Nov. 1, 1949. W. M. BACON 2,486,699

CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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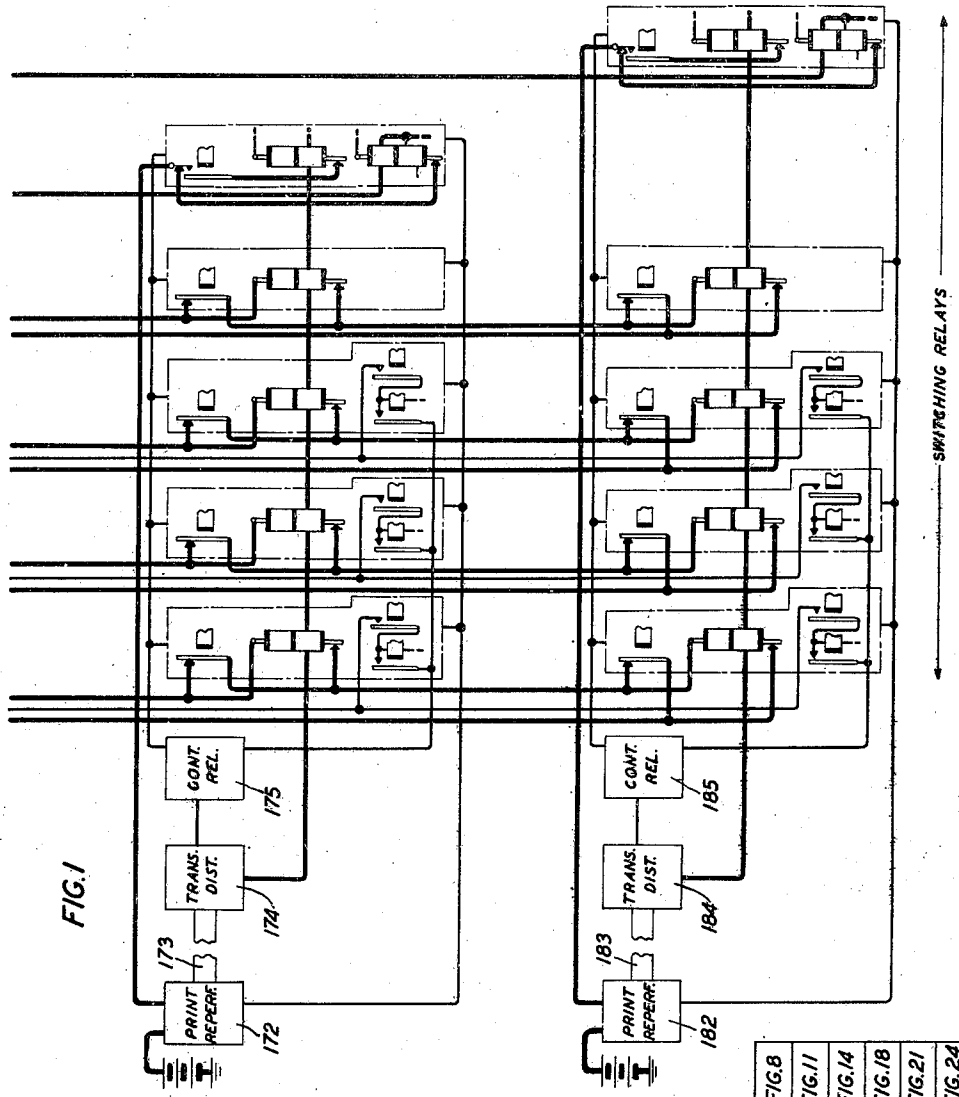

FIG. 1

FIG. 30

FIG. 2	FIG. 3
	FIG. 1

FIG. 31

FIG. 5	FIG. 6	FIG. 7	FIG. 8				
FIG. 2	FIG. 9	FIG. 10	FIG. 11				
FIG. 4	FIG. 12	FIG. 13	FIG. 14				
FIG. 15	FIG. 16	FIG. 17	FIG. 18				
		FIG. 19	FIG. 20	FIG. 21			
			FIG. 22	FIG. 23	FIG. 24		
				FIG. 25	FIG. 26	FIG. 27	

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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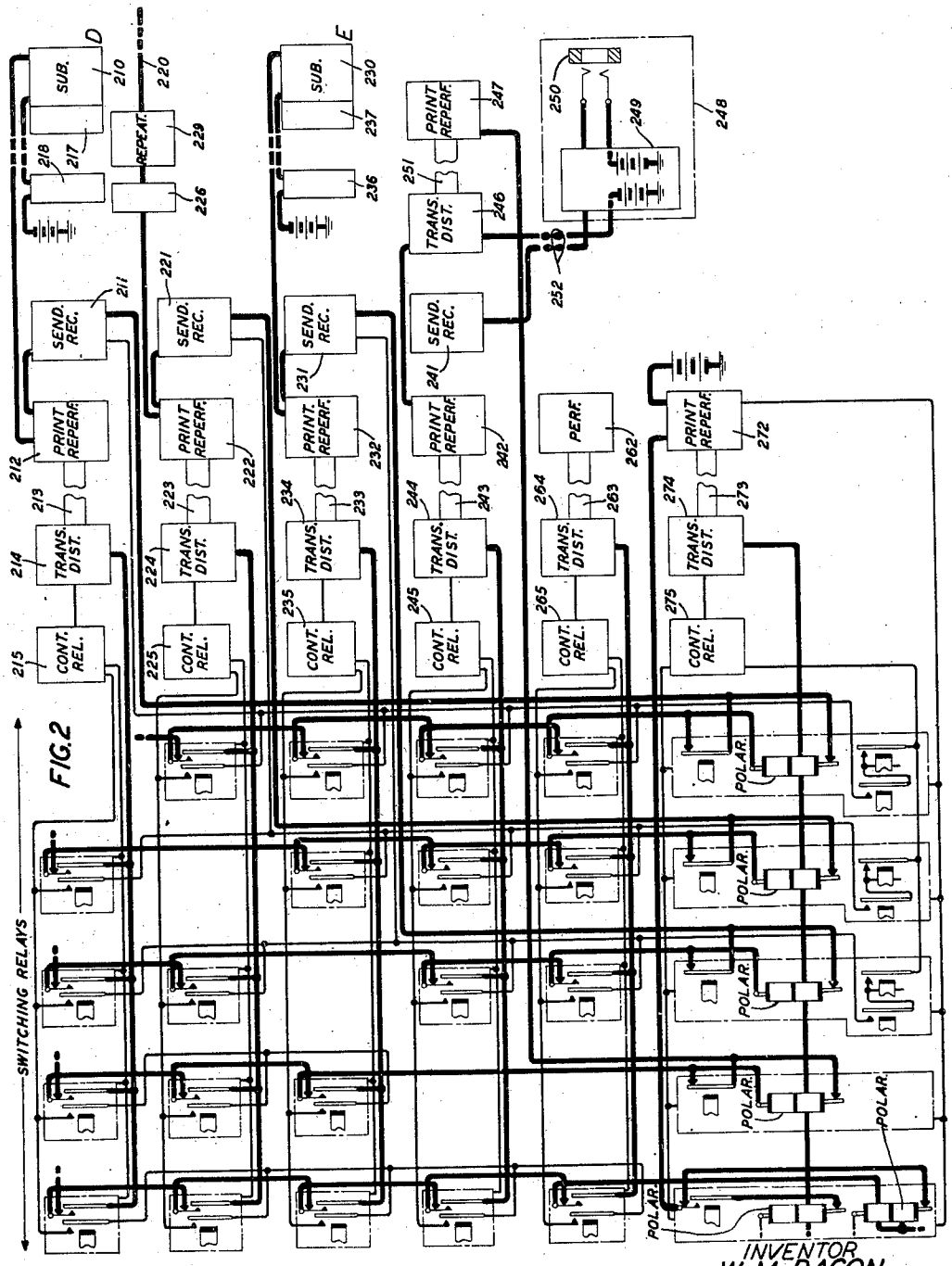

FIG. 2

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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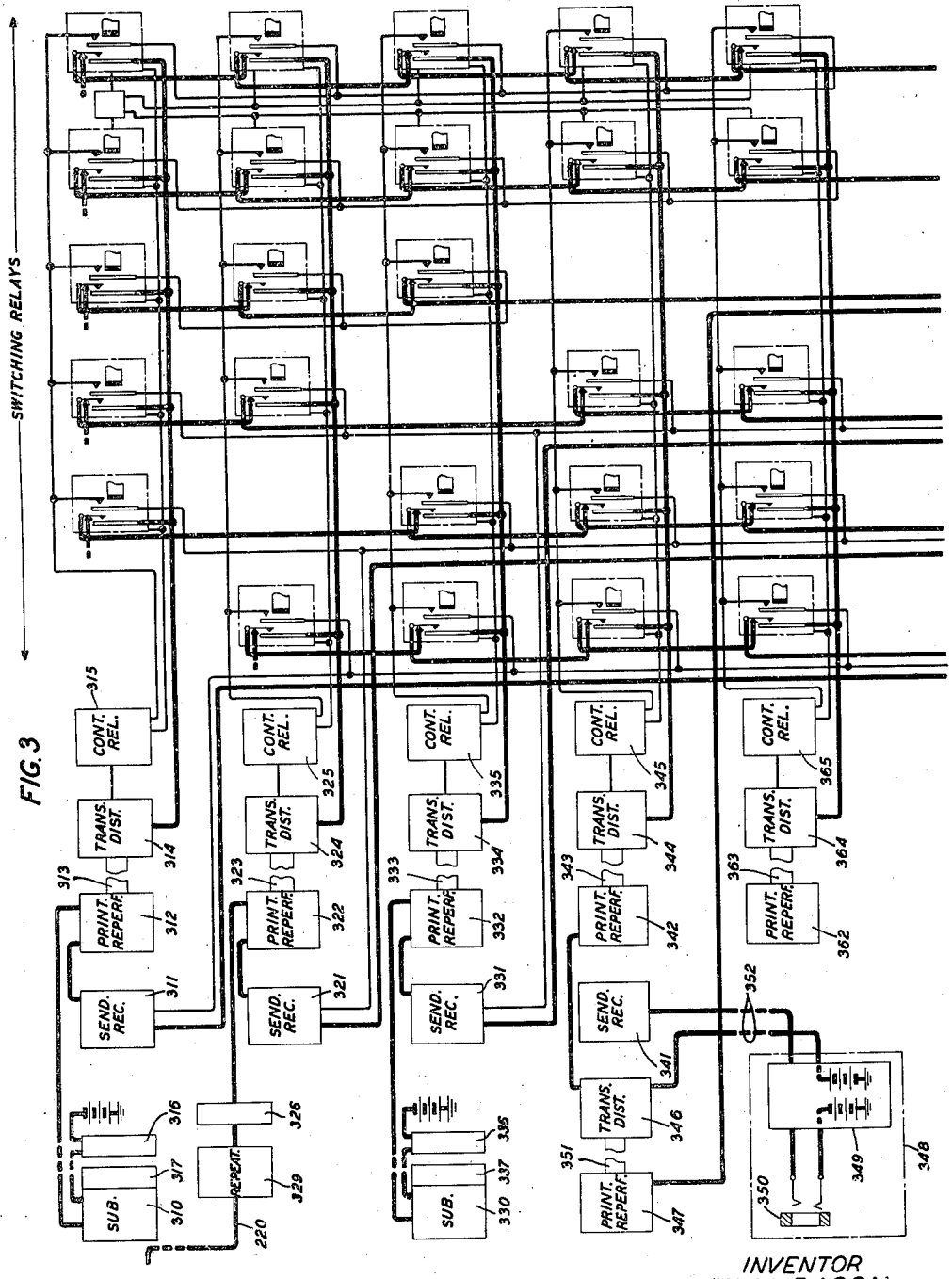

FIG. 3

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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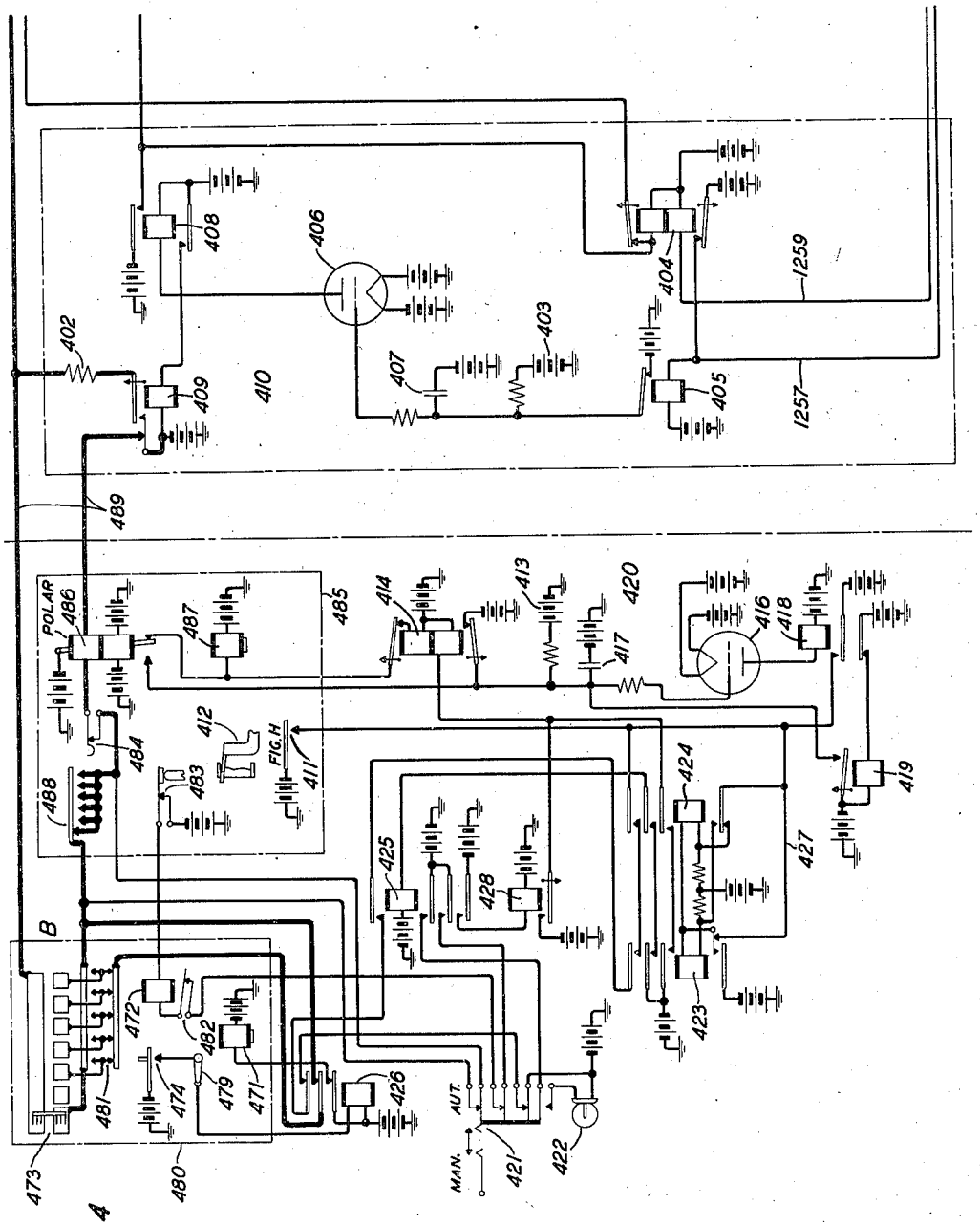

FIG. 4

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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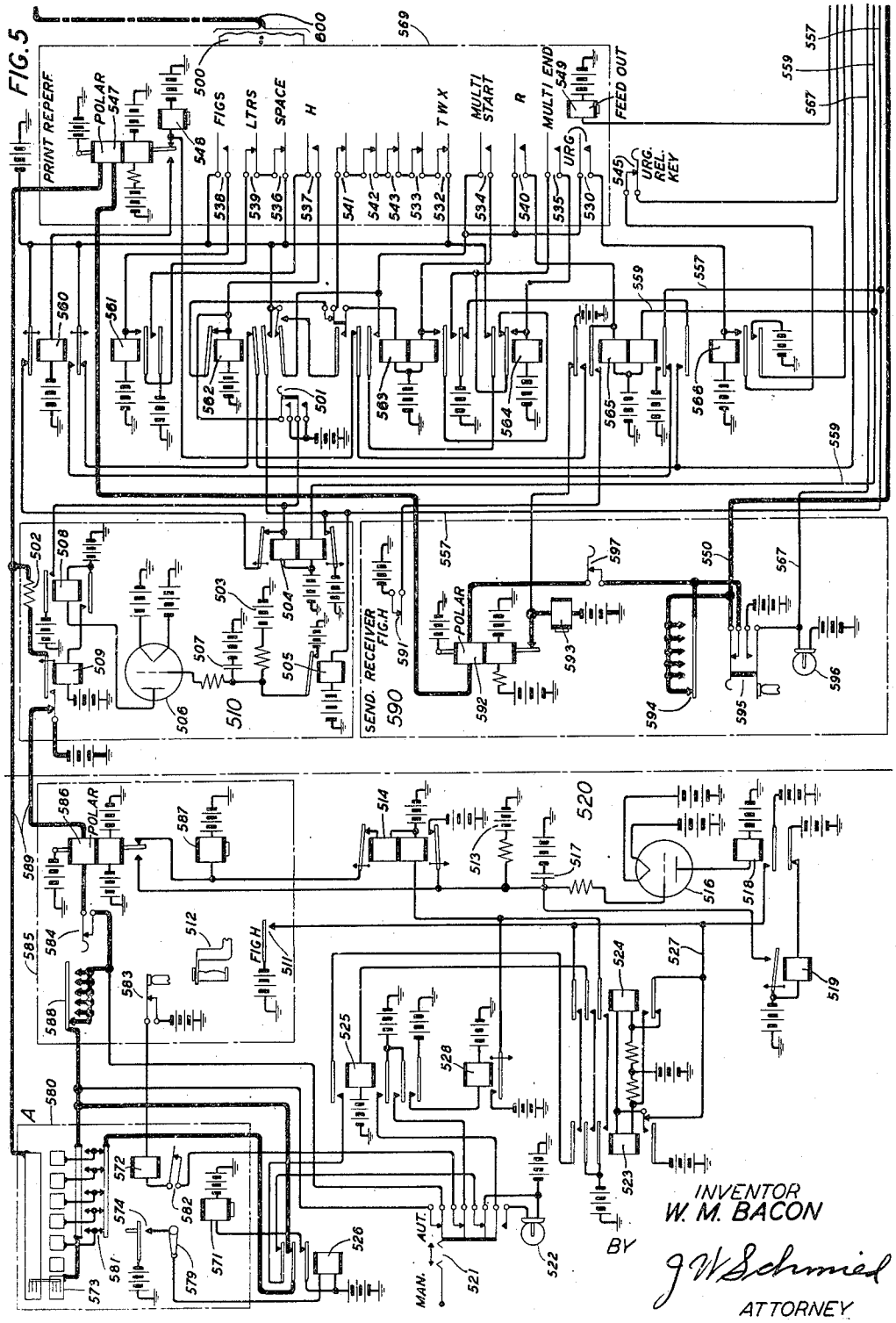
FIG. 5



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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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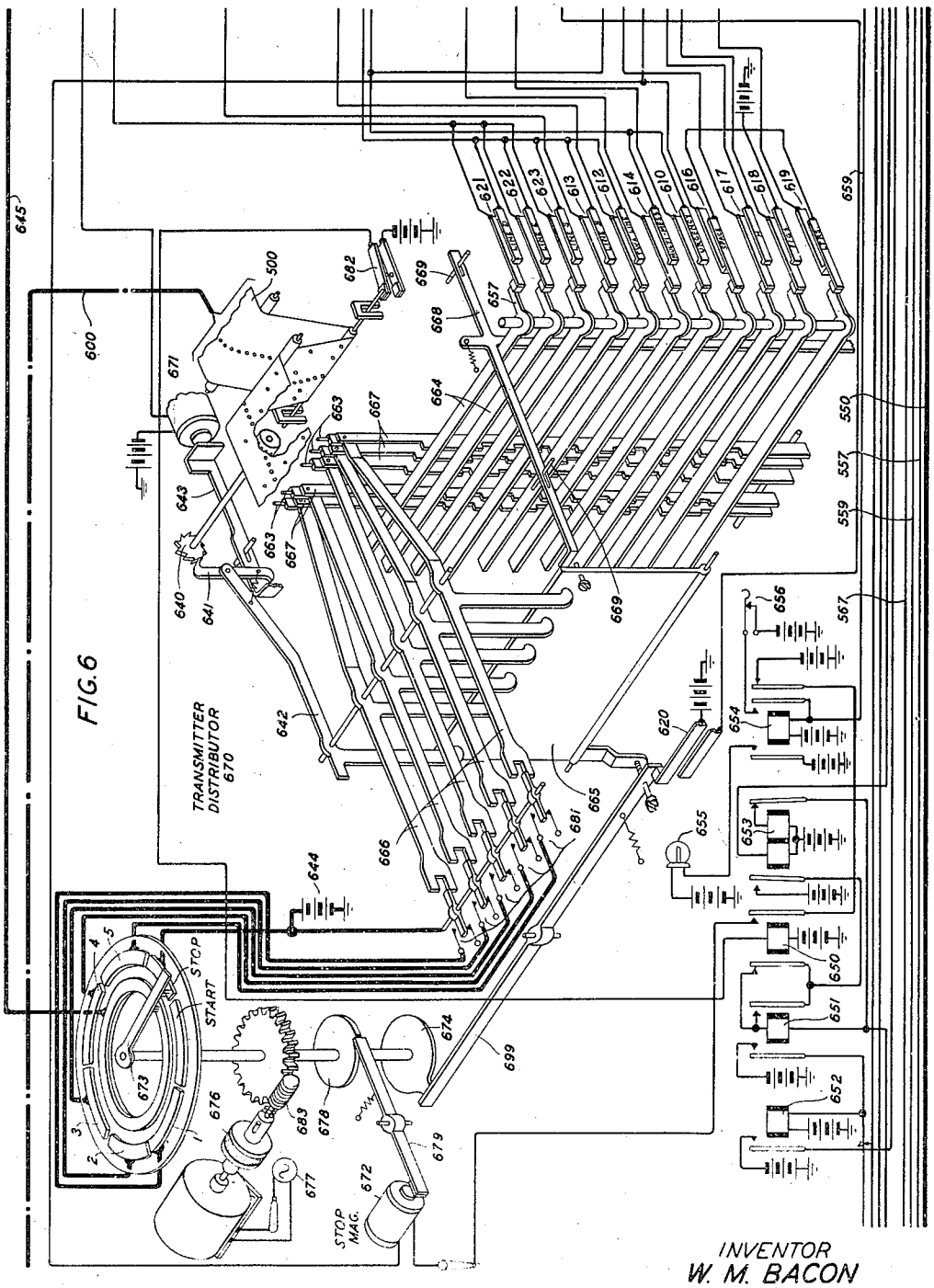

F/G. 6

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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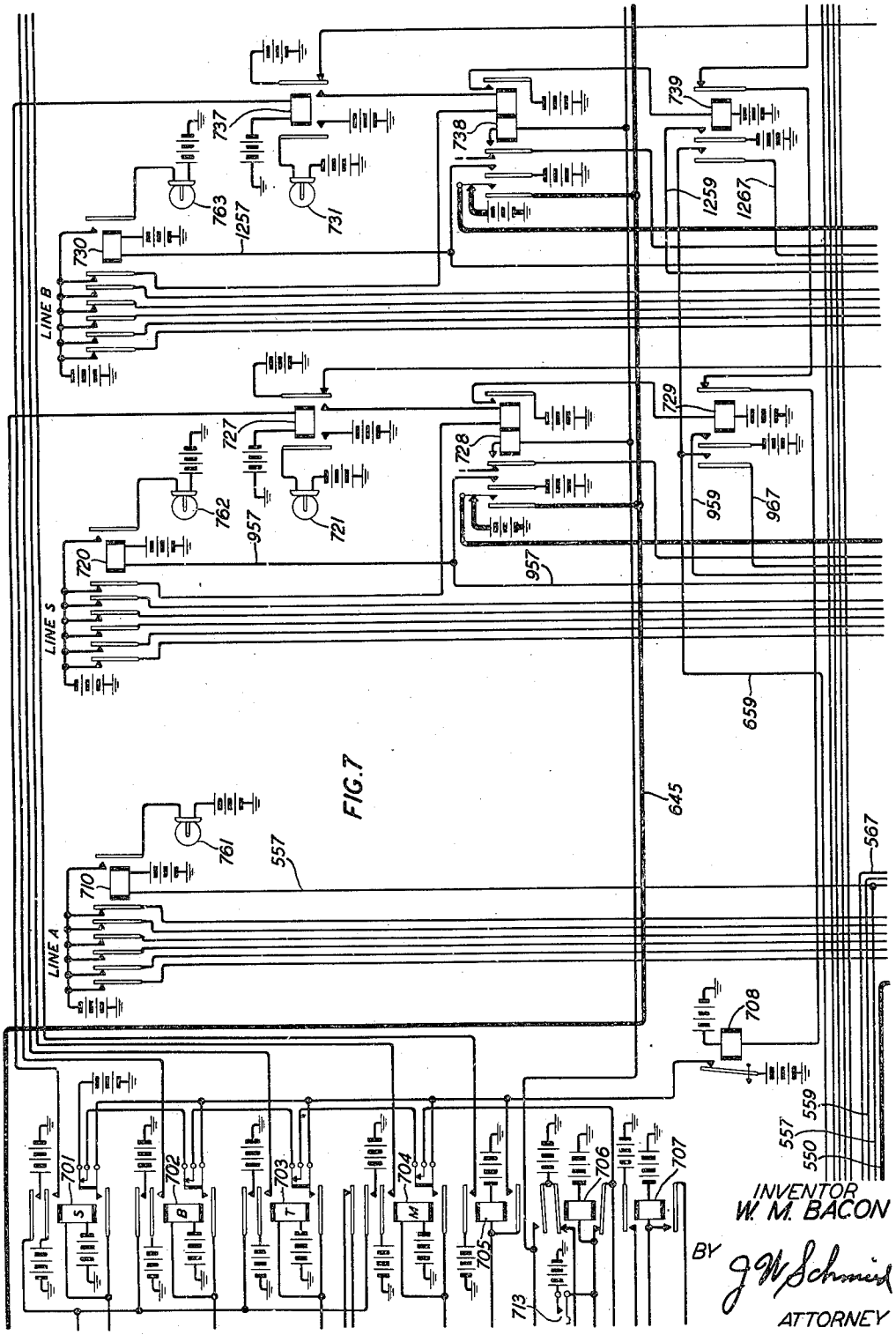

