June 14, 1932. M. L. ALMQUIST 1,862,587

SIGNALING ARRANGEMENT FOR TELEPHONE SYSTEMS

Filed June 19, 1931 3 Sheets-Sheet 1

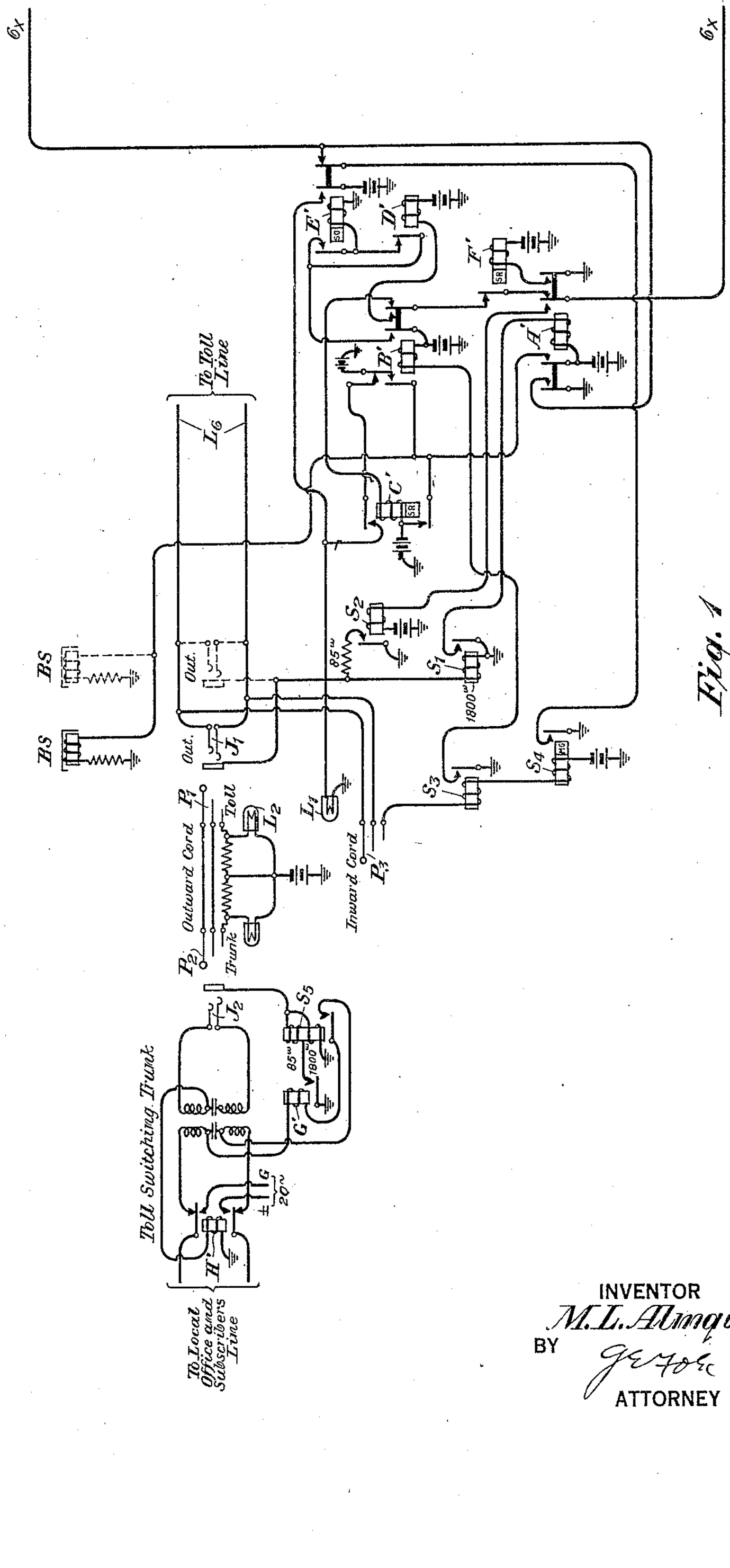

Fig. 1

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SIGNALING ARRANGEMENT FOR TELEPHONE SYSTEMS

Filed June 19, 1931 3 Sheets-Sheet 2

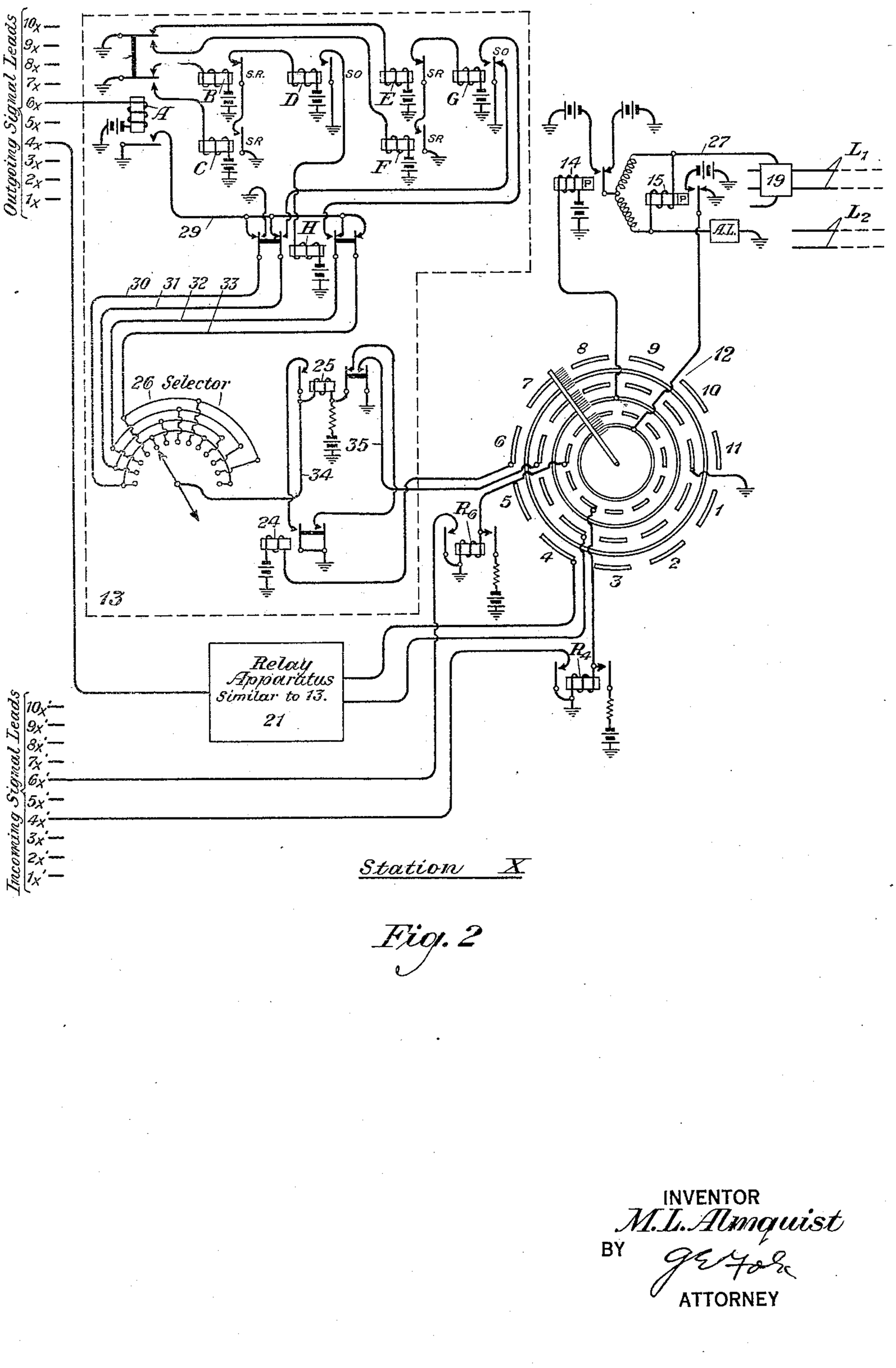

Fig. 2

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SIGNALING ARRANGEMENT FOR TELEPHONE SYSTEMS

Filed June 19, 1931 3 Sheets-Sheet 3

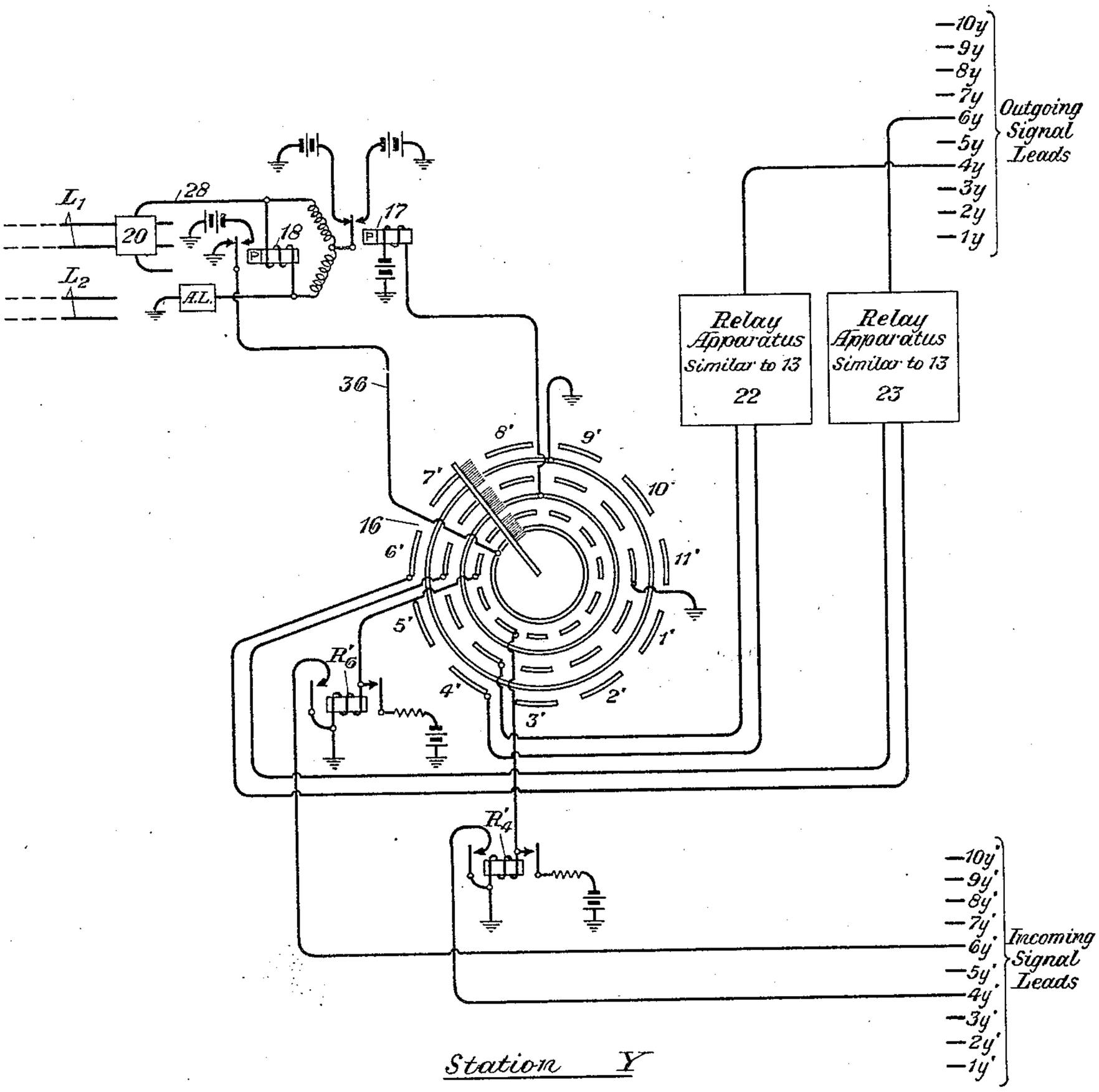

Fig. 3

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Patented June 14, 1932 1,862,587

UNITED STATES PATENT OFFICE

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SIGNALING ARRANGEMENT FOR TELEPHONE SYSTEMS

Application filed June 19, 1931. Serial No. 545,589.

This invention relates to telephone systems, and more particularly to improvements in signaling arrangements on such systems.

One of the objects of the arrangements of the invention is to provide means for obtaining a number of signaling channels for a group of telephone circuits, such as a group of toll lines, from one telegraph channel by multiplex methods and thus increase the number of channels available and reduce the cost per channel.

In toll telephone systems it is the practice to provide direct current channels for telegraph purposes by means of composite equipment. In some cases it may be desired to use these direct current channels for signaling purposes also, but the number of such channels available is