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W. H. MARTIN

EQUALIZING TRANSMISSION

Filed April 21, 1921

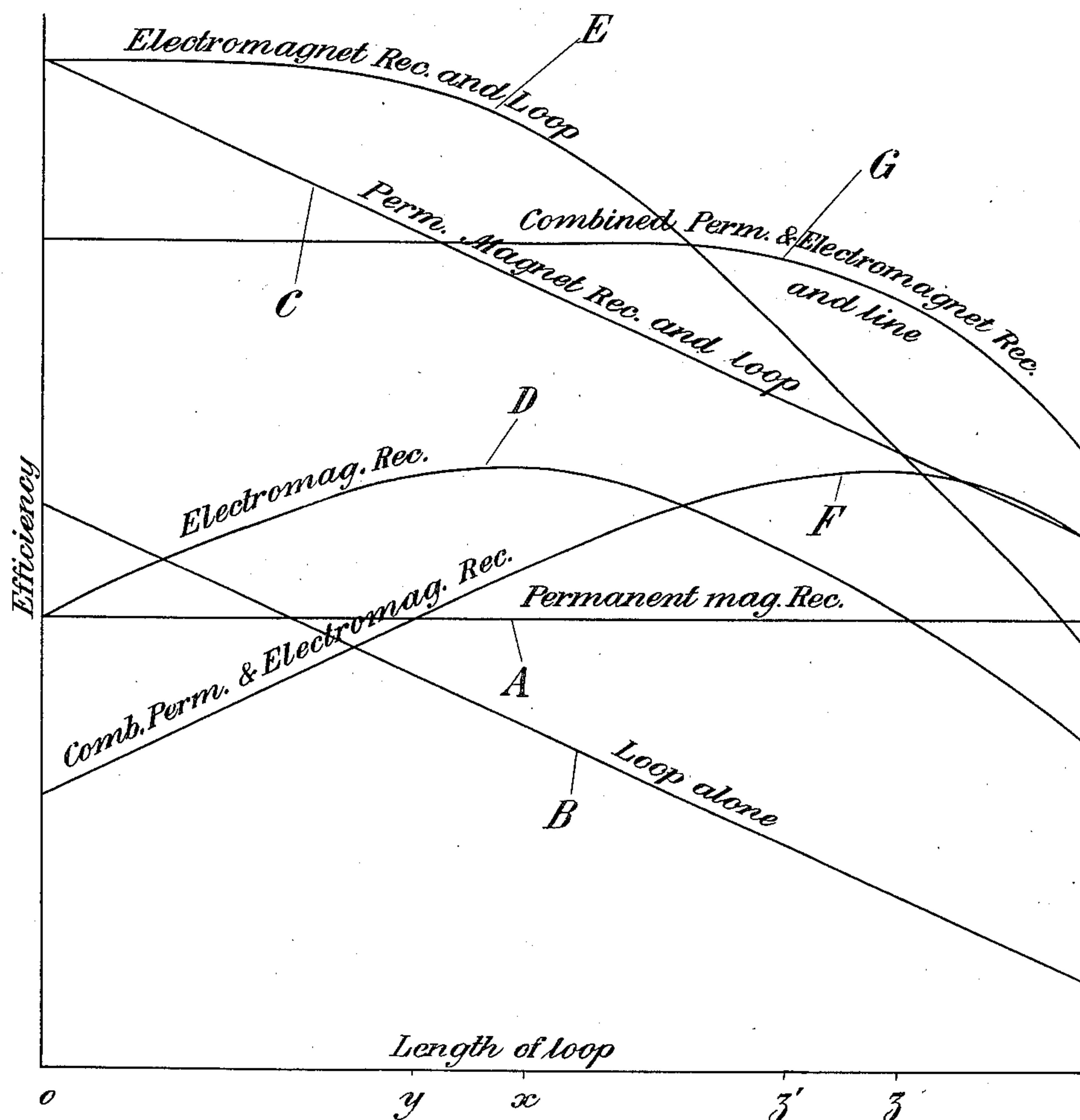
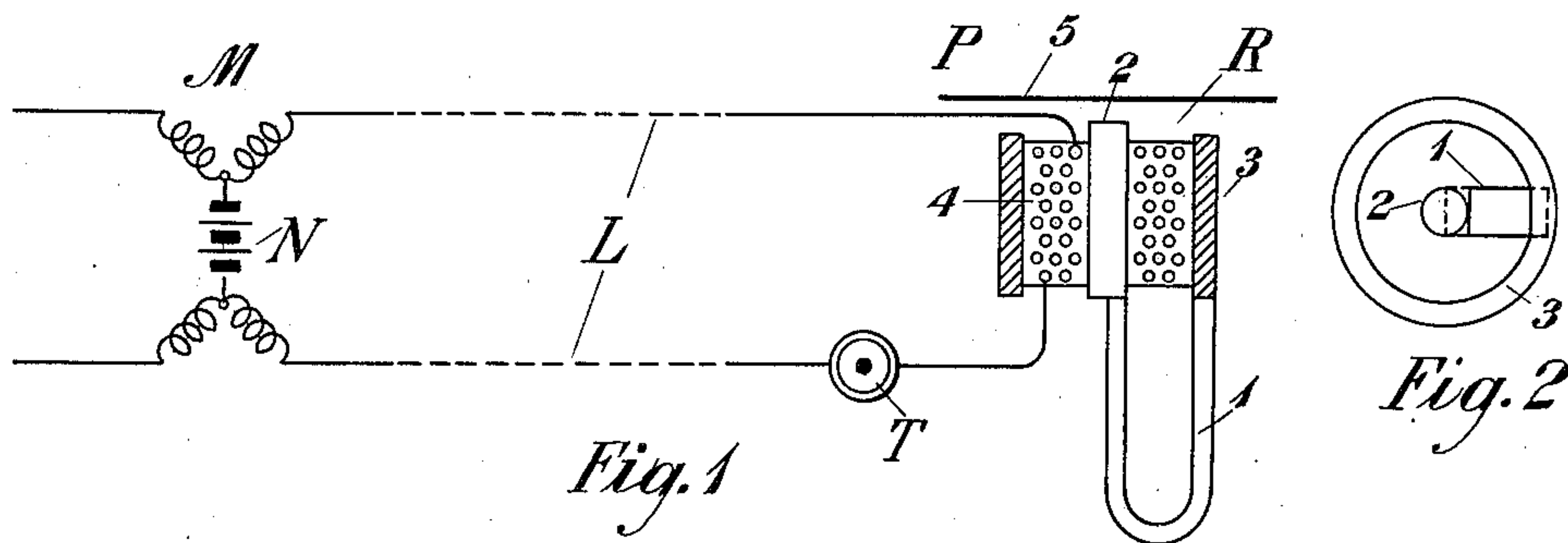


