

Aug. 14, 1928.

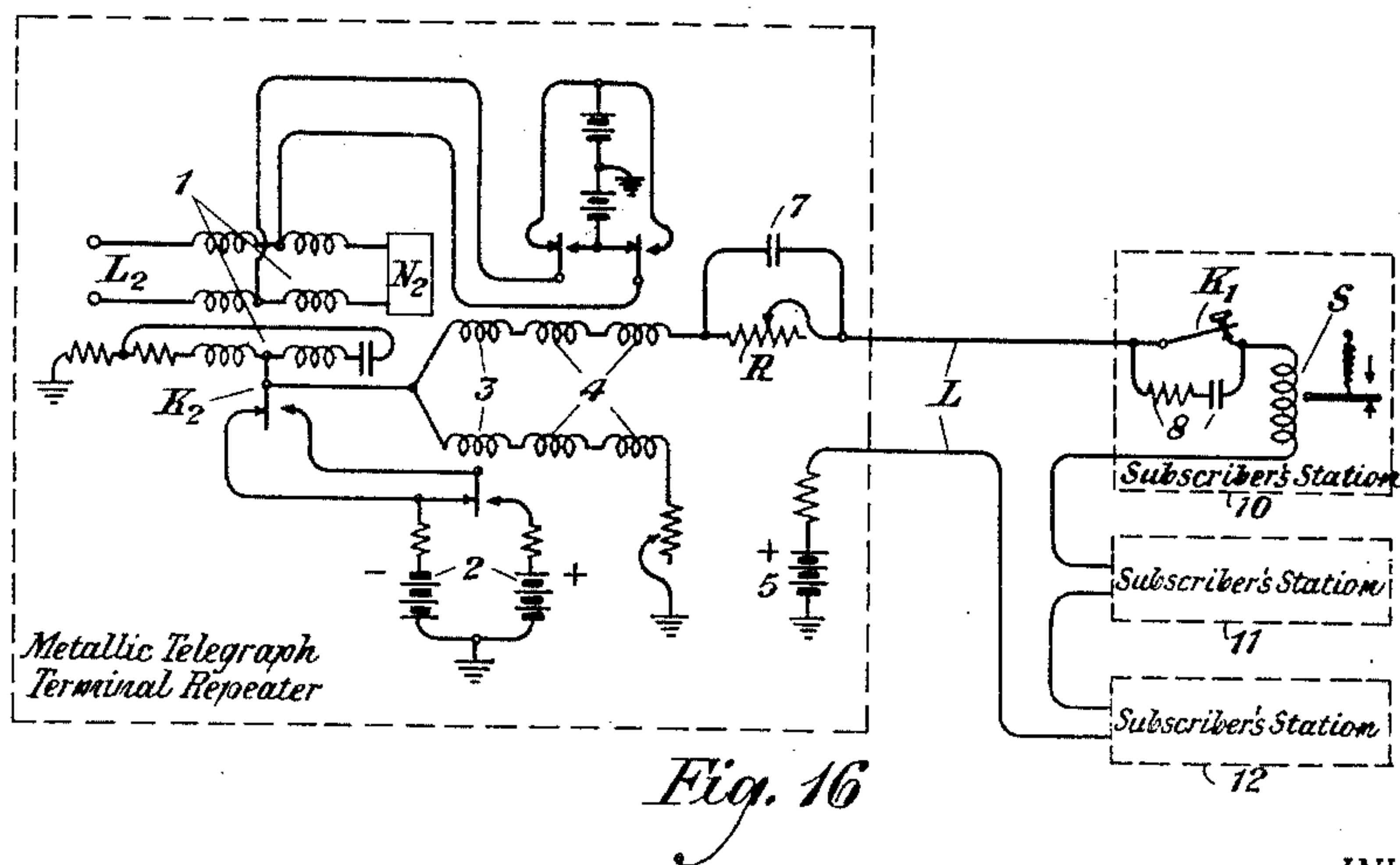
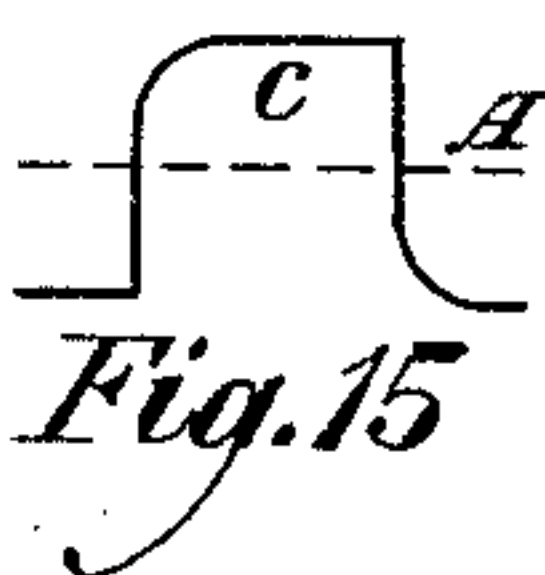
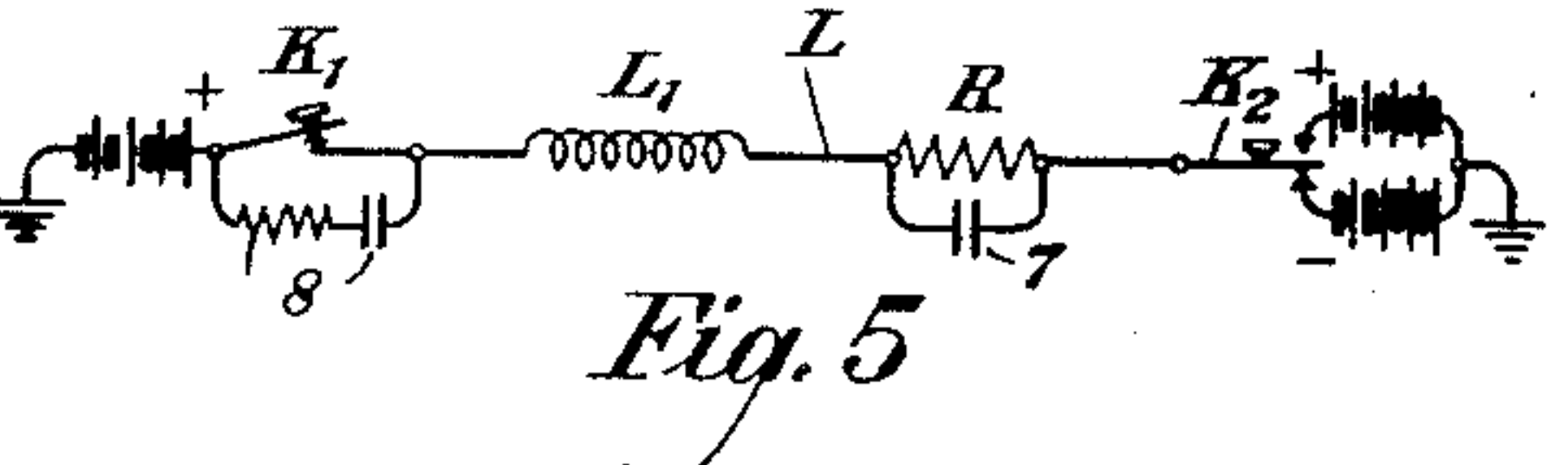