limited and may frequently be insufficient for the signaling requirements due to the fact that they are already in use for telegraph facilities or that additional signaling channels are required due to the use of carrier telephone equipment. Limitations are also involved with regard to the distances over which it is practicable to use the direct current channels for signaling because of cost and performance considerations. On the other hand, the speed of transmission required for a signaling channel is low as compared with that for telegraph transmission. In view of the latter characteristic, it is possible in accordance with the arrangements of this invention to obtain a number of signaling channels from a single telegraph channel by the use of multiplex methods and thus greatly increase the number of channels available and reduce the costs. While the arrangements of the invention are shown as applied to a D. C. telegraph channel, they are equally applicable to an A. C. telegraph channel.

Normal telegraph operation requires that the circuit be capable of transmitting about 23 dots per second, which is equivalent to 46 indications per second, an "on" and an "off" indication being required for each dot. The maximum speed required for signaling purposes is 120 interruptions per minute, which is equivalent to 2 dots per second. It therefore appears feasible with the arrangements of the invention to obtain ten such signaling channels from a single telegraph channel having the speed outlined above, while with a higher speed telegraph circuit the number of signaling channels could be correspondingly increased.

Other objects and features of the invention will appear more fully from the detailed description thereof hereinafter given.

The invention may be more fully understood from the following description, together with the accompanying drawings in the Figures 1, 2 and 3 of which the invention is illustrated. Figs. 1, 2 and 3 when placed side by side with Fig. 2 in the middle and Fig. 1 to the left thereof constitute a circuit diagram embodying a preferred form of the invention.

In the Figs. 1, 2 and 3 of the drawings, when arranged side by side, are shown a group of telephone lines, such as a group of toll lines L_1, L_2, interconnecting two stations X and Y. While only lines L_1 and L_2 are shown, it may be assumed for purposes of illustration that there are ten such lines in the group. Associated with one of the lines, such as L_1, by means of the composite sets 19 and 20 is a direct current telegraph circuit 27, 28. In accordance with the arrangements of the invention this one telegraph channel will handle all the signals for the group of lines, thus releasing for other purposes the other direct current channels associated with such lines. A telegraph circuit separate from any of the lines of the group might also be used. By multiplex methods there may, in other words, be obtained from one high speed channel a number of low speed channels for operating the signaling means associated with each of the lines of the group.

