AN ALL-BAND SSB EXCITER

UNIT CONSTRUCTION—RELIABLE CIRCUITRY—STANDARD COMPONENTS—PROGRESSIVE DEVELOPMENT

Part I

C. BOWDEN (G3OCB)

This article by a well-known contributor will be of considerable interest, not only to all who build their own gear, but also to those who want to understand SSB circuitry. A high-power linear amplifier to go with this Exciter was described in the July '64 issue of "Short Wave Magazine," and a VHF-Transverter/PA for two metres in October, 1963. These two items could, of course, be used with almost any existing Sideband exciter. The article following now describes the author's own SSB generator and driver/PA, built in five separate units, and operated with the equipments already mentioned. —Editor.

THE construction of this Sideband Exciter is based on the use of individual sub-chassis for the various sections of the unit, a practice which is much less common than the use of single chassis, and which is often ignored by constructors.

Although more expensive, there are many advantages to be obtained from unit type construction. A far more rigid assembly is possible and screening between various sections is much more effective, especially if feedthrough capacitors are used. Another useful feature is that various sub-units may be re-used in later designs. When the design of a particular unit proves unsatisfactory it can be very easily replaced without necessitating a complete re-build or, what is probably worse, leaving what was originally a neat piece of equipment looking like wire netting.

Five main assemblies are used in the exciter:

(1) AF Amplifier and Carrier Oscillator/Balanced Modulator.
(2) Filter and First Amplifier; First Conversion Mixer.
(3) Sideband Selection Oscillator, VFO, VFO Amp, Second Mixer and Amplifier.
(4) Final Conversion Oscillator, Mixer, Driver Amplifier and Power Amplifier.
(5) Vox and Control Circuits.

Although the Exciter described is fairly complex in order to produce good sideband with the minimum of spurious output, the less experienced constructor can obtain perfectly adequate results from a much simpler basic transmitter. The use of sub-assemblies permits the newcomer to gain much experience by building the "heart" of the SSB rig, *viz*, sub-assemblies 1 and 2 and obtaining efficient operation of these two fairly straight forward units before proceeding to sub-assemblies 3, 4 and 5.

Suggestions for the beginner: Build the filter with one half-lattice only to begin with, leaving room for the addition of a second one later. Instead of feeding a conversion input frequency of 1·6 or 2·525 mc into mixer V5, Fig. 2, a VFO covering about 50-100 kc at 4·2 mc (or a crystal oscillator in this range) may be substituted. IFT5 can be replaced by a single 3·7 mc tuned circuit and the output from V5 fed *via* a link winding to a simple 2-stage amplifier using say, an EF91 and 6CH6, which will permit a few watts of SSB to be produced. The remaining circuitry could then be substituted when the constructor feels he has gained enough experience.

Although testgear such as BC-221, Wobbulator and an Oscilloscope would make the task of alignment much simpler, these instruments are not absolutely essential. Provided a reasonable general-coverage receiver incorporating some form of S-meter is available the only other equipment needed will be a multi-range testmeter and a diode probe. The S-meter need not even be accurately calibrated as only a *relative* indication of output is required. Also some form of simple oscillator covering the filter frequency will be necessary.

The block diagram Fig. 1 shows the general operation of the circuit and the various frequencies used. There is, of course, considerable latitude in the choice of valves, crystals and other components. Where the latter have not been given a tolerance rating in the table of values there is considerable scope for variation, in some cases 100 per cent or more without materially affecting performance. Certain voltages and currents are more critical, however, and where these are important their values are given in a table.

Crystals for filter and carrier can be selected from any suitable frequency in the region of the normal IF range. Crystal XC8, Fig. 3, can be any frequency between about 1·5 and 1·8 mc and XC9 will then be higher by an amount equal to twice the carrier frequency.

The VFO range (Fig. 3) can be altered to suit the requirements of the constructor. As the coverage is reduced, tracking the various variable tuned circuits becomes simpler and it is also much easier to maintain drive over the whole range. Bandspread is also improved. By using a coverage of 500 to 750 kc, however, there are several advantages which will be described later.

A calibrated dial is not fitted, as at G3OCB this exciter is used in conjunction with a well-calibrated amateur-bands-only receiver and the Eddystone vernier dial used is quite satisfactory. The whole assembly is accommodated on a chassis 15¼in. wide by 12in. front-to-back, on which are assembled five sub-chassis units. (Layout diagrams will appear with Part II.)

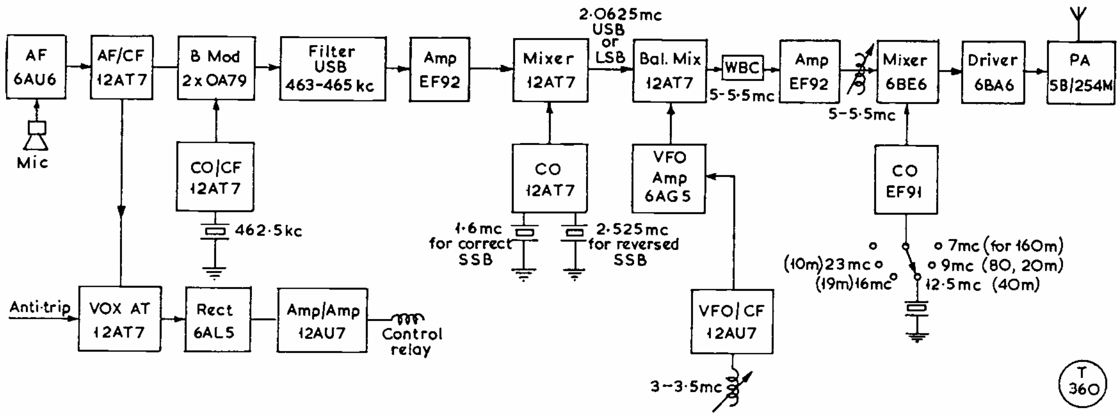


Fig. 1. Block diagram of the all-band Sideband Exciter described in the article by G3OCB. While it could be operated initially as a low-power SSB transmitter — the PA valve being a 5B/254M — it is intended as a driver for a 600-watt linear amplifier. On the constructional side, the arrangement breaks down into five separate units, made up as sub-assemblies for mounting on a single chassis. Details of the circuitry are shown in Figs. 2-4 herewith.

Individually, the circuits used are quite straightforward. All of the amplifying and mixing stages employ normal circuitry of the type found extensively in modern equipment.

Perhaps the only unusual feature in this circuit (Fig. 3) is the use of the amplifier V7 after the wideband coupler. There are two reasons for this: In the first place the whole performance of any exciter rests on its capability to produce adequate input to the last mixer over the whole range of the VFO coverage; many exciters do not provide adequate drive at this point. Since the gain after the latter is usually limited, in order to preserve stability, it is important to ensure that there is ample drive to the grid of the last mixer so that later stages will be able to drive the PA fully. The use of the amplifier V7 after the wideband coupler ensures that there is about 1v. peak SSB available from 4·75 to 5·5 mc (the coverage in the author's exciter), across the link winding on L1, Fig. 3.

The other reason for the use of the extra stage, and for tuning it, is that the wideband coupler is at best a compromise and may exhibit an appreciable response outside the passband, as well as passing anything spurious that may fall within the passband. Provision of the single fairly high-Q tuned stage after the coupler results in good rejection of unwanted signals.

Since mixer V6 is balanced (for reasons explained later) the use of a wideband coupler in its anode circuit is more or less unavoidable since a single tuned circuit cannot easily be used here without resorting to the use of an unbalanced mixer.

The balanced modulator, Fig. 2, is quite simple to construct, but the leads should all be kept short, and the layout should be as symmetrical as possible in order to balance the stray capacities. Even so it may be necessary to include C100 from one side or other of R33 to earth—*see* Fig. 2—the value being anything from zero to 50 $\mu\mu$F or even more.

The carrier oscillator V8 in Fig. 2 may not be easy to get going with some crystals. If this is so the capacitors C97 and C98 may be altered in value until the circuit oscillates readily.

