SHORT WAVE NEWS

Vol. I.
No. 6.
JUNE, 1946.

In this Issue :

Special ! !

NATURAL QUARTZ CRYSTAL.

AN AMALGAMATED SHORT WAVE PRESS PUBLICATION.

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SHORT WAVE NEWS

Vol. I. No. 6. Annual Subscription, 16/-. June, 1946

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Advertisement & Business Manager : C. W. C. OVERLAND, G2ATV.

The Return

EDITORIAL.

THE G.P.O. informs us that, as from June 30th, portions of the 7 and 14 Mcs. bands will be available for use by amateurs. The frequency limits are 7150-7300 kcs. and 14100-14300 kcs. The power allowed on the bands will be 25 watts (Class A) or 150 watts (Class B). Licences will not be amended at present.

The return, even if only partial, of our DX bands is welcome news indeed. Ten metres is wonderful when conditions are right but is normally erratic and "top band" has its limitations, so with the DX bands back everyone should be happy!

The G.P.O. also announce that the use of the 1.8 Mcs. band will continue on a "trial basis" for a further period of two months.

"Forty"

In pre-war days the 7 Mcs. band was called "The Lids Band"—and not without justification! We trust that, with its new lease of life, "forty" will not degenerate into its former unhappy state. With the maximum power now 150 watts we shudder to think what the band would sound like if those inane local "entertainers" of pre-war Sunday afternoons return! For "round the corner" contacts use 1.8 or 58 Mcs. and leave 7 Mcs. for DX and semi-DX work!

Our Constructional Programme

Many readers have requested details of what to expect in the way of magazine constructional features, and so we feel a few words on the subject is opportune.

Our immediate programme is calculated to appeal to most tastes and requirements, the final decisions on what to include being largely influenced by readers' letters. In other words—we will give you the articles you have asked for.

The August issue will contain the first article in the new series. This will describe a combined wavemeter/field strength indicator/'phone monitor, using an EA 50 triode. To follow this we have the "Top Band Ten," a ten watt CO PA transmitter for 1.8 Mcs. This high efficiency transmitter, designed for CW break-in operation is now undergoing tests, using the call-sign G2ATV, with a poor aerial. Readers reports will be very welcome, and should be addressed to the magazine. Then we have a 28/58 Mcs. battery TRF3, now nearing completion, which uses a new range of 2 volt valves. Also "on the stocks" is a general-coverage TRF4, using the same series of valves.

A useful piece of apparatus will be the magazine 100 kcs. Crystal Sub Standard, which is also nearing the testing stage. Other features will include a transmitter for the 7, 14 and 28 Mcs. bands.

The gear described above is that designed by us and built and tested in our workshops. We will, of course, be describing other apparatus in our pages, for example an SW superhet designed and constructed by "Centre Tap" which we hope to include in our next issue. A resistance/capacitance bridge, decade box, and UHF converter will also be appearing in due course.

This is our immediate programme—our future features will depend on you.

W.N.S.

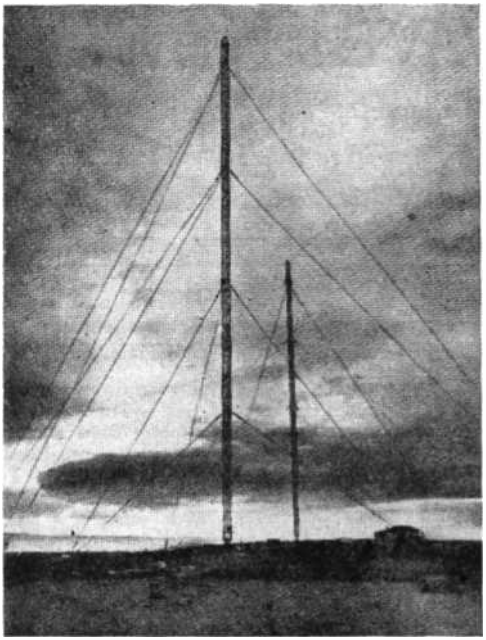
NOTICES

THE EDITORS invite original contributions on short wave radio subjects. All material used will be paid for. Articles should be clearly written, preferably typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtsman will redraw in most cases, but relevant information should be included. All MSS must be accompanied by a stamped addressed envelope for reply or return. Each item must bear the sender's name and address.

CLUB SECRETARIES are invited to submit details of activities for insertion in our monthly club notes, which must arrive at this office by the 15th of each month.

COMPONENT REVIEW. Manufacturers, publishers, etc., are invited to submit samples or information of new products for review in this section.

ALL CORRESPONDENCE should be addressed to "Short Wave News," 57 Maida Vale, Paddington, London, W.9. Telephone CUN. 6579.



ICELAND CALLING

Station Description No. 2

THE Iceland State Broadcast Service was established in 1930, and is conducted entirely by the State, under the control of the Ministry of Education. The programmes are supervised by a Programme Council, which consists of five members chosen by the Althing (the Icelandic Legislative Assembly) after each general election.

The island has three transmitters. A long wave transmitter is situated at a distance of some five miles from Reykjavik. The aerial is supported by two 500 ft. insulated steel masts, and has an input of 100 Kw. The transmitter is connected to to the studios in the Telephone and Broadcast Building in Reykjavik—a view of which is given here—by a special cable. The assigned frequency is 208 kcs. (1,142m.), but other frequencies were used during the war, and at present the station is operated on 271 kcs. (1,107m.).

A medium wave transmitter is located at Eioar, in the eastern part of the island, and is used for relay purposes, with an aerial power of 1 kw. The programmes from the long wave transmitter are picked up on a high quality receiver, with a unidirectional aerial, these being situated at a distance of half a mile from the relay transmitter.

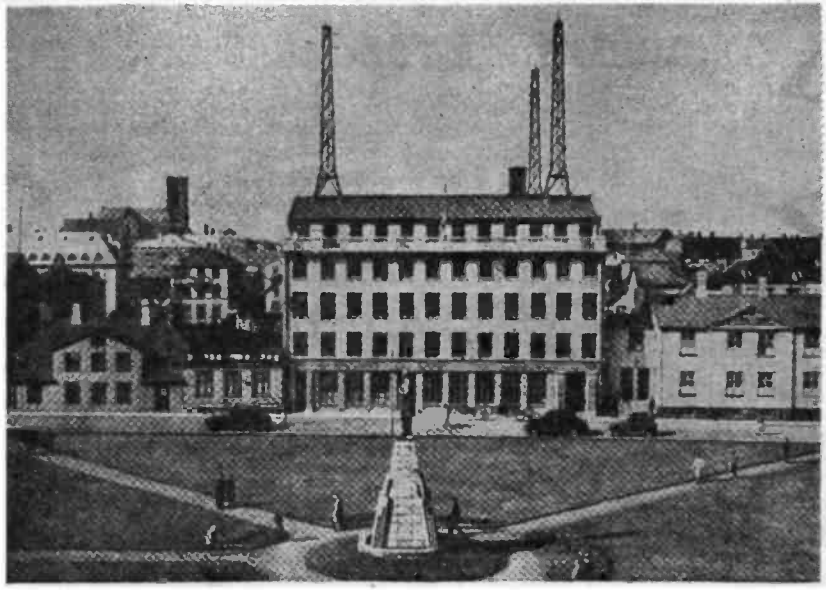
Special programmes are occasionally broadcast through the short wave transmitter—TFJ—which is situated at Reykjavik. This station is operated by the State Post and Telegraph Administration, and has aerials directed towards London, New York and Copenhagen. The aerial power is 7 Kw., and the usual frequency 12,235 kcs. (24.52m.) A view of this transmitter is shown in our third illustration.

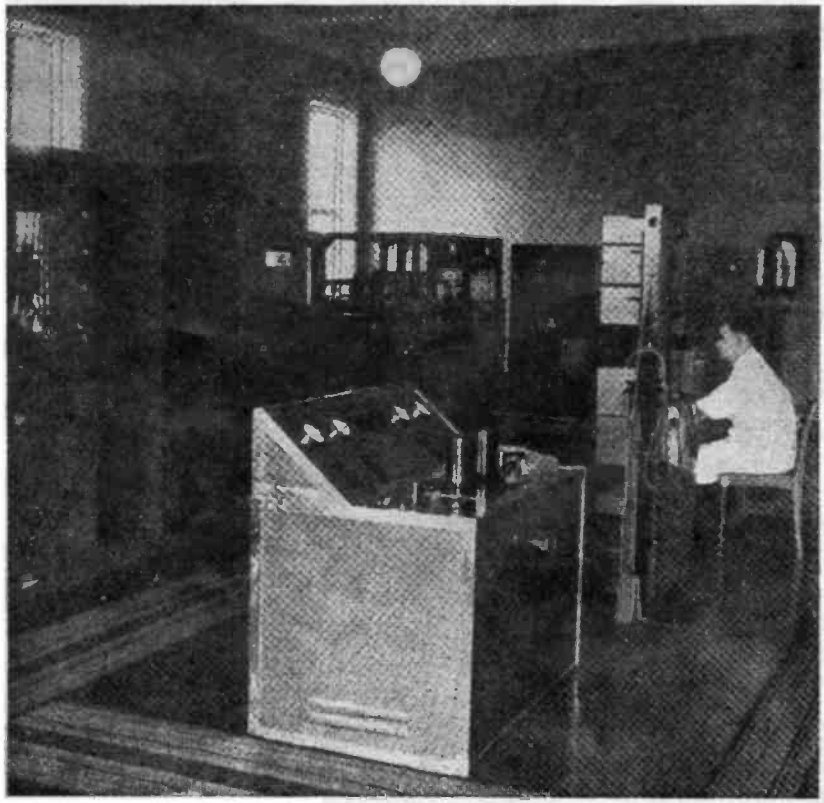
It is a point of interest that, in the year of the establishment of the Broadcast Service, there were practically no radio receivers in the country, the number being estimated at 450. By 1943 the number had risen to 24,400, and by October, 1945, this had reached 28,000, or 22 per cent. of the population.

The decision has been reached to build a new Broadcast House in Reykjavik, and work was scheduled to commence this spring. The drawings were prepared by a noted American architect, and the main cost will be borne by the Corporation, although the licence fee will be slightly increased.

Programmes from Iceland are in four languages, Icelandic, English, Danish and German. Esperanto was used, but has now been discontinued.

Reception reports are always appreciated, and promptly verified with an attractive card, and should be addressed to the Iceland State Broadcast Service, Reykjavik.





Around the Broadcast Bands.

Monthly survey by "Monitor"

All times are given in G.M.T.

LIKE a few foreign stamps for your collection? Then tune in to LRS, "Radio Splendide" on 9360 kcs., and send them a report—you'll get back a letter-veri and some free stamps of Argentine. Most useful!

North America

This continent has undoubtedly supplied most of this month's DX, and very good it has been too. I expect you will have heard the latest Sackville channel, CKLX on 15090 kcs. (19.88m.), which maintains the usual high standard of the C.B.C. transmissions.

The West Coast U.S.A. stations have been putting out some very strong signals recently, although reception is often not reliable. I have logged the following:—

Frequency	*Call*	*QSA*	*R*	*GMT.*
17850	KCBF	4	6	0000
17770	KCBR	5	7	2345
17760	KWID	3	5	2330
15340	KNBI	4	7	2315
15330	KNBX	5	8	2300
15130	KGEI	3	6	2230
11790	KNBA	4	5	0830
9750	KCBF	4	5	0300

C. G. Tilly has heard many of the above and also KWIX, 15290 kcs., Q3 R5 at 2300, and KROJ, 17770 kcs., Q5 R7 at 0000.

The 2,000 watt TIPG on 9618 kcs., "La Voz de la Victor" has been heard at 0400 (R7) but quality is very poor.

The best Cubans of the month were COBL, Havana, 9835 kcs. heard at 0245 with studio music, and COCY, Havana, R5 at 2305 on 11740 kcs.

