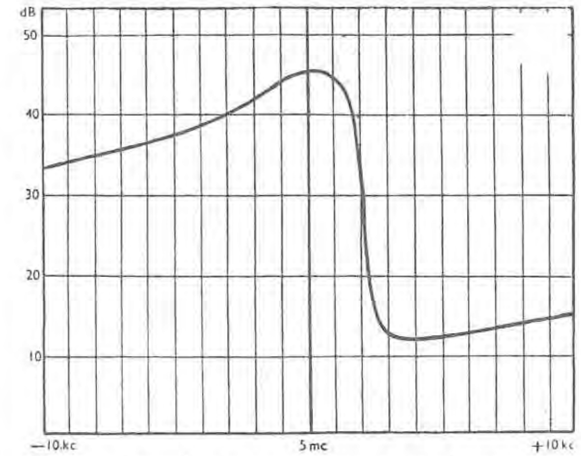



**Fig. 6. Equivalent curve 7 in Fig. 5 for a 5 mc crystal, drawn to an expanded frequency scale. Note that the upper cut-off is some 20 dB for 400 cycles.**

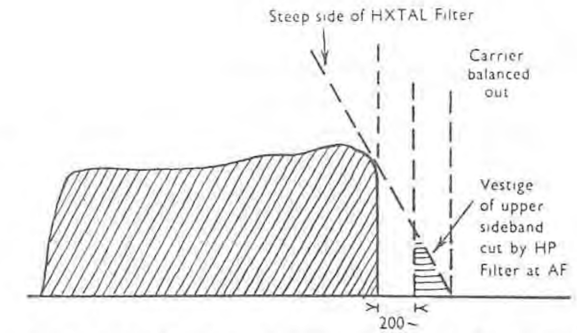



**Fig. 7. Single sideband suppressed carrier operation produced by a combination of balanced modulator, crystal filter and high-pass audio filter.**

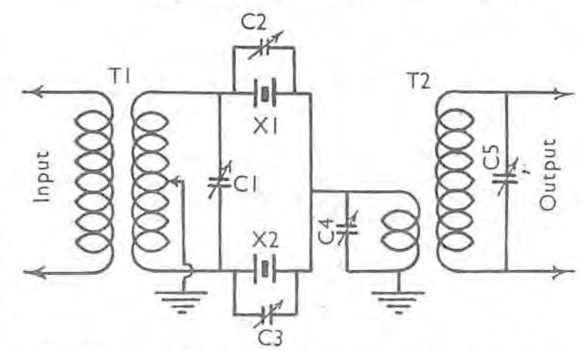
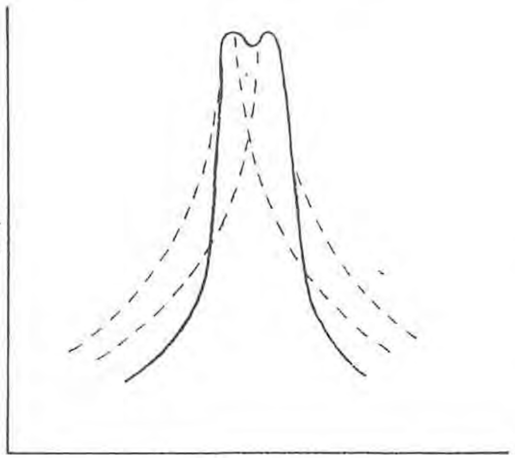



**Fig. 8. Band-pass crystal filter using two similar crystals with frequencies differing by a few hundred cycles. T1, input transformer tuned to pass-frequency ; T2, output transformer tuned to pass-frequency ; C1, tuning capacity for T1 ; C2, C3, phasing condensers, about 30 $\mu\mu F$ ; C4, C5, tuning capacities for T2.**

Fig. 9. Response obtained when using two crystals of slightly differing frequencies in the circuit of Fig. 8. Curves for the individual crystals are shown dotted.




### Selection of Suitable Crystals

The components of the circuit of Fig. 3 are a matter for some experiment but to obtain a sharp cut-off the input and output circuits of the crystal bridge should have an impedance of only a few thousand ohms. It is for this reason that T1 is a step-down transformer with its primary tuned and T2 is a step-up with its secondary tuned. The ratio will, of course, depend on the other circuits with which the filter is required to work. It is not possible to give precise constructional details as these will depend on the frequencies of the crystals which may be available.

In the case of one experimental filter for use with a crystal of 5·655555 mc. the values were as follows :

T1—*Pri.* = 30 turns 28 SWG DSC, 3/8 in. dia. former
*Sec.* = 15 turns 28 SWG DSC, 3/8 in. dia. former
T2—*Pri.* = 8 turns 28 SWG DSC, 3/8 in. dia. former
*Sec.* = 30 turns 28 SWG DSC, 3/8 in. dia. former
C1 = 100 μμF variable condenser
C2 = 30 μμF variable condenser
C3 = 100 μμF variable condenser

In order to improve the discrimination against the unwanted sideband still further, it is preferable to have two of these filters in cascade. They may be arranged as two parts of the same filter or they may be inserted separately in two successive valve anode circuits. In any case their effect will be additive. By this means the discrimination may be increased to 40 dB and the transmission may be regarded as truly SSB, though the addition of the second crystal may introduce fresh difficulties.

