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LOGARITHMIC COMPRESSOR

Aids in Preventing Overmodulation While Increasing Signal Effectiveness



Fig. 1. The Logarithmic Compressor ready to plug into your present microphone jack. Controls are, left to right, in-out switch, compression control, output control and a-c on-off switch.

FEATURES—

Provides 10 db increased effectiveness

Uses self-contained speech-range filter

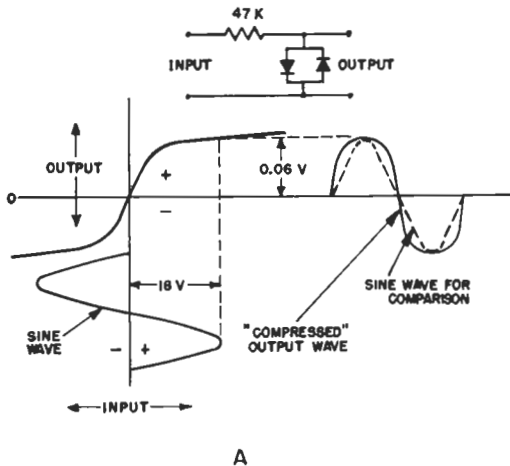
Three tubes, including rectifier

Small size—space saving

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TRANSFER CHARACTERISTIC OF BACK-TO-BACK
COPPER OXIDE INSTRUMENT RECTIFIER



TRANSFER CHARACTERISTIC OF
USUAL DIODE CLIPPER CIRCUIT

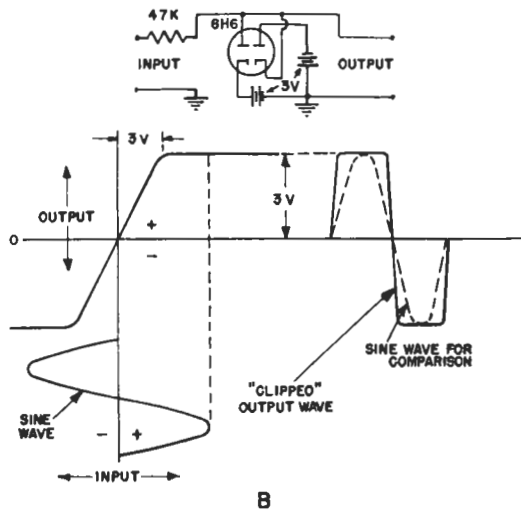


Fig. 2. A comparison between the output waveform of a Logarithmic Compressor and a diode clipper.

Every phone man, at some time in his QRM-ridden life, has wished that he had a small switch available which would permit him magically to increase his power tenfold. This would be Utopia—from one kilowatt to ten kilowatts by pressing a button.

This button is now available, and it is mounted on the front of the Logarithmic Compressor. This unit will give an effective signal gain which is adjustable from a few db up to as much as ten db (ten to one in power).

The Logarithmic Compressor is an audio amplifier device which is inserted between your microphone and your present speech amplifier. Its function is to push up the average modulation level, with the result that high percentage modulation is assured at all times, regardless of the sound level reaching the microphone.

COMPRESSION VS. CLIPPING

Those familiar with clippers or clipping circuits can see that the Logarithmic Compressor is intended to do the same sort of job as a clipper. There is, however, an important difference between logarithmic compression as used in the Logarithmic Compressor and clipping.

Fig. 2 compares the characteristics of the two different systems. In either case the input wave suffers distortion, but the distortion caused by the clipping action of the ordinary diode type clipper (Fig. 2B) is worse for a given amount of signal compression than that caused by the logarithmic compression of a copper-oxide instrument rectifier (Fig. 2A).

Distortion present in either circuit will add "harshness" to speech signals and without further treatment would result in excessively broad signals. Therefore, any distorting type circuit should be followed by a suitable filter to prevent the high frequency products produced by this distortion from reaching the modulated stage. With such a filter much of the "harshness" will still be present but the radio-frequency signal need not be broad. The harshness results from cross modulation (distortion) products that lie within the pass band of the filter.

