SSB Topics

HT-32 CIRCUITRY — Q-PROBE TEST DEVICE
HF CRYSTAL FILTER POINTS — GATED G-C LINEAR — NOTES AND NEWS

Conducted by **J. C. MILLER, DJØBX (W9NTV)**

THE current interest in single-sideband transmission and reception on the amateur bands has led many a neophyte to believe that this is an entirely new technique—a definite plunge into the mysteries of advanced electronics. It may come as a surprise to some that the basic techniques of single-sideband generation date back more than forty years and that the commercials have been using SSB since the early 1930's. In fact, the first known amateur SSB operation was in 1933 !

One of the points of confusion in understanding the generation of single-sideband signals is the meaning of the term "sidebands," which is usually associated with voice-modulation of a transmitter. Sidebands are, basically, groups of radio frequencies which result from modulating a single fixed RF signal with one or more audio frequency signals. The fixed RF signal is also known as a carrier, which by itself conveys no intelligence. The audio signals add to and subtract from the carrier frequency to produce these groups of closely related RF signals, both higher and lower than the carrier frequency. The number of individual audio frequencies in the modulating signal determines the number of individual signals present in both sets of sidebands at any given moment.

The mysteries of single-sideband techniques present a number of other formidable terms, such as: sideband filter, phase-shift network, balanced modulator, half-lattice filter, and so forth.

To add to the complication, two systems of generating an SSB signal are often mentioned. They are: (1) The filter system, and (2) The phasing system.

SSB output is derived from ordinary *amplitude-modulated* signals in both these systems. In the filter system a conventional amplitude-modulated signal is passed through a filter (or filters) which removes the undesired sideband by "brute force," leaving only the desired sideband. In the phasing system two amplitude-modulated signals are combined in such a manner that one set of sidebands is reinforced and the other set is cancelled out. In either system the carrier is balanced out from a signal that would otherwise be a completely standard amplitude-modulated signal. With proper adjustments, both systems will deliver the same type of signal.

The requirements for the filter system are quite rigid, since it is desired to pass only one sideband and attenuate the other at least 30 dB or more. This order of filter selectively is most easily achieved at frequencies below 500 kc. Therefore, many Sidebanders are using quartz crystal lattice-type filters, or mechanical filters operating in the vicinity of 450 kc. (However, there is a current interest in HF filters in the 5 to 10 mc range.)

The signal can be generated at any desired output frequency in the phasing system, but it is inconvenient and difficult to change frequency easily. In fact, it is a problem to design a bandswitching sideband exciter with either system.

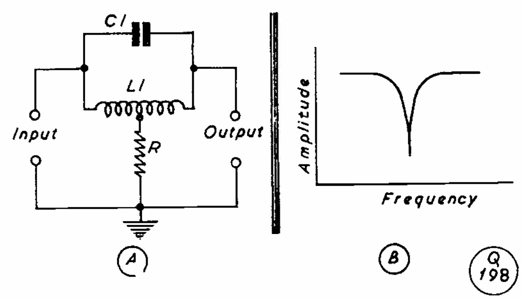
It should be noted that a further limitation is imposed by both systems—that of obtaining an SSB output signal on several bands. That is to say, the harmonics of the SSB generator cannot be used. This is because frequency multiplication depends upon non-linear operation of the multiplier stage, which would introduce intolerable distortion to an AM or SSB signal.

The practical solution to the band-changing and variable-frequency SSB generator problem is, at least for the home constructor, to use the same principle found in superheterodyne receivers—that is, to heterodyne the SSB generator output signal, which may be outside the amateur bands, to the desired amateur frequency.

More HT-32 Data

The basic design of this popular Hallicrafters' transmitter was outlined in the April "SSB Topics" feature. In answer to numerous queries from interested Sidebanders, several additional circuit details will be described this month, which may provide a few ideas for those who are designing a new SSB exciter.

The balanced modulator is of unusual design for carrier elimination. Variations of the bridged-T filter have been used quite widely in various amateur receivers for heterodyne interference elimination. To



At Fig. 1 (A) is the basic bridged-T filter arrangement. The resonant frequency of L1 with C1 determines the "notch" frequency; the depth of the "notch" is affected by the value of R. Fig. 1 (B) is a curve showing the transmission properties of the bridged-T filter when the value of R is equal to a quarter of the resonant impedance of C1, L1; when this condition obtains the "notch" is of maximum depth.