The telegraph circuit 27 terminates at station X in the usual telegraph apparatus comprising the receiving relay 15 and the sending relay 14. These relays have circuit arrangements associated with a distributor 12, the segments of which are numbered 1–11. Segments 1–10 would have connections to a group of outgoing signal leads $1x$–$10x$. These connections from the segments to the outgoing signal leads would each be estab-

lished through a relay arrangement such as 13. For example, outgoing signal lead $6x$ is shown connected through relay arrangement 13 to segment 6 of the distributor. Outgoing signal lead $4x$ is shown connected through relay arrangement 21 to segment 4 of the distributor. The relay arrangement 13 connected to lead $6x$ is shown in detail. Relay arrangement 21 connected to lead $4x$ is shown schematically but is of a construction similar in detail to 13. Similar relay arrangements would be provided in each of the outgoing signal leads $1x$–$10x$. The segments of the distributor would also have connections to a group of incoming signal leads $1x'$–$10x'$. These connections would be established through relay means. For example, segment 6 is connected to relay R_6 which in turn controls leads $6x'$. Segment 4 is connected to relay R_4 which in turn controls leads $4x'$. Each of the other leads $1x'$ to $10x'$ would be controlled through individual relays similar to R_6 and R_4 and connected to individual segments of the distributor. The outgoing signal lead $1x$ and the incoming signal lead $1x'$ would be connected as shown in Fig. 1 to signal apparatus individual to one of the toll lines of the group. The outgoing signal lead $2x$ and the incoming signal lead $2x'$ would be connected in a similar manner to signal apparatus individual to another one of the group of toll lines. The other pairs of outgoing and incoming signal leads would each be connected in a similar manner to signaling apparatus of other lines.

At station Y the telegraph circuit 28 terminates in the telegraph apparatus comprising the receiving relay 18 and the sending relay 17. These relays have circuits associating them with the distributor 16, the segments of which are numbered 1′–11′. The apparatus associated with distributor 16 is similar to that associated with distributor 12 at station X. A group of outgoing signal leads $1y$–$10y$ are provided connected through relay arrangements similar to 13 at station X to the distributor segments. For purposes of illustration outgoing signal leads $4y$ and $6y$ are shown connected through relay arrangements 22 and 23, respectively, to segments 4′ and 6′. These outgoing leads $4y$ and $6y$ would each be connected to separate signaling arrangements each associated with the same lines as the signaling arrangements at X to which the lines $4x$ and $6x$ were connected. The other outgoing leads $1y$–$10y$ would be connected to similar signaling arrangements of their respective lines. A group of incoming signal leads $1y'$–$10y'$ are also provided. These come from separate signaling arrangements associated at Y with each of the toll lines and are associated with the distributor segments through relays. For purposes of illustration incoming signal leads $4y'$ and $6y'$ are shown controlled by relays R'_4 and R'_6 connected to segments 4′ and 6′.

Before giving a detailed description of the operation of the arrangements of the invention, the various functions that the signaling arrangements of the invention perform will be briefly described. These functions are as follows: When the operator at station X makes a connection with one of the telephone lines, a signal will be transmitted to station Y and will light a signal lamp at the switchboard thereat at which the telephone line terminates. The operator at Y will then answer and get instructions for the completion of the call from the operator at station X. When the operator at Y answers, the signal lamp at Y will go out. When the call is completed, the operator at X disconnects. The act of disconnection by the operator at X again transmits a signal over the system and relights the signal lamp at station Y. The operator at Y then disconnects and the lamp goes out. Signals of this type may be termed plain "on" and "off" signals. Signals of this type are also transmitted from Y to X to light a supervisory lamp at X in order to indicate the progress of the call to the operator at X. In addition it may also be necessary to transmit signals of an intermittent type as hereinafter described.

The operation of the arrangements of the invention for plain "on" or "off" signals will first be described. For an "on" signal ground will be applied by the switchboard apparatus at station X to one of the outgoing signal leads, for example, lead $6x$, in a manner to be hereinafter described. This will operate relay A and put ground over conductor 29 and the contacts of relay H to conductors 30, 31, 32 and 33, or in other words to all the terminals of selector 26. This ground will be extended over the selector switch, conductor 34, winding of relay 25, to battery and ground, thus operating relay 25. The operation of relay 25 will connect ground over its right-hand outer contact to conductor 35 and to the middle segment 6 of the distributor 12. When the brush of the distributor passes over middle segment 6 ground will be applied to the middle ring of distributor 12 and thence through the winding of the telegraph sending relay 14, to battery and ground. This will operate relay 14, which will send a marking signal over the telegraph circuit 27, 28 and operate the receiving relay 18 at station Y. The operation of this relay will connect battery to conductor 36 and the inner ring of distributor 16. The rotating brush of distributor 16 being over inner segment 6′ at this time, due to the distributors being in synchronism, this battery will be applied to the winding of relay R'_6 to ground. This will operate relay R'_6, which will lock up and apply ground to the in-

coming signal lead $6y'$ at station Y. This will operate signal means at station Y in a manner to be hereinafter described. Due to the fact that relay R'_6 locks up, this ground will be held on incoming signal lead $6y'$ until a signal is sent from station X to release it.