The advantage of the logarithmic compression system is that the distortion is less severe (for a given amount of compression) than the clipper type, and this makes possible the use of a vastly simpler filter arrangement. Three "stages" of R-C type filtering used in the Logarithmic Compressor are as effective as more elaborate sharp-cutoff types of L-C filter virtually necessary with the clipper type of circuit.

Further, the transient response of the R-C type filter is such that no overshoot of signal peaks can occur. This is not the case with sharp-cutoff L-C filters. This means that the logarithmic compressor circuit with a properly designed R-C filter is superior to the ordinary clipper circuit followed by a sharp L-C filter. Repeated tests confirm this statement.

CIRCUIT DETAILS

With reference to Fig. 3 it will be seen that the first 12AT7 acts as a two stage audio amplifier to bring the signal from the microphone to a sufficient level so that the compression circuit itself operates at the proper level. Resistor R_1 in the first stage has been added as a precaution against radio-frequency feedback.

Special care has been taken to attenuate low audio frequencies prior to compression. Doing this gives a well balanced speech response as well as minimizing much of the distortion caused by cross-modulation between the low speech frequencies and the *intelligence-bearing* high speech frequencies. The values of condensers C_2 , C_3 and C_4 are chosen to attenuate the low frequencies adequately before speech compression. Condensers C_7 and C_9 serve the same purpose after compression has taken place.

Resistor R_4 , by varying the signal input to the second section of the first 12AT7, enables control of the amount of compression.

The audio transformer, T_1 , is necessary because the limiting circuit must be fed by a low-impedance, low-resistance source. Using the center-tap on this transformer accomplishes this function.

The actual limiting or compression circuit consists

ELECTRICAL CIRCUIT

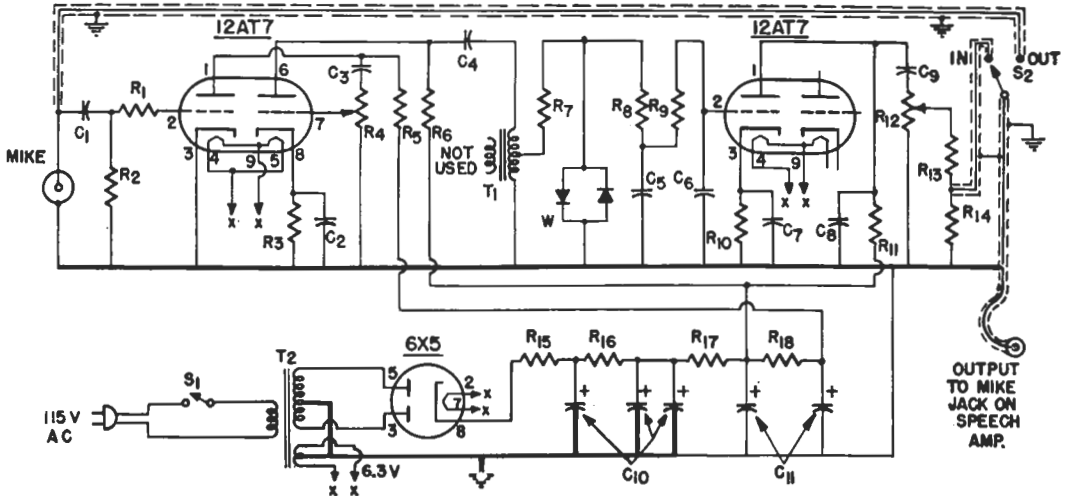


Fig. 3. Circuit diagram of the Logarithmic Compressor.