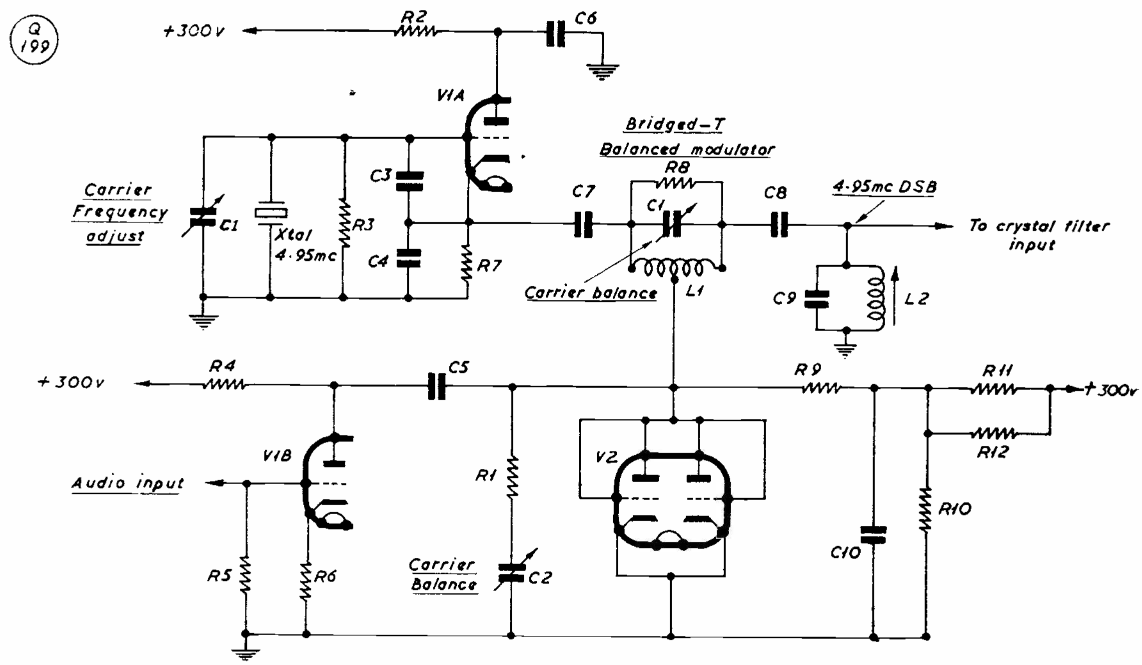


Fig. 2. The balanced modulator and associated circuitry in the Hallicrafters HT-32 transmitter. A bridged-T filter network is effectively used as a carrier eliminator, with the resistance of the diode-connected valve in parallel with R1 and C2, equal to the R of Fig. 1A. The carrier null is obtained by adjustment of the balancing condensers C1 and C2 ; R8 loads the circuit to prevent rapid changes in impedance with adjustment of C1. A small positive voltage applied to the anode of V2 makes it conductive. The dropping resistor is made up of R11 and R12. R11 is a thermistor which stabilises the voltage applied to the diode V2.

the writer's knowledge, this is the first application of this filter design in a commercially produced amateur sideband generating circuit.

The basic bridged-T "notch" filter is shown in Fig. 1A. The effective rejection frequency is determined by the resonant frequency of L1-C1. The value of the resistor R determines the depth of the rejection notch ; when this resistance equals one-fourth of the resonant impedance of L1-C1, the circuit will have a very high rejection at the resonant frequency. This condition is shown in Fig. 1B. The rejection is upset by a change in the value of R—that is, increasing or decreasing this resistance reduces the depth of the rejection notch.

In the HT-32 transmitter a thermionic diode is used in place of the resistor and the bridged-T circuit is used as a balanced modulator. In this application, L1-C1 is tuned to the suppressed carrier frequency and R (the diode valve) varies at the modulation frequency.