The signal for releasing the ground from incoming signal lead $6y'$ at station Y is initiated by removing ground at station X from the outgoing signal lead $6x$. This will be described hereinafter. The removal of ground from lead $6x$ will release relay A. This will remove ground from the terminals of selector 26 and release relay 25. This will remove ground from middle segment 6 of distributor 12, so that when the brush is again on middle segment 6 ground will no longer be connected to the circuit of sending relay 14 and a spacing signal will be sent over the telegraph circuit to receiving relay 18 and will hold this relay released. Accordingly, the brush of distributor 16 being again over inner segment 6′, the locking circuit of relay R'_6 will be short circuited to ground over the left-hand contact of relay 18 and relay R'_6 will release. This will remove ground from incoming signal lead $6y'$ at station Y.

In a like manner the application of ground to any of the outgoing signal leads $1x$–$10x$ will cause ground to be applied and held applied to incoming signal leads $1y'$–$10y'$. Ground may be disconnected from any of leads $1y'$–$10y'$ by disconnecting ground from the corresponding one of leads $1x$–$10x$ at station X in a manner similar to that described.

In a like manner ground applied and disconnected from the outgoing signal leads $1y$–$10y$ at station Y may cause ground to be applied to and disconnected from the corresponding incoming signal leads $1x'$–$10x'$ at station X.

The rotating brushes of the distributors may be kept in synchronism by any mechanism well known in the art. Segments 11 and 11′ are reserved for this purpose. It is pointed out that each time the switches pass over segments 11 and 11′ marking signals can be sent over the line. Synchronizing stops (not shown) may be provided controlled by these marking signals to start the rotating switches in synchronism on each revolution.

The description of the operation of the arrangements given above relates, as has been pointed out, to plain "on" or "off" signals, or in other words, to signals of a steady state. There are other types of signals which must be considered, however, for the transmission of which the arrangements of the invention are particularly designed. For example, after a plain or steady signal is sent from X to Y and the signal lamp lighted at Y, the operator at Y instead of establishing a connection with a subscriber's line which causes a plain or steady signal to be transmitted from Y to X and thus light the supervisory lamp at X steadily might find it necessary to make a connection to a busy-back circuit, whereby a busy signal would be transmitted over the system from Y to X and cause the lamp at X to flash. Also, after a connection is established by the operator at Y with a subscriber's circuit, the subscriber might find it necessary to signal the operator at station X. By moving his switchhook up and down interrupted signals would be transmitted over the circuit and cause the lamp at X to flash. Signals of this type would result in a series of comparatively rapidly changing indications to be transmitted over the system instead of the steady "on" or "off" indication previously described. While the arrangements of the invention would function satisfactorily for the plain "on" and "off" signals without the inclusion therein of the devices such as 13, the intermittent signals might not be properly transmitted for reasons explained in the following paragraph. The relay arrangements such as 13 have therefore been designed and incorporated in the system of the invention to take care of such types of signals. These may be at the rate of either 60 or 120 interruptions per minute when supplied mechanically or at an irregular rate when caused by the subscriber's switchhooking. In practice the 60 interruptions per minute are generally divided evenly, i. e., 0.5 second on and 0.5 second off, while the 120 interruptions per minute are generally divided 0.3 second on and 0.2 second off.

Without the apparatus 13 and under the condition where the leads $1x$–$10x$ were connected directly to the segments of distributor 12, as in the prior art, interrupted signals such as the busy signals referred to above would produce incorrect signals at the distant station in case the distributor speed is of the same order of magnitude as the number of indications required to transmit the fundamental frequency of interruption, unless the speeds of the interrupter and the distributor were exactly the same and the interruptions were applied to the distributor in the proper phase relation. For example, if the signal which is interrupted 120 times per minute is considered, 4 indications per second ("on" and "off" alternately) will be applied to the distributor, the rotor of which is assumed to be revolving 4 times a second and thus sending 4 indications per second over the signaling channel. As previously noted, the interruptions produced by the busy signal interrupter are not evenly divided. It can thus be seen that since the distributor 12 is sending an indication over the circuit every .25 of a second, if the busy signal "on" indication is applied just before

an indication is transmitted over the line, only "on" indications will be transmitted and the lamp at the distant office will light steadily instead of flashing. However, if the busy signal "on" indication is applied just after the distributor sends a signal over the circuit the relations will be such that the indication over the circuit will be alternately "on" and "off" and a correct flashing signal will result at the distant end. Obviously, changes in the speed of either the distributor or the busy signal interrupter will result in changing the relations from one of the above described conditions to the other and thus result in an erratic signal. Similarly, an erratic indication may also be produced by the signal interrupted 60 times per minute.