CIRCUIT CONSTANTS

(All resistors and capacitors $\pm 20\%$ tolerance unless specified otherwise)

C_1, C_9	0.01 mf 400 volt paper or mica	R_9	0.56 megohm, $\pm 10\%$, $\frac{1}{2}$ watt
C_2, C_7	1.0 mf paper (see text)	R_{12}	0.1 megohm potentiometer
C_3	1000 mmf mica	R_{13}	0.47 megohm, $\frac{1}{2}$ watt
C_4	0.05 mf 400 volt paper	R_{15}470 ohm, 2 watt
C_5	1000 mmf $\pm 10\%$ mica	R_{16}	2200 ohm, 2 watt
C_6	100 mmf $\pm 10\%$ mica	R_{17}	1000 ohm, 1 watt
C_8	0.005 mf $\pm 10\%$ mica	R_{18}	4700 ohm, 1 watt
C_{10}	15-15-15 mf 450 volt electrolytic	S_1	SPST toggle switch
C_{11}	(see text)	S_2	SPDT toggle switch
R_1, R_{14}	10,000 ohm, $\frac{1}{2}$ watt	T_1	Push-pull plates to voice coil audio transformer, UTC R-38A (see text)
R_2	10 megohm, $\frac{1}{2}$ watt	T_2	Power transformer, 300-0-300 volts at 50 mils, 6.3 volts at 2 amperes UTC R-54
R_3, R_{10}470 ohm, $\frac{1}{2}$ watt	W	Copper-oxide instrument rectifier (see text)
R_4	0.5 megohm potentiometer		
R_5	0.1 megohm, 1 watt		
R_6, R_{11}	47,000 ohm, 1 watt		
R_747,000 ohm, $\frac{1}{2}$ watt		
R_8	56,000 ohm, $\pm 10\%$, $\frac{1}{2}$ watt		

only of R_7 and W , the latter being two sections of a copper-oxide instrument rectifier. Resistors R_8 and R_9 , together with condensers C_3 and C_6 act as a two-section R-C filter. The output of this filter feeds the second 12AT7 directly. Resistor R_{12} acts as an output control so that the output level from the speech compressor may be made to match the output level of the microphone. Thus when the speech compressor is switched out of the circuit no other adjustment need be made.

The output tube is required for two reasons. It is necessary to present the proper load to the two R-C filters and, secondly, to permit a third R-C stage to be utilized. Inasmuch as the second section of the 12AT7 tube is not used this may seem like wasting part of the tube, but the use of a high- μ triode was dictated and the 12AT7 fills this requirement nicely. Note that the heater of the unused section need not be energized. Many uses for this extra tube section will undoubtedly suggest themselves.

The in-out switch, S_2 , allows the unit to be switched in and out of the circuit easily. Note that shielded wire is specified for the connections to this switch. The output itself is carried by a shielded lead which

plugs into the mike jack of any speech amplifier designed to handle a high impedance dynamic or crystal microphone.

The power supply is conventional in all respects. Because of the low current drain on the power supply a resistor-capacitor filter is employed. Resistor R_{15} and condenser C_{11} provide decoupling and additional filtering for the first 12AT7 section plate voltage.

The connections indicated by the heavy black lines in the power supply section should all be made to one ground point. This will prevent the chassis from carrying the circulating capacitor current and help to keep the unit hum-free.

CONSTRUCTIONAL DETAILS

As may be seen from the photographs, the entire unit, including power supply, is mounted on a 5 by 7 by 2 inch chassis. While the layout is not critical, it is advisable to keep the power supply portion of the circuit as far away from the rest of the circuit as possible. The layout shown is quite satisfactory.

With reference to Fig. 1, the front panel layout, from left to right, is: mike jack, output lead, in-out

