Telemetering

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Summary

Telemetering may be described as the art of metering at a considerable distance those quantities which are ordinarily encountered in industry, and in the generation of electric power. It is in the production of electric power that telemetering is particularly important, for it permits the system operator, or load dispatcher, to have before him at all times a continuous graphic record of the power output of each individual generating station together with an automatically made continuous graphic record of the total system output. Where desired, individual graphic records may be obtained showing power flow, in or out, on important tie lines, etc.

Such arrangements have the very great advantage that loads may be assigned to each generating station so that the best over-all system economy may be obtained and the system operator at all times may see with his own eyes that loads scheduled are actually held at the various stations. Moreover, with such equipment, in the event of system or station trouble the load dispatcher can see exactly what station, or stations, are affected and to what extent, without having to get in touch with anyone by telephone. Decisions can, therefore, be quickly reached for rescheduling the load.

One of the most accurate and reliable telemetering systems is based on the use of potentiometric circuits, the fundamentals of which are discussed below.

A member of such telemetering systems have been installed for the Boston Edicon Co., Boston, Massachusetts, the Consolidated Edison Co., of New York City, The Public Service Gas & Electric Co. of Newark, New Jersey, The Philadelphia Electric Co. of Philadelphia, Pennsylvania, and the Pennsylvania Railroad Co. for their electrified zone between New York and Washington a distance of over 200 miles. The scale of the totalizing recorder for the New York area is 3,000,000 KW. That of the totalizing recorder for the Philadelphia area is 2,000,000 KW.

The initial installation using this type of equipment described was placed in service for the Philadelphia Electric Co. in 1923. All of the original recording instruments are still in service, later instruments have been added to take care of additions to the power system and naturally these later recorders have incorporated in them refinements in design made since the earlier ones were manufactured.

Many other installations of similar equipment have been made in the United States in various locations such as at St. Louis,on the West Coast,at Baltimore and in Washington, D.C.

While the use of these basic potentiometric circuits involves the use of continuous metallic circuits of good insulation resistance and free of grounds,nevertheless,intermediate transmission links, involving an impulse method suitable for use on telephone Morse carrier channels is available. This same method may be employed on power line carrier systems and is also suitable for use on beam type mircrowave transmission. Many impulse type units are also used as a link in these potentiometric methods.

For the sake of brevity a description is given only of these basic potentiometric circuits. If there is sufficient interest in Korea, a further paper can be given covering those impulse circuits also.

Potentiometer Circuits

The fundamental circuit of a simple potentiometer is so well known that only a brief discussion is necessary in this case. In figure I is shown schematically a calibrated slide wire,S,in series with certain fixed calibrated resistances. The working current in the potentiometer circuit is supplied by a dry cell, E_B. This working current is adjusted to the correct value by comparing the drop over a certain standard resistance with potential of an Epply standard cell. If this drop across the standard resistance does not match that of the standard cell the working current in the potentiometer circuit is adjusted by means of the adjustable resistance,Ra, until it does. The potentiometer then may be used to measure accurately any e.m.f. placed across the terminals T_1 & T_2. In this case the contact on the standard slide wire is moved until $E_s = E_x$, the state of equality being shown by the galvanometer current being zero.

If then the small incoming e.m.f., E_x, can be made equal to a given watt measurement we can then measure watts with a potentiometer. Furthermore,the potentiometer may be placed at a considerable distance from the source of e.m.f., E_x,since the resistance of the connecting lines affects not the accuracy of the measurement but only the sensitivily,over a very wide range.

The potentiometer circuit just described is reduced to practice by incorporating it into the circuit of a motor-driven automatically self balancing potentiometer recorder of which there are several types commercially available.