Fig. 3

Inventor
W. H. Martin

By his Attorney

g. f. f. o. l. e

UNITED STATES PATENT OFFICE.

WILLIAM H. MARTIN, OF NEW YORK, N. Y., ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

EQUALIZING TRANSMISSION.

Application filed April 21, 1921. Serial No. 463,294.

To all whom it may concern:

Be it known that I, WILLIAM H. MARTIN, residing at New York, in the county of Bronx and State of New York, have invented certain Improvements in Equalizing Transmission, of which the following is a specification.

This invention relates to the transmission of signals and, more particularly, to the equalization of transmission over signaling lines having different electrical characteristics.

It has heretofore been proposed to partially equalize the receiving efficiency of subscribers' telephone lines of different lengths by using an electro-magnet receiver, that is, a receiver whose magnetic field is energized by direct current instead of a permanent magnet. As is well known, the efficiency characteristic of the electro-magnet receiver is such that, as the direct current through the receiver is decreased from the value obtained on a subscriber's loop of minimum length, the efficiency increases to a maximum which is reached with a given value of direct current. As the direct current is further decreased beyond this point, the receiving efficiency decreases.

A receiver having such an efficiency characteristic adapts itself to the equalization of transmission up to the point of maximum efficiency, since the efficiency of the receiver increases as the efficiency of the transmission loop decreases. Unfortunately, however, the direct current value corresponding to the maximum efficiency of the receiver is obtained on a relatively short loop, with the result that the receiving efficiency, while equalized up to this point, falls off very rapidly with increase in the length of the loop beyond this point owing to the fact that not only does the efficiency of the loop itself decrease with length, but the efficiency of the receiver also falls off. Furthermore, on shorter loops, the substantially constant receiving efficiency is greater than is desired and results in giving transmission which is too loud.

In order to correct these features, it will be desirable to have a receiver which, for the same impedance, would have its maximum efficiency correspond to a smaller value of direct current, as, under these conditions, the efficiency of the receiver would increase to a maximum obtained with a longer length

of loop. For any given receiver construction, this optimum value of battery supply could be decreased by increasing the number of turns in the receiving winding. This results in increasing the impedance, however, and the substation circuit, for best efficiency, requires a receiver of a certain impedance which makes it undesirable to change the receiver winding. It is, of course, theoretically possible to make an electro-magnet receiver with maximum efficiency at a lower current than that now obtained but practical difficulties have prevented the design of such a receiver up to the present time.

