A New Method in the Remote Indication of Meter Readings

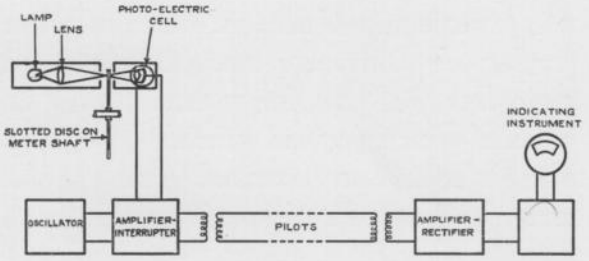

Fig. 1.

IN the remote supervisory control of such undertakings as electric power networks, water systems, etc., an essential feature is the indication at the control point of readings of meters situated at outlying points by reproduction on facsimile meters on the control panel.

When the number of pilot wires available for linking substations to control station is sufficient, one pair may be allotted for metering. Ammeters and voltmeters, for example, at the control point, are then connected directly to auxiliary shunts and potentiometers or current and voltage transformers at the distant point. A process of selection enables any given meter to be connected to the pilots, a reading being obtained on demand as required. The selection is made by means of apparatus of the automatic telephone type in a manner explained in a description of remote supervisory control given in Vol 5, No. 3, 1935, of this Journal. Selection of the appropriate auxiliary device and corresponding control panel meter is all that is necessary since the direct connexion then established between them over the pilot wires will result in the meter giving the required indication.

When, however, it is required that a number of readings be sent simultaneously over two meter pilots or that readings be given continuously over pilots not allotted solely for metering, or, again, if the whole of remote control, supervision and meter readings must be obtained over only two wires, then special measures are necessary It will be realised that it is not possible to obtain two simultaneous readings of say, current, by connecting two shunts at the substation and two meters at the control station simultaneously to one pair of pilots, nor may a shunt be connected to pilots already in use for control of substation plant. It is therefore necessary to install apparatus at the substation capable of generating signals whose characteristics are governed by variations in the quantity (current, voltage, power, water flow, etc.) to be measured, and whose nature is such that they may be transmitted either singly or simultaneously over the pilots for interpretation at the control station.

New development work on apparatus of this type has recently been completed by The General Electric Company, who have evolved a remote metering system (Patent No. 426144) which enables a large number of meter readings to be obtained simultaneously over one pair of pilots whether allotted solely to metering or not.

The principle is represented diagrammatically in Fig. 1 An oscillator generates a current at any convenient frequency,

generally from 300 to 3000 cycles per second, which is amplified and passed to the pilots. Since this current is in the voice-frequency range, it may successfully be applied to telephone lines rented for the purpose. The rays from a source of light act upon a photo-electric cell and are interrupted by a slotted disc rotating with a spindle. This spindle may be that of an ordinary watt-hour meter mechanism or any device in which rotary speed varies with the quantity to be measured.

As a result of rotation of the disc the photo-electric cell becomes alternately conductive and non-conductive and governs the action of the amplifier in a manner which causes the oscillator output to be interrupted in its passage to the pilots. Impulses of current are thus produced at a rate which corresponds to the interruptions of the light ray and therefore to the speed of rotation of the shaft. The impulses pass over the pilots and are amplified and rectified at the control station. The resulting D.C. impulses operate a high-speed relay, which forms part of a simple arrangement responsive to variations in the periodicity of the impulses. The indication on a meter incorporated in this arrangement is proportional to the periodicity and is thus a measure of the quantity measured at the substation.

It is seen that the indication at the control point is not a measure of the amplitude of signals received but of their periodicity. Furthermore, the ratio of "make" to "break" periods in impulsing is unimportant between wide limits, and thus adverse conditions of pilots tending to attenuate the signals or to produce distortion of impulses, have little effect, metering by this means being perfectly satisfactory over channels which could not

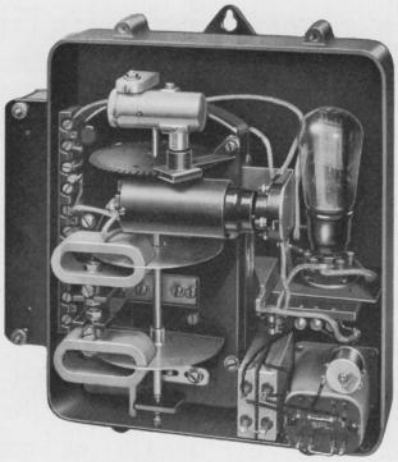

Fig. 2.

be used if other methods were relied upon.