Guatemala is well to the fore with terrific signals from TGWA on 9790 kcs. Has been heard as late as 0500 (or early—depending on how you look at it!) In addition to this old friend two new ones entered my log, namely TGWB and TGOA. The former is now on 6450 kcs. and was Q3 R7 at 0330 with call "La Voz de Guatemala." Suffered from intense CW QRM. Uses twin chimes between announcements. Power 1 kW. The other one, TGOA, now on 6495 kcs., was logged at 0400 with R6 signals.

Mexico is making itself heard! The famous XEWW has been very consistent between 0000-0600 with varying strength, sometimes R7, using 4 descending chimes between announcements. Call is given simply as "XEW Ciudad de Mexico." Power is 10 kW. But our old friend XEWW has lost the honour of being the loudest voice from Mexico, for XEBT having shifted down to 9625 kcs. is being heard solidly R8 from 0330-0500. No slogan is given, the call being "Transmite XEBT en Ciudad de Mexico." In the past this station has used the slogans of "El Buen Tono" and "Radiopanamericana." The programmes are of the usual style, recorded classical and dance music with news bulletins in Spanish, etc. A curious signal is used, though, between announcements. It comprises two "pips" of different tone, and run together so that they are very nearly superimposed. Very difficult to describe but quite characteristic to the ear. The power, by the way, is only 950 watts. To round off our tour of Mexico, mention must be made of XEQQ, fair signal on 9680 kcs., and XERQ, poorish signal on 9615 kcs. Both these stations suffer from QRM.

Nicaragua is also in the limelight! YNWW is the best signal, and is at Granada. Appears to have changed frequency to about 6890 kcs. Signal was Q4 R7 at 0200, with call "Radio Sport"

(All YN stations have now moved out of the 7 Mcs. amateur band. A full list, with new frequencies will be published next month.—Ed.)

Also at Granada, and new to my log, is YNFT "La Voz de la Sultana," Q4 R6 at 0300. YNPS, "La Voz de Nicaragua," was heard on 6765 kcs. R5 at 0330. Last, but not least, another new one. This is YNOW, Managua, "La Voz de America," heard on 6850 kcs. at 0315. Uses 600 watts and takes the CBS Latin American network.

J. G. Watkinson reports HP5G, Panama City, on 11780 kcs. with call "HOG y

HP5G Radio Panamericana" at 2300. Signals Q3 R4, call every half-hour.

The sole representative from Salvador this month has been YSN on 7310 kcs. Announces as "La Voz de la Democracia," and was heard Q3 R7 at 0230. Quality seemed to be good for music, but very poor on voice.

Pacific Notes.

Think you are good at DX? Your RX is just too good is it? Then try for some of these stations—if they don't break your back nothing will!

ZLT7 Wellington 6715 kcs.
XUPA Taihoku, Formosa 9695 kcs.
FK8AA Noumea, New Caledonia 6208 kcs.
PMH Bandoeng 6720 kcs.
VPD2 Suva, Fiji 6130 kcs.
FO8AA Papeete, Tahiti 6980 kcs.
WVTR Tokio 7545 kcs.
VIG Port Moresby, Papua 7300 kcs.

If any readers do hear any of the above more than once, please write me with details. These stations are NOT impossible to hear, as they have all been heard on odd occasions by intrepid DX'ers.

However, KRHO is still to be heard, although when I last heard it at 2200 signals were Q3 R4 with high-speed flutter. C. Tilly appears to have been more fortunate and reports it at R6 at 0000.

Guam, via KU5Q, is often an excellent R7 on 13360 kcs. Programmes consist of English news at dictation speed, and various musical items. Has been heard at 1555 broadcasting in parallel with KRHO, 9650 kcs., and Saipan, 1010 kcs. (Don't write and say you've heard the latter!) C. Tilly says the schedule of KU5Q is 1100-1700.

So now we leave the "palm fringed shores of the Pacific" for something a little easier in the way of DX.

South America

Personally, I haven't heard anything new from this part of the globe for some time. So here are a few observations listed in a nice orderly manner to soothe the Editor:—

I still haven't solved the question of the Argentine station on 6150 kcs., which I think announces as LRX1. Roger Legge does not agree so we won't argue! If it is not LRX1, then it must be a relay. (*LRX1 is still listed as on 6120 kcs.*—Ed.) I also think the 6180 Argentine station is LRA2, but others would have it as LRM, Mendoza. (*The station is LRM at Mendoza. Power is 10kW. and slogan "Radio Aconcagua." LRA2, on the same frequency is temporarily discontinued.*—Ed.)

Letter-veri from LRS gives frequency as 9360 kcs., and mentions the station operates in Red Argentina network.

L. Singer writes to say that the English transmission from PRL8 ceased on April 15th. They are making changes in equipment for longer broadcasts and better signals. They must be difficult to satisfy as I have always found PRL8 to be the most consistent station from South America. Even so I still fail to agree with their policy of asking for listener's reports and then failing to send a QSL! I note that Fortaleza has returned to the 19 metre band with PRE9 on 15165 kcs., an R8 signal at 0130.

From Chile, CE1180, "Radio Sociedad Nacional de Agricultura" of Santiago remains the most consistent. Frequency is 12000 kcs. and quality is usually very poor. Valparaiso's CE970, "Radio Co-operativa Vitalica," came in Q4 R5 the other evening at 0000, but was literally "sprayed" with sambas from Brazil's "Radio Nacional" on 9720 kcs!

The "best bet" for Paraguay is ZPA5, "Radio Internacion" on 11950 kcs. "Radio Teleco," ZPA3 is not so strong, but can still be heard chirping on 11950 kcs.

The amazing CXA19 continues to amaze! Still stronger than most Latins, "El Espectador" justifies its slogan of "A Uruguayan Voice to the world."

Asia

JCKW, Jerusalem, on 7220 kcs. heard at 2000, R8, with news in English (B. Hayes).

J. G. Watkinson reports that TAQ, Ankara, is again active on 15200 kcs. Heard at 1115 with foreign newscast. I might add that the B.S.W.L. dedicatory programme from TAP was Q5 R9 at my QTH. It was really exciting to hear "Hello and good evening! This is the Turkish shortwave station TAP calling the British Short Wave League!"

ZBW, Hong Kong, heard with English news at 1900 on 9525 kcs. Schedule is 0930-1330 (M. Harrison).

EPB, Teheran, heard with English news at 1130 on 15100 kcs. Power is 14 kW. (M. Forrest).

Acknowledgments

Roger Legge, BSWL 1830 (New York); B. Hayes, BSWL 1690 (Bletchley); L. Singer, BSWL 2360 (Finchley); M. Forrest (Salisbury); M. Bamford, BSWL 1680 (Macclesfield; C. Tilly, BSWL 319 (Bristol); A. H. B. Bower, BSWL 1952 (Hull); J. G. Watkinson, BSWL 1900 (Hedon); M. Harrison (Durham).

Crystal Oscillators

Editorial Note : The writer of this article, Dr. S. O'Hagen, G2CR, is well known as an authority on Quartz crystals. He describes here the characteristics of the various types of "cut," and outlines a number of crystal oscillator circuits suitable for the amateur transmitter.

QUARTZ has two qualities which render it of value to the radio engineer. The first is its hardness, which is excelled only by that of a diamond, and the second is its piezo-electric activity. This latter term implies that when a wafer of quartz is placed between two metal electrodes, and subjected to an alternating voltage, then it is induced to vibrate mechanically. Other materials, notably Rochelle salts and Tourmaline, also exhibit this same property, but none combine it with the physical hardness and resistance to all forms of chemical and physical action that is shown by quartz.

Now, every object has one or more resonant frequencies at which, when struck or similarly stimulated, it will vibrate. These frequencies are intimately connected with the hardness of the material and its physical dimensions, and when applied to a wafer of quartz it is found that at one or more frequencies—usually relatively high frequencies between 0.1 and 7 Mcs.—an alternating voltage applied across the faces of the wafer will cause a much more intense vibration of the quartz. This vibration generates similar voltages across the crystal itself with the result that the crystal behaves electrically like a coil and capacitor in parallel, with a resonant frequency equal to that of the crystal. But with this important difference—it behaves like a tuned circuit a hundred times as good as we could make from the best coils and capacitors available, and furthermore one whose resonant frequency cannot readily be changed.

The implications of these characteristics are two-fold. Firstly, since it is such a "good" tuned circuit ,it can be used in a super-heterodyne receiver to replace many tuned circuits and give extreme selectivity with very little cost or trouble. It may also be used as the frequency-determining tuned circuit of an oscillator, with the very great advantage of holding the oscillator very close to the pre-determined frequency in spite of changes in electrode voltages, valve characteristics, output circuit tuning and all the other factors that spoil the constancy of an ordinary oscillator. A crystal controlled oscillator plays two invaluable roles in radio. It may be used to drive a transmitter and thus ensure that the transmission is accurately "on frequency," or it may be used as a fixed reference point for the calibration of a heterodyne frequency meter such as was described in the February issue of this magazine. For the latter purpose, the crystal is usually cut to oscillate at either 100 or 1,000 kcs., and the type of circuit used is such that the output is rich in harmonics, strong "chirps" being produced in a receiver every 100 or 1,000 kcs. throughout the tuning range. This enables the receiver or frequency meter to be kept constantly and accurately calibrated, for the average amateur would have no difficulty in making a 100/1,000 kcs. oscillator that could be relied upon to with one part in 30,000 for an indefinite period of time. Under most conditions the crystal oscillator would maintain its frequency accurately to within ten parts in a million —and this without any great complication or expense.

The discussion above will suffice to emphasise the extreme value of quartz to the radio engineer, and it remains to describe some of the more common ways in which it is employed. To begin with, the wafer of quartz can be cut from the mother crystal —a typical specimen of which is illustrated on the cover of this issue—in a variety of ways to produce special effects. A crystal may be cut to show only a single resonant frequency (AC or BC cut), and this is of value in a crystal to be used as an I.F. tuned circuit in a receiver, or it may be cut to show no change in frequency as the temperature of the crystal varies with room temperature and heat losses from the oscillations (AT and BT cut). Of these, the "B" cuts are thicker for a given frequency than are the "A" cuts, and so can be ground to much higher frequencies than the latter; 6 Mcs. is about the upper limit for AT cut transmitting crystals, whereas BT cut crystals can be made for frequencies as high as 10 Mcs. The latter, however, have a much lower mechanical strength and will only stand very low-power working. This is no real disadvantage as practically all modern transmitters use at least two

stages, and valves such as the RCA 813 will give 200 watts output with less than one watt of drive, which can be provided by the most fragile crystal without risk. It does mean, though, that BT cut crystals will not stand abuse by misadjustment of the oscillator in the same way that AT cut crystals will.

For low-frequency work, especially frequency standards at 100 kcs., two very similar types of crystal, called the CT and DT cuts are available. These have their frequencies determined by the length of their edges rather than the thickness, but as in the AT and BT cuts, the frequency is unaffected by changes in temperature. The sole reason for their existence is ease of manufacture.