The actual HT-32 circuit is shown in Fig. 2, where a 12AU7 (ECC-82), diode connected, is used as the balanced modulator valve, V2. The operation of the circuit is as follows: V1A is a crystal controlled oscillator operating on 4·95 mc. (This frequency is ultimately converted to the desired transmitter operating frequency by heterodyne action in later stages.) The 4·95 mc signal from V1A is fed directly to the tank circuit of the bridged-T balanced modulator network. The audio output from the third

Table of Values

Fig. 2. Balanced Modulator, HT-32 SSB transmitter

C1, C2	2-13 μμF, midget variable	R2	= 10,000 ohms
C3	33 μμF	R3	100,000 ohms
C4	= 120 μμF	R4	= 470,000 ohms
C5	= .02 μF	R5	= 120,000 ohms
C6, C10	= .005 μF	R8	= 12,000 ohms
C7	= 39 μμF	R9, R12	= 220,000 ohms
C8	= 390 μμF	R10	= 22,000 ohms
C9	= 18 μμF	R11	= 1.1 meg. thermistor
L1	= 12 μH	Xtal	= 4950 kc
L2	= tune to 4.95 mc	V1	= ECC83/12AX7
R1, R6, R7	= 2,700 ohms	V2	= ECC82/12AU7

speech amplifier stage, V1B, is applied to the diode modulator V2, which is part of the grounding leg of the bridged-T network. Maximum carrier *null* is obtained by adjusting the carrier balance controls C1 and C2. A small positive voltage is applied to the anode of V2 to make it conductive. This voltage is stabilized by means of a thermistor, which is part of the voltage dropper.

With audio drive applied to the diode the effective resistance (diode resistance in parallel with the effective resistance of R1 and C2) is varied at the audio rate. The balance of the bridged-T network is thus upset at this same rate. Under balanced conditions the output of the balanced modulator consists of the upper and lower sideband of 4·95 mc.

The HT-32 high frequency filter circuit—which appeared in "SSB Topics" in our April issue—has prompted several readers to ask for the additional circuitry associated with the filter. The complete filter chain is set out in Fig. 3. It will be seen that two upper-sideband filters are actually used, with one in the input and the second in the output of the sideband filter amplifier stage, V1. The 4·95 mc double-sideband suppressed-carrier signal from the balanced modulator is passed through the two filters, where the lower-sideband is suppressed. The resulting upper-sideband signal is mixed in V2, with either 4·05 mc or 13·95 mc from the sideband selecting oscillator, to obtain upper or lower sideband at 9 mc. Additional suppression of the lower-sideband is obtained through the use of 4·949 mc shunt crystal in the grid of filter amplifier valve, V1.

The Q-Probe

A very handy device for sampling the field surrounding the output coil of an SSB exciter or linear amplifier, which can feed the station monitor oscilloscope without interference due to extraneous pick-up, has been placed on the amateur market by the Vantron Co., of Manchester, N.H., U.S.A.

Many Sidebanders connect a piece of wire to one of the vertical deflection plates of their 'scope to view the level of RF carrier, check the sideband envelope, measure sideband suppression, and adjust for optimum loading. Hanging the open wire in the vicinity of a high-impedance RF point not only changes the conditions at that point, but is extremely dangerous in any case.

A better approach would be to use a small one-turn pick-up loop, feeding into a few feet of coax cable, to take the RF information to the 'scope. This loop could be squeezed into tight places and be adjusted to discriminate between the fields surrounding nearby coils. When checking various tank circuits in an exciter one is apt to find only a few volts of RF at the output of the cable. This doesn't present much of a 'scope display when 50 to 100 volts RF is normally required at the deflection plates to obtain a useful presentation. A tuned circuit with a good Q—placed on the end of the cable—should improve on this.

Table of Values

Fig. 3. The HT-32 Sideband Filter

C1	= 5-25 µµF, midget variable	R2	= 470 ohms
C2	= 200 µµF	R4, R9	= 2,200 ohms
C3	= 5 µµF	R5, R7	= 4,700 ohms
C4	= .01 µF	R6	= 180 ohms
C5, C7, C8, C9, C10	= .005 µF	R8, R11	= 47,000 ohms
C6	= 47 µµF	R10	= 500 ohms
R1, R3	= 1,000 ohms	R12	= 100,000 ohms
		R13	= 10,000 ohms
		V1, V2	= 6AH6

