A High-Stability Oscillator Circuit

By ROBERT J. ROPES

Details on a ham circuit which oscillates vigorously and easily and tunes very well over a wide frequency range.

THE circuit to be described is a practical application of the circuit originally developed by Harris[1] as a "*Q*" multiplier, and recently suggested by Clapp[2] as having possibilities as a stable *LC* oscillator. This oscillator is exceptionally stable and its output possesses excellent waveform when the circuit is designed around the correct circuit constants.

The circuit can be called the "class A Colpitts," since it operates in class AB_1. As pointed out by Clapp,[2] the frequency coefficient of an oscillator is independent of the *LC* ratio of the oscillator tuned circuit *if* the operation of the circuit is *linear;* that is, class A, AB, or B. Since class A operation of an oscillator is, for all practical purposes, impractical, class AB or B operation must be used to give the necessary linearity of operation. Clapp has discussed[3] several other oscillators in which the input and output circuits of the tube are connected across portions of the tuned circuits and in which the tube is operated in a linear manner. In an oscillator of this type, the greatest stability is obtained when the grid and plate circuits are connected to points on the tuned circuit of the lowest impedance which will sustain oscillation.

This "class A Colpitts" oscillator is somewhat reminiscent of the old Colpitts oscillator, but does not resemble it at all in operation. Since the oscillator operates in class AB_1, no grid current flows during any part of the oscillatory cycle, there is no "grid-leak" capacitor and no grid bias voltage is produced by grid current flow, as is the usual case in a class C oscillator.

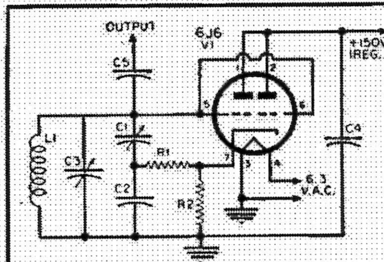
In referring to the schematic, the large values of resistance in the cathode circuits are at once apparent. The resistance between the cathode and the tuned circuit "tap" insures adequate isolation between the cathode and plate circuits, their associated capacitances, and the tuned circuit itself. In addition, this resistance helps to maintain the operation of the tube in class AB_1. A tube should be chosen which has a very small input capacitance, with transconductance being a somewhat secondary factor. The large cathode resistance limits the plate current to a low value and assures a minimum of distortion in the waveform. The highest stability (and, incidentally, the lowest output) is obtained with a high grid-to-cathode capacity ratio in the tuned circuit. Ratios for C_g/C_k on the order of 1/35 to 1/100 seems to be practical; ratios as low as 1/5 should not be used.

The circuit overcomes the distinct disadvantage of the Clapp series-tuned oscillator—that of limited frequency coverage when used as a variable frequency oscillator. In many amateur installations, trouble is encountered with the Clapp series-tuned oscillator when attempting to cover a rather large frequency range. Since, as Clapp has stated, with constant circuit "*Q*," the value of transconductance required to maintain oscillation of the series-tuned oscillator tends to become very unstable at the high frequency end of the band being covered. The Clapp oscillator cannot be used for frequency changes greater than about 1.2 to 1 for this reason. W. B. Bernard[4] has pointed out (and Clapp has admitted[5]) that "the series-tuned oscillator is no more stable than a high-C Colpitts having the same circuit '*Q*' and the same impedances presented to the tube." Clapp goes on to state that the advantages of the series-tuned oscillator begin to deteriorate at high frequencies (although he does not state what the frequency limit of the circuit seems to be), but he indicates that "improvements in stability of from 10 to 100 times over conventional circuits are readily obtained." This last statement would seem to refer to fixed-frequency operation of the series-tuned oscillator at the lower radio frequencies.

The foregoing information is brought in by the author to attempt to show reasons why the so-called "Clapp series-tuned" oscillator has been disappointing to many amateurs who have built the circuit into variable frequency oscillators and exciters covering the high amateur bands, with the oscillator usually on 160 or 80 meters.

In constructing the "class A Colpitts" oscillator, the oscillator tank

Complete schematic of a stable oscillator.



R_1—1 megohm, ½ w. res.
R_2—10,000 ohm, ½ w. res.
C_1—100 μμfd. variable capacitor (set at approximately 75 μμfd. and used as "bandset" capacitor)
C_2—5100 μμfd. silver mica capacitor
C_3—25 μμfd. var. capacitor (covers 3.5 to 4 mc. with approximately 90% rotation)
C_4—.01 μfd., 400 v. capacitor
C_5—100 μμfd. mica capacitor
L_1—21 μhy. coil, 24 t. #22 solid copper wire, closewound on 1¼" dia. form
V_1—6J6 tube

coil should have a high "Q" and should be wound on a good form, preferably ceramic. The tuning capacitor should be of the double-bearing type and should be mounted rigidly to avoid mechanical vibration and modulation of the oscillator. All wiring should be direct and short, using heavy solid conductor wire. The extreme stability of this oscillator, coupled with the ease of tuning over a wide frequency range, should make this new circuit very popular with the amateur fraternity.

The author chose to use a 6J6 tube, because several were available and reasonably high transconductance with fairly low input capacity was obtained. There are numerous other tubes which are equally suitable. The circuit oscillates easily and vigorously.

The operating conditions of one oscillator built using this circuit were: Plate current—1.2 ma. (approx.), plate voltage—150 volts (regulated), grid voltage—0 volt, cathode voltage—12 volts, and frequency—2.5 mc.

The oscillator frequency would hover within a very few cycles per second of WWV for hours at a time and could be tuned over a wide band with but slight variation in plate current.

In conclusion, the author feels that the circuit qualities enumerated above along with the simplicity of the design should be enough incentive for having the amateur and experimenter give the oscillator a trial. We believe the results will fully justify our claims.

REFERENCES

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4. Bernard, W. B.: *Correspondence section of the Proceedings of the IRE*, July, 1955.
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