FIG. 7

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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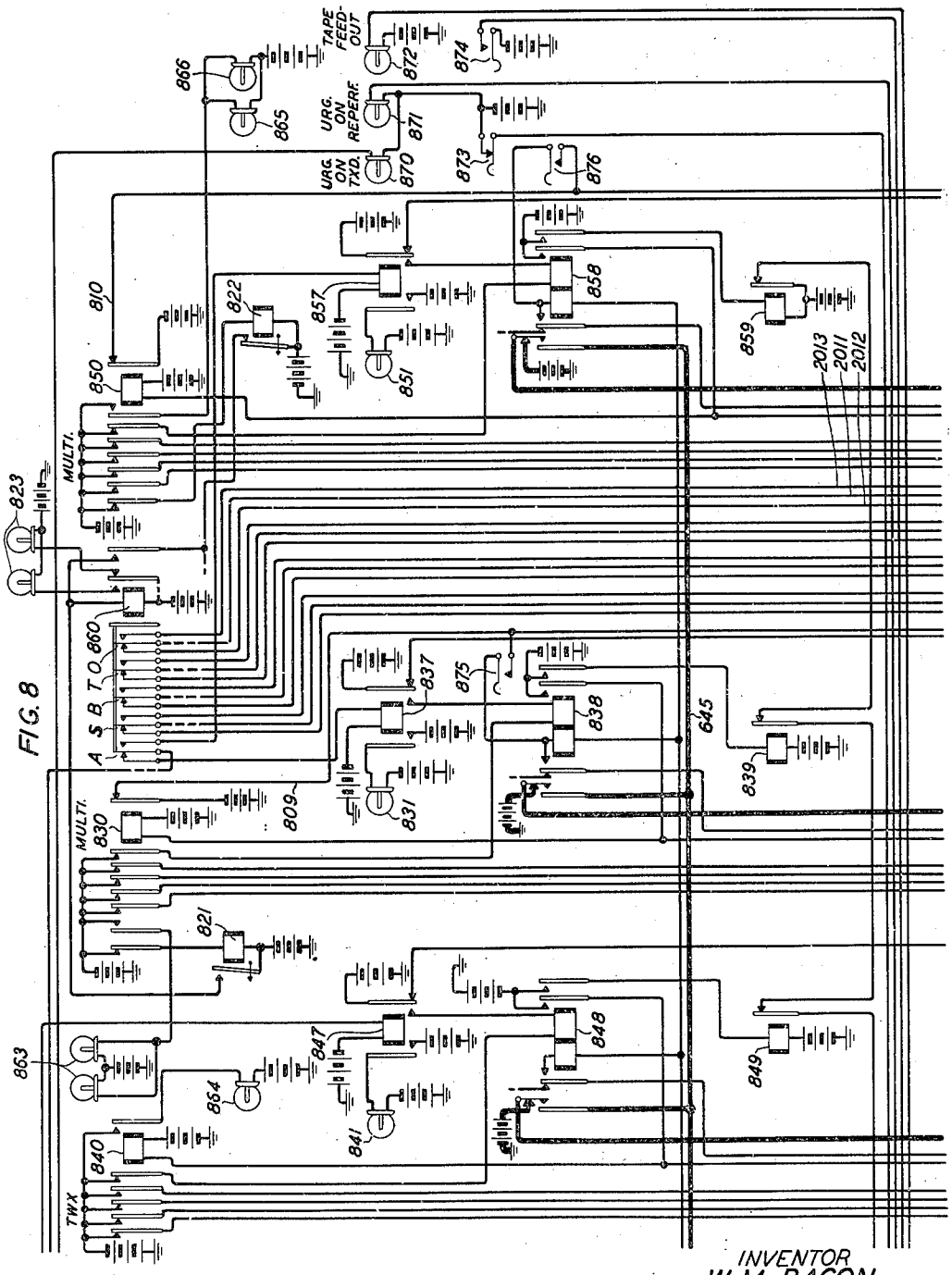

FIG. 8

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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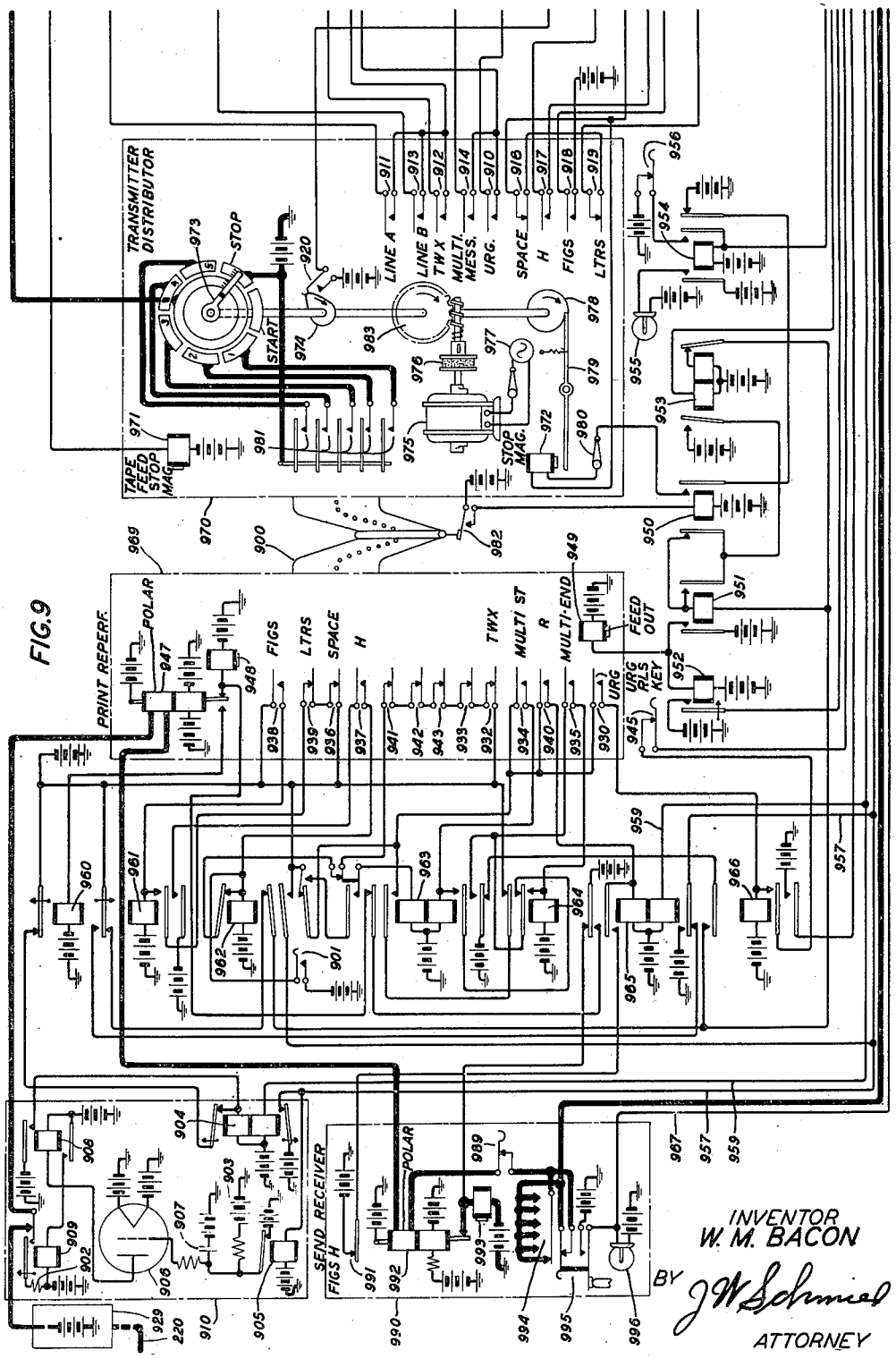

FIG. 9

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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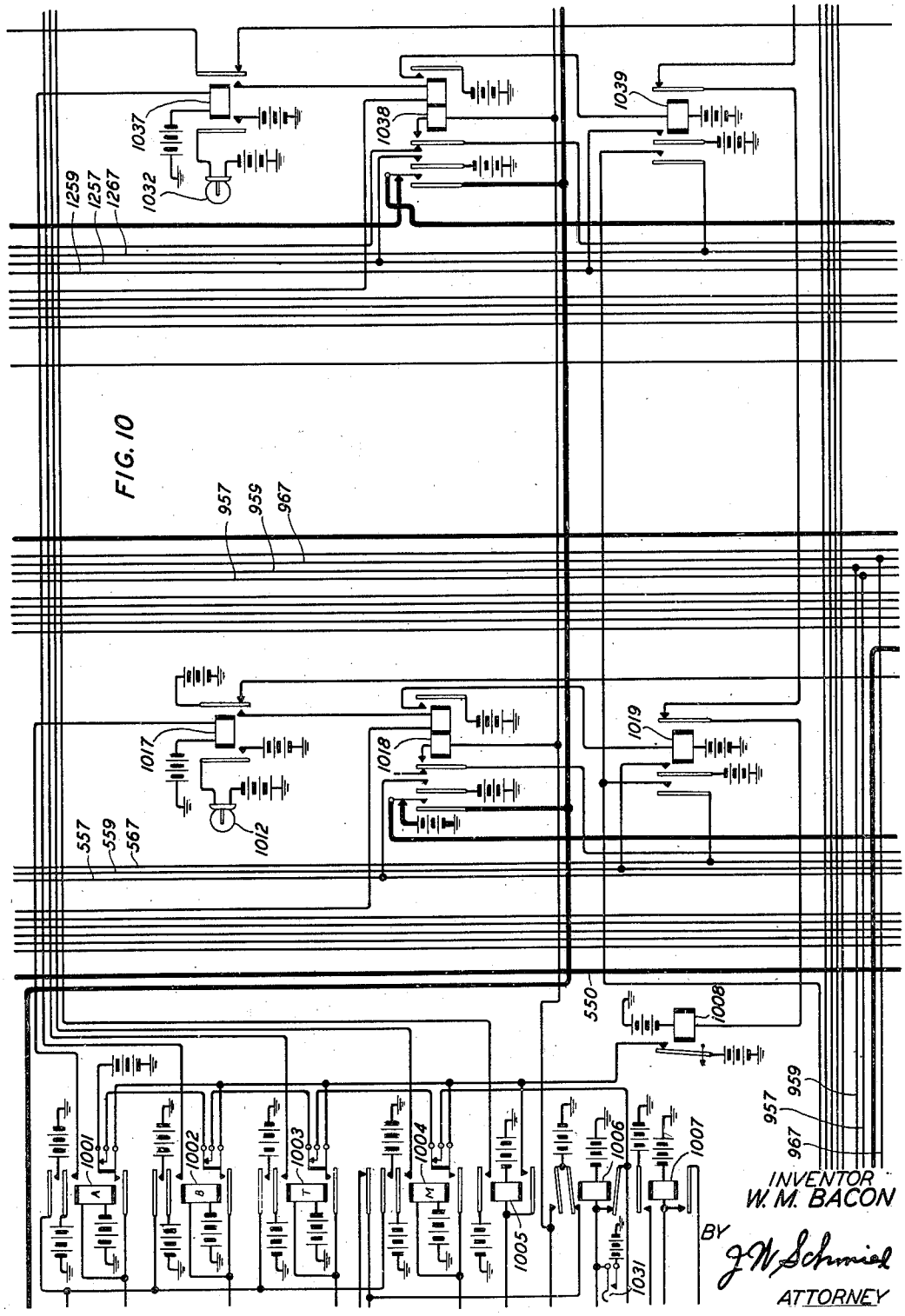

FIG. 10

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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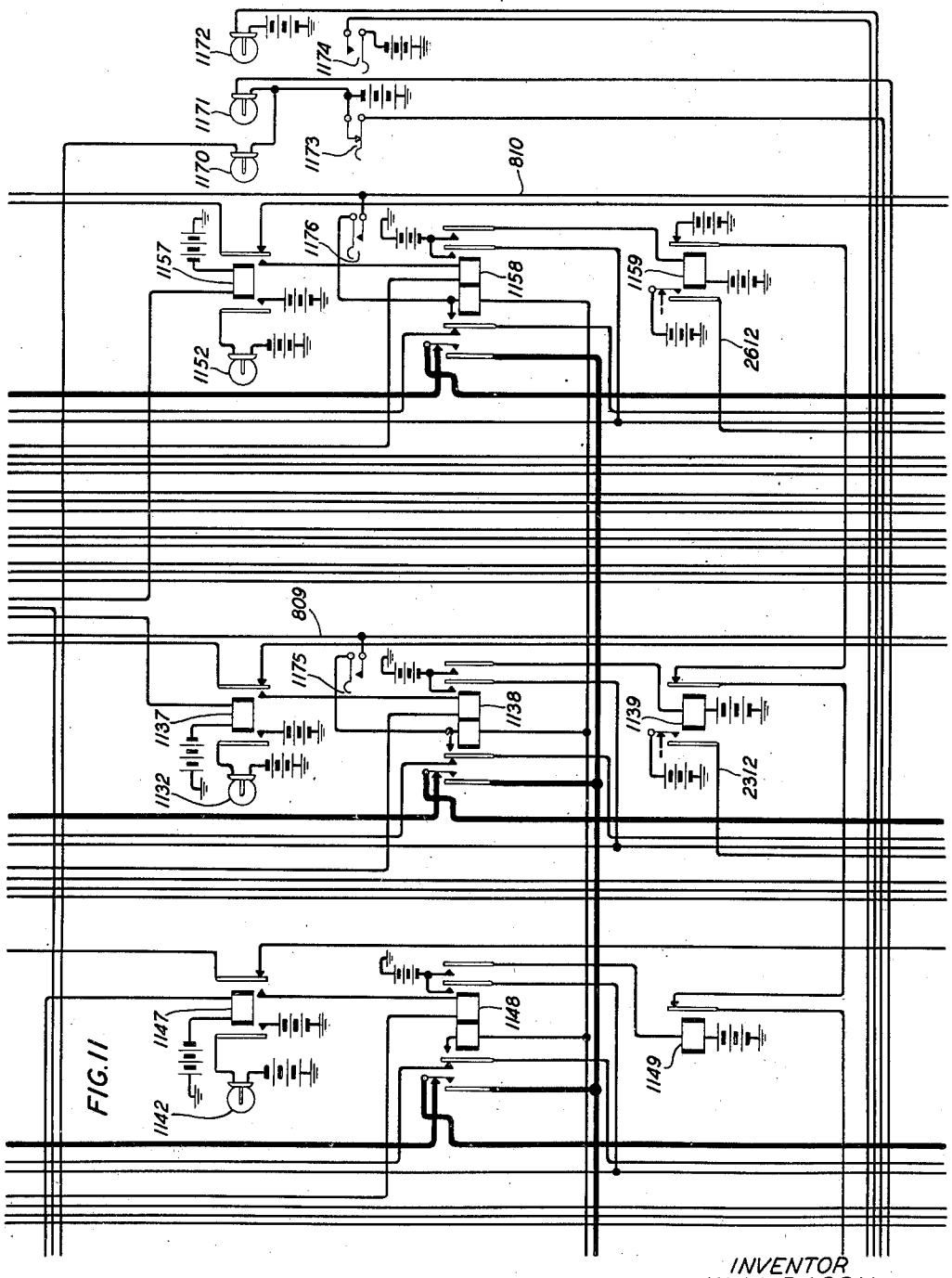

FIG. 11

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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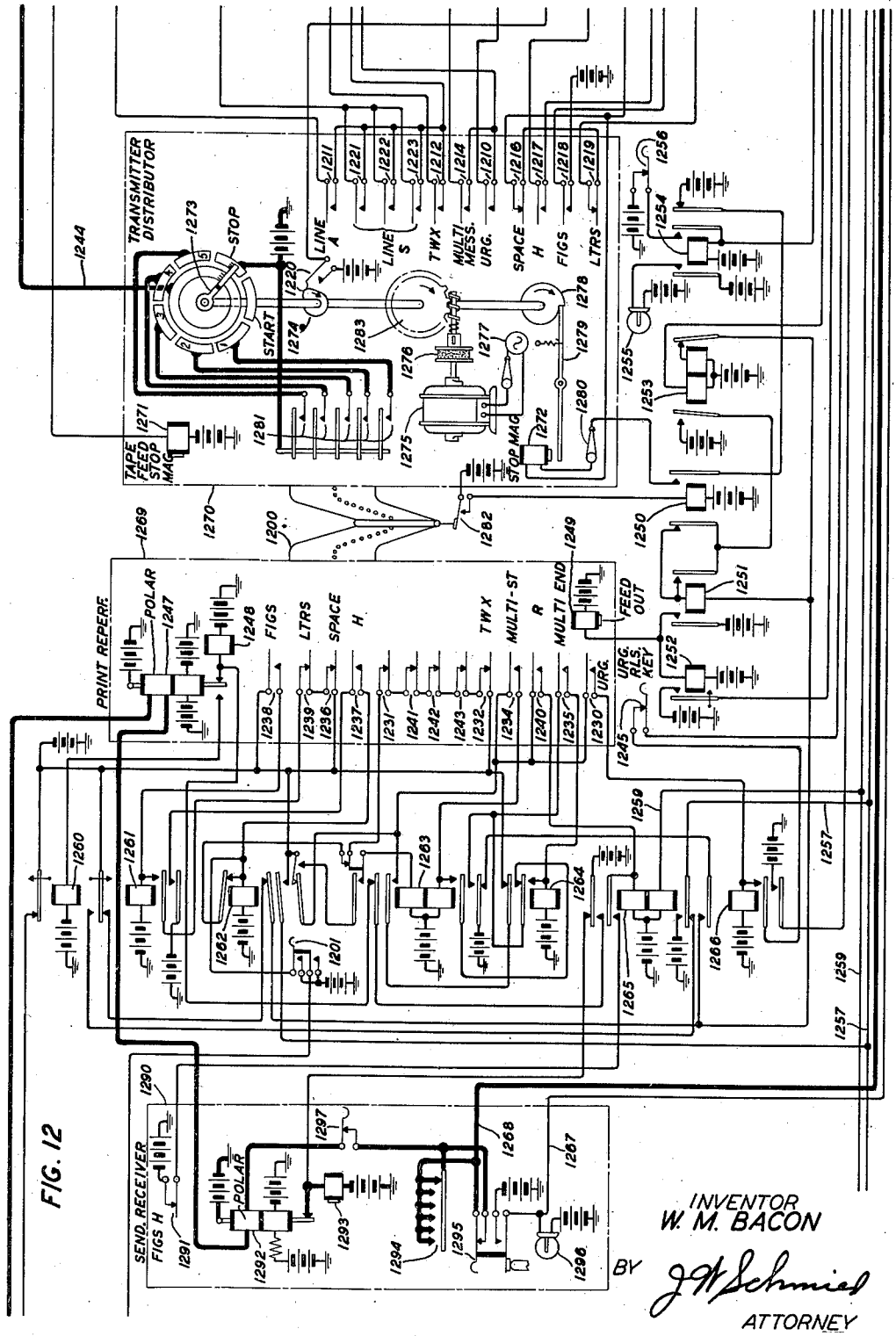

FIG. 12

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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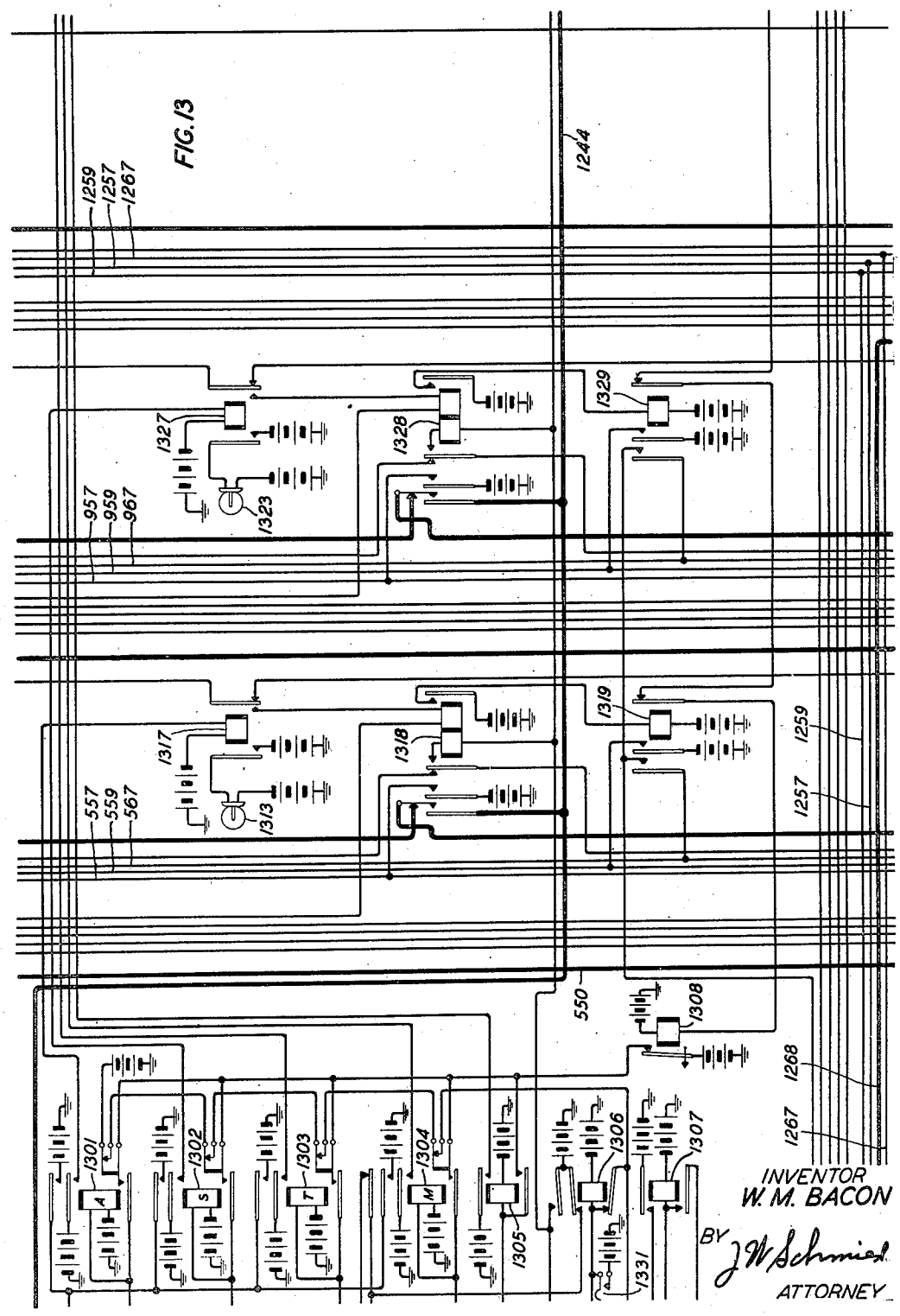

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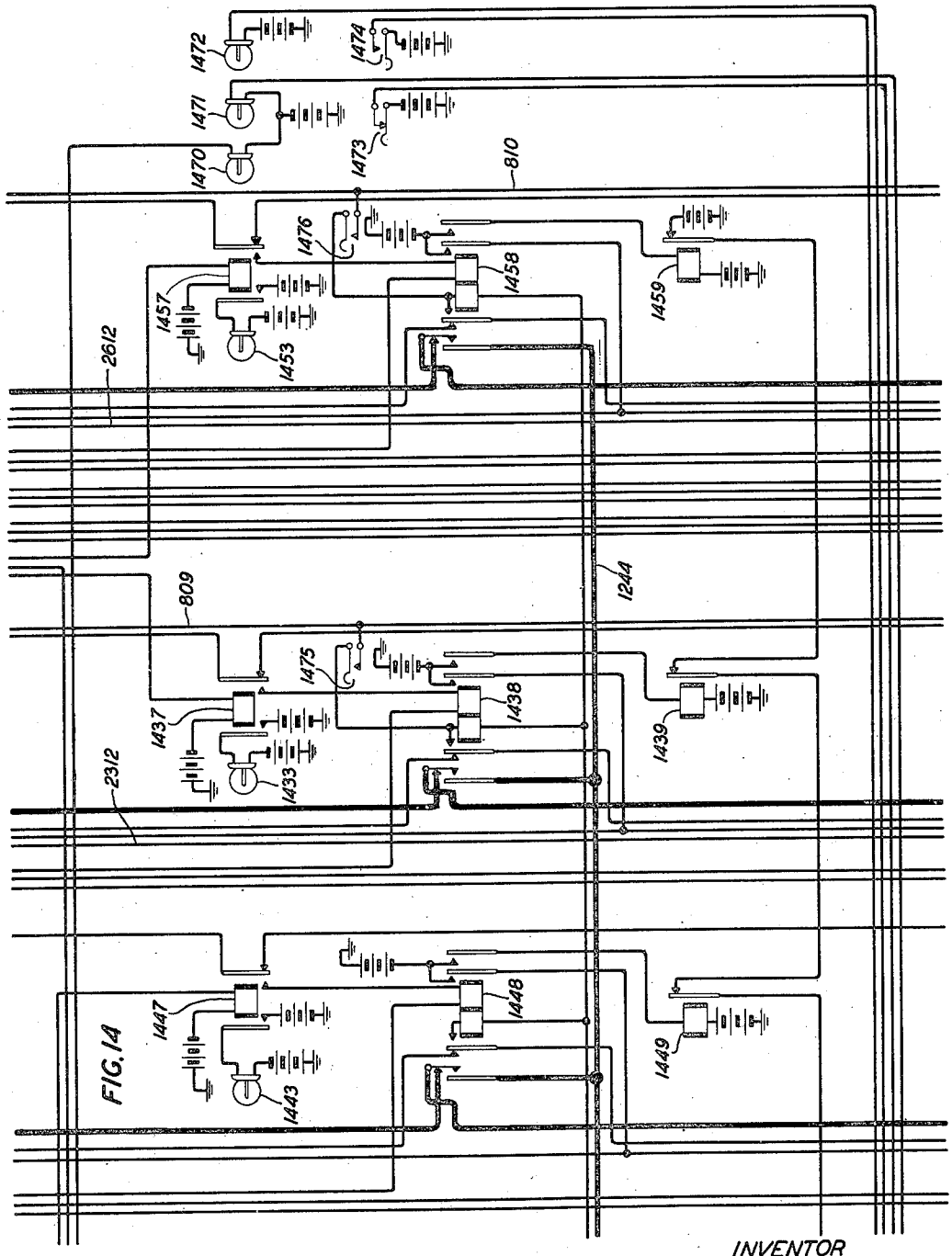