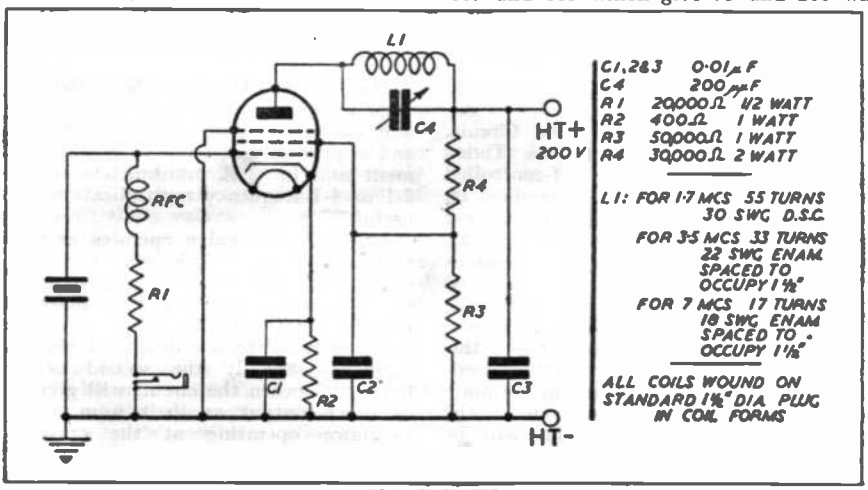


Fig. 1.—*Tuned Plate—Crystal Grid Oscillator.*

Two older types still exist, though now obsolescent. These are the X and Y cuts. The latter has no particular advantages and is the least reliable type; it is hardly ever used nowadays. The X cut has the advantage that for any given frequency it gives the thickest crystal of all, and X cut crystals have been ground by the author to operate in the 14 Mcs. band direct. Such crystals are about 1/200th of an inch thick, and correspondingly delicate to handle, though invaluable for special purposes. X cut crystals change their frequency 23 parts in a million per degree Centigrade change in temperature, whilst Y cut ones drift about a hundred parts in a million. Thus they are much less desirable than the AT and BT cut types which drift only about two parts in a million.

Crystals are adjusted to frequency by grinding, usually on plate glass or cast iron surface plates, with carborundum paste and infinite patience. The finishing touches are done on the ground surface of the glass without any abrasive, and this is extremely delicate work, for the frequency can only be increased, never decreased so that the slightest "overshooting" of the specified frequency ruins the crystal and a completely fresh start must be made.

Crystal Oscillators for Transmitting Frequency Control. The best modern practice is to use the crystal purely as a frequency control, and no attempt is made to get any great amount of power from the crystal oscillator stage. This allows the crystal to give the best possible stability with safety. The advent of valves such as the 807 and 813 which give 75 and 200 watts output with less than a watt of driving power makes it quite unnecessary to use anything larger than a small receiving audio or radio frequency pentode in any of the earlier stages of the transmitter. The most useful types of crystal oscillator valves are the EF50, and 7C5 and the 6L6 metal and 6V6 metal types. The 6SK7 is also a very good little valve and will give full output from an 807 when driving it as a straight amplifier on 7 or 14 Mcs. from a 3.5 or 7 Mcs. crystal.

Circuits for Crystal Oscillators. There are two basic circuits—the tuned plate crystal grid circuit as shown in Fig 1, and the Pierce or Ultraudion circuit shown in Fig. 2. The former is the basis of nearly all crystal oscillators in common use. A pentode is shown in the drawings because either a pentode or beam tetrode will give better output than a triode for a given strain on the crystal, and the use of triode

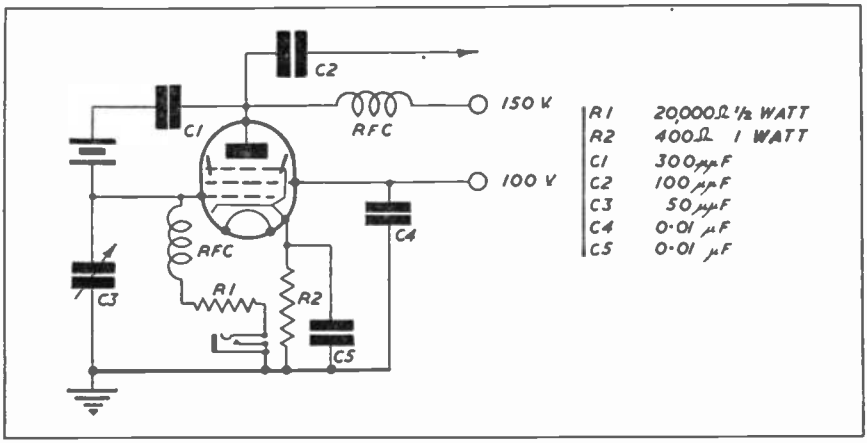


Fig. 2.—*Pierce Oscillator.*

oscillators—except for very low power in special cases—is obsolete. .

The Tuned Plate, Crystal Grid Circuit. This is entirely analogous to the Tuned Plate Tuned Grid type of self-controlled oscillator. The frequency is determined by the circuit, or equivalent, with the higher "Q," which in this case is the crystal. The tuning of the plate circuit is used as a feed-back control. The energy required to keep the crystal vibrating is very small, and is fed to the crystal through the anode-to-grid capacity of the valve. Where this is high, as in triodes, the amount of feed-back must be reduced by detuning the plate circuit on the high frequency side of the crystal frequency, or the crystal will be fractured instantaneously on switching-on. With pentodes and beam tetrodes, the anode-grid capacity is much smaller and the drive requirements are also less, so that full output results from much less feed-back and the strain on the crystal is thereby reduced, improving stability and safety.

The Pierce Crystal Oscillator. This circuit—shown in Fig. 2—is interesting because no variable tuned circuit is employed, and the potential dividing action of the valve's anode-cathode and cathode-grid capacity results in feed-back which is increased by adding the capacitor between grid and cathode. It is a dangerous circuit, giving very little output voltage and practically no power, and is very liable to shatter the crystal. However, in certain special cases it is still used. For example, crystal manufacturers sometimes use it for test oscillators, since the circuit will oscillate without adustment with a crystal of any frequency.

The Tritet Oscillator-Mutiplier. This very popular circuit economises in valves and current at the expense of simplicity, and is primarily of value in portable equipment and in H.F. transmitters where the 2-1 or 4-1 frequency multiplication is most useful.

In effect, the valve operates as a tuned plate crystal grid triode oscillator, with the screen-grid and, to a lesser extent, the anode, forming the effective plate. The output circuit in the anode lead of the valve is tuned to a multiple of the crystal frequency—usually the second or fourth harmonic—when the circuit will give nearly as much output as if it were a normal oscillator operating at the crystal frequency. From what was said above, it is obvious that steps must be taken to reduce the strain on the crystal resulting from the use of a triode oscillator. Electrode voltages must be kept low, thinking of the valve as a triode, which means that it is advisable to put not more than some 100-150 volts on the screen-grid. The plate voltage is not so important, and may be any value up to 350 **provided that the circuit is first adjusted on low voltage.** The cathode circuit, as in the case of the plate circuit of a normal triode oscillator, must be tuned to a frequency well above that of the crystal. This circuit may be fix-tuned by a pre-set capacitor.

It is possible, but very risky, to obtain output on the fundamental frequency of the crystal. It should not be attempted with the usual valves, the only effective valves for this purpose known to the writer being the types 802 and RK25. In general it is better to short-out the cathode circuit and to use the valve as an ortho-

dox pentode or tetrode crystal oscillator on the fundamental frequency.

The Pierce Oscillator-Amplifier. This is similar in principle to the Tritet, but the crystal is connected between the grid and "earth," and the cathode tuned circuit replaced by a 2.5 mH. choke with a 100 to 200 uuF capacitor in parallel. Thus the circuit behaves as a Pierce oscillator between the grid, cathode, and grounded electrodes, and as a pentode amplifier.

It is often suggested as a means of obtaining high output on the crystal frequency from such valves as the 6L6 and 807, especially for a single-valve, portable transmitter. For this purpose—with AT cut crystals—it is excellent, but the tuning of the plate circuit is not entirely free from coupling to the crystal, so that the voltage across the latter rises sharply with the plate tuned slightly above resonant frequency, and drops sharply at exact resonance. This effect is not seen in the types 802 and RK25 which behave as if the oscillator and amplifier stages were entirely separate, and the circuit gives excellent results with these valves.

The Bliley Oscillator-Multiplier. This is a simple and recent circuit for use with high mutual conductance pentodes, and gives greater efficiency on the 4th harmonic than does the Tritet, though it is not suitable for high-power working.

As will be seen from Fig. 5, the arrangement is that the screen-grid is used as the anode of a triode oscillator, observing the usual precautions of low L/C ratio in the tuned circuit, detuning the circuit from resonance, and keeping the screen voltage low. The anode of the valve is partly shielded from the screen-grid, which is not, of course, earthed, and it is tuned to four times the crystal frequency, using a relatively high L/C ratio in this curcuit. External shielding between the anode and the screen-grid circuits is advisable.

The fact that the cathode is at earth potential to R.F. is an advantage, especially for filament-type valves which are the best choice for portable work. Enough R.F. can be obtained on the 4th harmonic to drive an 807 without imposing an excessive strain on the crystal.

The Adjustment of Crystal Oscillators. In every case, the operation of the oscillator should be checked with about half the normal voltages on plate and screen, in the first instance. This will save many crystals from destruction.

The actual voltage across the crystal can be measured with a milliameter connected in series with grid-leak. The reading in milliamperes multiplied by the resistance of the leak in thousands of ohms may be taken as the peak R.F. voltage across the crystal. The reading in milliamperes should never exceed 50 with 7 Mcs. crystals, nor 100 with 3.5 crystals or 1.7 Mcs. crystals, and the feed-back must be controlled accordingly. In the case of pentodes and tetrodes, the screen-grid exerts a profound effect on the valve characteristics, and increasing the voltage on the grid increases both output and crystal voltage. It should always be operated with the lowest voltage that will give the required oscillator output.

The value of cathode resistance and grid-leak also affects the voltage across the crystal. The higher these resistances the higher the efficiency of the oscillator,

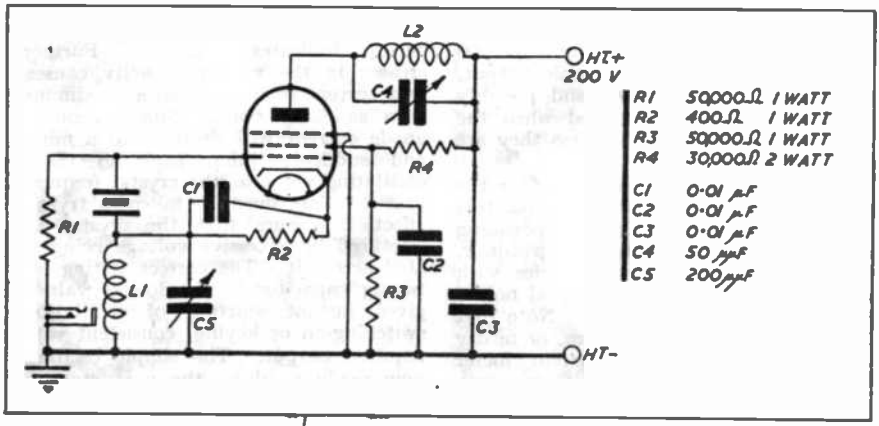


Fig. 3.—*Tritet Oscillator.*

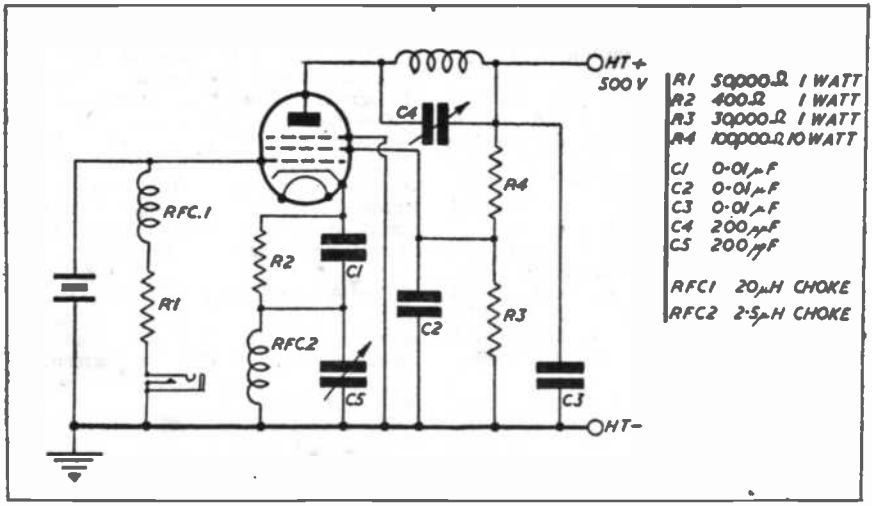


Fig. 4.—*Pierce Oscillator-Amplifier.*

especially at harmonic frequencies, but increased efficiency is obtained only at the cost of reduced input and output power and a sharp increase in crystal voltage. 400 ohms is a good all-round value for the cathode resistor, though it may sometimes be lowered to 200 ohms when the plate and screen voltages are kept low. It is best never to omit a cathode resistor altogether, especially with beam tubes, since it tends to prevent the valve from self-destruction by excessive plate-current, should the crystal cease oscillating for any reason. It also improves the response of the oscillator to keying. The grid-leak resistance is usually best at 20,000 ohms for output on the crystal frequency, 50,000 ohms for 2nd harmonic output, and 100,000 to 200,000 ohms for 4th harmonic output, bearing in mind that screen and possibly plate voltages must be reduced when the grid resistance is increased, unless they are already low.