There are several practical methods of producing a suitable d.c.

potential,suitable for a telemetering,transmitter,strictly proportional to watts. One of the earliest methods used in practice with this type of equipment was to employ the multiple unit Westinghouse, motor operated,Type R Graphic wattmeter. Since being motor operated this instrument has considerable power available for moving the pen without in any way increasing the friction load on the measureing elements. Under these circumstances a small sprocket and chain is added to the pen carriage drive in such fashion that the slide wire of a small transmitting potentiometer is driven through a sprocket and a worm reduction gear with the result that this transmitting potentiometer at all times produces an output e.m.f., E_X proportional to watts. More recently,in place of the Westinghouse Type R graphic wattmeter,it is usual to employ a Lincoln Thermo-Converter or a Weston Thermalverter. Both of these devices,without any moving parts or moving contacts,very accurately produce a small e.m.f.,E_X,strictly proportional to watts and should the direction of the power reverse,the polarity of the small e.m.f.,E_X,reverses automatically. Both these devices are hardly within the scope of this brief discussion,but are well described in the original paper by P.M. Lincoln and in a paper by engineers of the Weston Electrical Instrument Co. There is also available in America commercial literature covering both types. If there is interest in Korea,the writer will be very glad to obtain such documents for the benefit of those who wish to read them.

It has thus been shown very briefly how one simple potentiometer circuit may be used for telemetering.

In practice,using leased full metallic lines in local Bell Telephone cables,it has been found this method is entirely satisfactory for circuits between points 10 or 15 miles apart. For greater distances a rather simple electro-mechanical method of "amplification" is employed with no loss in accuracy. This arrangement is shown schematically in Figure #2.

G, is the galvanometer in an automatic current adjuster,A. This device so operates that the current,Iw,through Rw is at all times automatically so adjusted as to make the drop,Iw Rw,at all times equal the e.m.f.,E_X, coming from the thermal converter,T.C. Since the same current Iw which traverses Rw also passes through the line and the receiver resistor,Rr,the drop across Rr is always proportional to Iw, since Iw is proportional to Ex which is at all times proportional to watts. Thus a conventional potentiometer recorder may be employed to record the potential,E_R, across R_R and it be comes a telemetering recorder of watts. This type of circuit is independent of changes in line resistance over a wide range,for should a change in this line resistance tend to make a change in current not called for by a change in watts,the galvanometer,G,would immediately detect the discrepancy and automatically readjust the current to its proper val- value. Similarly,any drift in battery voltage would be detected in the same way and be compensated automatically in the same fashion. In practice such circuits are in use between points a hundred miles apart on continuous metallic circuits in a cable.

So far the description has been confined to transmissions merely from point to point. Figure #3 illustrates schematically a method for using potentiometer circuits for totalizing automatically the readings of any desired number of individual potentiometer recorders. These totalizing circuits may be operated with dry cells with,standard Eppley cells for standardizing the working currents of the various individual potentiometer circuits. If all the receiving recorders and the totalizer are on one switchboard or in one room it mey be more convenient to operate all the totalizing potentiometers on alternating current,each slide wire being fed from an individual miniature transformer or from a separate winding of a special miniature transformer.

A.C. should be employed only if its relability is assured beyond any question of reasonable doubt. The conventional use of dry cells and standard cells is the more conservative procedure.

In the actual mechanism,the contact on each totalizing slide wire picks off a potential proportional to the wattreading of the instrument. These potentials are all added together as shown schematically in diagram Figure #2,and the sum is continuously recorded by the Totalizing recorder,T,suitably caliberated in K.W. or M.W. It should be noted that each totalizing slide wire is in every case electrically insulated from,but mechanically locked to,its corresponding receiving slide wire. This has the great advantage that any trouble developing on any telephone telemetering channel is thereby isolated and cannot spread to any other channel or to the whole telemetering system. For the sake of simplicity the source of e.m.f. for each slide wire,whether A.C. or D.C. is not shown.

This very brief description of potentiometric telemetering circuits is made more difficult by the present lack of technical illustrations of actual mechanisms and installations,but some additional data is on the way from America. If there is interest here in Korea much supplementary technical information on the subject will be gladly obtained by the writer for your Engineering Society.