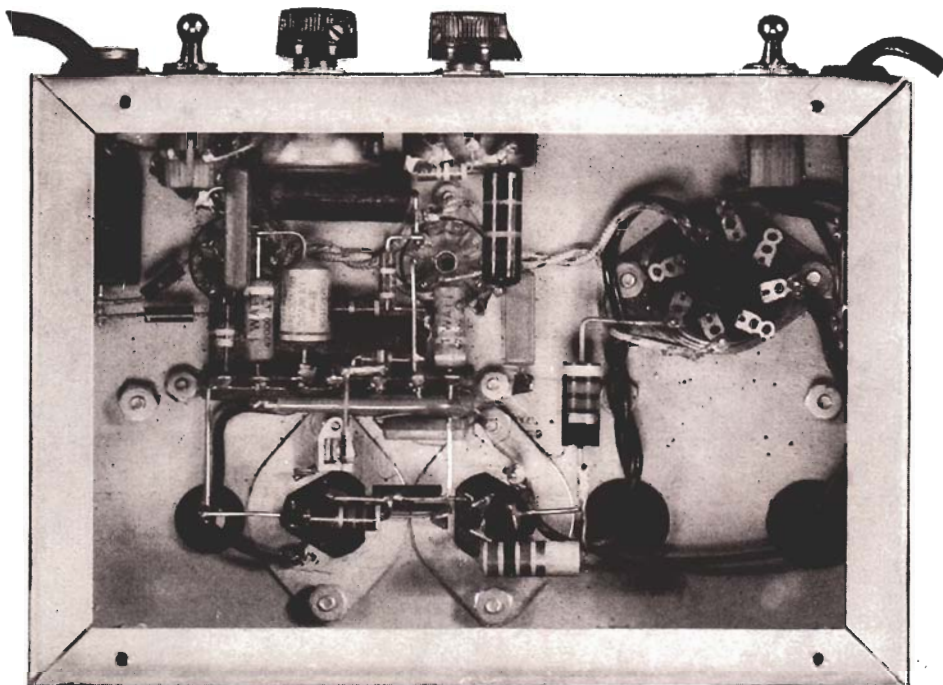


Fig. 4. Under-chassis view of the Logarithmic Compressor. There is ample room for all component parts.

switch, compression control, output level control, a-c on-off switch and a-c cord. The tubes are, left to right, input 12AT7, output 12AT7 and 6X5 rectifier. Note that the two 12AT7 tubes are shielded.

Fig. 4 gives the details of the wiring. Nothing here is critical if normal wiring procedure is followed. Note that R_1 is placed as close to the grid pin as possible.

The wiring can be made simpler if the unused leads from the power transformer are pulled inside the transformer case and securely taped to avoid shorts. This was done with the 2.5 volt and the 5.0 volt windings.

The unit pictured uses a bottom cover plate for the chassis. This is recommended to avoid r-f feedback. Any sort of thin metal will serve for this purpose, if your chassis comes without a bottom plate.

COMPONENT PARTS

While no extremely critical values are required, it is recommended that the specified values be used in all cases. For example, C_2 and C_7 are specified as 1.0 mf condensers. If lower values were to be used, the frequency response would suffer, and if higher values were used, the result would be insufficient low-frequency attenuation.

Condenser C_{10} is about the only component which could be changed. Here a 20-20 mf condenser could be used, with one of the 20 mf section on either side of R_{14} .

Almost any sort of push-pull plates to voice coil transformer will serve as T_1 . Wattage rating of this transformer is not important.

If possible, linear taper potentiometers should be used at R_4 and R_{12} . This sort of taper will give a smoother action than other types of taper.

Care must be taken in purchasing the limiter rectifier, W, because instrument rectifiers come in several different styles. Basically, of course, they are

used to make a-c meters out of d-c meters. However, they can be purchased as half-wave units, doubler units, full-wave units and bridge units.

Two separate half-wave units, connected as shown, will work, and the bridge-rectifier style will work if the proper leads are used. The "full-wave" unit will not serve because the two diode sections are connected improperly. In the doubler type rectifier the two diode units are connected as shown in Figs. 2 and 3 and therefore this type of instrument rectifier would be the best to use.

COMPRESSION ADJUSTMENT

The adjustment of the Logarithmic Compressor is done very easily. Plug in a mike and place the in-out switch, S_2 , in the "out" position so that the microphone is connected directly to your speech amplifier, then follow these three steps:

1. Adjust the audio gain control on the transmitter for normal modulation as seen on an oscilloscope (the best method) or some other instrument worthy of trust.

2. Put the output control on the unit to zero and set the compression control so that it is about half open. Switch the compressor to "in" and advance the output control while speaking into the microphone until the *peak* modulation is the same as in step 1. While an oscilloscope is not absolutely necessary in order to make this adjustment, it is strongly recommended.

3. Adjust the compression control so that the average plate current in the modulator stage on a sustained "00000—0" is, say, not over twice that obtained with the compressor out. Then try compressor "in" and "out" on a few QSO's to find the best operating point of the compression control for the microphone you are using and the receiving conditions prevalent at the other fellow's QTH.