Unless the two crystals are identical in frequency the two response curves will not coincide and the maximum discrimination will not be obtained. But identical crystals are not easily come by and in the case of three in the possession of the author, all calibrated as 5·655555 mc, there are differences of some 400 cycles. The ideal would be two identical crystals for the filters and one about 1,500 cycles away for use as the carrier oscillator though it will probably be found possible to trim the oscillator crystal by this amount to bring it to the correct position for the carrier.

There is another alternative in the band-pass circuit of Fig. 8 which uses two crystals with slightly different frequencies to obtain a band-pass with steep sides as shown in Fig. 9 and while 5 mc is quite a suitable frequency for the narrow single-crystal circuit, it is probable that for the wide-band circuit of Fig. 8 a lower frequency of the order of one or two megacycles would be required. The choice of type of crystal filter and the frequency employed will depend on the availability of suitable crystals and the best method is probably to choose some frequency around 5 mc (known to have been commonly used in ex-Service equipment but of no use for amateur bands and therefore available for a few shillings), and to obtain as many of them as possible in the hope of picking three that suit the requirements.

To sum up, then, the receiver type crystal gate offers considerable possibilities for use as a filter for SSB working provided a frequency about 5 mc is chosen and the phasing condenser is adjusted to give the steepest side of the response curve to coincide with the carrier. Alternatively, a band-pass crystal filter may be used at a lower frequency. Either of these filters is operated in conjunction with a balanced modulator for removal of the carrier and a high-pass audio filter to remove the lower frequencies which remain in both sidebands.





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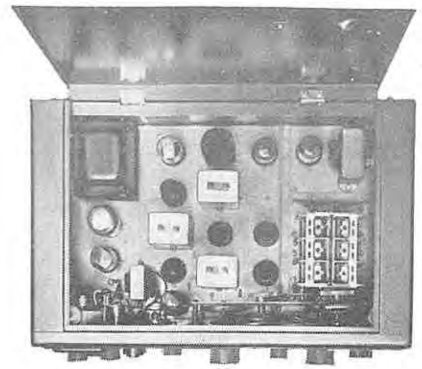

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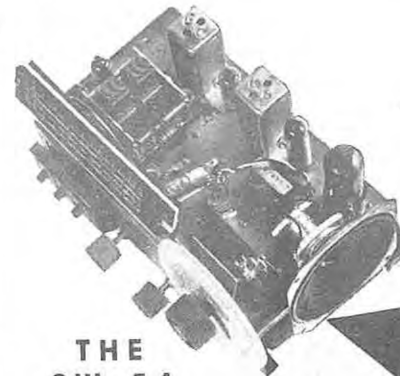

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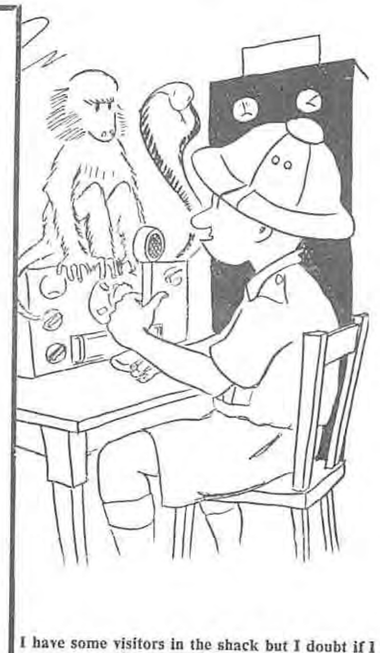
# HOW'S UR OBS IQ?

Official Bulletin Nr 290, April 25, 1951. Following recent conferences between Army, F.C.C. and A.R.R.L., the F.C.C. is releasing a public notice to amateurs, requesting voluntary cooperation in making 3700 to 3900 kilocycles available for military maneuvers in the South, from August six to September seven. All amateurs East of the Mississippi River are requested to stay off 3700 to 3900 kcs nightly from local sunset to sunrise during this period. In addition, no operation at any time in the band 3700 to 3900 kcs during the period of maneuvers is requested of amateurs in North and South Carolina, Georgia, Deleware, Maryland, Virginia, West Virginia and District of Columbia, and in Tennessee East of and including Hamilton, Rhea, Roane, Anderson and Camobell counties. No limitation on operation in possessions or West of Mississippi. A.R.R.L. urges all amateurs comply fully with above requests which are strictly on a basis of voluntary cooperation and are NOT changes in amateur rules.

Official Bulletin Nr 291, May 3, 1951. You are invited to participate in a U.S. Armed Forces Day receiving competition and operating test May 19. A message to amateurs from the U.S. Secretary of Defense will be transmitted at 2000 EST, from AIR on 14,405 and 20,994, NSS on 122, 4390, 9425, 12,630 and 17,000 and WAR on 3497.5 and 6997.5 kc. It will be sent also from AIR, NPG and WAR at 2400. NPG will transmit on 115, 9255 and 12,540 kcs. A Certificate of Merit will be issued to any person who copies the message without error. In the operating test, AIR NSS and WAR will be on the air between 1800 and 2400 to contact and exchange location and signal reports with amateur stations. Complete rules on this on page 49 of May QST. Check MARS frequencies.





"I have some visitors in the shack but I doubt if I can persuade them to speak . . . ."