It is proposed, therefore, in accordance with the present invention, to reduce the value of the direct current through the windings required to give maximum efficiency by employing a combination of an electro-magnet and a permanent magnet in the receiver. In general, the desired result of shifting the point of maximum efficiency on the efficiency curve may be obtained by arranging matters so that the flux of the permanent magnet and the flux of the direct current winding either oppose or assist each other. It is preferable, however, to pole the receiver with respect to the circuit, in such a manner that the two fluxes aid each other. By using a combined permanent and electro-magnet receiver, the receiver can be made to meet a given impedance requirement and, at the same time, the value of direct current through the receiver windings corresponding to maximum efficiency can be decreased as the strength of the permanent magnet is increased. The permanent magnet, by making the magnetic field stronger, would also decrease the efficiency on the shorter loops. This may be understood when it is considered that the point of maximum efficiency on the efficiency curve depends on the attainment of a definite flux in the magnetic structure. When this flux is obtained wholly or in part through the magnetic action of the direct current winding, the point of maximum efficiency of the receiver will correspond to a definite value of direct current in the winding, and in the case of a common battery system, it will correspond to a definite length of loop. If the flux be made up partly by a permanent magnet and partly by the direct current flowing through the

receiver winding, it will be apparent that the point of maximum efficiency will correspond to a lower value of direct current and the loop for which transmission may be equalized, may be made correspondingly longer than if the flux is entirely obtained through the magnetic action of the direct current winding.

The invention may be more fully understood from the following description when read in connection with the accompanying drawing, Figure 1 of which illustrates a simplified form of telephone circuit employing a receiver constructed in accordance with the present invention, Fig. 2 of which is an end view of the magnetic structure of the receiver and Fig. 3 of which illustrates a number of curves exemplifying the principles of the invention.

Referring to Fig. 3, the various curves are obtained by plotting lengths of loop against transmission efficiency. The curve A, for example, is a curve showing the variation in efficiency of a permanent magnet receiver, with different lengths of the subscriber's loop. As the efficiency of the permanent magnet receiver does not depend upon the current flowing over the loop, the efficiency of the receiver per se will remain constant, regardless of the length of the loop. The transmission efficiency of the loop, however, decreases with increase in length, as illustrated by the curve B, so that the combined efficiency of the permanent magnet receiver and loop will decrease with increase in the length of the loop. This is illustrated by the curve C of Fig. 3. This is a condition which is undesirable and one which it was sought to overcome by the use of an electro-magnet receiver. As previously stated, the efficiency characteristic of the electro-magnet receiver is such that the efficiency of the receiver per se increases with the decrease in the value of the direct current flowing through the receiver winding up to a certain maximum, from which point the efficiency decreases with decrease in the current value. The result is, that for an electro-magnet receiver, an efficiency curve such as illustrated by the curve D in Fig. 3 is obtained. In this curve, the efficiency of the receiver per se increases with the length of the loop up to the point represented by a loop having a length X, the efficiency rapidly falling off, however, with further increase in the length of the loop.

The use of such a receiver will give an efficiency curve for the combination of loop and receiver such as represented by the curve E in Fig. 3, this curve being obtained by combining curves B and D. An analysis of this curve shows that transmission is substantially equalized for loops up to length Y, but for loops of greater length the transmission efficiency falls off very rapidly.

As previously pointed out, it is proposed, in accordance with the present invention, to modify curve D so as to shift the point of maximum efficiency to a loop of greater length by combining with the electro-magnet a permanent magnet, so that the flux corresponding to maximum efficiency of the receiver will be made up partly by the permanent magnet and partly by the direct current flowing through the receiver winding. Such a receiver will have an efficiency characteristic represented by the curve F, in which the point of maximum efficiency of the receiver per se corresponds to a loop having a length Z. For shorter loops, the efficiency curve falls off to a lower value than the curve D, owing to the fact that the magnetic field is over-saturated to a greater extent than in the case of the electro-magnet receiver alone. The resultant efficiency of the line and combined electro-magnet and permanent magnet receiver is illustrated by the curve G, which is obtained by combining curves B and F. An analysis of this curve shows that the receiving efficiency is substantially equalized for various loop lengths up to a length Z'. The efficiency up to this point is also lower than that indicated by the equalized portion of the curve E, so that undue loudness of transmission will not be obtained on equalized loops.