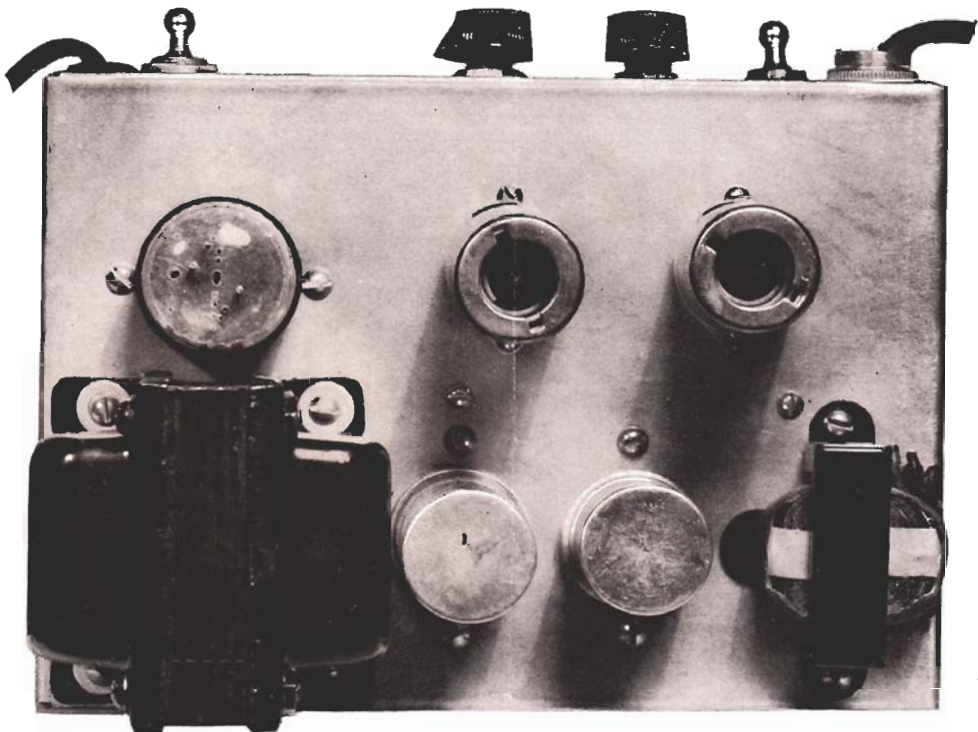


Fig. 5. Top view of the Logarithmic Compressor. The audio section is on the right and the power supply section is on the left.

USE OF THE COMPRESSOR

With the Logarithmic Compressor in use the modulator tubes are required to handle much more average power than usual. In fact, it is possible that your modulator stage will not be capable of handling the extra average power required. Careful checking with an oscilloscope will determine if this is the case.

As a general rule, if your modulator can handle a sine wave signal at 100% modulation, then the average power capability of your modulator is adequate for use with the Logarithmic Compressor. (After all, this ten db gain has to come from some place!) This means that, for a kilowatt rig, your modulator should be capable of continuous operation at 500 watts output at 1000 cycles. For lower powers the same ratio holds.

In operation the compressor must be used with judgment—good judgment that is. Too much compression may make an otherwise acceptable signal almost intolerable. With a judicious amount of compression one can expect to add from 6 db (4 to 1 in power) to 10 db (10 to 1 in power) in the effectiveness of his signal *provided* conditions at the receiving point are such that understandability without the compressor is impaired by QRM or high background noise.

RESULTS WITH THE COMPRESSOR

In many months of test at W2KUJ the following information has been obtained. Nearby stations, or stations not experiencing QRM, prefer that the compressor *not be* used. Stations receiving a weak signal or listening through severe QRM prefer that the compressor *be* used.

Reports from the latter stations range from eight to ten db jump in effective signal strength when the

compressor is switched in. Reports from nearby stations are that the signal is *louder*, but somewhat less readable with the compressor in use than without it.

In no case has a report been given that the signal was broader when the compressor was used, even when this question was asked of nearby stations.