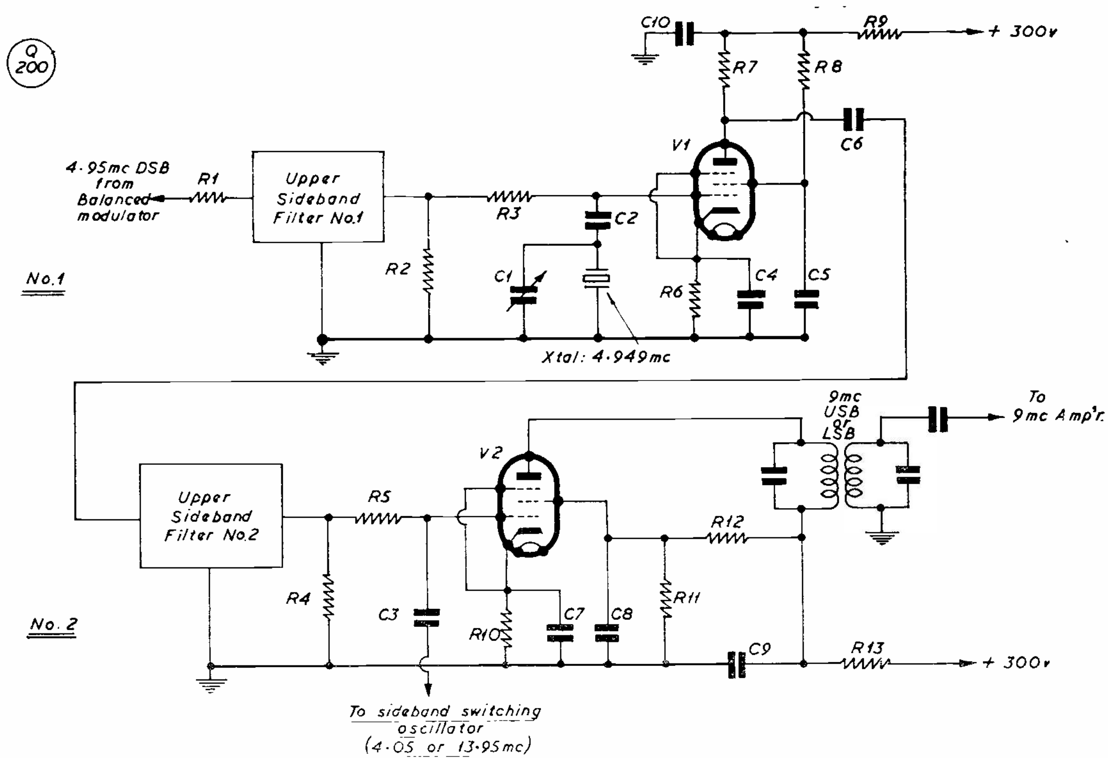


Fig. 3. The HT-32 sideband filter circuit in which two high-frequency filters are used in cascade to pass the upper sideband. This sideband filter circuit was shown in the April "SSB Topics." The 4.949 kc crystal in the grid of V1 is included to improve the suppression of the lower sideband. SSB output at 9 mc is obtained by selecting either 4.05 mc or 13.95 mc to mix with the 4.95 mc from the balanced modulator.

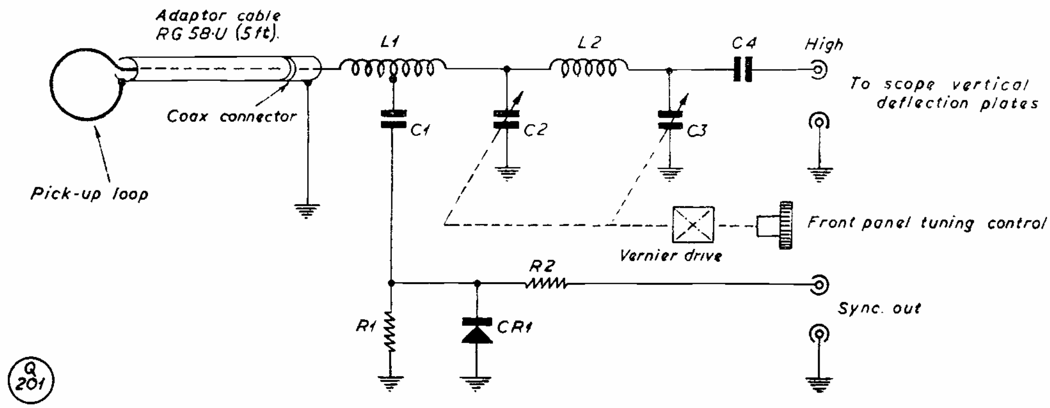


Fig. 4. The Vantron "Q-Probe" is an instrument designed to provide the necessary coupling and voltage step-up when measuring sideband equipment with an oscilloscope. A pick-up loop samples the RF energy and feeds the multi-band tuned circuit through a five-foot length of coaxial cable. The tuned circuit covers from 3 to 30 mc continuously. A detector is included which will provide the 'scope with a sync. signal obtained from the sideband wave form.