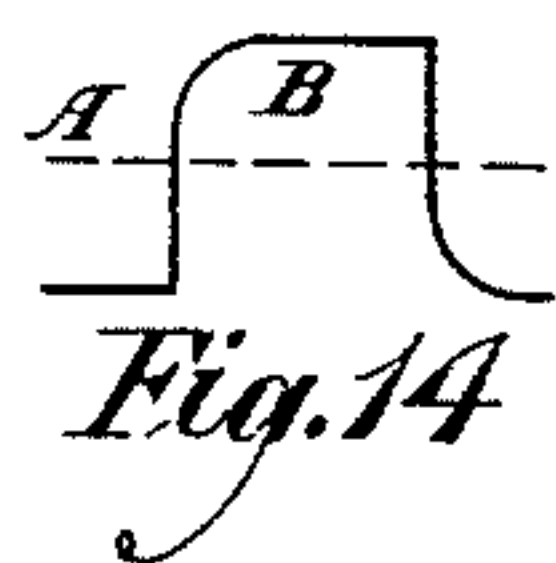
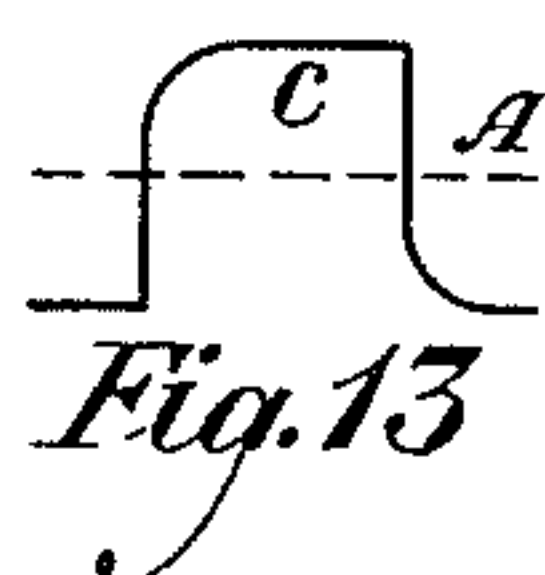
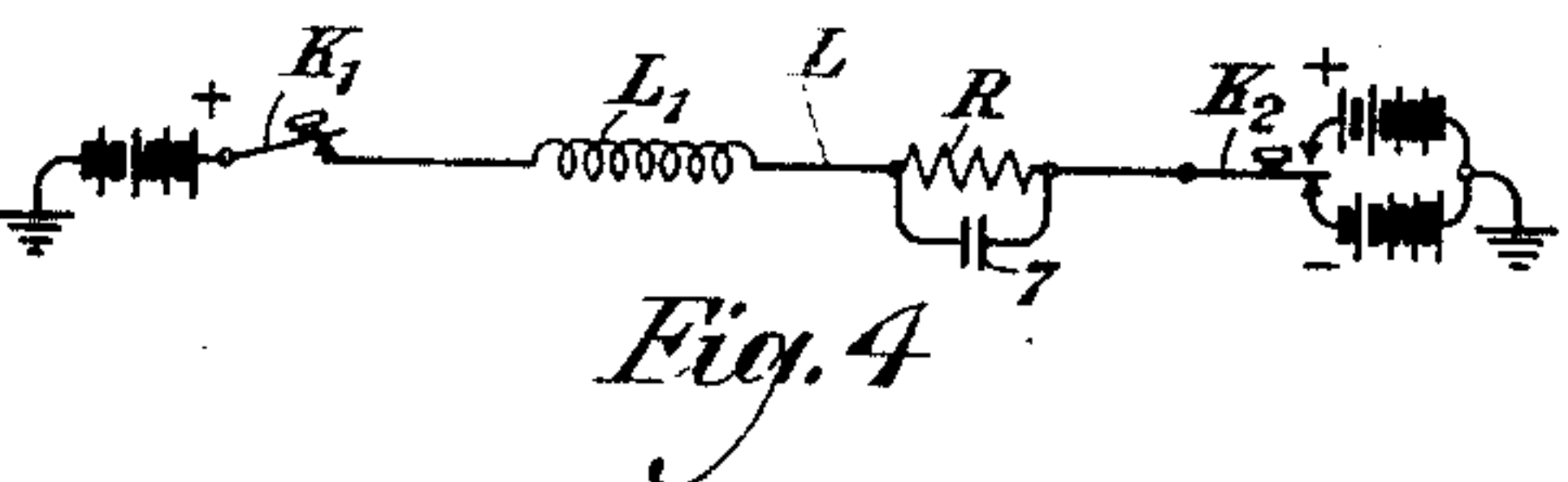
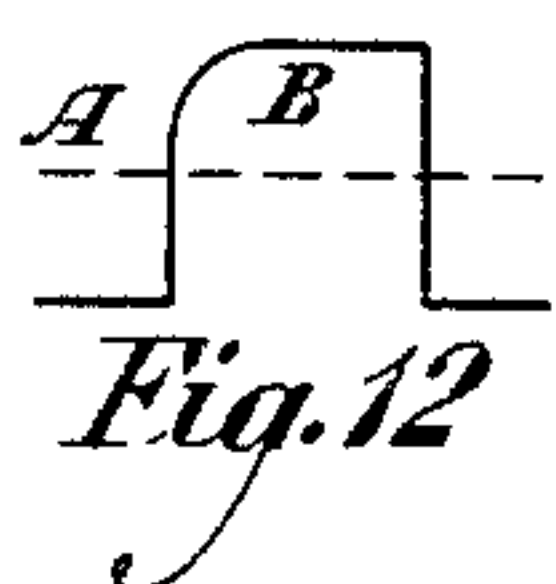