FIG. 14

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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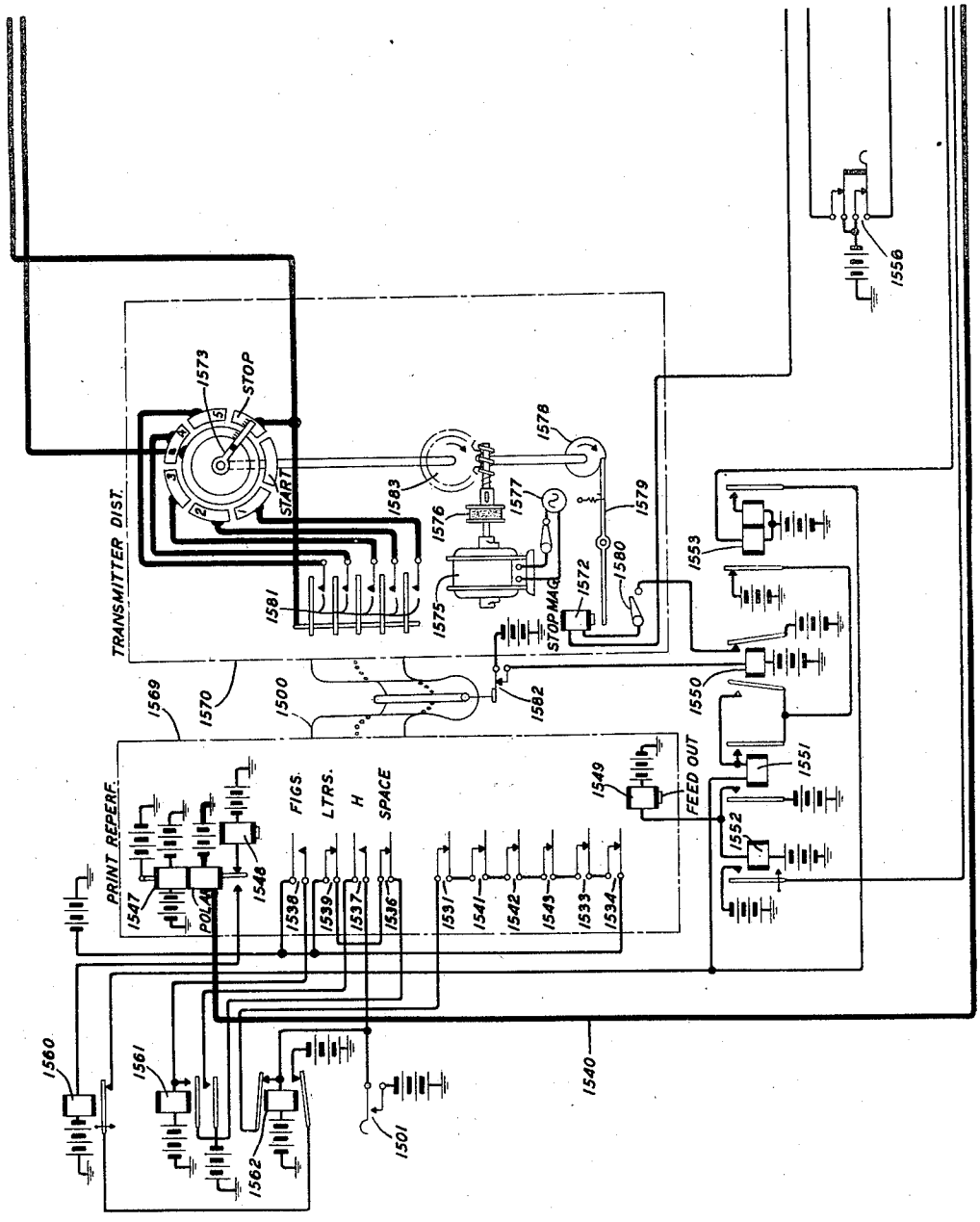

FIG. 15

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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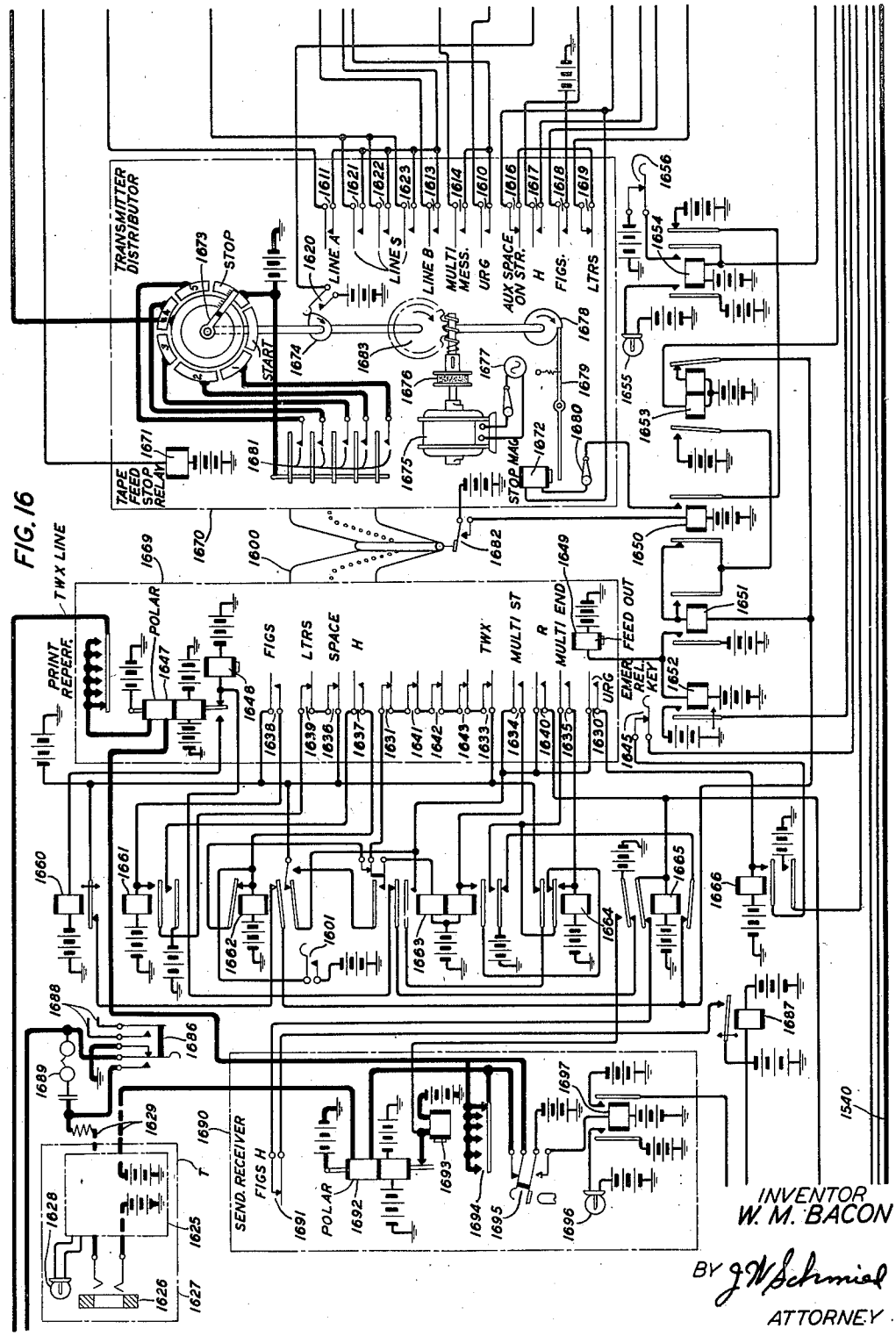

FIG. 16

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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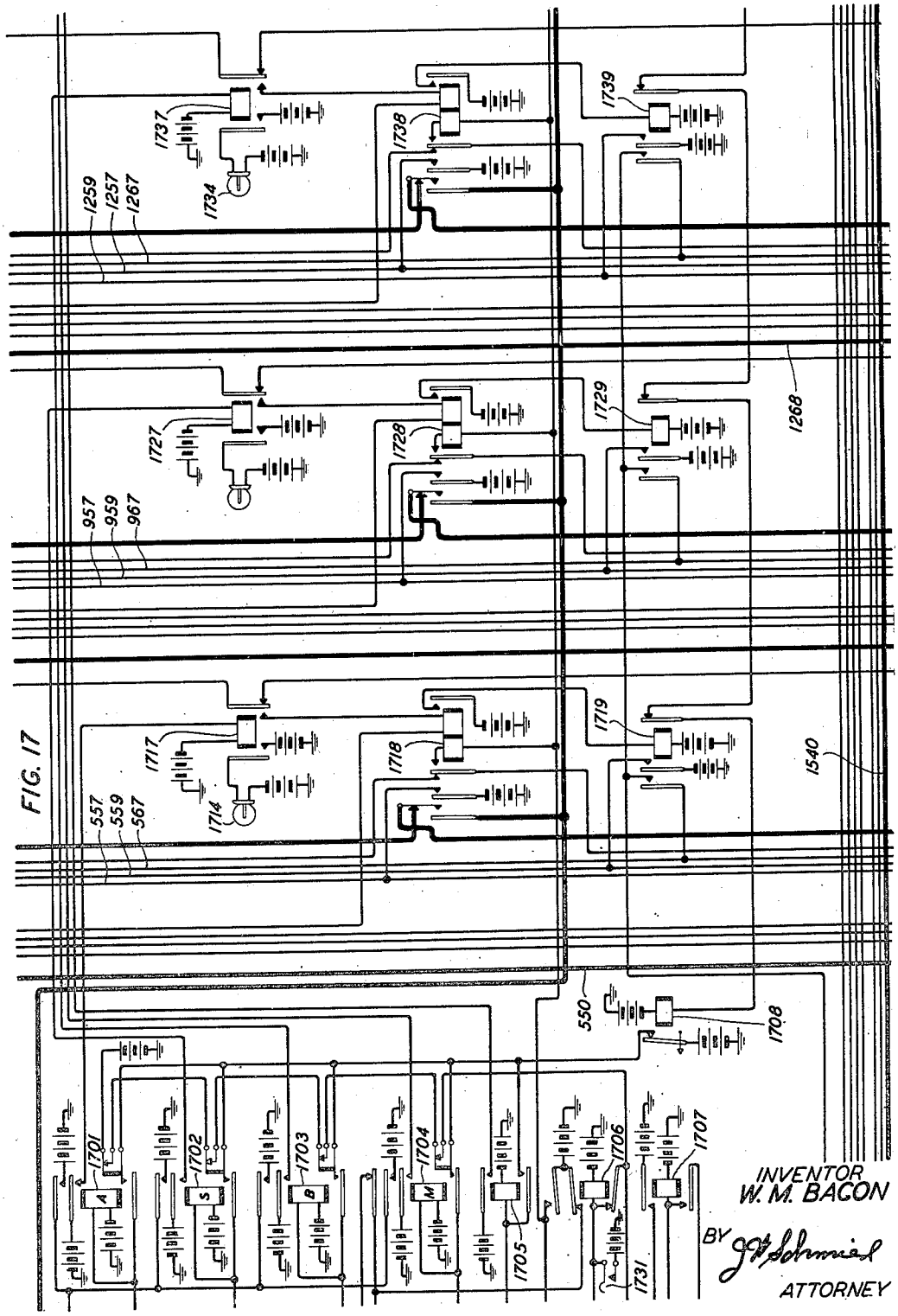

FIG. 17

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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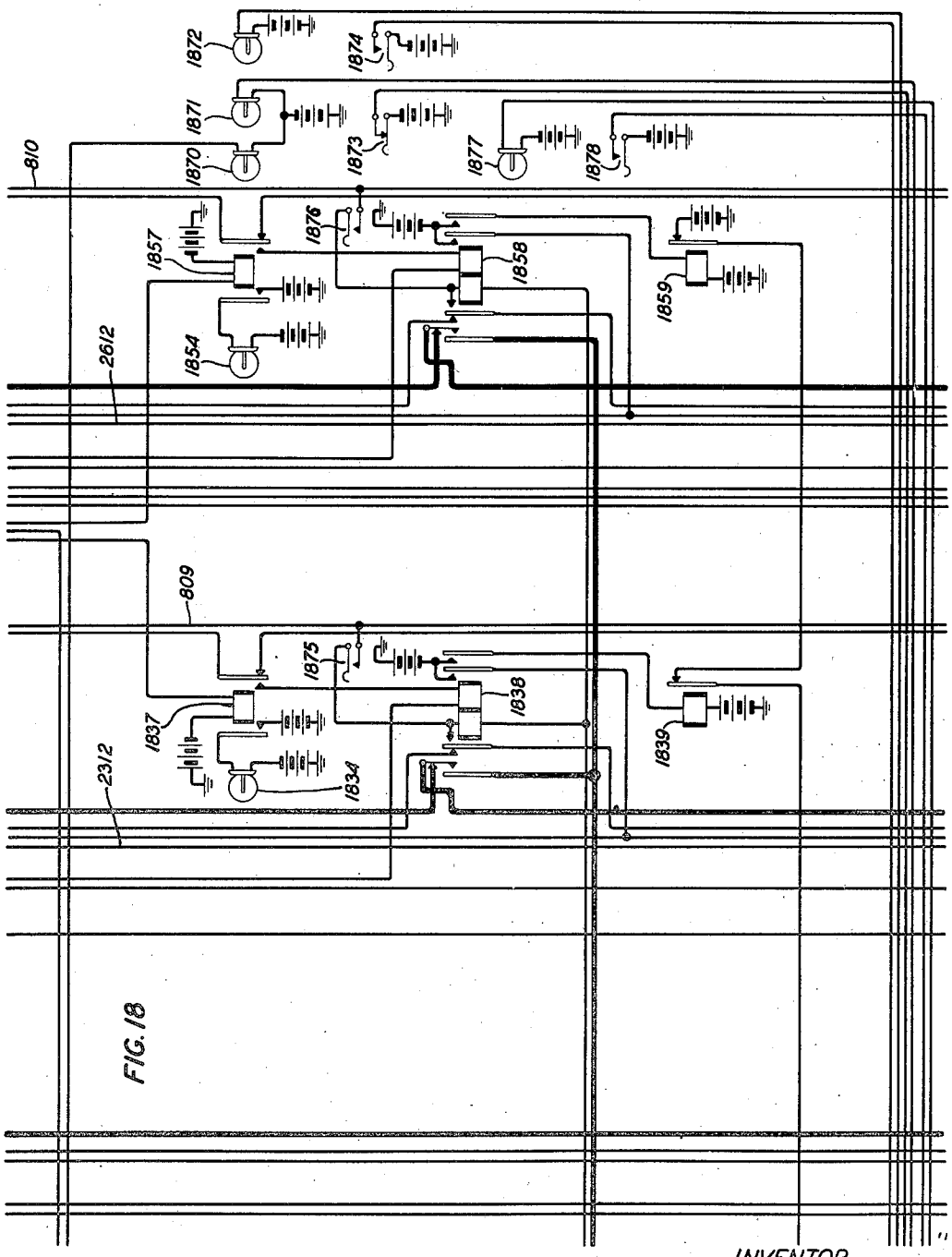

FIG. 18

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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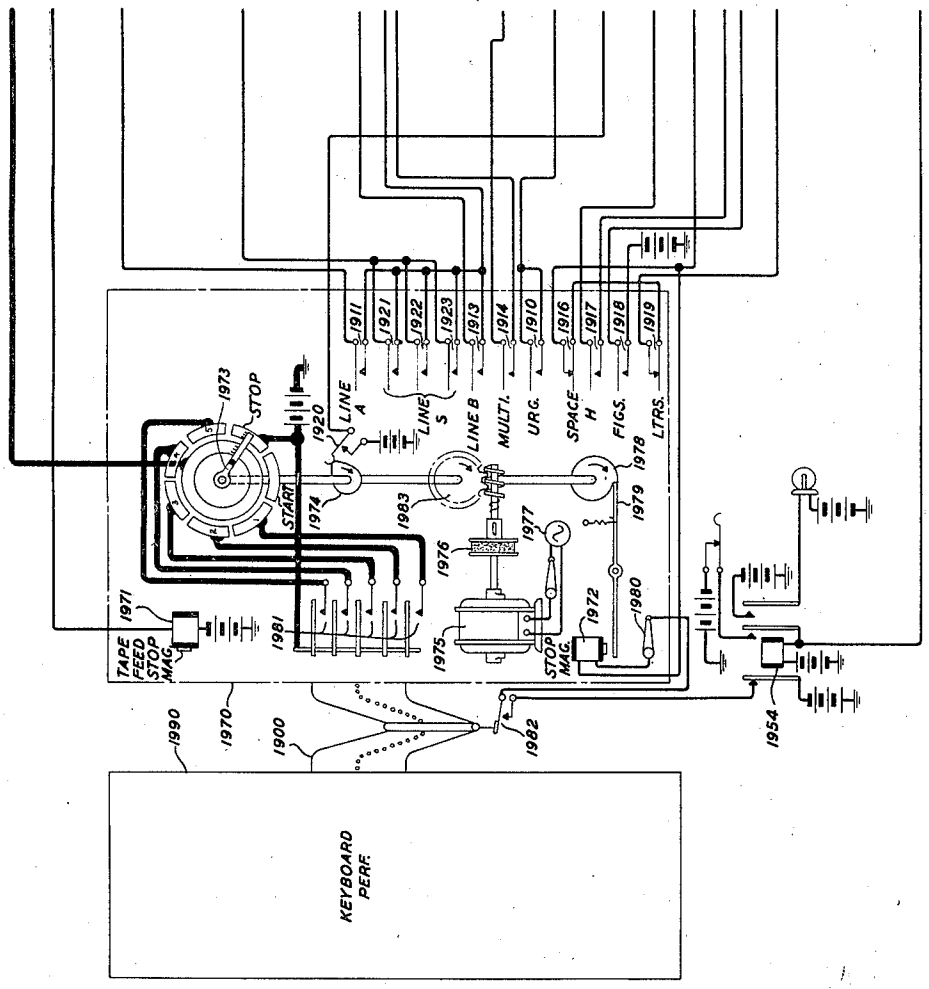

FIG. 19

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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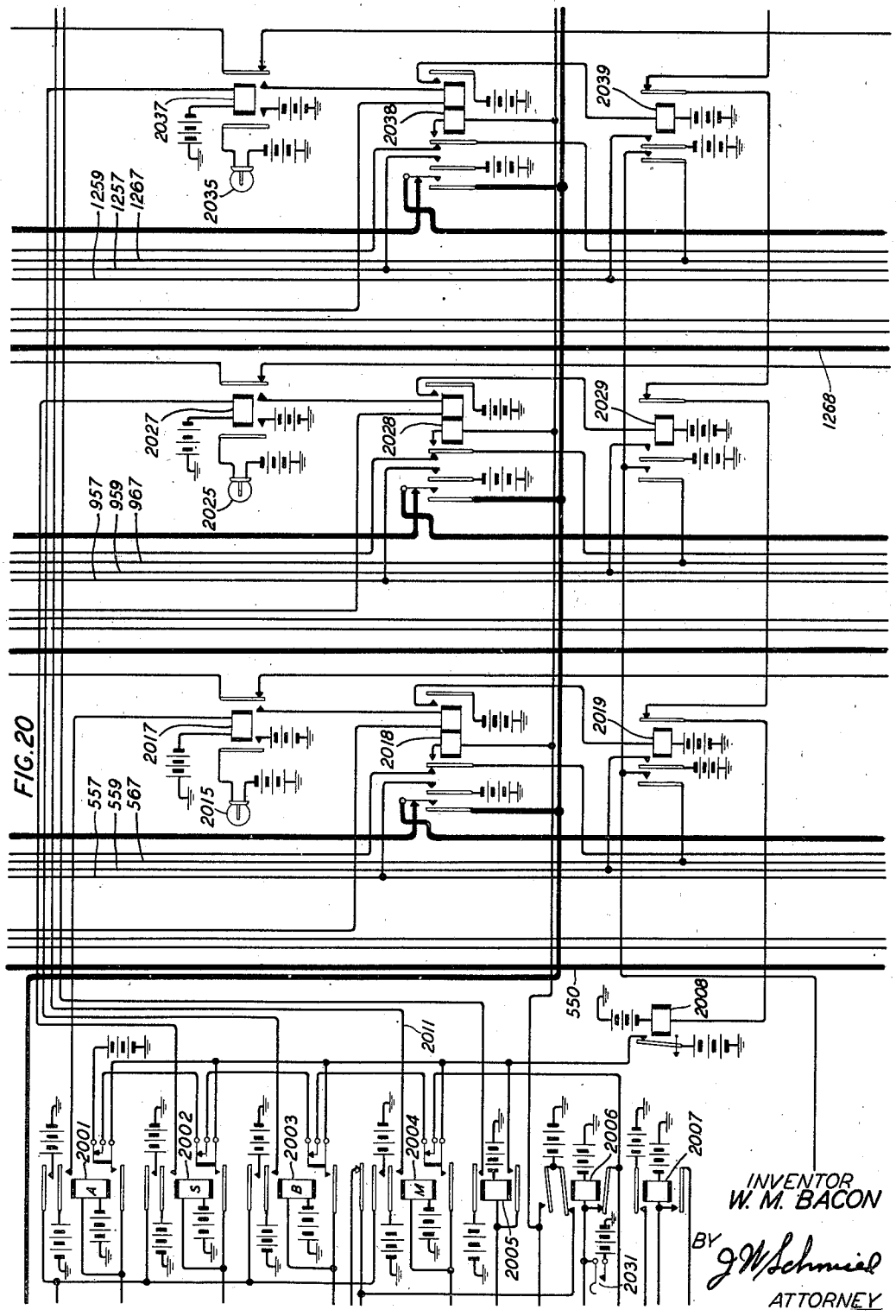

FIG. 20

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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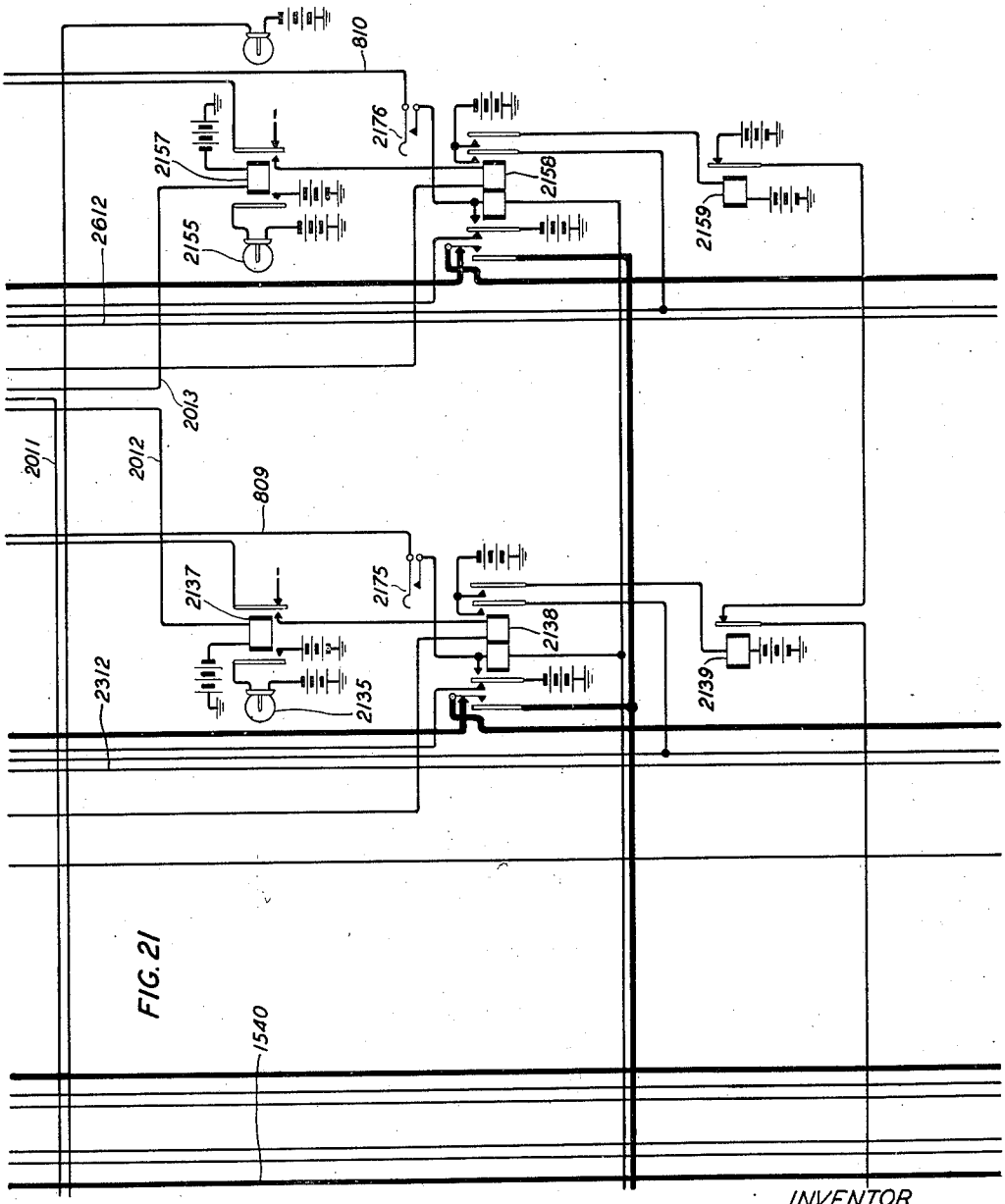

FIG. 21

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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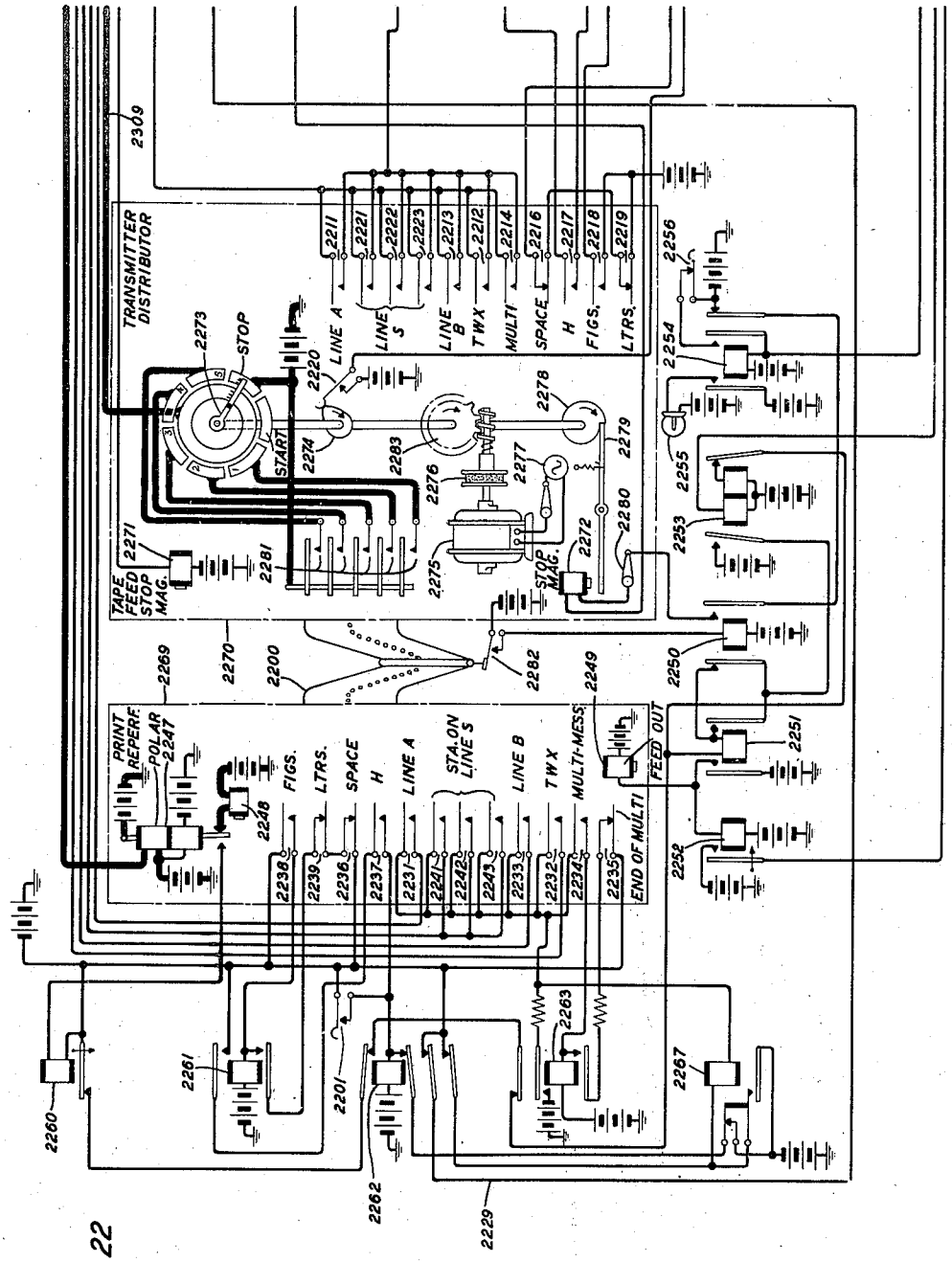

