Aug. 28, 1945. R. C. AVERY 2,383,759

REVERTIVE PULSE REPEATER

Filed Nov. 28, 1944 4 Sheets-Sheet 1

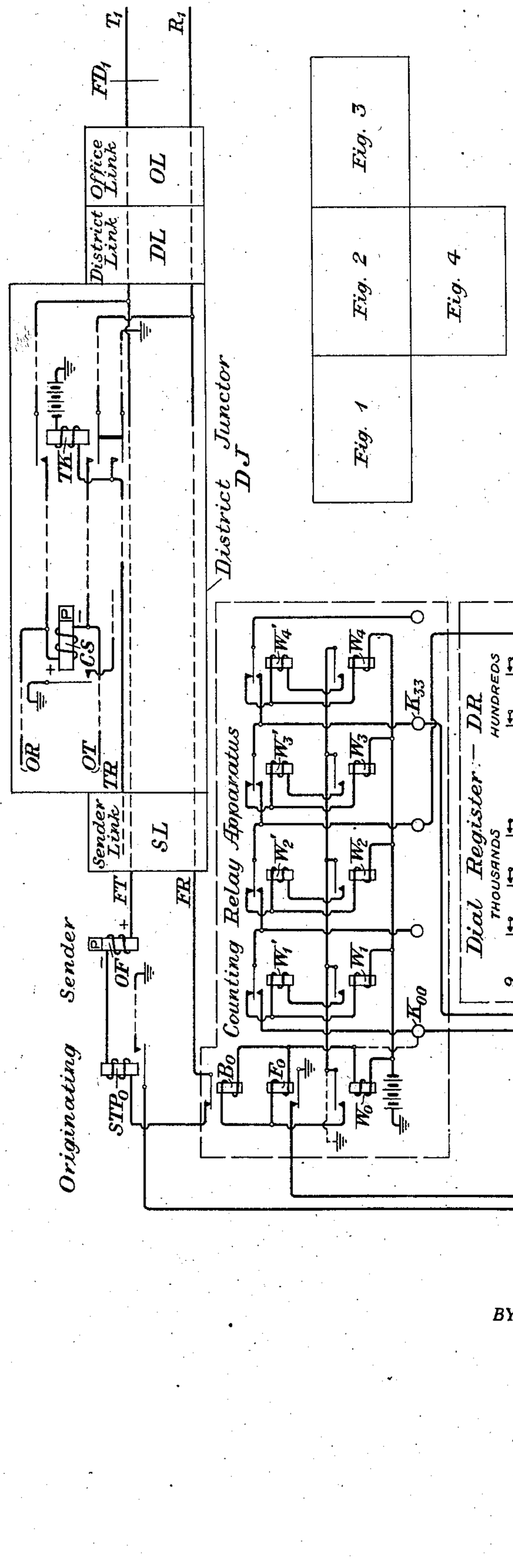

Fig. 5

Fig. 1

INVENTOR
R. C. Avery
BY Jefferson Ehrlich
ATTORNEY

Aug. 28, 1945. R. C. AVERY 2,383,759

REVERTIVE PULSE REPEATER

Filed Nov. 28, 1944 4 Sheets-Sheet 2

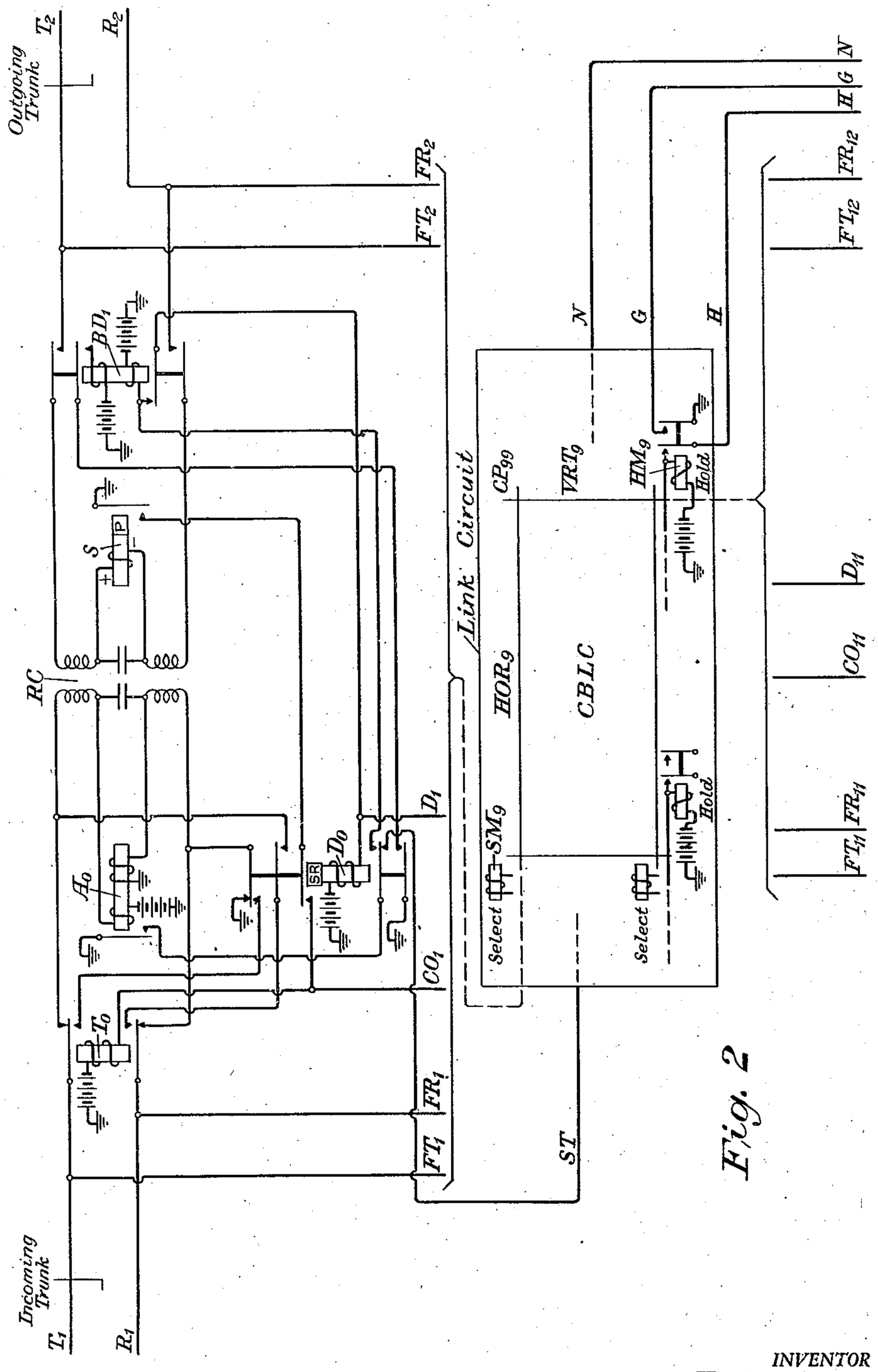

Fig. 2

INVENTOR
R. C. Avery
BY Jefferson Ehrlich
ATTORNEY

Aug. 28, 1945. R. C. AVERY 2,383,759

REVERTIVE PULSE REPEATER

Filed No 28, 1944 4 Sheets-Sheet 3

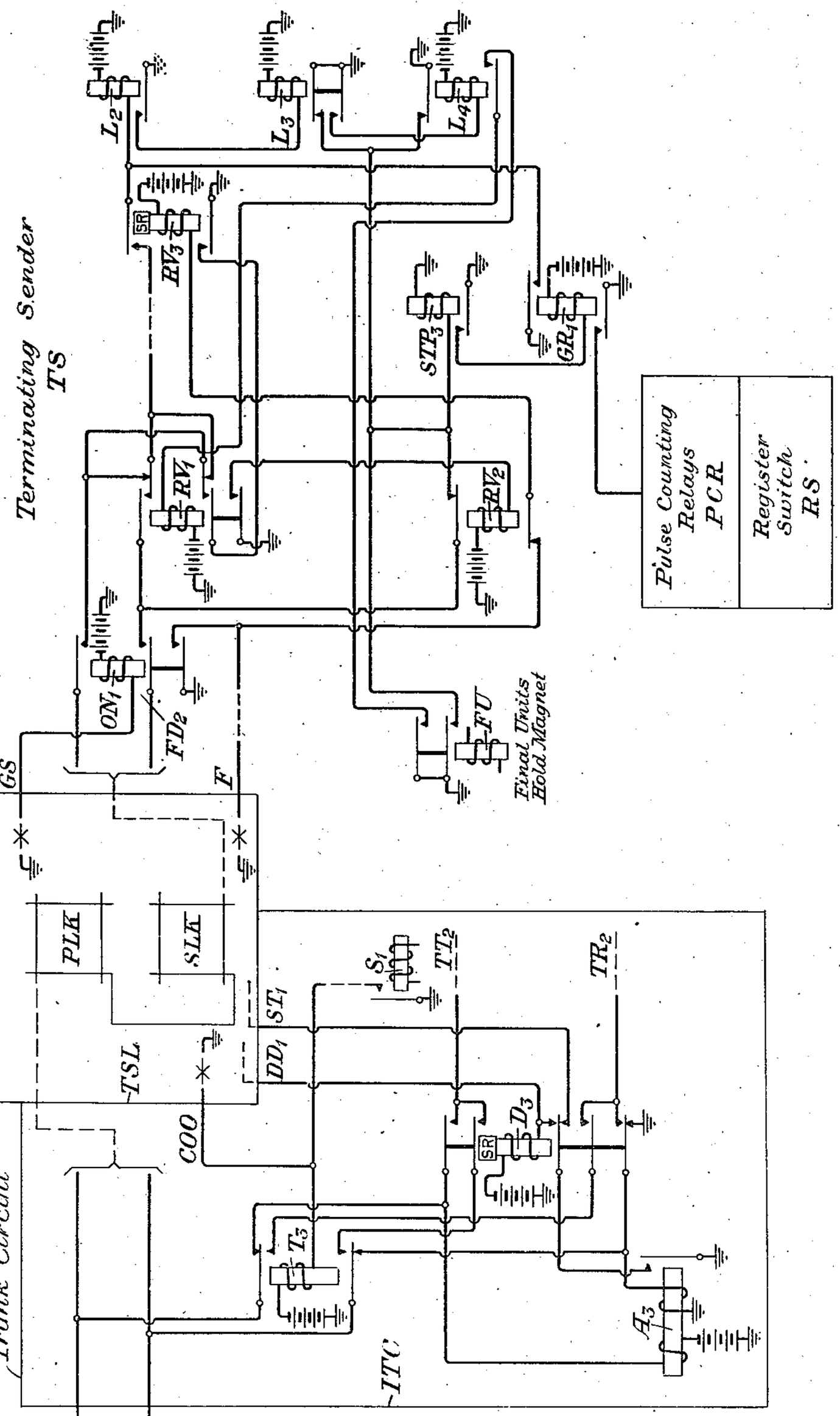

Fig. 3

INVENTOR
R. C. Avery
BY Jefferson Ehrlich
ATTORNEY

Aug. 28, 1945. R. C. AVERY 2,383,759

REVERTIVE PULSE REPEATER

Filed Nov. 28, 1944 4 Sheets-Sheet 4

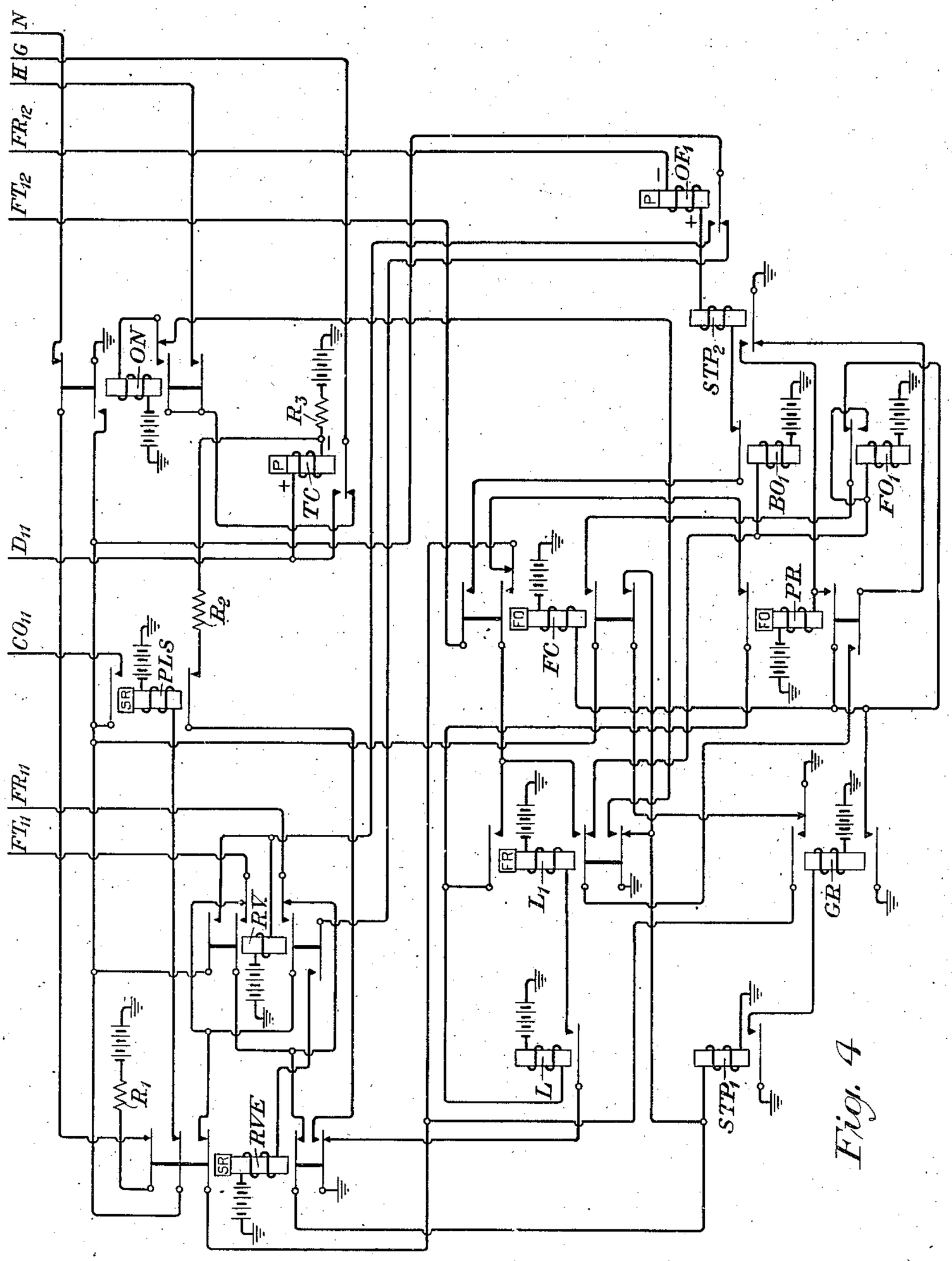

Fig. 4

INVENTOR
R. C. Avery
BY Jefferson Ehrlich
ATTORNEY

Patented Aug. 28, 1945 2,383,759

UNITED STATES PATENT OFFICE

2,383,759

REVERTIVE PULSE REPEATER

Robert Campbell Avery, Jackson Heights, N. Y., assignor to American Telephone and Telegraph Company, a corporation of New York

Application November 28, 1944, Serial No. 565,440

13 Claims. (Cl. 179—18)

This invention relates to automatic telephone systems and, more particularly, to apparatus in such systems for controlling the selection and operation of selectors. Still more particularly, this invention relates to apparatus, commonly known as revertive pulsing apparatus, by which a sender in the office of a calling subscriber may control the movement of selectors or the setting of registers in the office of the called subscriber. The revertive pulsing apparatus of this invention is also applicable to other apparatus, such as tandem senders and distant office selectors.

In the panel type of telephone system, a call from a subscriber in one office, known as the originating office, to a subscriber in another office, known as the terminating office, is completed through a series of selectors which are set into position one by one under the control of a sender located in the originating office. In order to connect the calling line to an outgoing trunk at the originating office, a district selector is operated and, in many cases, an office selector is also operated. The action of the selectors is to seize an outgoing trunk which is connected to the terminating office. At the terminating office an incoming selector which is associated with the particular trunk seized is then operated to pick one of a group of final selectors having access to the called subscriber's line and the final selector then connects the calling subscriber's line to the called subscriber's line.

The district and office selectors above referred to are controlled by the sender of the originating office in accordance with the office code registered, which may then be translated in terms of outgoing trunk locations by means of a decoder. The incoming and final selectors of the terminating office are also controlled by the setting of the numerical registers of the sender of the originating office. This invention relates primarily to revertive pulsing apparatus by which pulses produced and generated at the terminating office are transmitted to the sender of the originating office which then controls the movement of the various selectors or the setting of the various registers in the terminating office.

In a called office of the panel type the physical arrangement of the incoming and final frames and selectors is such that the thousands and hundreds digits of the called number must be translated into terms of incoming brush selection, incoming group selection and final brush selection, whereas the tens and units digits of the called number may be caused to control the selectors directly. Inasmuch as the average panel type of central office has a capacity of ten thousand lines and each final selector frame accommodates five hundred lines, twenty sections of final frame multiple are therefore provided in the central office. Each incoming frame must have access to each of the twenty sections of the final multiple. Consequently, the incoming multiple must be divided into twenty groups to correspond to the same number of sections of final multiple. Each of the incoming frames is arranged with five banks of terminals and each bank of the incoming frame is divided into four groups, thus providing access to all twenty sections of the final multiple. The incoming brush selection used corresponds to the incoming frame bank required, while the incoming group selection used is subsequently arranged to correspond with the final selector grouping required. The final brush selection used, which selects the bank in which the called number appears, is also determined in a similar manner. Actual selection of the individual line desired out of the one hundred lines appearing in the bank is made under direct control of the tens and units digits of the called number, the one hundred lines appearing in numerical order in the bank.

In the crossbar type of system, a similar translation of the called number is performed in order that the offices of both the panel and crossbar types may be properly co-ordinated with each other. In a terminating office of the crossbar type the called number is registered on a crossbar switch of a terminating sender in terms of panel selections and these panel selections are then transferred to a terminating marker in terms of the actual digits dialed so that the called line may be properly selected.

On a call from either a panel or a crossbar originating office to either a panel or a crossbar terminating office, the panel selectors or the crossbar register switch, as the case may be in the terminating office, are controlled by means of a circuit and equipment arrangement commonly called the fundamental circuit. This fundamental circuit includes a line relay with battery at the terminating office connected to the tip conductor of the trunk extending from the originating office, the tip conductor at the originating office being connected through the winding of a stepping relay to the ring conductor of the trunk which leads back to the terminating office. At the terminating office, the ring conductor may be connected to ground, either directly as is the usual case in a panel type of office,

or through the winding of another stepping relay as is the case in a crossbar office. The closure of the fundamental circuit at the time when a selection is to be made causes the stepping relay at the originating office and the line relay at the terminating office to be operated in a series circuit. In a panel type of office, the line relay operated causes a panel selector to move upward so as to generate ground pulses one by one which are to be transmitted to the tip conductor of the trunk and to the winding of the line relay. The number of pulses generated by the panel selector corresponds to the distance traveled by the selector. Similar pulses are generated and counted in a crossbar terminating office by the action of a group of relays. In either case, these ground pulses intermittently short-circuit and release the stepping relay in the originating office, which in turn operates a series of counting relays employed for counting the number of such pulses received from the terminating office. When the number of pulses so recorded in the originating office equals the number required for the selection at the terminating office as determined, for example, by the dial register of the originating office, a relay which forms part of the counting relay circuit at the originating office then opens the fundamental circuit, thereby releasing the line relay at the terminating office at the end of the pulse transmitted. This action in turn stops the panel selector at the terminating office at the desired point of its travel, or stops the count which controls the crossbar register of the crossbar terminating office. This action selects the required terminal at the terminating office or causes the required count to be registered at that office. Similar action will take place at intermediate trunk switching points where there may be tandem senders or distant office selectors operating in like manner under the control of ground pulses traversing the fundamental circuit.

From the foregoing it will be evident that the ground pulses used for a particular selection are generated and transmitted from the terminating office backwardly to the originating office, but that the signal for stopping the generation of the ground pulses and completing the selection is transmitted forwardly from the originating office to the terminating office. It will also be evident that any delay in the effectiveness of the latter signal to fix the completion of the selection might cause false additional selector travel or registration, thus resulting in connecting the calling party to a "wrong number." Due to the importance of this time or delay factor, it has not been practicable heretofore directly to repeat the ground pulses or the completing signal from one office to another through an intermediate point. The distance over which these selections may be made effectively has been circumscribed by experience to be somewhere around thirty miles.

It is an object of this invention to provide means for repeating ground pulses and completing signals of the type above referred to without introducing false operation of the selecting apparatus. It is also an object of this invention to provide for the transmission of ground pulses in one direction without unduly delaying the transmission of the completing signals in the opposite direction. The apparatus used for accomplishing these objects may be located at a trunk repeater station or in a tandem sender or in any other intermediate point. If the apparatus is located in a trunk repeater station, it will increase the range over which revertive pulses may be transmitted to around sixty miles by the mere addition of but one such repeater. Moreover, the range of the revertive pulsing may be increased to proportionately greater distances by the addition of two or more repeaters spaced at intervals of around thirty miles. If the revertive pulsing equipment of this invention is incorporated at tandem senders, it will reduce the amount of equipment now required for completely registering and retransmitting the ground pulses. The repeating apparatus may be used in connection with the transmission of office codes as well as called numbers, the former being at present represented by revertive pulses in both crossbar tandem senders and panel distant office selectors. In fact, the invention may be used with practically any type of panel or crossbar originating and terminating equipment.

This invention will be better understood from the more detailed description hereinafter following when read in connection with the accompanying drawings, in which Figure 1 illustrates circuits of a crossbar originating office; Fig. 2 shows a form of trunk circuit which may be used with the revertive pulse repeater of this invention; Fig. 3 illustrates circuits of a crossbar terminating office; Fig. 4 shows a form of the revertive pulse repeater according to this invention, and Fig. 5 shows the arrangement of Figs. 1 to 4 as described in this specification.

It will be assumed that a calling subscriber (not shown) connected to the originating office of Fig. 1 has dialed the office code and numerical digits corresponding to a desired line, and that the originating office circuits have functioned in the usual manner to select a trunk circuit such as is shown in Fig. 2, which extends to terminating office of Fig. 3. It will be further assumed that the originating and terminating offices of Figs. 1 and 3, respectively, are about sixty miles apart, and that the trunk circuit of Fig. 3, together with the associated repeater equipment of Fig. 4, are located at a distance of about thirty miles from the originating and terminating offices. It will be noted therefore that the trunk and repeater equipment of Figs. 2 and 4, which will hereafter be called the repeater circuit or station, actually divides the path extending from the originating office to the terminating office into two parts. One of these parts extends from the originating office to the repeater circuit and includes conductors T_1, R_1 and the other part extends from the repeater circuit to the terminating office and includes the conductors T_2, R_2. These two parts are connected together at the repeater station so that speech may be transmitted therethrough, the coupling for this purpose including a repeat coil RC. In a similar manner it will be shown that the fundamental circuit referred to above, which normally extends from the originating office to the terminating office, is also divided into two parts. More specifically, there are two separate fundamental circuits involved in this invention. The first fundamental circuit designated FD_1 connects the originating office to the repeater station, and the second fundamental circuit designated FD_2 connects the repeater station to the terminating office. The terminating office of Fig. 3 is illustrated as a crossbar subscriber office, but it will be understood that the description may be equally applicable to panel subscriber offices, or tandem offices, or panel distant office selectors, etc.

When the originating sender of Fig. 1 is ready to make an incoming brush selection, it will close

the fundamental circuit FD_1. The fundamental circuit FD_1 includes the conductors T_1, R_1 which extend through the office link OL, the district link DL, the district junctor DJ and sender link SL to the conductors FT and FR, the winding of relays OF and STP_0 and the armature and contact of relay BO. It will be understood also that the originating sender shown in Fig. 1 may be either of the panel or crossbar type, or it may be a tandem sender, although an originating sender of a crossbar office is illustrated. The type of call to be described is one which is made directly to the terminating office and involves only one repeater station (Figs. 2 and 4). The closure of the fundamental circuit FD_1 causes the relay A_0 of Fig. 2 to be operated in a circuit which may be traced to include, not alone the fundamental circuit FD_1 already described, but also a path which includes the upper armature and back contact of relay T_0, the upper left winding of the repeat coil RC, the left winding of relay A_0, battery and ground, together with another path which includes the lower armature of relay T_0 and its back contact, the upper outermost armature and back contact of relay D_0 and ground. The operation of relay A_0 is accompanied by the operation of relay STP_0 of the fundamental circuit FD_1, but relay OF which is of the polar type and is also included in this circuit, does not operate at this time. The operation of STP_0 closes ground at its contact through the sequence relays for incoming brush selection IBS_1, to the thousands vertical conductor TV_1 of the dial register DR shown in Fig. 1, this ground being then connected through the cross points of the dial register DR previously closed by the manipulation of the subscriber in dialing the called number, and then to the counting relays to battery. If the called number happenend to be 6200, for example, the cross point X_6 on the register conductors TV_1, TV_2 and TV_3 and cross point XX_2 on the hundreds vertical conductors HV_1 and HV_2 will have been operated. Consequently, the ground previously traced from the contact of relays STP_0 will be closed through conductor TV_1 and its cross point X_6, through terminal K_3 and K_{33} to the armature and back contact of relay W_3', and through the winding of relay W_3 to battery and ground. The originating sender is now ready to start brush selection. The incoming brush selection at the terminating office of Fig. 3, after certain operations of the repeater station of Figs. 2 and 4 have taken place, presently will be described. The counting relay W_3 operates in response to the operation of relay STP_0 and in turn will short-circuit the winding of relay W_3', the short-circuiting path including the circuit previously described from ground at the contact of STP_0 and conductor TV_1 to the upper terminal of the winding of relay W_3', as well as ground at the armature and make contact of relay W_3 to the lower terminal of the winding of relay W_3'.

In response to the operation of relay A_0 of Fig. 2, ground will be connected from its armature and make contact through the lower inner armature and back contact of relay D_0 to the start lead ST of the crossbar link circuit CBLC. The crossbar link circuit CBLC represents a link circuit such as is commonly used in crossbar systems. The purpose of this link circuit is to connect any one of a plurality of trunk circuits, such as the one shown in Fig. 2, to any one of a smaller number of repeaters of the type shown in Fig. 4. This link circuit CBLC may be any type of switch mechanism as will be understood and hence has not been described in detail. The ground now applied to the start lead ST causes the link circuit CBLC to connect the trunk circuit of Fig. 2 to an available repeater circuit such as is shown in Fig. 4. The availability of the repeater circuit will be made apparent by the presence of battery on the lead N, battery being connected to the lead N through resistor R_1 and the upper outermost armatures and back contacts of relays RVE and ON. The trunk circuit such as Fig. 2 makes its appearance on one of the horizontal elements, such as HOR_9, of the crossbar link circuit CBLC and is controlled by a select magnet SM_9, while a repeater, such as the one of Fig. 4, appears on a vertical element, such as VRT_9, and is controlled by a hold magnet HM_9. The operating circuits for the select magnet SM_9 and the hold magnet HM_9 are not shown as they are of well-known type. When these magnets operate, contact between the horizontal element HOR_9 and vertical element VRT_9 will be established at a corresponding cross point such as CP_{99}. The latter cross point controls the connection of the leads FT_1, FR_1, CO_1, D_1, FT_2 and FR_2, corresponding to the trunk circuit of Fig. 2, to the leads FT_{11}, FR_{11}, CO_{11}, D_{11}, FT_{12} and FR_{12}, respectively, corresponding to the repeater of Fig. 4.

The operation of the link circuit CBLC will cause relay L of Fig. 4 to operate over a circuit which includes battery and the winding of relay L, the upper armature and back contact of relay PR, the make-before-break contact of relay FC, the upper inner armature and back contact of relay RVE, the upper make-before-break contact of relay RV, conductors FT_{11} and FT_1, to the fundamental circuit FD_1, then back over conductors FR_1 and FR_{11}, the lower make-before-break contact of relay RV, the lower inner back contact and armature of relay RVE, the lower outer back contact and armature of relay L_1 to ground. The operation of relay L causes relay L_1 to operate over a circuit which includes battery, the winding of relay L_1, the make contact and armature of relay L, the lower back contact and armature of relay RVE and ground. The operation of relay L_1 causes relay ON to operate over a circuit which includes battery, the winding of relay ON and its make-before-break contact, the lower outer make contact and armature of relay L_1 and ground. Relay ON then is locked in its operated position, the locking path including the lower inner make contact and armature of relay ON, the back contact and armature of relay TC, conductor G and the right make contact and armature of hold magnet HM_9 and ground. The ground which is applied to conductor G is also transferred through the lower outer armature and make contact of relay ON to conductor H, then through the left armature, make contact and winding of the hold magnet HM_9, battery and ground, so as to lock the hold magnet HM_9. At the same time the operation of relay ON opens the circuit to conductor N at the upper outer armature of relay ON, thereby removing battery from conductor N. This indicates the unavailability of the repeater of Fig. 4 to the link circuit CBLC. Moreover, the operation of relay ON causes the operation of relay PLS, this circuit including battery, the winding of relay PLS, the upper intermediate back contact and armature of relay RVE, the upper inner make contact and armature of relay ON and ground. Relay PLS now causes relay T_0 of Fig. 2 to operate, the operating circuit here including the

upper inner armature and make contact of relay ON, the upper armature and make contact of relay PLS, conductors CO_{11} and CO_1, the winding of relay T_0, battery and ground. The operation of relay T_0 disconnects relay A_0 from its operating circuit previously described and hence relay A_0 releases. The release of relay A_0 now removes ground from the start lead ST, thereby making the link circuit CBLC available for connecting another trunk similar to that shown in Fig. 2, to another repeater similar to that shown in Fig. 4. However, the cross point CP_{99} of the link circuit CBLC will remain closed under the control of the hold magnet HM_9.

One terminal of the winding of relay STP_1 of Fig. 4 is permanently grounded while its other terminal is normally connected to ground at the lower outer armature and back contact of relay L_1. Moreover, the latter terminal of the relay winding is also normally connected to ground through the lower inner armature and back contact of relay RVE, the lower make-before-break contact of relay RV, conductors FR_{11} and FR_1, the lower armature and back contact of relay T_0, and the upper outermost armature and back contact of relay D_0. The operation of relay L_1, as already noted, however, will remove the former of these normal grounds from the winding of relay STP_1. Likewise, the operation of relay T_0, as already noted, will remove the other of the normal grounds from the winding of relay STP_1. Consequently, the winding of relay STP_1 will be connected in series with the fundamental circuit FD_1 through the path provided by the lower inner armature and back contact of relay RVE, the lower make-before-break contact of relay RV, conductors FR_{11} and FR_1, the fundamental circuit FD_1, conductors FT_1 and FT_{11}, the upper make-before-break contact of relay RV, the upper inner back contact and armature of relay RVE, the make-before-break contact of relay FC, the upper back contact of relay PR, the winding of relay L, to battery and ground. Relay STP_1 will now operate.

The operation of relay STP_1 will then operate relay GR. Relay GR will now act to short-circuit the relays STP_0 and STP_1. The short-circuiting path now established extends from ground through the upper make contact and armature of relay GR, the upper inner armature and back contact of relay RVE, the upper make-before-break contact of relay RV, conductors FT_{11} and FT_1 to the fundamental circuit FD_1, which has already been traced and found to be in series with the winding of relay STP_1. Relays STP_0 and STP_1 will therefore release. The ground established by the upper armature of relay GR will hold relay L operated. The closure of the lower make contact of relay GR will cause relay FC to operate. Relay FC will be locked, the locking circuit including, in addition to the battery and winding of relay FC, the back contact and armature of relay FO_1, the lower inner make contact and armature of relay FC, the upper inner make contact and armature of relay ON and ground. Relay FC changes the holding circuit for relay L which may now be traced from ground at the upper make contact and armature of relay GR, the upper inner make contact and armature of relay FC, the upper make contact and armature of relay L_1, the winding of relay L, battery and ground. The release of relay STP_0 will remove the short circuit around the counting relay W_3', whereupon the windings of relays W_3 and W_3' will be connected in series relationship. Consequently, relay W_3' will then operate. The release of relay STP_1 will then release relay GR. The release of relay GR will then remove the shunt path from the winding of relay STP_0 which is in the fundamental circuit FD_1, as well as from the winding of relay STP_1. The release of relay GR also causes a short circuit to be established for the winding of relay STP_1, this short circuit being established through the make-before-break contact of relay GR and the lower outer armature and make contact of relay FC. Thus, the release of relay GR will cause relay STP_0 to be reoperated in a circuit which may be traced to include the fundamental circuit FD_1 and the winding of relay L. The latter circuit includes battery, the winding of relay L, the upper armature and make contact of relay L_1, the upper inner armature and make contact of relay FC, the inner upper armature and back contact of relay RVE, the upper make-before-break contact of relay RV, conductors FT_{11} and FT_1, the fundamental circuit FD_1, conductors FR_1 and FR_{11}, the lower make-before-break contact of relay RV, the lower inner back contact and armature of relay RVE, the lower outer make contact and armature of relay FC, the make-before-break contact of relay GR and ground.

In response to the reoperation of relay STP_0, counting relay W_2 will then be operated over a circuit which may be traced from ground at the contacts of relay STP_0, conductor TV_1, cross point X_6, terminals K_3 and K_{33}, the armature and make contact of relay W_3', the armature and back contact of relay W_2', the winding of relay W_2, battery and ground. The operation of relay W_2 then short-circuits the winding of relay W_2' in a manner similar to that already described for the short-circuiting of the winding of relay W_3'. At the same time relay FC will be locked, as previously shown. The relay FC is employed to control the second fundamental circuit FD_2 which extends between the trunk circuit of Fig. 2 and the terminating circuits of Fig. 3. The terminating office of Fig. 3 is illustrated as of the crossbar type, but the operation of this terminating office may be similar to that which would take place in a panel subscriber office or a tandem office, or a panel distant office selector.

The operation of relay FC establishes a bridge across the trunk conductors T_2, R_2. This bridge includes conductor T_2, conductors FT_2 and FT_{12}, the upper outer armature and make contact of relay FC, the armature and back contact of relay BO_1, the winding of relay STP_2, the winding of relay OF_1, conductors FR_{12} and FR_2 to conductor R_2. The completion of this bridge circuit causes relay A_3 of the incoming trunk circuit ITC of Fig. 3 to operate. Battery is connected through the left winding of relay A_3 to conductor T_2 through the upper back contact and armature of relay T_3 while ground is connected through the lower outer back contact and armature of relay D_3 to conductor R_2 through the lower back contact and armature of relay T_3. The operation of relay A_3 causes the conductors T_2 and R_2 to be connected respectively to the upper armature and lower inner armature of relay ON_1, the connecting circuit being shown schematically as including the cross-points of the primary link switch PLK and the secondary link switch SLK of the terminating sender link TSL. The terminating sender link TSL, when operated, provides a ground path for the conductor F, through the lower back contact and armature of relay RV_2, winding of relay RV_3 and battery, operating RV_3.

It also provides a ground path for the conductor GS so as to operate relay ON_1. The operation of relay ON_1 will in turn hold relay RV_3, the holding circuit of relay RV_3 being completed through the lower outer armature and make contact of relay ON_1 and the lower back contact and armature of relay RV_2. The operation of relay RV_3 completes the second fundamental circuit FD_2, this fundamental circuit including battery, the winding of relay L_2, the upper armature and make contact of relay RV_3, the upper make-before-break contact of relay RV_1 to the upper make contact and armature of relay ON_1, which is connected to conductor T_2 through the switches PLK and SLK. The remainder of the fundamental circuit FD_2 is connected to conductor R_2 and includes switches PLK and SLK, the lower inner armature and make contact of relay ON_1, the upper armature and back contact of relay RV_2 to ground over either of two paths. One of these ground paths includes the lower inner back contact and armature of relay L_3 and the other ground path includes the upper back contact and armature of relay L_4. It will be observed that ground through the lower outer back contact and armature of relay D_3 is also connected to conductor R_2 through the lower back contact and armature of relay T_3. The fundamental circuit FD_2 just described being now connected to the bridge circuit of Figs. 2 and 4 previously described, will cause the operation of relay L_2 of the fundamental circuit FD_2 and the relay STP_2 of the bridge circuit. The terminating sender TS of Fig. 3 is now ready to start incoming brush selection.

From the foregoing it will be seen that upon the seizure of repeater circuit of Fig. 4, one revertive pulse is returned to the originating sender of Fig. 1 and is counted and recorded in the counting relay apparatus by an advance in the counting relays as already described. This revertive pulse is returned to the originating office independently of any operation of the circuits of the terminating office of Fig. 3 and without any control whatever by the apparatus of the terminating office. It will be observed also that the closure of the fundamental circuit FD_2 is completed after the transmission of the first revertive pulse to the originating office of Fig. 1. These are important factors of this invention and will be referred to later.

The operation of the relay STP_2 of Fig. 4, as already described, will operate relay PR. Relay PR then is locked through its lower inner make contact and armature, the back contact and armature of relay FO_1, the lower inner make contact and armature of relay FC and upper inner make contact and armature of relay ON and ground. At the same time the operation of the relay L_2 at the terminating office of Fig. 3 causes relay L_3 to operate, which in turn will cause relay L_4 to operate. Moreover, the terminating sender link TSL will apply ground to the conductor COO to cause relay T_3 to operate. The operation of relay T_3 will then disconnect the windings of relay A_3 from the bridge circuit previously described, whereupon relay A_3 will release. With relays T_3, L_3 and L_4 operated, short circuits are then removed from the winding of relay STP_3, thereby allowing the winding of STP_3 to be connected in series with the fundamental circuit FD_2 through the upper back contact and armature of relay RV_2. Relay STP_3 then operates and in turn causes relay GR_1 to operate. Relay GR_1 produces a ground pulse to be transmitted to the windings of relays STP_2 and STP_3 to cause the latter relays to be released. The ground pulse is transmitted over the circuit which includes the upper armature and make contact of relay GR_1, the upper armature and make contact of relay RV_3, the upper make-before-break contact of relay RV_1, the upper make contact and armature of relay ON_1, then through the switches SLK and PLK to conductor T_2, then over conductors FT_2, FT_{12}, the upper outer armature and make contact of relay FC, the armature and back contact of relay BO_1, the winding of relay STP_2, the winding of relay OF_1, conductors FR_{12} and FR_2, conductor R_2 then through switches PLK and SLK to the lower inner armature and make contact of relay ON_1, the upper armature and back contact of relay RV_2 to the winding of relay STP_3 and ground. As battery is absent from the circuit just traced, both relays STP_2 and STP_3 therefore release, while relay L_2 is held operated through the upper make contact and armature of relay GR_1. The release of relay STP_2 of Fig. 4 connects ground to the fundamental circuit FD_1 over a path which may be traced from the armature and back contact of relay STP_2, the lower outer armature and make contact of relay PR, the lower inner armature and make contact of relay L_1, the inner upper armature and make contact of relay FC, the inner upper armature and back contact of relay RVE, the upper make-before-break contact of relay RV, conductors FT_{11} and FT_1, conductor T_1, then through the fundamental circuit FD_1, then back over conductor R_1, conductors FR_1 and FR_{11}, the lower make-before-break contact of relay RV, the lower inner back contact and armature of relay RVE, the lower outer make contact and armature of relay FC, the make-before-break contact of relay GR to ground. Relay STP_0 of the fundamental circuit FD_1 therefore releases. Relay L of the repeater is held operated by the ground at the armature and back contact of relay STP_2, through the lower outer armature and make contact of relay PR, the lower inner armature and make contact of relay L_1, the upper make contact and armature of relay L_1, the winding of relay L, battery and ground. The release of relay STP_0 then allows the winding of relay W_2' to be connected in series with the winding of relay W_2 in a manner similar to that already described for the counting relays W_3 and W_3'. The simultaneous release of relay STP_3 of Fig. 3 allows relay GR_1 to release, which then removes the ground at its upper armature from the fundamental circuit FD_2. This terminates the ground pulse that causes the release of relays STP_2 and STP_3.

It is to be observed that the operation and release of relay GR_1 of Fig. 3 causes ground to be connected for a brief interval through its lower armature and make contact to the pulse counting relay apparatus PCR for counting this pulse as well as subsequent pulses. The removal of the ground from the upper armature of relay GR_1 also causes relays STP_2 and STP_3 to become reoperated, while relay L_2 is held operated in series path of the fundamental circuit FD_2. The operating circuits to perform these functions have already been described and therefore need not be repeated. The reoperation of relay STP_2 removes the short-circuiting ground from the fundamental circuit FD_1 previously described, whereupon the relay STP_0 of the latter fundamental circuit is reoperated. The operation of relay STP_0 in turn causes the counting relay W_1 to operate and at the same time short-circuit the relay W_1'.

It is therefore noted that after the original

pulse was sent to the originating sender of Fig. 1, upon seizure of the repeater of Fig. 4 (regardless of the operations of the terminating circuits of Fig. 3), the first pulse actually returned from the terminating office of Fig. 3 will be directly repeated by the repeater of Fig. 4 to the originating office of Fig. 1. The first pulse returned by the terminating office of Fig. 3 will be the second pulse received by the originating office of Fig. 1 through the repeater of Fig. 4. Later the second pulse returned from the terminating office of Fig. 3 will be repeated by the repeater of Fig. 4 to the originating office of Fig. 1 as the third pulse received by the originating office. This procedure will continue with each subsequent pulse from the terminating office of Fig. 3 (except the last pulse). These pulses will be repeated until the originating office is fully satisfied. When the satisfying pulse is received, relays BO and FO of the originating office will be operated upon the release of relay STP_0 and provide the completion signal to the terminating office. The fundamental circuit FD_1 will be opened at the back contact and armature of relay BO. The opening of the fundamental circuit FD_1 will cause relay L of Fig. 4 to be released at the conclusion of the pulse, which in turn will release relay L_1. At this time one pulse is yet to be received from the terminating office of Fig. 3, but this last pulse will not affect the originating office of Fig. 1, as will be explained.

For the case in which the subscriber dials number 6200 it was pointed out that four pulses are required for incoming brush selection and that these four pulses have already been received by the originating sender. However, only three of the necessary four pulses have been returned by the terminating sender of Fig. 3 to the fundamental circuit FD_1 of Fig. 1, but the fourth pulse from the terminating sender will be received by the repeating apparatus of Fig. 4, and will serve to open the fundamental circuit FD_2. This fourth pulse from the terminating equipment will not reach the originating office. This fourth or last pulse, in releasing relay STP_2 of Fig. 4 in the manner already described, will operate relay BO_1 and relay FO_1 over a path which includes ground at the armature and back contact of relay STP_2, the lower outer armature and make contact of relay PR, the lower inner armature and back contact of relay L_1 and parallel paths provided by the windings of relays BO_1 and FO_1 to battery and ground. Relay FO_1 locks over a path from the winding of relay FO_1 and its make contact and armature, the lower inner make contact and armature of relay FC, the upper inner make contact and armature of relay ON and ground. Of course, relay BO_1 will hold in parallel with relay FO_1.

The operation of FO_1 releases relays PR and FC. When relay FC releases, it will cause relays BO_1 and FO_1 to release. It is to be observed that the operation of relay BO_1 will open the fundamental circuit FD_2 at the contacts of relay BO_1 while the release of relay FC will also open the fundamental circuit FD_2 at another point in the circuit, namely, at the outer upper make contact of relay FC. Therefore, the fundamental circuit will be held open even though relay BO_1 is subsequently released. Hence, at the end of the last pulse, relay GR_1 being then released, the relay L_2 of Fig. 3 will be released, in turn releasing relays L_3 and L_4. This action in the terminating sender of Fig. 3 will cause the pulse counting relays PCR and the register switch RS to record the count for the incoming brush selection communicated to the terminating office of Fig. 3 by the originating office of Fig. 1. The terminating office will now be prepared for the next selection, namely, the incoming group selection.

The originating sender of Fig. 1 may also be advanced for the incoming group selection by the operation of its relay FO upon receipt of the last or satisfying pulse, as already described. The sequence relays will change the connections to the dial register DR and thereby prepare it for the group selection. This will also cause the release of the counting relays previously operated.

The incoming group selection now takes place in a manner similar to that already described for incoming brush selection. For the case where the number dialed is 6200, the incoming group selection will correspond to the number 0 which, as will be understood, requires but one revertive pulse. The fundamental circuit FD_1 will be closed as before, operating relay L of the repeater of Fig. 4 and relay STP_0 of the originating sender of Fig. 1. The ground at the contact of relay STP_0 will now be closed through the sequence relays for the incoming group selection apparatus IGS_2 to the vertical conductor HV_1 of the hundreds register and its contact at cross point XX_2, the vertical conductor TV_2 of the thousands register and its cross point at X_6, contacts K_0 and K_{00}, then through the winding of counting relay W_0 to battery and ground. The operation of relay W_0 will cause the windings of relays BO and FO to be short circuited. At the repeater station of Fig. 4, the operation of relay L will cause relay L_1 to operate, thereby removing the short circuit from the winding of relay STP_1. Consequently, relay STP_1 will operate and in turn will operate relay GR. The operation of relay GR will produce a ground pulse which will be returned to the originating sender of Fig. 1 in the manner already described. As only one ground pulse is required for the incoming group selection, closure of this pulse will release relay STP_0 of the fundamental circuit FD_1 and in turn allow relays BO and FO to become operated. The operation of relay BO will open the fundamental circuit FD_1, thereby releasing relay L of the repeater of Fig. 4 and in turn relay L_1 upon the release of relay GR. The operation of relay FO will cause the originating sender to advance for the next selection which will be the final brush selection as is well understood in the art.

It is pointed out that the pulse required for the incoming group selection is returned to the originating sender by the operation of apparatus in the repeater circuit of Fig. 4, and that the apparatus of the repeater circuit will cause the operation of apparatus at the terminating office so as to start pulsing. Inasmuch as the selection completion signal has already been recorded in the repeater by the release of relays L and L_1, the terminating office will return only one pulse in the manner already described and this pulse will be employed to record the count for the group selection at the terminating office. However, although the operation of the fundamental circuit FD_2 is dependent upon the operation of the fundamental circuit FD_1, the single pulse emanating from the terminating sender will not be repeated into the fundamental circuit FD_1 as was the case for incoming brush selection. It is not believed necessary to repeat the circuit operations which are required to relay the single ground pulse from the terminating circuit to the repeater circuit, as this has already been fully described. At the conclusion of the incoming group selection, the terminating sender will advance for the next se-

lection which will be the final brush selection and at the same time release the relays no longer required for this operation. The final brush selection will be followed by the tens selection and then by the units selection. After the units selection has been completed, the originating and terminating senders will close the "incoming advance" loop. The "incoming advance" signal is a reversal of polarity of the battery applied to the fundamental circuit of the terminating office, and it will indicate to the originating office that all selections have been completed. The closure of this loop is brought about by operation of the sequence relays already referred to, causing relay L of the repeater circuit to operate as well as relay STP_0 of the fundamental circuit FD_1. Briefly, the operation of relay L will in turn cause relays L_1, STP_1, GR and FC to operate. Relay GR will short-circuit and therefore release relays STP_0 and STP_1. The release of relay STP_0 will be ineffective at this time, because none of the counting relays have been operated. The release of relay STP_1 will release relay GR and allow relay STP_0 to reoperate.

The operation of relay FC again closes the fundamental circuit FD_2 at the make contact of its upper outer armature, and in turn causes the relay L_2 of the terminating sender to operate in series with relay STP_2. The operation of relay STP_2 again operates relay PR which will be locked as before. The operation of relay L_2 will again operate relays L_3 and L_4. With the final units hold magnet FU operated due to the completion of the final units selection, the operation of relay L_4 will cause relay RV_1 to be operated, the operating path including the lower armature and make contact of relay L_4 and the upper make contact and armature of magnet FU. The operation of relay RV_1 in turn will operate relay RV_2. When both relays RV_1 and RV_2 are operated, the battery connected to the winding of relay L_2 will now be connected to conductor R_2 to which the fundamental circuit is connected, this path being traceable through the upper armature and make contact of relay RV_3, the upper make contact and armature of relay RV_1, the lower inner make contact and armature of relay ON_1 and switches SLK and PLK. Ground will simultaneously be connected to conductor T_2, this path being traceable through the lower armature and make contact of relay RV_3, the lower inner armature and make contact of relay RV_1, the upper make contact and armature of relay ON_1, and switches SLK and PLK. This reversal of polarity applied to the conductors T_2 and R_2 then operates relay OF_1 at the repeater of Fig. 4, this relay being of the polar type. Ground at the upper inner armature and make contact of relay ON is now connected through the armature and make contact of relay OF_1 to the winding of relay RV, causing relay RV to be operated. Relay RV then locks through its upper outer make contact and armature to ground at the make contact of the upper inner armature of relay ON. Relay RV then reverses the polarity of the potential applied to the fundamental circuit FD_1. Battery at the winding of relay L is now being connected to the conductor R_1 which is connected to the fundamental circuit FD_1—over a path which may be traced through the winding of relay L, the upper armature and make contact of relay L_1, the upper inner armature and make contact of relay FC, the upper inner armature and back contact of relay RVE, the lower inner armature and make contact of relay RV, conductors FR_{11} and FR_1 to conductor R_1. At the same time the conductor T_1—which is connected to the fundamental circuit FD_1—will be connected to ground over a path which includes conductors FT_1 and FT_{11}, the upper inner make contact and armature of relay RV, the lower inner back contact and armature of relay RVE, the lower outer make contact and armature of relay FC, the make-before-break contacts of relay GR and ground. The reversal of polarity will, therefore, operate relay OF of the fundamental circuit FD_1, which is also of the polar type.

The operation of relay RV_2 at the terminating office will release relay RV_3. Relay RV_3 is, however, of the slow release type and it will not disconnect battery and ground from conductors R_2 and T_2 until a sufficient interval of time has elapsed. The release of relay RV_3 will thereafter release relays L_2, L_3 and L_4, and at the same time disconnect battery and ground from conductors R_2 and T_2. Subsequently, ground will be removed from conductor COO, releasing relay T_3, and thereafter ground will be connected to conductor DD_1, causing relay D_3 to operate in the usual manner. The release of relay RV_3, in opening the fundamental circuit FD_2, will release relays STP_2 and OF_1 of the repeater circuit. The release of relay OF_1 will connect ground at the upper inner armature and make contact of relay ON and through the armature and back contact of relay OF_1, lower outer armature and make contact of relay RV to the winding of relay RVE, thereby operating the latter relay. Relay RVE will in turn disconnect battery and ground from the fundamental circuit FD_1, thereby releasing relays STP_0 and OF of the originating sender. Although the various circuits controlled by relays STP_0 and OF are not shown because they are not required for an understanding of the present invention, they serve to advance the originating sender in a well-known manner, and at the same time apply ground to the conductor TR to operate the relay TK of the district junctor DJ. The relay TK will then be locked through its lower outer make contact and armature and the connection of the district junctor DJ to the originating sender by way of the sender link SL will be broken.

The operation of relay RVE will also release relay L_1, which then will cause relay L to release. The release of relay L_1 with relay STP_2 normal is accompanied by the operation of relays BO_1 and FO_1 in parallel, the operating circuits for which are completed through the lower outer armature and the make contact of relay PR and the lower inner armature and back contact of relay L_1. The operation of relay FO_1 releases relays PR and FC, after which relays BO_1 and FO_1 release. The operation of relay RVE will also release the relay PLS, this relay being of the slow release type so as to prevent interference with the advance of the circuits of the originating sender. The release of relay PLS will cause relay T_0 to release, but it will cause relay D_0 to become operated. The operating path for relay D_0 includes battery, the winding of relay D_0, conductors D_1 and D_{11}, the winding of relay TC, resistor R_2, the lower back contact and armature of relay PLS, the lower outer make contact and armature of relay RVE and ground. Relay TC is of the polar type and will not operate even though its winding is included in the operating path for relay D_0.

The operation of relay TK in the district junctor DJ performs the "trunk closure" function. The operation of relay TK connects the winding of the polar relay CS of the district

junctor DJ through the upper armature and lower inner armature of relay TK across the conductors T_1 and R_1. Consequently, relay A_0 of Fig. 2 will become operated. Relay A_0 repeats the "trunk closure" function by operating relay BD_1, the operating path for relay BD_1 traversing the lower inner armature and make contact of relay D_0. Relay BD_1 locks in a path from battery through its upper winding, upper inner make contact and armature, lower outer make contact and armature of relay D_0, to ground. Relay BD_1 in turn connects the winding of polar relay S through the upper and lower right windings of the repeat coil RC and through the upper outer armature and make contact and the lower outer armature and make contact, respectively, across the conductors T_2 and R_2. During this interval relay T_3 remains released and relay D_3 operated. Consequently, the connection of the winding of relay S across the conductors T_2 and R_2 will operate relay A_3 at the terminating office. The operation of relay A_0 and the subsequent operation of relay BD_1 will cause relay D_0 to be locked in its operated position, the locking path for relay D_0 including the lower inner armature and make contact of relay BD_1, the lower inner make contact and armature of relay D_0, the make contact and armature of relay A_0 and ground. The same ground will be connected through conductors D_1 and D_{11} to the winding of relay TC, resistor R_3, battery and ground, thereby operating relay TC. The operation of relay TC will then release both the relay ON and the hold magnet HM_9. The release of the hold magnet will open the cross-point CP_{99} of the link circuit CBLC. Relay TC will release when the hold magnet contacts and the cross-point CP_{99} are opened. The release of relay ON will release both relays RV and RVE. The simultaneous release of relays RVE and ON will render the repeater circuit of Fig. 4 available for subsequent seizure by another originating sender, the availability of the repeater being evidenced by the connection of battery through resistor R_1, the upper outermost armature and back contact of relay RVE, the upper outer armature and back contact of relay ON to conductor N, which terminates in the link circuit CBLC. The operation of relay A_3 at the terminating office connects ground to the winding of relay D_3 through the lower innermost armature and make contact of relay D_3 to lock relay D_3. This will signal the terminating sender to summon a marker (not shown) by applying ground to lead DD_1 which extends into the terminating sender link TSL. After the marker has caused the connection of the called line to be completed, the terminating sender will release relay ON_1 and the connection through the switches PLK and SLK of the terminating sender link TSL. Relays RV_1 and RV_2 and any other relays and magnets that may be operated release and the terminating sender is now returned to normal.

When the called subscriber answers in response to the application of ringing current to his line, the originating circuit, the trunk circuit and the terminating circuit will then be ready to transmit speech currents thereover. The connection of the called party's line to the terminating circuit will cause relay S_1 of the incoming trunk circuit ITC to operate, thereby operating T_3. Relay T_3 will reverse the polarity of the voltage applied to the conductors T_2 and R_2. That is, battery will now be connected through the left winding of relay A_3, the upper outer armature and make contact of relay D_3, the upper inner make contact and armature of relay D_3 and the lower make contact and armature of relay T_3 to conductor R_2. At the same time ground will be connected through the right winding of relay A_3, the lower outermost armature and make contact and the lower intermediate make contact and armature of relay D_3, the upper make contact and armature of relay T_3 to conductor T_2. This reversal of polarity applied to conductors T_2 and R_2 will not interfere with the previously operated condition of relay A_3, but polar relay S at the repeater station will now be operated. Relay S will then cause relay T_0 to operate, the operating path for which is completed through the upper inner armature and make contact of relay D_0. The operation of relay T_0 also reverses the polarity of the voltage applied to conductors T_1 and R_1. This reversal of polarity now causes battery to be connected to conductor R_1 over a path through the left winding of relay A_0, the upper left portion of the repeat coil RC, the upper intermediate make contact and armature of relay D_0 and the lower make contact and armature of relay T_0. Ground will be simultaneously connected to the conductor T_1 over a path which includes the right winding of relay A_0, the lower left portion of the repeat coil RC, the upper outermost armature and make contact of relay D_0 and the upper make contact and armature of relay T_0. The operated condition of relay A_0 will not be affected by this reversal of polarity, but the polar relay CS of the district junctor DJ will become operated. Relay CS controls message register apparatus (not shown) for charging the call to the calling subscriber. When the called subscriber disconnects, relays S_1, T_3, S, T_0 and CS will release in the order mentioned. Moreover, when the calling subscriber disconnects, relays TK, A_0, D_0, BD_1, A_3 and D_3 will release. All of the apparatus will therefore be restored to normal.

The revertive pulse repeater shown specifically in Fig. 4 is connected to the originating sender of Fig. 1 and the terminating sender of Fig. 3, through the trunk circuit of Fig. 2, so as to increase the range of revertive pulse control from about 30 miles to about 60 miles. Of course, two or more such repeaters may be connected in tandem to correspondingly increase the pulsing range to about 90 miles or more, as may be desired. Moreover, the repeater equipment need not be spaced by 30 miles from either the originating office or the terminating office, for this distance may be substantially less than 30 miles when conditions warrant a smaller spacing. If a repeater is connected to an office which is substantially less than, let us say, 30 miles away, an artificial line in the form of a T-pad, or a π-pad, or of any other form, may be inserted between the repeater circuit and either the originating office or the terminating office, or both, to introduce the required time delay factor which is important in the practice of this invention. Obviously the artificial line network just referred to may be part of the repeater of Fig. 4 or, if desired, it may be bridged across conductors T_1 and R_1 if the originating sender of Fig. 1 is spaced less than the predetermined distance of, for example, 30 miles from the repeater of Fig. 4; or it may be bridged across conductors T_2 and R_2 where additional delay is required between the repeater of Fig. 4 and the terminating office of Fig. 3. The insertion of such an artificial line

or network will allow all of the revertive pulses to be returned to the originating office in regular order.

It will be further understood that the repeater circuit of Fig. 4 may be included as a part of a part of a tandem sender, permitting such a sender to repeat pulses rather than record the digits which represent these pulses.

While this invention has been shown and described in certain patent arrangements merely for illustrative purposes, it will be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. In a signaling system, the combination of a selector, means for producing pulses to control said selector, means for seizing said selector, said seizing means including means for producing one pulse and at the same time for starting said pulse producing means, pulse counting means, means controlled by said pulse counting means for interrupting the pulse producing means after a predetermined number of pulses have been counted by said counting means, said interrupting means causing said pulse producing means to produce one additional pulse thereafter, and means to prevent the transmission of said additional pulse to said pulse counting means.

2. In a signaling system, the combination of a first station having pulse counting apparatus, a second station having a selector controlled by pulses, a source of pulses at said second station, a repeater interconencting said first and second stations, means controlled by the connection of said repeater between said stations to produce one pulse for transmission to said first station to be counted by said counting apparatus and at the same time for starting said source of pulses at said second station, the pulses produced at said second station being relayed by said repeater to said first station to be counted by said counting apparatus, means to signal the repeater after a predetermined number of pulses have been counted by said counting apparatus, and means responsive to said signal received by said repeater to cause said source to produce one additional pulse and then to interrupt said source.

3. In a signaling system, the combination of a pulse controlled device, a source of pulses connected to said device to control said device, apparatus for counting pulses, means responsive to the connection of said apparatus to said device to produce a pulse to be counted by said apparatus and to start the source of pulses connected to said device, and means responsive to the reception by said apparatus of a predetermined number of pulses from said source to cause said source to produce one additional pulse and then to interrupt the production of pulses by said source.

4. In an automatic telephone system, the combination of a first telephone office having pulse-counting apparatus, a second telephone office having a pulse-controlled selector and a source of pulses therefor, a repeater interposed between said first and second telephone offices, means responsive to the connection of the first office to said repeater to produce a pulse to be transmitted to the first office to be counted by said apparatus, means for thereafter establishing a path between said repeater and said second office and for starting said source of pulses, the pulses emanating from said source being relayed by said repeater to the counting apparatus of the first station, means responsive to the reception of a predetermined number of pulses by said counting apparatus to signal the repeater to interrupt the source of pulses, and means controlled by said signal to interrupt said source of signals after said source has produced one additional pulse.

5. In an automatic telephone system, the combination of a first telephone office having pulse-counting apparatus, a second telephone office having a pulse-controlled selector and a source of pulses associated with said selector, a repeater interposed between said first and second telephone offices, means responsive to the connection of the first office to said repeater to produce a pulse to be transmitted to the first office to be counted by said apparatus, means for thereafter establishing a path between said repeater and said second office and for starting said source of pulses, the pulses emanating from said source being relayed by said repeater to the counting apparatus of the first station, means responsive to the reception of a predetermined number of pulses by said counting apparatus to signal the repeater to interrupt the source of pulses, means controlled by said signal to interrupt said source of signals after said source has produced one additional pulse, and means controlled by said additional pulse to disconnect said repeater from said first and second offices.

6. In a telephone system, the combination of a first office having pulse-counting apparatus, a second office having a pulse-controlled selector and a source of pulses associated with said selector, a trunk circuit interposed between said first and second offices, a repeater associated with said trunk circuit, means responsive to the connection of said first office to said repeater through said trunk circuit to produce a pulse for transmission over said trunk circuit to the counting apparatus of said first office, means for thereafter starting the production of pulses by said source at said second office, the pulses emanating from said source at said second office being relayed through the trunk circuit to the repeater and back over the trunk circuit to the counting apparatus of the first office, means responsive to the reception of a predetermined number of pulses by said counting apparatus to signal said repeater to interrupt the transmission of pulses to said first office, means controlled by said signal to interrupt the source of pulses at the second office after one additional pulse has been produced by said source.

7. In a telephone system, the combination of a first office having pulse-counting apparatus, a second office having a pulse-controlled selector and a source of pulses associated with said selector, a trunk circuit interposed between said first and second offices, a repeater associated with said trunk circuit, means responsive to the connection of said first office to said repeater through said trunk circuit to produce a pulse for transmission over said trunk circuit to the counting apparatus of said first office, means for thereafter starting the production of pulses by said source at said second office, the pulses emanating from said source at said second office being relayed through the trunk circuit to the repeater and back over the trunk circuit to the counting apparatus of the first office, means responsive to the reception of a predetermined number of pulses by said counting apparatus to signal said repeater to interrupt the transmission of pulses to said first office, means controlled by said signal

to interrupt the source of pulses at the second office after one additional pulse has been produced by said source, and means controlled by said additional pulse to disconnect the repeater from said trunk circuit.

8. In a telephone system, the combination of an originating sender, a terminating office, a repeater intermediate said originating sender and said terminating office, means responsive to the seizure of said repeater by said originating sender to cause said repeater to return a pulse to said sender and to cause said terminating office to start producing pulses, said repeater including means for returning each pulse received from said terminating office to said originating sender, means responsive to the reception of said originating sender of a predetermined number of pulses to signal the repeater to cease returning pulses to said sender, and means responsive to said signal at said repeater to cease the production of pulses by said terminating office after an additional pulse is received by said repeater from said terminating office.

9. In an automatic telephone system, the combination of a first office having relays for counting received pulses, a second office having selector apparatus to be controlled by pulses, means at the second office to produce pulses for controlling said selector apparatus, a repeater which may interconnect said first and second offices, means responsive to the connection of said first office to said repeater to cause said repeater to transmit a first pulse to said first office to be counted by said relays, the repeater relaying the pulses received from the second office to said first office to be counted by said relays, means responsive to a predetermined number of pulses received by said relays to prevent the repeater from relaying additional pulses to said first office, and means controlled by the latter means to stop the production of pulses at said second office after one additional pulse has been produced at said second office.

10. In an automatic telephone system, the combination of a first office having relays for counting received pulses, a second office having selector apparatus to be controlled by pulses, means at the second office to produce pulses for controlling said selector apparatus, a repeater which may interconnect said first and second offices, means responsive to the connection of said first office to said repeater to cause said repeater to transmit a first pulse to said first office to be counted by said relays, the repeater relaying the pulses received from the second office to said first office to be counted by said relays, means responsive to a predetermined number of pulses received by said relays to prevent the repeater from relaying additional pulses to said first office, means controlled by the latter means to stop the production of pulses at said second office after one additional pulse has been produced at said second office, and means controlled by said additional pulse to disconnect said repeater from said first and second offices.

11. In a signaling system, the combination of a pulse-controlled selector, a generator of pulses to control said selector, means responsive to the seizure of said selector to produce a pulse, said means also starting said generator to produce pulses, pulse receiving means, and means controlled by said pulse receiving means to signal said generator to stop its production of pulses, said generator producing an additional pulse after the transmission of said signal.

12. In a signaling system, the combination of a pulse-controlled selecting device, a generator of pulses connected to said device to control its operation, a pulse counter, means for connecting said pulse counter to said generator to start the production of pulses by said generator for transmission to said counter, said starting means including means to generate a first pulse for transmission to said counter, and means controlled by said counter to transmit a signal to said generator to stop said generator, said generator producing only one additional pulse after the stopping signal has been received.

13. In a signaling system, the combination of a pulse-controlled selecting device, a generator of pulses connected to said device to control its operation, a pulse counter, means for connecting said pulse counter to said generator to start the production of pulses by said generator for transmission to said counter, said starting means including means to generate a first pulse for transmission to said counter, means controlled by said counter to transmit a signal to said generator to stop said generator, said generator producing one additional pulse after said signal has been received, and means controlled by said additional pulse to disconnect said pulse counter from said generator.

ROBERT CAMPBELL AVERY.