The apparatus 13 is so designed that no matter whether the signals are sent at the rate of 60 interruptions per minute or 120 interruptions per minute and no matter whether the signals are regular or irregular pulses, they will result in regular pulses at the other station regardless of whether the distributor speed and the interrupter speed remain constant or not and independent of the phase relation between them. The apparatus 13 consists of the relays A to H, the rotating selector 26, and the relay 25. This selector has a bank of terminals which are a multiple of 4. Every fourth terminal should be connected together. A stepping magnet 24 is also provided and connected to the distributor so that the selector switch will take one step for each revolution of the distributor. This step is taken on the release of the magnet and not when it operates. Relay A serves to interpret the switchboard condition to the relay circuit 13. Relays E, F and G form a combination which will permit relay G to operate when relay A pulses at 120 interruptions per minute, but not when it pulses at 60 interruptions per minute or when it operates steadily. Relays B, C and D, form a second combination which will permit relay D to operate when the relay A pulses at either 60 or 120 interruptions per minute but not when it is operated steadily. Relay H serves as a translating relay to place the proper condition on the selector bank contacts depending upon the condition of relays A, D and G. Thus, if relay A is operated steadily, ground is placed on all of the selector bank terminals; if relay A is released, the ground is removed; if relay D is operated and relay G released, ground is placed on alternate groups of two selector terminals; and if relays D and G are both operated, ground is placed on alternate contacts of the selector. The condition of the selector terminals is then transmitted over the line at regular intervals as the selector steps under control of the distributor. The relay 25 is provided to prevent the selector from changing the condition applied to the line while a signal (for the particular channel under consideration) is in the process of transmission.

If the intermittent signal applied to lead $6x$ is at the rate of 120 impulses per minute, the relay A will operate and release 4 times per second. Relays B, C, E and F are slow-release relays. When relay A is released, relays B and E are normally held operated; when relay A operates, relays C and F will operate. Due to the slow-release feature of these relays all of them will remain operated while relay A is operating intermittently at the rate of 120 interruptions per minute. Accordingly, relay D will be held operated and relay G will be held operated. The operation of relay D will operate relay H. This will place ground on conductor 30, remove ground from conductor 31, place ground on conductor 32, and remove ground from conductor 33. Thus it will be seen that ground will be placed on alternate terminals of the selector 26. Accordingly, no matter at what speed the distributor brush and selector switch 26 operate, the pulses transmitted over the system to the distant station will be of regular duration.

If the intermittent signals at the switchboard are at the rate of 60 interruptions per minute, relays B and C will be operated and remain operated. Relays E and F will operate and release. This is because the slow-release characteristic of relays B and C is greater than the slow-release characteristic of relays E and F. Accordingly, relays B and C will maintain the relay D in an operated condition. However, the intermittent functioning of relays E and F will cause the relay G to remain released. Under these conditions, when relay H is operated by relay D, ground will be applied to leads 30 and 31 while leads 32 and 33 will have no ground connected thereto. This will result in ground being applied to the first two terminals of the selector switch and not to the next two terminals, etc. In other words, ground will be applied to alternate sets of two consecutive terminals of the selector. Accordingly, at no matter what rate the selector switch and distributor brush operate, regular impulses will be transmitted over the system, and if the rate of speed of the distributor brush and selector switch are substantially the same as before, the signals will be half as fast as the 120 interruption per minute signals or at the rate of 60 interruptions per minute.

A detailed description has heretofore been given of the operation of the arrangements of the invention in Figs. 2 and 3 for the various types of signals applied to the incoming and outgoing signal leads at the stations X and Y, such as plain "on" or "off" signals and intermittent signals. A description will now be given of the operation of the switchboard apparatus at stations X and Y to illustrate

how these various types of signals are applied to and from the outgoing and incoming signal leads.

In Fig. 1 is shown apparatus located at the switchboard X and individual to each one of the toll lines L_1, L_2, etc. For purposes of illustration the switchboard apparatus associated with toll line L_6 and its associated signal leads $6x$ and $6x'$ is shown. Similar switchboard apparatus would be provided for each of the other toll lines at station X and also for each of the toll lines at station Y. A toll switching trunk and operator's cord circuit is also shown in Fig. 1.

When an operator at station X receives word that a connection is desired with one of the toll lines, such as L_6, she will insert the plug P_1 of her cord in the jack J_1 of the toll line L_6. This will operate relay S_1, which in turn will operate relay A'. The operation of relay A' sets the busy signals BS of toll line L_6 and places ground on the outgoing signal lead $6x$. The application of this continued ground to outgoing signal lead $6x$ will cause a signal to be transmitted by the arrangements of the invention to the station Y, operating relay R'_6, and placing ground on incoming signal lead $6y'$ in a manner heretofore described in detail.

As has been pointed out there would be provided at station Y switchboard apparatus connected to line L_6 similar to that shown in Fig. 1. Incoming lead $6y'$ would be connected to this apparatus in the same manner as lead $6x'$ of Fig. 1 and outgoing lead $6y$ would be connected to this apparatus in the same manner as lead $6x$ of Fig. 1. In describing the operation of the apparatus at station Y reference will be had to the apparatus at station X shown in Fig. 1.