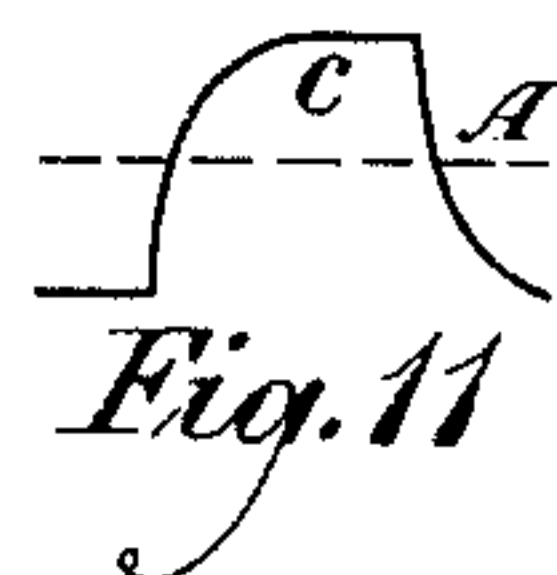
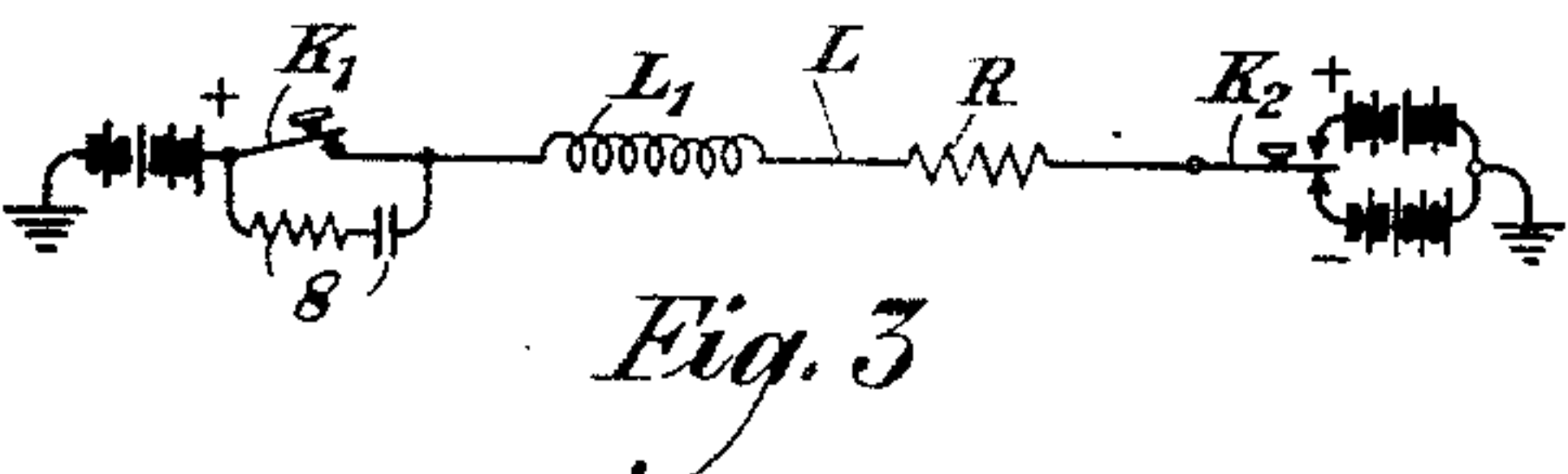
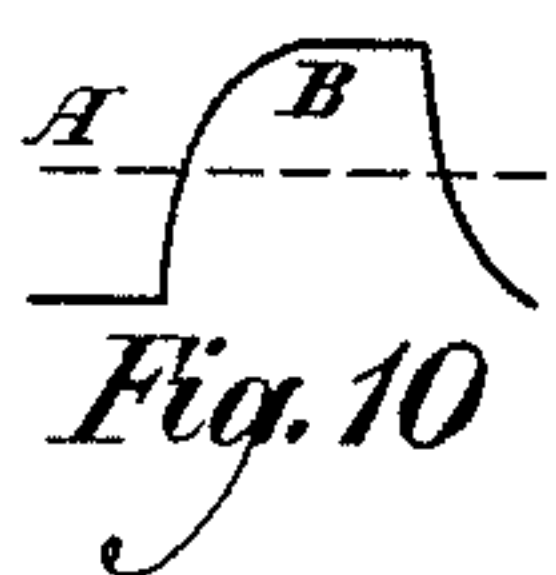