By employing oscillators giving outputs of different frequencies, together with suitable filters at the control station, a number of readings may be transmitted simultaneously. Readings may be received continuously or on demand and in each case will faithfully indicate all fluctuations. Again, since oscillatory currents are used, transmission may be effected at the same time as the pilots are passing D.C. impulses for the purposes of remote control and it is therefore unnecessary for separate pilots to be allotted to metering. The choice of suitable frequencies and the use of appropriate filters will also enable metering to be effected over pilots in use for telephone communication without interruption of speech.

The system is particularly suited to the remote indication of watts since not only is the necessary rotary movement of the spindle produced by the action of standard meter mechanisms, but readings are obtained over only two pilots instead of the three or five which would be necessary for direct connexion of a watt meter.

A unit incorporating a watt-hour meter mechanism, photo-cell and lamp, and

amplifier-interrupter, is shown in Fig. 2. A cast-iron case accommodates the component parts, the shaft and discs of the watt-hour meter mechanism being seen on the left. At the top of the shaft is the slotted disc, which rotates between the lamp and the photo-cell, whilst on the right is the amplifier valve and associated transformer. As is seen from the following circuit description, the photo-electric cell figures in the grid circuit of the amplifier-interrupter and it is therefore necessary that the length of connexion between them be small, a requirement which accounts for their incorporation in one case.

Circuit Description.

On the left of Fig. 3 is seen the oscillator circuit, consisting of valve VO, condenser and transformer, across the third winding of which is connected a potentiometer regulating the feed to the amplifier valve VA1. The photo-cell is connected directly to the grid of this valve and, when conductive, so biasses it that it ceases to pass the current from the oscillator. With the cell intermittently effective, valve VA1 alternately amplifies and interrupts the current, thus producing impulses in the pilots.

The amplifier-rectifier at the control station (Fig. 4) comprises two valves, one operating as an amplifier (VA2) and the second as an anode-bend rectifier (VR), the output of which is applied to the high speed relay HR seen in Fig. 5. The rectified impulses operate HR, contacts on which alternately charge and discharge condensers C1 and C2 from a stabilised D.C. supply The constants of the circuit are such that each condenser is fully charged and discharged at all impulsing speeds and thus the meter

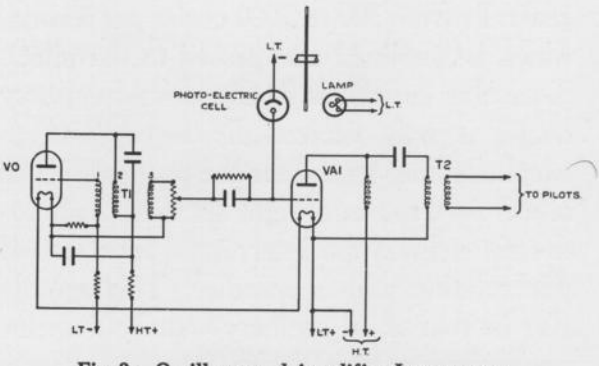

Fig. 3.—Oscillator and Amplifier-Interrupter.

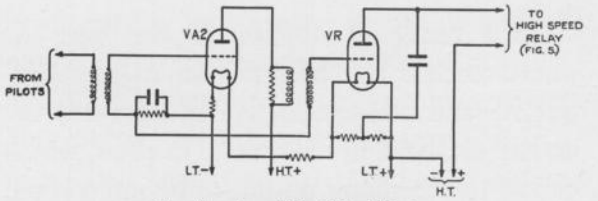

Fig. 4.—Amplifier-Rectifier.

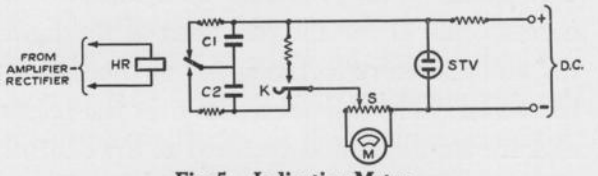

Fig. 5.—Indicating Meter.

receives a mean current proportional to the frequency of the impulses and, therefore, proportional to the quantity measured at the substation.

It is, of course, important that the voltage of the D.C. supply be constant, since any variation would affect the meter A stabilised supply is obtained by employing a glow gap divider (STV) connected as shown in Fig. 5. When replacement of the stabiliser proves necessary, the effects of any difference in characteristics are avoided by a simple calibration process which makes use of shunt S. This variable shunt is adjusted until deflection on the meter, with key K operated, is to a calibration mark on the scale.