Tests made at W2RYT's shack indicate that different microphones give somewhat different results when used with the compressor. For example, an Electro-Voice Model 605 dynamic mike (pictured in Fig. 1) and an Electro-Voice Model 915 crystal mike seemed to have identical speech characteristics (although the dynamic mike had less output) when used without the compressor.

When used with the compressor, the dynamic mike was found to have a speech quality which was less harsh than that of the crystal mike. Further, it was found advisable to advance the compression control with the dynamic mike.

The foregoing is not intended as a recommendation for dynamic mikes, nor is it intended as an authoritative comparison between two Electro-Voice microphones. The comparison has been made to emphasize the importance of testing your compressor carefully with each microphone you may use with it.

In summary, one can expect to boost the effectiveness of his signal when it is needed most by use of the compressor (it frequently means the difference between making a contact or not) with some decrease in ease of reading the signal where the compressor is not needed.

Bear in mind that the compressor *can be* misused (to your disadvantage). Seek honestly to find the operating points which best exploit its use. In many cases it is best to *not* use the compressor. But in those cases where it is needed, the Logarithmic Compressor can really do a job for you.

Sweeping the Spectrum



I have received inquiries and letters on all sorts of stationery, in all kinds of envelopes (some without stamps on), from a good many countries, but several months ago W4IKC pulled the best stunt of all.

At eleven o'clock on a regular working day my telephone rang. The voice identified himself as a local ham—W2PGV. He told me to QRX, and shortly, via ten meter phone and a phone patch Ivan of W4IKC asked if he was talking to Lighthouse Larry.

Although somewhat taken aback, I answered in the affirmative. Ivan then went on to ask if I would send him several certain copies of the *Ham News*. I assured Ivan that I would be more than happy to oblige.

W2PGV cleared the phone patch and went on with his QSO, and that was that. I must say that this phone patch deal is very effective. I have used one myself many times, but this was the first time I was ever on the receiving end.

Needless to say, Ivan got his *Ham News* issues post haste.

* * *

Now and then I am recognized on the air. The last time was during the ARRL DX Contest. I got in contact with VP9KK, and Dean came back to me, gave me my number, and then asked if I weren't the fellow who had previously sent him some copies of the *Ham News*.

I pleaded guilty, after which we had a very nice, but short, QSO. Any day now I expect to get a request for the *Ham News* by carrier pigeon.

* * *

Speaking of the *Ham News*, here's an open offer to all of you. If you build a piece of equipment described in the *Ham News*, and find that as a result your copy of *Ham News* has become bedraggled, spotted with flux, burned with a soldering iron, or otherwise disfigured, let me know and I'll be happy to see that you get a fresh, clean copy. This assumes, of course, that the back copy you request is still available.

All of this is another way of saying that I am interested in how you make out when you build *Ham News* units. Those of you that have trouble usually let me know. How about hearing from some of you that don't have any trouble?

* * *

On the first of March I received a publicity release from the Receiver Division of the General Electric Company. I think it will interest you. It says, in part: "Radiation from FCC approved diathermy and industrial equipment, and international short-wave stations, does not affect either the image or the audio in General Electric's current line of television receivers, the Company's distributors have been told in a letter mailed today by the G-E receiver division.

"G.E. stands practically alone today in being able to offer this demonstratable advantage because the Company's TV sets now operate in the 'relatively quiet' 40-45 megacycle band, the distributors have been informed.

"In its report to distributors, G.E. enclosed a letter from the Liebel-Flarshein Company of Cincinnati congratulating G.E. 'on being the first major producer of television receivers to adopt an intermediate frequency that is not sensitive to the 27.12 megacycle signals generated by FCC approved industrial, medical and scientific apparatus.'

"The Cincinnati company explained that it had placed one of G.E.'s receivers alongside its short-wave diathermy unit and 'after prolonged tests there was no sign of TVI,' it said.

"The company pointed out that 'the earlier 21 to 26 megacycle IF standard used by most television receivers has been the cause of considerable television interference when sets are operated in the vicinity of FCC approved diathermy apparatus.'"