The Vantron "Q-Probe" includes several features of interest, which should make RF 'scoping a pleasure. The pick-up loop and connecting cable feed a fully shielded all-band tuned circuit requiring no plug-in coils or bandswitching. The unit contains a built-in detector capable of developing a sync signal, which can be fed directly to the *external sync* input of the 'scope. This will take care of the synchronizing problems.

The circuit of the unit is shown in Fig. 4, from which it will be seen that L1 and L2, C2 and C3 constitute a multi-band tuner capable of continuous tuning from 3 to 30 mc. The crystal diode rectifies a small amount of RF across L1 and feeds the demodulated audio signal to the sync-out jack through an RF filter. Connecting jumper wires from the output terminals to a vertical deflection plate and ground will feed the RF signal to the CRT.

A completely shielded, tuned all-band probe of this type should find many applications in the Sideband station.

HF Crystal Filter Experiments

The recent review of this subject—*see* April "SSB Topics"—has stirred up considerable interest among the Sideband fraternity, with a number trying the two half-lattice filters in the back-to-back arrangement. FT-243 HF crystals seem to be in plentiful supply on the "surplus" market; they are priced reasonably, which means that a substantial quantity of any one frequency can be obtained at relatively little expense.

One of the first reports on HF crystal filter experimentation comes from G2MA, who is planning to use a back-to-back filter in the IF-strip of his new receiver. The advantages of a high-frequency IF are most appealing when one considers that single conversion will give the same selectivity as is obtained in a normal double-conversation receiver. G2MA has found that the terminating resistances in the back-to-back circuit are very critical and suggests that potentiometers be used for filter termination during preliminary adjustments. The optimum value can then

Table of Values

Fig. 4. Circuit of the Q-Probe

C1	= .01 μF	L2	= 1.5 μH, 16 turns, 20g., ½in. dia. 1-in. length
C2, C3	= 20-250 μμF, split-stator variable (receiving type)	R1	= 220,000 ohms
C4	= .001 μF, 5,000-volt rating	R2	= 10,000 ohms
L1	= 5 μH, 12½ turns, 24g., ⅜-in. winding length, tapped at 1-turn, 1in. dia.	CR1	= 1N34, or standard crystal diode

be measured when the tests are completed and a fixed resistor of this value substituted for the pots. He has found that the value of resistance decreases with an increase in the frequency separation of the crystals. Using crystals with 1·5 kc separation, he obtained a flat-topped pass-band with a shape-factor of 60:1, producing a measured bandwidth of about 2·3 kc at the 6 dB down points. With separations greater than 1·5 kc, the dip in the centre of the pass-band became quite pronounced.

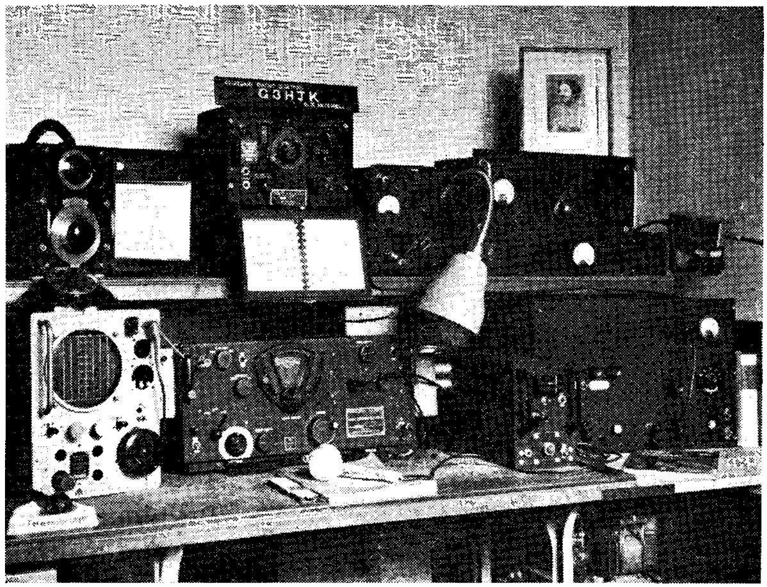
GM3CIX advises that his first experiments with the back-to-back filter have been very encouraging. He started with some 8·5 mc crystals that were at hand, etching them to a 1·6 kc separation. A powdered-iron pot-core "of unknown characteristics" was used for the coupling coil former with fairly good results. However, he is planning to obtain some ferrite torroidal cores for further tests, before installing the filter in the new exciter.

