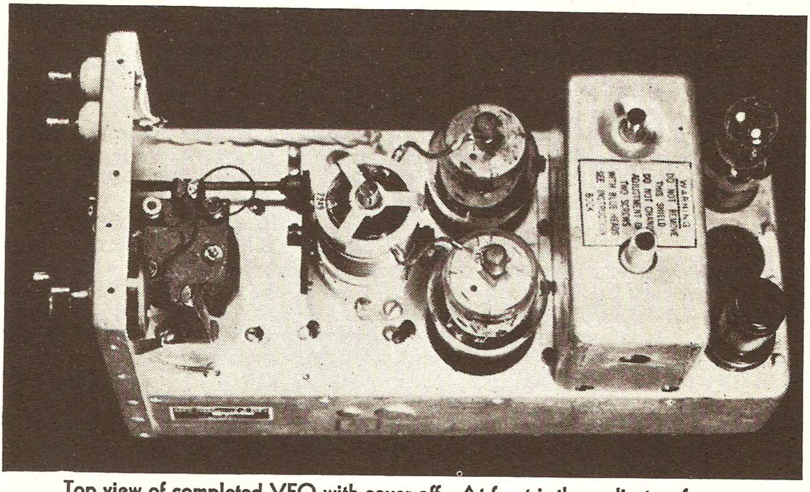
AN SCR-274N VFO FOR AM,FM

An increasing amount of surplus Army equipment is appearing on the civilian market. Among various items of interest to the radio amateur is the SCR-274-N, an aircraft unit that is very easily adapted to amateur use as a stable, variable-frequency oscillator (VFO), either for AM or FM operation. The SCR-274-N is the overall designation given the principal components of a multi-channel aircraft radio receiving and transmitting set-up used on thousands of planes and now "declassified." So that the reader may know what to look for, the army numbers of the equipment are as follows:

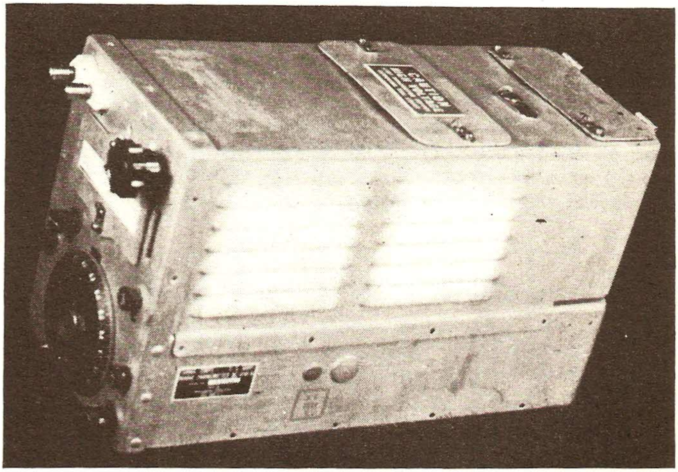
The receiving end consists of three separate units—the BC-453-A (190-550 kc), the BC-454-A (3.0 to 6.0 mc) and the BC-455-A (6.0 to 9.1 mc). These receivers operate from the airplane 24-28-volt storage battery and each contains a separate dynamotor for plate power. It is an easy matter to substitute 6-volt tubes for the 12-volt series type originally in the receiver, and rewire the filament string for parallel 6.3-volt operation from a standard filament transformer. (Alternatively, a 24-volt transformer may be used to energize the heater circuits with the receiver left as is.) Any light 250-volt receiver power supply will provide plate power for the sets, or a vibrapack may be used if mobile operation is contemplated. These receivers are very sensitive, incorporating an r-f stage, BFO for c.w. reception, and, all-in-all, make excellent receivers up to approximately 10 megacycles.