# DX PREDICTIONS

Prepared by C.B. McKee, Engineering Division, CBC International Service

PREDICTIONS FOR MONTH OF MAY, 1951

Skywire frequency predictions are for amateur communications on various circuits to almost any part of the world. These tables are for five major areas in Canada, and amateurs who are operating reasonably close to the cities indicated will find these predictions quite adequate.

Figures shown are in megacycles and indicate the band to be used. They are for normal F layer transmission and don't consider Sporadic E which may provide unusual DX openings!

| Toronto to: EST | 00 | 02 | 04 | 06 | 08 | 10 | 12 | 14 | 16 | 18 | 20 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Europe | 7 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Africa | 7 | - | - | - | - | - | - | 14 | 14 | 14 | 14 | 7 |
| Caribbean | 14 | 14 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 7 |
| S. America | 14 | 14 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Australia | 14 | 7 | 7 | 7 | - | - | - | - | - | - | - | 14 |
| U.S. - West | 14 | 14 | 14 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| U.S. - Central | 7 | 7 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| U.S. - South | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Vancouver | 14 | 7 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Watrous | 7 | 7 | 7 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Montreal | 4 | 4 | 4 | 4 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Sackville | 7 | 7 | 4 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |

| Sackville to: AST | 01 | 03 | 05 | 07 | 09 | 11 | 13 | 15 | 17 | 19 | 21 | 23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Europe | 7 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 7 | 7 |
| Africa | 7 | - | - | - | - | - | - | 14 | 14 | 14 | 14 | 7 |
| Caribbean | 14 | 14 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 7 |
| S. America | 14 | 14 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Australia | 14 | 7 | 7 | 7 | - | - | - | - | - | - | - | 14 |
| U.S. - West | 14 | 14 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| U.S. - Central | 14 | 14 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| U.S. - South | 14 | 14 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Vancouver | 14 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Watrous | 14 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Toronto | 7 | 7 | 4 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Montreal | 7 | 4 | 4 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |

| Watrous to: MST | 22 | 00 | 02 | 04 | 06 | 08 | 10 | 12 | 14 | 16 | 18 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Europe | 14 | - | - | - | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Africa | 7 | 7 | 7 | - | - | - | - | 14 | 14 | 14 | 14 | 14 |
| Caribbean | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| S. America | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Australia | 14 | 14 | 14 | 7 | 7 | 7 | - | - | - | - | 14 | 14 |
| U.S. - West | 14 | 7 | 7 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| U.S. - Central | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| U.S. - South | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Vancouver | 14 | 7 | 7 | 7 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 |
| Toronto | 7 | 7 | 7 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Montreal | 7 | 7 | 7 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Sackville | 14 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |

| Montreal to: EST | 00 | 02 | 04 | 06 | 08 | 10 | 12 | 14 | 16 | 18 | 20 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Europe | 7 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 7 | 7 |
| Africa | 7 | - | - | - | - | - | - | 14 | 14 | 14 | 14 | 7 |
| Caribbean | 14 | 14 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 7 |
| S. America | 14 | 14 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Australia | 14 | 7 | 7 | 7 | - | - | - | - | - | - | - | 14 |
| U.S. - West | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| U.S. - Central | 7 | 7 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| U.S. - South | 14 | 14 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Vancouver | 14 | 7 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Watrous | 7 | 7 | 7 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Toronto | 4 | 4 | 4 | 4 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Sackville | 7 | 4 | 4 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |

| Vancouver to: PST | 21 | 23 | 01 | 03 | 05 | 07 | 09 | 11 | 13 | 15 | 17 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Europe | 14 | - | - | - | 14 | 14 | 14 | 14 | 14 | 14 | - | 7 |
| Africa | 14 | 7 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Caribbean | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| S. America | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Australia | 14 | 14 | 14 | 7 | 7 | 7 | - | - | - | - | - | 14 |
| U.S. - West | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| U.S. - Central | 14 | 14 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| U.S. - South | 14 | 14 | 14 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Watrous | 14 | 7 | 7 | 7 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 |
| Toronto | 14 | 7 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Montreal | 14 | 7 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| Sackville | 14 | 7 | 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |

## DX QTH's

| | |
|---|---|
| EA8TM | Tomas Morales, Box 8, Laguna, Tenerife, Canaries. |
| F9QU/FM8 | Charles Bernicot, c/o C.G.T., Fort de France, Martinique. |
| FF8GP | G. Pijeau, Chef Reseau Radio, Gao, French West Africa. |
| FF8MM | Box 207, Dakar, French West Africa. |
| FF8PM | Box 566, Dakar, French West Africa. |
| FQ8SN | c/o S.C.K.N., Brazzaville, French Equatorial Africa. |
| HZ1KE | British Military Mission to Saudi Arabia, Taif, MELF. |
| KG6FH | Box 100, Guam, Marianas (*ex-J9SIR*). |
| MD7GR | G. H. Rathbone, Evridiki Street 28, Famagusta, Cyprus. |
| MD7WE | c/o R.A.F., Nicosia, Cyprus. |
| MF2AA | Major M. H. R. Carrogher, HQ VG Police, Trieste. |
| MI3GH | A.P.O. 843, c/o P.M., New York. |
| MP4BAC | R.A.F., Sharjah, Trucial Oman, Persian Gulf. |
| PJ5KO | c/o W6MEK, 2719 Richie Street, Oakland, Calif. |
| PK4KS | Tan Koon San, Pangkalpinang, Banka, Indonesia. |
| PK5RU | Box 25, Bandjermasin, Celebes. |
| PZ1QM | Box 679, Paramaribo, Surinam. |
| VQ3AA | S. H. W. Tanner, c/o Traffic Dept., East African Railways, Dodoma, Tanganyika. |
| VQ3AD | c/o C. I. R., Arusha, Tanganyika. |
| XZ2TH | 75 Montgomery Street, Rangoon. |
| YK1AC | Alan Rabbat, Salhie Shouhada Street, Damascus. |
| ZD4AC | J. C. Breakell, Box 933, Accra, Gold Coast. |
| ZP9FA | C. S. Martin, Box 716, Asuncion, Paraguay. |

# OUTDOORS CAN BE FUN AT NIGHT WITH BACKYARD SPORTSLIGHTING

By KIRK REID and JIM JENSEN.