The construction of IFT7 is shown in Fig. 6. The coil was removed from an old 465 kc IFT and the threads were reamed out until the coil slid easily on to a Neosid former. The original condenser which resonated the coil is used in the position C34 (Fig. 3). The secondary consists of 50 turns, 25 being wound either side of the coil and tightly coupled to it.

The construction of the wideband coupler is shown in Fig. 7. The formers used are again taken from old IFT formers and reamed to slide on the Neosid former, which allows the coupling between the coils to be varied.

The Filter

Articles describing the construction and alignment of filters are often made to appear very complicated. Filters are not difficult to make and align although the beginner may be well advised to start with a single half-lattice version to avoid the complications which may arise with double-filters. Room can be left for the addition of another section after some experience has been gained.

In the opinion of the author it is unnecessary and indeed inadvisable to try to alter the frequency of the very delicate FT241 surplus crystals by plating, etching or edge grinding. When a single-section filter is to be built there is no need to shift crystals around. In the case of a two-section filter it can be avoided by buying a number of each of the required frequencies and selecting suitable pairs by experiment or, if available, by using a BC-221. Most amateurs number among their acquaintances one who is the proud possessor of a BC-221 or similar instrument and who would be pleased to assist in matching the crystals.

Even if it is not possible to match accurately the constructor should not despair. Experiments with a Wobbulator and 'Scope on some double half-lattice filters revealed that it was possible to obtain quite a

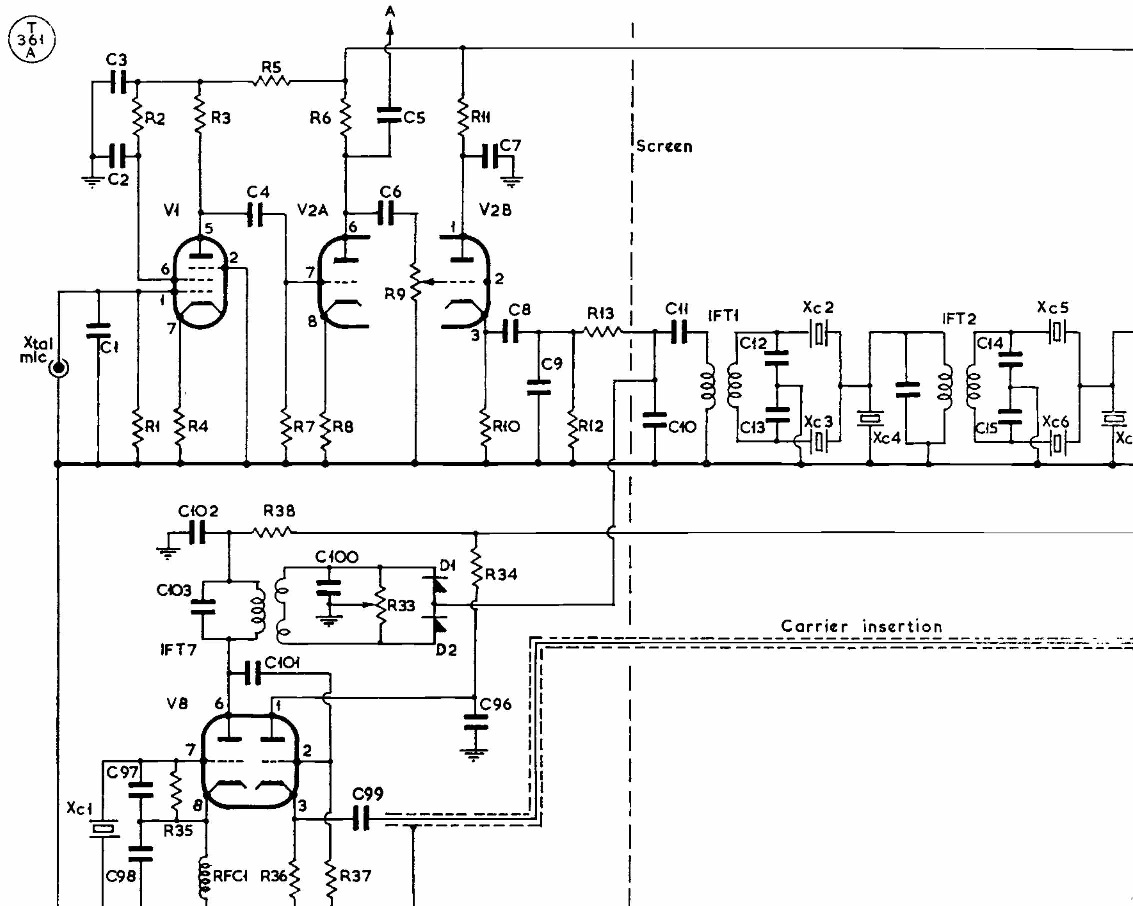


Fig. 2.

reasonable selectivity curve even if some of the crystals were as much as 150 cycles separated in frequency. The side-responses were slightly inferior and occasionally very narrow slots appeared in the passband, but on a listening test results were usually quite satisfactory. If it is found impossible to construct a satisfactory double half-lattice filter the constructor can still resort to a single half-lattice with acceptable results.

A double half-lattice filter should result in a sideband suppression of about 55 dB without difficulty, while with a single half-lattice the figure will be about 35 dB. The carrier rejection crystals XC1, XC4, XC7, can be omitted but their inclusion will greatly improve the performance as the remaining carrier will be much attenuated and the passband will be a great deal steeper on the carrier side, resulting in improved transmission of the middle frequencies of the audio register (250 to 300 c/s approx.).

Commercial crystals can be obtained which should enable the filters to be built with more predictable results, or a mechanical filter can be considered as an alternative. Either of these will, however, result in much greater expenditure as something like 18 to 20 surplus crystals can be obtained at half the price of commercial crystals or a mechanical filter.

High Q transformers should *not* be used in the filter. The types recommended are excellent for this application. Whatever type is used the fixed tuning capacity should not exceed about 100 $\mu\mu$F or difficulty may be experienced in obtaining a good passband shape due to the mismatch of impedances. The IF transformers IFT1 and IFT2 (*see* Fig. 2) feeding into the filters are modified slightly, the internal 65 $\mu\mu$F capacitors being removed from the secondary side and being replaced by two 120 $\mu\mu$F capacitors in series which are mounted externally. In addition the primary capacitance of IFT1 is removed and replaced by 65 $\mu\mu$F and ·001μF condensers connected in series, again both being mounted externally. This allows the low impedance balanced modulator to be effectively matched into the filter.

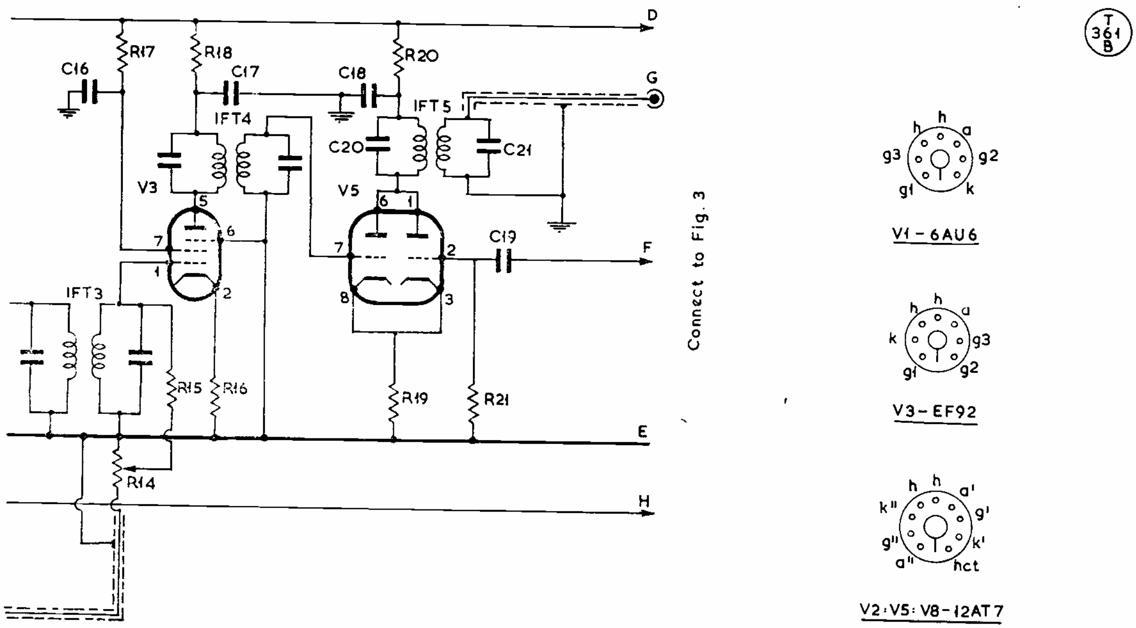


Fig. 2. The audio, carrier and filter section in the Sideband Exciter by G3OCB. This is fully discussed in the text, and the crystal frequencies to use are given in the table on p. 660. With full filtering, a very high degree of carrier suppression can be obtained.