The Transmitters

Four separate transmitters are included in the sending unit. The BC-696-A covers 3 to 4 mc, the BC-457-A from 4 to 5.3 mc, the BC-458-A, 5.3 to 7 mc, while the BC-459-A tunes from 7.0 to 9.1 megacycles. Each transmitter consists of a master oscillator tube (1626 or 12J5) exciting a



Top view of completed VFO with cover off. At front is the audio transformer (500 ohms input) Next can be seen the power amplifier coil with the variable coupling to the link and the twisted pair to the output terminals. Tubes and master oscillator frequency control box next. At the rear are the master oscillator tube and the FM reactance tube. The center socket is not used.



View showing completed VFO. Upper left is the output. Upper right is the volume control when used for FM operation. Center is the dial which controls the frequency

pair of beam tetrodes in the power amplifier stage (1625's or twelve volt 807's). The tubes in the amplifier are connected in parallel. The master oscillator and r-f power amplifier tuning capacitors are gauged, and an excellent worm drive, with plenty of reduction, is incorporated in the dial system. Included in each transmitter is a piezo-electric crystal and an electronic resonance indicator for calibration. This may be removed to make way for additional FM features, to be described later, or left as is if only AM VFO operation is contemplated. The power output may be varied from a few watts to approximately 55 watts according to the power supply on hand. Thus, one of these little jobs may be used as a fixed variable-frequency transmitter or as a driver for a higher-power amplifier.

The components are of exceptionally high quality and the assembly rigidly constructed. By using standard aircraft shock mountings (which are attached), the mechanical stability is excellent; and with a stabilized 200-volt supply to power the master oscillator, the drift is very small. This equipment was designed to hold the frequency quite constant in aircraft under vibration and extreme temperature changes; so it can be understood that the frequency variation will be practically nil with the set mounted on the operating table, subject to little vibration and relatively constant temperature.

Modifications for Amateur Use

At W5AJG, we were interested in a VFO unit to work directly into the crystal oscillator tube—in fact, to work in place of the crystal itself. Since all the crystal stages started with either 6 or 7-mc crystals (6 mc for the 144-148-mc band as well as the 50-54- mc band) it was decided to purchase the BC-458-A transmitter unit which covers 5.3 to 7.0 megacycles. Actually, this unit will reach to about 7.5 mc and will replace any 7-mc crystal.

It was decided to add a simple reactance tube modulator circuit and have the choice of either AM VFO or narrow-band FM transmissions. This was accomplished by a simple modification, and the unit works on either frequency or amplitude modulation. Should the crystal stage of the regular station transmitter start with a 3.5-mc crystal instead of a 6 or 7-mc crystal, the BC-696-A, with its range of 3 to 4-mc, should be selected.

The changes necessary to do the job are as follows. Reference is made to the *original* schematic, *Fig. 1*, and to the *modified* diagram *Fig. 2*. To begin with, the 24-volt former airplant battery supply is replaced with a 110 to 24-volt transformer for the heaters. These transformers are surplus stock in any mail-order catalog and sell for around $1.25. This is cheaper and easier than replacing the oscillator tube and the two tetrode finals with 6-volt versions, and obviates wiring changes in the heater circuits.

Next, the unwanted components are removed from the chassis—namely the variable antenna loading inductor $L52$ (this will serve admirably as an antenna tuning coil elsewhere around the station), as well as the antenna change-over relay *K*54. Relay *K*53 is either tied down in the energized position or removed and the wiring circuits closed. This relay switches plate voltage to the master oscillator and shorts out resistor *R*75 which was used for c.w. work. An extra feed-through insulator is employed to bring out the low-impedance line coupling the output transformer, *T*54, to the crystal oscillator stage of the transmitter it drives (*Fig. 3*).

For AM VFO operation, the above changes are all that are necessary. Of course a power supply, preferably a regulated 220-volt unit, is used to power the master oscillator—while anything from 200 to 550 volts, unregulated, is suitable for the amplifier, depending on the desired power output.