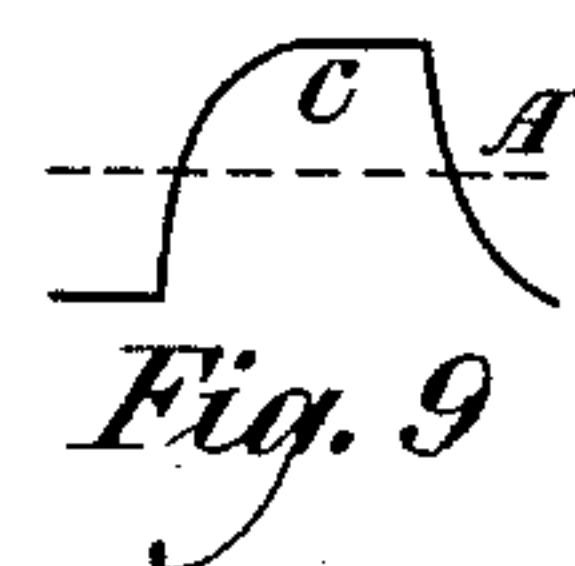
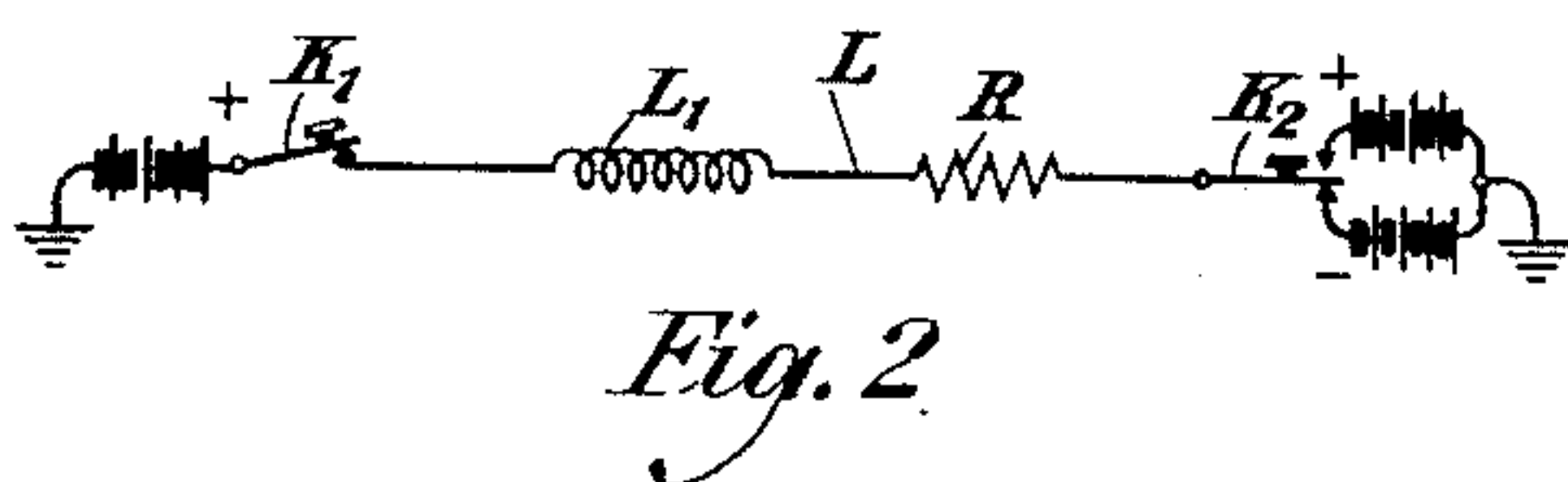
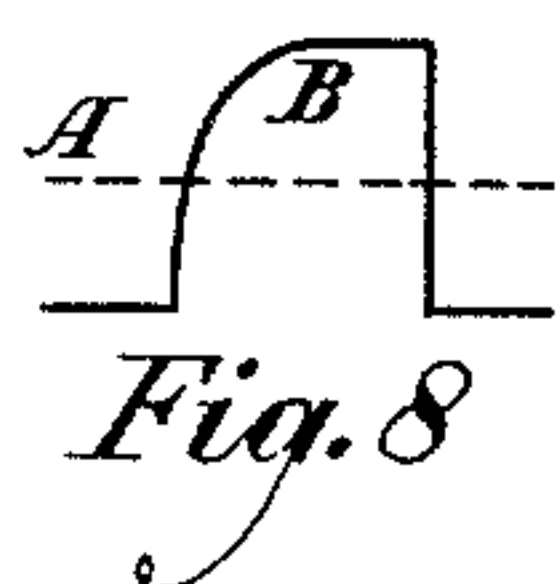
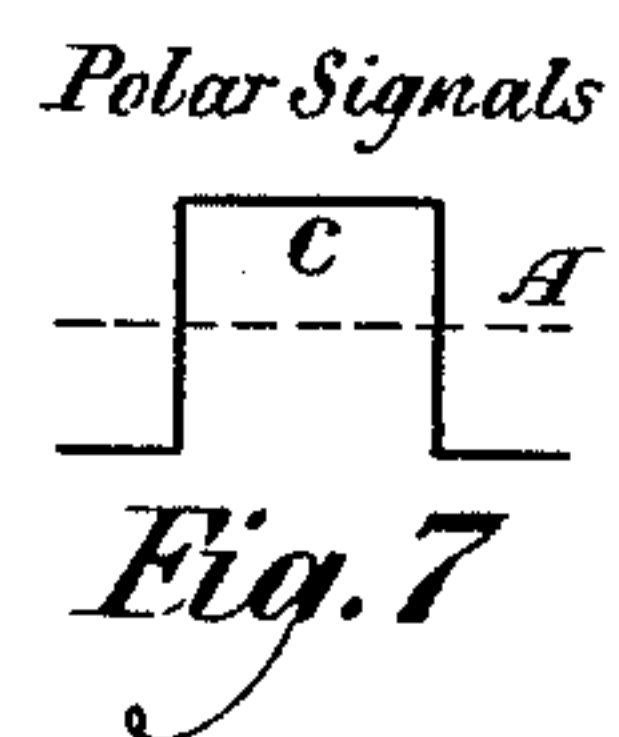