Before switching on an oscillator for the first time, set all the variable capacitors to minimum, and connect a low-reading milliameter in series with the grid-leak, and an 0—100 mA. meter in series with the HT+ lead. Remove the crystal holder from its socket, and switch on. Note that the grid current meter reads zero, or nearly zero, and that the plate current meter gives a steady, high reading. Swing each of the variable capacitors through its tuning range; the two meters should not change their readings at any setting. Then return the capacitors to minimum capacity. The crystal can next be plugged in, in the certain knowledge that any output from the oscillator will be crystal controlled, and not merely an unstable parasitic oscillation. With the crystal in circuit and the power on, normally the grid current meter will give a positive reading and the plate current reading will be reduced somewhat. Should there be no reading on the grid current meter, slowly increase the capacity of the oscillator tuning capacitor—the anode capacitor in the case of a simple oscillator, or the cathode capacitor in the case of a Tritet—until a sudden rise in grid current and corresponding fall in anode current indicates oscillation. Further increases in the tuning capacity causes the grid current to increase to a maximum and then suddenly cease. Simultaneously the anode current will decrease to a minimum and suddenly jump back to the non-oscillating value as the crystal frequency is passed. Care must be taken in trying this effect to ensure that the crystal is not fractured by excessive voltage being generated across it. The correct setting for the tuning capacitor is the lowest value that gives instant starting of oscillation on switching-on or keying, consistent with the required output. The simple oscillator is now ready to drive the next stage. The Tritet requires one other adjustment—that of tuning the output circuit to the required

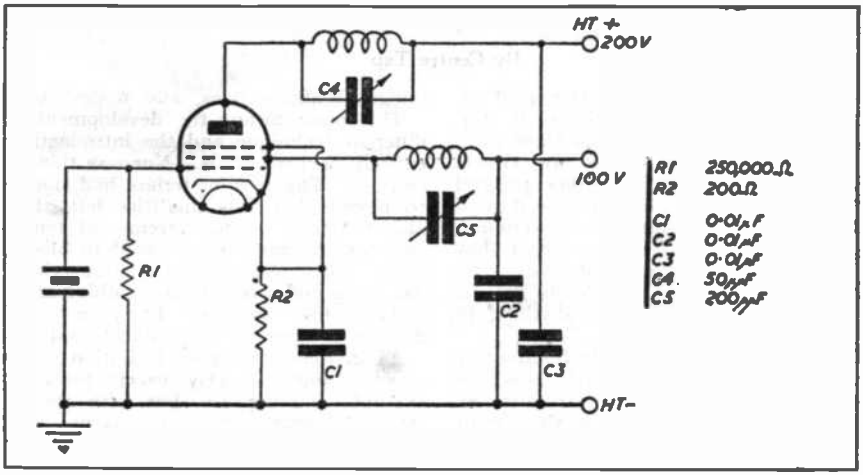


Fig. 5.—*Bliley Oscillator-Multiplier.*

harmonic. Resonance will be shown by a further sharp dip in plate current, most marked at the second harmonic and less marked on the third and fourth harmonics. A flash-lamp bulb with a loop of wire connecting its contacts will indicate the presence of R.F. when coupled to the output coil.

It still remains, however, to check with an absorption wavemeter that the output is being obtained on the correct harmonic frequency. This is an indispensable step as off-frequency working is inevitable if the wrong harmonic is selected at this stage.

The Pierce oscillator amplifier will usually oscillate instantly on switching-on and plugging in the crystal, and it then only remains to tune the plate circuit for minimum plate current or maximum output, keeping a wary eye on the grid meter, and lowering the screen voltage if the grid reading approaches the danger line.

The adjustment of the Bliley oscillator-multiplier is similar to that of the Tritet.

Coupling the Load. In all cases except that of the simple Pierce oscillator, the load may be coupled either inductively or capacitively to the output circuit of the oscillator. The simple Pierce, having no tuned output circuit, can only be coupled capacitively to the grid of the next stage.

28 Mcs. DX. G6DH's FINE LOG

ONE of the most consistently good stations on 28 Mcs. is G6DH at Clacton-on-Sea. Listen on ten at any time, and if the band is open, you will not listen long before you hear some station calling 6DH! If it is a phone station, you'll probably hear references to "Eileen", as the XYL is the very capable 2nd Op. of this station. How's this for last month's log of "stations worked"? XABJ, XACD, XABZ, XAAN, XADF, XADB, EAIB, HB9CE, XZ4AM, YI2XG, W2JE/J5, W6NFL/J5, EQ3W, XUIYY, SUILT, SUIRC, SUIKE, SUIMW, SUICX, SUIJM, ZS2CI, ZS6DF, ZS2CB, VQ3TOM, VQ2HC, KAIJM, W7GXR/KB6, W9HJW/Saipan, VK4GE, VK4FY, PK4DA, VOID, PY4GT and PY2AC. This log is a better one than we published last month. After reading that, several readers asked, "How is it done?" A long wire aerial, 60ft. horizontal, 38ft. vertical, end fed, 50ft. high, and a W8JK beam, are part of the answer. A good receiver is another. And the operators of the station, Denis and Eileen Heightman, are yet another. The output valve is a Standard Telephone's 4304-C. There are another 109 call signs in the "calls heard" section of the log! These include: SVIEC, WIJQK/Athens, XZ2ON and XZ2DF, W8CUF/J5, CR9AG, OQ5AE, OQ5BQ and OQ5BL, ZEIJM, ZD4AC, W8FYF/VO, CXIFY, CE3CR, VP6YB, K4AH and W4FAY/K4.

Resonant Lines.

By Centre Tap

THE world has grown accustomed to hearing of so many things in the U.S. as being bigger than those anywhere else, except of course for Gracie Fields' aspidistra, that we either pretend to regard it as eccentricity, or take it with a pinch of salt, according to the circumstances. When I first discovered that they have really got a longer inch than ours, I felt that did have us completely nettled and have still not thought of anything to effectively answer that one.

Their inch, of course, is only fractionally longer (about 1% of .002) but now the Scientists are planning to introduce an Anglo-American unit, it seems they want quite a different inch—longer than ours but shorter than America's. As the standard is measured by light wavelength, there is no question of giving them an inch and they taking a yard in this matter!

Information Dept.

Beset by difficulties in getting supplies, I have carefully sorted over my old junk boxes seeking discarded treasures which may have escaped the ravages of the Blitz, the moths and rust. Happily my Scrapbook is intact. I often wonder how many amateurs keep one? Mine in which I enter details of components, etc., as acquired, has proved a wonderful help on many occasions, particularly so for some of the items I have unearthed.

It must be annoying to find an L.F. choke or transformer and wonder if it will carry the current you now require! That simply cannot happen if you enter it in your Scrapbook together with colour coding of leads or terminal arrangements.

My Scrapbook is voluminous and well thumbed, containing masses of information on all sorts of things. Circuits used (with notes on tried modifications), gen on components, abacs, dozens of tables, home made enamels, low temperature solders, formulae, polarity testing, cures for all sorts of evils from mains hum to motor-boating, even a recipe for a home made wax polish and hints on drilling glass.

Lilliputian

During the War years the "back-room boys" gave much thought and time to reducing the dimensions of components in order to save as much space as possible both in land vehicles and aircraft. How successful they were is evidenced by midget Walkie-talkies, and midget valves.

This often meant the development of a different technique and the introduction of entirely new materials. Nor was this alone enough. The new materials had not only to possess low loss qualities but also be able to stand up to extremes of temperature ranging from intense cold to blistering heat. They had also to be impervious to dampness and shock, to say nothing of withstanding the "he-man" handling to which Service equipment is constantly subjected.

As amateurs this miniaturisation may not affect us much directly, except perhaps for portable and car use, but with the great mass of research work also comes greater improvement in the design and manufacture of standard parts and insulation, with still greater possibilities for the future.

To the Other Extreme

The exception that proves this rule of becoming smaller is the modern tuning dial and meter scale, where the tendency seems for them to grow still bigger and brighter. At least one post-war receiver laying emphasis on its short-wave advantages, boasts of a 20 inch tuning scale. For critical work geared drives are highly desirable, but on the grounds of economy it is more usual to depend on a cord or cable for the cursor or pointer movement.

After considerable use one often finds the cord stretches with the resultant slipping preventing accurate tuning and upsetting the calibration. Once when confronted with this difficulty I found that powdered resin mixed in a small quantity of petrol and brushed well into the offending cord, effected a permanent cure. The petrol soon evaporates and the resin ensures a firm grip of the cord on the tuning wheel.

Freedom For All

Kind friends ask after the Dumb Blonde. She is in good health and spirits, being busily engaged campaigning for the prevention of harmonic suppression. She points out that if they leave us to carry on with our knob-twiddling in peace, we have no right to try stop them using their mouth-organs!

Centre Tap

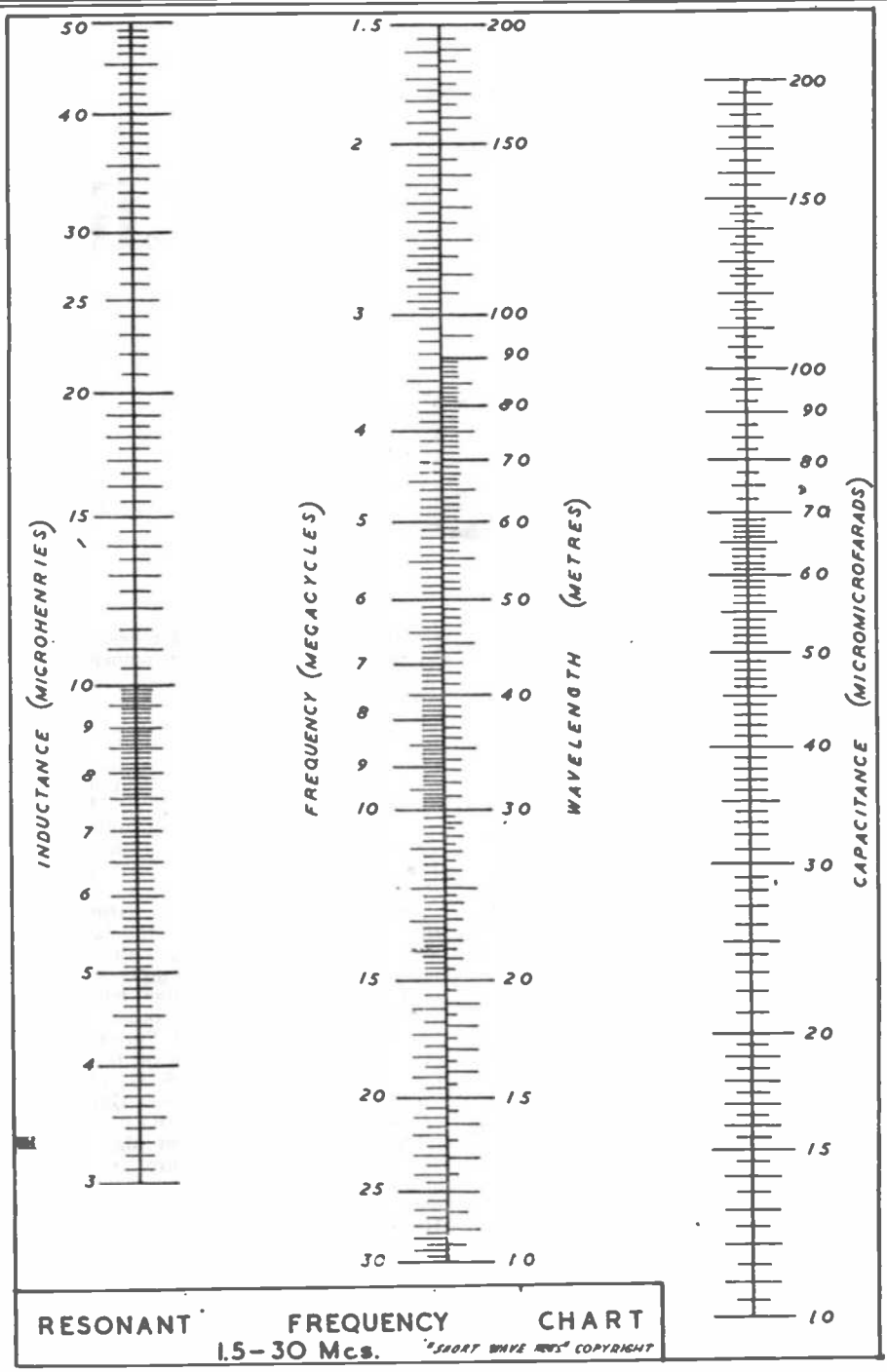
BROADCASTING STATION LIST.