FIG. 22

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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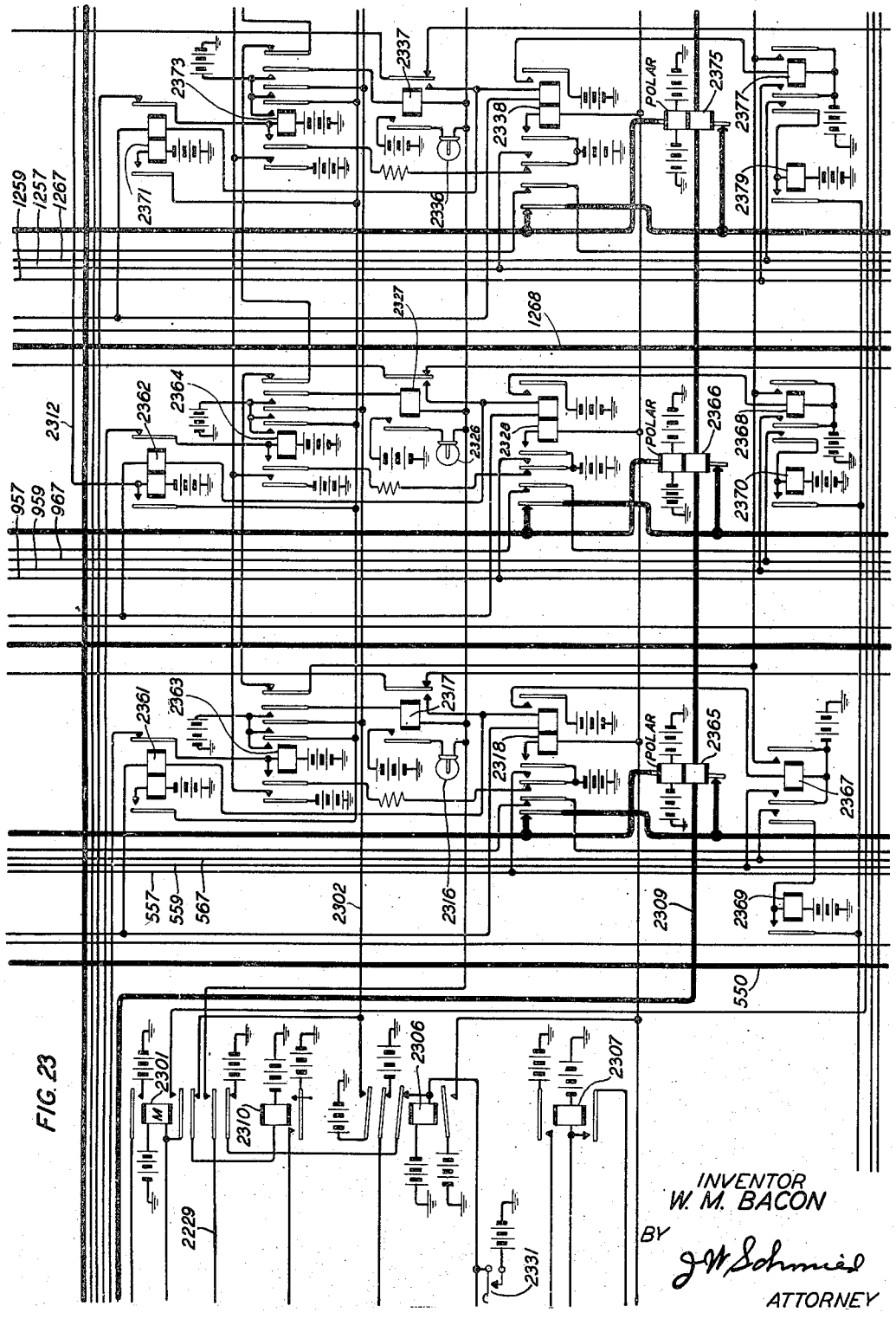

FIG. 23

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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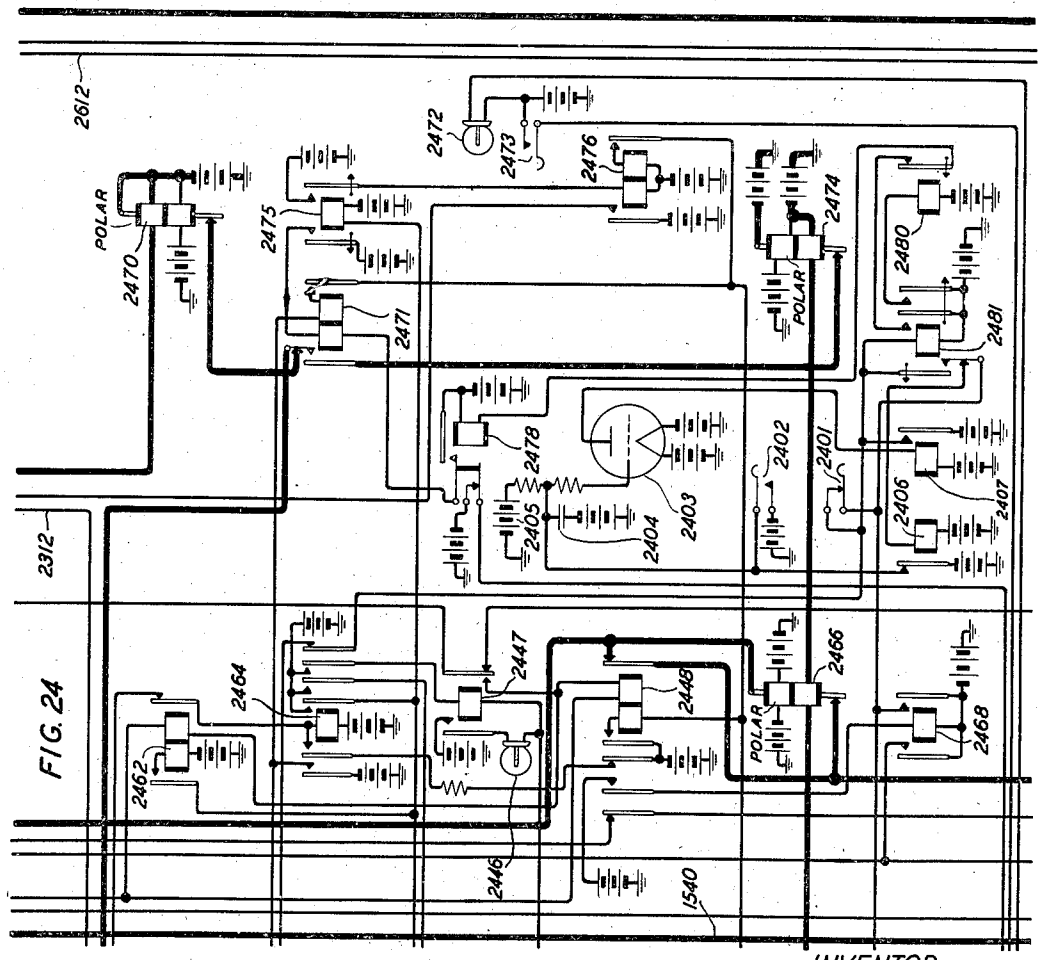

FIG. 24

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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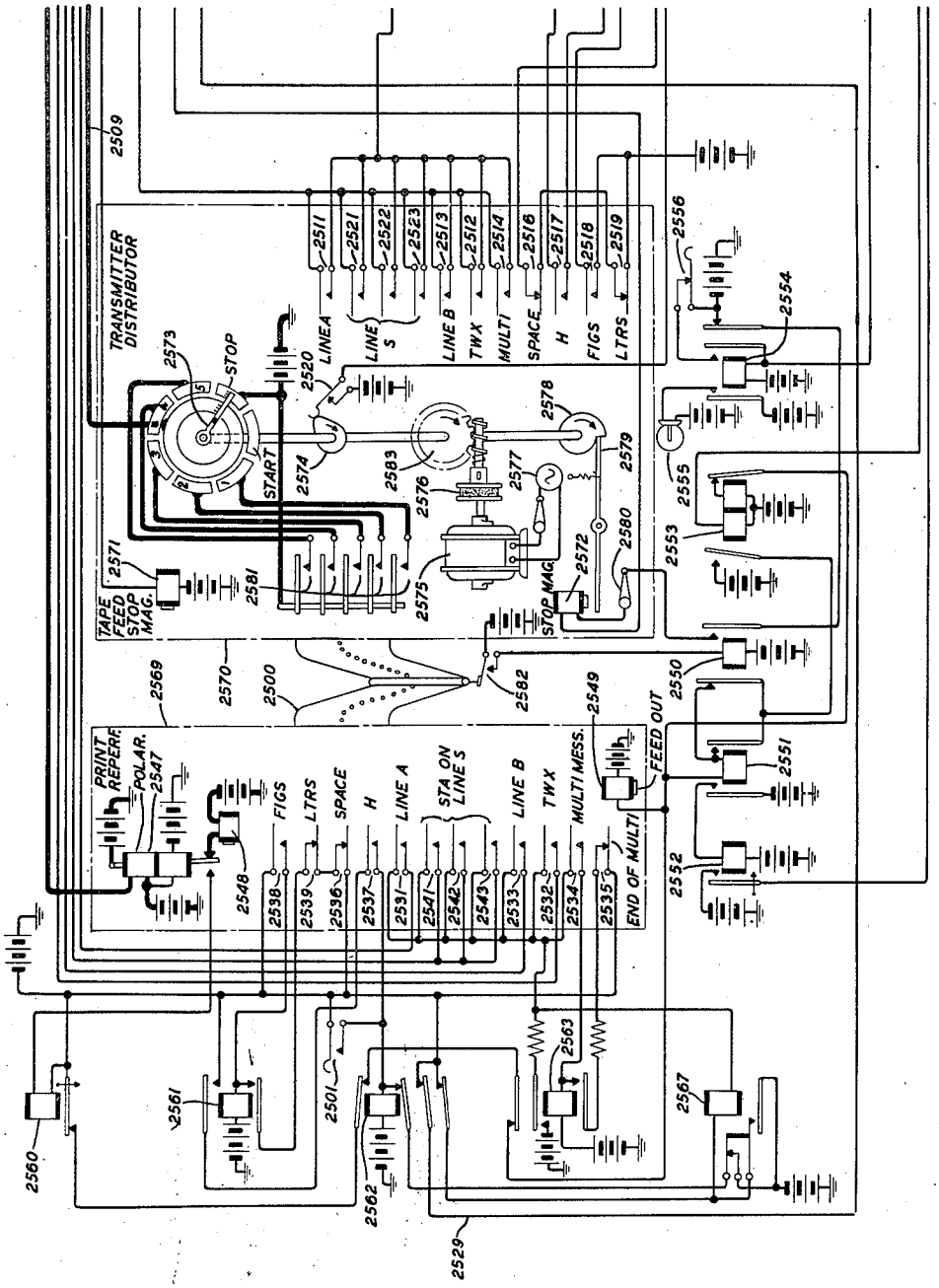

FIG. 25

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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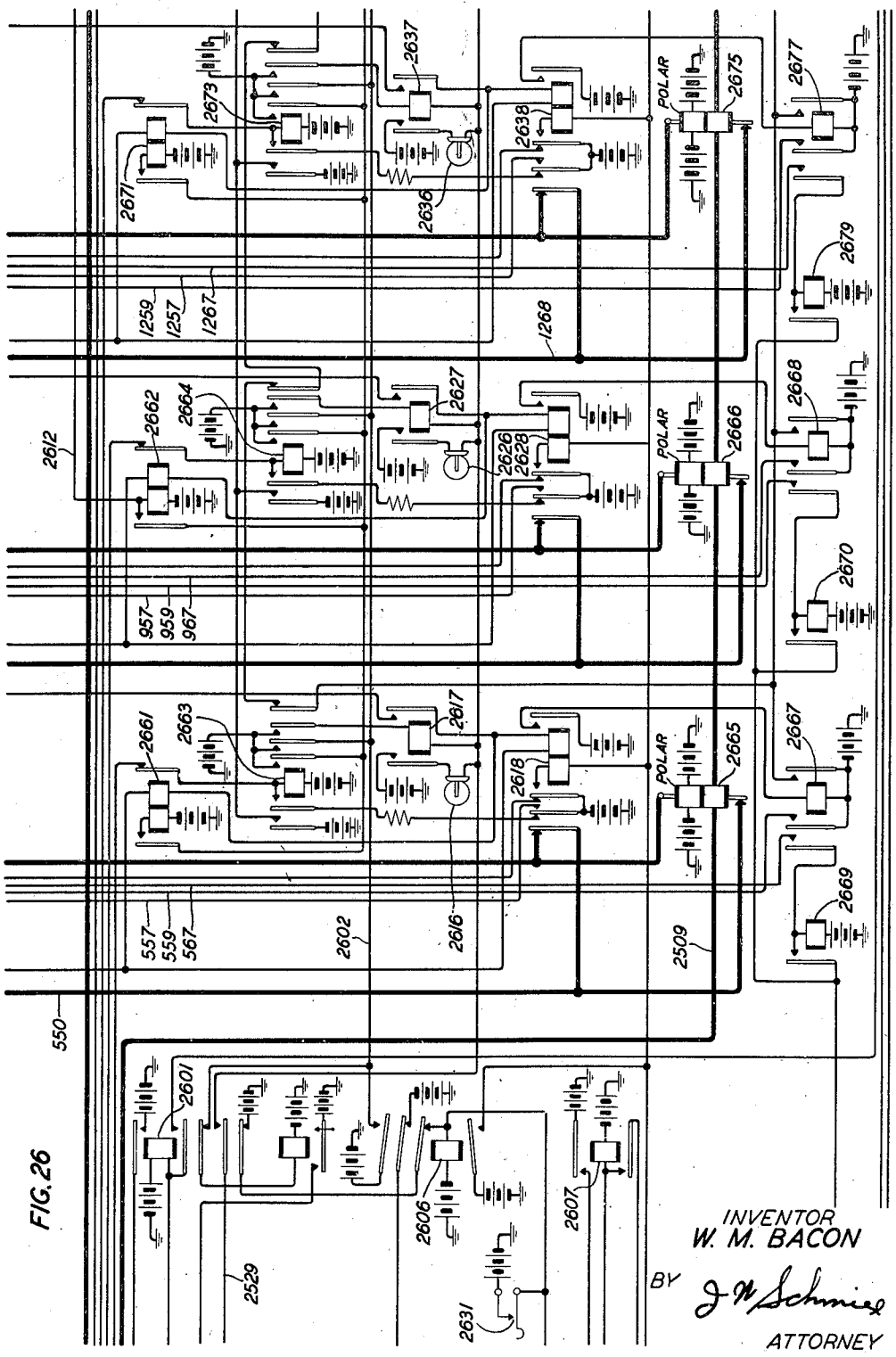

FIG. 26

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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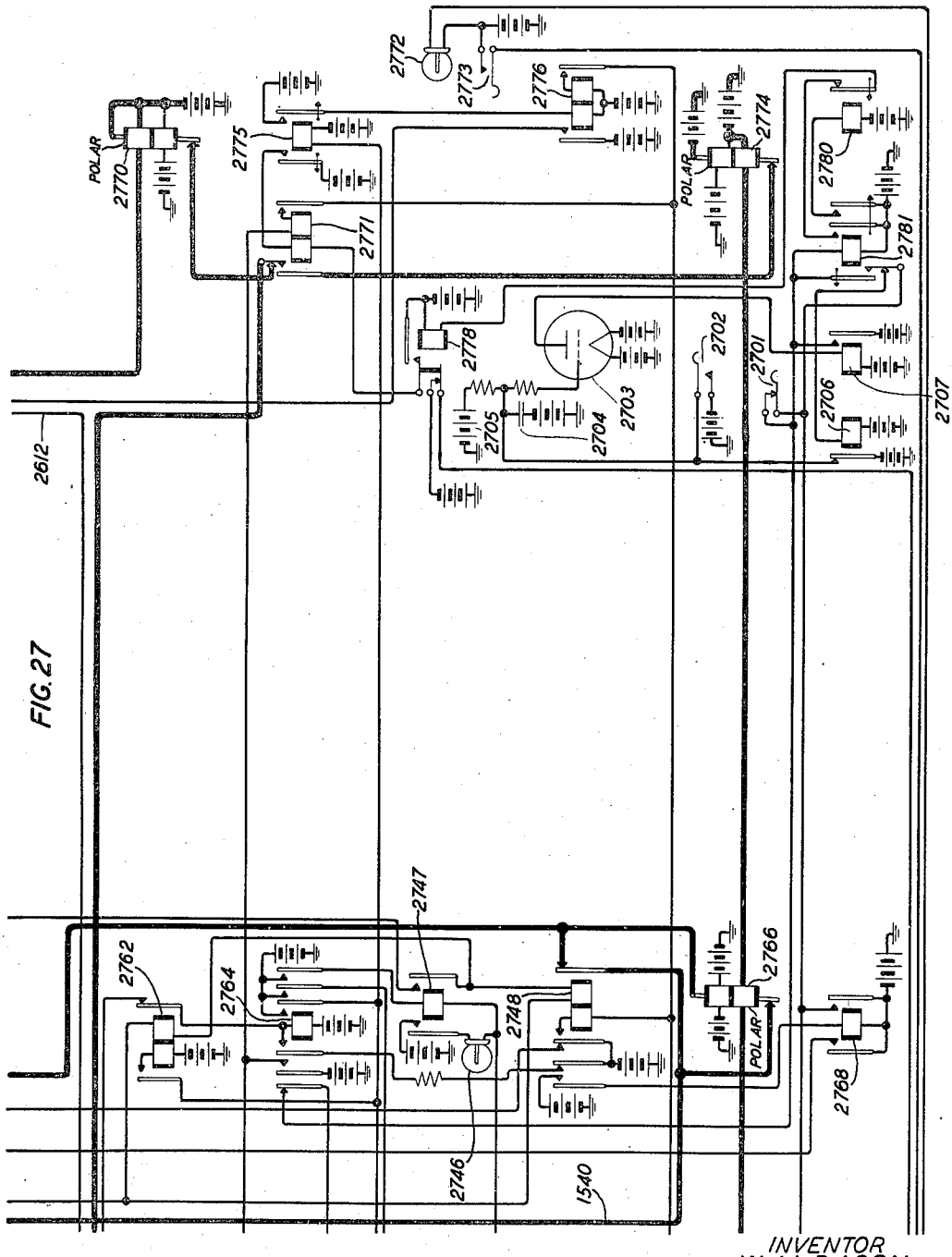

FIG. 27

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CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

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FIG. 29

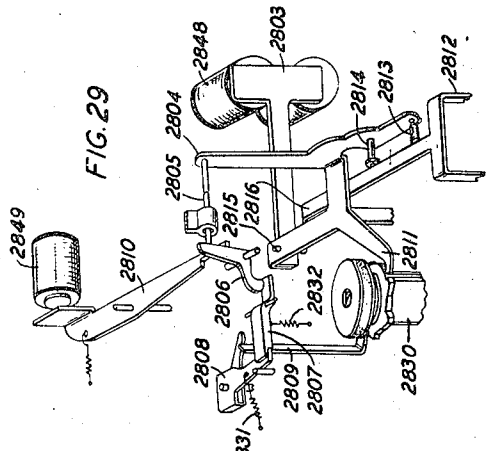
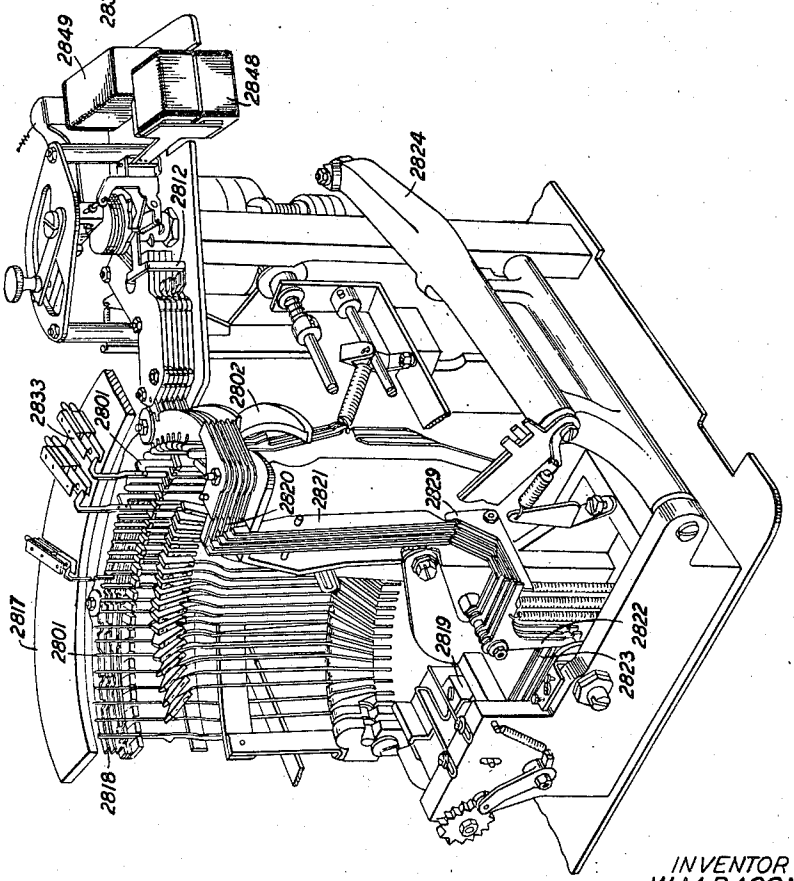


FIG. 28



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Patented Nov. 1, 1949

2,486,699

UNITED STATES PATENT OFFICE

2,486,699

CHANNEL AND TRANSMITTER CONTROL FOR TELEGRAPH SYSTEMS

Walter M. Bacon, New York, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application November 17, 1945, Serial No. 629,300

36 Claims. (Cl. 178—2)

1

This invention relates to communication systems and more particularly to automatic switching systems controlled by permutation code groups of signaling impulses.

An exemplary embodiment comprises a full automatic switching telegraph system of the storage type.

It is an object of the present invention to provide an automatic switching arrangement and a method of switching in which a telegraph message may be transmitted from any one of a plurality of stations through one or more switching stations to one or more of the connected stations without requiring all of the stations to which the message is directed or all the lines or trunks extending thereto to be simultaneously idle and without requiring the retransmission of the message from the originating station successively to all of the stations or lines or trunks to which it is directed.

In previous automatic telegraph systems it has been the custom to transmit directing signals preceding each message. When the message is to be transmitted automatically through more than one switching station or apparatus it has been necessary to transmit a character or group of signals for controlling the switching apparatus at each of said stations or each stage of the switching apparatus. The characters or signals controlling each step in the switching system are absorbed by the apparatus controlling that step of the switching operation and the remaining signals are transmitted on to the next stage or step of the system. This requires the transmission of a considerable number of switching signals preceding each message and in addition requires the transmission of different signaling impulses preceding each message directed to a given station or apparatus depending upon the station from which the message is transmitted, that is, the station from which it originates.

It is therefore another object of this invention to improve automatic switching systems of the type in which the same groups of signal impulses are employed to control the switching apparatus at each stage or step in a switching system and are transmitted on to the succeeding stage and then finally to the desired station. This arrangement has the advantage that each station is designated by a given group or groups of switching impulses and all messages in the system, irrespectively of the station at which they originate and from which they are transmitted, are directed to the desired station by the same group or groups of switching impulses. In addition the number of switching impulses preceding each message is greatly reduced, which results in a more convenient method of operation and permits a considerable portion of the time formerly required for transmission of switching impulses to be saved and rendered available for the transmission of the message signals.

2

Another object of this invention is to provide an improved automatic communication system to which additional switching centers may be added at will through which messages may be transmitted to additional stations and from which messages may be directed to the existing stations connected to existing switching centers without changes, additions or alterations of the switching information required to be transmitted preceding messages intended for any of the existing stations.

Another object of this invention is to provide automatic transmitter control and timing features in combination with automatic repeating arrangement which is capable of receiving and storing messages and directing them to one or more than one station connected to the switching system to which it is desired that the messages shall proceed without interfering with incoming messages.

Another object of this invention is to provide an improved multiple address arrangement and method in which a message may be automatically transmitted from any one of a plurality of stations to any plurality of stations to which it is desired to transmit it either simultaneously or in succession as said stations become idle.

Another object of the invention is to provide an automatic arrangement in which more than one incoming message may be sent selectively and simultaneously to different groups of receiving stations or successively as the stations in each group become idle.

Another object of this invention is to provide overflow circuits to which messages may be directed by the operator at the central switching station in case the addressed station is busy and from which the message is automatically transmitted to said station when it becomes idle.

Another object of this invention is to provide improved means for and methods of receiving and storing messages from other types of telegraph switching systems for transmission through the switching system provided in accordance with this invention.

Another object of this invention is to provide improved means for storing messages originating within the telegraph system arranged in ac-

cordance with this invention, transmitting them over other types of telegraph systems, particularly other types of switching systems employed in the telegraph network, to the stations to which the messages are directed.

Another object is to improve methods and systems for automatically transmitting code directed messages in two directions over a two-way trunk or telegraphic transmission path by preventing double seizure of the trunk or path.

Another object is to expedite, more effectively than heretofore, the transmission of messages from a storage point to a plurality of ultimate transmission points by providing for their transmission over idle channels immediately and over channels, busy at the initiation of the first transmission, by a later transmission.

In accordance with a principal feature of the invention, the switching station is provided with a plurality of broadcasting switching channels or multiple senders.

In accordance with another feature of the invention, a multiple-directed message stored at the switching station may be forwarded to the addressed stations over any one of said plurality of broadcasting switching channels which is idle.

In accordance with a more specific feature of the invention, the said plurality of broadcasting switching channels are provided with a busy arrangement whereby, upon one channel being busy another channel is made available for service.

In accordance with another feature, a timing circuit is associated with a multiple sender whereby the sender, upon finding at least one of the addressed stations being busy or otherwise unavailable, will be conditioned to wait a predetermined interval of time before beginning to transmit the stored message. Because the lines of the idle stations are immediately seized, the sender may in this manner seize lines to still other stations which become idle during the interval before the first transmission. As a specific feature, the timing circuit is arranged to omit the waiting interval if the lines to all of the addressed stations are available.

In accordance with a further object of the invention, provision is made for preventing a message intended for transmission through the switching station from a subscriber's station and another message intended for transmission to the same subscriber's station from appearing coincidentally in the same transmission circuit. Thus in accordance with a feature of the invention, a subscriber's transmission circuit is made available alternately to the subscriber and to the switching station for predetermined time intervals, determined by timing circuits associated with the loop circuit, there being one timing circuit at the subscriber's station and a cooperating timing circuit at the switching station. In accordance with more specific features, the signaling circuits at opposite ends of the loop circuit are conditioned for transmission in alternation by their associated timing circuits and are arranged to send control impulses over the loop in opposite directions, respectively, at the end of each interval for mutual control, and one of the timing circuits includes a counting circuit which counts two periods, one assigned for incoming and one assigned for outgoing transmission.

Provision is similarly made for assigning transmission intervals alternately to two switching centers interconnected by an interoffice trunk so that the trunk is alternately made available first to one and the other of said centers for outgoing transmission.