The dial is very closely calibrated and a 4,600-kc crystal resonator is used to check the calibration. This is very simply observed by tuning for maximum indication on the electronic eye tube and then noting if the dial reads exactly 4,600 kilocycles. The transmitter is then calibrated over the rest of the dial. This crystal does not stabilize the frequency in any way—it is merely a built-in standard to check the master oscillator dial setting. A crystal of another frequency could be substituted—for instance one spotting a particular pet or net op-

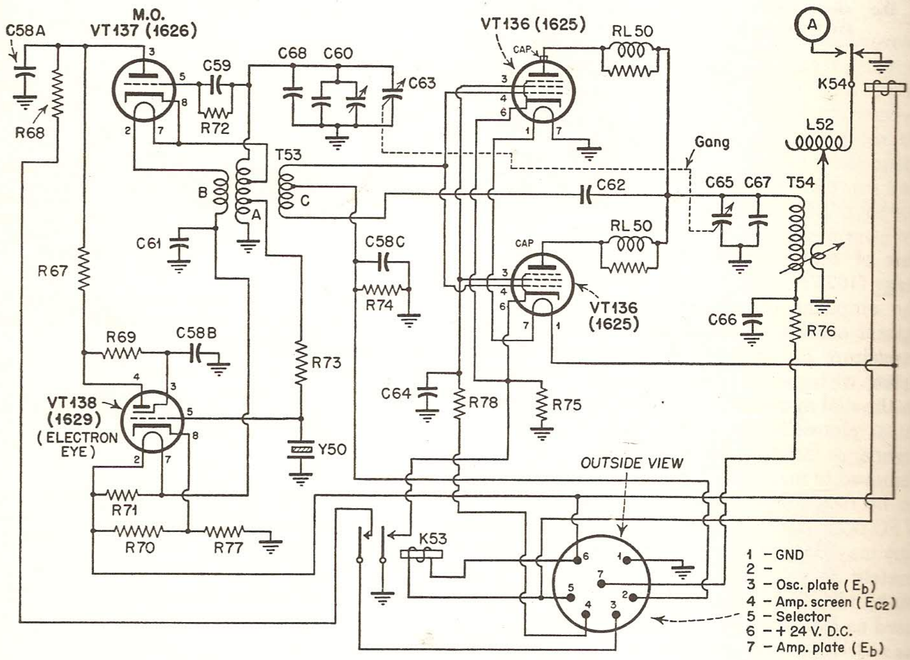


Fig. 1. Original schematic of the BC-458-A (5.3 to 7.0 megacycles with a bit of leeway). The following parts are identified:

$C_{58}A$, $C_{58}B$, $C_{58}C$—.05 μf
C_{59}—.00018 μf
C_{60}—master oscillator padding
C_{61}—.006 μf
C_{62}—fixed neutralizing
C_{63}—master oscillator tuning
C_{64}—.002 μf
C_{65}—power amplifier tuning
C_{66}—.01 μf
C_{67}—power amplifier padding
C_{68}—3.0 μμf
C_{69}—50 μμf
K_{53}—transmitter selector relay
K_{54}—transmitter output relay
L_{52}—antenna loading coil
R_{67}, R_{72}, R_{75}—51,000 ohms
R_{68}, R_{76}—20 ohms
R_{69}—1 megohm
R_{70}—1,000 ohms
R_{71}—126 ohms
R_{73}, R_{74}—15,000 ohms
R_{77}—390 ohms
R_{78}—51 ohms
RL_{50}—parasitic suppressors
T_{53}—oscillator coils
T_{54}—amplifier coils
Y_{50}—crystal unit
7-prong female plug, outside view