Part 4: 9660 kcs. — 9320 kcs.

THIS list has been compiled by the Signal Survey Section of the British Short-Wave League, and contains only stations that are operating on regular or irregular broadcasting schedules. Stations not in use, channels not in use at the time of going to press, and stations under construction are not included.

Frequency	*Call*	*Location*	*Slogan*	*Power (watts)*
9660 ...	HHBM	Port-au-Prince, Haiti	National Broadcasting Company	1000
	HVJ	Vatican City	Radio Vaticano	25000
9650 ...	KRHO	Honolulu, Hawaii		100000
9640 ...	LRY	Buenos Aires, Argentine	Radio Belgrano	10000
	COX	Havana, Cuba	Radiodifusora del Ministerio de Educacion	5000
	GVZ	Daventry, England		
	CXA8	Colonia, Uruguay	Radio Belgrano	
9630 ...	CP12	La Paz, Bolivia	Radio Fides	250
	CBFX	Montreal, Canada		7500
	VUD7	Delhi, India	All India Radio	
	VUD10	Delhi, India	All India Radio	100000
9625 ...	XGCA	Kalgan, China		
	GWO	Daventry, England		
9623 ...	CXA6	Montevideo, Uruguay	Radio Electrica	3000
9620 ...	TPB24	Paris, France		
9618 ...	TIPG	San Jose, Costa Rica	La Voz de la Victor	2000
9615 ...	VLC6	Shepparton, Australia		50000
	XERQ	Mexico City, Mexico	Radio Continental	500
9610 ...	ZYC8	Rio de Janeiro, Brazil	Radio Tamoio	25000
	——	Algiers, Algeria	Voice of America in North Africa	50000
9607 ...	HP5J	Panama City, Panama	La Voz de Panama	380
9606 ...	ZRL	Capetown, South Africa		5000
9603 ...	CE960	Santiago, Chile	Radio la Americana	1000
	XEYU	Mexico City, Mexico	Radio Universidad Nacional	250
9600 ...	GRY	Daventry, England		
9595 ...	——	Athlone, Eire	Radio Eirrean	1500
9590 ...	VUD4	Delhi, India	All India Radio	10000
	PCJ	Huizen, Holland		60000
	WCBX	New York, U.S.A.		50000
	WLWO	Cincinnati, Ohio		75000
9580 ...	VLG	Melbourne, Australia		10000
	VLR	Melbourne, Australia		2000
	GSC	Daventry, England		
9570 ...	KWID	San. Francisco, Calif.		100000
	WRUS	Boston, Mass.		50000
	WBOS	Boston, Mass.		50000
	CXA2	Montevideo, Uruguay	Radio Continental	5000
9656 ...	——	Komsomolsk, U.S.S.R.		50000
9650 ...	——	Paris, France		
9557 ...	XETT	Mexico City Mexico		500
9555	JHKD	Singapore, Malaya		

Frequency	*Call-sign*	*Location*	*Slogan*	*Power (watts)*
9550 ...	OLR3A	Prague, Czechoslovakia		30000
	GWB	Daventry, England		
	——	Paris, France		
	OAX5C	Ica, Peru	Radio Universal	150
	KGEI	San Francisco, Calif.		50000
	HVJ	Vatican City	Radio Vaticano	25000
9545 ...	XEFT	Vera Cruz, Mexico	La Voz de Veracruz	250
9540 ...	VLC5	Shepparton, Australia		50000
	VE9AI	Edmonton, Canada		
	——	Paris, France		
	LKJ	Oslo, Norway		5000
9535 ...	SBU	Motala, Sweden		12000
9530 ...	WGEO	Schenectady, U.S.A.		100000
9525 ...	GWJ	Daventry, England		
	OQ2AA	Leopoldville, Bel. Congo	Radio Leopoldville	50
	ZBW3	Hong Kong, China		2500
9523 ...	ZRG	Johannesburgh, South Africa		5000
9520 ...	TPB11	Paris, France		
	RW96	Moscow, U.S.S.R.	Radio Centre Moscow	
9518 ...	OXF	Skamlebak, Denmark		6000
9510 ...	GSB	Daventry, England		
9505 ...	YUC/D	Belgrade, Yugoslavia		10000
	PRE8	Rio de Janeiro, Brazil	Radio Nacional	
9500 ...	OIX2	Pori, Finland		15000
	——	Paris, France		
	XEWW	Mexico City, Mexico	La Voz de la America Latina	10000
	PRF5	Rio de Janeiro, Brazil		
9490 ...	KNBI	Dixon, Calif.		50000
	WCBX	New York, U.S.A.		50000
9480 ...	CP38	La Paz, Bolivia	Radio Nacional de Bolivia	250
	——	Moscow, U.S.S.R.	Radio Centre Moscow	
9470 ...	CR6RC	Luanda, Angola	Radio Club de Angola	250
9465 ...	TAP	Ankara, Turkey	Radio Ankara	20000
9460 ...	CP1	Sucre, Bolivia	Radio Chuquisaca	250
	GRU	Daventry, England		
9440 ...	FZI	Brazzaville, E.E.A.	Radio Brazzaville	50000
9437 ...	COCH	Havana, Cuba	Radio O'Shea	1000
9430 ...	CP21	Sucre, Bolivia	Radio La Plata	270
	——	Moscow, U.S.S.R.	Radio Centre, Moscow	
9425 ...	——	Belgrade, Yugoslavia		10000
9410 ...	GRI	Daventry, England		
9405 ...	LRA	Buenos Aires, Argentine	Radio El Mundo	
9380 ...	OTM2	Leopoldville, Bel. Congo	Radio Congo Belge	
9370 ...	——	Madrid, Spain	Radio Nacional de Espana	40000
9362 ...	COBC	Havana, Cuba	Radio Progreso	1000
9360 ...	——	Cetinje, Yugoslavia	Radio Centinje	
	CBFX	Montreal, Canada		
9355 ...	HC1BS	Quito, Ecuador	Radio Teatro Bolivar	250
9345 ...	——	Sofia, Bulgaria	Rodina	1000
9340 ...	OAX4J	Lima, Peru	Radio Internacional	200
9330 ...	——	Andora, Andora	Radio Andora	
9320 ...	——	Madrid, Spain		40000


INDUCTANCE (MICROHENRIES)
50
40
30
25
20
15
10
9
8
7
6
5
4
3
FREQUENCY (MEGACYCLES)
1.5
2
3
4
5
6
7
8
9
10
15
20
25
30
WAVELENGTH (METRES)
200
150
100
90
80
70
60
50
40
30
20
15
10
CAPACITANCE (MICROMICROFARADS)
200
150
100
90
80
70
60
50
40
30
20
15
10
RESONANT FREQUENCY CHART
1.5–30 Mcs.
"SHORT WAVE NEWS" COPYRIGHT

V.H.F. News

First Post-War DX worked

WE commence another feature this month. VHF activity is now at quite a high level, and on this page we shall include each month 60 Mcs. news and other VHF information. This seems an appropriate month to start this feature as the news is just to hand that on May 19th, two British stations contacted the Italian station I1IRA and F8YY, thus making the first DX contacts since pre-war days. The two stations who share the honours for this work are G5BY of Devon and G5MQ of Liverpool. These two stations deserved this success, as they have been two of the most active stations on this band since it was opened for amateur activity. Both of them are "old hands" on the band and these contacts show the value of experience in this sphere. There were "short skip" conditions on 28 Mcs. at the time, G, D4 and F signals being audible, indicating high ionisation conditions.

In our April number we reported that SUIMW, Cairo, had received the 41.5 Mcs. Alexandra Palace signals. We illustrate above the receiver—an AR77—and the special antenna used for this reception.

There is a good deal of 60 Mcs. activity throughout the country and even before the above DX contacts, some pre-war DX records had been broken. The pre-war inter-G record of 187 miles, made in August, 1939, between Sheffield and Worthing, was broken on April 16th, when G5BY worked G6CW—233 miles. 6CW has worked the London area on numerous occasions, whilst the contact with 6CW was 5BY's tenth two-way contact over 150 miles. G5BY again exceeded the pre-war record on May 16th, with a solid 35 minute contact with 5MQ—218 miles, 5MQ receiving 5BY's cw at 569 and his phone at R6. 5MQ was received at 559. This brought 5BY's DX (over 150 miles) up to 29 contacts. Then on the 19th came the I and F contacts, giving 5BY and 5MQ their first "outside G" QSOs.

G6VX, Hayes, Kent, is radiating one of the outstanding signals on the band. He has had numerous contacts with 5BY—184 miles, and with 5MQ—185 miles. Recently licensed G2BMZ at Torquay has lost no time in building a rotary beam, resulting in QSO's with Kent and Surrey. South of England stations active on 60 Mcs. include G6LK, G5MA, G8RS, G2NA, G5TX and G2XC. On the east coast G6DH is, of course, one of the most active. G5LL and G5BD are both active most nights further up the coast in Lincolnshire, but activity is not at a high level in these parts. 6DH's only contact, for instance, was G6VX at Hayes in Kent, although he has heard G6FO, G6YU, G6YQ and G5MQ during the past month. The latter two stations were about 220 miles distant.

We should like to thank those who have sent in information for this feature, particularly R. B. Holman, S. Devon.

On the Ham Bands.

Conducted by "CQ"

HAVING now fully recovered from my temporary indisposition, I take up the pen again.

The last month on the air has not been unduly exciting, probably due to the fact that the novelty of hearing DX is wearing off slightly! However, there is much DX to be heard for those who dig for it.

1.8 Mcs.

Much DX in the form of D2, GM, GW and GI has been logged here after darkness. Many D4's are heard but these are not considered as DX since they all use excessively high power and are, in effect, nothing more than local broadcasting stations! The best catch here was G6HB/I, heard very well most evenings between 2300-0100. Surely the best piece of QRP work for some years must be credited to G2HIL at Colchester who worked G6HB/I with only *three watts!*

A grand old-timer is back on top-band—G2TK—who puts in some very fine work on phone, although he QRT's at 1930. My friend G4AK recently worked Manchester on 6 watts, putting in an RST 599x signal. It would appear that a good aerial is the real secret to success on the top-band. QRN has been troublesome at times, and has ruined what would otherwise have been perfect QSO's. Several readers have asked if 1.8 Mcs. news is required, and all we can say is that ANY news of ANY band is always most welcome. We cannot promise to publish everything we receive but all good DX snips and news items will appear. Readers reports are useful in compiling records here, and considerable time is spent in tabulating notes of signals heard and conditions.