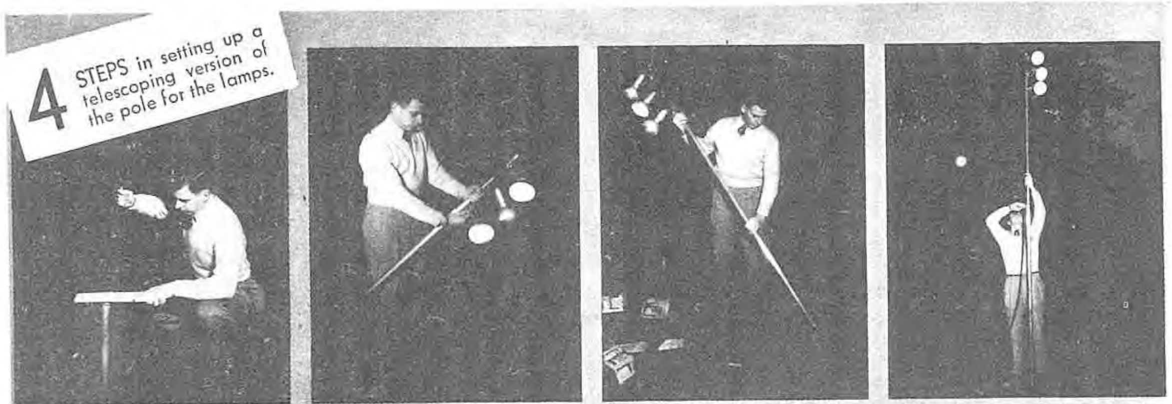
IF YOU'RE a typical, recreation-loving American citizen, you've been putting up with an unsatisfactory set of conditions when it comes to outdoor recreation at home. Of course you take great pride in your yard—you spend the weekends getting it in shape and keeping it that way.

But during the week you miss out on the wonderful possibilities your yard offers, for it gets dark just about when you're ready to enjoy them. There aren't enough daylight hours in your day. That's especially true, with the days so much shorter as winter draws on.

Probably you've often thought it would be great if you could light up your yard practically and inexpensively. Perhaps you remembered the elaborate systems required for baseball or football, and you've dismissed the idea of outdoor lighting as being for millionaires only.

Well, here's good news: you can have portable, inexpensive backyard lighting that will operate on ordinary household wiring circuits.

How do you do it? By using weather-resistant lamps mounted on easily constructed poles and connected to your house wiring. You can use either floodlights or spotlights, and you can get either of them in two ratings: 150 and 300 watts. The use of such lamps on metal poles to light gas stations sug-




FIRST STEP: Drive metal sleeve into the ground at desired location. Use a flat board (or a metal cap over the sleeve) to protect sleeve opening during pounding. Sleeve should be driven deep enough to support the pole adequately yet leave upper part of sleeve protruding far enough to allow for easy loosening when it's time to take the equipment down after use. SECOND STEP: Place lamps in adjustable sockets and aim them in the approximate direction desired. THIRD STEP: Insert bottom of pole carefully into the supporting sleeve and plug in the wire. Check the aiming of the lamps in the general direction desired and tighten the screws. FOURTH STEP: Extend pole to full 12-foot height and aim the lamps accurately either by twisting or by lowering and readjusting.

gested a similar technique, with lighter poles, for backyard sportslighting.

The success of the system lies in getting one or two three-lamp assemblies up in the air far enough to reduce glare, give satisfactory light distribution, and keep night-flying insects at a reasonable distance during the insect season.

### Twelve-foot Poles

Twelve-foot poles are the answer. They may be made of metal or wood, and they may be as inexpensive as a handyman's ingenuity dictates—or as convenient as the lightweight telescoping poles now being manufactured for this purpose.

If the handyman tackles the problem of building 12-foot poles, he should provide some method for collapsing them for portability and storing, not to mention greater ease of adjustment. Various types of pole, both metal and wooden, are shown in the accompanying illustrations. If they're not inserted into a metal sleeve in the ground, they should be supported by guy wires.

If you don't make your poles of wood, you can always make them from pipe purchased at any hardware store. Such pipe should be no smaller than a half inch in diameter, and preferably an inch. If you're going to have a length of pipe in the ground as a holder or sleeve, that will determine the size of the pipe to use for the pole. There shouldn't be too much play between sleeve and pole.