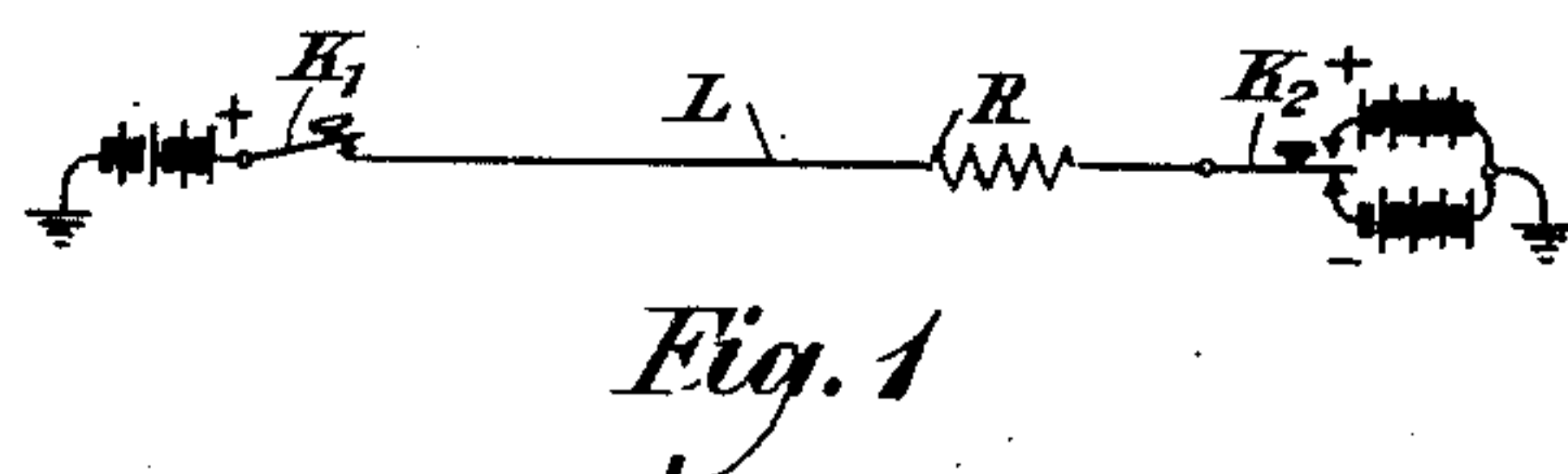
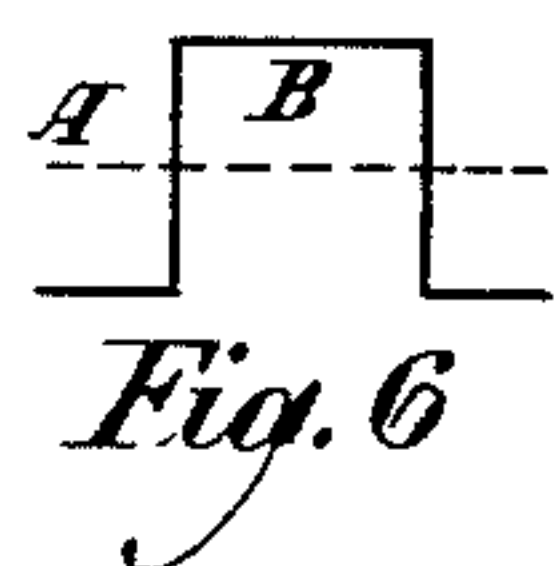
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J. HERMAN ET AL