Carrier Re-Insertion

In order to tune up the exciter it is necessary to be able to introduce a constant signal at will. This can be easily done by by-passing the filter and balanced modulator with a certain amount of carrier. RF from the carrier oscillator is fed to the second half of V8, a cathode follower; from there it is passed to R14, the carrier insertion control (Fig. 2). When this is advanced, carrier energy is fed directly to the grid of V3. Inserted carrier is also necessary for CW transmission and for amplitude modulation (carrier and one sideband only).

After amplification by V3 the upper sideband signal is passed to mixer V5 where it is converted to a new frequency at about 2 mc, the output of the latter being either upper or lower sideband depending on the frequency of the input from V9.

The various RF circuits of the individual sub-chassis are coupled together by short lengths of coaxial cable and the standard TV type plugs and sockets, the latter being indicated by Sk 1 to Sk 4.

The two transformers IFT5 (Fig. 2) and IFT6 (Fig. 3) are modified so that they resonate at around 2·06 mc, by removing the original 100 $\mu\mu$F capacitors and replacing these by condensers having values of about 50 $\mu\mu$F (two 100 $\mu\mu$F in series in the case of IFT6 secondary).

VFO and Amplifier

The VFO circuit used has been found to be very stable in operation, even without negative temperature coefficient capacitors, although use of the appropriate degree of compensation would remove most of the remaining drift. The output from the VFO is low, however, as stability has been given priority, so it is necessary to amplify the VFO output in order to assure adequate conversion gain in V6.

Crystal Oscillators V9, V15

Both oscillators are straight-forward and easy to get going. Only one coil is used in the case of V15, Fig. 4, this being tuned to the appropriate crystal harmonic by C59 to C64. This results in a reduction of coil Q on lower frequency bands, but since lower order harmonics are used on these bands, there should be ample output. The tuning condenser is set to a point at, or just off resonance, at which the required mixer injection is obtained. If injection is insufficient on any particular band, then a coil and capacitor having a better L-C ratio can be switched in on that band, but this will require an additional switch wafer.

Mixing Circuits and Distortion

It will be noticed that the two mixers V5 (Fig. 2) and V16 (Fig. 4) use different valves and circuit. There is very little practical difference in either circuit and the choice of each was governed by the valves available at the time the exciter was built. Both are very low distortion types but the gain is rather low and in the case of V5, there may be some damping of IFT5 by the low Ra of the triode mixer.

Mixer V6 (Fig. 3) employs a completely different type of circuit. Since the heterodyne input to the

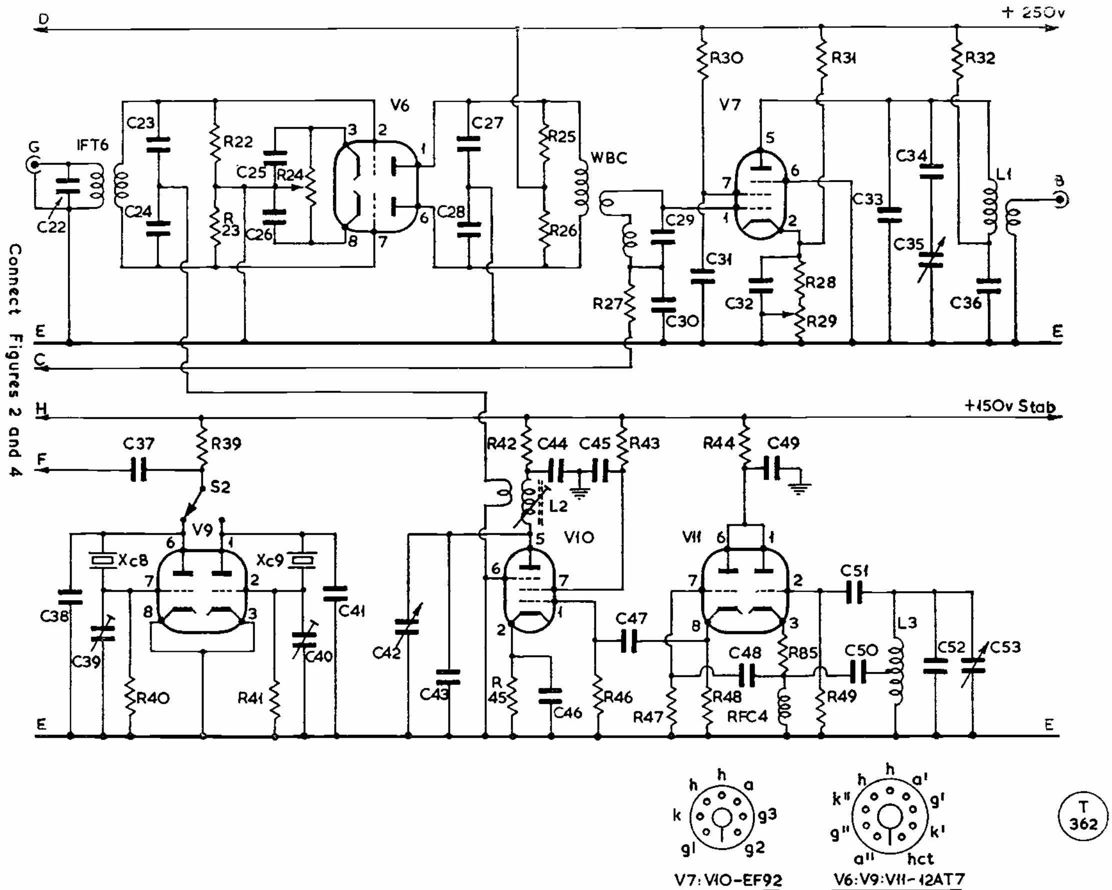


Fig. 3. Circuitry for the VFO and Sideband selection in the G3OCB SSB Exciter. The latter operation is performed by S2, in the plate of V9, and values for the appropriate crystals are given in the table. V11 is the VFO, and V10 its amplifier stage, since the output from V11 is kept very low in the interests of stability. Further details are given in the text, and it will be noted from the lettering how Fig. 2 connects to the next section and how Fig. 3 feeds into Fig. 4.

valve is a variable frequency, there is greater chance of any signal that leaks through to the following stages causing spurious responses and by employing a balanced mixer, the VFO signal is reduced by some 20 dB or more in the anode circuit. The balanced mixer also provides more gain than either of the other two circuit configurations.

The use of the two transformers IFT5, IFT6 connected back-to-back provides enough selectivity for adequate rejection of the crystal controlled input from V9 without having to make V5 a balanced mixer, which would have introduced problems with regard to the transference of the signal from V5 to V6 *via* a pair of long balanced leads.

Mixer V16 (Fig. 4) is unbalanced but in practice it has been found that there is again more than enough rejection of unwanted frequencies due to the overall selectivity of the various cascaded tuned circuits (V17 grid, V17 anode, V18 anode). The input to V16 from V7 is quite free from spurious signals and the heterodyne input from V15 is about 5 mc away from the output frequency. If the crystal frequencies indicated are chosen, no crystal harmonic should fall closer than 2 mc (weak fourth harmonic when on 10 metres) and little trouble should be experienced due to radiation of one of these harmonics.

