Here the ratio $\frac{V_2}{V_1}$ is small except when the crystal is at minimum resistance so that by arranging the amplifier gain μ to satisfy the condition $V_1 = \mu V_2$ only in the region of minimum resistance, oscillation will be restricted to the crystal frequency. This type of oscillator is not satisfactory with crystals of resistance much in excess of 1,000 ohms due to the increasing difficulty in preventing self oscillation through stray capacity. While being a useful circuit in many respects stability is not as good as the previous circuits described as variation of the tuned circuit produces a considerable frequency shift.

Low frequency oscillator for flexure mode crystals—Single Valve

The circuit is shown in Fig. 46. Flexure mode crystals are normally produced for frequencies between 1 kc/s and 50 kc/s. The range 1—12 kc/s is covered by the XY flexure and over-lapping this from 8 kc/s to 50 kc/s the NT cut flexure is used. As would be expected the characteristics of such crystals vary greatly from the other modes and have been dealt with elsewhere.

The mechanical movement of the quartz at the lower end of the frequency band is of considerable magnitude, making it necessary to operate the crystal at a low level of oscillation to restrict this movement. Failure to observe this point will result in complete disintegration of the crystal. In addition, above a certain level the series resistance of the crystal will rise rapidly causing oscillation to cease on the flexure mode and to commence on the longitudinal mode.

The crystal operates as a three terminal network with the common point taken to the earth line via a 150 pF maximum variable capacity. The remaining terminations are taken to the control grid and screen grid respectively. The screen grid acts as the oscillator anode and amplification takes place at the valve anode. The output is fed to a germanium rectifier and the resulting DC is fed back to the control grid.

As the equivalent series resistance of the flexural type of crystal varies considerably with frequency it is necessary to change the grid resistor to suit.

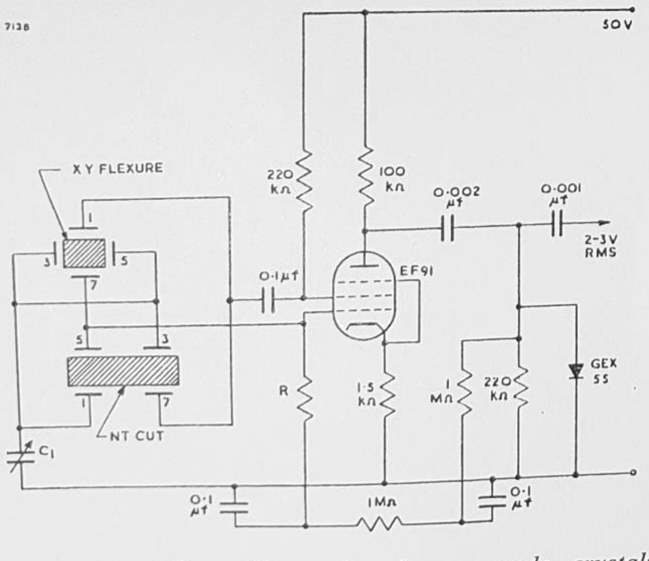

FIG. 46. *LF oscillator for flexure mode crystals. Condenser C_1 is normally 75pF for test purposes, but may be varied between 50 and 150pF for adjustment of crystal frequency. Approx. 100 parts in 10^6 frequency swing can be obtained.*

Values of R:

Mode	*Frequency*	*R*
XY	1.6—4.49 *kc/s*	2.2*MΩ*
XY	4.5—12 *kc/s*	220*kΩ*
NT	8—19.99 *kc/s*	220*kΩ*
NT	20—50 *kc/s*	47*kΩ*

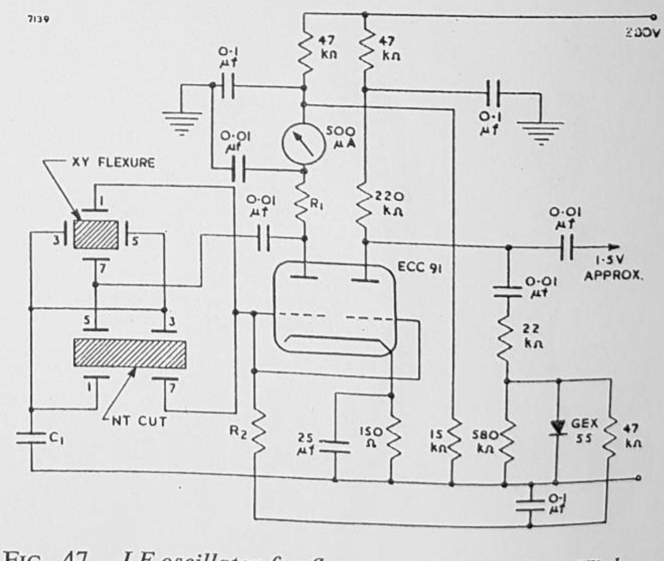

FIG. 47. *LF oscillator for flexure mode crystals.—High stability. Condenser C_1 is normally 75pF for test purposes, but may be varied between 50 and 150pF for adjustment of crystal frequency.*

Values of R_1 and R_2:

Mode	*Frequency*	R_1	R_2
XY	1.6—2.79 *kc/s*	220*kΩ*	1*MΩ*
XY	2.8—5.99 *kc/s*	220*kΩ*	220*kΩ*
XY	6—12 *kc/s*	68*kΩ*	47*kΩ*
NT	8—50 *kc/s*	68*kΩ*	47*kΩ*

Ref.	40—150 kc/s	100—500 kc/s
C_1	100 pF trimmer	100 pF trimmer
C_2	500 pF	250 pF
C_3	0.01 μF	0.01 μF
C_4	0.01 μF	0.01 μF
C_5	0.01 μF	0.01 μF
R_1	4.7M Ω	1,5M Ω
R_2	10k Ω	6.8k Ω
R_3	4.7k Ω	4.7k Ω
R_4	100k Ω	68k Ω
R_5	100k Ω	100k Ω
R_6	22k Ω	22k Ω

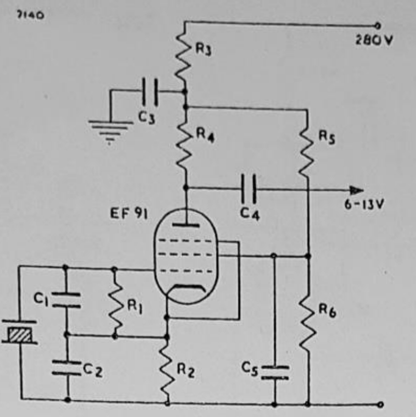

FIG. 48. *Colpitts oscillator, parallel resonance. Frequency range* 50—500 *kc/s. Input capacity* 30, 50 *or* 100*pF, adjustable by* C_1.

Final alignment should be made using a Crystal Test Set Type 330. *Adjustment to exact frequency may be made by variation of* C_1. *Frequency swing available,* 150 *parts in* 10^6.

Variation of C_1 between 30 and 150 pF will vary the crystal frequency approximately 150 parts in 10^6.

It should be noted that care must be taken in laying out wiring as, due to the high impedances in the circuit, excessive stray capacity can cause appreciable changes in oscillator performance. The output from this oscillator is rich in harmonics.

Low frequency oscillator for flexure—High stability

This circuit (Fig. 47) is a modification of the previous oscillator for use where better stability is required together with a pure sine wave output. A greater degree of level control has been obtained by the addition of a stage of amplification.

Single valve operation has been retained by the use of an ECC91 double triode. Grid and anode resistors are selected by a four position switch to match the crystal resistance.

LF Colpitts oscillator. Parallel resonance—Single valve (30, 50 *and* 100 *pF input capacity*)

This oscillator is basically the same as the circuit shown in Fig. 40 with component values suitably adjusted for the lower frequencies used.

It provides three input capacity conditions namely 30, 50 and 100 pF and is intended to line up with the new Crystal Test Set Type 330.

The use of the 30 pF input condition is not recommended as small variations of capacity values produce a large frequency shift.

As the full frequency range 40—500 kc/s cannot be covered without component changes the range is split into two and tables of suitable values given. The circuit and these details appear in Fig. 48.

LF Colpitts oscillator. Parallel resonance—Level controlled (30, 50 *and* 100p F *input capacity*)

Where greater stability is required in the frequency range 40 to 500 kc/s the circuit shown in Fig. 49 is recommended. This uses the same oscillator circuit as Fig. 48 with the addition of an amplifier and diode to provide automatic level control. The crystal thus operates at a lower level reducing frequency drift due to crystal heating.

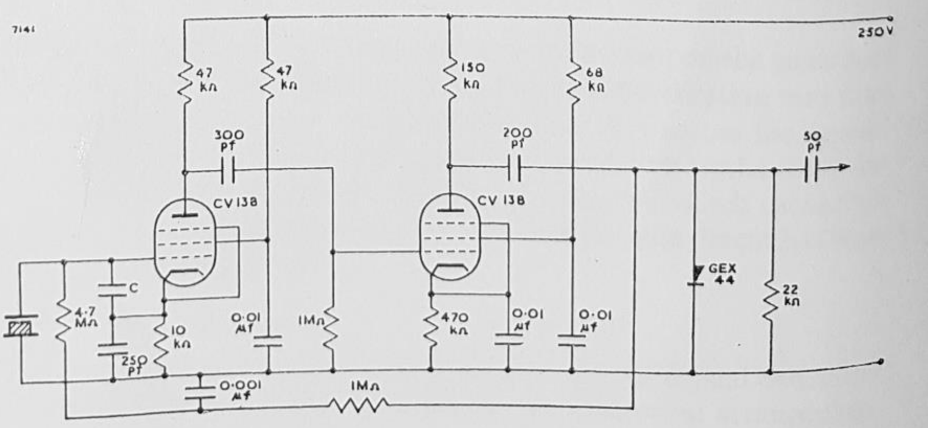

FIG. 49. *Colpitts oscillator, parallel resonance—level controlled. Frequency range* 50—500 *kc/s. Input capacity* 30, 50 *or* 100*pF, adjustable by means of the* 100*pF trimmer (C). Fine adjustment of frequency can also be effected by variation of this trimmer.*