It is apparent that during daylight hours top-band working is confined to distances of less than 50 miles, although larger distances can be covered if QRN and QRM permit. The general standard of operating on this band is high, but we regret to say that certain local phone stations cause a lot of unnecessary QRM with their tests which could easily be made on an artificial aerial. However, perhaps it is a good sign to see this band so fully occupied since in pre-war days it was a difficult matter to persuade G's of the usefulness of it. It will be interesting to note the difference when we get back 20 and 40 metre bands!

3.5 Mcs.

Now that the W's are back on the band, it will be interesting to hear from readers if they log any. W's are still real DX on 80 metres, so . . . ? N. A. Phelps (Fortis Green) has been hearing many European signals including D4, EI, HA, HB, I, LA, OE, PA, SM and SP.

7 Mcs.

My colleage "Monitor" tells me that there is plenty of DX to be heard around 0200-0500. He has logged the following, all on phone:—XE1A, XE1G, XE3AH, XE3AQ, HK7CA, TI4JE, PYOAM, PY2MA, PY3EA, CO8RL, CO2PM, CO5AV, etc. Very fine indeed! Our Assistant Editor bears out the fact by reporting many PY, LU, etc., on CW between 2100-2230, which may encourage those not prepared to stay up TOO late!

14 Mcs.

There is not much further to add to the Assistant Editor's summing-up in last months' issue. The Latins are fast becoming mere "locals"! We would like to quote from the log of D. Parker, BSWL 1915 (Huddersfield) who has some DX worth noting:—HP2HP, HC1FG, OA4M, PZ1A (2240), HH2PH (2240), CP1UU (2130), YN1LB (2300), CR6AM (2240), etc. BSWL 1915 mentions that the Aurora Borealis, which was visible from his QRA, appearing on 23rd April, interfered with reception on the 23rd-25th after which normal conditions prevailed. He also notes that QRN has become more noticable of late, mostly in the early evening, but gradually fades out by the time the Latins come through. The RX, by the way, is a HiQ-3, and the aerial 16ft. 6in. indoor, NE/SW.

28 Mcs.

Moving to that fascinating band where 2 watts during a spell of good conditions can do more than 2 kW. during poor conditions, we find things still rather variable. A weekly report from Geoff. Johnson, G2BJY, has been of considerable use to me—thanks a lot, OM. Here is a summary of these reports:—

Week ending April 19th: Conditions good for Pacific DX during the mornings and afternoons, and for South America during the late afternoon and evening. Best DX heard:—XU1YU (RST 449), XU1YT (449), VK6SA (459), VQ6MI (449), W6QKB/KB6, LU9EV, KA1BB,

VU7BR, KA1IW, ZS1BM andPY2AC VU7BR, KA1IW, ZS1BM and PY2AC. Week ending April 29th: The 21st opened promisingly at 0900 with ZS5B and ZS1CX. After 1200, all W districts, VE1-3, V4, PY2, ZS1, ZS6 were heard. On the 22nd conditions were still good, but deteriorated with practically complete fade-out on the 24th. On the 25th, although no W or VE were heard, CR9AG, PK4DA, VU7BR, and VQ2HC were all heard. The 26th and 27th were both bad days, but the 29th produced some good DX. At 0900 VU2BR, VQ6MI, and VU2AA were logged. After 1400 I heard ZS1CV, ZS1AJ, LU7AZ, KA1AW, LU8DR, KA1ABA, KA1BK, etc. Tuesday, the 30th was absolutely dead, whilst Wednesday produced only W6PUZ (1400), PY5AI (1800), ZSIC, and a few locals. Thursday and Friday between them brought forth but SU1MW! Conditions improved slightly on Sunday, May 5th, the best signals being SU1RC, VQ6MI, VQ2AM, ZS1AX and a strange-sounding fellow YI2XG.

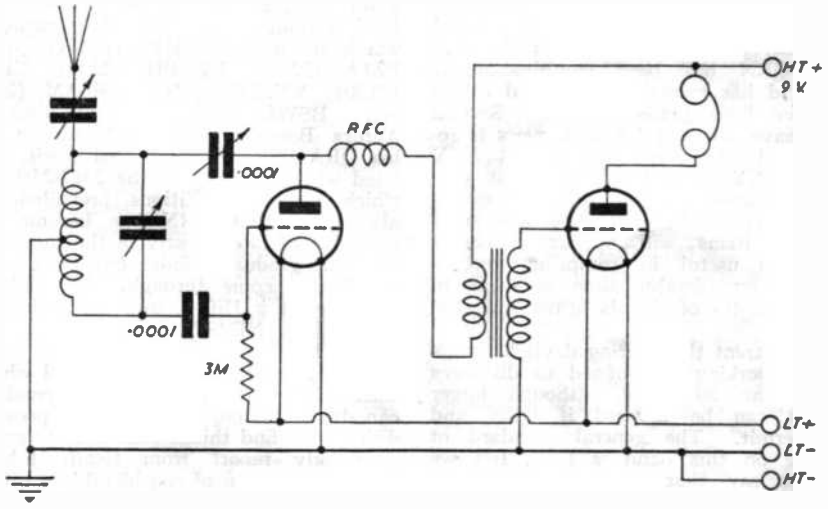
Until the 13th May, conditions just got worse and worse. Then, suddenly the band woke up again! A group of unusual phones appeared, the best being XZ2DN (Q5, R7/8), XZ4AB (Rangoon, Q5 R6), ZB1AC (Q4 R5), and G2VG (at Stoke-on-Trent—45 miles away!) On CW a number of good ones were logged, including KA1AY, ZS6CY, PY1AJ, ZB2A, ZS1BW, PY2OE, OQ5B (?), VQ2HC and ZE1JJ.

Tail Note

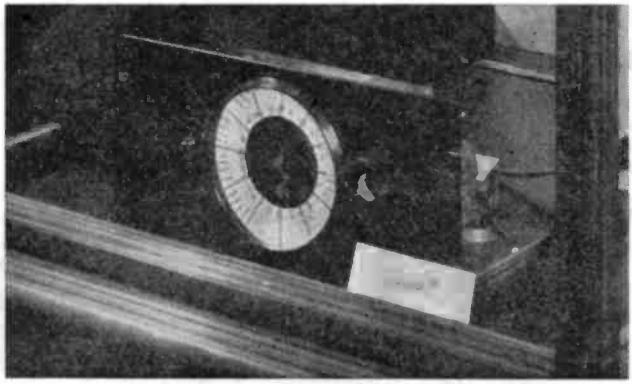
From the above you will all gather that 2BJY is keen on 28 Mcs.! All I need now is someone as keen on all the other bands! Any offers? I would like to thank the many kind friends who write in with their items of news—it all helps keep me up-to-date. Just one point, and that is please quote times in GMT for the sake of uniformity and to save confusion to our overseas friends.

My Favourite Short Wave Receiver.

No. 4: S. Naylor



THIS month we introduce the favourite short wave receiver of Sam Naylor, of Hunslet, Leeds. The circuit used is a Hartley oscillator parallel fed into one audio stage. Mr. Naylor finds that the receiver does not function satisfactorily if too high an HT voltage is used, 9 volts being the most favourable. This fact makes the set an "economy" one which is suitable for portable work. Incidentally this reader has built the O-v-1, featured in our January issue, and comments on its high efficiency.



QUARTZ CONTROLLED CLOCKS

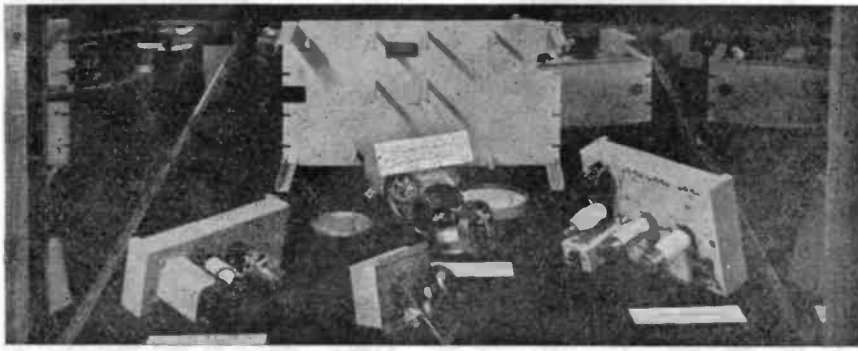
UNTIL 1938, the most accurate clocks in existence were the pendulum clocks of astronomical observatories. There were many difficulties to overcome, but it was possible to make pendulum clocks which would be accurate to within 1/100th second per day. This would seem to be accurate enough to satisfy the most meticulous, but recently a new type of time-piece has been perfected which is ten times as accurate, namely the quartz clock.

The controlling mechanism in these new clocks is a quartz plate oscillating under electronic stimulation, the oscillatory current thus produced being used to control the clock mechanism. Eighteen of these time-pieces have recently been installed at the Royal Observatory, Greenwich, for the control of radio time signals and for the study of the Earth's rotation. There are three similar clocks on view at the Science Museum, South Kensington. All these time-pieces were constructed at the G.P.O. Research Station, Dollis Hill.

Each clock uses a quartz crystal with a frequency of 100,000 oscillations per second. The oscillator output is passed to two divider circuits, the first being tuned to a frequency of 10,000 cycles; the second to 1,000 cycles per second, so that the electrical impulses of this frequency are obtained from the 100 kcs. crystal. The oscillating electric current is passed to an electromagnet, between the poles of which is pivoted an iron wheel with 100 teeth. Under the electromagnetic impulses, this wheel revolves at the rate of ten times per second and enough energy is provided by its momentum to drive the clock dial mechanism.

Interesting features of the clock are that the quartz crystal is contained in a temperature-controlled oven which is evacuated of air. The oven is controlled to 1/500th degree Centigrade. The time is indicated by a 24-hour dial with hour, minute and second hands. The Science Museum exhibit shows two methods of comparing the accurancy of the clocks one with another, using either a cathode ray tube or by an electromechanical method.

Our illustrations, for which we are indebted to the G.P.O., show various views of the Science Museum exhibit.



Component Review.

This month, we present a review of the quartz crystal units available from British manufacturers, particularly those units suitable for the frequency control of amateur radio transmitters, and for use in frequency standards and other precision apparatus.

BROOKES CRYSTALS, LTD.,

51-53, Greenwich Church Street, Greenwich, S.E.10.

Of great interest to the amateur is this firms' range of quartz plates for the 7 Mcs. band. These consist of low temperature co-efficient plates mounted between specially designed electrodes. These are enclosed in a holder of novel design, as shown in the illustration herewith, which allows a row of switched crystals to be set up in a small space. The holder is of the plug-in type, with two pins at ¾ inch spacing, and the design is such that any expansion due to heat on the holder has no effect on the crystal frequency. These units will drive on higher harmonics, output is good, and the accuracy is within ±0.01%.

Brookes Crystal Unit.

The price is £2 7s. 6d. for a BT cut to specified frequency, and £2 for one selected from stock. Similar units, but fitted with X cut plates, are available at £1 17s. 6d. and £1 12s. 6d. each respectively.

Brookes Crystals, Ltd., also offer a 100 kcs. reference unit which, when used in a suitable oscillatory circuit, will give check points at frequencies up to 100 Mcs. or higher. This unit is enclosed in an aluminium can of small dimensions, and is of the plug-in type. In view of its shape, it lends itself readily to fitting up for oven control.

A combination crystal unit of 100 and 1,000 kcs. is also available, the 1,000 kcs. harmonics being particularly useful in giving more widely spaced marker points. This unit is mounted in a heavy brass base which can be fixed by one screw. The grid connection takes either octal or English valve cap connectors.

An unlimited range of special crystal units can be made to order, including those for filter units, pulse operation, etc.