The level of all spurious signals can be kept down by ensuring that the heterodyning input to each mixer is at the correct level. Too much input can cause a drop in conversion gain and a considerable increase in the generation of harmonics. In a similar way excessive SSB input to an amplifier or mixer can result in severe distortion and generation of spurious signals both in adjacent channels and on harmonic frequencies. The ratio between the heterodyne and signal voltages fed to a mixer stage should always be at least four or five to one if distortion is not to be introduced. Similarly the audio input to the balanced modulator should not exceed about 25 per cent of the carrier input. It is for this reason that the AF gain control is mounted inside the exciter. Once set it should not be touched.

A table is given later showing the approximate voltages which may be expected at various points in the circuit, as measured on the diode probe shown in Fig. 8 (Part II). In the same table a number of maximum permissible voltages are quoted and these figures should not be exceeded.

When a tone of about average speech level is sounded into the microphone with the drive control advanced, then about one volt should be indicated on the diode probe if the latter is connected across R76 (Fig. 4). If this figure is not obtained then it is useless to try to increase drive to the PA by increasing the gain of the exciter in any stage *before* V16 grid. To do so will not improve the drive level to any material extent. Any apparent increase in drive will be accompanied by an increase in harmonic and intermodulation distortion. The only solution here would be to increase the gain at a later stage in the circuit.

Examination of the circuit will show that some of the amplifier stages are operating without cathode decoupling since there is ample drive into the grid of V16 without this. Due to the differences in gain which may arise in individual cases, however (due to differing filter loss, etc.) it may be found that the drive at this point is insufficient in which case the gain can be increased by introducing cathode decoupling, or in extreme cases by employing a higher slope valve in the position of V3 or V7.

If the general design suggested here is followed there should be little difficulty in obtaining ample input to V16. It is usually the gain after the final mixer which is insufficient and it is often difficult to employ a high-slope driver valve due to the circuit becoming unstable. Should this be decided on it may be necessary to neutralise the driver. Suitable alternative valves which may be used as drivers include the EF91, 6CH6 or E180F.

The PA Stage

A 5B254M is used in the exciter, V18 in Fig. 4, and it provides ample drive for a linear running a pair of TT21's in passive grid. Some constructors may have other valves available or may wish to use the exciter as a self-contained transmitter capable of about 100 to 200 watts p.e.p. input. This may be done quite simply although it may be necessary to enlarge the final chassis and PA compartment. Suitable valves include the 6146, TT21, 4X150A (needs blowing) and the QQV06-40A. Although the 6BA6 employed in this exciter should be capable of driving these valves in Class-AB1, to avoid running the driver flat out it may be advisable to substitute a valve capable of slightly more output to drive any of the larger PA valves.

The QQV06-40 is especially suitable as it is capable of being run at 200 watts p.e.p. and yet it is not as large as a TT21. It would, of course, be

Table of Values

Figs. 2, 3 and 4. Circuitry of the G3OCB SSB Exciter

C4, C5, C6, C16, C17, C18, C25, C26, C31, C32, C36, C44, C45, C46, C49, C54, C55, C65, C69, C71, C72, C80, C81, C85, C102, C105	= .01 µF tub. ceramic
C1, C38, C41	= 30 µµF
C2	= 0.1 µF
C3, C106	= 8 µF, elect.
C7, C57	= 0.5 µF
C8	= 0.25 µF
C9, C10, C50, C84	= .001 µF
C11, C27, C28, C34	= 65 µµF, 1%, silver mica
C12, C13, C14, C15	= 120 µµF, 1%, silver mica
C20, C21, C22	= 50 µµF, 1%, silver mica
C23, C24	= 100 µµF, 1%, silver mica
C29	= 33 µµF, 2%, silver mica
C33, C43, C52	= 500 µµF, 1%, silver mica
C19, C37, C48	= 10 µµF, silver mica
C30	= .005 µF
C35, C42, C53	= 300 µµF 3-gang var.
C39, C40	= 3-30 µµF Philips trimmer
C47	= 200 µµF silver mica
C51	= 15 µµF silver mica
C56	= 16 µF, elect.
C58	= .02 µF
C86	= .005 µF, 2.5 kV
C66, C79	= 100 µµF, silver mica
C67	= 25 µµF, silver mica
C68	= 220 µµF, silver mica
C82	= 300 µµF, silver mica
C70	= 500 µµF, feed-through
C83	= 50 µµF, var.
C87A, C87B	= 30 + 30 µµF (*see text*)
C104A, C104B	= 300 + 300 µµF (*see text*)
Cn	= Neut.capacity (*see text*)
R1, R15	= 1 megohm
R3, R6, R34, R35, R37, R40, R41, R46, R72, R88	= 100,000 ohms
R2, R7, R9, R55, R61, R64	= 470,000 ohms
R4, R19, R36	= 1,500 ohms
R5, R17, R56, R67, R69, R72	= 47,000 ohms
R8, R20, R66, R71, R73	= 2,200 ohms
R10, R12, R13, R32, R65, R76, R86	= 1,000 ohms
R11, R48, R54, R70, R81	= 10,000 ohms
R31	= 10,000 ohms, w/wound
R16, R45, R85	= 220 ohms
R18, R43, R44, R68	= 4,700 ohms
R21, R47, R52, R53, R59, R60	= 220,000 ohms
R22, R23	= 220,000 ohms 5%
R25, R26	= 22,000 ohms 5%
R30, R74, R78, R80	= 22,000 ohms
R27, R39	= 68,000 ohms
R28, R79	= 100 ohms
R38	= 27,000 ohms
R42	= 6,800 ohms
R87	= 12,000 ohms w/wound
R49	= 18,000 ohms
R57, R58	= 3,300 ohms
R75	= 56 ohms
R84	= 16,000 ohms, w/wound
R82	= 180,000 ohms
R62	= 10 megohms
R14	= 1 megohm pot.
R24	= 10K pot.
R29	= 5K pot.
R33	= 1K pot.
R50, R51	= 500K pot.
R63	= 25K pot.
R83	= 30K pot., w/wound,
S1	= SP 4-w, 4-bank Control
S2	= SPDT, Sideband select
S3	= SP 6-w, 4-bank, Band select
S4	= SP 4-w, Coarse load
D1, D2	= Matched OA79, 1 mA
M1, M2	= 100 or 200 mA
IFT1-IFT4	= *Denco* IFT 11/465
IFT5, IFT6	= *Denco* IFT 11/1.6
IFT7	= *See text*
WBC	= *See text*
RFC1-RFC4	= Small Rx type
RFC5	= Pi-network type
RL1	= 10,000 ohm, DPCO
V1	= 6AU6
V2, V5, V6, V8, V9, V11, V12, V14	= 12AT7
V3, V7, V10	= EF92
V4	= Min. Neon
V13	= 6AL5
V15	= EF91
V17	= 6BA6
V16	= 6BE6
V18	= 5B254M (*see text*)
V19, V20	= OA2, VR150/30

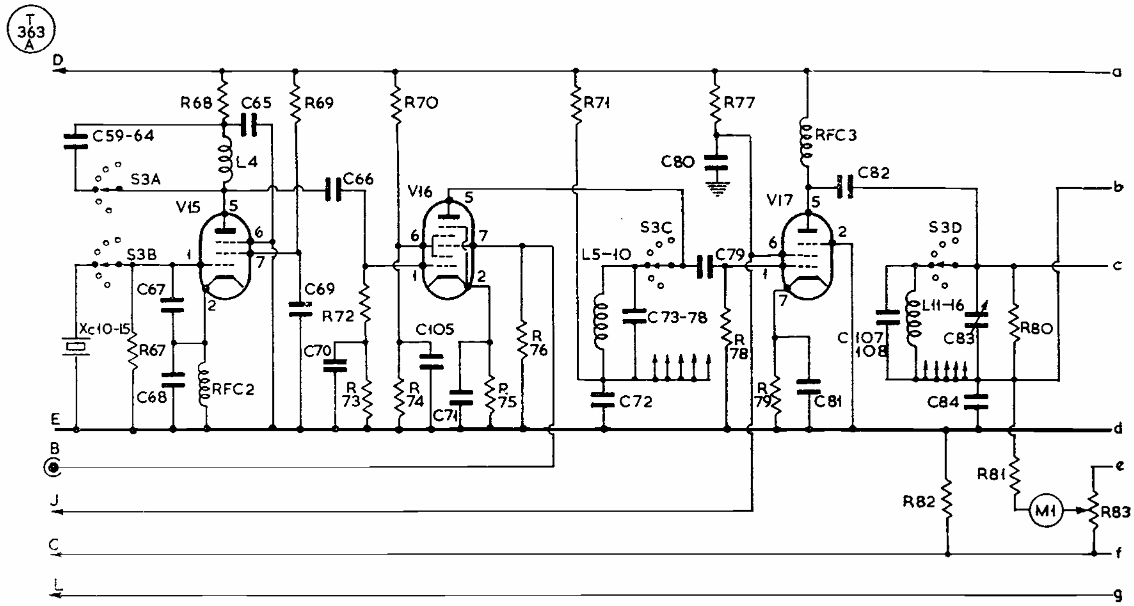


Fig. 4.

run with both sections in parallel to avoid the complications of bandswitched push-pull circuitry. Alternatively, a very low powered output stage could be incorporated employing a 6CH6 or similar type and providing enough output comfortably to drive any Class-AB1 linear stage employing a tuned input. (These remarks applying to PA stages in this equipment refer to Class-AB1 operation only and may not hold good for other modes of operation.)