A form of receiver for obtaining the results just discussed, together with a simple form of circuit in which it may be used, is illustrated in Fig. 1. In this figure, L represents a transmission line extending from a central station M, at which a common battery source N is provided, to a sub-station P, at which is located a telephone transmitter T and a receiver R. The receiver R comprises a permanent magnet 1, to the poles of which are attached a central pole piece 2 and the usual cylindrical wall 3 of the receiver cup of an electro-magnet receiver. In this instance, however, the bottom wall of the cup, which serves to close the magnetic circuit in the case of the ordinary electro-magnet receiver, is omitted, the magnetic circuit being closed through the permanent magnet 1. A direct current coil 4 is wound about the pole piece 2 within the cylindrical wall 3, and the terminals of this winding are connected to the line L, as indicated. The usual receiver diaphragm 5 is associated with the magnetic structure thus obtained. By proper design of the receiver, the direct current winding 4 and the permanent magnet 1 may contribute such proportions of the total flux of the magnetic system as to produce the result indicated by the curve G of Fig. 3.

A receiver of the type just discussed is not limited to use in connection with a substation circuit arrangement such as that shown in Fig. 1, but is adapted to be used

with any type of substation circuit which is so designed that the current supplied from the common battery at the central office may flow through the receiver winding.

Furthermore, it will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated, without departing from the spirit of the invention, as defined in the following claims.

What is claimed is:

1. In a signaling system, a plurality of transmission lines of different lengths, a common source of current supply therefor, and receiving instruments associated with each line, each receiving instrument having a magnetic structure consisting of a permanent magnet, and a direct current coil supplied with current from said source, said magnetic structure being so designed that the combined flux due to the permanent magnet and the direct current coil will be such as to render the receiver most efficient for a current value smaller than the current value corresponding to the point of maximum efficiency when the direct current coil is used alone.

2. In a signalling system, a plurality of transmission lines of various lengths, a common source of current supply therefor, receiving instruments associated with each of said lines, each receiving instrument, including a magnetic structure, comprising a permanent magnet, a pole piece therefor and a direct current coil wound about said pole piece, said coil being supplied with current from said source, said magnetic structure being so designed that the combined flux due to the permanent magnet, and the direct current coil will be such as to render the receiver most efficient for a current value smaller than the current value corresponding to the point of maximum efficiency when the direct current coil is used alone.

3. In a signaling system, a plurality of transmission lines of unequal lengths, a common source of current supply therefor, receiving instruments associated with each line, each receiving instrument including a magnetic structure comprising a permanent magnet having a central pole piece associated with one pole thereof, and a cylindrical pole piece associated with the other pole thereof, and a direct current coil wound about said central pole piece within said cylindrical pole piece, said direct current coil being supplied with current from said source, and said magnetic structure being so designed that the combined flux due to

the permanent magnet and the direct current coil will be such as to render the receiver most efficient for a current value smaller than the current value corresponding to the point of maximum efficiency when the direct current coil is used alone.

4. In a signaling system, a plurality of transmission lines of different lengths, a common source of current supply therefor, receiving instruments associated with each line, each instrument having a magnetic structure consisting of a permanent magnet and a direct current coil supplied with current from said source, said magnetic structure being so proportioned as to produce such relative values of the fluxes due to the permanent magnet and the direct current coil that the point of maximum efficiency of the receiver will correspond to a loop of predetermined length.

5. In a signaling system, a plurality of transmission lines of various lengths, a common source of current supply therefor, receiving instruments associated with each line, each receiving instrument including a magnetic structure comprising a permanent magnet, a pole piece therefor, and a direct current coil wound about said pole piece, said coil being supplied with current from said source, and said magnetic structure being so proportioned as to produce such relative values of the fluxes due to the permanent magnet and the direct current coil that the point of maximum efficiency of the receiver will correspond to a loop of predetermined length.

6. In a signaling system, a plurality of transmission lines of unequal lengths, a common source of current supply therefor, receiving instruments associated with each line, each receiving instrument including a magnetic structure comprising a permanent magnet, a central pole piece associated with one pole thereof and a cylindrical pole piece associated with the other pole thereof, and a direct current coil wound about said central pole piece within said cylindrical pole piece, said magnetic structure being so proportioned as to produce such relative values of the fluxes due to the permanent magnet and the direct current coil that the point of maximum efficiency of the receiver will correspond to a loop of predetermined length.

In testimony whereof, I have signed my name to this specification this 18th day of April 1921.

WILLIAM H. MARTIN.