The foregoing objects and features of this invention, the novel features of which are specifically pointed out in the claims appended hereto, may be more fully and more readily understood from the following description read with reference to the attached drawings in which:

Figs. 1, 2 and 3, when positioned as shown in Fig. 30, show in simplified form the various stations, elements and apparatus in the manner in which they all cooperate to form a typical telegraph switching system in accordance with this invention;

Figs. 2 and 4 through 27 when positioned, as shown in Fig. 31, show in detail various circuits and apparatus employed in a typical telegraph system in accordance with this invention; and

Figs. 28 and 29 show in fractional perspective views certain mechanical and electrical details of a receiving selector and perforator used in the system illustrated in Figs. 2 and 4 through 27.

GENERAL DESCRIPTION

Referring now to Figs. 1, 2 and 3, when arranged as shown in Fig. 30, Fig. 2 represents a switching center or station together with represenations of the different aparatus and equipment associated therewith and also the lines and stations connected to this switching center. Fig. 2 shows arranged in horizontal rows, the equipment associated with subscriber's lines, office trunks, attendant's position and broadcast channels, respectively, as will be described below. In the left-hand portion of Fig. 2 the horizontal rows extend into the field of switching relays which are arranged also in vertical rows for switching the equipment from any horizontal row of equipment over a vertical row of interconnecting circuits to another horizontal row of equipment.

Two representative outlying or subscriber stations **210** and **230** are shown in Fig. 2.

A trunk circuit **220** extends to a second switching station shown in Figs. 1 and 3 which is similar to the switching center or station shown in Fig. 2, except as will be pointed out hereinafter. Here two representative subscriber stations are shown at **310** and **330**.

In addition, trunks or connections to other switching stations **248** and **348** are shown together with the associated equipment for connecting them to the switching system shown in Figs. 2 and 3. At each of the central stations a local transmitting arrangement is provided and indicated at **262** and **362**, respectively.

Each subscriber's station, as, for example **210**, is connected over a telegraph line to its respective central switching station. At the central switching station the line terminates in receiving and switching equipment. In the preferred embodiment of this invention, two types of receiving equipment are associated with each of the lines connected to an outlying station. One of the receiving equipments, for example **211**, is designed to record messages intended for the central switching station while the other receiving apparatus **212** is employed to record or store the messages intended for other stations which may be reached through the switching equipment.

In the preferred embodiment of this invention the receiving equipment for receiving messages intended for the central switching station is a

teletypewriter or other teleprinting mechanism, while the equipment for receiving messages directed to other stations is a reperforating mechanism which may or may not be also provided with printing means for printing the message besides perforating the tape. Auxiliary contacts are provided in both of these machines and controlled by them so that, generally speaking, either of these machines may be connected to the incoming line and the other disconnected therefrom, depending upon the destination of the following message.

To accomplish the various switching functions at the central switching station, certain characters or combinations of characters are transmitted from the outlying subscriber's station to the central station preceding each message or group of messages it is desired to transmit through the system to any other station which may be reached through the system.

The switching combinations preceding each message or group of messages are employed to control the auxiliary contacts associated with equipment at the central station and, in the case of the receiving devices **211** and **212**, they determine which of the two devices will receive the message. Under certain circumstances, as pointed out hereinafter, both of these devices may simultaneously receive the same message.

The messages received by the reperforator **212** are recorded in a tape or other signal storing means **213**. This tape controls the transmitting device **214** which, in turn, controls selecting relays **215**. The selecting relays control switching relays for connecting the transmitting apparatus **214** for transmission to any of the other lines connected to the system.

Means are also provided for causing any of the incoming lines to test busy at the central station as soon as signals are received from it, so that another transmitter can not be connected to it until the message in progress of transmission over this line has been completed. The line is also made busy when messages are transmitted to it from any of the transmitting apparatus at the switching station, so that none of the other transmitting apparatus at the central switching station will be able to attempt to transmit to this line at that time. Thus interference with the messages being transmitted is prevented.

However, it is inevitable that the setting up of a connection for a calling message through the switching station should take some short time so that the called station may make its own loop circuit busy while the calling message reaches the switching stage and there finds the transmission circuit for the called station still indicated as being idle. Thus for the purpose of avoiding an attempt by the system to transmit two messages in opposite directions over the half-duplex loop circuit under this contingency, timed control circuits for assigning time for transmission alternately in opposite directions are provided at each end of the loop circuit and, for the same purpose, at each end of the trunk circuits. These transmission control equipments are indicated at **216** and **217** for the loop to subscriber **210**, at **226** and **326** for the interoffice trunk **220**, and at **236** and **237** for the loop to subscriber **230**. Similar corresponding timed control circuits are shown in Fig. 3 at **316** and **317** and at **336** and **337** for the subscribers **310** and **330**, respectively.

Each of the other outlying stations, such as **230**, is similarly provided with lines extending to the central switching station where receiving

apparatus **231** is provided for receiving messages intended for the central switching station and apparatus **232** intended for recording the messages directed to other stations which may be reached through the system. This apparatus records the signals in tape **233** which tape, in turn, controls the transmitter **234**. The switching signals preceding the message cause this transmitter to control the selecting relays **235** to connect the transmitter through the switching equipment to the proper line.

Trunk circuits, such as **220**, extending to other switching stations may be similarly provided with two types of receiving equipment **221**, **222**, signal recording tape **223**, transmitting device **224** and selecting relays **225**. This equipment operates in the same manner as equipment associated with the lines extending to outlying stations.

The trunk circuits, such as **220**, are also provided with two-way repeater equipment at each switching station, according to standard practice on inter-office trunk circuits. This equipment is indicated at **229** and **329** for the trunk circuit **220**. The repeater equipment may be of any well-known suitable type operating as single line repeaters for transmission in one direction at a time. By this means, the trunk circuit may be supplied with suitable sources of current, independently of the sources otherwise supplied at the switching centers for operation with the local loop circuits.

At the switching station shown in Fig. 2, other apparatus is provided for receiving messages from and transmitting messages to other types of switching stations, such as a manual switching station of any of the usual types employed in telegraph switching networks and illustrated diagrammatically by the rectangle **248**. This connecting system indicated at **248** is connected by means of trunk **252** to the switching equipment shown in Fig. 2. Associated with trunk **252** at the station shown in Fig. 2 is a receiving device **241** for recording messages received from the connecting system **248** and addressed to the switching station shown in Fig. 2, and a second receiving apparatus **242** intended to receive and record the messages, which are intended for outlying stations, by perforating tape **243**. Transmitting device **246** is controlled by a second perforated tape **251** and is also associated with the line or trunk **252** for transmitting messages, received from other lines or stations, to the connecting system represented by the rectangle **248**.

The connecting station represented by rectangle **248** may be of any type and, if of the manual type, is provided with line equipment **249** and a jack **250**. In case the connecting system **248** is of an automatic type, the jack would be replaced by the type of switches otherwise employed in the system **248**. The system shown in Fig. 2 is, in accordance with this invention, designed to transmit the same type of supervisory and message signals over line **252** as those normally employed on local or trunk lines extending from the system **248**, so that it will usually be unnecessary to provide any additional or special equipment at these connecting stations to enable messages to be exchanged between the different systems.

Means are also provided at the switching station in Fig. 2 for transmitting messages originating at the switching station to any of the other stations which may be reached through the system, this means comprising a manually operated signal storing device **262** for perforating tape **263** in accordance with the messages to be trans-

mitted. Perforated tape 263 controls the transmitter 264 which, in turn, controls the selecting relays 265 which cause the operation of the switching equipment to connect transmitter 264 to any of the lines to other stations.

The system in accordance with this invention is also designed to enable any station to transmit the same message to more than one of the other stations in the system without requiring the station transmitting the message to repeat it for each station for which the message is intended.

To accomplish this, a special repeating arrangement is provided which comprises the perforating device 272 which perforates the tape 273. When it is desired to transmit such a message, the operator at the outlying station will first transmit a special switching signal and then the switching signals of all of the stations to which it is desired to send the message. A second special switching signal or character will then be transmitted following which the message itself will be transmitted.

The special switching signal preceding the usual switching signals and the message will cause the message as received by any one of the typing reperforators such as 212, 222, 232 or 242, to be repeated through the switching equipment to the typing reperforator 272. The tape 273 is perforated in accordance with this message intended for a plurality of stations and controls a special transmitter 274. The reperforator 272 controls the selecting relays 275 which in turn control the switching equipment and connect all of the lines to the transmitter 274 which are idle and for which the message is intended. If any of the lines for which the message is intended are busy, a connection is also established between the transmitter 274 and receiving device 272 for reperforation.

However, it is desirable that the entire message be received and recorded by the receiving device 272 before transmitting device 274 is connected to any of the lines or to receiving reperforator 272 to prevent holding any of these lines busy an unnecessarily long interval of time and to prevent any interference with the message being received by the receiving device 272. After the entire message is received by the receiving device 272, transmitter 274 will be connected to the lines which are idle and to which the message is directed. Transmitter 274 will then be started and transmit the message to all of the lines to which transmitter 274 is connected and also to the receiving device 272 if any of the lines to which the message is directed are busy, so that the message will still be available for transmission to these other lines which were busy during the first transmission of the message. When any of these busy lines become idle after the entire message has been transmitted to the idle lines, the message may be transmitted to it in the same manner and this operation repeated until the message has been transmitted to all of the lines for which the message is intended.

The switching system shown in Figs. 1 and 3 is substantially a duplicate of the switching station shown in Fig. 2 and operates in substantially the same manner. It should be noted that any of the stations of the system shown in Fig. 3 may transmit a message to any of the stations shown in Fig. 2. Furthermore, any of the stations, such as 310 in Fig. 3 or 210 in Fig. 2, may send a single message addressed both to stations connected to its respective central switching station and to stations connected to the other central switching station. For example, station 310 may direct a single message simultaneously to station 330, the central switching station shown in Fig. 2, and stations 210 and 230. The system shown in Fig. 3 operates in this case substantially the same as that described with reference to Fig. 2. Thus the message transmitted from station 310 may be preceded by special switching signals which cause the message to be directed to the receiving device 172. The usual switching signals are transmitted following this special switching signal so that the message may be broadcast to the proper lines. In this case the switching signals for directing the message to the central switching station shown in Fig. 2 and stations 210 and 230 will, after the entire message has been recorded by the receiving device 172, cause the selecting relays 175 to select trunk 220 extending to the second switching station. All the switching signals are transmitted over the trunk 220 to the switching station shown in Fig. 2 where certain of them cause the message to be directed to the receiving device 272 of the special repeating device. Thereafter this repeating device 272 causes the message to be transmitted to stations 210 and 230 when they become idle, as described above. In case the message is also intended for the central switching station shown in Fig. 2, as assumed above, the switching signals transmitted over the line 220 will cause the message to be repeated to both the receiving devices 221 and 222, the message recorded on the device 221 being the copy of the message for the switching station shown in Fig. 2.

The switching station shown in Figs. 1 and 3 differs from that shown in Fig. 2, in being equipped with a second special repeating arrangement including devices 182, 184 and 185 and switching relays similar to the devices 172, 174 and 175 described above. The second special repeating arrangement operates in the same manner and for the same purpose, namely, for the simultaneous transmission of a message to a plurality of stations as they become idle. The second repeating arrangement is automatically made available for operation whenever the other repeating arrangement is busy.

It should be understood that the switching station shown in Fig. 2 and other stations similar to that of Fig. 2 may each be equipped with two or more repeating arrangements depending upon the demand for multiple address or broadcasting service. At a switching station one of the repeating circuits may be always first available or any one of the repeating circuits may be first available at different times, another being switched into service when the first is busy.

As pointed out hereinafter, the selecting relays and switching equipment, as well as the transmitters, are all arranged so that a different group of switching signals may be assigned to each of the stations connected to the system and messages preceded by the respective switching signals will be directed to that station irrespectively of where they originate within the system. Furthermore, in case it is necessary to transmit the message through more than one switching station between the originating and terminating stations, the same switching signals will direct the message through each of the switching systems over the proper lines and trunks to the proper terminal station.

The specific embodiment of this invention is illustrated in Figs. 1, 2 and 3 as being applied to a telegraph system comprising two central

switching stations. It is to be understood, however, that any number of central switching stations may be connected in the system and that each of the switching stations will have trunks extending to any or all of the other switching stations, the connections between the selecting relays and switching equipment at each station being so arranged that the messages will be properly routed between the various switching stations so as to be transmitted to the proper terminal station. Furthermore, the switching information is repeated ahead of the message to each of the switching stations and will control the switching equipment at the respective stations to direct the message to the proper line or trunk.

Idle condition

Referring now to Figs. 2 and 4 through 27 when arranged as shown in Fig. 31, the relays assume the positions shown in the drawing when the system is in normal condition and with power applied thereto. When power is first applied to the system all of the various power switches are closed and power is applied to the driving motors for the transmitting and receiving apparatus, some of which are not shown in the drawing. In the case of the typing reperforators, no motors have been shown. However, the usual driving motors are provided for this apparatus and power is supplied to them and they are to be continuously operating whenever the system is to be used so that the equipment is ready to respond to received signals. When power is applied to the system, polar relay **547** will be operated to its right-hand position which maintains an obvious circuit through the receiving magnet **548** and maintains this magnet operated, thus holding the receiving reperforator **569** in its idle condition. Relay **547** is operated to its right-hand position in the transmission circuit extending from negative battery over loop **589**, including the subscriber's station A shown in Fig. 5, upper winding of relay **547**, upper winding of polar relay **592**, contacts **594** and **595** in parallel, lead **550** which extends through Figs. 6, 7, 10, 13, 17, 20, 23 and 26, through the outer left-hand break contacts of switching relays **2518**, **2318**, **2018**, **1718**, **1318** and **1018** to positive battery. Similar transmission circuits may be traced through the upper windings of relays **947**, **1247** and **1647**.

Relay **592** is also maintained in its right-hand position by current flowing through its upper winding at this time and thus completes an obvious circuit through the printer magnet **593** of the receiving teletypewriter **590** at the central station associated with the incoming line or loop **589**. An obvious circuit is also completed through the upper break contacts of relay **565** for maintaining a circuit through the printer magnet **593**, thus insuring that teletypewriter **590** will remain idle at this time.

If there should be a sufficient supply of perforated tape **500** between the tape transmitter **670** shown in Fig. 6 and reperforator **569** shown in Fig. 5, tape controlled contact **682** will be closed and an obvious circuit for the temporary operation of relay **650** will be completed when power is applied to the system. Relay **650**, in operating, completes a circuit for the operation of start magnet **672** from negative battery through the right-hand break contacts of relay **654**, the left-hand operated contacts of relay **650**, switch **680**, start magnet **672** to positive battery through the lower break contacts of relays **704**, **703**, **702** and **701**. Magnet **672** will operate in this circuit withdrawing the stop latch **679** from engagement with the cam **678**, thus permitting the distributor to rotate. The transmitter will also operate and advance tape **500** through the transmitter. At this time, however, the transmitter is not connected to any line. The transmitter will thus continue to advance tape **500** until the supply of tape between it and the reperforator **569** has been reduced so that tape lever contact **682** will open, thus interrupting the circuit of relay **650**. Relay **650** releases and interrupts the circuit of the start magnet **672**, whereupon the transmitter will come to rest and remain in that position until signals are recorded in the tape **500** by the printer reperforator **659**. This is the condition represented in Fig. 6, and similarly in Figs. 9, 12, 16, 22 and 25.

Tape controlled transmitter **970** similarly advances the tape **900**. Likewise, the tape controlled transmitters **1270**, **1670** and **1970** advance their respective tapes **1200**, **1600** and **1900** until the supply of perforated tape is reduced to a predetermined minimum quantity. In a somewhat similar manner the tape controlled transmitters **2270** and **2570** cause tapes **2200** and **2500** to be advanced until the supply of perforated tape between them and the reperforators **2269** and **2569**, respectively, is reduced to a predetermined minimum quantity. The transmitter **1570** will similarly reduce tape **1500** to the predetermined minimum quantity whenever switch **1580** is closed.

Relay **708** also operates when power is first applied in a circuit from negative battery, through its winding and right-hand break contacts of relays **729**, **739**, **849**, **839** and **859** to positive battery. Similar circuits may be traced for the operation of relays **1008**, **1308**, **1708** and **2008**.

A circuit is also completed at that time for operation of relay **710** from positive battery through the winding of relay **710** over busy lead **557** which extends through Figs. 6 and 5 to negative battery through the center set of lower break contacts of relay **562** which has not yet been operated. The operation of relay **710** completes a circuit for lighting busy lamp **761**. Similar circuits are completed over conductors **957** and **1257** from contacts on relays **962** and **1262**, respectively, for the operation of relays **720** and **730** and for lighting lamps **762** and **763**.

The circuits from the same break contacts of relays **562**, **962** and **1262** are also extended over busy leads **557**, **957** and **1257** to relays **505**, **905** and **495**, respectively, which also are operated at this time. These relays are included in timing circuits such as the circuit **510** associated with the loop circuit **589** and cooperate with the timing circuit **520** at station A, in the manner and for the purposes which will be described hereinafter. A similar pair of timing circuits **910** and **226** is associated with the opposite ends of the trunk circuit **220** and a similar pair **1210** and **420** is associated with the subscriber's loop circuit **489**. In general such pairs of timing circuits are associated with all outgoing loop and trunk circuits. Their functions and purposes will be fully set forth hereinafter.

The operator will be instructed to at that time operate non-locking keys **501**, **731**, **901**, **1031**, **1201**, **1331**, **1501**, **1601**, **1731**, **2031**, **2201**, **2331**, **2501** and **2631**. The operation of these keys will complete obvious circuits over their upper contacts for the operation of the respective relays **562**, **706**, **962**, **1096**, **1262**, **1306**, **1562**, **1662**, **1706**, **2006**, **2262**, **2306**, **2562** and **2606** which relays in operating complete locking circuits for maintaining themselves operated as will be described hereinafter.

Of course one or more multicontact keys could be provided to operate all of these relays when power is first applied to the system; or the key or keys could operate one or more multicontact relays which relays in turn would complete circuits for the operation of the relays listed above; or an automatic arrangement might be provided for the operation of these relays at this time as is well understood in the art. The arrangement employing the plurality of keys is shown merely because it is the simplest and adds the least complexity to the drawings. The system is shown in the drawing in the condition initially established by the operation of these keys.

The operation of the relays **562**, **962** and **1262** conditions the system and apparatus for the reception of switching signals which precede the messages.

Keys **501** and **1201**, which are associated with loop equipments, also have a lower pair of contacts by which they at that time closed obvious circuits for the operation of corresponding relays **504** and **404** in the timing circuits **510** and **410** for purposes which will be explained hereinafter. These relays close obvious locking circuits for themselves through their upper windings and over their upper make contacts to battery at the upper break contacts of relays **560** and **1260**, respectively, and thus remain operated after the keys have been released. They in turn connect battery at their lower make contacts to busy leads **557** and **1257** to maintain the busy condition and keep relays **505** and **405** operated.

Upon the initial conditioning of the switching station by the operator, the operation of relay **562** initiates the operation of relays **651** and **652**, the energization of feed-out magnet **549** and the consequent feeding-out of tape by the receiving reperforator **569** for about 15 seconds until the lamp **872** lights and the operator actuates the key **874**. This operates relay **653** and releases relays **651** and **652**. These operations will be described more in detail hereinafter under the heading "Tape feed-out." At the present stage of operations the result will be that any message record left in the tapes of any transmitter will be removed, the tape will become taut and contacts **682** will open, thereby releasing relay **650**.

Similar initial operations will take place in the circuits shown in Figs. 9, 12, 16, 22 and 25 requiring the operator to actuate keys **1174**, **1474**, **1874**, **2473** and **2773**. These keys thus operate relays **653**, **953**, **1253**, **1653**, **2253** and **2553**, which lock up and stop the feed-out of tapes, as will be described more in detail hereinafter.

The contacts of key **1556** are normally closed, so that circuits will be completed for the operation of relays **1665** and **1687** at that time. The operation of relay **1665** renders the typing reperforator **1669** non-responsive to any received signals by completing a circuit through the selector magnet from negative battery through the winding of magnet **1648**, the inner upper break contacts of relay **1663** to positive battery through the upper outer operated contacts of relay **1665**. The operation of relay **1665** interrupts the holding circuit for magnet **1693** of the recording device **1690** and thus permits this magnet to follow the operation of relays **1692**.

In the case of the receiving devices **1669** and **1690** the circuits for the driving motors extend through leads **1688** which are open at the contacts of key **1686**. These motors are not normally operating, like all the other motors, for driving their equipment at the central station.

The equipment at a subscriber's station, such as the station A showed in Fig. 5 and connected over the loop circuit **589** to the central switching station, may comprise any suitable type of telegraph transmitting and receiving apparatus. Tpyical examples of suitable printing telegraph apparatus, such as would be employed in typical telegraph systems in accordance with this invention, are described in detail in United States Patents 1,904,164, granted to S. Morton et al., April 18, 1933 and 1,745,633, granted to S. Morton et al., February 4, 1930. The disclosures of these patents are hereby made a part of the present application to the same extent as if set forth herein in full. When desirable, tape transmitting apparatus may be also included at the subscriber's station. Details of typical keyboard perforating mechanisms and associated transmitters are shown in detail in United States Patents 1,965,572, granted to Burcky et al., July 10, 1934; 1,965,602, granted to Lake, July 10, 1934; and 1,969,891, granted to Lake et al., August 14, 1934. These patents are also hereby made a part of the present application as if fully included herein.

The tape perforating transmitting and receiving devices at stations A and B are designated **595** and **495**, respectively, in the drawing and the associated tape transmitters and distributors are designated **580** and **480**, respectively.

The line circuit at station A includes a winding of the receiving relay **586**, break key **534**, keyboard contacts **538**, tape transmitter contacts **581** and distributor contacts **573**. The polar receiving relay **586** controls the printing magnet **587** of the recording device **585** for recording of incoming messages or for home recording of outgoing messages.

The outgoing signals may be transmitted directly from the keyboard contacts of the sending and recording device **585** or the circuit may be switched by operation of the key **521** to its automatic position into condition for automatic sending, in which case a tape, perforated by the keyboard, is inserted in the tape transmitter **580** for transmission. In either case signals are transmitted by opening and closing the loop circuit **589** to the central switching station.

The transmitting and receiving devices at the subscriber's station are constructed to cooperate under certain conditions and to operate individually under other conditions. Thus the receiving device **585** may independently receive an incoming message and type a record thereof and the transmitting device may independently send a message from a previously prepared tape. The keyboard is however capable of being conditioned in three different manners by the operation of a lever **512** into three different positions. Thus in one position of the lever the keyboard operates the keyboard contacts **538** for direct transmission to the line and causes the printer to print a record, but does not perforate tape; in another position the keyboard perforates tape without operating the contacts **538** and without causing the printing of a record; and in the third position the keyboard operates the contacts **538**, perforates tape and causes the printing of a record. A lever such as lever **512** and its control mechanism and operation for the herestated purposes is disclosed in the patent to Burcky et al. referred to above, where the lever is designated **127**.

The transmitting device **580** has a set of five sending pins arranged in the sensing head for

control of the contacts 581 in accordance with the perforations in the tape. A so-called sixth pin is also provided in the sensing head which will be depressed when tape is present in the sensing head, and which will be unaffected by the perforations in the tape during transmission. The sixth pin operates suitable contacts for circuit control. When the tape is removed, or when the end of the tape is reached, the sixth pin rises. A tape transmitter provided with a sixth pin of this type is disclosed in the United States Patent 2,074,189, issued to E. Rice et al. on March 16, 1937. The use of such a sixth pin in a tape transmitter for circuit control has been disclosed in my Patent 2,340,576, issued on February 1, 1944. These patents are also hereby made a part of the present disclosure as if fully included herein.

With the key 521 in the normal position shown, the circuit is adjusted for automatic transmission. When the tape is inserted in the transmitter 580, the sixth pin 574 is depressed thereby and upon closing of the start switch 579, a circuit is completed for operation of relay 526, which at its middle break contact opens a bypass for the transmitter contacts 581, which thus are rendered effective. Relay 526 also releases the tape feed withholding magnet 571 which thus permits the tape to be fed out one step for each revolution of the distributor 573, when the latter becomes released. The start magnet 572 is included in a circuit from minus battery at the break lock contacts 583 in the recorder 585 and over the tape lever contacts 582, closed contacts of key 521, lower make contact of relay 525 to plus battery. The contacts 583 remain closed except during an incoming break condition; the contacts 582 may be controlled by the bight in the tape if the tape is passed from the perforator 585 directly into the transmitter 580 and thus will remain closed unless the tape tightens up. The starting of the transmitter by magnet 572 thus awaits the operation of relay 525, which depends upon the operation of a timing circuit 520 at station A, as will be described herinafter, which temporarily holds up the outgoing message. After a predetermined time lapse, relay 525 will be operated and transmission will commence from station A.

With the key 521 in its alternate position for keyboard transmission, the circuit traced above for the stop magnet 572 is opened at the upper break contact of the key, which prevents the tape transmitter 580 from operating. The bypass around the sending contacts 588 of the keyboard is opened at the key 521 so that the operator may send by operating the keyboard. Usually the operator must await the lighting of the lamp 522 by relay 525 before commencing to operate her keyboard for direct transmission. The lighting of the lamp 522 depends upon the operation of the timing circuit 520.

When power is first supplied to the equipment at station A, the timing circuit 520 will establish the predetermined time interval and, at the end of that interval and in a manner to be explained hereinafter, will first condition the station A for transmission and, if no message is ready, will cause a spacing pulse of unit signal length to be sent to the equipment at the switching center, which is permanently connected to the loop 589, to condition that equipment for transmission to station A.

Transmission of messages simultaneously from both terminals of a half-duplex circuit would of course result in multilation of the messages. In prior systems such events were automatically indicated to attendants who were expected to set the tapes back and retransmit the mutilated messages. The present system includes equipment for controlling the admittance of a transmitter to a transmission path or channel for the initiation of transmission in a manner to avoid even infrequent occasional mutilation of messages as would require the attention of an attendant. The function of this equipment is sometimes designated "Circuit assurance."

Circuit assurance applied to systems which include equipment for automatically directing messages to their addresses is a broadly novel feature of this invention. From another viewpoint this function may be described as "Non-interfering transmitter control."

From the description of operations given hereinafter, it will be apparent that the setting up of a connection between two stations involves a series of successive operations which occupy some appreciable time. Thus a calling station may have progressed to the point of switching and be about to seize the called loop circuit, which still appears idle at the switching point. During this setting-up interval the called station might make its immediate receiving circuit at the switching center busy by starting to send a message. Thus when the called loop circuit is seized, the two messages would be interfering.

To avoid the possibility of such interference, provision is made for making each loop circuit available to its associated station during regularly occurring time intervals alternated with other similar intervals during which the loop circuit will be available to the switching station for messages intended for the subscriber's station. Similar provisions are made for interoffice trunk circuits. Thus each station at the ends of an outgoing loop or trunk circuit is assured of its circuit before transmission can be started. For this purpose each loop or trunk circuit has a timing circuit connected thereto at each end thereof.

Thus referring again to Fig. 5, there is a timing circuit 520 located at the substation end of the loop 589, which comprises a three-electrode electron discharge vacuum tube 516. The tube 516 may be of some other known type suitable for the purpose. A timing condenser 517 is connected from negative battery to the control electrode or grid of the tube. The timing circuit 510 located at the switching station similarly includes the vacuum tube 506 and timing condenser 507. The characteristics of tubes 506 and 516 are such that when the negative battery is applied to the control grid, the tube will be practically non-conducting. Whenever the negative battery is removed from the grid circuit, the timing condenser will gradually become charged from permanently connected positive battery 502 or 513, respectively, and after a predetermined interval, which may be of about ten seconds duration, the potential on the grid will be sufficiently positive to render the tube conducting. The time intervals may of course be different for the two timing circuits.

