Oscillator Circuits as Used in Industry

By ED BUKSTEIN*

IN addition to their usual signal-generating function, oscillator circuits are suitable for a wide variety of control applications. For example, starting or stopping oscillation may cause a relay to operate and to control an external circuit. For this purpose the oscillator is a sensitive and reliable control.

Fig. 1 illustrates the operating principle of one type of control oscillator. The circuit is simple, oscillation resulting from the energy fed back from L1 to L2. When the circuit is in oscillation, the plate current of the tube is at minimum and the relay is open. The reason for this is that during oscillation grid current flows and produces a bias voltage across the grid resistor. The negative grid voltage limits the plate current.

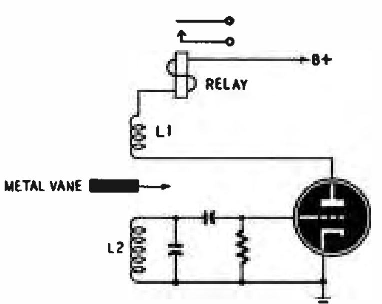

Fig. 1—Vane stops oscillation—relay closes.

If, for any reason, oscillation ceases, no bias voltage is developed, the plate current increases, and relay closes. For instance, if a metal vane is brought into the space between L1 and L2, feedback is reduced to a point where oscillation stops. In short, insertion of the metal vane causes the relay to operate.

One application for this circuit is leveling elevators at floor levels. An oscillator is mounted at each floor, and the metal vane is attached to the bottom of the elevator platform. The electrical connections to the elevator door are made so that the door cannot be opened until the oscillator relay is closed; that is, until the elevator is properly leveled.

A similar arrangement might be used with railroad cars. With the oscillator mounted on the underside of the car and the metal vane between the tracks, arrival of the car at a given point on the tracks would operate the relay.

Another variation of the same basic principle is the protective meter. Coils L1 and L2 are made compact and are mounted on the face of the meter as shown in Fig 2. A small aluminum slug is attached to the pointer. As the meter reading increases to a predetermined value, the aluminum slug passes between the coils and the relay closes, preventing a voltage or current from rising above a certain level. The coils may be made movable to permit setting at any desired level.

The oscillator shown in Fig. 1 could also be adapted to assembly-line problems such as detecting metal particles in packaged foods passing on a conveyor belt. Operation of the relay would energize a reject mechanism to remove the objectionable item from the conveyor belt automatically.

In other applications, it may be desirable to have the relay normally closed so that it will open upon the insertion of the metal vane. This may be accomplished by providing some other form of feedback and reversing coil L1 so that its feedback is degenerative. Under these conditions, oscillation is prevented by the degenerative feedback until the metal vane is inserted. The metal vane reduces the degenerative feedback, allows the circuit to oscillate, and causes the relay to open.

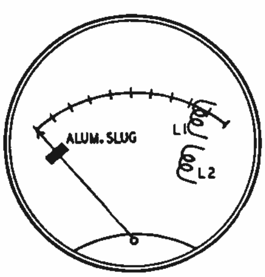

Fig. 2—The vane circuit adapted to a meter.

Another form of control oscillator is the capacitance-operated relay often used as an alarm to indicate the approach of a person or object. Here again the circuit consists of an oscillator containing a relay in its plate circuit (Fig. 3).

If a finger is touched to the grid of this oscillator, the grid-to-ground capacitance is so altered that oscillation ceases. As in the previous case, when the oscillation stops, no bias is developed and the plate current increases to a value sufficient to close the relay.