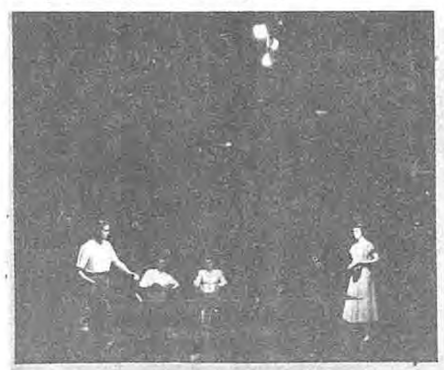
One end of the sleeve should be flattened so it can be driven into the ground more easily. In locations where the poles will be used frequently, it may be wise to drive the outer sleeve entirely into the ground, covering it with a cap to keep out dirt when not in use.

A large selection of weatherproof sockets and other accessories is now on the market. Several of them are shown in the accompanying illustrations.

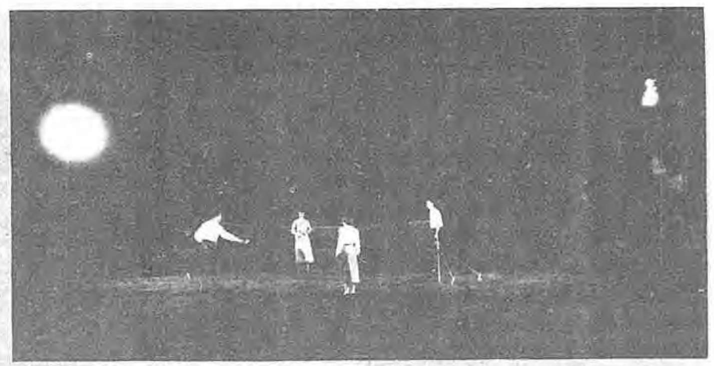
### Types of Sockets

Some sockets come equipped with pipe-clamp mountings. Others can be fastened to wooden or metal poles by means of bolts and wing nuts. Some manufacturers provide a very convenient cluster of three sockets which may be attached to the threaded end of a pipe. Our own Company's Apparatus Department manufactures a flood- and spotlighting fixture.

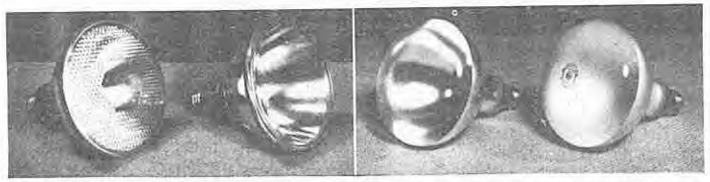
General Electric lamps recommended for typical backyard sportslighting are also shown in the illustrations. The 150-



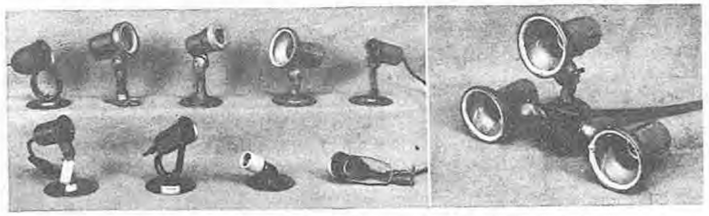
For table tennis, three 300-watt reflector floodlamps on the standard 12-foot pole give 40–70 footcandles on table.



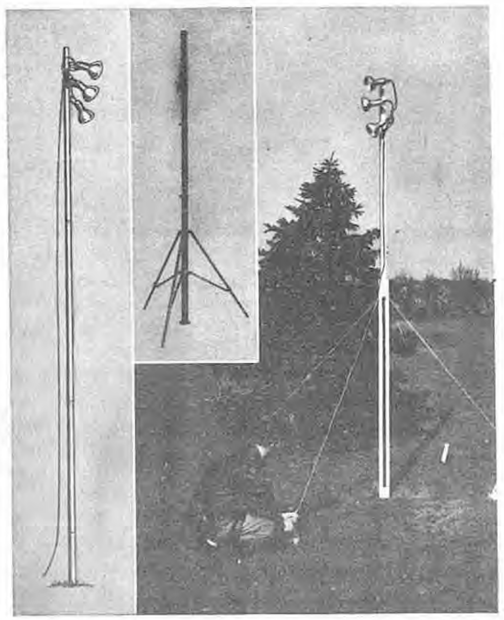
In badminton, two of the three-lamp, 12-foot poles are used, located on the net line 15 to 20 feet from the net. Equipped with 300-watt floods, these provide ample light for following birds.



150-watt PAR flood lamp | 150-watt PAR spot lamp | 300-watt R-40 reflector spot | 300-watt R-40 reflector flood



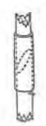
Here is a representative assortment of weatherproof adjustable sockets now available on the market. Any of these could be adapted readily for use on poles.



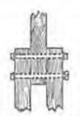
THREE POLE TYPES: Left, a telescoping aluminum pole; center, metal pole with tripod base; right, one of wood two-by-twos.

One way (chain and pipe) of joining pipe sections.

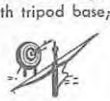
This type socket can be clamped to a metal pole.



Wood sections joined by metal sleeve and pin.

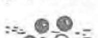


Detail of wood pole made from pieces of 2 x 2.



30-yard archery range has four 300-watt lamps: two reflector spots aimed at target, one flood each for shooting spot and lost-arrow area.

For pitching horseshoes, one-pole lighting is used with three 300-watt floods, one aimed at middle and others aimed at ends of the area.



Lawn bowling area is large, has no standard dimensions. It's desirable to use at least six 300-watt flood lamps mounted on two 12-foot poles.