When power was first applied to the system at the switching station, as described above, battery was connected over the lower middle break contact of relay 562 to the conductor 557 and relay 505 was operated, thereby connecting negative battery to the grid of tube 506. In response to the initial operation of key 501, relay 562 was

operated and removed battery from conductor 557. The operation of key 501 also connected battery over its lower contact to the upper winding of relay 504 which operated and again connected negative battery to conductor 557. Relay 505, therefore, remained operated and the tube 506 remained non-conducting or cocked. Relay 504 closed a locking circuit for itself over its upper contact and upper break contact of relay 560. This left circuit 510 in a waiting condition with relay 504 locked in operated condition.

When power was first applied at station A relay 519 operated, thereby removing a short circuit for condenser 517. In the present instance the operation of relay 519 and the operation of line relay 586 to marking permitted the condenser 517 to charge and after ten seconds the tube 516 became conducting and caused relay 518 to operate to start the following series of operations.

Relay 518, on operating, removes battery from relay 519 which releases after a short delay. Relay 518 also places battery on conductor 527 causing a current to flow over lower break contacts and winding of relay 523 which operates and locks itself. The winding of relay 524 was shorted over its lower break contact and remains shorted after the operation of relay 523. When thereafter relay 519 completes its release, condenser 517 will be short-circuited and tube 516 cocked in non-conducting condition, thereby releasing relay 518 which in turn reoperates relay 519 and thus removes battery from conductor 527. This removal of battery eliminates the short circuit for relay 524 which operates over the closed make contact of relay 523. Thus upon the application of battery to conductor 527 and the subsequent removal of battery therefrom, relays 523 and 524 will be operated and self-locked.

This pair of counting relays 523 and 524 is used to close three distinct circuits when both relays are operated. Thus at the present instant a first circuit is closed over their inner upper contacts for operation of relay 514 which may lock itself over marking contact of line relay 586. A second circuit is closed over the middle upper contacts for operation of relay 525 and the third circuit extends conductor 527 over the outer upper contacts through upper make contact of relay 525, when operated, outer break contacts of relay 526, when released, and middle contact of key 521, when in "automatic" position, to negative battery.

The operation of relay 525 closes a start circuit from positive battery over its lower make contact, upper break contact of key 521, tape lever contacts 582, starting magnet 572 and break contacts 583. With no tape in the transmitter 580, contact 582 will be closed at this time and starting magnet 572 will operate and release the distributor 573 for one revolution. As the distributor 573 rotates, a "start" pulse will be transmitted over the loop 589 followed by five marking selecting pulses and by the "stop" pulse, which is also a marking pulse. The five selecting pulses will be marking pulses because at this time, the transmitting contacts 581 are bridged by a circuit through the middle upper break contacts of relay 526.

Relay 525 also operates slow release relay 528, which connects direct battery to the operating circuit for relay 514. In the meantime, relay 514 has applied negative battery to the tube 516 thereby insuring that the tube remains non-conducting.

The completion of the third circuit by relays 523 and 524, as referred to above, extends negative battery to conductor 527 and over the lower make contacts of relay 524 to short-circuit relay 523, which thus releases and opens the operating circuit for relay 524, which also releases. In this manner the three operating circuits referred to above will again be opened in response to the second application of negative battery to relays 523 and 524 and the removal of battery from these relays. Thus the operating circuit for relay 514 will be opened. The opening of the second operating circuit releases relay 525, which starts the relay 528 on its release period, and the opening of the third circuit removes battery from conductor 573. This series of operations will be completed before the distributor 527 reaches its stop position so that the starting magnet 572 will have been released in time to prevent further rotation of the distributor.

When the start pulse passed out over the loop circuit 589, the line relays 586, 547 and 592 were operated to spacing. The relay 586 went to spacing while relay 514 was still held operated by relay 528, which does not open its contacts for release of relay 514 until some time after relay 586 returns to marking at the end of the spacing pulse. Thus relay 514 remains locked up over the marking contact of relay 586 and the circuit 520 now will be left in a waiting condition.

At the switching center the operation of relay 592 to spacing will have no effect at this time since the magnet 593 is independently energized.

The operation of relay 547 to spacing will cause the printing device 569 to advance the tape one step and relay 560 to operate, which opens the locking circuit for relay 504. Relay 504 commences its release period. At the end of the start pulse from station A, relay 547 returns to marking and relay 560 begins to release. The complete release of relay 504 is timed to take place under the present circumstances before relay 560 releases and restores the locking circuit for relay 504. Thus relay 504 releases and shortly thereafter relays 560 and 505 release. The release of relay 505 permits condenser 507 to charge.

After ten seconds the tube 506 becomes conducting and causes relay 508 to operate, which in turn operates relay 509. Relay 509 opens the loop circuit which, due to intervening operations in the circuit 510 and the slow release feature of the relay, will remain open exactly for the time of a standard unit pulse. Relay 509 also substitutes resistance 502 for the loop circuit so that line relays 547 and 592 will remain in marking position. Relay 508 again operates relay 504 which locks over contacts at relay 560. Relay 504 again operates relay 505 which in turn cocks the tube 506. This restores relay 508 and causes relay 509 to commence its release period. Complete release of relay 509 again leaves the circuit 510 in the waiting condition.

The opening of loop 589 by relay 509 causes the line relay 586 at station A to operate to spacing for the duration of a standard pulse. Relay 586 opens the locking circuit for relay 514 which will release before relay 586 returns to marking. Relay 514 removes battery from condenser 517 and, when relay 586 returns to marking, it removes battery from condenser 517 which thus begins to charge up and initiate another cycle of operations.

The cooperation between the two timing circuits 510 and 520 under idle conditions may be described in a more general manner as

follows: Beginning with the 10-second timing period of the circuit 520 at substation A, the loop circuit is in a waiting condition with relay 514 released by a spacing pulse from the switching station. At the end of the time interval the counting relays 523 and 524 operate, in turn operating relays 525 and 528. This momentarily conditions station A for transmission by preparing the operating circuit for starting magnet 572 and by opening the by-pass for the keyboard contacts 588. Relay 514 is also operated and finally the assurance pulse from distributor 573 is transmitted over the loop. At this time relays 523, 524 and 525 are released, thereby again blocking the operation of the transmitting equipment at station A. Station A then will have returned to the waiting condition with relay 514 locked up.

During all this time relay 504 at the switching center has been locked in operated position, thereby applying battery to conductor 557 which operates relay 710 to make line A busy in the switching relay circuit.

When the assurance or assignment pulse from station A is received by the reperforator 569, relay 560 is operated to release relay 504 and temporarily maintains relay 710 operated by applying battery over its lower make contact to conductor 557. Upon release of relays 560 and 505 at the end of the assurance pulse from station A, the charging period for condenser 507 commences, and line A no longer appears busy in the switching station. The circuit remains in this condition for ten seconds until the tube 506 becomes conducting and the loop is opened by operation of relays 508 and 509 for transmission of the assurance pulse to the subscriber's station. Line relay 547 now remains in marking during the assurance pulse. Relay 508 reoperates relay 504 and the circuit 510 is returned to the waiting condition with relay 504 locked up and making line A busy again.

In response to this assurance pulse over the loop circuit, line relay 586 releases relay 514 thereby initiating the charging time for condenser 517.

Thus it will be seen that during idle conditions spacing pulses will pass over the loop at predetermined intervals and alternately in opposite directions. During one interval the loop will appear idle at the switching station and may be seized at any time during the interval, and the substation distributor cannot be started. During the alternate interval the loop will appear busy at the switching station and cannot be seized, and the equipment at the substation will be conditioned for starting transmission at any time during the alternate interval.

Subscriber initiates a call

It will now be assumed that the subscriber A, shown in Fig. 5, desires to send a message, say to station B, shown in Fig. 4.

If the operator at station A desires to send a message by tape, the tape is inserted in the transmitter 581 and thus closes the sixth pin contacts 574 and in turn causes the operation of relay 526. Therefore, when relays 523, 524 and 525 operate at the end of the ten-second interval of the circuit 520, the transmitter will start sending and the restoring circuit for relays 523 and 524 will remain open at the upper break contacts of relay 526, so that these relays will remain operated and in turn keep relay 514 operated and the tube 516 cocked for the duration of the message. However if the operator at station A desires to

send a message directly from the keyboard contacts 588, the key 521 will be operated to its keyboard position, thereby also opening the restoring circuit for relays 523 and 524 at its middle break contacts and similarly keeping relays 523, 524 and 514 operated, so that the tube 516 remains cocked until the end of the message. In this case the operation of relay 525 will light the lamp 522 indicating that the loop is available and that the operator may start sending.

Assume that station A is prepared to send a message by the automatic transmitter 580. Key 521 therefore will be in the normal or automatic position. A message tape will have been inserted in transmitter 580 depressing the sixth pin 574 and operating relay 526. The lever 512 will also be adjusted into the position in which the keyboard perforates tape without operating the keyboard contacts 588 and without printing a record. Whether transmission can commence will depend upon the condition of the assurance timing circuits 510 and 520.

Assuming that the timing circuit 510 at the switching station is timing and at the end of the interval sends the assurance pulse, relay 586 operates to spacing, releases relay 514 and returns to marking. With the lever 512 in the assumed position, the only effect of the assurance pulse at station A is to operate magnet 587 without affecting the printer. Thus the time interval by circuit 520 is started and after about ten seconds the counting relays and associated relays are operated as previously described. Thus relay 514 is operated and will remain operated during the message and keep the tube 516 cocked. Relay 525, operating, starts the transmitter distributor 580 which thereafter will continue operating until the tape becomes taut and opens the tape lever contacts 582 or else until the end of the tape passes off the sixth pin 574.

At the central station the timing circuit 510 upon transmitting the assurance pulse returns to its waiting condition with relay 504 operated and locked up over contacts of relay 560. Thus battery will be applied to conductor 557 operating relay 505 and making station A busy by operating relay 710.

When the message from station A arrives at the central station, relays 547 and 592 follow the signals. The selector magnet 548 follows the signals repeated to it by relay 547. However the printing magnet 593 does not follow the signals because its circuit is maintained closed by positive battery through the upper break contacts of relay 565.

In initiating a message the attendant at station A may transmit one or more "letters" signals followed by the switching character or characters and then the message. In order to allow sufficient time for the different switching and receiving devices and apparatus and circuits to function, it may be desirable to transmit one or more "letters" signals before and after as well as between the switching signals or code combinations. The transmission of the "letters" signals does not in any way interfere with the operation of the various switching apparatus and circuits and provides time for their operation.

Under the assumed condition the first signal combination transmitted by the operator at station A will be a B, representing the desired station B. When this signal is received by the selector magnet 548, it causes the associated selector apparatus to close contacts 533. One manner in which receiving selector and reperforator 569

may cause the contacts 533 or other similar contacts to operate is described in detail in United States Patents 2,112,234, granted to Beattie et al. March 29, 1938 and 2,120,235, granted to Beattie et al. June 14, 1938. The disclosures of these patents are hereby incorporated and made a part of this application to the same extent as if set forth herein in full. It is to be understood, however, that the contacts controlled by the selector mechanism are connected as shown in the drawings attached hereto and not as shown in the above-identified patents to Beattie et al. However, the contacts are selectively operated in a similar manner by the receiving selector in both cases in response to preassigned signal combinations.

In the embodiment of this invention shown in the drawing it is desired to print the message on the tape as well as to perforate the tape in accordance with it. This enables operators and attendants to readily read the message stored in the tape. Fig. 28 shows details of the manner in which contacts or switches, such as contact 2833, which corresponds to contact 533 of Fig. 5, are operated by the same selecting mechanism as controls the printing and perforating mechanism. When the B pull-bar 2891 is selected, it moves to the rear, or right as viewed in Fig. 8. This allows associated contact 2833 to be operated and in this case closed when the pull-bar is pulled down by the pull-bar bail 2802. The contact remains closed during the time this pull-bar is actuated by the pull-bar bail. When the pull-bar 2801 returns to normal, it returns contact 2833 to normal. The operation of the printing reperforating mechanism shown in Fig. 28 will be described in more detail hereinafter.

It is to be understood that the signals normally transmitted by the station A in addition to causing the various contacts to momentarily close, as described above, also cause the receiving equipment to print the corresponding characters on tape 500 as well as to perforate or punch this tape in accordance with the received signal. In accordance with the preferred embodiment of this invention, the individual perforations in the tape need not be complete in that no paper is entirely punched out of the tape. Thus each punching may be cut only along three sides of a square or along part of the circumference of a circle. Thus small pieces of paper are left attached to the tape which therefore presents a continuous surface, so that the printing on the tape may be just as readily read as if there had been no perforations. The punched pieces are however loosely enough attached to the main body of the tape to readily permit the feelers or sensing pins of the transmitter to pass through the openings.

Returning now to Fig. 5, the momentary operation of contacts 533 in response to reception of the B signal opens a locking circuit for relay 562 which includes the upper make contact of relay 562, upper break contact of relay 563 and selecting contacts 541, 542, 543, 533 and 532 in series to battery. Relay 562 therefore releases at this time.

It should be noted that when the B signal is received by relay 547, an obvious circuit is completed at the spacing contact of this relay for the operation of slow release relay 560. This relay is made slow in releasing so that it will be maintained operated by relay 547 while the armature of relay 547 is following the signals received over loop 589. The operation of relay 560 applies negative battery over the lower operated contacts of relay 560 and lower inner break contacts of relay 565 to busy lead 557. Thus when slow release relay 564 completes its release and remove battery from conductor 557, this battery will have been replaced by the battery from the make contact of relay 560 so that relay 505 will remain operated and the busy condition will be maintained. The release of relay 562 connects negative battery directly to lead 557 and thus will maintain relays 710 and 505 operated and line 589 busy, even if there should be a sufficiently long pause in the tranmission of the message to permit relay 560 to release.

The message transmitted from station A will be recorded in tape 500. The various characters received by the reperforator 569 will cause the contacts controlled by the selector equipment to momentarily open or close, but with no further effect after the release of relay 562.

At the end of the message the operator at station A transmits a "figures" signal followed by a signal representing the letter H. In response to the setting up of the fig.-H combination in the sending receiver 585, the contacts 511 will momentarily close after a short delay. The manner in which these contacts are operated in response to a succession of two assigned signal combinations is fully described in the above-identified patents to Morton and therefore need not be described here. Thus the contacts 511 apply negative battery to the conductor 527 for the release of relays 523, 524, 525 and for the delayed release of relay 526. Relay 514 will lock itself up over the marking contact of relay 535 and the timing circuit 520 will be in waiting condition. With relay 525 released, no transmission can take place from station A.

When the "figures" signal is received by the receiving device 569, the selectable contacts 538 will be operated to momentarily close a circuit for operation of relay 561, which consequently locks over contacts 539 and 536. If the next signal should be "letters" or "space," contacts 539 or 536, respectively, would be opened for the release of relay 561. However, when the H combination follows immediately upon the "figures," the momentary closing of the corresponding contacts 537 will reoperate relay 562 over a circuit through its winding, over contacts 537 and lower operated make contact of relay 561. This operation of relay 562 at the end of a message conditions the receiving device 569 for selective operations in response to the switching signals at the beginning of the next message. Relay 561 will release on subsequent reception of "letters" or "space" signals. The circuit at the switching station thus will be in the same condition after each message as when it was first conditioned by operation of key 501.

It is to be understood that any two predetermined code combinations, assigned for this purpose and not used in messages, representing any two characters or functions may be employed in immediate succession to activate or condition the contacts and selecting mechanism for operating suitable relays. It is also within the scope of this invention to employ only one signal combination for accomplishing this or to employ three or more signals for this purpose. The adoption of two signals in the specific embodiment, disclosed in this application, is merely by way of an example of a typical practical system.

The operation of relay 562 now removes battery from busy lead 557. When thereafter relay 560 releases, battery will be entirely removed from the busy lead 557 thereby removing the busy

condition from the line equipment for station A and also releasing relay 504 and hence 505. Thus the timing circuit 510 will commence its timing period and alternate operation of the circuits 510 and 520 may proceed in the manner already described for idle condition.

Transmitting the message to the selected station

When the first signals are received and perforated in tape 500 by device 569, as described above, an additional supply of tape will be provided between the receiving device 569 and the transmitting device 670 shown in Fig. 6. It is assumed that tape 500 passes continuously from the receiving device 569 in Fig. 5 to the transmitting device 670. The tape is represented in the drawing by the heavy dash line 600 and is shown in this manner merely for drafting convenience to make the operation of other parts of the system more readily understandable from the drawing.

The additional supply of perforated tape between the receiving device 569 and the transmitting device 670 causes contacts 682 to close and complete a circuit for the operation of relay 650, as described above. The operation of relay 650 completes a circuit for the operation of the start magnet 672 which withdraws the stop latch 679 from engagement with the stop cam 678 and thus permits the transmitter to operate and advance tape 500. Tape 500 will be advanced through the transmitter 670 without producing any significant results until a switching character arrives at the control position of the transmitting device.

At the beginning of the rotation of distributor 673 the cam 674 will allow lever 699 to rotate in the clockwise direction. This in turn permits plate 665 to also rotate in the clockwise direction. The plate normally engages the vertical arms of the selecting levers 666 thereby clearing the pins 663 of the punches in the tape 500, but when rotated the plate admits the pins into such punches as are presented at the moment. The plate 665 when rotated also engages the sliding member 668 which by its vertical arm will admit the pivoted members 664 into engagement with the various notched front edges of the selecting members or bars 667, attached at their upper ends to the selecting levers 666. It should be understood that the admissive movement of the various elements in this machine is accomplished by means of individual springs, many of which have been omitted from the drawing for the sake of clearness. The timing is so arranged that the pins 663 will be in their selected positions and thus will have correspondingly operated the transmitting contacts 681, by the time the brush arm of distributor 673 has passed over the start segment and the pins will not be removed from the tape nor will contacts 681 be restored until the brush has passed over the fifth or last selecting segment in the distributor. Thus the code combination represented by a set of punchings in the tape will normally be passed into the transmission circuit 645 through the switching relay system.

Under the assumed conditions the signal combination representing the letter B punched in the tape will cause the sensing pins to take a corresponding setting, and the contacts 681 will be correspondingly opened and closed while the transmitter makes one rotation. However, since the transmission circuit 645 is open at this time, no signal will be transmitted.

As the pins 663 will go through the perforations or punches of the tape 500, the corresponding selecting elements 667 will be raised so that notches in the front edges of these elements line up before the switching lever 664 which controls the B contact 613. Member 668 is then moved to the right on bearings or supports 669 and releases all of the members 664 so that they may rotate. However, all of these levers except the one controlling contacts 613 are prevented from rotating because they will engage the front edge of one or more of the selector elements 667. In case of the switch lever 664 controlling contacts 613, the notches in the front edges of the selecting levers 667 are lined up before this switch lever so that it is permitted to rotate in the clockwise direction and momentarily close contacts 613. Near the end of the revolution of the transmitting distributor shaft, cam 674 engages lever 699 and rotates it in the counter-clockwise direction which, in turn, rotates plate 665 in a counter-clockwise direction. This causes element 668 to move to its left-hand position, rotating the switching lever controlling the contacts 613 in a counterclockwise direction. During the continued rotation of the transmitting distributor 673 and just before it stops, plate 665 engages the fingers 666, rotates them in a clockwise direction, carrying pins 663 out of engagement with the perforations in tape 500 and normally causing tape 500 to be advanced by means of sprocket 640 and levers 641 and 642. However, under the assumed conditions the tape will not be advanced, as explained hereinafter.

The closing of contacts 613 shortly after starting of the distributor 673 completes a circuit for the operation of relay 702 from positive battery through the upper inner operated contacts of relay 706, the upper outer break contacts of relay 704, operated contacts 613 to battery through the winding of relay 702.

The operation of relay 702 completes a circuit for maintaining itself operated from negative battery through its winding, lower operated contacts to positive battery through the operated contacts of relay 708. The operation of relay 702 also interrupts the locking circuit of relay 706 thus permitting this relay to release. It should be noted, however, that during the operation of relay 702 its locking circuit is completed prior to the interruption of the locking circuit of relay 706 thus insuring that relay 702 will fully operate and lock itself operated.

The operation of relay 702 also completes a circuit through its upper operated contacts from positive battery to negative battery through the winding of tape feed withholding magnet 671. The magnet 671 operates and attracts its armature 643 to the right. This rotates lever 641 in a counter-clockwise direction so that the pawl carried by the end of this lever no longer engages with the ratchet or pinion 640 so that, as the distributor 673 completes the revolution then in progress, the tape will not be advanced.

The operation of relay 702 also interrupts the operating circuit of the start magnet 672 thus allowing this magnet to release and stop the transmitter at the completion of the revolution or cycle of operation of the distributor then in progress in response to the B code combination.

The operation of relay 702 completes a circuit for operating relay 737 from negative battery through the upper inner operated contacts of relay 702 to negative battery through the wind-

ing of relay 737. The operation of relay 737 completes a circuit for lighting lamp 731.

If the line 489 is busy, relay 730 will be operated and lamp 763 will be lighted to indicate that this line is busy. If this line is busy, the circuits remain in this condition until line 489 becomes idle.

However, assuming that the line is idle the operation of relay 737 completes a circuit for the operation of relay 738 from negative battery through the inner break contacts of relay 739, the right-hand winding of relay 738, operated contacts of relay 737 to positive battery. The operation of relay 738 completes a circuit for maintaining itself operated from negative battery through the left-hand inner break contacts of relays 2638, 2338, 2038, 1738 and 1038, the left-hand inner operated contacts and left-hand winding of relay 738 to positive battery through the upper break contacts of relay 706 which is released at this time, as described above.

The operation of relay 738 applies battery to the busy lead 1257 and thus causes the operation of relay 730. The operation of relay 730 completes the circuit for lighting lamp 763 and establishes the busy condition for station B by removing the operating potential from the other switching relays 1038, 1738, 2038, 2338 and 2638 thus preventing these relays from operating and interfering with the connection established between the transmitter 670 and station B.

The assumption that station B is idle implies not only that no message is being transmitted over the loop circuit 489 but also that the timing circuits 510 and 520 are passing through the time interval during which the loop circuit will be accessible to the switching station. As already has been explained, this condition prevails when the timing circuit 410 is passing through its time interval with relays 404 and 405 released. Under this condition, relay 404 will have removed battery from the busy lead 1257 and thus will have put the loop circuit to station B in idle condition.

When now relay 738 in operating applies battery to busy lead 1257, relay 405 will immediately operate and cock the tube 406, thus preventing the circuit 410 from transmitting a transmission assignment pulse to station B and therefore retaining control of the loop 489.

Relay 738 in operating completes a circuit for the operation of relay 739.

The operation of relay 739 connects negative battery to lead 1259 through its inner left-hand contacts. Lead 1259 extends through Figs. 10, 13 and 12 to positive battery through the lower winding of relay 1265. Relay 1265 operates in this circuit and completes a path for maintaining itself operated from positive battery through its upper winding and upper inner operated contacts to negative battery through the switch contacts 1291 controlled by recording teletypewriter 1290. The lead 1259 also extends through the lower windings of relay 404 to positive battery. Relay 404 thereof operates at this time and applies negative battery to busy lead 1257. The operation of relay 1265 removes the positive battery connected to the upper winding terminal of the printing magnet 1293 through the upper break contacts of relay 1265, thus permitting this magnet to follow the signals repeated by relay 1292, which relay is connected in the transmission circuit extending to station B, as will be described hereinafter. Magnet 1293 in following the signals transmitted over loop 489 at this time to station B causes the receiving device or teletypewriter 1290 to record these signals. The operation of relay 1265 also connects positive battery to the left winding terminal of the selector magnet 1248 through the upper break contacts of relay 1263 and the upper outer operated contacts of relay 1265. This circuit prevents the selector magnet 1248 from following the signals transmitted over the transmission circuit to station B, as described, hereinafter, and thus prevents messages transmitted to station B from being recorded in the tape 1260. This circuit also prevents the operation of the contacts controlled by the selector magnet 1248 and thus the message transmitted to station B does not in any way affect the switching equipment which is employed to handle messages received from station B.

The operation of relay 738 also extends the transmission path from the transmitting distributor 673 to line 489 in a circuit traced from positive battery 644 through contacts 681 and distributor 673, over lead 645 through the left-hand outer operated contacts of relay 738 and the left-hand outer break contacts of relays 1638, 1738, 2038, 2338 and 2638, lead 1268 through Figs. 23, 20, 17, 13, 12, through the upper contacts of switch 1295, the upper windings of relays 1282 and 1247 over loop 489 to station B, through distributor contacts 473, tape transmitter contacts 481, keyboard sending contacts 488, break key contacts 484, and upper winding of receiving relay 486 to negative battery over loop 489 and break contacts of relay 409.

The operation of relay 739, as described above, also interrupts the circuit traced above for maintaining relay 708 operated and permits this relay to release. The release of relay 708 in turn interrupts the locking circuit of relay 702 and permits this relay to release. The release of relay 702 reestablishes the circuit through the start magnet 672 thus causing this magnet to operate and start the transmission of the letter B from the distributor 673. The release of relay 702 also interrupts the circuit through magnet 671 so that, during the operation of the distributor, tape 500 will be advanced through the transmitter in a normal fashion to transmit the message intended for station B. It should be noted that the signal representing letter B, in addition to controlling the establishment of the connection of the transmitter 670 to line 489 extending to station B, is also transmitted to station B prior to the transmission of the message.

The transmission of the message then proceeds from the transmitter 670 to station B over the transmission circuit extending through loop 489 as described above. During the transmission of the message from the transmitter 670 various selecting contacts controlled by this transmitter will be operated when the corresponding signals are transmitted to station B. However, since the combination of "figures" signal followed by an H signal will not be transmitted in succession during the message without either a "letters" signal or a space signal being interposed between them, the operation of the contacts controlled by the transmitting equipment 670 will be ineffective to control any of the switching circuits which thus will be ineffective to interfere with the transmission circuit from this transmitter to station 485.

When the first signal of the message arrives at station B, the operation of line relay 486 to spacing will cause relay 414 to release. Relay 414 by removing negative battery from condenser 417 permits this condenser to charge up. However,

during a continuous message, line relay 486 will repeatedly apply negative battery over its marking contact to the condenser thereby discharging it repeatedly and preventing the timing circuit 420 from completing its time interval. Line relay 486 controls the printers magnet 487 in accordance with the incoming signals for recording of the incoming message.

Receiving subscriber breaks

If a message is not properly received at the station B for any reason or if the operator thereat desires to interrupt the transmission and attract the operator's attention at the switching station, the operator at station B will operate the break key 484 and maintain this key operated for an interval of time at least as long as the time required to transmit two signal combinations representing two characters or functions. This will cause the receiving or monitoring teletypewriter 1290, which is connected in the transmitting circuit at the central switching station, to operate switch 1295. This switch corresponds to and is operated in the same manner by a break signal as the so-called send-receive-break switching key described in the above-identified patents to Morton et al. The operation of switch 1295 at this time removes the short circuit from around the keyboard contacts 1294 thus rendering these contacts effective to transmit signals to station B. The operation of switch 1295 at this time also completes an obvious circuit for lighting lamp 1296 to attract the operator's attention to this machine so that she can go to it and operate the keyboard contacts 1294 and communicate with the operator at the outlying station B to determine what the trouble is or what additional service is required. In addition, the operator may also go to the transmitter shown in Fig. 6 and move the tape back so that the entire message will be again transmitted to station B. The transmitter will for this purpose be indicated to the operator by the lighting of lamp 655, as will be described below.