To eliminate the necessity of touching a grid, the grid is connected to a large metal plate. Contact with this plate will cause the relay to operate. The circuit may be made sufficiently sensitive so that direct contact with the plate is not necessary, the approach of a person or object being sufficient to trigger the circuit. The metal plate may be a metal door or a large plate fastened to a door; the circuit will indicate the approach of anyone toward the door. In

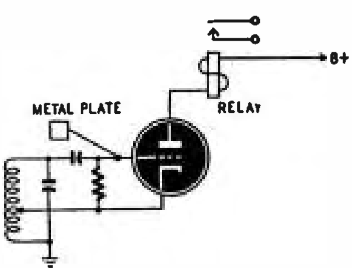

Fig. 3—The simplest capacity-operated relay.

other cases, the doorknob itself or the handle of any cabinet or compartment door may be used as the metal plate. The system may be used to protect a bank vault or safe, in the latter case the safe itself being used as the metal plate.

Another possible use of the circuit is for counting, for instance, the number of automobiles passing over a bridge. The automobile's approach to a metal plate initiates circuit action. The relay is replaced by an electromechanical counter with numbered disks. The same system could be used to count objects passing down an assembly line.

The circuit is also adaptable for the protection of power-machine operators. The metal plate is located so that the operator's hand, if in a dangerous position, will prevent the machine from operating.

One system of remote control involves the use of carrier-current transmission. An impulse of r.f. energy is transmitted over the power lines. Somewhere else in the same building or vicinity a re-

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ceiver connected to the same power lines and tuned to the same frequency picks up the signal and operates a relay. This method of remote control is illustrated in Fig. 4. When the transmitter is turned on by a key or push-button, a pulse of r.f. energy is transmitted through the power lines. At the other end of the system, the pulse is picked up by the receiver whose output operates a relay.

Suitable transmitter and receiver circuits are shown in Fig. 5. The transmitter is a conventional oscillator. For convenience and simplicity, no rectifier is used, the oscillator operating directly from the a.c. line. When the switch is closed, the circuit oscillates and feeds r.f. energy into the line.

The receiver also is small and simple. A series-resonant L-C circuit tuned to the frequency of the transmitter picks up the signal from the power lines. The signal voltage developed across C causes ionization in the OA4-G gas tube. The resultant increase of plate current closes the relay. This system is satisfactory for a wide variety of remote control uses.

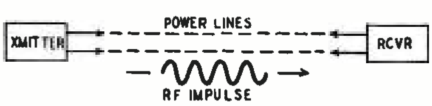


Fig. 4—Power lines carry control impulses.

Use of the oscillator for measurement is demonstrated by the circuit of Fig. 6. The frequency of the signal is determined by the L and C of the tuned circuit. The capacitor is made up of two plates, one of which is free to move. As the plates become farther separated, the capacitance is decreased and the frequency of oscillation increases. Conversely, as the plates move closer together, the frequency decreases. This oscillator may be used as a highly sensitive electronic micrometer for accurate thickness measurements, the thickness of a material placed between the two plates determining the frequency of oscillation. Thus, oscillator frequency becomes a function of material thickness.

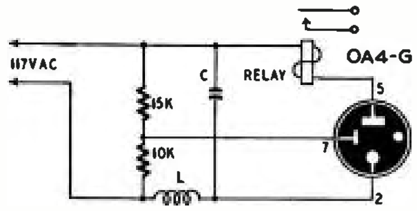
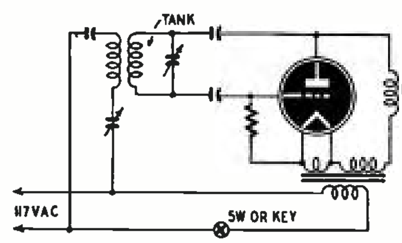


Fig. 5—Typical receiver (above) and transmitter (below) for power-line control circuits.



The plates may also be moved by the changing thickness of a belt of manufactured material as it passes between them. Sensitivity may be increased by passing the material between rollers mechanically coupled to the plates. A mechanical gain resulting from lever action will cause a small movement of the rollers to produce a relatively large movement of the plates.

The same circuit may be used also as a humidity gauge. In this application, the two plates are connected to opposite ends of a stretched fiber. Changes in the air's moisture content cause the fiber to expand or contract and consequently vary the frequency of oscillation.