All Brookes crystals are checked against a controlled frequency source of long term accuracy, which itself is checked daily with Greenwich Observatory signals and Droitwich.

100 kcs. DT cut units are priced at £8 (±0.001%), £2 10s. (±0.01%), and £2 5s. (±0.025%). These are fitted in 2 pin plug-in holders.

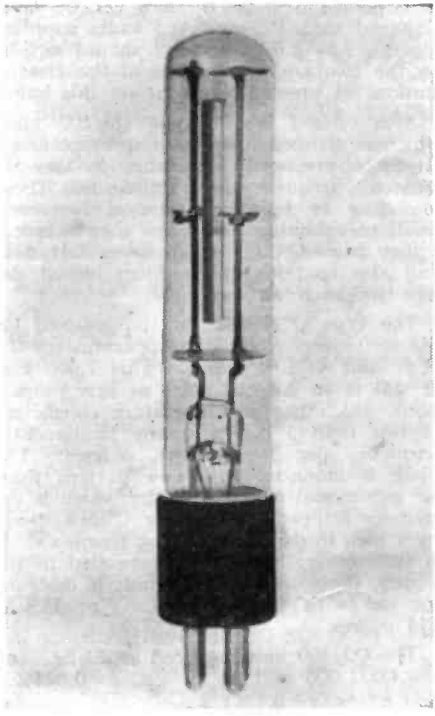
1 Mcs. units are available at £8 (within 10 cps.), £3 (±0.01%), and £2 12s. 6d. (±0.025%).

The 100/1,000 kcs. dual reference unit, in a chassis holder, is priced at £3 (±0.01%).

Standard enclosed holders, two pin plug-in at ¾ inch spacing, are available at 7s. 6d. each.

G.E.C.

The General Electric Co., Ltd. of England are marketing a very full range of standard types of crystals from 6 kcs. to 20 Mcs., many of them in vacuum mounted holders, the units being manufactured by a subsidiary company, Salford Electrical Instruments Ltd. For amateur use, they are offering quartz plates with a fundamental frequency of about 3.5 or 7 Mcs., which are suitable for frequency multiplication to give frequencies up to 60 Mcs. These "Type 2" plates, as they have been desig-



G.E.C. QC.200 Unit.

nated, have a temperature co-efficient such that the fundamental frequency will not change by more than 500 cps. for the range of temperatures normally encountered. They are priced at £1 10s. for random frequencies in either band, and at £1 16s. for specified frequencies +10 kcs.

The standard ranges of Types BA and DA plates are also available for amateur use, and are priced for frequency accuracy to +0.1% at £2 9s. for specified frequencies in the 7 Mcs. band, and at £2 8s. for the 3.5 Mcs. band. These are supplied in sealed holders, and are suitable for use in all types of transmitters, fixed or mobile. The crystal plate is rigidly clamped in position, and the unit will withstand a considerable amount of rough usage without damage. The holder is a moulding of high grade bakelite with two pins at ¾ inch spacing. The electrodes are precision ground from high grade stainless steel. The plates are processed so as to eliminate frequency and activity ageing.

For those wishing to construct their own frequency standard or harmonic calibrator for wavemeters, G.E.C. recommend their 100 kcs. vacuum mounted low temperature co-efficient bar mounted in the QC.200 holder. The latter is § inch in diameter and three inches high, excluding pins, and is fitted with a standard four pin miniature base. The price of these units adjusted to an accuracy of +0.01% is £2 15s.

All the crystal units mentioned above are available for immediate delivery. It should be noted that plates are not supplied except complete in holders, and the prices given include these.

HAMRAD WHOLESALE LTD.

The Hamrad Frequency Control Unit type MC7 incorporates an X cut crystal, processed to a fundamental frequency in the 7 Mcs. range, from the finest Brazilian Quartz, and guaranteed to be a ready oscillator of maximum activity. The temperature co-efficient is 25 cycles in a million per degree Centrigrade change, and the calibration accuracy is within 0.02% at 25 deg. Cent. The type MC holder is of new design and is moulded from high quality plastic material. It is of miniature size, being only 1¼ inches in diameter and 1 inch in depth, with a pin spacing of ¾ inch. The electrodes are of stainless steel, and are held in position by spring metal clips. The dustproof cover may be removed without interfering with the operation of the crystal. Hamrad also offer their type MC2 unit, which incorporates an AT cut crystal processed to any frequency in the 1.8 to 2.0 Mcs. band. Both types of unit are moderately priced.

Hamrad 7 Mcs. Unit.

Q.C.C.

The following crystals are obtainable from the Quartz Crystal Co., Ltd., of 63 Kingston Road, New Malden, Surrey.

The type P-5 incorporates the well known Q.C.C. power type crystal which was so popular before the war. It is a modified X cut plate, which can be used in any of the usual pentode or tetrode circuits, giving 6 watts or more R.F. on its fundamental frequency. The temperature co-efficient is 20 cycles per Mc. per degree Cent. The maximum R.F. current is 140 mA. Mounted in the type "U" holder, plates are available for the 1.8, 3.5 and 7 Mcs. bands at the following prices: Ground to specified frequency—£1 17s. 6d., selected from stock—£1 12s. 6d.

Q.C.C. Crystal Unit.

The type Q.5 is a low temperature co-efficient unit embodying an AT cut plate for the 1.8 and 3.5 Mcs. bands, or a BT cut plate for the 7 Mcs. band. When used with a 6L6 or similar valve, it will give more than 10 watts of R.F. on the fundamental frequency, and 6 to 8 watts on the second harmonic. The temperature co-efficient is 5 cycles per Mc. per degree C. Maximum R.F. crystal current is 150 mA., and the type "U" holder is again used. Prices are:—Specified frequency £2 7s. 6d., and from stock £2.

The type "U" holder is of low loss moulded bakelite, fitted with ¼ inch diam. pins spaced ¾ inch. Ground stainless steel electrodes are fitted. This holder is very neat, measuring only 1½ inch diam. and ½ inch deep. A nickel and black name plate is fitted on which the serial number and the fundamental frequency are stamped. It will plug into a standard U.S.A. 5-pin UX base for chassis mounting, or a special base for baseboard mounting can be obtained from Q.C.C. This latter is priced at 2s., while the holder costs 7s. 6d.

A point to note is that Q.C.C. have arranged that P.5 and Q.5 units supplied for the 1.8—2.0 Mcs. band should not be on the frequencies of either of the Beacon stations at present operating on this band.

Also offered is the type Q5/100 unit, which is claimed to be an improvement on anything previously available for use in amateur frequency sub-standards. Those intending to build a standard frequency oscillator should apply for the technical leaflet from Q.C.C. which gives full data and also contains an excellent circuit design for such an oscillator.

The type Q5/1,000 unit is designed for use in frequency checking apparatus for the H.F. and V.H.F. bands. This 1,000 kcs. crystal is an AT cut plate of new proportions which has a temperature co-efficient of less than 5 cycles at the fundamental frequency per degree Cent. change. The plate is mounted in a new pattern fixed air gap mounting, in a holder which is extremely compact, measuring 1 inch diam. by ½ inch in depth, excluding terminals. It is sufficiently light to be suspended in the wiring, if so desired. The unit is designed for use with the Osram L.63 or U.S.A. 6J5 valves.

The Q5/100 unit is priced at £2 5s., and the Q5/1,000 unit at £3 10s. (±0.025%), and £2 5s. (±0.1%).

Answers to Crossword No. 5

Across: (1) Resonating. (7 and 8) Ceramic Cup. (9) Rains. (10) Super. (12) Ideal. (14) Marks. (15) GPO. (17) Outline. (18) Coherer Set.

Down: (1) Recordings. (2) Service. (3) Names. (4) Tacks. (5) NBC. (6) Sparks Sent. (11) Permits. (13) Loose. (14) Metre. (16) OVO.

TRANSMITTING FACILITIES AGAIN ON TWENTY AND FORTY

The G.P.O. announces that the frequencies 7150-7300 kcs. and 14100-14300 kcs. will be available for amateur use from 30th June. Class A licensees may use inputs of 25 watts, Class B licensees inputs of 150 watts on each band.

Club News of the Month.

BRADFORD SHORT WAVE CLUB

This club has now been revived, and the secretary will be pleased to supply interested readers with full particulars of future activities.

Secretary: V. W. Sowen, G2BYC, 6 West View, Eldwick, Bingley, Yorks.

BRITISH SHORT WAVE LEAGUE

The newly appointed CR for South Wales, Trevor Denning, invites local readers to assist in the formation of a Chapter in Cardiff. A suitable meeting place is "in mind." T. Denning should be contacted at 118, Crwys Road, Cathays, Cardiff.

Another new CR, G. R. Whiteside, is making headway with the formation of a local group at Kendal. Several local members are co-operating, and they appeal to readers in the district to add their support. Please write to 9, Aynam Road, or telephone Kendal 85.

GRAFTON RADIO SOCIETY

The first meeting of this club was held on the 12th of April with an attendance of 16. This figure has been improved upon at later meetings. It has been decided that membership be open to anyone with any interest, in no matter what field, in Amateur Radio. Morse classes have been started, those taking part being divided into groups capable of varying speeds, so that no one is neglected. It is hoped in the near future to open other sections, catering for servicing, construction and the design and operation of transmitters, amongst other subjects.

At present the club is open every Thursday and Friday in the evening, but later on it is hoped to make it three nights a week. The subscription is 2/- per term, and the Secretary and Treasurer is W. H. C. Jennings, A.M.I.R.E. It is hoped that local G's, SWL's and any readers with even the faintest interest in Amateur Radio will come along and help to swell the ranks of this up-and-coming club at Ebourne Road L.C.C. School, Holloway. (5 mins. from the "Nags Head.")

HOUNSLOW & DISTRICT RADIO SOCIETY

This society has been formed to arrange meetings on the 2nd and 4th Wednesday in each month, for the purpose of discussion, instruction and experimenting in radio and kindred subjects. The Inaugural Meeting was held on May 8th, when 21 members were elected. June meetings will be held on the 12th and 26th, at 7.30 p.m., at the Grove Road School. Subscriptions are: Life Members £5, ordinary members 10/- per annum, and members under 21—2/6 per quarter.

Secretary: A. Pottle, 11 Abinger Gardens, Isleworth, Mddx.

MEDWAY AMATEUR TRANSMITTERS SOCIETY

This society is now well established and enjoying well attended meetings at the new HQ at 207 Luton Road, Chatham. Recent lectures have included such subjects as "The Cathode Ray Oscillograph," given by R. H. Hammans, G2IG, "The Double Superhet," and "Army Radar." All the summer months have been taken care of and a very fine programme arranged.

A building crew has been formed under the direction of G2CM, and has started construction of the society's apparatus. It is hoped that the society's station will be on the air by the end of the summer. With the restoration of the 7 and 14 Mcs. bands, the committee hope to formulate the rules for the "Observer Cup" competition, an event which was looked forward to eagerly before the war.

Members active on the 1.8 and 28 Mcs. bands include G5FN, G5WL, G6NU, G6BA, G2CM, and G2DOH.

Secretary: S. Howell, G5FN, 28 Rosebery Road, Gillingham.

NORTH MANCHESTER RADIO & TELEVISION SOCIETY

A meeting of the above pre-war society is to be held on Monday, July 8th, 1946, at 8 p.m., in the Stand Grammar School for Girls, Higher Lane, Whitefield to discuss the future of the society. Items for discussion will be, accommodation, officials, affiliations and amalgamation.

THE READING & DISTRICT RADIO CLUB

This society, which was founded in 1943, has its HQ at the Palmer Hall, West Street, Reading. The subscription is 10/6 per annum, and meetings are held on the Last Saturday in each month at 6.30 p.m., when lectures and demonstrations are given, and each 14 days after, when general subjects such as morse practice.

construction of club equipment and discussion are tackled.

A recent visitor was G6CU (of Cocos Island fame) who will be giving on June 29th a description of the rig that was used out there, and experiences and details of the contacts that were made.