Accordingly the application of ground to lead $6y'$, will cause the operation of a relay C' at station Y. This causes the busy signals BS connected to line L_6 at Y to be operated and also lights the incoming signal lamp L_1 at Y. The operator at Y upon the lighting of lamp L_1 will receive the necessary information regarding the call from the operator at X (by means of a telephone set not shown) and will then plug the inward cord P_3 into the jack J_2 of a toll switching trunk at Y and pass the number called to the operator in the local office. Plugging P_3 into J_2 will cause the operation of relays S_3 and S_5. The operation of relay S_5 serves to connect supervisory relay G' across the switching trunk for purposes to be described hereinafter. The operation of relay S_3 operates relay B' which extinguishes the lamp L_1 and provides a holding circuit for the busy signals BS to take the place of the one supplied by relay C' which now releases. In addition relay B' applies battery to contacts on relay D' and E' and transfers the "in" lead $6y'$ to relay D', which operates since there is ground on "in" lead $6y'$. Relay E' is made slow operating to keep it from operating in case it receives battery momentarily before relay D' operates.

When the operator in the local office associated with Y establishes the connection to the subscriber's line the relay G' in the toll switching trunk operates and changes the resistance of the sleeve from 1800 ohms to 80 ohms. When the sleeve becomes 80 ohms the marginal relay S_4 in the toll line circuit at Y operates and connects ground to the outgoing lead $6y$. This will cause a signal to be transmitted from Y to X over the arrangements of the invention shown in Figs. 2 and 3 as heretofore described and will cause relay R_6 at X to operate and apply a steady ground to incoming signal lead $6x'$ at X.

As has been heretofore pointed out relay A' at station X is already operated. Hence when ground is applied to the incoming signal lead $6x'$, relay S_2 will be operated. The operation of relay S_2 connects an 85 ohm resistance in shunt with relay S_1 and thus reduces the sleeve resistance to 80 ohms, which causes the lamp L_2 associated with the toll end of the outward cord circuit to light. Thus when a connection is established with the subscriber at Y, the lamp L_2 at X will light.

When the subscriber at Y answers, relays G' and S_4 at Y release. This will remove ground from lead $6y$ at Y and remove ground from $6x'$ at X and cause lamp L_2 to go out. Obviously if the subscriber at Y operates his switch-hook the lamp L_2 will flash. Also if an intermittent busy signal is applied at Y the lamp L_2 will flash.

When the subscriber at Y hangs up, relays G' and S_4 reoperate and the lamp L_2 at X will light again. This will be the signal for the operator at X to disconnect plug P_1 from the jack J_1 of the toll line L_6. When the operator at X disconnects, ground will be removed from lead $6x$ and a signal will be sent by the arrangements of the invention, as heretofore described, to remove ground from lead $6y'$ at Y. This will cause relay D' at Y to release and causes the operation of relay E', which locks up under control of relay B'. The operation of relay E' supplies battery to light lamp L_1 at Y as a disconnect signal and removes ground from outgoing signal lead $6y$ in order to prevent a false signal being given at the distant end X during the time required for the operator at Y to pull down the connection. The slow release relay F' at X prevents a momentary signal being given at X during the time required for the relays at Y to function and remove the ground from lead $6y$. When the operator at Y removes the cord P_3 from the switching trunk, relays S_3, S_4, B' and E' in the toll line circuit release and the circuit

restores to normal. Relays G′ and S_5 in the switching trunk release and a disconnect signal is given to the operator in the local office.

The operation of the switchboard arrangements associated with other of the toll lines of the group will be substantially the same as that heretofore described.

While the invention has been disclosed as embodied in certain specific arrangements which are deemed desirable, it is understood that it 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 a telephone system, the combination of a plurality of telephone circuits extending between two offices, a signaling path common to said telephone circuits, switching apparatus at each end of said signaling path, said switching apparatus having switch arms connected to the ends of said signaling path and having contact terminals with which said arms successively connect, a plurality of local outgoing signaling circuits and local incoming signaling circuits for each end of said telephone circuits and individual thereto, connecting circuits for associating the local signaling circuits of each telephone circuit with corresponding contact terminals of said switching apparatus at the two ends of said common signaling path, and translating devices in the connecting circuits of each of said local outgoing signal leads, said translating devices each comprising a combination of relays for interpreting the type of signals applied to the local signaling circuit and a mechanism upon which said interpreted signals may be set up by said relays.

2. In a telephone system, the combination of a plurality of telephone circuits extending between two offices, a signaling path common to said telephone circuits, switching apparatus at each end of said signaling path, said switching apparatus having switch arms connected to the ends of said signaling path and having contact terminals with which said arms successively connect, a plurality of local outgoing signaling circuits and local incoming signaling circuits for each end of said telephone circuits and individual thereto, connecting circuits for associating the local signaling circuits of each telephone circuit with corresponding contact terminals of said switching apparatus at the two ends of said common signaling path, and translating devices in the connecting circuits of each of said local outgoing signal leads, said translating devices each comprising a combination of relays for interpreting the type of signals applied to the local signaling circuit, mechanism upon which said interpreted signals may be set up by said relays, and means for transmitting said interpreted signals set up on said mechanism to the contact terminals of said switching device.