Provided that suitably rated components are used the PA voltage can be as high as 1,000v. with any of the valves mentioned and in some cases it can be considerably more. The TT21 and 4X150 can be quite safely run at voltages up to 1,800v. or so. It would be advisable, however, to build a separate PA if it is intended to run more than about 1,000 volts or 100 watts p.e.p. otherwise the limited space will introduce problems in regard to tank efficiency, heating and component ratings.

It is also essential that the screen voltage be stabilised, or power output will be reduced and distortion may occur; 250 to 300 volts is quite a satisfactory figure for all of the PA valves suggested, except the 6146 which requires only about 200 volts.

Plug-in coils are used for a variety of reasons. One advantage is that less space is required as there is no separate 10/15 metre coil, as with a switched *pi*-network and stray capacities can be kept considerably lower. Leads can also usually be made much shorter as the switch is no longer needed in order to select the tappings—the coil base can be mounted so as to minimise lead lengths. It is also much easier to obtain the optimum L/C ratio and due to the fact that there are no shorted turns the tank efficiency is considerably improved.

CRYSTAL SELECTION TABLE

XC1, XC4, XC7, 462.5 kc (Channel 333)
XC2, XC5, 462.9 kc (Channel 50)
XC3, XC6, 465.3 kc (Channel 335)
Or any similarly related selection of surplus or commercial crystals.

XC8, 1.6 mc approx.

XC9, XC8 + (2 × freq. XC1).

XC10-XC14

Crystal frequency	7.666	8.0	9.0	6.25 or 12.5	7 mc.
V15 anode frequency	23.0	16.0	9.0	12.5	7 mc.
Tuning cap, C59–64, approx. values	15μμF	30μμF	100μμF	50μμF	160μμF

especially on the higher frequencies. Another advantage is that spare pins on the coil may be arranged to select extra fixed or variable capacitor sections automatically, depending on the band in use. (An application of this idea was shown in the circuit on p.269 of the July, 1964, issue of SHORT WAVE MAGAZINE.) This results in good bandspread on all bands and helps to reduce stray capacities on the higher frequency bands, again improving tank efficiency due to the better L/C ratio. The PA tuning condenser is a split stator 30 + 30 μμF of which only one half is used on 10, 15 and 20 metres. On 40m. both sections are used in parallel, while on 80 and 160 metres extra fixed capacitors (C88-C90 in Fig. 4) are selected. Similarly, the loading condenser is a two-gang 300 μμF variable, and extra capacity (C91-C94) can be selected in parallel by S4. There is no reason, however, why a normal switched *pi*-network should not be used if so desired provided that the foregoing points are borne in mind.

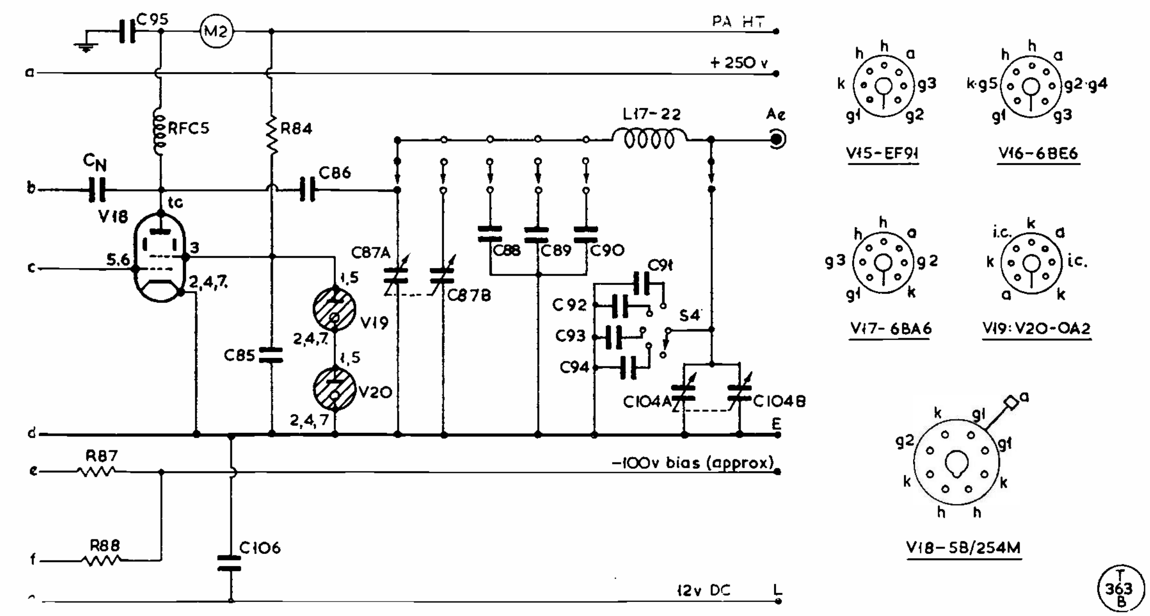


Fig. 4. The final conversion, driver and RF power amplifier section of the Exciter. The output at V18 is for all bands 10-80 metres, the small capacities C87 and C104 being selected and loaded as required for the correct L/C ratio from band to band. This is partly achieved by the way the plug-in coil mount is wired for the different bands. This section of the circuit connects into Fig. 3 as shown by the side lettering.

Since the exciter is normally run at quite a low power level no provision has been made for metering the PA screen current. Where the PA valve is to run fairly near to its full ratings or where the operator is less experienced it is advisable to arrange for screen current to be checked by including an extra switch which will enable meter M1 to be switched from grid to screen at will. The notes on tuning and loading given later will make it clear why it is so important to be able to see what the screen current is doing in a high-level amplifier.

It will be found essential to neutralise the PA if stable operation is to be obtained. The usual methods of neutralising by watching for variations in grid current or by trying to detect RF on the tank circuit by using a neon will be quite useless as they are far too insensitive. With the PA valve driven hard into grid current and with anode and screen voltages removed, it will usually be found possible to detect some RF on the tank by means of the diode probe as the tank is tuned through resonance. Cn should be adjusted for minimum RF pick up, care being taken to ensure that the tank is brought to resonance after each adjustment. This method is very sensitive and will enable the PA to be almost perfectly neutralised.

(To be continued)

TABLE OF COIL VALUES

L1, L2, L3	*All on ⅜-in. Aladdin type polystyrene former with dust core.*
L1	18 turns close wound, 26g. enamel, 5-turn link.
L2	16 turns close wound, 26g. enamel, 4-turn link.
L3	12 turns close wound, 26g. enamel, 4-turn link.
	All following on ½-in. polystyrene former with dust core.
L4	9 turns 24g. enamel, spaced 1 turn.
L5	160m. 100 turns, 36g. close wound, tuned by C73, 100 μμF.
L6	80m. 75 turns, 30g. close wound, tuned by C74, 33 μμF.
L7	40m. 25 turns, 26g. close wound, tuned by C75, 33 μμF.
L8	20m. 15 turns, 26g. close wound, tuned by C76, 25 μμF.
L9	15m. 12 turns, 22g. spaced 1 turn, tuned by C77, 20 μμF.
L10	10m. 10 turns, 20g. spaced 1 turn, tuned by C78, 15 μμF.
L11-L16	as L5-L10, but tuned by C83 (50 μμF var.), and C107, C108 50 μμF and 25 μμF respectively.
L17-L22	*wound on Eddystone 537/538 formers.*
L17	160m. 30 turns, 26g. close wound.
L18	80m. 20 turns, 26g. close wound.
L19	40m. 15 turns, 22g. slight spacing.
L20	20m. 11 turns, 20g. wound in former grooves.
L21	15m. 8 turns, 20g. wound in former grooves.
L22	10m. 6 turns, 20g. wound in former grooves.