TELEGRAPH CIRCUITS

Filed Aug. 11, 1927

Open & Close Signals



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TELEGRAPH CIRCUITS.

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This invention relates to telegraph systems and more particularly to improved arrangements for reducing differences in bias between polar and open-and-close signals in differential telegraph loop circuits, such as are usually associated with carrier and metallic telegraph sets in such systems.

Loop circuits are usually opened and closed by the telegraph key when signals are sent from the loop to the line and have the polarity of the battery reversed at one end by the receiving relay when signals are being received from the line. Consequently, any relay or sounder which is connected into such a loop will have to function with either type of signal, namely, open-and-close signals or polar signals. It has been found in practice that a noticeable difference of bias will occur between the two types of signals when the loop circuit contains from one to three relays. When the loop contains more than three relays or sounders the difference in bias becomes fairly large. It has also been found that the bias difference also varies with the bias adjustment of the loop relays or sounders, particularly for adjustments made with open-and-close signals. The difference of bias is least for a negative bias adjustment of the relays and greatest for a positive bias adjustment and increases with an increase in the inductance connected into the loop. It has been found in practice that the inductance due to three sounders in the loop, which is the average condition, prevents a sufficient positive bias adjustment of the sounders on open-and-close signals because of the excessive positive bias which would then result from polar signals. Such an adjustment is desirable, however, in the case of repeating relays on bridge polar duplex sets in order to permit correction of bias in signals, and in the case of subscribers' relays and sounders in order to prevent an objectionable lag in the operation of the sounder at a sending station when the operator at that station transmits into the loop.

It is one of the primary objects of this invention to provide improved correcting devices in the loop circuits to overcome these differences of bias, which are due chiefly to the differences in wave shape of open-and-close and polar signals. These correcting devices have been devised to make the wave

shape of the two types of signals approximately alike. Other purposes and objects of the invention, together with the method and means for accomplishing them, will be more clear from the following detailed description hereinafter given.

The invention may be more fully understood from the following description, together with the accompanying drawing, in Figures 1-16, inclusive, wherein the invention is illustrated.