For darts, one 300-watt flood lamp is adequate for a throwing distance of 15 feet. Another could be used to light up the area behind target.

watt spot- and floodlights (type PAR) will very likely be carried in your employee store. The heat-resistant 300-watt reflector spot- and floodlights (type R-40) may not be carried in stock at your store, but they'll probably be glad to order them for you. And while you're in the store looking around, they may be able to show you one type of socket (L-65-P) for the 150-watt lamps and also the G-E "Handy" floodlight (L-65).

Don't forget: the benefits of portable outdoor lighting aren't limited to backyard sportslighting. There are hundreds of additional uses, some of which are bound to be of interest to you.

Gardening and lawn mowing, for example, can be more pleasant after dark when it's cool. And it will be bètter for the vegetation, too.

Churches and fraternal organizations can find many uses for several portable 12-foot poles with lamps. If you belong to a PTA, remember that many school athletic departments hold light practice sessions in late evening hours on unlighted fields. Limbering-up exercises and the teaching of training fundamentals can be conducted with the aid of portable outdoor lighting.

If you're a suburban or rural dweller, you'll find that many gardening or farm tasks can be accomplished more efficiently and at more convenient times with the aid of light. And if you have a roadside stand, lighting of this kind is one way to boost the sale of surplus perishables; the traffic is often heavy after dark.

At Christmas, too, you'll find your new lighting equipment will come in very handy to enhance other lighting and decoration.

For ice skating, either at small resorts or small neighborhood ponds, portable outdoor lighting equipment can be used to advantage. And that goes for other winter sports, too.

There are, of course, many applications where the portable type of equipment is inadequate, and a permanent job is in order. Such installations are beyond the scope of this article, but your nearest distributor of these G-E products (such as the G.E. Supply Corporation) or your own electrical contractor will be glad to advise you in such cases or refer you to someone who knows the answer.

*Amateur Radio*

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To write articles on transmitters, receivers, antennas, test equipment, and any material of general interest to amateurs. Articles should be typewritten, between 2000 and 2500 words in length, accompanied by suitable diagrams, photos, and parts lists. Liberal payment made upon acceptance.

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# TELEVISION

## VIDEO DETECTION AND A. G. C.

## INTERCARRIER METHOD OF SOUND RECEPTION

By Wilfred B. Whalley

*This month we are printing the sixth and seventh of the series of articles on Television by Sylvania Engineers.*

### Video Detector

Following the Picture IF amplifier described in the December issue, and which increased the signal voltage over its pass band $f_1 - f_c - f_2$, (where $f_c$ is the equivalent carrier frequency of the Picture IF, usually 25.75 mc.) is the video detector, sometimes called the video demodulator. Its function is to reproduce from the IF signal, the video signal originally developed by the camera in the television station, in the same manner that the second detector in the usual radio receiver reproduces the sound frequency signal originally developed in the broadcast studio microphone.

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"... Will now carry out my final test, OM..."

The video detector rectifies the intermediate frequency signal converting the voltage envelope of IF into a "pulsating" DC signal having, in present television receivers, a frequency range from 60 cycles to 4 mc.

It may be pointed out that a television receiver could be constructed having a first detector (directly after the antenna tuning network) and followed by a multistage video amplifier. However, aside from adjacent channel selectivity difficulties in the detector input circuit, there would be a practical limit to the maximum gain, determined by the video amplifier stability; hence, the reason for the usual procedure of r-f amplification followed by the converter, then the IF amplifier (which has the greatest gain in the receiver), video detector and a moderate gain video amplifier.

The video detector can be any one of the usual radio receiver types, such as; half-wave or full-wave diode, plate circuit, grid leak, or infinite impedance type. For simplicity the diode detector is used almost exclusively. Some diode circuits in general use are shown in Figures 1 and 2. Both of these are half-wave rectifiers.

As the IF voltage envelope varies in magnitude due to its contained video modulation, the rectified voltage from the detector also varies in magnitude being a maximum during the synchronizing pulse interval and a minimum at the time when the signal corresponds to maximum white in the picture. A previous article has explained the modulation pattern. Figure 3 illustrates the choice of positive or negative polarity, positive sync with cathode output, negative sync with anode output.

Since the video detector output covers the whole video frequency range from 60 cycles to 4 mc., the coupling circuit to the receiver video amplifier should be designed to pass this frequency range with-

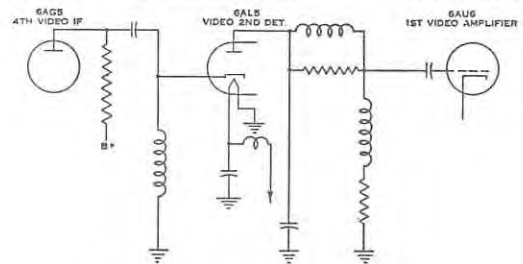


FIGURE 1
DIODE VIDEO DETECTOR OF A TYPICAL RECEIVER

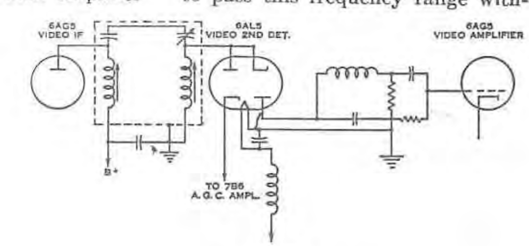


FIGURE 2
ANOTHER VIDEO DETECTOR

out attenuation. To compensate for the capacity of the detector and the grid circuit of the video amplifier, this coupling network may be either of the peaking coil-resistor type or the low-pass filter type. Most receivers are now using the latter type as shown in Figure 1.