Notes: These coil values should prove correct provided stray capacities are kept low. The PA coil base is an *Eddystone* type 946. Coils L17–L22 are wound on three *Eddystone* type 537 and three type 538.

R.N.A.R.S. GET-TOGETHER INVITATION

We are asked to announce that an informal get-together for radio amateurs is to be held at G3BZU, the Hq. station of the R.N.A.R.S. at the R.N. Signal School (H.M.S. *Mercury*) near Petersfield in Hampshire, on Thursday, January 28, starting at 7.30 p.m. Talk-in will be on 70·26 mc in the 4-metre band. The occasion is the School's social evening and we are told that "there will be something for everybody." For any further information, write G3JFF, *QTHR*.

AN ALL-BAND SSB EXCITER

CHASSIS AND PANEL LAYOUTS —FINAL ADJUSTMENT AND SETTING UP

Part II

C. BOWDEN (G3OCB)

The first part of this article appeared in the January issue of SHORT WAVE MAGAZINE, *to which cross-references are made in the text following. For the complete equipment, a full Table of Values was given on p.659, January. The block diagram on p.655 of that issue, together with the main layout plan given here, shows how the Exciter can be built up in five separate units, made up as sub-assemblies. This Exciter will drive a 600-watt linear amplifier (Sideband/CW) and a suitable L/A to go with it was described in our issue for July, 1964.—Editor.*

PICKING up the threads from Part I in the January issue, we now look at the Vox circuit (Fig. 5, p.717), which is quite straightforward.

A sample of the audio input to the SSB exciter, taken from V2A (C5 in Fig. 2 on p.656, January), is first amplified in V12A and then rectified by V13A, causing C58 to be charged negatively. C58 discharges through R62 but during the time that it is negatively charged it holds V14A cut off. The anode potential of V14A rises, neon V4 conducts making the grid of V14B more positive. The latter conducts and RL1 is energised. Anti-trip precautions are incorporated to prevent sounds from the receiver loudspeaker operating the Vox when they are picked up by the microphone. A portion of the receiver output is taken from across the loudspeaker terminals, R50, stepped up in T1 and then amplified by V12B after which it is rectified by V13B. The resulting negative voltage which is developed across C57 is applied to the grid of V12A as a blocking bias, preventing the latter from responding to any inputs which may come *via* the microphone and V2A. The Vox is therefore prevented from operating. The Vox is fairly simple to adjust although there is some interaction between the settings of the various controls and they may have to be gone over several times to obtain best performance. R63 is set so that V14B is just cut off, *i.e.*, RL1 de-energised, with no input to the microphone or loudspeaker. Then R51 is set so that RL1 holds in for the desired interval with normal speech in to the microphone. Finally R50 is adjusted until loud signals from the receiver do not trip the Vox.

Vox is rather a luxury and it can be quite adequately replaced by the press-to-talk switch (PT) which can be incorporated in the microphone. The full Vox and anti-trip circuits have been included, however, as some operators prefer this mode. If it is desired to omit the Vox feature simply join the junction of R65 and PT to the anode end of RL1 and then remove V12, 13, 14 and their associated circuitry.

Relay RL1 in Fig. 5 here has several important functions. In the receive (de-energised) position one contact which is on the "made" side short circuits the receiver mute lines. The receiver muting circuit operates in a manner exactly similar to the muting circuit of the exciter, *i.e.*, short circuiting a resistor connected to a negative bias supply. In the case of the receiver the bias power supply and associated resistors are located inside the cabinet so that it can be operated independently of any transmitter bias pack. In fact the receiver bias pack could be used to supply the exciter as well if required.

At the same time another contact on RL1 "makes," removing a similar muting bias from V7 and V18 in the exciter, placing it in the "transmit" position. Another contact on RL1 completes the 12v. supply to the aerial change-over relay. (When the

Table of Typical Readings

(1). ***Carrier insertion advanced***

Position	Voltage	
	Typical	Maximum
Probe either side of R33 to earth, R33 set to mid travel	1–2v.	
V5 anode (Retune to allow for probe capacity.)	1–2v.	
Across R76	2v.	

(2). ***Carrier removed***

Position	Readings	
	Typical	Maximum
VFO Amplifier output across L2 (on probe)	2–5v.	5v.
Crystal osc. input to V5 by current through R21	25 μA	50 μA
Crystal osc. input to V16 by current through R74	50 μA	100 μA
Normal audio level tone into mic., SSB across R76 (on probe)	½v. peak	1–v. peak
Normal audio level tone into mic., SSB to V17 grid (on probe)	½v. peak	1v. peak

Notes: The SSB level is too weak to measure accurately at any stage prior to V16 grid (across R76). The probe used is as shown in Fig. 8, p.719.

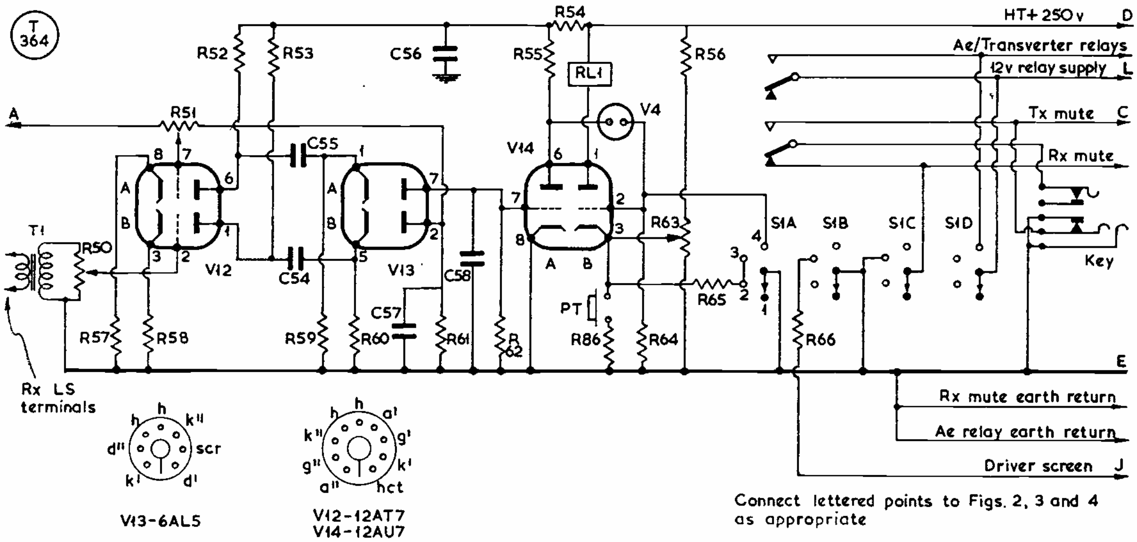


Fig. 5. The Vox and control circuitry for the Sideband Exciter described in the article. It should be noted that values for the circuit shown were included in the full Table of Values on p.659 of the January issue — which also carried Part I of the article. Points affecting the Vox side are discussed in the text, which is fully cross-referenced.

VHF transceiver is in use this 12v. supply also controls the latter.)

Operation of Control Switch S1 (a-d), Fig. 5

Position 1 (Vox). The switch wafers make no connections in this position. Pressing PT or speaking into the microphone will operate the transmitter.

Position 2 (Manual). A contact on S1A earths the cathode of V14B *via* R65, causing the valve to cut on and RL1 is energised. The press-to-talk function is by-passed with S1 in this position.