Over 150 visitors have been along to the meetings, and the present membership is around 50.

Secretary: R. G. Nash, 9, Holybrook Road, Reading.

SALISBURY & DISTRICT SHORT WAVE CLUB

The Salisbury and District Short Wave Club has recommenced activities after six years of war, the majority of its members either having been in the services or on essential work.

The Club was formed in 1936, it's foundation-patron being the late Sir Oliver Lodge the famous radio pioneer and scientist.

Groups have been formed to cover transmitting, receiving, aerial design, amplifiers, morse class, beginners section, and U.H.F. including television. A modern short wave superhet receiver is in the course of construction, and application has been made for a transmitting licence.

The subscription has been fixed at 3/- per quarter, and prospective members are invited to get in touch with the Hon. Secretary, Mr. C. A. Harley at 85, Fisherton Street, Salisbury, Wilts.

SLADE RADIO SOCIETY

Meetings of this society are held on the 4th Friday of each month at Broomfield Road, Slade Road, Erdington. The immediate provisional programme includes, June 28th—D.F. Night. Talk on procedure, methods and suggested circuits. July 26th—Discussion Evening. Aug. 23rd —"Electronics in Industry."

Secretary: L. A. Griffiths, 47 Welwyndale Road, Sutton Coldfield, Birmingham.

WEST BROMWICH & DISTRICT RADIO SOCIETY

At a recent meeting held at the Gough Arms Hotel it was decided to form a radio society under the above title. Meetings will be held fortnightly at the Gough Arms, commencing at 7.30 p.m. Interested readers in the locality are asked to communicate with the Secretary.

Secretary: G. Johnston, G2BJY, 22 Lynton Avenue.

From Our Mailbag.

Sir,

I am interested in the comment relative to tuning dials in the May issue. If this letter should meet the eye of the manufacturers of the tuning dials fitted to R.A.F. and other service receivers, I would suggest that this type of tuning dial be made available to amateurs as post-war policy. We have had nothing manufactured in this country up to date to equal the tuning dials fitted to American receivers.

The pre-war types, including the aeroplane type, have served their purpose and the time for a more satisfactory design is NOW. I hope that British manufacturers will get down to supplying the demand and not leave it to America before making a move, as in the case of the communications receiver. Positive lock ganged bandsetting, with associate band-spreading units are another requirement (Messrs. Eddystone pioneered with this idea with single capacitors, and I hope they will follow it up).

Yours faithfully,
A. W. Mann (Middlesborough).

* * *

Dear Sirs,

I am particularly interested in 10 and 5 metre work, and would like to see details of converters for these bands to be used in conjunction with existing receivers.

Can any readers provide me with any data on the 6AG5 and 6J6 valves?

Best Wishes,
W. H. Longhurst
(82 Gower Road, Sketty, Swansea).

* * *

Dear Sir,

I agree with the views expressed by BRS 2286 in the May issue. I notice that, although you gave an abac, no mention was made describing it and its uses. I had reader Whitehead's trouble and found the only cure was to mount the capacitors away from the chassis with extended spindles.

Yours respectfully,
S. Russell, G2CBI (Rugby).

(For the benefit of the newcomers to abacs the use is as follows:—Knowing any two values, the third may be obtained by placing a rule on the two known values and reading off the third. For example, a capacitor of 20 uuF and an inductor of 15 uH will resonate at approximately 9.2 Mcs. (32.5 metres). The range of the abacs can, of course, be "extended" by suitable multiplication or division.—Ed.)

SHORT ENDS

Radio Amateurs' Examination. First Paper.

We have just been perusing the first paper set by the City and Guilds of London Institute for the Radio Amateurs' Examination on May 8th. At their request, we are refraining from publishing the paper or commentating on it until next month as we gather some papers have been sent out to Service personnel overseas, whose answers are not due in until July. We can remark, however, that the paper covers just the sort of material which the transmitting radio amateur should know.

Another Export Order.

Apropos our editorial comment last month, we have received yet another export order this month, this time for the Far East.

Note from Bermuda.

One of our readers in Bermuda writes that he has been granted an "experimental" licence as distinct from an "amateur" licence. He is now on the air with the call VP9D—CW on 28 Mcs. He has an 8JK beam up at present, but is planning much more ambitious schemes as he has about 200 acres of ground to play around in !

Moscow's Television Service.

According to Moscow Radio, all new flats to be built in the city are to have television installations.

Radio-Controlled Model Aircraft.

The "Aeromodeller" is encouraging the development of radio-controlled model aircraft. The G.P.O. has authorised the use of a frequency of 460.5 Mcs. with an input of 5 watts for this purpose. We should like to hear from any of our readers who are interested in this subject, or in the radio control of model boats.

Microwave Relay Chain.

The Western Union Telegraph Co. has been authorised to build a chain of experimental microwave relay stations extending from New York to Pittsburgh, on to Washington and thence to Philadelphia and back to New York. Frequencies varying from 1853 to 11858 Mcs. will be used.

French Amateurs are now authorised to use the 14000-14400 kcs., in addition to their ten—and five—metre allocation.

This Month's Howlers.

Electronics is similar to radio, but more electrical.

A beam tetrode should be used with a directive aerial.

Ohm's Law is an international law passed in 1827 to standardise the amount of resistance in a circuit.

There are three kinds of electricity—AC, DC and batteries.

COUNTRY PANEL

No. 2: Ecuador.

HCJB: Quito. "La Voz de los Andes." 15115, 12455, 9958, 6240 and 4107 kcs. Power 1,000 watts, except 12455 kcs. (10 kW.)

HDZ: Riobamba. "Voz del Chimborazo." 3228 kcs. 250 watts.

HC1VT: Ambato. "Voz de Tungurahua." 7000, 3708 and 4200 kcs. 250 watts.

HC5EH: Ciudad Cuenca. "Voz del Tomebamba." 3935 kcs. 400 watts.

HC1IM: Ibarra. "Voz del Imbabura" 4020 kcs. 300 watts.

HC2AK: Guayaquil. "Radio Ecuador." 4650 kcs. 1,000 watts.

HC2ET: Guayaquil. "Radio el Telegrapho." 4720 kcs. 300 watts.

HCJ: Tulcan. "Voz del Carachi." 5580 kcs.

HC1PM: Quito. "El Palomar." 5725 kcs.

HCQRX: Quito. "Radio Quito." 5972 kcs. 250 watts.

HC2RL: Guayaquil. "Quinta Piedad." 6635 kcs. 150 watts.

HC3SC: Loja. "Coro de Santa Cecilia." 6670 kcs. 300 watts.

HC2CM: Guayaquil. "Radiodifusora Iman." 7055 kcs. 250 watts.

HC4FA: Portoviejo. "Voz de Manabi." 7140 kcs. 100 watts.

HC1BF: Quito. "Radio Comercial." 7160 kcs. 500 watts.

HC1AC: Quito. "Voz de Democracia." 7200 kcs. 200 watts.

HC1CQ: Quito. "Radio Union Agencias Unidas." 7240 kcs. 130 watts.

HC2DC: Guayaquil. "Radiodifusora Cenit." 7350 kcs. 130 watts.

HC1CG: Quito. "Radio Oriente Ecuatoriana." 7875 kcs. 200 watts.

HC1BS: Quito. "Radio Teatro Bolivar." 9355 kcs. 250 watts.

Small Advertisements.

Readers' small advertisements will be accepted at 3d. per word, minimum charge 3/-. Trade advertisements will be accepted at 6d. per word, minimum charge 6/-. If a Box Number is required, an additional charge of 1/6 will be made. Terms: Cash with order. All copy must be in hand by the 10th of the month for insertion in the following month's issue.

THE BRITISH SHORT-WAVE LEAGUE extends a cordial invitation to all short-wave enthusiasts to apply for membership. We offer QSL Bureau, Free Technical Queries, Station Identification Service, Translation Service, DX Certificates, and other facilities including the monthly issue of the "Short Wave Review." The B.S.W.L. is a non-profit organisation run by the listener for the listener, which has served the interests of DX-ers for over ten years. Write NOW for details of membership and sample "Review" to Dept. S.W., 17 Bedford Road, Alexandra Park, London, N.22.

FOR SALE 5v. Battery S.W. S'het with valves and built-in speaker £4. Ekco eliminator, 3 tappings 20/-. 2 volt accumulators 10/- ea. Eddystone & Lissen Hi-Q S.W. components. Also 1-v-2 rx, tuned R.F. bandspread, down to 10 metres. Professionally built, complete £9. —J.H.B., 18 Marion Rd., Norwich, Norfolk.

WANTED to complete files, certain issues of "QST," "Radio," and "R9," 1930-1946. Good price paid—GW6AA, "Flagstaff," Colwyn Bay, Wales.

AMATEUR REQUIREMENTS.—We are now able to resume mail order business. Send 2½d. for our new summer catalogue containing over 500 lines. Raymart and Eddystone agents. Southern Radio & Electrical Supplies, 85, Fisherton Street, Salisbury, Wilts.

WANTED. QST August, 1945, WIRELESS WORLD, February, 1946; and PRACTICAL WIRELESS, January and February, 1946.—Tytler, Beechcroft, Cults, nr. Aberdeen.

FOR SALE. Two quality pick-ups. TELEFUNKEN ITI & BURNDEPT N.A. Offers near £5 and £2 10s. G6HG, 109a, The Grove, Ealing, W.5.

BRS.9064 invites you to send for his list of brand new Radio Spares, condensors, resistors, volume controls, speakers, m/coil mikes, T1154 ex-RAF 80 watt transmitters, etc., etc. 1d. S.A.E. please to 1 Mercedes Cottages, St. John's Road, Haywards Heath, Sussex.

BOOKS for the ham! The most comprehensive stock of radio books in the country, including many now out of print. Write, or call, for complete list. (Price 1d.)—Dept. S.4., THE MODERN BOOK CO., 19-23 Praed Street, London, W.2.

RADIO SUPPLIES of Romiley, Cheshire. Everything for every Ham! Examples: 807 30/5; 0.001 uF 1000 volt 8d.; 3 watt wirewound resistors 2/-. Stamp for complete list to 34 Birch Avenue, Romiley, Cheshire.

ALUMINIUM CASE suitable for the M.I.P. test meter, with all holes drilled, only 10/6 post free. Steel chassis and panels a speciality:—J.H.B., 18 Marion Road, Norwich, Norfolk.

RADIOCRAFT LIMITED.

11, CHURCH ROAD, UPPER NORWOOD, LONDON, S.E.19.

(one minute from Crystal Palace (HL) Southern Railway Station, and 'bus Terminus)

In previous editions of this publication we have given details of specialised power equipment we can supply. We now give brief particulars of some general items, which will be of interest to Constructors.

CERAMICS

Valve Holders—4 pin, English 1/-, American 1/3, Octal 1/6, 7 pin, English 1/3, American 1/3, For EF50 2/-, For Acorns 2/6.

Coil Formers—5in. x 2½in. grooved 5/6, 3½in. x 1¾in. grooved 4/3. Strips, plugs and sockets for above are available.

Insulators—Feed-through—Two-piece with cork washers 1/1. Lead-in—Three cones with nuts, etc. 2/6; Two cones with nuts, etc. 1/9. Stand-off—3½in. high 1/9; 1¾in. 9d.; 1in. 7d. Feeder-spreaders—6in. 7d.. Transmitting aerial—12in. 2/-.

VARIABLE CONDENSERS (Ceramic Insulation)

	Standard	Midget	Double-spaced
15 mmfd.	3/3	3/3	3/6
40 mmfd.	3/6	—	4/6
100 mmfd	4/3	4/6 (120 mmfd.)	—
160 mmfd.	5/3		

Coil-formers—6 pin (plain) 1/11. 6 pin ceramic holders 1/6. Range of wound coils also available.

High voltage transformers, rectifiers, oil-immersed condensers, chokes, etc., stocked, or can be specially provided to fulfil your specification. We will willingly forward further details, and will quote for any gear upon receipt of particulars.

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