The oscillator shown in Fig. 6 is often used in conjunction with a fixed oscillator as shown in Fig. 7. The fixed oscillator and the variable one both feed into a mixer circuit to produce an audio beat note. Any variation of plate spacing produces a change in the audio note in the loudspeaker, giving an aural indication.

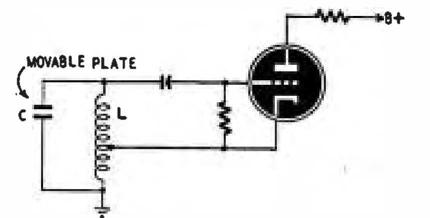


Fig. 6—An oscillator used for measurement.

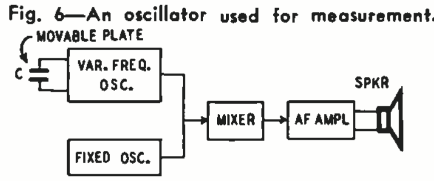


Fig. 7—Measuring circuit with aural output.

FOR SAFER ANTENNA INSTALLATIONS

The rapid increase in the use of television receivers has brought a flood of inquiries as to the relative fire and life hazards of television sets, and as to their proper installation and the installation of their antenna systems.

Since television operates on essentially a line-of-sight basis, proper reception usually necessitates an exterior antenna and as the distance from the television transmitter increases, the antenna must of necessity extend higher in elevation. This increases somewhat the possibility of damage by lightning, and, as the antenna is usually mounted on a pole or tower on the roof, there is a possibility that, unless properly installed and supported, the system may fall in high winds, dropping across power lines or injuring persons or property.

The National Electrical Code, in Article 810, contains provisions covering radio receiving aerials, but these provisions were designed primarily to cover conventional radio installations and do not appear adequate for the special conditions of television. . . . Arresters for ordinary radio aerials are not suitable for television, but proper arresters are available. These arresters should be placed on each conductor of a ribbon-type lead-in. If a co-axial cable is used for lead-in, suitable protection will be provided by grounding the exterior metal sheath.

Where the antenna is mounted on a metal pole or tower, the pole or tower should be properly grounded. Opinions vary as to the size of the grounding conductor, but it should preferably be at least a No. 6 or 8 A.W.G., connected to a suitable ground such as an underground water pipe, and if the building is equipped with a lightning rod system, should be properly bonded to this system.

The type of lead-in commonly used is the polyethylene ribbon type. Although this material burns much like rubber, and falls in flaming drops, its use for this purpose is not considered particularly hazardous. Recent improvements of the polyethylene lead-in, although still flammable, have eliminated the flaming drops. The co-axial cable lead-in is generally considered the best from the fire hazard viewpoint, but is considerably more expensive and has operational disadvantages.

Considerable care should be given to the mechanical stability of the antenna and its support. Where located on the roofs of buildings the antenna and supporting guys should not be so located as to interfere with operations of the fire department or where liable to crosses with electric power lines. Some fears have been expressed as to the possibility of shock hazard on contact with an antenna or lead-in, because of the high voltage used in the receiver, but these fears are groundless if the receiver is properly designed.

It is generally considered that a television receiver has a greater inherent fire hazard than a conventional radio receiver, because of its greater current consumption, a greater number of heat producing components and the higher voltage used. Particular care should be taken that the natural ventilation built into the set is not obstructed or reduced by location or blanketing. Television sets should not be left turned on while unattended.

Television sets of several manufacturers have been listed by Underwriters' Laboratories, Inc., as having been acceptably designed and constructed with respect to the fire and life hazard. Prospective purchasers should assure themselves that the set they contemplate purchasing is listed by the Laboratories.

(*The report quoted above was Special Interest Bulletin No. 275 issued by the National Board of Fire Underwriters, New York, N. Y.—Editor*)