Even with the best type of filter coupling circuit, the load resistor is usually relatively small in value, averaging about 4000 ohms. This means that the diode should have a low internal resistance to give a reasonable efficiency.

The detection efficiency of a typical half-wave diode video detector circuit is of the order of 35%, that is; with an IF voltage of 1.4 rms imput to the diode, the video output is in the order of 1.5 peak to peak volts (from maximum white to synchronizing pulse tip).

### Automatic Gain Control

In a television receiver, the circuit which automatically controls the overall amplification in order to maintain a constant video level at the picture tube is called the automatic gain control circuit, AGC, since it must be separate from the sound or automatic volume control system.

A good automatic gain control circuit in a receiver makes it possible to switch the tuner from station to station with little change in the picture contrast and reduces the effect of fluctuation in signal level caused by fading or by the alternate in-phase out-of-phase "flutter" from an airplane. It is desirable that the circuit be able to react rapidly to changes in signal strength, but not so rapidly as to

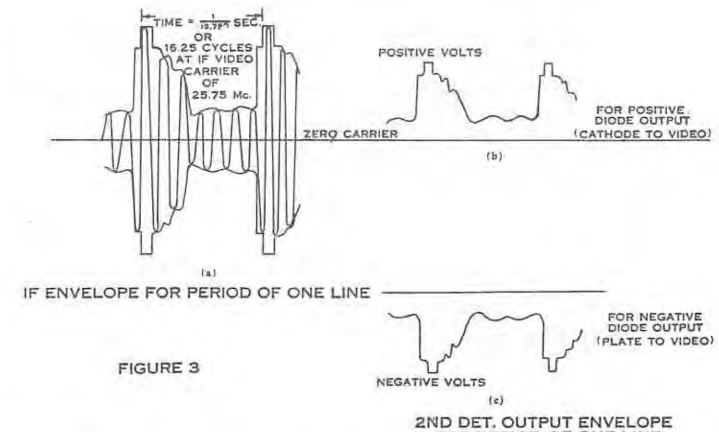


FIGURE 3

reduce the gain at 60 cycles; otherwise the vertical blanking and the background level would be affected.

There have been many types of AGC circuits for television receivers, one of which is shown in Figure 4. Its operation is as follows:

The signal from a direct coupled video amplifier is applied to a Type 7F7 AGC rectifier, which produces a positive voltage across the resistor R and condenser C corresponding to the black level of the video signal. The amplifier is direct coupled to the video detector, and the plate voltage of the amplifier has a single value of voltage for the black level. The DC voltage at the output of the rectifier tends to increase in a positive direction with increasing signal strength and, by means of the associated triode, Type 7AF7, the output plate voltage moves in a negative direction, increasing the bias on the IF and RF amplifier tubes, and adjusting the gain to the correct value for the desired video output voltage.

Another type of circuit is that shown in Figure 5 where the rectified intermediate frequency voltage controls the bias of a triode Type 7B6 which has a 15,750 cycle pulse signal (from the horizontal deflection system) coupled to the grid; hence, the output of this amplifier has pulses varying in amplitude with the detector diode voltage, and the pulse voltages after rectification by the auxiliary diode D, supply the negative control voltage to the RF and IF tubes.

It should be noted that the circuit of Figure 5 operates to maintain a constant IF output voltage, which may not correspond to the black level of the signal since the synchronizing pulse amplitude may not be constant from station to station.

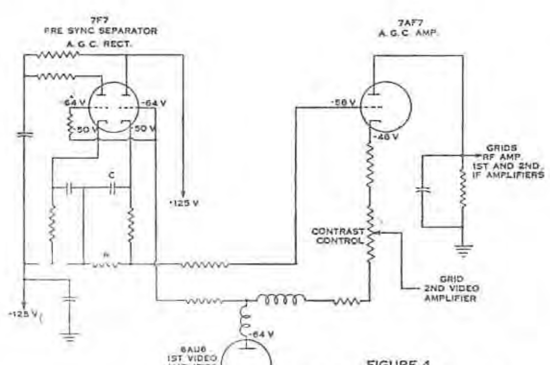


FIGURE 4
ONE TYPE OF A.G.C. SYSTEM

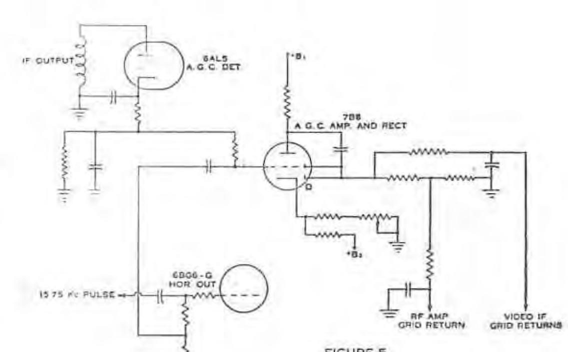


FIGURE 5
A.G.C. CIRCUIT

An interesting method of sound reception in television receiver operation was proposed some years ago by Messrs. L. W. Parker and R. B. Dome. The particular purpose of this system was to reduce the number of componenets and tubes in the IF amplifiers, by making use of the modulated 4.5 megacycle beat signal which is present at the output of the video detector of any television receiver. This modulated 4.5 megacycle signal is produced by the simultaneous rectification of the AM modulated picture IF carrier and of the frequency modulated sound IF. (In a typical receiver the picture IF equivalent carrier frequency is 25.75 megacycles and the sound IF equivalent carrier frequency is 21.25 megacycles.) As is well known, the spacing between a television sound transmitter RF carrier frequency and the associated picture transmitter carrier frequency is set at 4.5 megacycles.