Figs. 1, 2, 3, 4 and 5 represent schematically five different loop conditions showing the operation of a relay in a non-inductive and in an inductive differential loop circuit, the causes which lead to large differences in bias between open-and-close and polar signals, and the effect of the proposed correcting circuits. For each condition shown in Figs. 1-5, inclusive, there is illustrated in Figs. 6-15, inclusive, the wave shape of the current for the case where the loop is opened and closed at one end, and for the case where the polarity of the battery is reversed at one end. These two cases obviously represent the two methods of transmitting signals into a differential telegraph loop. In Fig. 16 is shown a circuit diagram illustrating a practical embodiment of the invention. Similar reference characters have been used to denote like parts in all of the figures.

In Fig. 1 is illustrated a stable condition of operation of a relay or sounder, namely, a condition where a small change in the relay adjustment introduces very little or no bias into the repeated signals. This would be obtained in a loop circuit L, as shown in Fig. 1, where the operating current builds up and dies down instantly, as illustrated by the curves B and C in Figs. 6 and 7. This occurs only when a resistance, such as R, is connected into the loop and is true for open-and-close signals and for polar signals. With such a wave shape of the current in the loop it would be theoretically impossible to introduce bias into the repeated signals. The relay would always operate at the instant the key, such as K_1 , was closed and released at the instant the key was opened, no matter whether it was adjusted to operate on a large or small value of current. This may be visualized by assuming

that the points where the dotted line A intersect the curves of the building up and of the dying down of the current wave, represent the instants at which the relay operates and releases, respectively. This line may be shifted up or down on the current wave, depending upon whether the relay is adjusted to operate on a large or small value of the current, but the length of the repeated signal will remain unchanged. In practice, an unbiased operation of a relay under the above conditions cannot be fully realized, due to the inductance of the relay winding, the inertia of its armature in traveling between contacts, and due to the residual magnetism of the iron in the relay magnet. The combination of these factors results in a small negative bias of the repeated signals as the dotted line A is shifted to the top of the wave, and a small positive bias as it is shifted to the bottom of the wave. However, the effect will be practically the same for open-and-close as for polar signals, provided the inductance of the relay is negligibly small. This is because the wave shapes are practically the same and because the factors which modify the operation of the relay, as mentioned above, remain the same. Consequently, there will be a negligible difference in bias for the two types of signals.

If the loop circuit contains a number of sounders or relays the inductance in the circuit becomes an important factor. In Fig. 2 is shown a loop circuit L having an inductance L_1 . The wave shapes for the two types of signals under such conditions are shown in Figs. 8 and 9. The manner in which the current builds up in the circuit is the same for open-and-close as for polar signals, but the manner in which it dies down is different. For polar signals the current dies down in the same manner as it builds up, namely, in the form of a logarithmic curve. For open-and-close signals it dies down almost instantly except for momentary sparking at the key contacts when the key K_1 is opened. Evidently, a relay connected into such a circuit will repeat signals differently for the two methods of transmission.

For a particular adjustment of the relay (a certain position of the dotted line), the relay will operate at the same instant for open-and-close and for polar signals when the key is closed. When the key is opened it will release instantly for open-and-close signals but will release a short time later for polar signals. This is obvious from the shapes of the curves B and C for the decay of current in the two cases. If the relay is adjusted to repeat signals with a large negative bias (dotted line A located near the top of the signal wave) the difference of bias for the two types of signals will be

small, since the slower decay of current in the case of polar signals has not yet lengthened the signals appreciably at that point. If the relay is adjusted to repeat signals with a positive bias (dotted line A near the bottom of the current wave) it is evident that there will be a large difference of bias. The relay in this case will release instantly for open-and-close signals and an appreciable time later for polar signals because of the difference in wave shape. This explains why large differences of bias occur on relays in differential loops if the relays are adjusted to repeat signals with a positive bias. An inspection of the wave shape B for the open-and-close signal of the loop of Fig. 2 also shows why a large lag occurs between the closing of the key K_1 and the operation of the sounder if the sounder is negatively biased (dotted line A near the top of the wave). It is also evident how this lag is decreased if the sounder is positively biased (dotted line near the bottom of the wave).

The action upon the loop circuit of Fig. 2 of the proposed correcting circuit arrangements of the invention both singly and in combination, is shown in Figs. 3, 4 and 5, together with the curves illustrating resulting wave shapes of the signals shown in Figs. 10-15, inclusive. In Fig. 3 a spark killer arrangement 8, consisting of a resistance and condenser, is connected across the contacts of key K_1 from which the open-and-close signals are sent, with the result that the decay of current for open-and-close signals is made similar to that for polar signals, as will be seen from an inspection of curves B and C of Figs. 10 and 11, respectively. However, a particular design of spark killer for open-and-close signals will give an accurate reproduction of the decay of current of polar signals only for a particular inductance in the loop. In practice, the inductance L_1 varies considerably for different loops so that one design of spark killer would not be suitable for all loops due to the large differences in wave shape over the range of inductances encountered. Furthermore, the spark killer only prolongs the decay of the open-and-close signals and does not decrease the time of build-up of these signals, nor the time of build-up and decay of the polar signals. It is desirable to do this because that will cause the signals to approach the ideal shape shown in Figs. 6 and 7. These disadvantages are overcome by using, in conjunction with the spark killer, another type of correcting circuit which prevents a large difference in wave shape over the necessary range of inductance in the loop. The effect of this correcting circuit used by itself is shown in Figs. 4, 12 and 13.