The break signal from station B was transmitted by opening the break contacts 484. This causes the operation of contacts 483 which are similar to the contacts 583. Contacts 483 remove negative battery from the circuit for the start magnet 472 thus preventing the distributor 473 from operating. The operator at station B also operates the key 421 to keyboard position thereby preparing the keyboard contacts 488 for transmission. Upon operation of the key 421, the contacts 483 will be restored by the operator. The lever 412 will be moved to the position for keyboard transmission and printing.

As will presently be explained, the operation of the contacts 1295 at the switching center stops further transmission by the transmitting distributor 670. Thus no signals will be passing over the loop 489 after the break signal until the attendant at the switching station begins to manipulate the keyboard contacts 1294.

It is evident that keyboard controlled communications may be expected to be carried on with some variation in timing and sequence and that therefore the timing circuits associated with the loop circuit may be thrown out of their normal regularity of operation.

Thus, again considering the present instance of a called subscriber sending a break signal against an incoming message, when the timing circuit at the switching station is kept in waiting condition by the message and the timing circuit at the substation is in timing condition but is prevented from timing by the incoming message. After the break signal has been sent and in the absence of further signals from the switching station the timing circuit 420 will resume its timing. In this case the attendant at the switching center may answer before or after the ten-second interval has been completed. When the answer or inquiry arrives at station B before the circuit 420 has completed its interval, the timing will start all over again, and if the communication should proceed with no pause longer than ten seconds the circuit 420 will still be in timing condition at the end of the conversation. If on the other hand, the inquiry should arrive later than ten seconds after the break signal the timing circuit 420 will have operated the relay group including relay 414, which thus cocks the tube 406 so that the circuit 420 thereafter will be in waiting condition during the communication and at the end thereof.

The two operators may sent the fig.-H combination at the end of each contribution to the conversation or only at the time the conversation is completed. These signals will have no effect at the switching station, but at the subscriber's station the fig.-H signal will release the relay group, if it has already been operated, or will operate the relay group if it be already released. Thus, at the end of the communication, the timing circuit 420 may be either in waiting or in timing condition, respectively. When at the end of the communication the key 421 is restored to its automatic position, the circuit for applying battery from the middle of the key to conductor 427 will be closed at the inner contacts of relays 423 and 424 when these relays are operated and will release the relay group; but when relays 423 and 424 have already been released this battery circuit will be opened and the relay group remains released. Thus, after the key 421 is operated to automatic position and upon release of relay 428 the timing circuit will be put in timing condition by subsequent signals, no matter what happened during the communication.

The lamp 422 will be lighted or extinguished every time the condition of the circuit 420 is changed during the communication. This will evidently have no significance and may be ignored by the operator, who during keyboard communication will be watching the printed record.

When key 421 is in keyboard condition the start circuit for magnet 472 is open, so that the distributor can not operate, and no assurance pulses will be sent to the switching station during the communication.

After the key 421 and the lever 412 have been restored the substation B will again be in condition to receive the message from station A.

When the switch 1295 is operated, as described above, it also causes the transmitting equipment shown in Fig. 6 to stop and thus prevents this equipment from interfering with the transmission to station B by the keyboard of the monitoring teletypewriter 1290. This is accomplished by switch 1295 connecting negative battery to lead 1267 which extends through Figs. 13, 10 and 7 through the left-hand outer operated contacts of relay 739 and lead 659 extending through Figs. 7 and 6 to positive battery through the winding of relay 654. Relay 654 operates in this circuit and interrupts the operating circuit of the start magnet 672 thus causing the transmitting distributor to stop at the end of the cycle then in

progress; that is, at the completion of the code combination then being transmitted.

The operation of relay 654 also completes a circuit for maintaining itself operated under control of key 656 and in addition completes an obvious circuit for lighting lamp 655. The operator upon noting the lighted lamp 655 together with the lighted lamp 1296 and after communicating with the operator at station B will know that she should both restore the switch 1295 to its normal position and momentarily operate key 656 after she has moved the tape 500 back so that the message will be retransmitted to station B. Upon the momentary operation of key 656 after switch 1295 has been restored, the locking circuit of relay 654 is interrupted and this relay is restored to normal. The operation of key 656 also interrupts the circuit over lead 659, contacts of relay 739 and lead 1267 to lamp 1296, and thus extinguishes this lamp. The release of relay 654 also reestablishes the circuit through the start magnet 672 so that this magnet will be reoperated and the transmission of the message to station B may be resumed.

Tape feed-out

In case only a single message has been transmitted from station A and recorded in tape 500 after which no further messages are transmitted from station A for a considerable interval of time, the printing reperforator 569 will come to rest with the last character recorded in the tape just beyond the recording position. The last character will be the H signal which was immediately preceded by the "figures" signal following the end of the message. Then as the message is transmitted by the transmitter 670 the supply of tape between the reperforator 569 and the transmitter will be reduced to the predetermined quantity which causes contacts 682 to open and interrupt the operating circuit of relay 650. Relay 650, in releasing, interrupts the operating circuit of magnet 672 and thus permits this magnet to release and stop the transmitter 670.

The release of relay 650 at this time, however, completes a circuit for the operation of relay 651 from positive battery through the right-hand break contacts of relay 653, the right-hand break contacts of relay 650, winding of relay 651, through the lower inner operated contacts of relay 562 to negative battery through the lower break contacts of relay 560. It is noted that the relay 562 is locked operated at this time, having been operated by the H signal following the "figures" signal which was the signal last transmitted by the operator at station A at the end of the message.

Relay 651, in operating, completes a circuit for maintaining itself operated from positive battery through the right-hand break contact of relay 653, right-hand operated contacts of relay 651, winding of relay 651 to negative battery through the lower inner operated contacts of relay 562, lower break contacts of relay 560.

Relay 651, in operating, also completes an obvious circuit for the operation of relay 652 and feed-out magnet 549 of the receiving device 569. Relay 652 is slow in operating and requires approximately fifteen seconds to operate. At the end of this time interval relay 652 operates and completes a circuit for lighting lamp 872 before the operator. The operator, upon noting the lighted lamp 872, will momentarily operate key 874. The operation of key 874 completes a circuit for the operation of relay 653. Relay 653, in operating, interrupts the operating and locking circuits of relay 651, thus permitting this relay to release and, in addition, completes a circuit for maintaining itself operated from positive battery through its left-hand winding and left-hand operated contacts to negative battery through the lower inner operated contacts of relay 562 and lower break contacts of relay 560. The release of relay 651 interrupts the operating circuit of magnet 549 and relay 652. The release of relay 652 extinguishes the lamp 872.

The operation of feed-out magnet 549 during the delayed operating interval of relay 652 caused the reperforating device 569 to automatically perforate an additional supply of tape even though no signaling impulses are received.

The manner in which magnet 549 causes the printing reperforator to automatically feed out and perforate an additional supply of tape may be more fully understood by reference to Figs. 28 and 29. Here magnet 2849 corresponds to magnet 549 of the printing reperforator 569 shown in Fig. 5. In addition the printing magnet 548, Fig. 5, is illustrated by magnet 2848 in Figs. 28 and 29. The printing or selecting magnet 2848 controls the selecting equipment in the usual manner, as is well understood and as described in the above-identified patents to Morton et al. The code combinations are set up on the code bars 2818 in the usual manner to select one of the pull bars 2801 which is then actuated by the pull bar bail 2802 to print the desired character on the tape 2819 represents the platen at which point the printing takes place. The tape is not shown in order that some of the details of the mechanism may be shown. The code combinations are transferred from the code bars 2818 through the linkage levers 2820, 2821, 2829 and 2822 to the interponents 2823 which control the perforations in the tape in the usual manner which is clearly shown and described in the above-identified patents to Burcky et al., Lake, and Lake et al. and also in Patents 2,005,748, granted June 25, 1935 to Larson and 2,042,788, granted June 2, 1936 to Krum, which patents are hereby made a part of this application as if fully included herein. It is to be understood that there are as many of each of the levers 2820, 2821, 2829, 2822 and 2823 as there are code bars and that one of each of these levers is individual to each of the code bars.

During the normal operation of this receiving equipment in response to signals received by magnet 2848, the receiving cam barrel 2830 is released for one revolution for each code combination received representing some character or function of the receiving apparatus. The release of the cam barrel 2830 is accomplished by magnet 2848 releasing its armature 2803. This permits the armature assembly to rotate in a clockwise direction about pivot 2815 and causes extension 2804 to move to the left, pushing pin 2805 to the left. When pin 2805 moves to the left it rotates a lever 2806 in a counter-clockwise direction which in turn rotates lever 2807 in a clockwise direction. This releases the stop latch 2808 and permits it to rotate in a counter-clockwise direction as viewed in Fig. 29 under the influence of extension 2809 from the cam barrel 2830 thus permitting the cam barrel to rotate. This operation takes place during the start pulse preceding the reception of each group of impulses representing a character or function, as is well understood in the art and is described in the above-identified patents. During the stop pulse

magnet 2848 is energized and locks the stop latch in position to stop the cam barrel.

When magnet 2849 operates it attracts its armature 2810 and causes it to rotate in a clockwise direction which in turn causes the member 2806 to rotate in a counter-clockwise direction and in turn rotate member 2807 in a clockwise direction thus releasing the latch 2808 and permitting the cam barrel 2530 to rotate. Thus, the operation of members 2806, 2807, 2808 and the cam barrel 2830 are operated in the same manner by the operation of magnet 2849 as they are by the operation of magnet 2848 in response to the reception of the start impulse. So long as magnet 2849 remains operated the members 2806 and 2807 remain in their operated position so that the cam barrel 2530 continues to rotate.

During the rotation of cam barrel 2830 under these circumstances magnet 2848 will be operated. This is due to the fact that line relay 547 shown in Fig. 5, is maintained in the right hand position at this time, since no signals are being received from station A over the loop 589. Consequently, all of the code bars 2818 will be positioned in their so-called marking position and in turn will cause the interponents 2823 controlled thereby through the linkage described above to also be positioned in their so-called marking position where they will all cause corresponding perforations to be made in the tape. This operation continues so long as magnet 2849 remains operated. Upon the release of magnet 2849 its armature will be rotated in a counter-clockwise direction and allow members 2806 and 2807 to return to their normal position under influence of spring 2832 and thus engage stop latch 2808 and cause cam barrel 2830 to come to rest at the completion of the revolution then in progress, whereupon the receiving equipment is in condition to receive further signals transmitted from station A.

Returning now to Figs. 5 and 6, when the operation of magnet 549 causes an additional supply of tape to be perforated with all-marking or "letters" signals, this additional supply of tape will permit contacts 682 to again close and complete a circuit for the operation of relay 650. Relay 650 in operating reestablishes a circuit through the start magnet 672 thus operating this magnet and permitting the transmitting equipment 670 to continue transmitting the signals remaining in tape 500.

The operating time of relay 652 is so chosen that this relay will not operate to light the lamp 872 until after the balance of the message recorded in tape 500 has had ample time to pass through the transmitting device 670. Upon the release of magnet 549 in response to the operation of key 874, which stops the perforation of tape 500 as described above, the supply of perforated tape between the reperforator 569 and transmitting device 670 will again be reduced to a predetermined minimum quantity whereupon contact 682 reopens and again interrupts the operating circuit of relay 650 and allows this relay to reelase. The release of relay 650 again interrupts the operating circuit of the start magnet 672 and permits this magnet to release which in turn stops the transmitter 670. The release of relay 650 at this time, however, does not cause the reoperation of relay 651 because relay 653 is locked operated as described above. Consequently, battery is not applied to the upper winding terminal of relay 651, so that this relay cannot operate.

Different conditions of tape feed-out may arise during ordinary traffic conditions. In the case where the called subscriber B is idle at the time of selection, the message from station A to the switching station and the corresponding retransmitted message from the switching station to station B will proceed coincidentally, and near the end of both messages the tape feed-out operation will commence. The calling subscriber A is now unable to send another message for ten seconds due to the circuit assurance feature in which time the feed-out will have been completed. However, in the case of the called subscriber B being busy at the time of selection, the message tape will be stored up between the receiver 569 and the transmitter 670 until station B becomes idle. In such case the calling station A may have become conditioned to send by the timing circuit 520 and may be starting a second message during the feed-out operation at the end of a preceding message. In this case it will be necessary to immediately stop the feed-out operation so that the new message may be properly recorded on the tape. For this purpose the feed-out magnet 549 is quickly released and control of the receiving device 569 is returned to the selector magnet 548.

To accomplish this the first operation of relay 547 to its left-hand position in response to the first start impulse received from station A completes an obvious circuit for operating relay 560 and relay 560 in operating immediately removes negative battery through its lower break contact and the lower inner operated contacts of relay 562 from the lower winding terminal of relay 651 thus allowing this relay to immediately release and release the magnet 549. The release of magnet 549 stops the automatic perforation of tape 500 and permits the selector magnet 548 to control the receiving device 569 so that tape 500 will be perforated in accordance with the received signals and also so that contacts controlled by this selecting equipment will be properly actuated by the received signals. Usually a revolutilon of the cam barrel 2830 will be in progress when the attendant at station A initiates the transmission of the second message during the time magnet 549 is operated. Consequently, the first signaling combination will not be properly received by the receiving equipment. To prevent any errors or difficulties arising due to this condition the attendant at station A will always precede the transmission of any message by one or more "letters" signals. These "letters" signals will serve to cause magnet 549 to release, as described above, and return the control of the receiving device to the selector magnet 548 but in general, will not perform any other useful function at this time. The reception of these "letters" signals by the receiving device 569 may cause contacts 539 to momentarily open and itnerrupt the locking circuit of relay 561. This permits relay 561 to release but relay 562 remains operated at this time. Consequently, the release of relay 561 performs no useful function.

In case the attendant at station A waits until after magnet 549 has released before initiating the transmission of a second message from station A the receiving device 569 will be in condition to receive this message and properly record it on tape 500. In this case the operation of relay 560, in response to the first start signal transmitted from station A, interrupts the locking circuit of relay 653 through the lower contacts of relay 560 and the lower inner operated contacts of relay 562 and the left-hand operated contacts of relay 653 thus permitting relay 653 to release.

The release of relay 653 at this time prepares the circuit of relay 651 for operation at the end of this second message, if no further signals are then transmitted from station A and after the supply of tape between the reperforator 567 and the transmitting distributor 670 is again reduced to a predetermined minimum quantity.

In case line 589 is subject to so-called "hits" or short momentary open or spacing impulses it may be desirable to retard the operation of relay 560 for an interval of time so that it will not respond to these short stray signals and interfere with the operation of these circuits as described above.

Disconnection

After the transmission of the message to station B is completed, the "figures" signal followed by the H signal will arrive over the pins 663 of the transmitter 670. As pointed out above, the operator at station A transmitted these signals immediately following the message and they were recorded in tape 500 when received by device 569. When the "figures" signal arrives over the pins 663 it causes contacts 618 to close. The momentary closure of contacts 618 completes an obvious circuit for the operation of relay 707 which, in turn, locks operated over its lower make contacts, contacts 619 and 616 and contacts in series of relays 704, 703, 702 and 701. Relay 707 then conditions a circuit over contacts 617, which will be momentarily closed in response to the following H signal, thereby causing the operation of relay 706. The operation of relay 706 completes a circuit through its inner upper operated contacts to condition other selecting contacts of the transmitter. The operation of relay 706 also completes a locking circuit for maintaining itself operated under control of relays 704, 703, 702 and 701.

The operation of relay 706 also removes positive battery from the locking circuit of relay 738 which was supplied through the upper break contacts of relays 706. Relay 738, however, does not immediately release at this time because battery is still connected to its locking winding through contacts 620 which are closed at this time until the cycle of operation of the transmitter 670, during which the H signal is transmitted, has been completed.

It should be noted that both the "figures" signal and the H signal are transmitted by the transmitter 670 over the transmission circuit extending through loop 1209 as described above. These signals are recorded by the monitoring teletypewriter 1290 and in response to the "figures" signal followed by an H signal contacts 1291 are momentarily opened. The contacts 1291 are similar to the contacts 511 in the receiving device 585 and may be operated in a similar manner by two signal combinations in immediate succession assigned for this purpose. It should be noted that the receiving teletypewriter 1290 will not open contacts 1291 until a short interval of time after the H signal has been completely received. In the meantime, however, the transmitting distributor 673, shown in Fig. 6, will have come to rest and opened contacts 620, thus interrupting the locking circuit of relay 738, whereupon relay 738 releases and, in turn, releases relay 739. The release of relay 739 completes the operating circuit of relay 708 and removes the negative battery connected to lead 1259 which extends to the lower windings of relays 1265 and 404 and then, when contacts 1291 are opened a short interval of time later, relay 1265 releases and connects positive battery to the upper winding terminal of the printing magnet 1293, thus maintaining this magnet operated and preventing the receiving or monitoring instrument 1290 from following subsequent signals that may be received over loop 489. The release of relay 1265 also removes the battery connected from its operated contacts through the upper break contacts of relay 1263 to the left-hand winding terminal of the selector magnet 1248, thus enabling this magnet to respond to the signals that may be transmitted over the loop 489 and repeated by relay 1247. This restores the circuits controlling the selector mechanism 1269 and the teletypewriter 1290 to their normal condition.

The release of relay 738 disconnects the transmission circuit of the transmitter 670 from the transmission circuit of loop 489 and connects positive battery to this loop circuit to maintain it closed and thus maintain the apparatus controlled by it in their idle condition.

It will be noted that the last signal combination, namely that for the letter H, was transmitted from the distributor 673 to the line relay 1247 immediately after the selecting contacts 617 were closed. Upon opening of contacts 620 relays 738 and 739 released in succession. Relay 1247, remaining in marking position after reception of the last signal causes relay 1260 to commence its release period. Thus the release of relay 739 in response to the end-of-message combination removes battery from conductor 1259 and starts the slow release of relay 404 an appreciable time after relay 1260 begins its release period. This delay in removal of battery from conductor 1259 at the end of an outgoing message is sufficient to delay the complete release of relay 404 under these conditions until after relay 1260 completes its release. Thus under these conditions relay 404 will remain locked up when relay 1260 completes its release. The timing circuit 1210 therefore remains in waiting condition and, by keeping battery on conductor 1257, keeps relay 730 operated and the line circuit for station B busy.

As previously explained, the timing circuit 420 at station B has repeatedly been attempting to establish its time interval. When the fig.-H combination arrives, contacts 411 will momentarily close and operate relays 423, 424, 425, 428 and 414 in succession. Relay 414 locks up over the contact of line relay 486 and cocks the tube 416. With the key 421 in automatic position, the transmitter 480 will be free to rotate. In the case of a tape already having been inserted, the transmitter will immediately begin sending of the message, as under the condition at the end of a time interval. However, when no tape has been inserted, the transmitter will send a transmission assignment pulse to the switching station and all the relays, except relay 414, will release leaving the timing circuit 420 in waiting condition. As previously pointed out, relays 404 and 405 release in response to the assignment pulse and remove the busy condition by removing battery from the busy lead 1257. Now relay 730 releases and connects battery to the operating windings of the switch relays 738, 1038, 1738, 2038, 2338 and 2638, thus conditioning these relays for operation in response to the operation of some one of the respective relays 737, 1037, 1737, 2037, 2337 and 2637, when it is desired to transmit another message to station B.

If there are "letters" signals recorded in tape 500 following the "figures" and H signals, these

signals will be advanced through the transmitter until the supply of perforated tape 500 is reduced to the predetermined minimum quantity after which contacts 682 will be opened. This interrupts the circuit of relay 650 which releases and interrupts the circuit of start magnet 672, thus stopping the transmitter. Combinations other than "letters" signals, which are not assigned to any of the contacts controlled by the switch levers 664, are likewise passed through the transmitter without any effect upon it.

When the first "letters" signal passes through the transmitter and each of the following "letters" signals, contacts 619 are momentarily opened. This interrupts the locking circuit of relay 707, thus permitting this relay to release. Relay 706, however, is maintained operated until one of the relays 701, 702, 703 or 704 is operated.

From the description given above it will be apparent that the transmission of a message from a subscriber's station commences at the end of the time period established by the subscriber's timing circuit, and that the message, similar to an assignment pulse, will condition the timing circuit at the switching station for its timing period, which, however, will be deferred until the end-of-message combination is transmitted by the subscriber. At that time the subscriber's timing circuit will be put in waiting condition and the circuit at the switching station will commence its timing, during which a message to the subscriber may be started at any time. Such a message would discontinue the interval and put the timing circuit at the switching station in waiting condition, whereas at the subscriber's station the message, similar to an assignment pulse, would condition the timing circuit for its timing operation, which, however, will be repeatedly stopped during a continuous message. At the end of a message to the subscriber the subscriber's timing circuit will be stopped in its timing operation by the end-of-message combination and the subscriber's station will send an assurance pulse or another message to the switching station conditioning the timing circuit there for its timing operation. Thus, it will be seen that the two timing circuits will operate in alternations even when held up by messages, thereby admitting waiting messages to the loop circuit alternately in opposite directions and thus preventing interference between messages.

Thus, under relatively light traffic conditions delays up to five seconds in the use of a channel may be encountered; under such light traffic conditions such delays are relatively unimportant. In times of heavy traffic such delays would be important; however, they are largely eliminated because at the end of reception of a message over a channel in one direction the end-of-message codes immediately condition the channel at the receiving end for transmission; if a message is awaiting transmission, it may be transmitted immediately; if no message is awaiting an assignment pulse is sent over the channel in a very short time to make the channel available for transmission again from the terminus wherefrom the last message came and, therefore, if another message is awaiting at that terminus it is transmitted with quite negligible delay. Consequently, if there is an accumulation of messages at either or both ends of the channel, the five second delay periods are cancelled until all awaiting messages have been transmitted. Moreover, the code sequence of "upper case" followed by "H" may be transmitted at any time from the terminal of a channel which is at the instant conditioned for transmission with the result that the direction of assignment for transmission is reversed. This may be made use of for special purposes. Suppose, for example, a central office operator or subscriber is about to send a very long message which might tie up the channel for a considerable time but such operator or subscriber may first wish to determine whether a message (which may be urgent) is waiting for the channel at the distant terminal. Before transmitting the long message the operator or subscriber may send upper case H with the result that if a message is waiting at the distant end its transmission immediately begins whereupon the long message is withheld until the incoming message is completely received; if no incoming transmission is received the operator may transmit the long message with the assurance that no urgent message waiting at the other end of the channel was ready for transmission appreciably prior to the beginning of use of the channel for the long message.

The transmission from a subscriber's station may be temporarily or finally discontinued in different ways.

Thus again assuming that the subscriber A, Fig. 5, is transmitting to the switching center, the message will usually be terminated by the end-of-message combination, with the effect upon the receiving equipment at the switching center and upon the two timing circuits 510 and 520 already described.

In this connection it should be noted that the fig.-H combination received at the switching center from the calling subscriber causes the operation of relays 561 and 562 and the subsequent release of relay 560, which in turn removes the busy condition from busy lead 567 and, since relay 504 is released, permits the timing circuit 510 to start its timing period, during which a call from the center may be extended to station A. On the other hand, when the fig.-H combination terminates a message sent to station A as a called station, this combination causes the delayed removal of battery from conductor 559 and relay 504, so that slow release relay 504 will remain operated until after the complete release of relay 560 and will maintain the busy condition on busy lead 557. Thus, the timing circuit 510 will be prevented from timing, and station A will be permitted to send. In this manner the two directions of transmission over the loop 589 are recognized in the system at the switching center and the timing circuit 510 is controlled accordingly.

At the substation there is no corresponding discrimination between the two directions of transmission, so far as the circuit access feature is concerned, because the fig.-H combination in either case will operate the same set of fig.-H contacts, such as contacts 511 at station A. The necessary control of the timing circuit 520 is exerted through the counting action of the counting relays 523 and 524, which by their alternate operation and release control the timing circuit to agree with the alternate directions of transmission over the loop 589. Thus when a timing pulse or a message is sent from station A relays 523 and 524 will be in operated condition, but when a pulse or message is received by station A the relays 523 and 524 will be in released condition. When station A sends the fig.-H combina-

tion relays 523 and 524 will release, and relays 528 and 514 will prevent the timing circuit 520 from timing, giving the switching center access to the loop. When station A receives the fig.-H combinttion relays 523 and 524 will operate and condition the station for sending. In this case the timing circuit 520 has already been conditioned for timing, though up till this time it has been prevented from timing by the continuous message from the switching center. Therefore, if a message is ready for automatic transmission at station A at this time it will be transmitted immediately. Otherwise, the timing pulse will be transmitted immediately. In either case the timing circuit 520 will be put in waiting condition. At the end of the outgoing message relays 523 and 524 will again be released by the fig.-H combination. In the case of no message being ready relays 523 and 524 will release immediately. Thus, no time period is wasted at the substation, if there is no message ready for automatic transmission. Of course, as has already been explained, if station A is waiting to transmit by keyboard at the end of an incoming message the key 521 will at such times have been thrown to keyboard position, whereby station A may retain access to the loop 589 indefinitely after the incoming message has been completed, which latter condition will be indicated by the lamp 522, after the fig.-H combination has arrived.

As has already been explained the counting relays 523 and 524 are operated or released in accordance with the prevailing direction of transmission. In the case of keyboard sending relays 523 and 524 will be operated or released depending upon the direction of the originating call. Whereas they may thereafter be affected by the sending of the fig.-H combination at odd times and in either direction during such keyboard conversation, the relays will be restored to their original condition at the end of the conversation by operation of key 521 to its automatic position as has already been explained.

The message from station A may also be discontinued by the fortuitous opening of the sixth pin contacts 574, as in the case of a break in the tape, in which case an end-of-message combination would not be sent. Relay 526 releases and in turn releases the counting relays 523 and 524, but relay 514 remains locked up by the line relay 586. The transmitter stops. The timing circuit 520 remains in waiting condition. Also in this case the circuit at the switching center will be left in waiting condition, awaiting continuation of the message. In this case, however, it will not be possible to continue the interrupted message at station A. When this emergency condition is observed by the operator at station A, the condition may be remedied as by the operator switching the key 521 to keyboard position, sending an appropriate emergency message to the called subscribed and sending the end-of-message signal. The message may then be retransmitted by station A after the timing circuits 510 and 520 have run through their timing intervals.

Transmitting message to the central switching station

Assume now that the operator at station A has a second message to be addressed to the central switching station immediately following the first message transmitted to station B.

As already explained, the transmission of the fig.-H combination at the end of the first message put station A in waiting condition and conditioned the equipment at the switching center for transmission to station A during the following ten seconds. During this interval the operator at station A operates key 521 to keyboard position. When the assurance pulse arrives at station A, the timing circuit 520 runs through its timing interval, at the end of which relays 518, 523, 524, 525, 526 and 528 operate, as already explained. With key 521 in keyboard position the start magnet 572 is not operated and no assurance pulse is transmitted from station A. The operation of relay 525 now lights the lamp 522 whereupon the operator may send from the keyboard 588 at any time. Thus the operation of key 521 to keyboard position holds the loop 529 busy at the switching center.

The operator usually begins by sending a few "letters" signals and for the purpose of calling the attendant at the switching station, the operator sends the letter R, followed by a break signal.