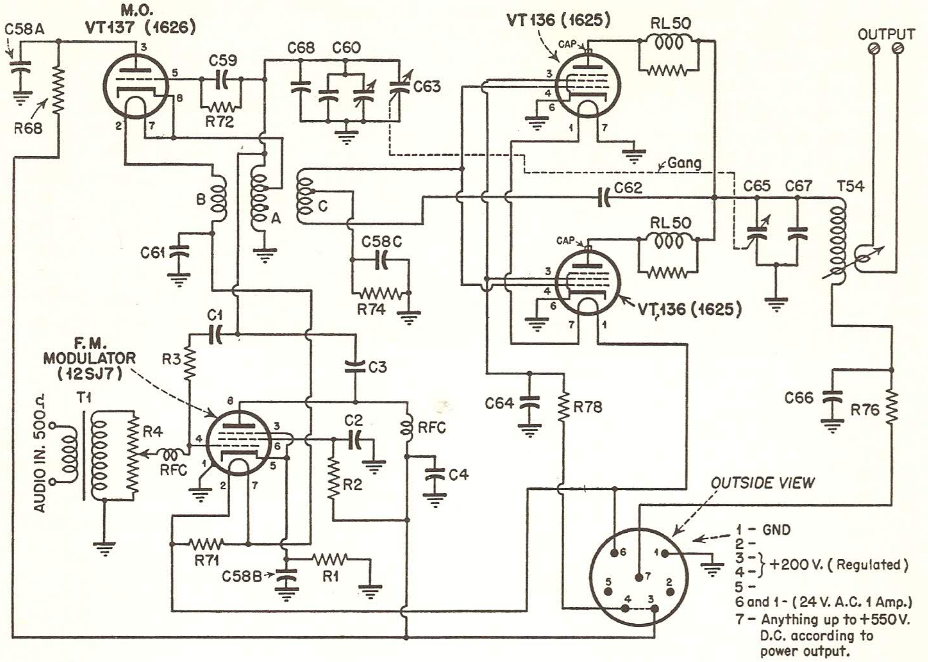


Fig. 2. Modified diagram of transmitter covering from 5.0 to 7.3 megacycles. Referring to Fig. 1., the following components were eliminated mainly from the electronic eye circuit: R_{67}, R_{69}, R_{70}, R_{73}, R_{77}, Y_{50}, K_{53}, K_{54} and L_{52}. Parts added for the FM reactance modulator comprise—

C_1—.00025 μf mica
C_2, C_4—.01 μf paper
C_3,—.0005 μf mica
R_1—1,000 ohms, 1/2, watt carbon
R_2, R_3—50,000 ohms, 1/2, watt carbon
R_4—500,000 ohms gain control
RFC—2.5 mh r-f chokes
T_1—line input audio transformer, 500 ohms to grid
12SJ7 metal or glass tube

eration frequency. This would enable the operator to place himself exactly on a particular frequency in the band.

Additional Modifications for FM

It is probable that the amateur will engage extensively in FM narrow-band operation in the near future as well as amplitude modulation. Advantages are claimed for FM in services closely paralleling amateur operation, such as mobile police and point-to-point communications. Not the least among these features is the very modest requirement in regard to modulating power. Also, existing superhets will do a good job of receiving FM transmissions. Later, of course, an FM channel will no doubt be standard equipment in all ham receivers.

By making a few more additional changes, the

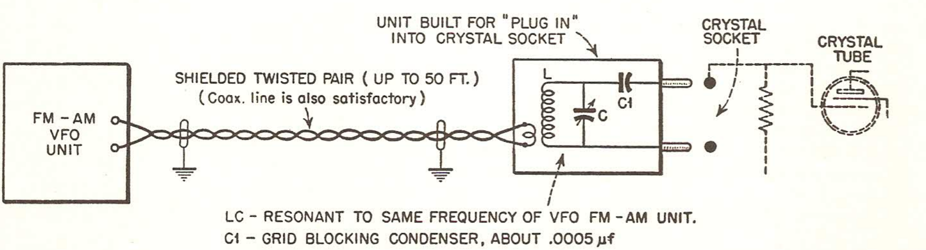
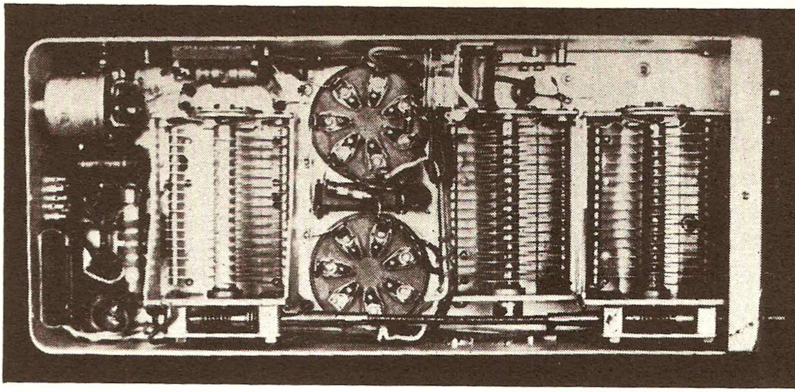