The amplitude of the 4.5 megacycle signal at the output of the video amplifier of a television receiver, depends upon the frequency response characteristic of the picture (or video) IF amplifier and of the video amplifier, being small when good quality bandpass filter circuits are used, large in amplitude when staggered-tuned IF amplifiers with inadequate sound rejection filters are used. In the intercarrier type of receiver, the frequency response of the IF amplifier is controlled to give a reasonable gain at the sound IF frequency usually between 30 and 40 db. below that of the gain at the picture IF frequencies.

Figure 1 shows the basic layout of an intercarrier receiver. The sound and picture RF frequencies, after passing through the tuner, are converted to suitable frequencies for the IF amplifier by the mixer and local oscillator. The IF output signals (those of the picture frequencies having been amplified 30 to 40 db more than those of the sound frequencies) are rectified in the second detector giving (a) the usual video frequencies from 60 cycles to 4 megacycles, (b) a low level 4.5 megacycle amplitude-and-frequency-modulated beat signal, (c) signals whose frequencies are the sum of the two IF frequencies and their side-bands. Both (a) and (b) are amplified by the video amplifier, but (c) does not pass through. At the output of the

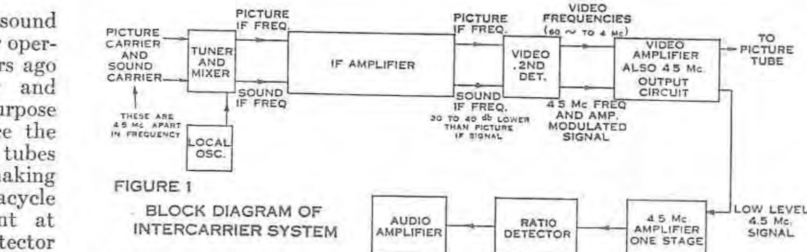


FIGURE 1
BLOCK DIAGRAM OF INTERCARRIER SYSTEM

video amplifier a suitable coupling circuit abstracts the 4.5 megacycle signal which then passes through a single stage 4.5 megacycle amplifier into a ratio detector and to the audio amplifier.

The ratio type of detector is preferred since it will operate satisfactorily with a weaker signal than will the usual type of FM discriminator. Figure 2 shows the voltage frequency characteristic of a typical picture IF amplifier slope of the response curve on the high frequency side is designed to suit the single side-band operation of the television picture transmitter and give optimum overall receiver operation. In an intercarrier receiver using an IF amplifier of the same basic design, it is necessary that the sound IF frequency response be not too small, otherwise the 4.5 megacycle signal level from the video amplifier will be too

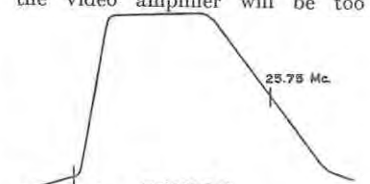


FIGURE 2
TYPICAL IF RESPONSE

small for the single stage amplifier. Also, the local oscillator in the receiver must always be higher in frequency than the received signal RF frequency.

A cheaper IF amplifier may be made by employing a symmetrical frequency response; this is illustrated in Figure 3. One disadvantage is that the overall receiver bandwidth will be much less than 4 megacycles; however, the local oscillator may be operated on the higher channels at a frequency lower than the received carrier signal, making the highest required frequency of the local oscillator,-for channel 13,-equal to 190 megacycles.

Operating tests and measurements have already indicated that the stability requirements of the local oscillator in an intercarrier receiver are less stringent than in a conventional two IF amplifier receiver. A change in frequency of the local oscillator moves the frequency of both the picture and sound intermediate frequencies by the same number of cycles, leaving the difference frequency of 4.5 megacycles unaffected. For the same reason, microphonic and hum modulation of the local oscillator has much less effect upon operation than in a conventional receiver and tuning of the receiver is less critical.

A necessary condition for satis-

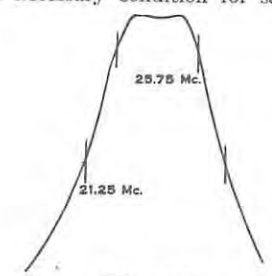


FIGURE 3
TYPICAL SYMMETRICAL IF RESPONSE CURVE

factory sound reception, is that the television picture transmitter radiate some carrier power at all times, requiring that the whitest part of the transmitted scene correspond to a power level of not less than 1% of the power during the synchronizing pulse interval (to not less than 10% in terms of voltage). Cessation of the picture carrier will immediately cause the 4.5 megacycle beat frequency to disappear giving no sound output from the receiver. If the power level of the picture transmitter drops below the 1% peak power point, the amplitude of the 4.5 megacycle beat frequency will drop giving sufficient additional amplitude modulation to show up in the audio amplifier and speaker. This would manifest itself as 60 cycle hum superimposed upon the sound.