A point of interest: Suitable ferrite torroids are manufactured by Mullard. A variety of characteristics and sizes are available. Further information may be obtained from: Mullard Ltd., Component Division, Mullard House, Torrington Place, London, W.C.1.

A Gated Grounded-Cathode Linear

The W6EDD screen controlled linear amplifier was described in SHORT WAVE MAGAZINE for February, 1959. The circuit as presented was for a grounded-grid arrangement, although it was mentioned that it had been used with a conventional grounded-cathode amplifier.

In order to answer several queries (and relieve the writer's correspondence chores) the grounded-cathode gated linear is shown in Fig. 5. As in the original description, a 6F6 or 6L6 valve is used as the control valve, connected in series with the amplifier screen and the screen voltage supply. Without RF drive the grid of the control valve is at DC ground. As SSB drive is applied to the grid of the control valve, its anode current increases, the voltage drop across its cathode resistor increases and the amplifier valve screen voltage increases. The action is effectively that of a series-gate valve. It has been claimed by several users that this amplifier circuit will retain linearity when overdriven. However, the extent to which this can be done is not known.



G3HJK (Longsight, Manchester) is on SSB and runs a crystal/VFO mixer for heterodyning to tbe required output frequency, over 10 to 160 metres. The PA is an 813 as a Class-B linear amplifier. His receiver is now (the BC-348 visible being no longer in use) an arrangement incorporating two half-lattices in cascade, a Q-multiplier, and a switchable detector, with the audio channel restricted to the AF range 250-2,500 cycles only ; crystal controlled converters are used for the 10, 15 and 20 metre bands. A phasing-type exciter is available for all bands Ten to One-Sixty.

The very interesting twenty and eighty metre SSB transmitter designed by G3HRO and described in SHORT WAVE MAGAZINE for January, 1959, will be produced in the near future by one of the firms now manufacturing amateur gear. While further information is not available at the moment it is anticipated that this item should be announced within the next few months. This should be a big help to those G's who have rather shied away from home construction of SSB gear !