I don't believe much comment is required. This change will make a lot of hams happy and it will certainly mean that there will be many happy G-E television receiver customers. Of course, if that TV set you are messing up is not a new G-E model, there is always the Harmoniker (*Ham News*, Vol. 4, No. 6)!

— *Lighthouse Larry*

TRICKS AND TOPICS

How did you solve that last problem that almost had you stumped? Be it about tubes, antennas, circuits, etc., Lighthouse Larry would like to tell the rest of the hams about it. Send it in! For each "trick" published you win \$10 worth of G-E Electronic Tubes. No entries returned. Mark your letter "Entry for Tricks and Topics" and send to Lighthouse Larry, Tube Division, Bldg. 269, General Electric Company, Schenectady, New York, or in Canada, to Canadian General Electric Company, Ltd., Toronto, Ontario.

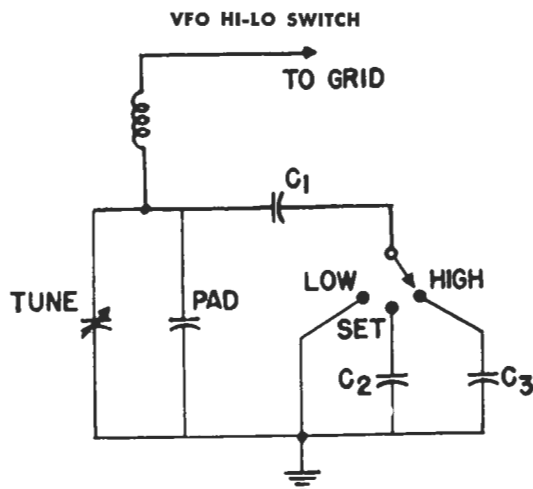


Fig. 6. Details of the HI-LO Switch described by W2FZW.

The idea of providing a panel switch on VFO's arranged to alter the VFO output frequency by a small amount (5 kc-10 kc) higher or lower than the "set" frequency has had much appeal both to DX operators and to traffic operators. In both of these activities the ability to switch 5 kc-10 kc either side of the nominal VFO frequency adds a flexibility to operating procedure which effectively increases the operating efficiency of the station many fold.

The difficulty in providing such an arrangement for the VFO lies in the small frequency shift desired. For example, at 28 mc a shift of 5 kc represents a frequency change of one part in 5600, or approximately 0.02%. In order to achieve this result the necessary capacitor change should be approximately 0.04% or one part in 2800. Assuming the VFO tank capacitor to be 500 mmf, the indicated change would be roughly 0.2 mmf. Many series-tuned (or Clapp) VFO's have tank capacitors one tenth or less that of this example, and would require changes of 0.02 mmf or less. These capacity changes are very small compared to the stray capacities associated with the best switches available for providing the circuit changes. In addition, capacitors of these small values are not commercially available and attempts to construct small trimmers for the purpose are likely to be disappointing because of mechanical difficulties and additional stray capacity effects.

A solution for these difficulties may be readily found if one recalls the once popular series bandspread scheme which was used by many home constructors in years past, and which is still used commercially in

the National HRO series receivers. The problem is identical; that of making the relatively large tuning capacitor behave as if it were a rather small one. To adapt it to our VFO problem we need only make the circuit look like Fig. 6.

This figure shows the "business end" of a Clapp oscillator tank with a typical switch arrangement. The tank (or pad) capacitor might be 50 mmf. Let us also assume that we wish to have approximately 5 kc frequency changes between switch steps at 28 mc. This, as was noted above, represents frequency changes of 0.02% per switch step, or changes in effective capacity of 0.04% per switch step. A change of 0.04% in capacity would amount to 50×0.0004 , or 0.02 mmf. In other words, C_1 and C_2 in series should have an effective capacity of C_1 minus 0.02 mmf, while C_1 and C_3 in series should have an effective capacity of C_1 minus 0.04 mmf.

If C_1 is chosen as 1 mmf, then C_2 should be approximately 50 mmf, and C_3 should be approximately 25 mmf. These capacities are readily available in the normal range of trimmer values (or small fixed ceramic units if these are preferred) and will also be reasonably large compared to the switch capacity and other wiring stray capacities.