The loop circuit of Fig. 4 includes a condenser 7, which for purposes of illustration

may be assumed to be of approximately 4 mf., shunted across the loop current regulating resistance R, which for purposes of illustration may be considered to have a value of at least 2,000 ohms. The condenser 7 in effect short circuits the resistance R at the instant the key K_1 is closed and at the instant the key K_2 is open or closed. The result is a much more rapid building up and dying down of the currents in an inductive loop causing the wave shapes to approach those shown in Figs. 6 and 7. However, for highly inductive loops and where the voltages are limited to a certain maximum value and the current is limited to a certain minimum value it is impossible to increase R sufficiently and there remains a noticeable difference in the curves for the dying down of current of open-and-close and of polar signals when this type of correcting circuit is used by itself. This may be seen from an inspection of the curves B and C of Figs. 12 and 13.

By combining the spark killer 8 with the shunted condenser 7, the loop circuit arrangement of this invention, shown in Fig. 5, is obtained. This combination, if designed so as to correct for the average number of loop relays (about three), will give very nearly as good results over a range of one to five loop relays, which is generally the range encountered in practice. From an examination of curves B and C of Figs. 14 and 15 which show signals of both types to have identical wave shapes, it will be seen that this loop circuit arrangement not only reduces the differences in bias for the two types of signals over a moderate range of bias adjustments, but also reduces the lag in the operation of the sounder for open-and-close sending, due to the more rapid building up of the current in inductive loops.

In Fig. 16, the arrangements of the invention, which have been shown schematically in Fig. 5, have been illustrated as embodied in a loop circuit L arranged for half duplex operation and associated with a metallic telegraph terminal repeater. The telegraph line L_2 is shown terminating in a balancing artificial line N_2 and including the hybrid coils 1 of a receiving relay. The contacts of the receiving relay have been given the designation K_2 as they may connect battery of either polarity from the source 2 to the loop circuit L to produce the so-called polar signals. The differential windings 3 and 4 of a break relay and a sending relay respectively, are illustrated. The sending relay 4 will be operated by the open-and-close signals from the key K_1 and the battery 5 in the usual manner. Connected to the loop circuit L is shown the winding of a relay or sounder S at the subscriber's station 10. The loop circuit L might have serially connected thereto other similar subscriber's station, such as 11 and 12. Bridged across the contacts of the key K_1 at the subscriber's set, such as 10, would be the spark killer device 8, similar to those heretofore shown. Included in the loop L would be a loop current regulating resistance R. Shunted about this resistance R would be the condenser 7. Accordingly, it will be seen that the loop L with its relays or sounders has applied thereto the corrective devices of the invention, namely the spark killer 8 and the condenser 7 shunted around the resistance R. These arrangements will operate on the principles heretofore pointed out to make the wave shape of both types of signals in the loop circuit substantially the same so as to reduce the difference in bias for the two types of signals encountered and also to reduce the lag in operation of the sounder for the open-and-close sending signals.

It is pointed out that the corrective circuit arrangements of the invention may equally well be applied to loop circuits associated with many types of telegraph systems other than the one illustrated, such, for example, as with a loop circuit associated with a carrier terminal repeater or in printer systems. Accordingly, while the invention has been disclosed as embodied in certain specific arrangements which are deemed desirable, it is understood that the invention is capable of embodiment in many and other widely varied forms without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. In an electrical signaling system a circuit adapted to accommodate both polar signals and open-and-close signals, and correcting devices in said circuit to make the wave shapes of both types of said signals approximately alike.
2. In an electrical signaling system including a circuit adapted to accommodate both polar signals and open-and-close signals, receiving devices in said circuit, and wave shape changing devices in said circuit for reducing differences in bias between said polar signals and said open-and-close signals in the operation of said receiving devices.
3. A telegraph system including a circuit adapted to accommodate both polar signals and open-and-close signals, said circuit including contacts for sending open-and-close signals and contacts for sending polar signals, and a regulating resistance, and correcting devices in said circuit to make the wave shape of both of said types of signals approximately alike, said correcting devices comprising a condenser shunted around part or all of said regulating resistance and a spark killer bridged across said contacts for sending open-and-close signals.
4. A telegraph system including a differential loop circuit adapted to accommodate

both polar signals and open-and-close signals, said loop circuit including a sending key and a regulating resistance, and correcting devices in said loop circuit to make the
5 wave shape of both of said types of signals approximately alike, said correcting devices comprising a condenser shunted around said regulating resistance and a spark killer

bridged across the contacts of said sending key. 10

In testimony whereof, we have signed our names to this specification this 9th day of August 1927.

JOSEPH HERMAN.
FRED J. SINGER.