The Sideband column in *CQ Magazine*, covers

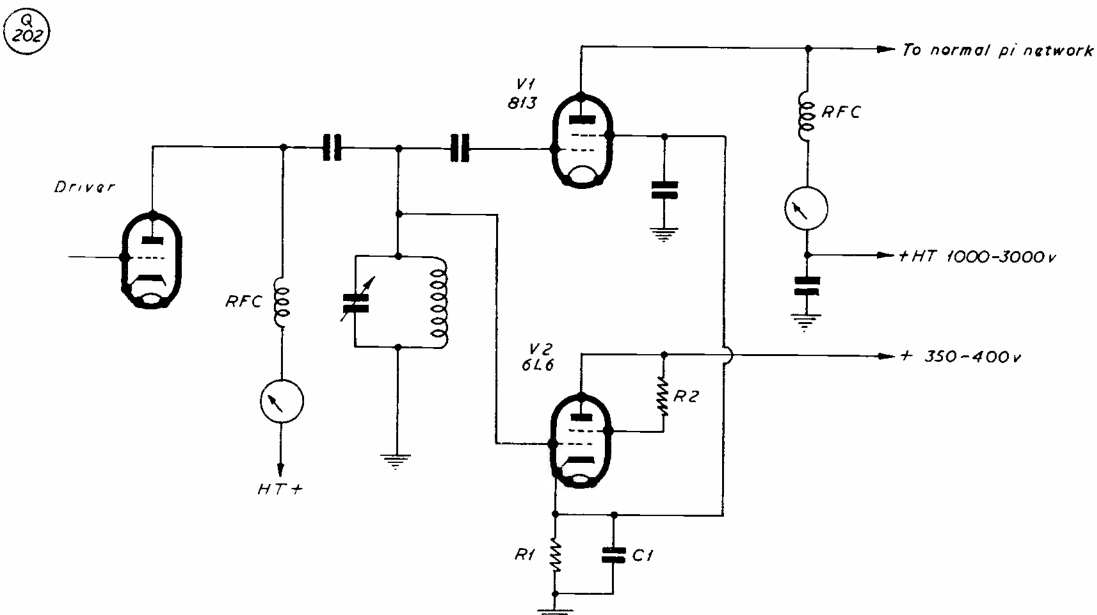


Fig. 5. Another version of the gated Linear Amplifier designed by W6EDD. In this case a grounded-cathode circuit is used and the amplifier screen voltage is controlled by the gate-control valve. Application of SSB drive increases the amplifier screen voltage. In this circuit, C1 is 2 μF, oil-filled, 600v. working ; R1 is 20,000 ohms, 10-watt, wirewound ; and R2 is 100-200 ohms, 1-watt.

many newsy items each month. W3SW has announced in the April issue that 45 awards for stations who have worked 100 countries on two-way sideband have been issued. In addition, ten of these stations have submitted proof of having worked 150 countries —all on two-way sideband! If you have the necessary QSL cards verifying the 100 contacts, send them to: W3SW, P.O. Box 625, Silver Spring, Maryland, U.S.A., together with a list of the countries in alphabetical order by prefix. Be sure to include sufficient postage for returning your cards, plus fifty cents (U.S.) to cover costs of sending the certificate—IRC's acceptable.

W3SW will also be pleased to send certificates for "Worked 50" and "Worked 75" countries. All that is necessary for these two awards is to send a list of stations worked, with a signed statement by another amateur that he has examined the cards. It is not necessary to send in the QSL's for these two awards. Just be sure that all stations were worked two-way SSB !

K2MGE and her OM, K2HEA, appeared on a television quiz programme a short time ago. They apparently knew the correct answers as they were the winners of $400! That should help in the purchase of some new Sideband gear !

F7AF, one of the most active Sidebanders from the Paris vicinity, has packed up for a return trip to the States. We should be hearing him shortly from W with his usual good signal.

The U.S. authorities (FCC) are at the moment considering the matter of expanding the U.S. 20-metre phone band to include 14300 to 14350 kc. All *pros* and *cons* on this matter were to have been submitted by May 1, with a final decision following. If the W sideband stations suddenly appear in the high-end DX area of Twenty, the results of this action will be obvious. By the time this is read, the decision should be announced.

In Conclusion

The large correspondence received from our readers throughout the world is always appreciated. This column is interested in your activities, experiments, sideband circuits and suggestions. If you have a special SSB QSL card, or photograph of yourself or station, send it to this column for appropriate reproduction.

"SSB Topics" will next appear in the August issue, for which all correspondence should be in by June 30. Address "SSB Topics," c/o Editor, SHORT WAVE MAGAZINE, 55 Victoria Street, London, S.W.1, or direct to your contributor at Mauerkircher Strasse 160, Munich 27, Germany.

Until August, let's enjoy a Summer of Sidebanding. *Vy 73 de Jim, DJØBX.*

". . . . a 6V6 will be adequate . . . ."

SCOUT RADIO JAMBOREE

The Scout Jamboree-on-the-Air which took place in May of last year aroused considerable interest, but due to certain adverse factors—including insufficient advance publicity and poor radio conditions—its success was not as great as the project deserved. The period for this year's event, October 23-25, has been chosen so as not to conflict with summer activities and to give adequate time for preparation. What the Jamboree amounts to is a QSO-party for all radio amateurs, throughout the world, who are scouts or interested in Scouting. To this end, it is hoped that licensed operators will make contact with local scout groups and give them demonstration QSO's, during October 23-25, with other scout stations. The Hq. station of the Boy Scouts International Bureau will be on the air from Ottawa, Canada. The U.K. organiser for the event is: L. R. Mitchell, G3BHK, Katoomba, Tyneham Close, Sandford, Wareham, Dorset, who will be glad to give further details.

COUNCILLOR W. KROHN, M.C.S.P. (G6KJ)

At the recent local government elections, G6KJ was again returned for the Buckingham Borough Council, six candidates being up for four seats. This makes his fourth term on the Council over a period of ten years. As many readers will remember, G6KJ has been sightless from birth—nevertheless, this has not shut him away from many of the normal activities of life. He has been an active amateur since 1923, runs his own electrical and hardware business, is a chartered physiotherapist, and his work in both wood and metal would put many a sighted person to shame. He is also a confident and fluent public speaker, and brings a mature mind to bear on Council affairs.