The same stunt will work on all bands, with C_1 usually chosen larger on the lower frequency bands (where a larger percentage frequency shift is desired) or where higher C VFO circuits are used.—W2FZW.

WIRE COVERING

Having two parallel loose wires going to a phone plug, I wanted a covering over them to keep them from separating and to form a smooth flexible cord. At the local dime store I purchased a pair of 40 inch shoe laces. The ends from one lace were removed which left me a hollow cotton tube. (Most shoe laces are hollow.) The ends of the wires were wrapped with a small piece of scotch tape. The wires were then very easily pushed through the hollow shoe lace as the lace tends to increase slightly in diameter and slightly decrease in length like shield wire. After the wires were in the lace it was pulled out to its original length by a pulling action along the lace while holding one end and the wires firmly. This makes a smooth snug fit. A drop of cement was added to the ends of the shoe lace and then wrapped with a short piece of thread.

This method can also be used for three or four wires and makes a professional looking cable to your exact specifications.—W2FEN.

PROPER CARE OF CRYSTAL MICROPHONES

Crystal microphones are likely to lose their sensitivity and frequency response during hot humid weather. Although microphones are sealed against moisture, moisture may creep in and damage the crystal element.

For sometime I have noticed the modulation percentage in my transmitter gradually go down until I could barely modulate 50% with the audio gain wide open. A careful check of the speech amplifier and modulators indicated no trouble there. The microphone was then suspected because of the unusually damp weather that has existed here all summer. I was about to discard the mike or send it to the factory for repairs, but I decided to try a little stunt as a last resort. The microphone was placed in a clean, dry, airtight can with one pound of fresh silica gel

obtained from a local radio and refrigeration supply house. In twenty-four hours the mike worked as good as new; in fact, it works better now than it has in two years.

I would recommend that this trick be tried on all crystal microphones which have been subjected to excessive moisture or humidity before discarding. In fact, I believe it would be good practice to store the mike in this manner when not in use particularly during the hot humid months of summer.—W4AEE (Ed.'s note—the following complete story on the proper care of crystal microphones appeared in a recent Electro-Voice release—Lighthouse Larry.)

"What causes crystal microphones to lose sensitivity? To answer this let's first see what the crystal is made from.

"Rochelle salt crystals are formed synthetically. When the rochelle salt crystal is grown it takes four molecules of water of crystallization for every molecule of sodium potassium tartrate. In humid climates, the crystal has the property of absorbing moisture and the result is leakage resistance or low output. Placing the microphone or cartridge in a silica gel desiccator will reduce this excess moisture but there is the possibility that if left in too long the moisture content of the crystal might be lowered to the point of damage.

"If the humidity is less than 23% for a long period you will get dehydration or drying out. If the temperature rises to 127°F. the sodium potassium tartrate dissolves into the water of crystallization. In other

words, if a crystal microphone gets too hot, too dry or too wet, it won't work.

"These statements seem to run down devices using rochelle salt crystals. This is not true. If the humidity is between 23% and 86%, except for brief periods, crystals will stand up fine. If the temperature is below 127°F., no trouble will result. That's why the manufacturer puts a guarantee on crystal devices and caution is given about heat. Occasionally crystals are damaged when the limits mentioned above are exceeded.

"Rochelle salt crystals are treated to prevent damage from moisture. E-V has given an additional protection for added life on crystal cartridges. The case is completely filled with silicone to prevent moisture from getting to the crystal. The leads are a bad spot for moisture to enter and the E-V silicone treatment eliminates this fault. E-V crystal devices are all thoroughly moisture inhibited, the result of intensive moisture-proofing research." (Electro-Voice "Report to the Distributor," August 15, 1949. Reprinted by permission of Electro-Voice, Inc.)

MICROPHONE COVERS

To the hams that use crystal mikes which are subject to moisture conditions, just snoop in the kitchen for cellophane dish covers, and secure the proper size cellophane cover for your microphone. It makes a much nicer cover for a mike than a dish. Try it, it also keeps out dust and other foreign particles.—W ϕ DWF.



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FROM: