Oct. 25, 1949. G. A. LOCKE 2,486,302

TELEGRAPH STORAGE SYSTEM

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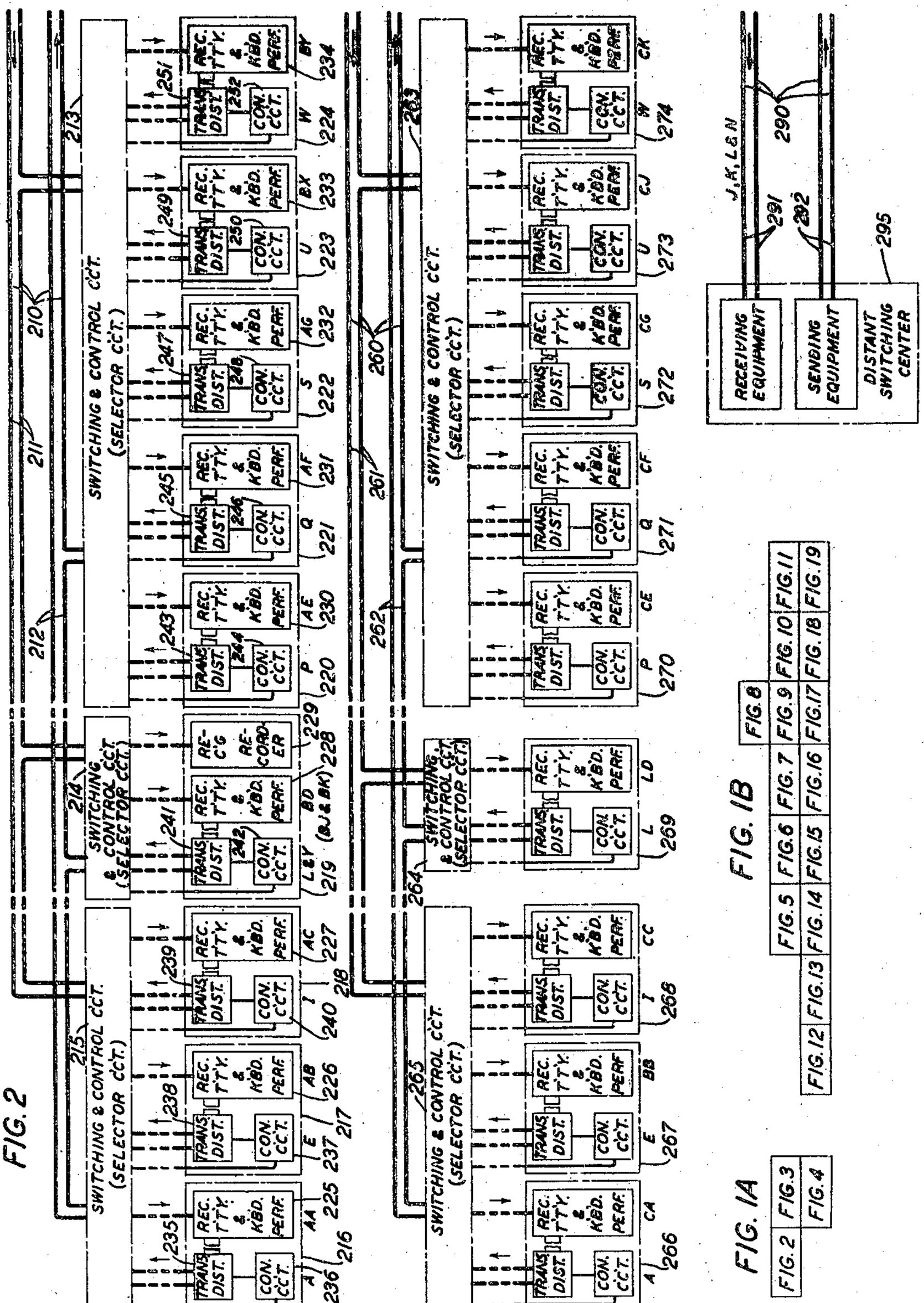

FIG. 2

FIG. 1A

FIG. 2	FIG. 3	
	FIG. 4	

FIG. 1B

FIG. 8				
FIG. 9	FIG. 10	FIG. 11		
FIG. 17	FIG. 18	FIG. 19		
FIG. 5	FIG. 6	FIG. 7	FIG. 16	
	FIG. 14	FIG. 15		
FIG. 12	FIG. 13			

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TELEGRAPH STORAGE SYSTEM

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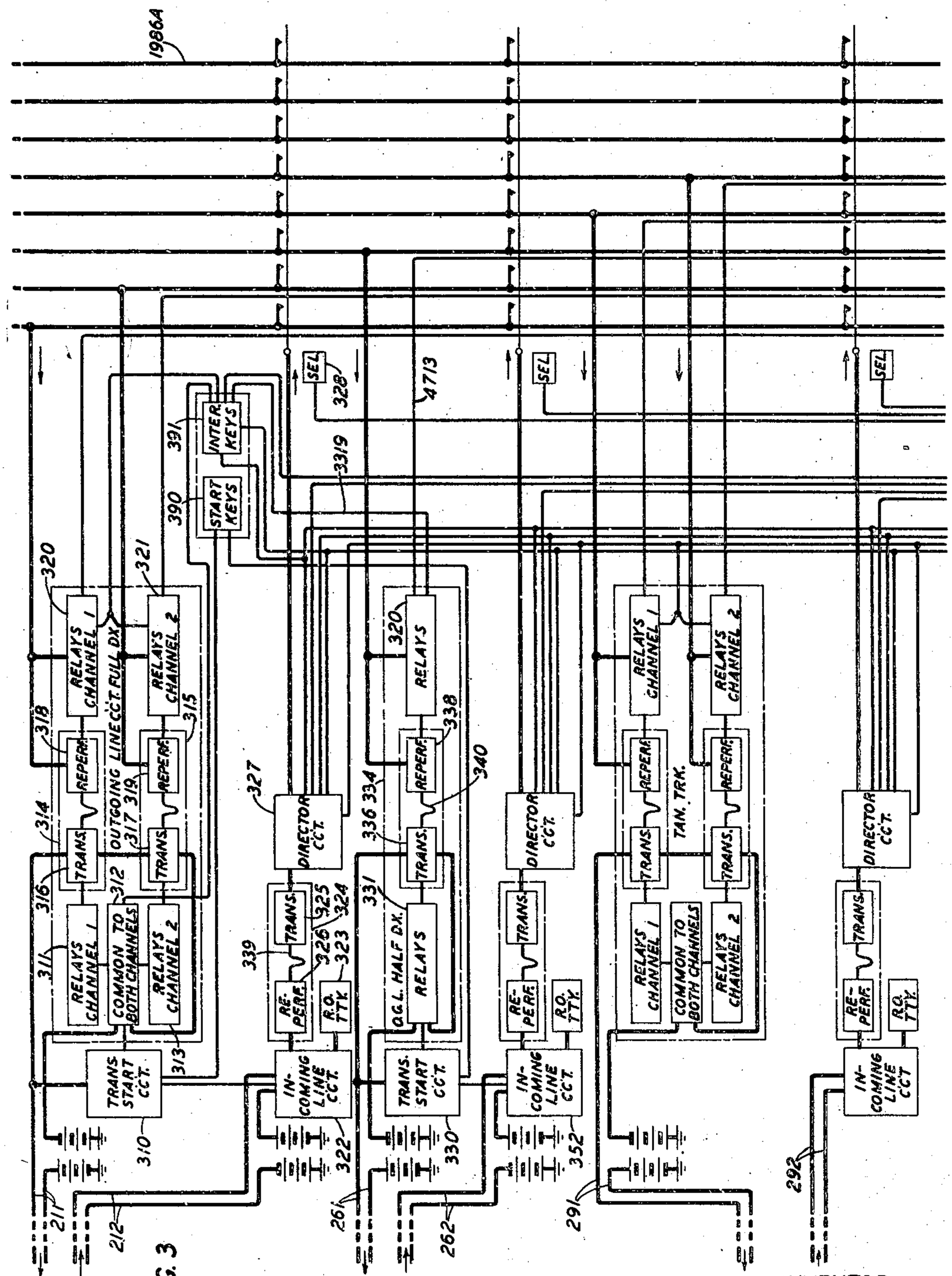

FIG. 3

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TELEGRAPH STORAGE SYSTEM

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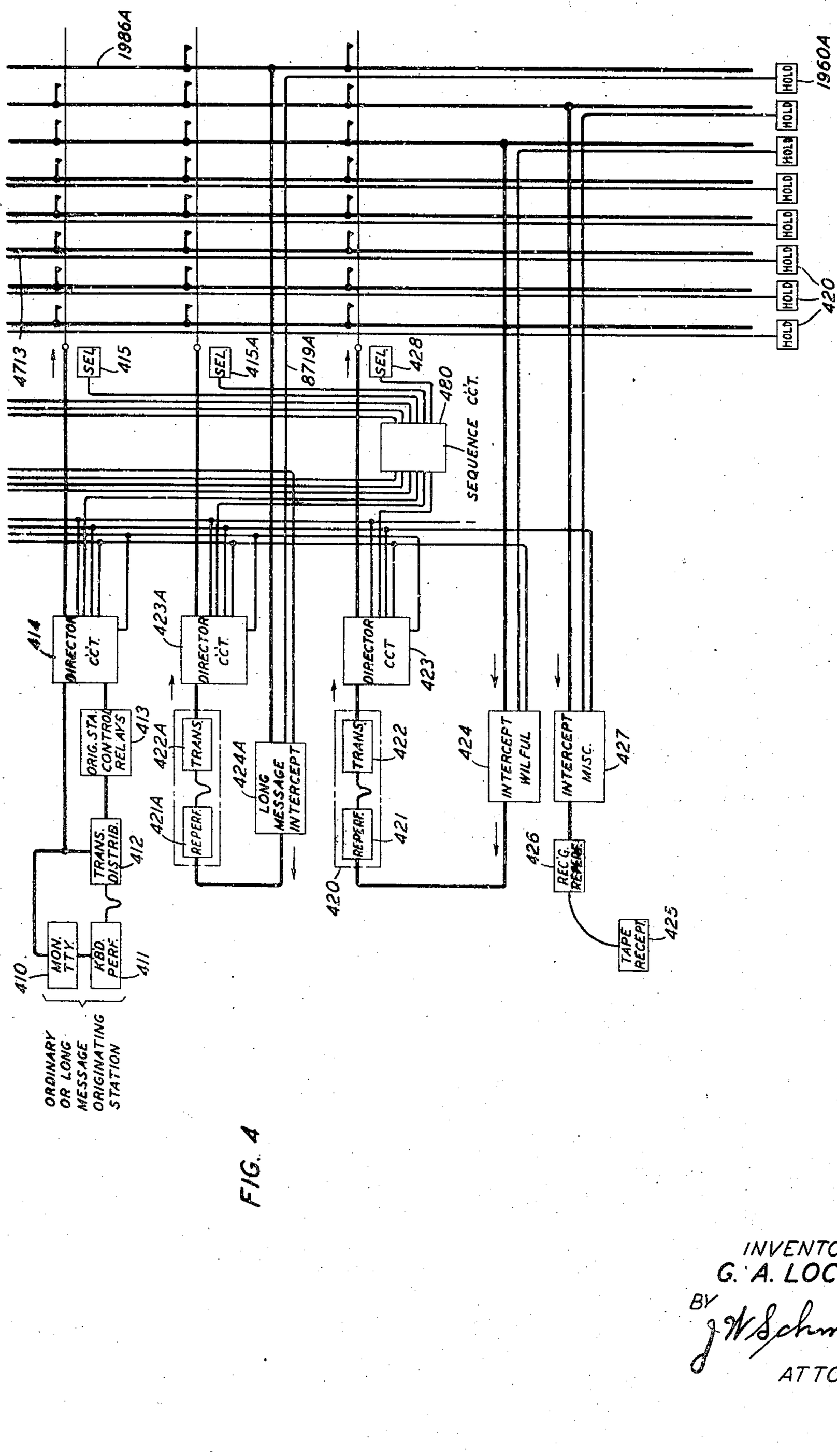

FIG. 4

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TELEGRAPH STORAGE SYSTEM

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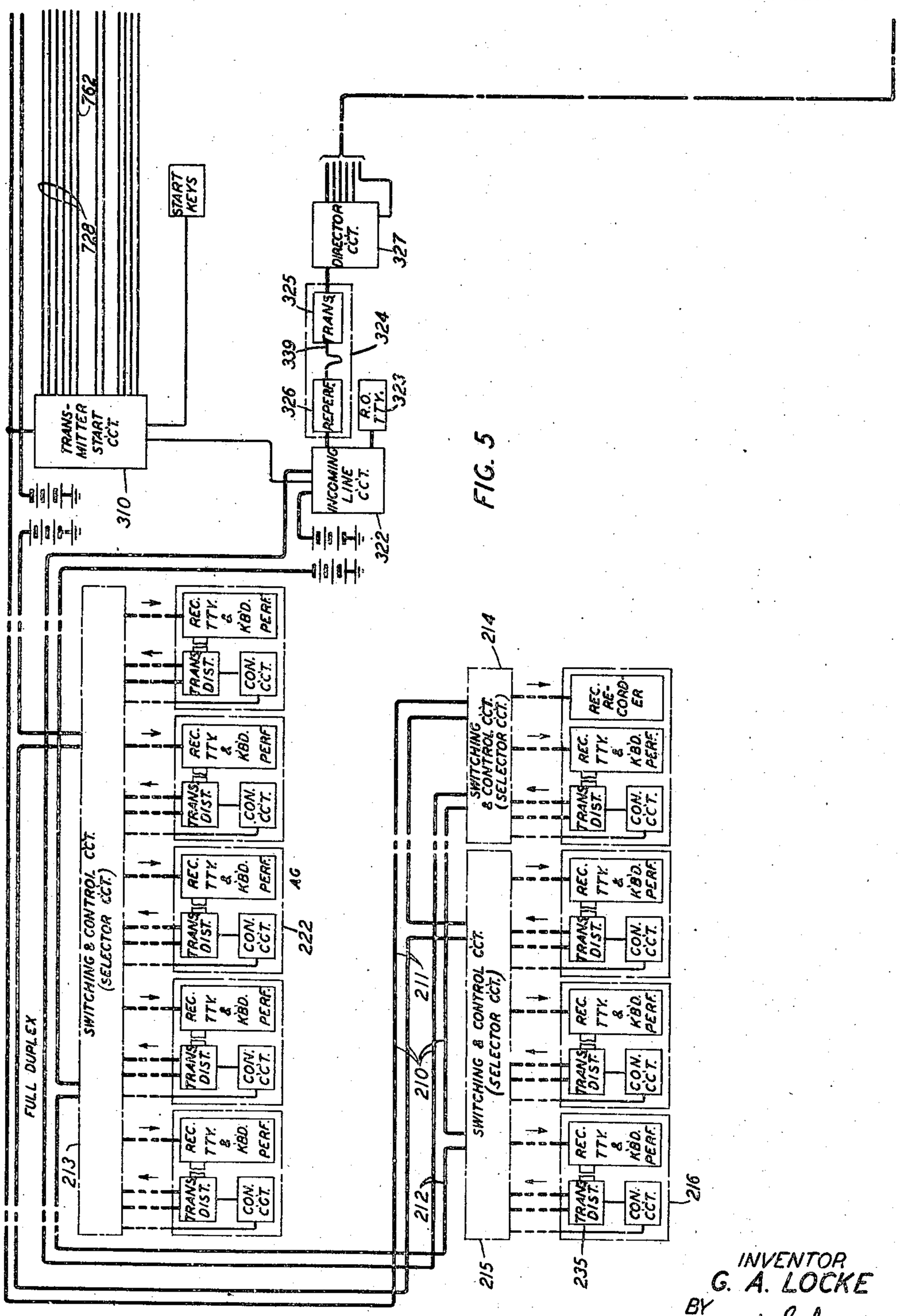

FIG. 5

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TELEGRAPH STORAGE SYSTEM

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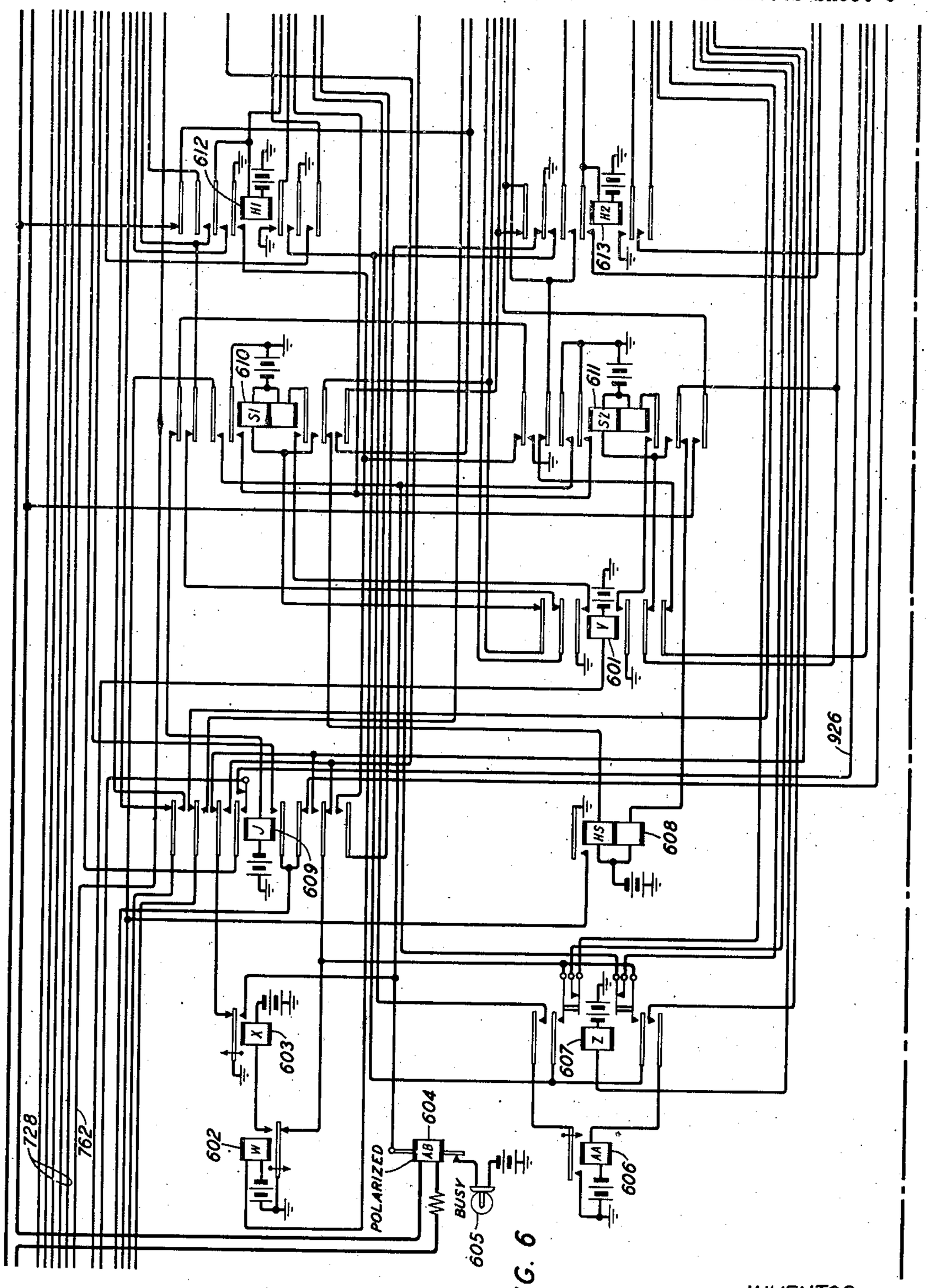

FIG. 6

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TELEGRAPH STORAGE SYSTEM

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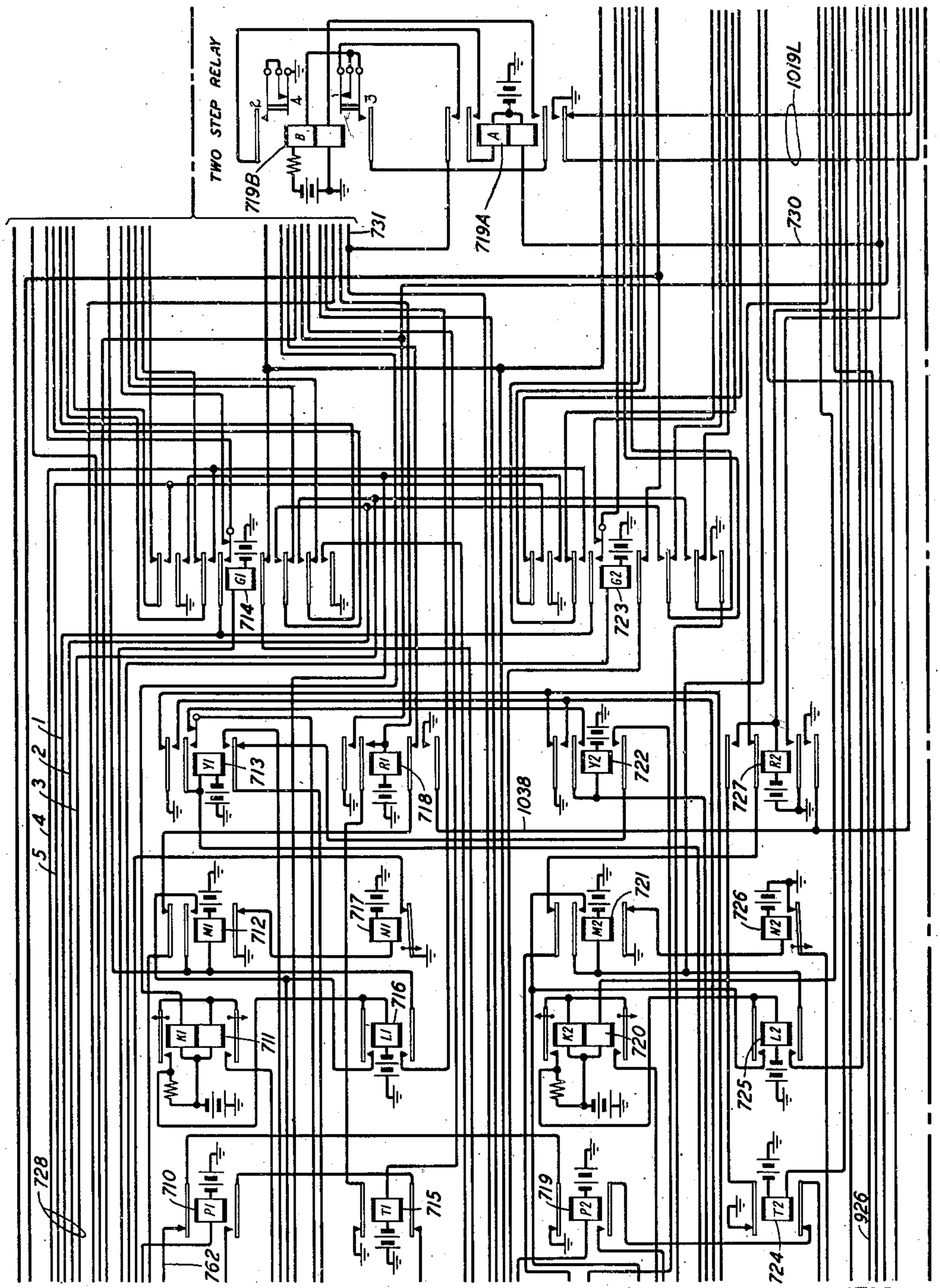

FIG. 7

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TELEGRAPH STORAGE SYSTEM

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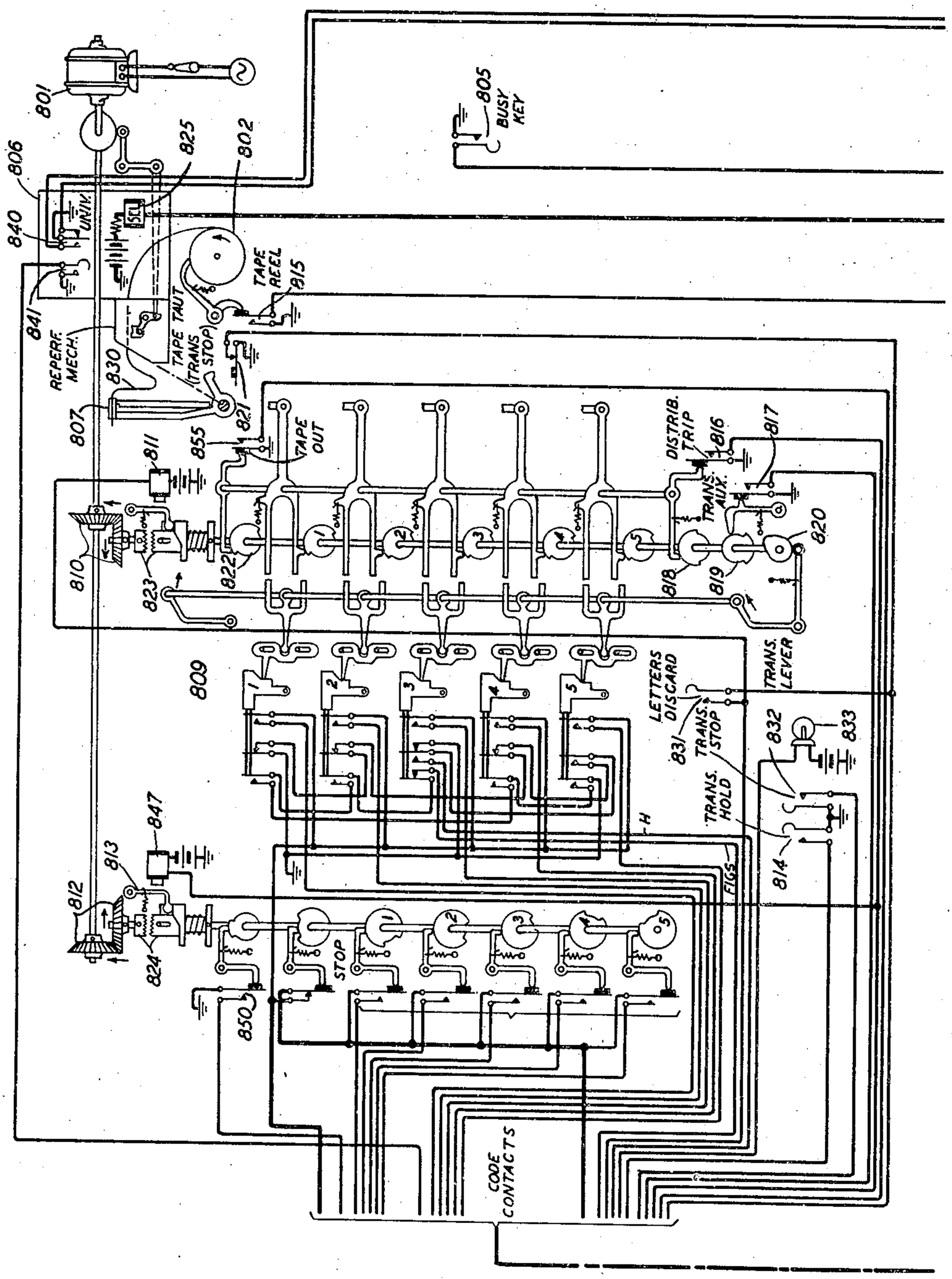

FIG. 8

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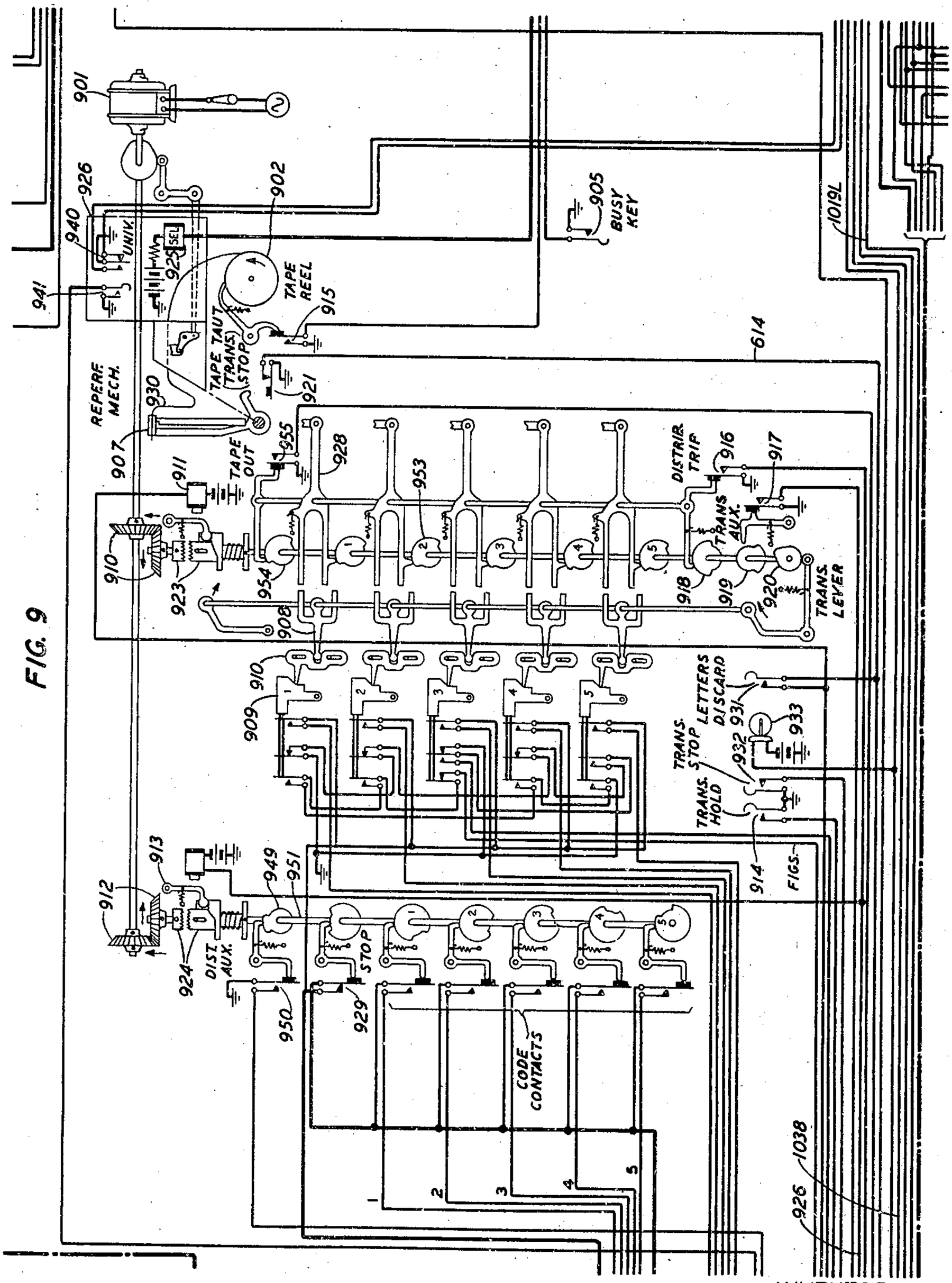

FIG. 9

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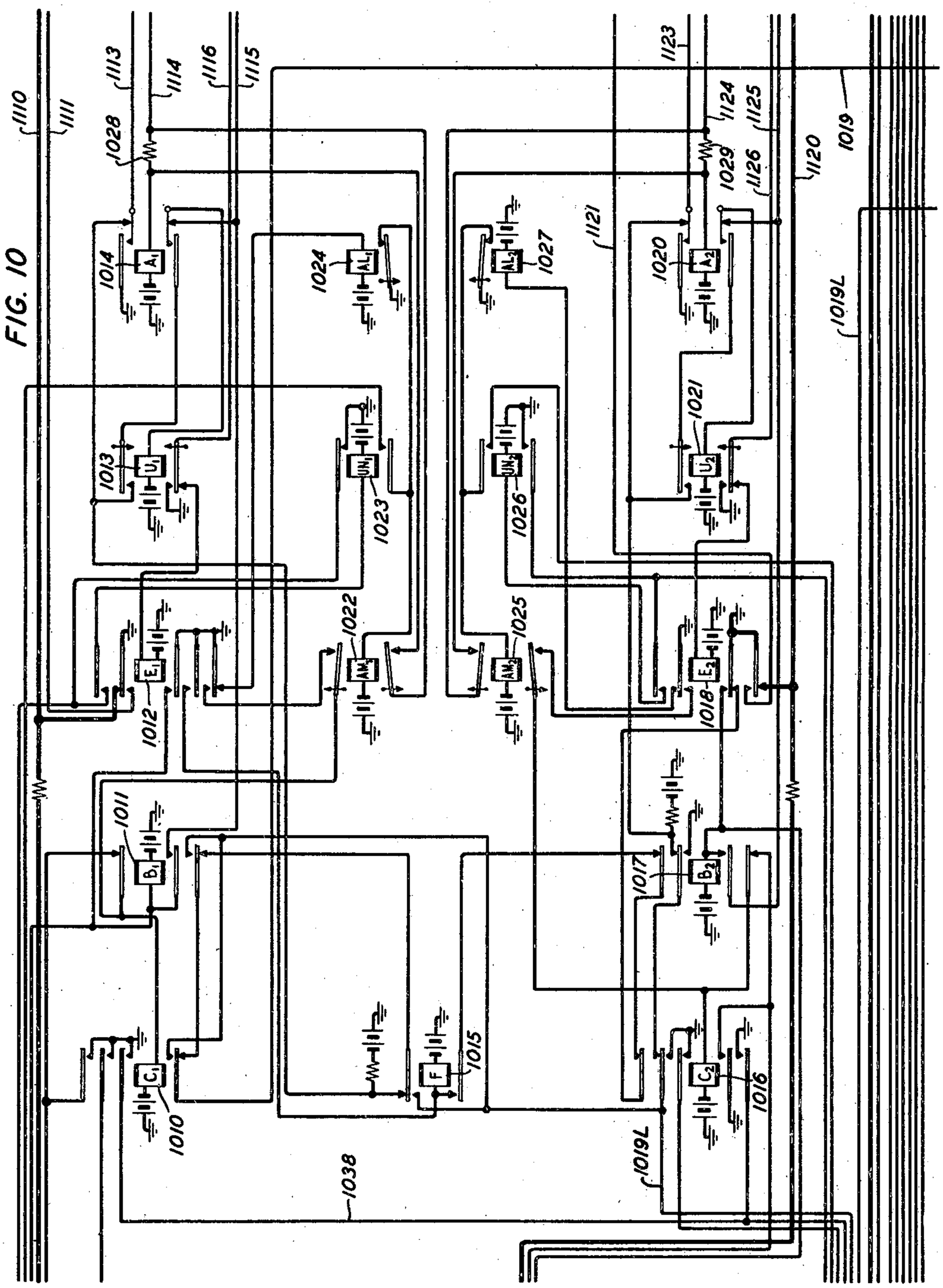
FIG. 10



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TELEGRAPH STORAGE SYSTEM

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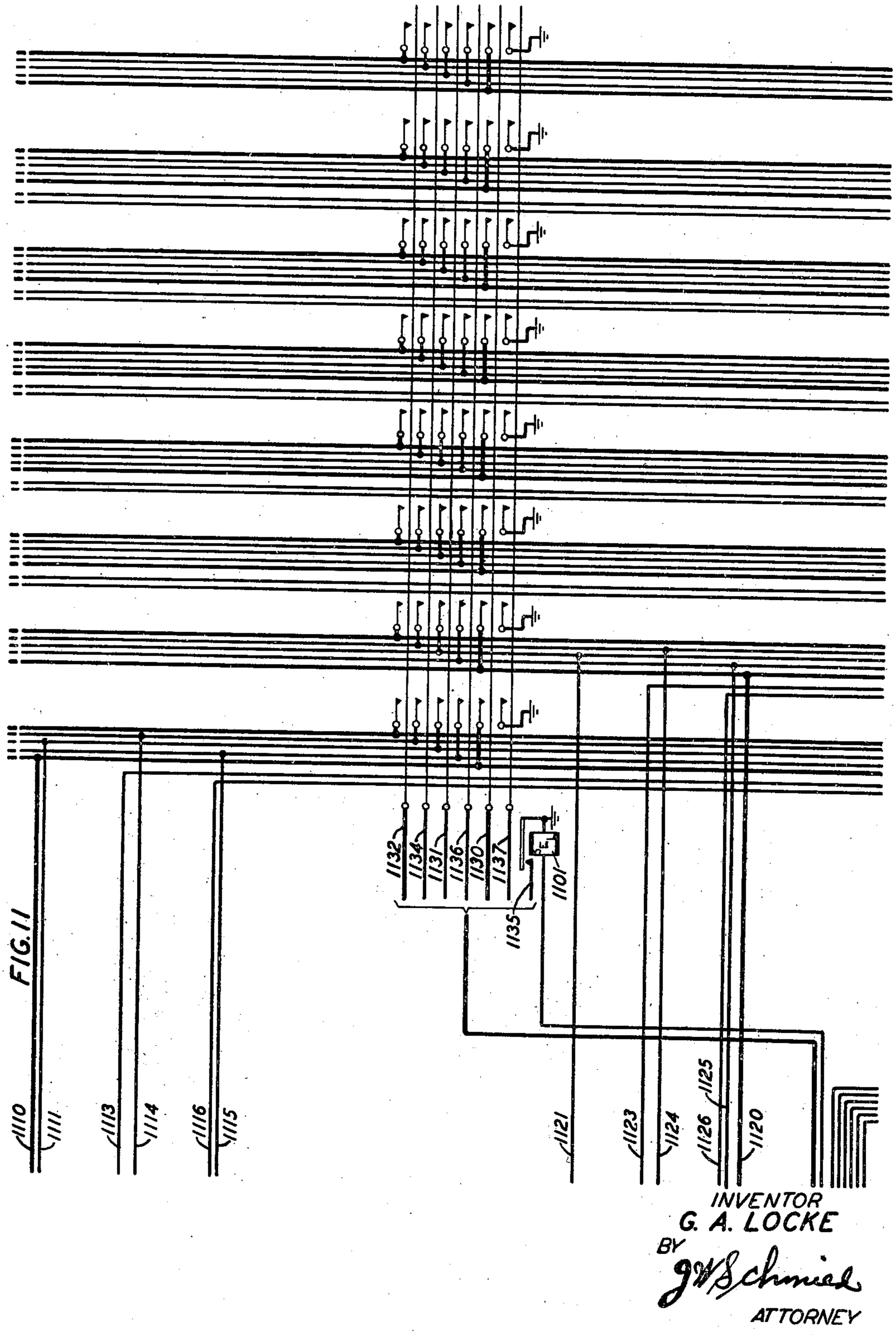

FIG. 11

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TELEGRAPH STORAGE SYSTEM

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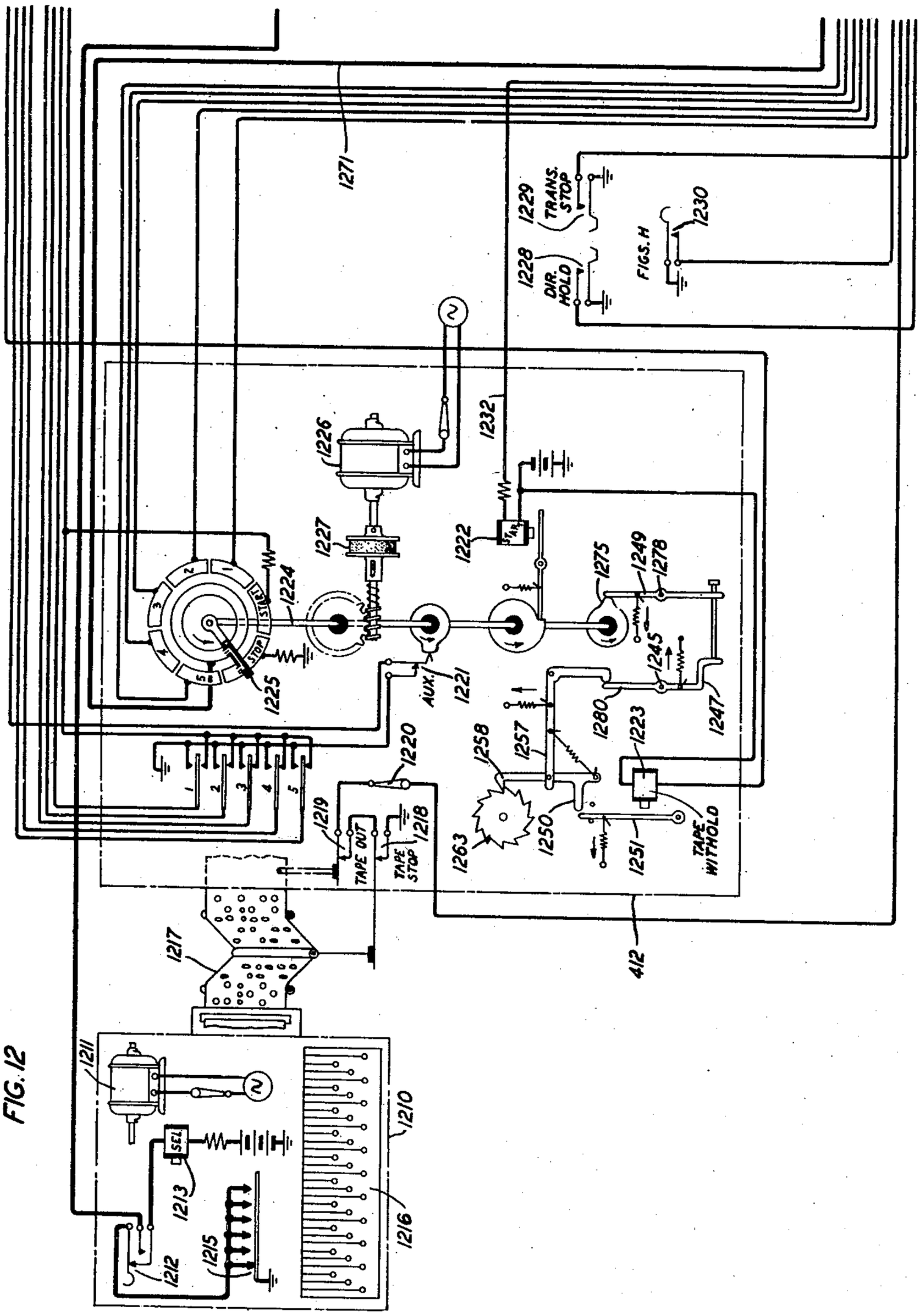

FIG. 12

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TELEGRAPH STORAGE SYSTEM

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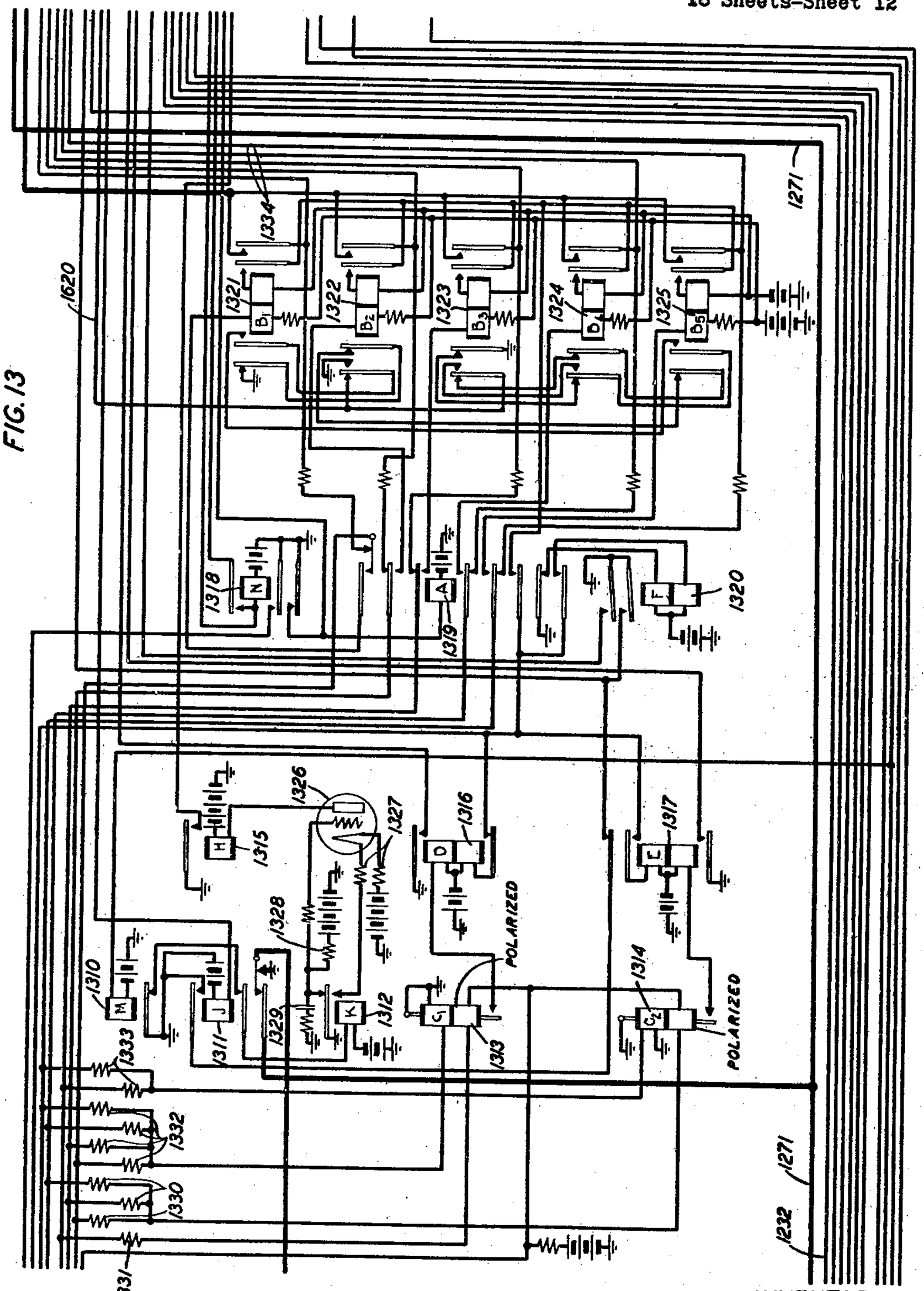
FIG. 13



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TELEGRAPH STORAGE SYSTEM

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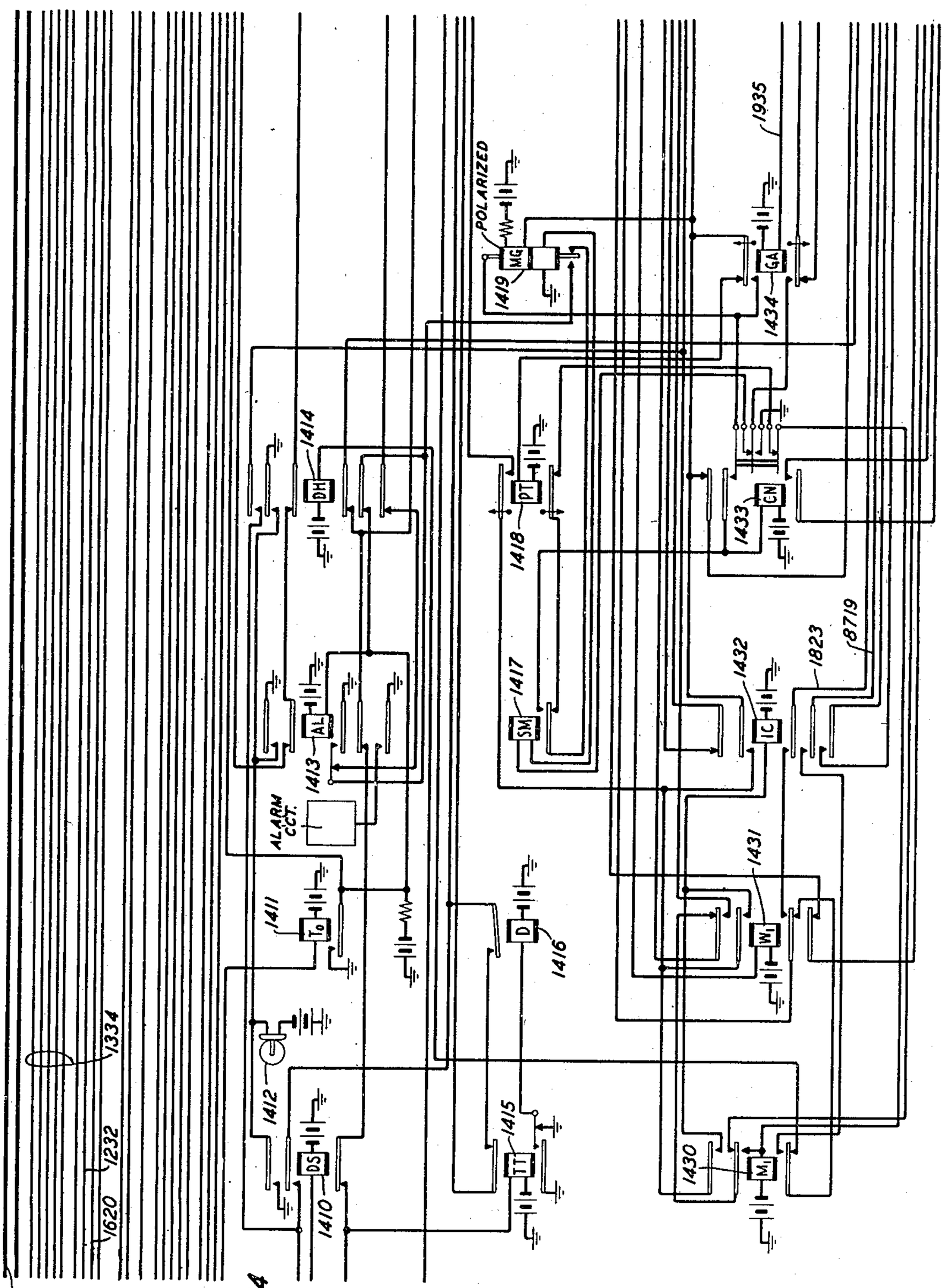

FIG. 14

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TELEGRAPH STORAGE SYSTEM

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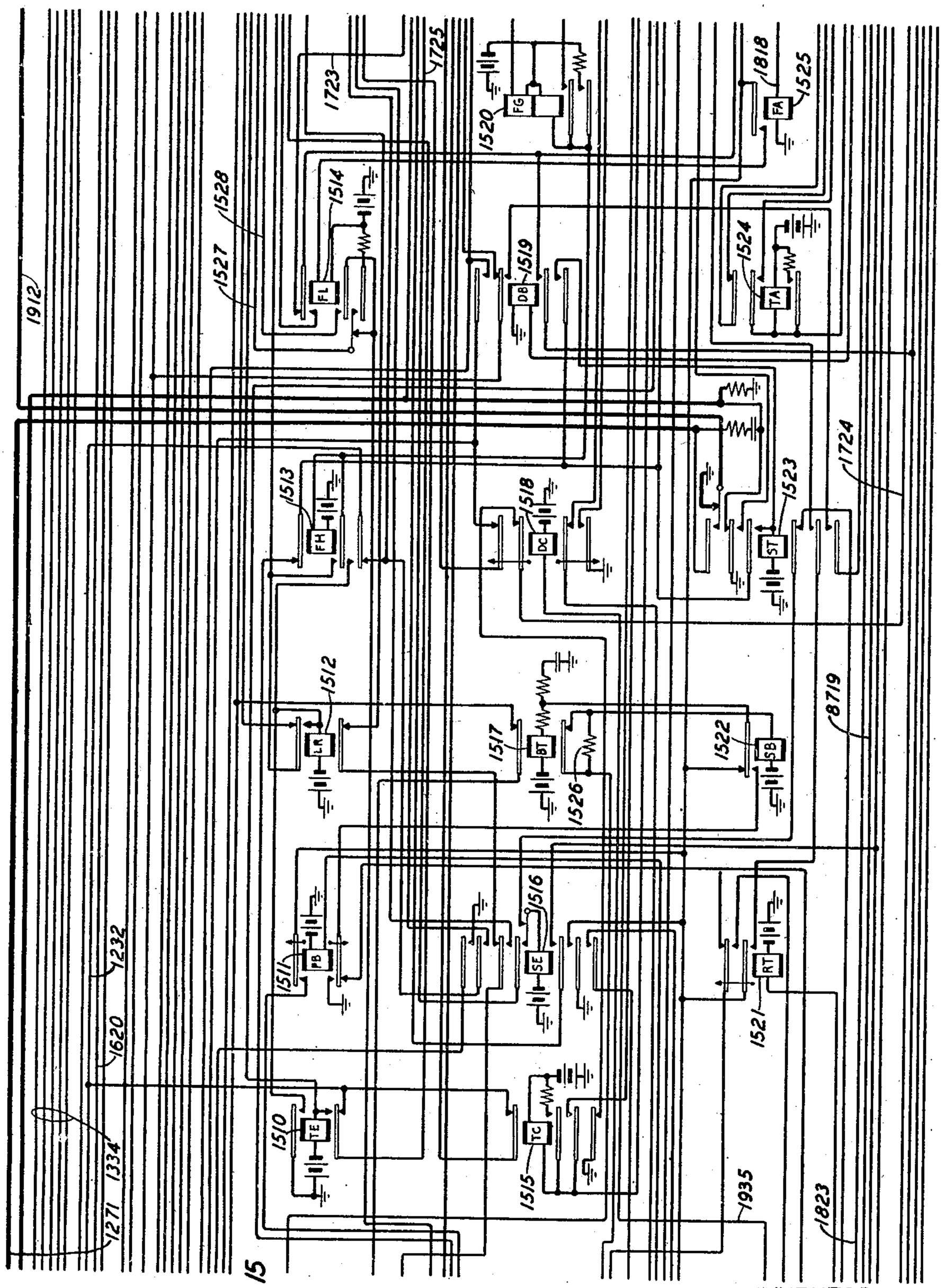

FIG. 15

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TELEGRAPH STORAGE SYSTEM

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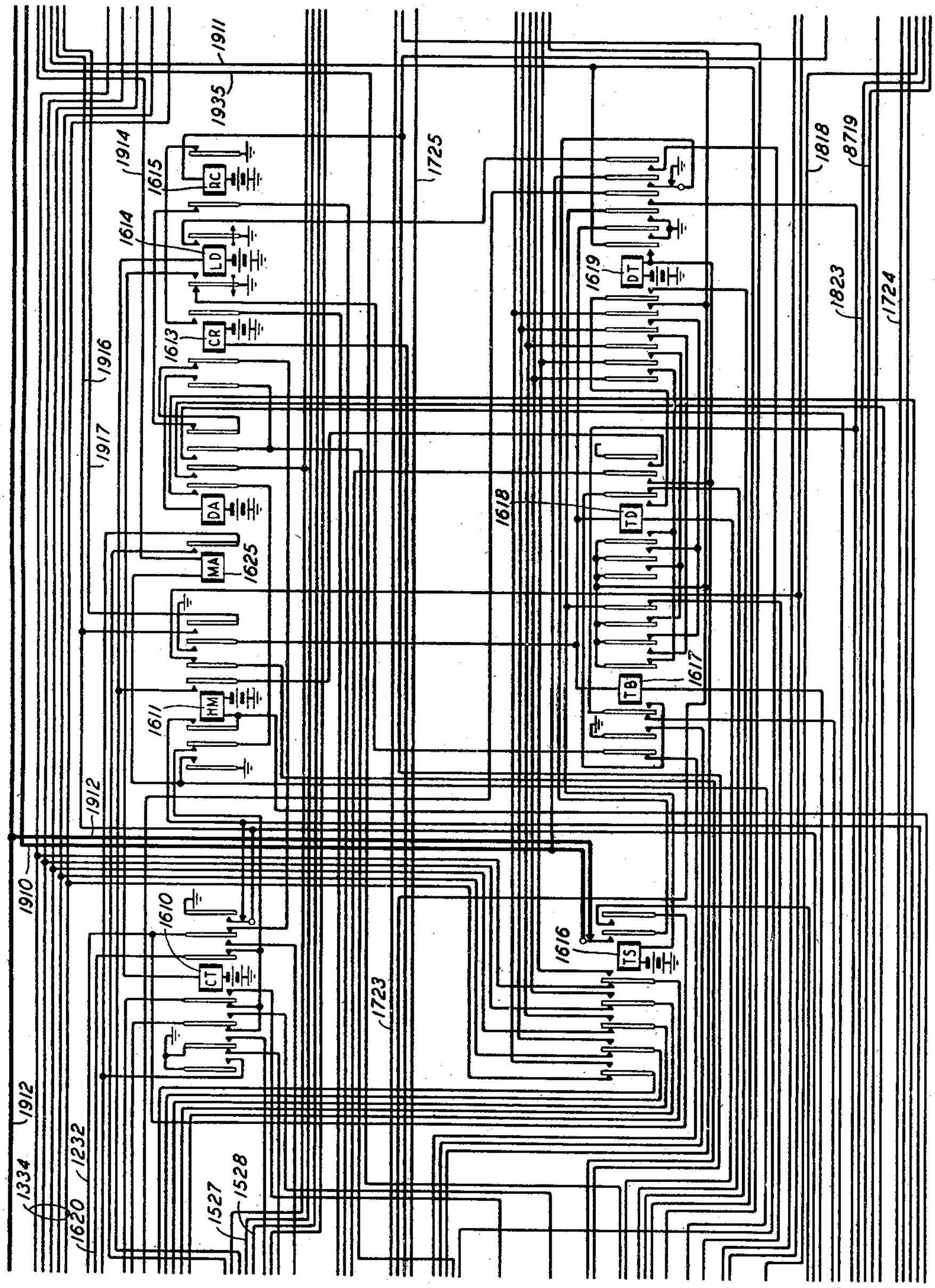

FIG. 16

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TELEGRAPH STORAGE SYSTEM

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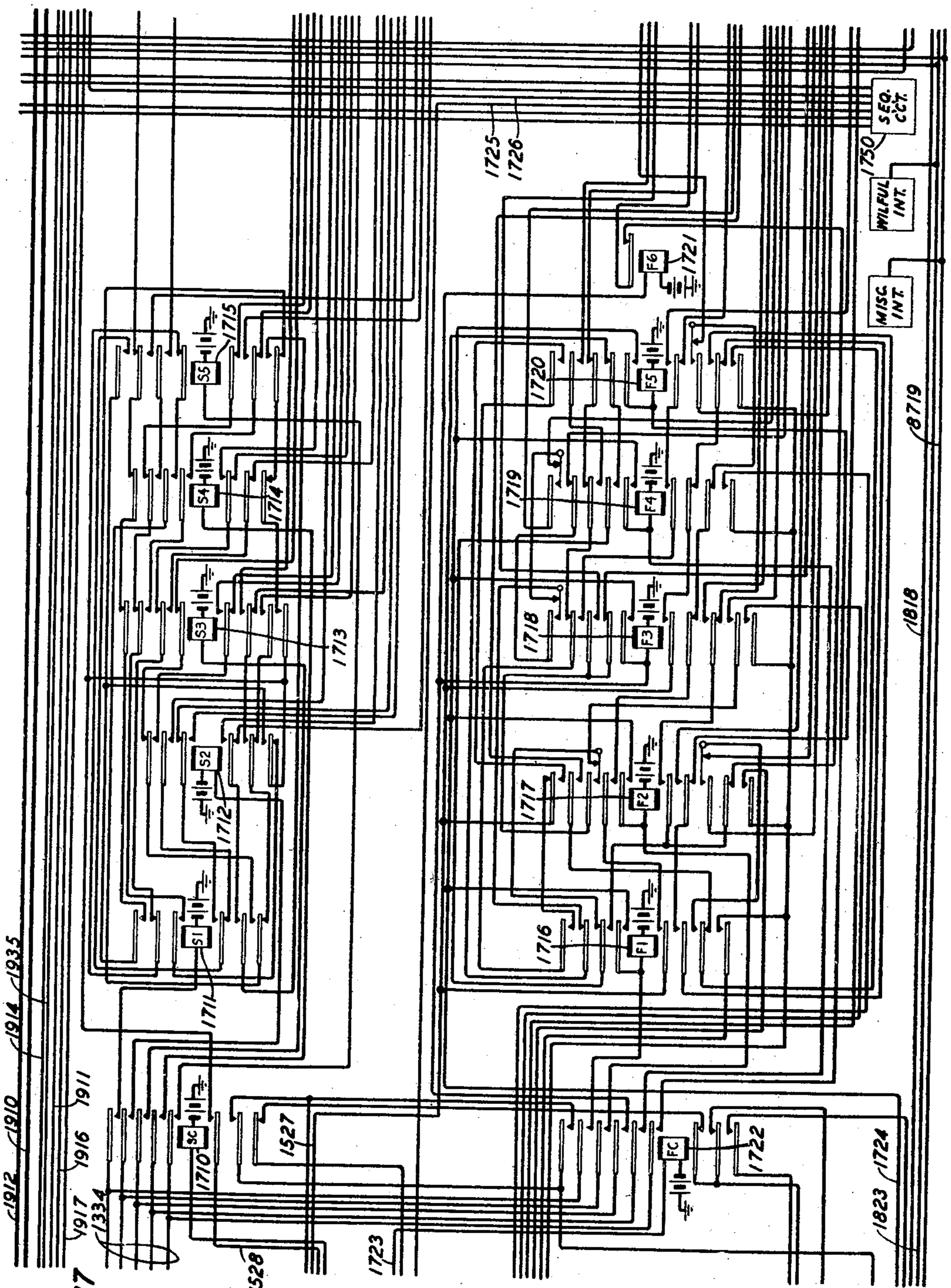

FIG. 17

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TELEGRAPH STORAGE SYSTEM

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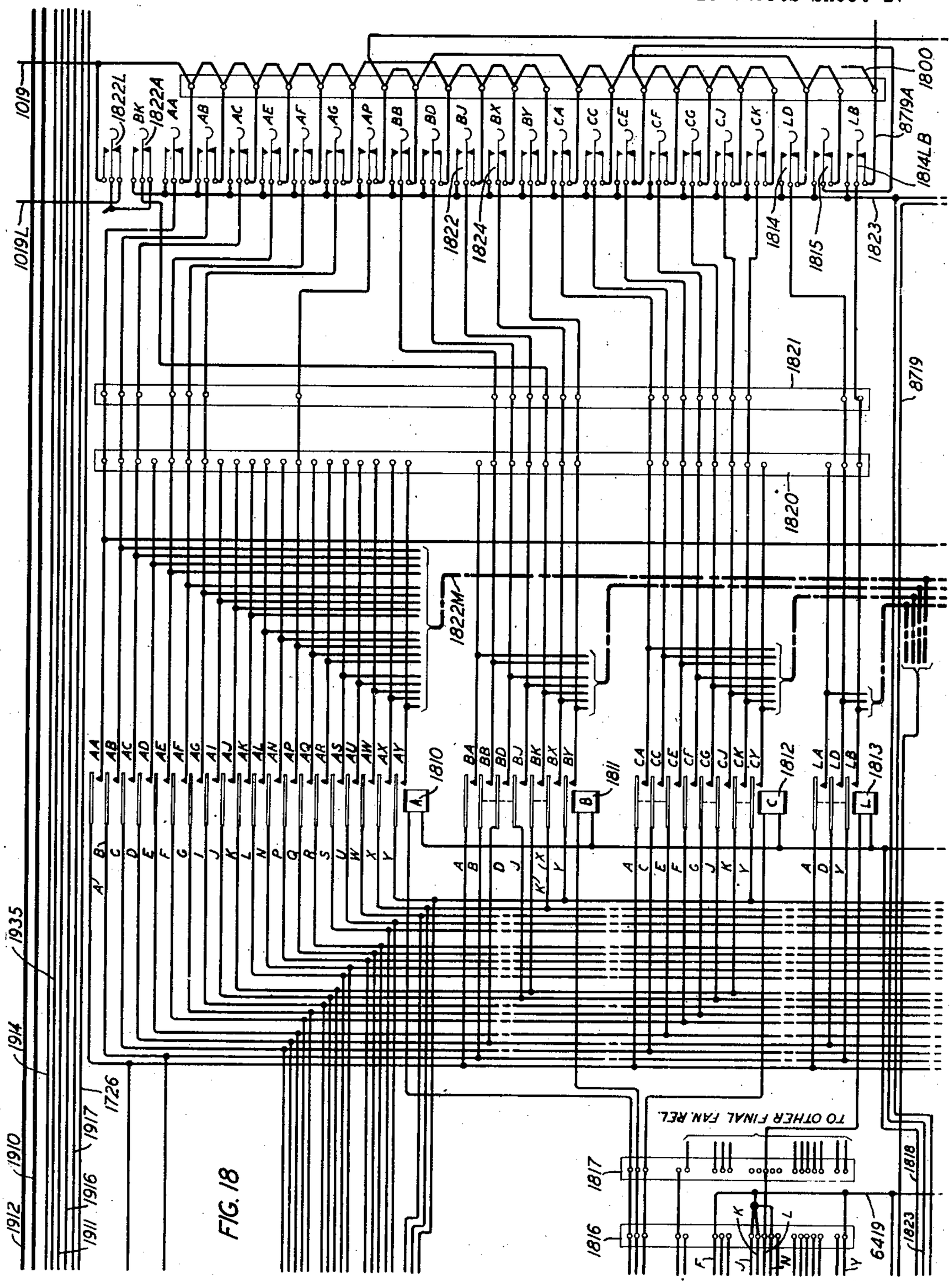

FIG. 18

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TELEGRAPH STORAGE SYSTEM

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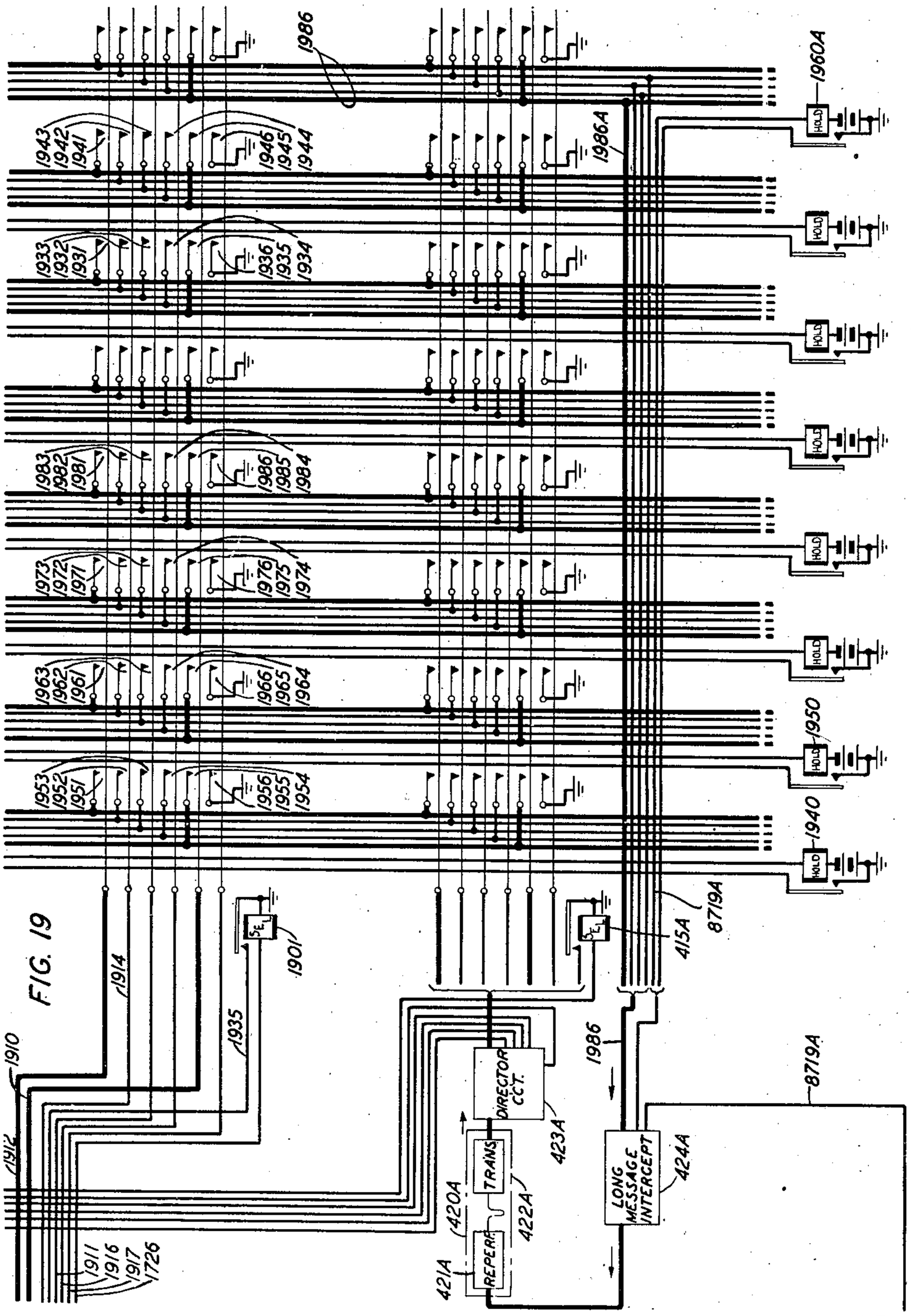

FIG. 19

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Patented Oct. 25, 1949

2,486,302

UNITED STATES PATENT OFFICE

2,486,302

TELEGRAPH STORAGE SYSTEM

George A. Locke, Glenwood Landing, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application June 28, 1946, Serial No. 679,956

3 Claims. (Cl. 178—3)

1

This invention relates to telegraph switching systems in which messages are stored in switching offices, and more particularly, to improvements in such systems for the purpose of preventing or reducing temporary overloading of outgoing lines or channels of transmission with certain classes of messages with resultant exclusion from those lines of other messages or classes of messages.

Arrangements according to the invention or involving the principles thereof may be embodied in different forms of system. In order to elucidate the principles of the invention and make manifest arrangements comprising exemplary embodiments thereof, it will first be necessary to summarize the principal features of a type of existing system in which exemplary types of the invention may be incorporated.

In an existing type of system a message storing and automatically operating message directing switching office is provided which may be connected by trunk lines to other identical or similar offices. To the central switching office there are connected a number of lines or channels of transmission which are usually duplexed, that is, they may transmit in both directions simultaneously and may utilize the same wires for incoming and outgoing transmission or transmission over intermediate sections between offices in accordance with well-known telegraph duplex practice, or they may use separate and oppositely directed paths of transmission, two of which, incoming and outgoing, are associated together as a duplex two-way line. The invention does not exclude half-duplex lines or channels which are or may be used as a part of the lines or channels of such a system or as the entirety thereof. At one or more outlying stations of such a channel of transmission, which will often hereinafter for convenience be referred to as a line, there are provided telegraph transmitters usually of the automatic type, or which may be manually operated, with associated teletypewriter or code receivers. The transmitters and receivers may be used together as a station or some stations may have transmitters only and others receivers only or some stations may have two different receivers, one of which may be provided with multiple code forms, and the other provided with means for producing a single copy only of the received message. Means are provided at the central switching office whereby the outlying transmitters are assigned times or opportunities to transmit to the central office where at the incoming transmitted messages are recorded in a reperforator. There may also be single station lines connected to trans-

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mit into a similar reperforator in the central office and there may also be originating stations in the central office consisting of a keyboard perforator into which message material may be recorded for transmission to one or more of the various outlying offices of the system. Incoming messages recorded by the central office reperforators or recorded by the keyboard perforators of the originating stations at the central office are self-directing. Usually each message begins with one or more Letters shift code combinations, then an upper case or Figures shift combination, followed by a combination which, in general, may be used as an end-of-message message signal to clear out any false or erroneous connections accidentally established through the system (if there be such), then one or more letters characters, then two code combinations comprising the address, followed by the message proper, followed by an upper case code combination used as an end-of-message message signal. The two code combinations which comprise the address function coadjuvantly to select a path of transmission across the switching office from an automatic transmitter controlled by the stored message along with its address to a reperforator associated with an outgoing line or channel of transmission which, in general, may be any one of the duplex lines or half-duplex lines referred to previously. Each outgoing line in the exemplary type of system is provided with two reperforator-transmitter sets (there may be more) which are so arranged as to transmit their messages alternately one after the other, first a message from one transmitter then a message from the other transmitter so long as both are provided with messages to be transmitted. When only one is provided with such messages it proceeds to transmit messages one after the other until its message material is exhausted or the other transmitter is provided with message material comprising one or more messages. Reperforators receive messages from the incoming lined transmitters over one or another of two types of paths. Paths of both of these types are selected by each two code combinations constituting an address but the reperforators are connected to one or the other only and the other remains idle. If the path connected is such as to lead to a reperforator associated with line connected to one or more outlying stations, the first code combination, after it is used to select the path, is not transmitted over the used path but is absorbed or dropped. The second code combination is transmitted over the path and appears in the outgoing line reperforator and is

transmitted over the outgoing line by the outgoing line transmitter to control a switching selector remotely located on the line and it causes the selective conditioning of the receiver constituting the proper address to receive the message. If the two code combinations which select a path across the office are such as to select a reperforator associated with a trunk circuit leading to another switching office, the transmission across the office occurs over another type of path over which both the code combinations of address are transmitted to be recorded by the reperforator associated with the trunk line. In this prior type of system there are also arrangements sometimes referred to as intercept circuits. One kind of intercept circuit is known as a wilful intercept circuit. In accordance with the operation of this arrangement, upon the operation of a certain key or keys, messages intended for certain stations or certain outgoing lines, instead of being directed to an outgoing line reperforator, are directed to a wilful intercept reperforator and stored for subsequent retransmission if and when the keys are restored and other appropriate keys properly positioned. The transmitter associated with the wilful intercept reperforator is coordinate in function to the transmitter associated with the perforator of a message originating station or position in the central switching office. Messages transmitted to the wilful intercept reperforator proceed thereto over a path which sends to the reperforator both the directing code combinations. A system of the type thus described is known and is described in a copending patent application of the joint inventors D. E. Branson-F. S. Kinkead-J. A. Krecek-G. A. Locke, Serial No. 448,878, filed June 27, 1942, and which issued as Patent 2,430,447 on November 11, 1947.

In the operation of a system such as just described, the system or certain lines of the system may be fully occupied during certain hours of the day with regular business messages whose expeditious transmission is desired. There may be certain other times when the system is lightly loaded with such messages and it is desired to make use of it for relatively long messages for which expeditious transmission is not particularly necessary. With respect to such long messages originating at the switching office attendants may introduce them into the system during period of light loads but this requires special attention on the part of operating personnel. Moreover, let it be supposed that the control board shows a particular outgoing line to be lightly loaded and the operating personnel at such times initiates the transmission of two or more long messages directed to a particular outgoing line. These long messages each may seize a path directed to outgoing line reperforators and if there are two such reperforators, both might become occupied by two long messages. To make the situation concrete, if each of these messages require six minutes transmission time (herein assumed maximum transmission time of a long message) and one seizes each of the two reperforators associated with an outgoing line, the line will be occupied for twelve minutes because each of the two transmitters associated therewith as stated above operate alternately to send one message each when both are supplied with messages. Let it be supposed that at the instant of initiating transmission of such long messages from an originating station at the switching office a particular outgoing line is idle but immediately thereafter several short messages arrive from outlying stations directed to the same outgoing line, then it would be almost twelve minutes before the outgoing line is free and available for the transmission of these short messages, several of which may become accumulated in the meantime. Furthermore, in the case of long messages originating at outlying stations the attendants thereat ordinarily lack present knowledge of conditions at the central switching office and may initiate the transmission of long messages at a time when the particular outgoing line to which they are directed is or is about to be fully occupied. Such long messages arrive at the central office and immediately in their proper turn preempt the outgoing line reperforators to which they are directed for periods of time up to six minutes or mutiples thereof which may result in an undesired delay of short regular business messages. It therefore becomes desirable to prevent the clogging of the storage tape of outgoing line reperforators of the system with too many long messages and an object of this invention is to provide methods of operation and equipment whereby this prevention is automatically accomplished. In the exemplary embodiment each outgoing line is provided with two transmitters as stated above and these transmitters when fully loaded operate in alternation to send messages stored by their associated reperforators to the outgoing line.

The object of the invention is accomplished by intercepting long messages which originate at outlying stations in a special intercept circuit or circuits and so condition their delivery from such intercept circuits as well as the delivery of long messages originated at the central switching office to outgoing line reperforators that delivery of any long message to outgoing lines reperforator-transmitter sets is restricted to one only of the two reperforator-transmitter sets associated with a given line and further restricted in that after delivery of one long message to this reperforator-transmitter set no further long message may be delivered thereto until a previous long message is completely transmitted and further restricted in that the other associated reperforator-transmitter set of the line has at some time or other been void of message material after the preceding long message has been delivered to the one available reperforator-transmitter set which is open to receive such messages, and further restricted in that the reperforator-transmitter set which is assigned to receive and transmit long messages must be void of message material before it is permitted to receive any long message. In accordance with this arrangement an outgoing line can not usually be utilized for more than six minutes while ordinary messages are awaiting transmission in the switching office over that line although a long message may proceed to its destination before one or more short messages. Thus, for example, let us designate one reperforator-transmitter set on a line as No. 1 and the other which is assigned to receive long messages as No. 2. It may happen that after being idle for some time the reperforator-transmitter of set No. 1 will receive several messages in succession for transmission and at the same time the reperforator-transmitter set No. 2 which has become idle will receive and accept a long message. As soon as the first message has been cleared out of reperforator-transmitter set No. 1 the reperforator-transmitter set No. 2 will seize and preempt the line for transmission of its long message where-

as subsequent messages stored in reperforator-transmitter set No. 2 will await the completion of transmission of the long message of reperforator-transmitter set No. 2. However, under these circumstances the use of the line for a long message will not consume more than six minutes whereupon no further long messages can be accepted by the reperforator-transmitter set No. 2 until reperforator-transmitter set No. 1 has at some time become void of message material and, furthermore, until reperforator-transmitter set No. 2 is void of message material. Thus the maximum time of usage of the outgoing line by a long message when short messages are awaiting transmission is limited to the time of transmission of one long message. Of course, the assumed six-minute duration for a long message is purely arbitrary time selected for purposes of explanation. In practice, the long messages may be of any length. In other words the term "long" is used broadly as a designation for a special class of messages. Message classes may consist of messages assorted according to length, urgency, address or addresses, page or tape receiving machines at their addresses, or business nature; however, to be handled by the exemplary system as "long" messages they must have a special code address.

The means whereby long messages are prevented from clogging up the outgoing line reperforator-transmitter sets will now be outlined. All such long messages which originate at outlying stations are preceded by a special character which causes them to be directed to the long message intercept reperforator in the switching office. Thus, let us suppose, that the address of a station comprises the character BK. In the case of a long message an extra character is prefixed to the address, for example, the character L (any other available character may be used), so that the address transmitted from the outlying office then comprises LBK. Upon arriving at the central switching office the combination LB is employed as a selecting combination along with other combinations prefixed by L to direct such a message to one or another of several of the long message intercept reperforators. The cross-office path leading to this reperforator is of that type mentioned above in which the first code combination is discarded so that the message upon arriving at the long message reperforator then possesses only the address BK. In the use of the system long messages may be directed to any or all stations but in current practice are directed to only certain stations of the system and all such messages are assigned special groups of code combinations such as LBK when they originate at outlying stations or BK when they originate at the central switching office. The equipment is so arranged that the special code combination such as BK being present as the address of the message in an originating station at the central office or in a long message intercept reperforator at the central office controls the associated director in the central office in such a manner as to pick a path which leads only to one reperforator-transmitter set of an outgoing line. This path is selected only under the conditions outlined above. If a particular outlying station is to receive ordinary messages as well as long messages it may be provided with two receivers, one of which has a special address such as BK assigned for long messages and the other of which

receives other messages under control of a different address.

However, an outlying station receiver may be wired to respond to and record messages represented by more than one address of which BK, for example, might be a long message address and BL an ordinary message address. Under such conditions an outlying station would originate ordinary messages with the address BL and long messages with the address LBL. These latter messages would always be intercepted in the long message intercept circuit at the switching office.

The exemplary form of the invention is similar in function to an invention of W. M. Bacon disclosed and claimed in application Serial No. 674,723, filed June 6, 1946. The present invention of which several varieties are disclosed or suggested herein may be considered an alternative species or a modification of, and an improvement upon the arrangement disclosed by Bacon.

Specific objects of the present invention are to provide arrangements more simple, convenient and effective and more easily installed than those disclosed in the said Bacon application; provide an arrangement which may be readily and conveniently added to or removed from a basic system of the type of the Branson-Kinkead-Krecek-Locke system or other similar systems without changing or modifying the circuit connections, wiring, or relays thereof; to employ for performing the desired functions a more simple and effective type of relay means and circuits including a two-step relay and to provide for associating means according to the invention with any selecting lead to be chosen by any long message cross-office transmitter in a simple manner.

A general feature of the invention is to provide for the control of telegraphic apparatus and, more particularly, a reperforator or similar storage device by relay means including a two-step relay.

A further feature comprises means for creating a busy test condition of a particular reperforator in response to the present condition of storage of said reperforator, as manifested by a condition of a single step relay, and the historical or past condition of storage of another reperforator, as manifested by a condition of a two-step relay.

From the foregoing it is evident that a feature of the invention comprises specific forms of apparatus whereby the delivery of message material to a reperforator or similar storage device is conditioned conjointly on a present condition of that storage device and the past condition of one or more other storage devices with respect to the availability thereof for storage or with respect to the quantity of message material stored therein.

Exemplary forms of the invention will now be further described in connection with the accompanying drawings wherein:

Fig. 1A illustrates the relationship in which Figs. 2, 3, and 4 are connected;

Fig. 1B shows the manner in which Figs. 5 to 19 of the drawings are connected together to illustrate one embodiment of the invention;

Figs. 2, 3, and 4 comprise a schematic showing of a system incorporating the invention; and

Figs. 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, and 19 illustrate in detail circuit arrangements embodying the invention.

The general features of an entire system of the type in which the exemplary embodiment of the invention is incorporated are known and are described in the application of Branson-Kinkead-Krecek-Locke, supra, and one entire line circuit is disclosed in an application of Bacon and Young, Serial No. 502,944, filed September 13, 1943, and which issued as Patent 2,412,955 on December 24, 1946. Hence, the following description will be limited as far as possible to the improvements constituting the present invention: the disclosures of the applications mentioned are incorporated herein by reference to the same extent as though set forth here in full and such disclosures are available for a description of any features of operation and detail not herein set forth. Apparatus operating according to the principles of the present invention may, however, be employed in other types of systems than the preferred embodiment which is illustrative rather than limiting.

In order to aid in the understanding of the relationship of arrangements according to the present invention to the disclosure of the Branson-Kinkead-Krecek-Locke application in which exemplary forms of the invention as described are incorporated, the relationship of certain portions of the present disclosure to the disclosure of the drawings of the said Branson-Kinkead-Krecek-Locke application will be set forth.

Figure of Present Disclosure	Figure of Branson et al. Disclosure
Fig. 1	Fig. 2
Fig. 2	Fig. 2
Fig. 3	Fig. 3 modified to include cross-bar vertical and selecting leads of long message intercept circuit and appurtenant apparatus.
Fig. 4	Fig. 4 modified to include long message intercept circuit together with selecting and transmission leads appurtenant thereto.
Fig. 5	Stations of and line 210 of Fig. 2 with an appropriate portion of Fig. 3.
Fig. 6	Fig. 17
Fig. 7	Fig. 18 as modified.
Fig. 8	Fig. 19
Fig. 9	Fig. 20
Fig. 10	Fig. 21 as modified.
Fig. 11	Fig. 22 modified to include contacts of an additional line circuit.
Fig. 12	Fig. 74
Fig. 13	Fig. 75
Fig. 14	Fig. 76
Fig. 15	Fig. 77
Fig. 16	Fig. 78 as modified.
Fig. 17	Fig. 79 as modified.
Fig. 18	Fig. 33 or Fig. 80 as modified.
Fig. 19	Fig. 34 or Fig. 81 with addition.

Reference numerals not specifically mentioned herein identify corresponding parts of the Branson et al. disclosure when account is taken of the fact that the last two digits identify specific elements and the first one of 3-digit numbers and the first two of 4-digit numbers identify the figure of location of such elements.

Let it be supposed that the outlying subscriber upon any outlying station of the system, for example, the subscriber at station **216** who uses the transmitter-distributor **235**, wishes to send a long message to a station such as the station **219** which, it will be noted, has two receivers, one designated by the address BK. The receiver BK may or may not especially be assigned for the receiving of long messages. In the case where it is so assigned it may include a page printer adapted to print messages on multicopy forms. The operations and principles would be similar in case any other outlying station wished to send a long message to any other outlying station.

The operator at the station **216** perforates tape comprising a long message and its address beginning with the address LBK. The manner in which the central office equipment controls the initiation of the transmission of this message from transmitter-distributor **235** and its delivery to a reperforator **326** in the central office is completely elucidated in the basic Branson et al. disclosure. Upon arriving in the reperforator **326** the immediately effective part of the address, namely, LB, functions to deliver this message to the reperforator of a long message intercept circuit consisting of reperforator **421**A, transmitter **422**A, a long message director **423** A, and control relays **424**A. The lead extending from the control relays **312** through the normally positioned intercept keys **391** to the long message intercept circuit through the control relays **424**A controls the delivery of this message to the long message intercept circuit in the same manner as that in which a message is described as delivered through an operated intercept key to the wilful intercept circuit in the basic Branson et al. application except that the transmission path is such that the character L is dropped from the address in the same manner as that in which the initial character of the two-character address is dropped from a message in delivering its cross-office to an outgoing party line reperforator. In the Branson et al. disclosure each outgoing line reperforator, each outgoing trunk reperforator and each intercept reperforator is provided with one vertical on a cross bar switch. Over this vertical there are two transmission paths. For transmission to reperforators associated with trunks or to intercept reperforators the transmitters transmit over the right-hand transmission lead of the vertical on the cross bar switch and the left-hand transmission lead remains idle although it is connected from the cross-office transmitter through the director. In transmission over this right-hand transmission lead no address character is dropped and the full address is transmitted to the particular reperforator in question to which a connection is made. On the other hand, in the case of transmission to an outgoing line reperforator associated with a party line the transmission is over the left-hand transmission lead of the cross bar vertical and the right-hand one remains idle; in this case the cross-office transmitter and each associated director is so arranged that this left-hand transmission lead is grounded during transmission of the first character of the address for which reason said first character does not arrive at the connected reperforator and is not recorded thereby.

In accordance with the present invention the exemplary and every other intercept reperforator for long messages is provided with an additional vertical on a cross bar switch with its own holding magnet, this vertical being designated **1986** in Fig. 19 and its transmission conductor being designated **1986**A in Figs. 3, 4, and 19; its holding magnet being designated **1960**A in Figs. 4 and 19; the lead to this holding magnet being designated **8719**A in Figs 4, 18, and 19. It will be seen that on the vertical conductors **1986** the long message intercept reperforator is connected to the left-hand transmission lead of the cross bar vertical in the same manner as the outgoing line reperforators are connected in Fig. 11. Consequently when the long message having the code address "LBK" is delivered to the long message intercept reperforator the "L" has been dropped and the address which

remains is "BK." Other code addresses beginning with "L" and having any other subsequent characters such as LCA or "LCL" may have their selecting leads multipled at terminal 1800 to direct messages to the long message intercept circuits. In fact any pair of characteristics may be assigned to thereby direct messages. Moreover more than one long message intercept circuit may be provided and these may be so arranged as to have long messages directed to them selectively or directed to a pair of them alternately or to only one of the pair if one is idle, in the same manner in which messages are directed to an outgoing line or directed to reperforators 1909 or to 2009 in Figs. 8 and 9 of the present disclosure, Figs. 19 and 20 of the Branson et al. disclosure.

It has now been explained how certain messages preceded by three character addresses beginning with the character "L" or other suitable character assigned for the purpose, become delivered to the one or other long message intercept reperforators with incident dropping of the "L" or other character which causes them to be so directed. Transmission out of the tape produced by such a long message reperforator is then entirely similar to transmission from a message originating transmitter in the central office, an example of which is shown in Fig. 12 of the present application together with its associated control and director circuits shown in Figs. 13, 14, 15, 16, 17, 18, and 19.

The arrangements by which delivery of such long messages either from a long message intercept transmitter or a local long message originating station to outgoing line reperforators are conditioned in accordance with apparatus embodying the invention will now be described.

The means for doing this includes a two-winding relay 719A of the one-step variety which closes all of its front contacts and opens its back contact when operated; and a two-winding two-step relay 179B having four contacts 1, 2, 3, and 4 and two windings so organized that upon energization of its main operating winding it operates to a half-way position, otherwise called one step, to close its contacts 2 and 3 but not to open its contacts 1 and 4, but on both of its windings being energized it takes a second step which not only maintains the contacts 2 and 3 closed but also opens the contacts 1 and 4. The principles of constructing such a relay are well known and relays of the kind are and have been disclosed and used. They assume various structural forms; the form is not important so long as the relay has windings and contacts equivalent to those described and is operable first to a half-step position and then to a full step position under the conditions and with the results set forth. The main operating winding of relay 719B is under the control of a front contact of relay 719A so that relay 719B cannot be operated through its main operating winding at any time unless the relay 719A is already operated or becomes operated during the time the condition for operating relay 719B through its main winding exists. If at any time while relay 719A is operated and relay 719B is operated one step, the main operating ground for relay 719B is removed and relay 719B is operated on its second step which so conditions relay 719A that it will be released if its main operating winding path is open or becomes open and, moreover, incident to the release of relay 719A, the relay 719B is also released so that both relays are then released. The further association of these relays with each other and with the rest of the system through the interassociating circuit arrangements will be apparent from the following description.

As previously stated and in accordance with a preferred form of the invention a long message can be delivered to one only of the two outgoing line reperforators. It will be assumed that, after the L is dropped off such a message has the address BK and, consequently, is directed to a receiving recorder 229 at station 219. By reference to Fig. 18, the selecting lead corresponding to address BK, beginning at contact of relay 1811, proceeds over an intercept key 1822A. If the intercept key 1822A is not normal that is, is operated, as could be the case if station 219 is idle for the day or out of order, this long message would be directed to a wilful intercept circuit over lead 1823 and thereafter proceed as described in the Branson et al. disclosure. This, however, would be an unusual condition and ordinarily the intercept key 1822A would be normal as indicated and the lead would proceed to a special key 1822L. If key 1822L were operated the message would be directed to one or the other of the two outgoing line reperforators 806 or 926 of Figs. 8 and 9 in the regular manner. This, however, would be the condition only when long messages were to proceed as regular messages. Ordinarily, the long message key 1822L would be normal as positioned in Fig. 18 and the selecting lead 1019L would proceed through Figs. 10, 9 and 7 to the lower armature of relay 719A. If the relay 719A were operated the lead would be grounded at a front contact which would give a busy indication to the busy test relay 1517 and no selection would occur. If relay 719A is released the lead 1019L proceeds over a back contact thereof to the middle armature of relay 1016 over which it meets ground if reperforator 926 is busy and battery if reperforator 926 is idle to make a selection which connects the transmitter of Fig. 12 or any transmitter making a selection on the address BK such as another long message intercept transmitter, to the reperforator 926 to initiate storage of the message in tape 930. Therefore it is seen that the operated condition of relay 719A indicates to the transmitter of Fig. 12 or other transmitter seeking it over lead 1019L that the reperforator 319 is unavailable, in other words, the indication is just the same as if the reperforator 926 were busily engaged in reperforating a message transmitted by some other cross-office transmitter regardless of whether it is busy or not; on the other hand, if relay 719A is released, the selecting lead is extended as aforementioned to the middle armature of relay 1019 to determine whether the reperforator 926 is actually busy owing to its having been seized and still remaining seized by some other cross-office transmitter. If it is actually busy the busy indication is given regardless of the operated or unoperated condition of relay 719A. But when reperforator 926 is not actually busy and the relay 719A is released the selecting lead is extended to battery over the inner upper armature and back contact of relay 1017. This causes the relay 1517 to operate. It therefore appears that in addition to the normal busy condition of reperforator 926 due to the fact that it is at the instant connected to a transmitter for the recording of a message there is a superimposed possible busy condition which is a function of the position of the lower armature of relay 719A.

When relay 719A is released and reperforator 926 is not busy the result is that the holding mag-

net 1950 operates (horizontal magnet 1901 having been previously operated as described in the Branson et al. disclosure) to connect the transmitter 412 (Fig. 4) which is more fully disclosed in Fig. 12 to the receiving magnet 925 of the lower level reperforator 926 shown in Fig. 9. The long message will then be transmitted to the lower level reperforator of Fig. 9 and stored in the tape 930 thereof. Following this other messages from other cross-office transmitters may be stored in the same tape and also after the initiation of storage other messages may become stored in the tape 830 of the upper level reperforator machine 806. Messages stored by the two reperforators will be transmitted over the outgoing line in the manner set forth in the Branson et al. disclosure, it being noted that no further message from the transmitter of Fig. 12, or other long message transmitters, seeking access thereto over lead 1019L may be delivered into storage in the reperforator 926 of Fig. 9 until such time as relay 719A is again released.

At any time either reperforator 926 or 806 is idle it may be seized by any cross-office transmitter seeking it over selecting lead 1019, always assuming of course that use of the cross bar switch has been assigned for the purpose by the sequence circuit. Upon such seizure message material will be transmitted to it. Assuming that storage of a long message by the reperforator of Fig. 9 in the tape 930 has commenced it may be possible that storage of several other messages in the tape 830 of the reperforator of Fig. 8, one after the other, will be initiated and will proceed. Whichever transmitter associated with these reperforators seizes the outgoing line will proceed to transmit one message. If this happens to be a message from tape 830 the transmitter associated with tape 930 will take the next turn and subsequent messages, however long or short and of whatever number, which have arrived in tape 830 will be obliged to remain stored in the tape 830 until the long message stored in the tape 930 has been completely transmitted. It will be noted that cross-office transmission for the purpose of storing the long message in tape 930 of Fig. 9 will be over the left-hand transmission lead of the vertical on the cross bar switch under the control of vertical magnet 1950 with the result that the character B of the address BK will have been dropped. The manner in which a message proceeds over the outgoing channel 211 of the party line 210 and is recorded in the recorder 229 of the outlying station 219 under control of an address character such as the character K is all set forth in the Branson et al. disclosure and need not be repeated here.

To repeat, the reperforator 926 always tests busy when relay 719A is operated and may test idle and available to a long message reperforator when relay 719A is released. It therefore becomes pertinent to enter onto a discussion of when and under what circumstances the relay 719A is operated or released.

Relay 719A has an operating winding extending from battery over conductor 730 to ground upon the tape contact 921 of reperforator 926. When the reperforator is supplied with one or more characters including blank or all spacing codes of untransmitted punched tape the contact 921 is closed and the operating path 730 of relay 719A always operates or maintains the relay operated. When relay 719A is operated and relay 719B is not operated the relay 719A closes at its inside lower armature a locking path having to

do with the second step of relay 719B and at its inner upper armature a locking path for itself and at its outer upper armature a path to prepare for the operation of relay 719B. But, under the condition that relay 719B is released and contact 921 is opened, none of these contacts closed by relay 719A is effective and when contact 921 is again opened relay 719A is released. If, however, relay 719A operates at any time while contact 921 is closed, the operating path of relay 719B is established from battery through its upper winding, its contact 1, the upper front armature of relay 719A and conductor 731. This causes the double-step relay 719B to operate one step which closes the upper armature to its front contact 2 and the lower armature to its front contact 3. This establishes a locking circuit to lock the relay 719A operated on a path from battery through its upper winding front contact on its inner upper armature and contact 2 of relay 719B to ground. The relay 719A cannot then release until relay 719B opens at its contact 4 the path through its contact 2 and then only if the main operating path of relay 719A through conductor 730 is open or becomes open at contact 921 which can only occur if the reperforator 926 is devoid or becomes void of stored untransmitted tape. On the other hand, relay 719B remains operated so long as ground is applied at the contact 921. If at any time this ground is removed a path is established to cause the double-step relay 719B to take another step, namely, a short circuit on its lower winding, which has previously been maintained by the contact 921, is removed and battery is extended through both of its windings, namely, through the upper winding, its contact 3, front contact on an inner lower armature of relay 731, lower winding of relay 719B to ground. This causes the relay 719B to take a second step which opens its contact 4 thus rendering its contact 2 ineffective and opens its contact 1 which frees the relay 719B from its main operating path and, consequently, renders it temporarily independent of the closed condition of contact 921, and, consequently, independent of whether the reperforator 906 is or is not supplied with untransmitted stored tape characters. The reperforator may then become devoid of stored untransmitted characters repeatedly with intervening storage of characters without any effect upon the relay combination consisting of relays 719A and 719B unless and until relay 719A has its main operating path opened by opening of the contact 921. Upon the occurrence of this event, inasmuch as the locking path for relay 719A is opened at the open contact 4 of relay 719B, the relay 719A releases. Incident to this release relay 719B is released, and thereupon inasmuch as the selecting lead 1019L has been rendered continuous up to the middle armature of relay 1016, the transmitter of Fig. 12 or any similar transmitter seeking the reperforator 926 over the selecting lead 1019L is free to deliver a message to the reperforator.

Consequently, it will be seen that the condition for delivery of a message to the reperforator 926 is that it must be free of untransmitted stored message material at the instant and furthermore that reperforator 806, regardless of its present condition of storage, has at some time been devoid of untransmitted stored message material after the reperforator 926 was so devoid.

The foregoing may be summarized under several conditions:

Condition No. 1

Reperforators **926** and **806** are both devoid of untransmitted message material under which conditions selection of reperforator **926** may be made by a long message.

Condition No. 2

If reperforator **806** continues devoid of message material and reperforator **926** supplied with message material, the relay **719A** is operated and no selection of reperforator **926** by a long message may be made.

Condition No. 3

Beginning with Condition No. 2, if reperforator **926** becomes devoid of message material, relay **719A** releases and the conditions are the same as under Condition No. 1.

Condition No. 4

With both reperforators devoid of untransmitted message material and reperforator **806** becomes supplied with this material, relay **719A** remains released and relay **719B** remains released. Consequently, selection of reperforator **319** by a long message may be made.

Condition No. 5

If during Condition No. 4 reperforator **926** perforates untransmitted message material to the extent of one character or more, relay **719A** operates, relay **719B** operates one step, relay **719A** locks over the contacts of relay **719B** and no selection of reperforator **906** by a long message may be made.

Condition No. 6

Reperforator **806** becomes devoid of message material once or any number of times while reperforator **926** remains supplied with untransmitted message material; this causes relay **719B** to take its second step as described above but because relay **719A** remains operated no selection of reperforator **319** by a long message may be made.

Condition No. 7

Beginning with Condition No. 5, reperforator **806** becomes devoid of untransmitted message material once or any number of times and then becomes supplied with untransmitted message material again at which time reperforator **926** becomes devoid of message material. Under this condition, for the reasons previously described, relay **719A** becomes released and selection of reperforator **926** by a transmitter seeking to transmit to it a long message may be made.

Condition No. 8

With both reperforators **926** and **806** supplied with untransmitted message material both become devoid thereof either simultaneously or successively. This restores the circuits to Condition No. 1 and reperforator **926** is available for forwarding of a long message.

It therefore appears that messages other than long messages will never become stored behind more than one long message and that messages other than long messages will never be delayed in transmission because of a long message by more than the transmission time of one long message; however, several other messages may at times be so delayed by one long message. It also appears that a pair of outgoing line transmitters will never be devoid of message material awaiting transmission at any time while any message including the class of messages designated long

messages are awaiting transmission in the tape of an incoming line reperforator or the tape of a switching office message originating station except fortuitously and at rare intervals such a message may have to await the use of the cross bar switch. However, since the cross bar switch is used for a time of the order of a fraction of a second for routing each message, delays due to this cause will be exceedingly short. As previously stated, the object of the invention is to prevent the clogging of the outgoing line transmitters at the switching office by the class of messages designated long messages but the same principles may be applied to any particular class of messages whether long or short.

Furthermore, messages of the class of long messages as we have previously pointed out may normally be directed by means of a selecting lead **8719A** to one or another of one of the long message intercept circuit reperforators. If it should happen that the tape of the long message intercept reperforators becomes clogged with too great an accumulation of such messages during a time when the system is working at full capacity, such messages may be intercepted by operating key **1814LB** which causes them to be directed to one or one of more than one wilful intercept reperforators **421** which is or may be provided in a system of this type. Key **1814LB**, when operated connects code point LB to lead **1823** for this purpose. In being transmitted to this wilful intercept reperforator these messages will not drop the character "L" from their address designation and such character will remain stored as the first code of the address "LBK" so that later they may be transmitted automatically from the wilful intercept transmitter and delivered to a long message intercept reperforator from which they will take their course in the manner previously described. Also it is obvious that certain long messages stored in long message intercept circuits may be intercepted in part in wilful intercept circuits by operating intercept keys corresponding to their individual addresses to the exclusion of others which are automatically routed to their proper outgoing lines. It is therefore seen that the system is extremely flexible; by operating appropriate keys at appropriate times a sorting operation of various messages may be carried on whereby certain messages may be sorted out from others and arranged in consecutive order in a storage tape whereby the others may be arranged in consecutive order in another storage tape or forwarded over outgoing channels; all this being done automatically with no more difficulty than the timely operation or release of appropriate keys. Once having been sorted, one group of messages may be transmitted ahead of another or not at will by the operation of certain other keys.

Selecting lead **1019L** need not necessarily be limited to selection of reperforator No. 2 but after passing through the contact of relay **719A** it may be extended to connect back to selecting lead **1019** whereby either reperforator No. 1 or reperforator No. 2 or both may be enabled to receive a long message under the same conditions as previously outlined under which reperforator No. 2 may receive a long message. This further illustrates the flexibility of this type of system as it will enable only some given maximum number of one class of messages to proceed over a cross-office path while others of another class remain concurrently awaiting transmission over a path to an outgoing line reperforator associated with the particular outgoing line.

The Branson et al. system discloses an arrangement in which at a first switching office which we may call "Office A" code addresses beginning with certain characters direct their messages over a trunk to another switching office which we may call "Office B." In the disclosure the initial code character "L" is a character so chosen. Care must be taken to avoid confusion of characters so in the present system it is assumed and indicated that character "L" is not used to direct messages to a trunk in the office illustrated in the drawings. This leads to a discussion of a system of this type in which a message of a class designated "long message" may be directed to a special long message intercept reperforator at "Office A" and again at "Office B." This can be done by proper assignment of addresses. Let all addresses of long messages originating at the "Office A" end of the system directed through the "Office B" end of the system begin with "L" which, in combination with a second character identifies a selection path which leads to the long message intercept circuit and let all addresses beginning with a chosen character such as "F" direct such messages over a trunk. Thus, a message having the address "LFYX" at "Office A" could be sent to long message intercept by "LF," "L" being discarded; to an outgoing trunk by "FY"; to a long message intercept at "Office B" by "FY," "F" being discarded; to a proper outgoing line by "YX," "Y" being discarded; and to a proper receiving station by "X."

At "Office B" a message having the address "FLBK" would be sent to a long message intercept together with all other messages having "F" as a first directing character, "F" being discarded; to a trunk extending to "Office A" by the characters "LB," along with other pairs of characters beginning with "L"; to a long message intercept at "Office A" by "LB," "L" being discarded; to the proper outgoing line 210 by "BK," "B" being discarded, and to the proper receiving station and recorded 229 by character "K."

Thus, "L" followed by any character could direct messages to the long message intercept at "Office A"; and "F" followed by any character could direct messages to the trunk toward "Office B"; at "Office B," "F" followed by any character could direct messages to the long message intercept and "L" followed by any character could direct messages to the trunk toward "Office A." Suitable selection of address codes and cross connections and multiple connections to code points could be made accordingly. The flexibility and utility of systems involving apparatus and methods according to the invention is thus further exemplified.

What is claimed is:

1. In combination, a test conductor, a first and a second device each having a first and a second condition, means whereby said test conductor always tests available if both of said devices are in their first condition, means whereby the test conductor may test available if the second only of said devices is in its first condition, comprising a two-step relay, means operating said relay one step if both of said devices are in their second condition simultaneously, means to step said two-step relay a second step preparatory to making said test conductor test available if said first device assumes its first condition while said second device is in its second condition, and means operated conjointly by said two-step relay in its second step position and the assumption by said second device of its first condition to cause said test conductor to thereafter test available regardless of whether said first device remains in its first or second condition.

2. A reperforator-transmitter set having is storage means, a relay operated by the presence of untransmitted stored material in said storage means, another reperforator-transmitter set having storage means, a relay operable one step by the absence of untransmitted stored material in said other set when said first-named relay is operated, means operated by untransmitted stored material in said second-named reperforator-transmitter set's storage means to operate said second relay another step, and means thereafter operated by exhaustion of stored material in the means of said first-named reperforator-transmitter set to cause said first-named relay to release regardless of the present condition at that instant of the presence or absence of tape in said second-named reperforator-transmitter set.

3. A recording device, selective means for delivering message material to said recording device for recording comprising a relay rendering said recording device available whenever it is free of untransmitted message material, a second recording device, other relay means for rendering said first-named relay ineffective to render said recording means available if and when said second recording device first becomes supplied with recorded material, and means interconnecting said relay means with said relay whereby absence of recorded material from said second recording device reconditions said relay to render said first-named recording device available thereafter upon exhaustion of its recorded material regardless of the existing presence or absence of material stored by said second recording device.

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