Position 3 (Net). S1A functions as above. In addition S1C removes the muting bias from the receiver. In order to prevent overloading of the receiver during netting, the screen of driver valve V17 is earthed *via* R66 and S1B. When carrier is introduced in order to net the low driver screen voltage prevents the PA from operating at any appreciable input.

Position 4 (CW). Carrier is inserted for the transmission of CW. Keying is effected by controlling the muting bias to V7 and V18. To prevent key noise from operating the Vox, the grid of V14B is shorted to earth when the control switch S1A is in this position. Since RL1 is then inoperative, S1d provides a 12v. supply to the aerial relay (and also to the VHF transverter when it is used).

A 3-position jack plug is used. The rear contact is connected so as to mute the receiver when the key is depressed. The front contact energises the transmitter by short circuiting the bias to V7 and V18.

The transmission can be monitored by placing a variable resistor of about 50K across the receiver muting lines and adjusting for a comfortable audio output level.

ADJUSTMENT AND TUNING

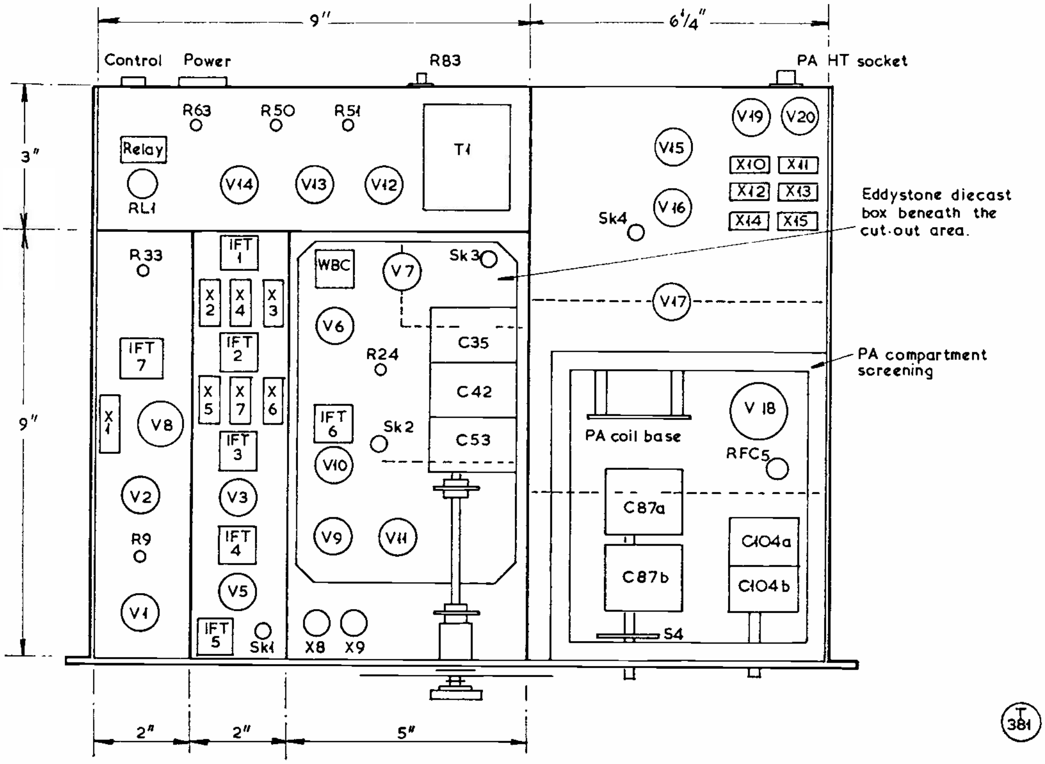
G3OCB All-Band SSB Exciter

First the wiring should be checked and a suitable power supply arranged. Then all valves and crystals should be inserted with the exception of the oscillator valves, stabilisers and the PA stage. Each oscillator except V11 may then be inserted in turn and checked to see that it goes off and that the injection to its associated mixer is within the range stated in the table of voltages given on p.716 opposite.

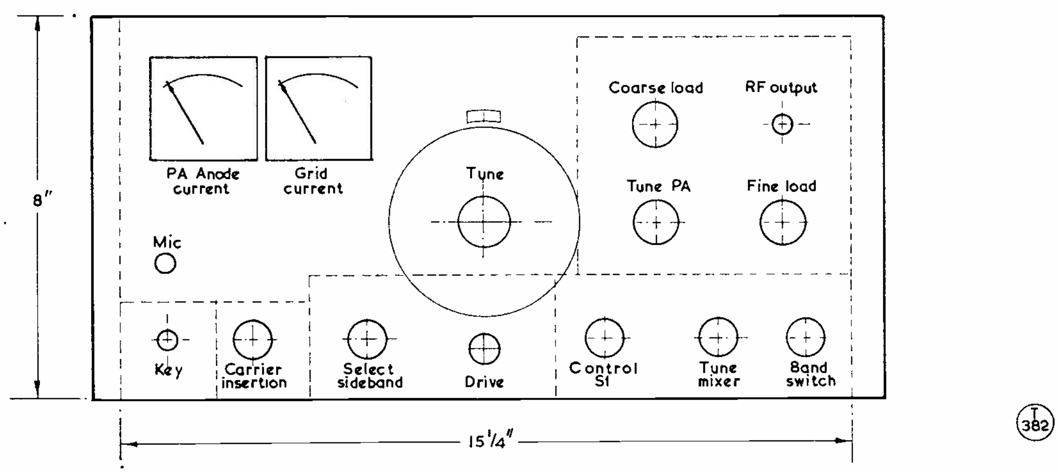
When all the oscillators are functioning satisfactorily the VFO valve V11 may be inserted and the tuned circuit core adjusted until the range covered is about 3·0-3·5 mc. (In the author's case the initial coverage of the VFO was from 2·75 to 3·5 mc. and it was decided to retain this range as the coverage on 2m. and 10m. would be greater and there would be a wider choice of crystal frequencies to be used with the final oscillator V15—p.660, January.) The VFO amplifier can then be padded and tracked to gang over this range. A check across the link winding on L2 with the diode probe should give a reading of about 2-3 volts into the mixer V6. The anode circuit of V7 cannot be tracked until after the wideband coupler (Fig. 3, p.658, January) has been set up.

Due to the relatively small percentage change in frequency (about 16 to 25 per cent) the tracking of the circuits V7, V10 and V11 is quite uncritical and if the general component values suggested are used there should be no difficulty. Trimming capacitors were not needed (purely by luck) but as stray capacities will vary in individual cases it may be necessary to include 3-30 $\mu\mu$F trimmers across coils L1, L2 and L3.

[over



Main chassis layout diagram for the G3OCB Sideband Exciter. The side panels are 12in. by 8in., and the two smaller chassis are 2in. deep; the other chassis are 2½in. in depth. The front panel (as shown in another drawing) is 16½in. by 8in. deep. The construction is in (five) unit form, and there is some additional screening beneath the main chassis.



Front panel layout as used by G3OCB for his Sideband Exciter. If the main chassis arrangement as shown in the other mechanical diagram is followed, then the front panel will necessarily have to be laid out somewhat as indicated here. However, other constructional arrangements are possible. An Eddystone die-cast box is used for the VFO, and this can be mounted to ensure that the main dial is central.

V11 should now be removed. Set the balanced modulator balancing control R33 (Fig. 2, p.656, January) to mid-travel and with V8 inserted it should be possible to measure about 1 to 2 volts from either side of R33 to the chassis using a diode probe. R33 may then be set to one end of its travel and IFT's 1-4 should be peaked for maximum output using a loosely coupled receiver as indicator.

If a BC221 is not available then it will be necessary to build a small oscillator which can be tuned across the frequency band in the region of the filter crystal frequencies at a slow rate and having a dial which can be reset fairly accurately.

Filter Adjustment

The carrier oscillator V8 should be removed and the test oscillator or BC221 connected across C10. With a receiver loosely coupled to the anode side of V3 the test oscillator should be tuned slowly across the crystal filter passband. As this is done there should be two definite peaks in output corresponding to the frequencies of the filter crystals. The test oscillator must be tuned exactly half way between these two frequencies and IFT's 1-4 should then be peaked again. (Without test instruments this is the best that can be done but filter performance should be quite acceptable by this method of setting up.)