3. In a telephone system, the combination of a plurality of telephone circuits extending between two offices, a signaling path common to said telephone circuits, switching apparatus at each end of said signaling path, said switching apparatus having switch arms connected to the ends of said signaling path and having contact terminals with which said arms successively connect, a plurality of local outgoing signaling circuits and local incoming signaling circuits for each end of said telephone circuits and individual thereto, connecting circuits for associating the local signaling circuits of each telephone circuit with corresponding contact terminals of said switching apparatus at the two ends of said common signaling path, and translating devices in the connecting circuits of each of said local outgoing signal leads, said translating devices each comprising a combination of relays for interpreting the type of signals applied to the local signaling circuit, a selector switch having a bank of terminals upon which said interpreted signals may be set up by said relays, means for operating said selector switch in timed relationship to the switch arm of said switching mechanism, and means controlled by said selector switch for transmitting the interpreted signals set up on said bank of terminals to the contact terminals of said switching device.

4. In a telephone system, the combination of a plurality of telephone circuits extending between two offices, a signaling path common to said telephone circuits, switching apparatus at each end of said signaling path, said switching apparatus having switch arms connected to the ends of said signaling path and having contact terminals with which said arms successively connect, a plurality of local outgoing signaling circuits and local incoming signaling circuits for each end of said telephone circuits and individual thereto, means for applying intermittent signals of different speeds to said local outgoing signaling circuits, connecting circuits for associating the local signaling circuits of each telephone circuit with corresponding contact terminals of said switching apparatus at the two ends of said common signaling path, and translating devices in the connecting circuits of each of said local outgoing signal leads, said translating devices each comprising a relay responsive to the applied intermittent signal, a set of relays controlled by said first relay and operative when the speed of the applied intermittent signal is high or low, a second set of relays controlled by said first relay and non-operative when the speed of the applied intermittent signal is low but operative when the speed of the applied intermittent signal is high, a selector switch having a bank of terminals connected in multi-

ples of four and so connected to said relays that when all of said relays are operated ground will be applied to alternate ones of said terminals and when only said first set of relays are operated ground will be applied to alternate sets of each two of said terminals, and means for applying the signals set up on said bank of terminals to the contact terminals of said switching apparatus.

5. In a telephone system, the combination of a plurality of telephone circuits extending between two offices, a signaling path common to said telephone circuits, switching apparatus at each end of said signaling path, said switching apparatus having switch arms connected to the ends of said signaling path and having contact terminals with which said arms successively connect, a plurality of local outgoing signaling circuits and local incoming signaling circuits for each end of said telephone circuits and individual thereto, means for applying intermittent signals of different speeds to said local outgoing signaling circuits, connecting circuits for associating the local signaling circuits of each telephone circuit with corresponding contact terminals of said switching apparatus at the two ends of said common signaling path, and translating devices in the connecting circuits of each of said local outgoing signal leads, said translating devices each comprising a relay responsive to the applied intermittent signal, a set of relays controlled by said first relay and operative when the speed of the applied intermittent signal is high or low, a second set of relays controlled by said first relay and non-operative when the speed of the applied intermittent signal is low but operative when the speed of the applied intermittent signal is high, a selector switch having a bank of terminals connected in multiples of four and so connected to said relays that when all of said relays are operated ground will be applied to alternate ones of said terminals and when only said first set of relays are operated ground will be applied to alternate sets of each two of said terminals, a stepping magnet controlled by said switching apparatus for moving said selector switch in timed relationship to the switch arm of said switching apparatus, a relay having a locking circuit operated and controlled by said selector switch, and means controlled by said last mentioned relay for applying ground to one of the contact terminals of said switching apparatus.

6. In a telephone system, the combination of a plurality of telephone circuits extending between two offices, a signaling path common to said telephone circuits, switching apparatus at each end of said signaling path, said switching apparatus having switch arms connected to the ends of said signaling path and having contact terminals with which said arms successively connect, a plurality of local outgoing signaling circuits and local incoming signaling circuits for each end of said telephone circuits and individual thereto, means for applying steady signals and means for applying intermittent signals of different speeds to said local outgoing signaling circuits, connecting circuits for associating the local signaling circuits of each telephone circuit with corresponding contact terminals of said switching apparatus at the two ends of said common signaling path, and translating devices in the connecting circuits of each of said local outgoing signal leads, said translating devices each comprising a relay responsive to the applied signal, a set of relays controlled by said first relay and non-operative when the applied signal is steady but operative when the speed of the applied intermittent signal is high or low, a second set of relays controlled by said first relay and non-operative when the applied signal is steady or of low intermittent speed but operative when the speed of the applied intermittent signal is high, a selector switch having a bank of terminals connected in multiples of four and so associated with said relays that when the applied signal is steady ground will be applied to all of the terminals and when the applied signal is intermittent and of high speed ground will be applied to alternate ones of said terminals and when the applied signal is intermittent and of low speed ground will be applied to alternate sets of each two of said terminals, and means for applying the signals set up on said bank of terminals to the contact terminals of said switching apparatus.

In testimony whereof, I have signed my name to this specification this 17th day of June, 1931.

MILTON L. ALMQUIST.