C.P. Steinmetz 博士, J. Facciali 及 F.W. Peek氏와더부러 研究에 從事

世界第一次大戰中 二三年間 佛蘭西及墺地利에서 救濟事業及再建事業에從事

1920年 philadelphia 에있는 Leeds & northrup 会社에奉職

多年間 綜合研究所 公益事業体 Bell 電話研究所 western 電気会社及大学에奉職

1942年 公職에서 辞退하야 外交使節団으로 北아푸리카 에가서 数千避難民을救済함

1948年 電力使節团으로來韓

1925年 以後 美局電気學会(A.I.E.E.)会員

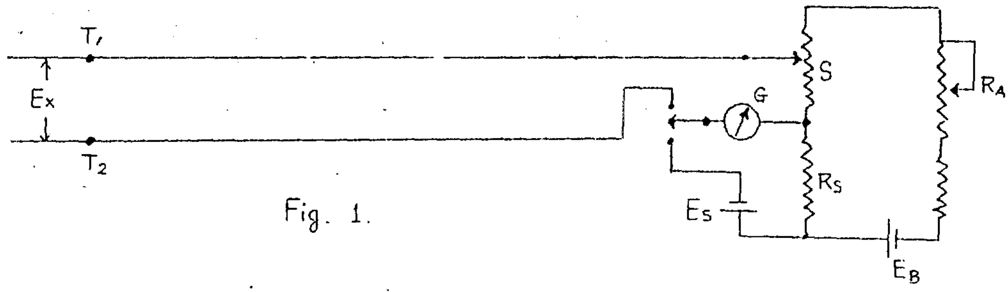

Fig. 1.

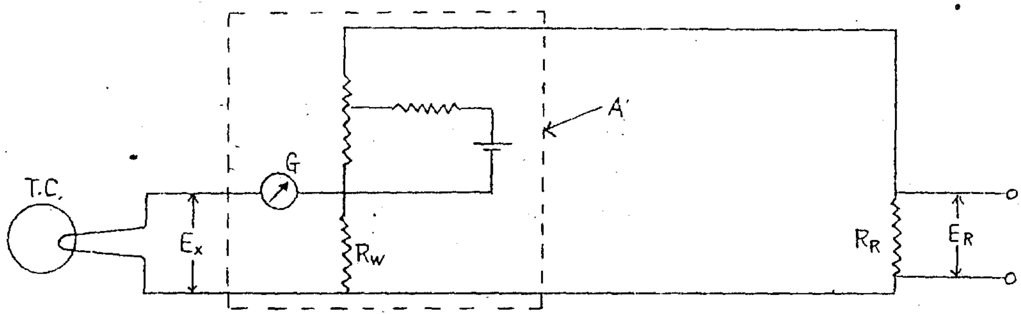

Fig. 2

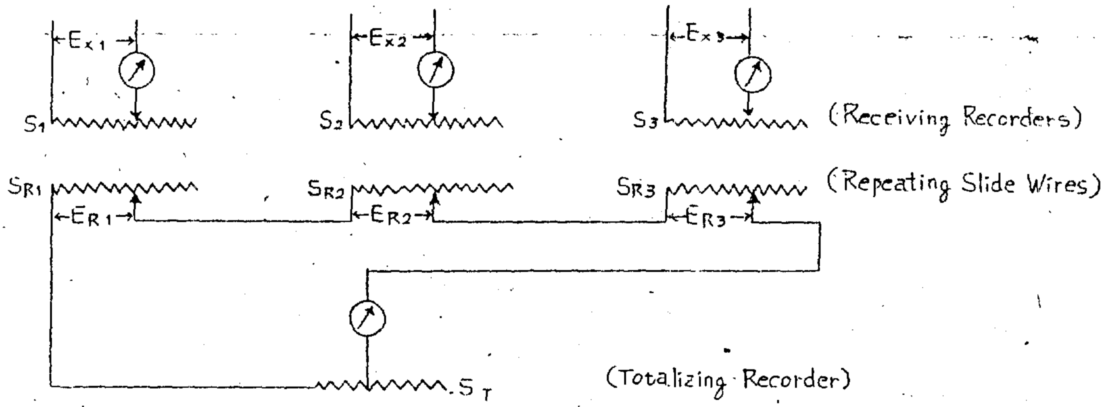

Fig. 3.

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Drawn By Kim Kap Hyun

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