Fig. 3. Suggested arrangement for coupling the VFO to the regular station transmitter when high power is desired



This shows the bottom view and is practically as is when it comes from the ARMY. The reactance tube and components are mounted in the rear. The ganging of the Master oscillator and power amplifier condensers is clearly shown. Notice worm gears on the condensers.

already modified AM VFO can just as easily be converted to narrow-band FM operation. This is accomplished by adding a reactance modulator tube and shunting its output circuit directly across the master oscillator tube—thereby varying the frequency of the master oscillator in accordance with the audio applied to the reactance tube input circuit. Of course purely AM operation is still possible as above. The FM feature is additional.

Again referring to the original and modified schematics, the electronic eye (1629) is removed to make way for the substitute reactance modulator tube. This new addition will be a 12SJ7 type tube. Also the resonator crystal is dispensed with, and all wiring from these two sockets removed, with the exception of the heater leads to the 12SJ7 tube. Note that the original resistor *R*71 remains in the circuit across the heater terminals. The new wiring is simple and follows that in the modified schematic. A 500-ohm line to the grid transformer permits the output of the speech amplifier to modulate the reactance tube. Audio required is approximately zero db.

Should AM operation be desired, it is merely necessary to turn off the reactance tube gain control, *R*4, and plate modulate the station transmitter in the usual way. With FM operation, the zero db audio track is fed into the 500-ohm input circuit and the gain control turned up sufficiently to produce the required swing of the carrier. Of course the mean frequency may be spotted anywhere in the band by using the calibrated dial in the usual way. Needless to say, it is necessary, when using FM, to stay within the confines of the FM portion of the band. A swing of a few kilocycles on the fundamental frequency of the VFO will be multiplied by the same ratio of frequency multiplication in the transmitter. Thus, if FM operation in the 144-148-mc band is desired with a VFO frequency of 6 megacycles, a swing of 1 kc at this point will be multiplied by 24, which is more than ample for narrow-band amateur FM work.

Coupling to Main Rig

The output of the FM-AM VFO unit can be coupled to the crystal tube of the regular station transmitter in a number of ways. At W5AJG, a shielded twisted pair runs from the operating desk, upon which the VFO is mounted, to the crystal stage of the transmitter proper across the room (*Fig. 3*). The crystal is removed and a separate tuned tank circuit substituted by plugging into the crystal holder. Should the ex-crystal tube be a harmonic type, this tuned tank can be of the same frequency as the crystal. In tri-tet crystal oscillators, the cathode coil should be shortened. With pentode type oscillator tubes, it is usually possible to work straight through without self-oscillation. However, should 7-mc operation be primarily desired, it is advisable to choose a VFO unit operating on 3.5 megacycles so that the former crystal-controlled tube will operate as a doubler. In any event, care should be taken to avoid shorting the grid bias of the ex-crystal tube by connecting a blocking capacitor in series with the high side of the oscillator tube.

It will be found that the SCR-274-N makes a very nice VFO unit with AM or FM operation optional at a very low cost. It is suggested that those interested in obtaining equipment of this type, contact firms that rebuild and reconvert government aircraft apparatus to civilian requirements. As used in Army service there is usually about three times the amount of equipment needed for civilian purposes, and the surplus gear is generally available at a very moderate cost.