Before final tailoring of the filter for best carrier rejection the first mixer stage V5 should be put into operation in order to prevent direct pick-up of the carrier oscillator by the receiver, which could occur if the latter were tuned to the carrier frequency. V9 should be inserted and with V8 also in position, R14 should be advanced until the carrier is heard on the receiver, tuned to 2·06 mc and loosely coupled to IFT5. The transformers IFT5 and IFT6 should then be peaked at 2·06 mc, after which R14 may be turned back. The carrier should now be much weaker.

The filter can now be adjusted for best carrier rejection, *viz:* Crystals XC1, XC4 and XC7 can be interchanged and any other crystals of this frequency can also be tried. After each crystal change V8 should be removed and the IF transformers 1 to 4 repeaked at mid-band. R33 and C100 should be adjusted for best carrier rejection, different values of C100 being tried from either side of R33 to chassis. The receiver S-meter may be used as an output level meter but the gain controls and the coupling between the receiver and exciter should not be touched while adjustments are being made. The settings of R33 and C100 which provide the best carrier rejection should be adopted.

IFT's 1 to 4 must be re-tuned to the centre of the filter passband after each change of crystal as the variation of crystal positions can often cause quite a change in the shape of the passband if this is not done. In addition it is important to try each crystal of the nominal carrier frequency in the position XC1, the others being tried in positions XC4 and XC7, as certain layouts of the crystals provide much better carrier rejection. (This is probably due to the parallel resonant frequency of the crystal used in the position XC1 coinciding with the series resonant frequency of the crystals in positions XC4 and XC7.)

Headphones can now be connected across R12 and

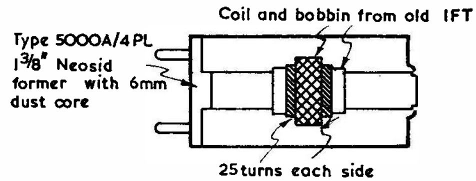


Fig. 6 : Construction of IFT7 (not to scale).

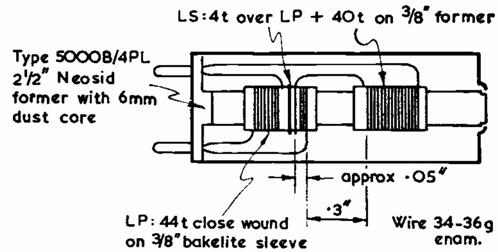


Fig. 7 : Construction of WBC (not to scale).

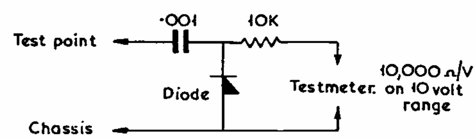


Fig. 8 : Suitable diode probe

T 365

Sketches referred to in the text, and self-explanatory.

with the AF gain (R9, p.656, January) turned up speech into a crystal microphone should sound quite clear with no distortion or hum. If all is well here disconnect the phones and instead connect an AC voltmeter across R12. With a tone of normal speech level into the microphone R9 should be set so that the meter indicates about ¼ volt.

The receiver (still tuned to 2·06 mc) should then be set to receive SSB and with V8 inserted speech into the microphone should result in the signal being quite clear and easily resolved. If the receiver coupling and gain are adjusted so that the speech level is about S9, then the carrier should be much weaker—about S2 or less—and the unwanted sideband should be not more than about S3 even with a single half-lattice filter. If R14 (carrier insertion control) is advanced the carrier level should be greater than S9.

V11 may now be replaced and with R14 and R29 advanced the cores of the wideband coupler and the tracking of L1 (Fig. 3, p.658, January) should be adjusted for even output over the range of the VFO, using a receiver as indicator during the earlier stages. The wideband coupler as shown in Fig. 7 above is quite flat from 4·9 to 5·5 mc and to offset the drop in output from 4·75 to 4·9 mc, the core of L1 is slightly detuned to the LF side. When this adjustment has been completed it should be possible to obtain about 2 volts output across the link winding on L1 as measured on the diode probe (Fig. 8), this voltage being reasonably constant across the whole band.

Valves V15, 18, 19 and 20 may now be inserted, the control switch set to net and the coils L5-10, L11-16, L17-22 tuned up and checked for band coverage. Power should be temporarily removed from the PA and the control switch set to " manual." With the exciter tuned to one of the higher frequency bands and with carrier and drive controls (R14, R29), turned up it should be possible to obtain some PA grid current. The PA can now be neutralised. A dummy load may then be connected and the PA tuned up, power having of course been restored. If an RF ammeter of lamp load is available the RF power output can be checked and the efficiency can be expected to be in the region of 60 per cent. The rig is now ready for air testing—and it will be for your contacts in QSO to tell you how the signal sounds.

ONE-TRANSISTOR TOP BAND CONVERTER

TO WORK WITH ANY MEDIUM-WAVE RECEIVER

B. J. P. HOWLETT (G3JAM)

OF the three main points at which one can have the local oscillator to convert the 160m. Band to Medium Wave, namely :

(1) Oscillator above signal frequency;

(2) Oscillator above IF but below signal; or

(3) Oscillator below IF and below signal,

the writer believes that the most difficult is the first case. Besides giving reverse tuning, the 2nd channel lies near the 49m. broadcast band, full of high power transmissions, and short-wave breakthrough could become a severe problem.

The choice seems to lie between Case No. 2 and Case No. 3. Taking some typical values :

	No. 2		No. 3	
	A	B	A	B
	kc	kc	kc	kc
Osc.	1100	950	800	600
IF	700-900	850-1050	1000-1200	1200-1400
2nd Ch.	200-400	100-100	200-400	600-800

Number 2B is definitely out, and one can look at it two ways. The IF range includes the oscillator frequency. Alternatively, the 2nd harmonic of the oscillator falls in the 160m. band. In fact any oscillator frequency between 900 and 1000 kc is automatically ruled out. However, frequencies HF of this are quite in order up to about 1250 kc when the main receiver will reach the LF end of the band coverage.

No. 3B itself is workable, just. The third harmonic of the oscillator falls at 1·8 mc and the 2nd harmonic at its IF equivalent. Oscillator frequencies between 600 and 667 kc are out for the same reason —harmonic falls in the band. And that leaves a broad section 667 to 900 kc in which to play around, so case No. 3A is near-enough in the middle of the optimum section.

It is fortunate for Londoners that the corresponding IF range does not include any powerful local stations ; other parts of the country may not be so lucky.

The writer has actually tested using all the investigated possibilities, and has confirmed all the possible reasons for rejection. As a result, 820 kc was chosen for the local oscillator, giving a tuning range of 980-1180 kc (2nd channel 360-160 kc, which admittedly includes Droitwich, but this station is no problem in S.E. England).

Circuit

The great care in choosing the IF range was well worth the trouble, as only a single OC44 frequency changer was required in the end, connected in a Clapp circuit with high-Q coils knocked up with 34g. wire on cast off fragments of rod aerial ferrite! It was found important to avoid diffused-junction transistors of all kinds, for two reasons:

In the first place, it is desirable not to have any gain on short waves proper; and if there is no appreciable gain at higher frequencies there is less tendency for the oscillator waveform to become distorted. The local oscillator was adjusted so that it starts readily but gives near enough a sine wave on an oscilloscope.

Stage gain is slight, but the frequency change action introduces very little noise, and when used with a good centre-loaded whip a Pye hybrid type car radio sounded just like a proper Top Band receiver. Matching out is done with C1 and matching in with C6. The series-tuned input greatly improved reception when used with the regular car aerial but performance is not very impressive under those conditions.

Used in the home station with the same centre-loaded whip. but working into a CR-100. it was extremely difficult to tell when the converter was in use. so the comparison had to be by listening carefully for MW breakthrough. There is a little such down in the South-East, the strongest being Hilversum III. (Since writing this, one of the D.I.Y.S. stations has appeared in that section of the MW band !)

The writer would like to add that the input tuning does not have to be removed when using a centre-loaded whip; two series tuned circuits in