Upon receipt of the first start pulse at the switching station, the timing circuit 510 will attempt to establish its timing period. Relay 560 operates and removes battery at its lower break contact from the locking circuit of relay 653 which releases. Relay 560 also applies battery to the busy lead 557 over the lower inner break contact of relay 565 to make line A busy and to cock the tube 506 by the operation of relay 505.

When the letter R is received by the selecting magnet 548 it will cause selecting contacts 540 to momentarily close. The momentary closure of contacts 540 completes a circuit for the operation of relay 565 from positive battery through the upper winding of relay 565, closed contacts 540 and lower outer operated contacts of relay 562 to negative battery. Relay 565, when operated, completes a circuit for maintaining itself operated from battery through its winding and upper inner operated contacts to negative battery through contacts 591. The operation of relay 565 connects positive battery through its upper outer operated contacts and the upper outer break contacts of relay 563 to the left-hand winding terminal of selector magnet 548 thus maintaining this magnet in its operated position and preventing the further operation of the receiving mechanism 569.

The operation of relay 565 also removes the positive battery through its upper outer break contacts from the upper winding terminal of printer magnet 593 thus permitting this magnet to follow the signals transmitted over loop 589 and repeated by line relay 592. Thus the signals transmitted by the operator or attendant at station A are received by the printing magnet 593 and recorded on the receiving teletypewriter 590.

The operation of relay 565 connects negative battery directly to the busy lead 557 instead of through the lower operated contacts of relay 560 thereby keeping relay 505 operated independently of pauses in the message. Lead 557 extends through Fig. 6 to Fig. 7. The application of negative battery to lead 557 causes the operation of relay 710 as described above. The operation of relay 710 completes an obvious circuit for lighting busy lamp 761 and in addition removes the operating potential from the switching relays 1018, 1318, 1718, 2018, 2318 and 2618. This prevents any other transmitter being connected to line 589 during the transmission of this message. The operation of relay 565 also connects nega-

tive battery from lower outer break contact of relay 563 through its lower outer operated contact to the lower winding terminal of relay 651 thus preparing a circuit for the operation of relay 651, as will be described hereinafter. It should be noted that during the transmission of this message from station A receiving relay 547 follows the signals transmitted; however, as pointed out above, the printing magnet 548 does not follow them because it is maintained operated. Relay 547 in following these signals, however, causes the operation of relay 560 which in turn removes the negative battery connected through its lower break contacts and lower inner operated contacts of relay 562 to the lower winding terminal of relay 651. However, as pointed out above, battery through the lower break contacts of relay 563, lower outer operated contacts of relay 565 is connected to the lower winding terminal of relay 651 and replaces the battery from the lower break contact of relay 560.

When the break signal is transmitted, contacts 583 at station A operate and may be restored, without any effect, and contacts 595 at the switching station operate to light lamp 596 and draw attention to the message.

During the entire time this message is being received by teletypewriter 590 the printing reperforator 569 remains idle and does not perforate any additional tape. Assuming that the transmission from the transmitter 670 of the first message is still going on and approaches the end of the message, the supply of perforated tape between the receiving reperforator 569 and the transmitter 670 will be reduced to a predetermined minimum quantity, which in turn causes contacts 682 to open and interrupt the circuit of relay 650 and allow this relay to release. The release of relay 650 will complete a circuit for the operation of relay 651 from the negative battery through the lower break contacts of relay 563, the lower outer operated contacts of relay 565, winding of relay 651 and right-hand break contacts of relay 650 to positive battery through the right-hand break contacts of relay 653. The operation of relay 651 in this circuit completes a locking circuit and also a circuit for operating relay 652 and feedout magnet 549 as described above, thus causing an additional supply of tape 500 to be perforated with letters signals. After a predetermined interval of time relay 652 will operate and light lamp 872 whereupon the operator will operate key 874 which in turn operates relay 653. Relay 653 in operating completes a locking circuit for maintaining itself operated under control of relays 565 and 563 and interrupts the locking circuit of relay 651 thus permitting this relay to release and in turn release magnet 549 and relay 652. The release of magnet 549 stops the automatic perforation of tape 500 and the release of relay 652 extinguishes lamp 872.

Under these conditions no part of the first message will remain in the perforated tape between the reperforator 569 and the transmitting distributor shown in Fig. 6.

At the completion of the message transmitted from station A to the receiving teletypewriter 590 at the central switching station the operator at station A will again perforate a "figures" signal followed by an H signal. When these signals have been set up by the keyboard 588 at station A, contacts 511 momentarily close and the timing circuit 520 and the associated relays return to the waiting condition with relay 514 locked up. At the switching station the end-of-message combination similarly causes the contacts 591 of the teletypewriter 590 to momentarily open thereby interrupting the locking circuit for relay 565 which releases and restores the circuit to normal. Upon taking notice of the message recorded in the printer 590 the attendant restores the contacts 595 to normal.

However in cases of this kind the calling station often desires to receive an immediate reply from the attendant at the switching station, in fact this condition often develops into a continuous back and forth keyboard conversation betweeen the two attendants.

For this purpose the calling station A will omit the end-of-message combination, thereby retaining control of the loop circuit 589. Relay 565 also remains operated to keep the printer 590 in the loop circuit. By the operator sending a break signal at the beginning or the end of the message, the contacts 595 in the monitoring printer 590 operated to cut the keyboard 594 into the signaling circuit and to attract the attention of the attendant by lighting lamp 596, as has already been described.

It is evident that the sending over the loop circuit may take place either from the keyboard 588 at station A or from the keyboard 594 at the switching center and that the messages from both points will be recorded on both printers 585 and 590. The line equipment at the switching station for station A will remain busy by the application of battery to busy lead 557 by relay 565 in operated condition.

At the end of the conversation either operator sends the fig.-H combination, thereby operating the contacts 511 and 591 in the two printers. Contacts 511 restore the timing circuit 520 to waiting condition and contacts 591 cause the release of relay 565, which in turn removes the waiting condition and starts the timing circuit 510 on its timing operation. The subsequent return of key 521 at the substation to its automatic position will insure the release of the counting relays and associated relays in case these relays should have become operated during the conversation, as by a pause of more than ten seconds or by both operators sending the fig.-H combination. In the absence of further signals the timing circuit 520 remains cocked and the timing circuit 510 continues its time interval.

The switching station breaks

In the case of a break signal from the switching station to a calling station, such as station A, the attendant at the switching station will operate the break key 597 which is associated with the monitoring printer 590. This break in the line circuit will operate the contacts 595 in the monitoring printer 590 and the contacts 583 in the printer 585 at station A. The contacts 583 open the operating circuit for start magnet 572 and stop the transmitter 580, as previously described.

The attendant at the switching center next sends the combination fig.-H from the keyboard contacts 594, which through line relay 547, selecting contacts 538 and 537 cause the operation of relay 562, as already described. Relay 562 prepares the tape feed-out control, which will be awaiting release of relay 569. This relay may however, be kept operated by "letters" signals. Thereafter the attendant sends the letter R, in response to which selecting contacts 540 and relay 565 operate, as has been explained. Relay 565 conditions the printer 590 for recording and stops further perforation by the device 569. With

relay 565 operated, the busy condition is maintained independently of relay 560, by battery at inner lower make contact of relay 565 being applied to conductor 557. The timing circuit 510 thus is kept from timing.

The operation of relay 565 prepares the tape feed-out control at its lower outer contacts, so that, when the tape between reperforator 569 and transmitter 670 becomes taut and closes contacts 620 the tape will be fed out until stopped by the operation of key 874, as already explained. Thus, when the perforated fig.-H combination passes through the transmitter the entire connection to the called station will be knocked down.

In response to the break signal the operator at station A operates the key 521 to its keyboard position, restores contacts 583 and adjusts lever 512 for keyboard sending and printing.

When the fig.-H combination arrived at station A the relay group 523, 524 and 525 was released, but relay 514 remained operated by slow release relay 528 so that the timing circuit will be in waiting condition. The two sending receivers 590 and 585 thus are conditioned for keyboard conversation. The first spacing signal of the conversation to arrive after the release of relay 528 will release relay 514, but the timing circuit will be repeatedly prevented from completing its time interval during the conversation.

At the end of the conversation the sending of a fig.-H combination will release relay 565 and prepare the equipment at the switching center for retransmission of the message from station A. The attendant restores contacts 595. When relay 560 completes its release the busy condition is removed from busy lead 557 and the timing circuit 510 commences its timing function. At station A the fig.-H combination will operate the relay group and cock the timing circuit. The key 521 is reset and the tape is moved back to its beginning for retransmission of the selecting character and the message. Thus when relay 526 was temporarily released the relay group was released, except relay 514 which remained locked up. The timing circuit 520 therefore will be left in waiting condition. When the assurance pulse arrives the retransmission of the message will commence after the usual interval.

Review of the circuit assurance equipment

Reviewing the functions of the transmission assignment equipment there are the following five most common traffic conditions:

Idle condition;
An original message transmitted by a calling station to the switching center;
A break by the switching center during such a message and keyboard conversation;
A message retransmitted from the switching center to a called station; and
A break by the called station during such a message and keyboard conversation.

In general, the two timing circuits, provided for the transmission assignment of a given loop circuit and here referred to for the sake of brevity as the center circuit and the sub-circuit, establish alternate time intervals during which one or the other station will have access to the loop. During idle conditions each timing circuit sends a spacing assignment pulse to the other at the end of these time intervals, whereupon it waits; the other then starts its time interval.

During the interval by the center circuit the substation equipment at the switching center is in idle condition and a message may be put through to the called substation at any time; during this interval the substation will be unable to transmit a message. A break signal will, of course, go through at any time.

During the interval by the substation neither circuit can transmit. The substation equipment at the switching center is made busy during the whole interval. The substation is conditioned for sending at the end of the interval.

In general, a timing circuit which is waiting will start its timing function in response to an incoming spacing pulse, which during idle condition will be the assurance pulse, but which otherwise may be a break signal or the first spacing pulse of a message. Thus, a signal or a message will stop the timing function of the timing circuit at the sending end and will condition the other timing circuit for its timing function.

During a message from the switching center the center circuit will be locked in waiting condition and at the end of the message, due to the delay produced by a sequence of release operations which have been described hereinbefore, the center circuit remains locked in waiting condition. At the substation the subcircuit has been put in timing condition by the message but is prevented from completing its time interval by the message. At the end of the message the timing is obviated, the end-of-message signals conditioning the substation for immediate sending either of a message or an assurance pulse.

During a message from the substation the center circuit will be unlocked for its timing function, but will be prevented from timing by the busy condition, and at the end of the message it will be released for timing. At the substation the timing circuit is locked during the message in its transmitting condition established by its preceding time interval, and at the end of the message the fig.-H combination restores the subcircuit to its normal waiting condition.

During automatic operation, whether during idle condition or during transmission of a message, the counting relays in the subcircuit pull up preparatory to the sending and they release at the end of the sending. If only an assurance pulse is sent the relays release immediately. If a message is sent from tape, a fig.-H combination will release the relays.

In case of tape failure the relays release due to operation of the sixth pin. In case of a message left unfinished, as by unfinished keyboard perforation the relays remain operated; the substation retains its hold on the loop circuit and may continue the message at any time. In both of these cases the busy condition prevails at the switching center, preventing timing by the center circuit.

Break signals and keyboard conversations, of course, have some immediate effect upon the functions of a pair of timing circuits and the effect will be different for the different conditions under which the break is made. However, at the restoration of the loop circuit after the conversation the timing circuits will be returned to the condition which prevailed when the break was sent.

Thus, during a message being transmitted automatically from the switching center to a called substation, the subcircuit will be stopped from timing and will be continually prevented therefrom; the center circuit will be locked in waiting condition. A break from the substation will not affect the busy condition at the switching center and therefore will not affect the center circuit. Nor will the subcircuit be affected. Keyboard

messages in either direction will have no effect on the timing circuits. The subcircuit will, however, be affected by a pause of more than ten seconds and by end-of-message signals. If however, the counting relays in this case should be left operated at the end of the conversation the restoration of the substation to automatic transmission will release the counting relays, provided the start key or the sixth pin contacts are open. The next spacing signal of the message will restore the subcircuit to timing condition.

During an automatic message from a calling substantion to the switching center, the center circuit will be in condition for timing, but will be prevented therefrom by the busy condition; the subcircuit will be locked in waiting condition with the counting relays operated. A break at the inactive monitoring printer at the switching center will not affect either timing circuit. The fig.-H-R combination will condition the monitoring printer for recording and break down the connection through the office to the called station, but the busy condition for the calling station will be maintained and the center circuit remains unaffected. At the substation the counting relays will be released and the first subsequent spacing pulse will start the subcircuit timing. Pauses of more than ten seconds during the ensuing keyboard conversation and further fig.-H signals will leave the counting relays either released or operated at the end of the conversation. The fig.-H combination at the end of the keyboard conversation restores the substation equipment at the switching center to normal idle condition and the center circuit starts timing. At the substation the tape will be removed and reset to the beginning of the message. The operation of the sixth pin will insure the release of the counting relays and the conditioning of the subcircuit for waiting. The message will then be started after an assurance pulse has arrived and when the subsequent time interval has been completed by the subcircuit.

If at any time the two timing circuits should accidently fall out of step, the condition will be automatically corrected. There are of course, many different circumstances under which this may occur, but in view of the detailed explanation presented hereinbefore on the assurance functions it appears unnecessary to consider them in detail. Suffice it to point out that the center circuit would stay in waiting condition until an abnormally delayed spacing pulse arrives and would temporarily stop its timing in response to an abnormally early assurance pulse, due to the temporary busy condition, whereupon it would restart its normal time interval. The subcircuit would similarly stay in waiting condition until a delayed spacing pulse arrives and would renew its time interval after an early assurance pulse, due to the cocking of the subcircuit by the line relay in spacing position.

There is also the special condition of an accidental break during idle condition. Such a break would put the center circuit in timing condition or would cause it to renew its time interval, as already explained. At the substation the reverse condition would of course exist, provided the station were set for automatic operation. The subcircuit would either renew its time interval or would be put in timing condition, respectively. Thus, the two timing circuits would begin timing at the same instant. Depending upon the adjustments of the two timing circuits, they may transmit their assurance pulses more or less coincidentally or in either order of succession.

For the purpose of obviating the possibility of both timing circuits being locked in waiting condition when the assurance pulses are transmitted under this particular set of circumstance, the adjustments of the timing circuits should be such that the interval between two pulses from one station is longer than the interval between two pulses from the other station and the difference in length should preferably be definitely greater than the duration of an assurance pulse. Under the assumed conditions the substation may still be in the course of timing when the pulse of a message from the switching center arrives, and would retime; in which case the center circuit would be locked in waiting. Or the center circuit may still be timing when the pulse from the substation arrives and would retime; in which case the subcircuit would be locked in waiting. However in this latter case it is evident that the substation may be set for sending a message at the end of its time interval while the busy condition still is removed at the switching center; two opposed messages might therefore be sent simultaneously. The adjustments in the disclosed system therefore are such, that the interval between assurance pulses from the substation are longer than between those from the switching center.

The following is a simplified schedule of the sequence of operations performed under normal traffic conditions by a typical pair of timing circuits, such as **510** and **520**, associated with a loop circuit, such as **589**, for assignment of transmission direction between the switching center and a subscriber's station, such as station A, both in the absence and the presence of a message to be sent over the loop in either direction.

TIMING CIRCUIT 510 AT SWITCHING CENTER

A. Waiting—no message to send

1. Assurance pulse arrives
2. Relay **547** to space
3. Relay **560** up—busy applied to lead **557**
4. Relay **504** down—busy taken off lead **557**
5. Relay **505** down—timing starts
6. Relay **547** to mark
7. Relay **560** down after ¼-second—idle condition on lead **557**

10. No message to send—timing ends after 10 seconds
11. Relay **508** up
12. Relay **509** up—sends assurance pulse relay **560** unaffected
13. Relay **504** up—busy on lead **557**
14. Relay **505** up—tube **506** currentless
15. Relay **508** down
16. Relay **509** down, slow releasing to complete standard pulse

Waiting

B. Waiting—message to be sent

21. Assurance pulse arrives
22. Relay **547** to space
23. Relay **560** up—busy on lead **557**
24. Relay **504** down—busy taken off lead **557**
25. Relay **505** down—timing starts
26. Relay **547** to mark
27. Relay **560** down after ¼-second—idle condition on lead **557**

30. Message to be sent—(may have been waiting during busy on lead **557** or may arrive at transmitter during timing)

31. Relays **565**, **504** up—over lead **559**, due to selection—busy on lead **557**
32. Relay **505** up—timing discontinued
33. Relay **560** up—due to message signals.
40. End-of-message signals go out
41. Relay **560** down after ¼-second
42. Switching relays (Figs. 7 or 8) down—lead **559** opened
43. Relay **504** starts release but locks on relay **560**—keeps busy on lead **557**
44. Contacts **591** open after ½-second and close
45. Relay **565** down

Waiting

C. Waiting—message to be received

51. Message arrives (selecting character)
52. Relay **547** to space and mark
53. Relay **560** up—busy on lead **557**
54. Relay **504** down—prepares for timing
55. Relay **505** stays up on lead **557**—prevents timing
56. Relay **562** down—due to selecting character—busy on lead **557**
60. End-to-message signals arrive
61. Relay **562** up—busy taken off lead **557**
62. Relay **560** down after ¼-second—idle condition on lead **557**
63. Relay **505** down—timing starts

Continue with A10 for no message to send, or B30 for message to be sent

TIMING CIRCUIT **520** AT SUBSTATION A

D. Waiting—no message to send

101. Assurance pulse arrives
102. Relay **586** to space
103. Relay **514** down (slightly slow)
104. Relay **586** to mark—timing starts—timing ends after 12 seconds
111. Tube **516** conducting
112. Relay **518** up
113. Relays **523** and **524** up
114. Relay **525** up—closes start circuit for start magnet **572**
115. Relay **528** up
116. Relay **519** down (slow)—tube **516** currentless
117. Relay **514** up
118. Relay **518** down
119. Relay **519** up
120. No message to send (sixth pin contacts **574** are open, relay **526** is down)
121. Transmitter **580** sends assurance pulse
122. Relay **586** to space
123. Relays **523**, **524** down
124. Relay **525** down—opens start circuit for magnet **572**
125. Relay **586** to mark
126. Relay **528** down after ¼-second
127. Relay **514** held up by relay **586**
128. Transmitter **580** stops at end of revolution

Waiting

E. Waiting—message to be sent

101.–119. As in case D
130. Message to be sent (sixth pin contacts **574** are closed, relay **526** is up)
131. Transmitter **580** sends message
132. Relay **586** to space and mark
133. Relay **514** held up on relay **528**
140. End-of-message signals go out, followed by "letters"
141. Relay **586** to mark
142. Contacts **511** close after ½-second and open
143. Relays **523**, **524** down
144. Relay **525** down—opens start circuit for magnet **572**

145. Transmitter **580** stops at end of revolution
146. Relay **528** down after ¼-second
147. Relay **514** held up on relay **586** in mark

Waiting

F. Waiting—message to be received

151. Message arrives
152. Relay **586** to space and mark
153. Relay **514** down on first space—timing started by each mark—timing discontinued by each space
160. End-of-message signals arrive
161. Relay **586** to mark—timing starts
162. Contacts **511** close after ½-second and open
163. Relays **523**, **524** up
164. Relay **525** up—closes start circuit for magnet **572**
165. Relay **528** up
166. Relay **519** down (slow)—tube **516** currentless
167. Relay **514** up
168. Relay **518** down
169. Relay **519** up

Continue with D120 for no message to send or E130 for message to be sent

Transmitting message to another type of switching system

Assume now that an attendant at station B, that is, the station shown in Fig. 4, has a message intended for some subscriber who can be reached only over a connection through a distant manual telegraph switching system to which a large number of subscribers scattered throughout the country are connected. In this case the operator at station B will transmit a number of "letters" signals first. When these "letters" signals are received by the receiving instrument **1269** they cause it to momentarily open contacts **1239** and interrupt the locking circuit of relay **1261**. Release of relay **1261** thus is assured, but relay **1262** does not release at this time. Upon the first operation of relay **1260**, relay **404** released, but relay **405** remains operated by the busy condition of conductor **1257**.

It is assumed that the circuits associated with line **1289** have been previously conditioned by the reception of the "figures" signal followed by an H signal at the end of the previous message or that the relays **1262** and **1306** have been operated by the operation of the respective keys **1201** and **1331** or in any other suitable manner. Under the assumed conditions the operator at station B will transmit the signal T designating the central station T indicated by **348** in Fig. 3 and by **1627** in Fig. 16, following "letters" signals. It is understood that any suitable designation may be employed for any of these stations. Upon the reception of the letter T signal by the printing reperforator **1269**, contacts **1232** will be momentarily opened and interrupt the locking circuit of relay **1262** thus permitting relay **1262** to release. The release of relay **1262** interrupts the circuit of the lower winding terminal of relay **1251**, this relay thus being prevented from operating during the time relays **1262** and **1265** are released. The release of relay **1262** in addition connects negative battery to lead **1257** which extends through Figs. 13, 10 and 8 to the winding of relay **730** thus completing a path for holding this relay operated, it having operated when relay **1260** operated upon the reception of the first impulse transmitted from station B. The operation of relay **730** completes an obvious circuit for lighting busy lamp **763** to indicate to the operator that line **489** extending to station B is busy. The operation of

relay 730 in addition removes the operating potential from the operating windings of relays 738, 1138, 1738, 2038, 2338 and 2638 thus preventing the connection of any transmitter at the central station to line 489 at this time. As previously described relay 405 remains operated to keep the timing circuit 410 from timing.

It may be desirable after the transmission of the switching characters or combination of characters to again transmit one or more "letters" signals to provide sufficient time to insure that the various relays and switching circuits have ample time to operate to establish the proper transmission and control circuits so that none of the message characters will be either mutilated or lost due to the operation of any of the switching circuits. Following these signals the operator or attendant at station B will transmit a message intended for some station connected to the switching network of station T.

Following the transmission of the message the attendant at station B will transmit the "figures" code combination followed by an H code combination. When the "figures" code combination is received by the printing reperforator 1269 it causes contacts 1238 to momentarily close and complete an obvious circuit for the operation of relay 1261. The operation of relay 1261 completes a locking circuit for maintaining itself operated under the control of contacts 1239 and 1236. Relay 1261 in operating also connects negative battery to one spring of contacts 1237.

When the H signal is received by the receiving device 1269 it causes contacts 1237 to momentarily close and complete a circuit for the operation of relay 1262. The operation of relay 1262 completes a circuit for maintaining itself operated under control of contacts 1231, 1241, 1242, 1243 and 1232. The operation of relay 1262 also connects battery to one of the terminals of contacts 1234, 1240, and 1230.

A short interval of time after the last signal is received from station B, relay 1260 will release and remove negative battery from lead 1257 extending to relays 730 and 405. Relay 730 then releases, extinguishes the busy lamp 763 and connects the operating battery to the windings of switching relays 738, 1038, 1738, 2038, 2338 and 2638 to enable them to connect any of the transmitters at the central station to line 1289. The timing circuit 410 then begins its timing operation.

When the first signals are received by the printing reperforator 1269 it perforates tape 1200 in accordance with the received signals. This permits the tape control contacts 1282 to close and complete an obvious circuit for the operation of relay 1250. Relay 1250, in operating, completes a circuit for the operation of the start magnet 1272 from negative battery through the right-hand outer break contacts of relay 1254, the right-hand operated contacts of relay 1250, switch 1280, winding of start magnet 1272, to positive battery through the lower break contacts of relays 1304, 1303, 1302 and 1301 in series. The start magnet 1272 will be operated by current flowing in this circuit and attract its armature 1279 which will then release the stop cam 1278 and permit the distributor 1273 to rotate and advance tape 1200.

It is to be understood that the transmitter 1270, shown in Fig. 12 is similar in construction to the transmitter 670 shown in Fig. 6. All of the mechanical details have not been shown, as for example the selecting levers similar to levers 667 and switch levers 664 controlling the contacts have not been shown. In addition, contacts 1220 are similar to the contacts 620 and are operated in a similar manner. They have been shown in Fig. 12 actuated directly by cam 1274 instead of through the intermediate lever 689 as shown in Fig. 6. It is to be understood that these contacts may be operated by the lever of the transmitting distributor 1270 which corresponds to the lever 799 of the distributor shown in Fig. 6. In addition, it has been assumed that the "figures" signal followed by an H signal at the end of the previous message, which caused the transmitter 1270 to be disconnected from the line to which it was transmitting, operated relays 1307 and 1306 and that these relays completed circuits for maintaining themselves operated, as has been explained with reference to relays 707 and 706.

When the start magnet 1272 operates and releases the transmitter 1270, it will advance the tape through the transmitter and ignore all of the "letters" signals which may have been perforated in the tape. It is to be noted that contacts 1219 open momentarily for each "letters" signal perforated in tape 1200 as it passes through the transmitter 1270. The first time contacts 1219 thus open, the locking circuit for relay 1307 is interrupted and relay 1307 releases.

Thereafter the tape 1200 is advanced through transmitter 1270 as long as tape lever contacts 1282 remain closed or until a switching character perforated in tape 1200 reaches the control point of the transmitter 1270, at which time the associated switching contacts close. Under the assumed conditions, when the perforations representing the letter T arrive at the control point of the transmitter 1270 they will cause contacts 1212 to momentarily close. The momentary closure of contacts 1212 completes a circuit for the operation of relay 1303 from positive battery through the upper inner operated contacts of relay 1306, the upper outer break contacts of relay 1304, operated contacts 1212, to negative battery through the winding of relay 1303. The operation of relay 1303 completes a circuit for maintaining itself operated from negative battery through its winding and lower operated contacts to positive battery through operated contacts of relay 1308. Relay 1308 is maintained operated at this time by current flowing in a circuit from negative battery through the winding of relay 1308 to positive battery through the right-hand break contacts of relays 1319, 1329, 1449, 1439 and 1459.

The operation of relay 1303 interrupts the locking circuit for relay 1306 and allows this relay to release. It also interrupts the circuit of the start magnet 1272 and thus allows this magnet to release, which will cause the distributor 1273 to come to rest at the end of the revolution then in progress. The operation of relay 1303 also completes a circuit for the operation of magnet 1271. Magnet 1271 of the distributor 1270 corresponds to magnet 671 of the transmitter 670 shown in Fig. 6. Operation of this magnet causes the tape feed pawl to disengage its associated ratchet and thus prevents the tape from being advanced. Consequently the perforations representing the letter T remain at the control point in the transmitter 1270 at this time.

The operation of relay 1303 completes a circuit for the operation of relay 1447. Relay 1447 in operating completes a circuit for lighting lamp 1443 which indicates to an attendant that a

message is waiting for transmission to the equipment associated with the line to station T designated 1627 in Fig. 16. If this equipment is busy at this time, relay 840 will be operated so that the circuits will then remain in this condition until the equipment shown in Figs. 15 and 16 becomes idle.

If in the meantime another message is directed to station T from Station A, for example, relay 847 will also operate and light lamp 841. If, for example, it is also desired to transmit a message from some station at the second switching center, shown in Fig. 2, to station T, relay 1147 will be operated when the letter T preceding this message arrives over the control pins of transmitter 970. All these messages then await transmission to the equipment shown in Figs. 15 and 16 until this equipment becomes idle, it being assumed that it is busy receiving a message in the multiple transmission circuit shown in Figs. 22, 23 and 24, or some other station not shown in the drawing, the operation of which is described hereinafter. Upon the termination of the message from this multiple transmission circuit, relay 840 will release and apply operating battery to the right-hand windings of relays 848, 1148 and 1448. However, since relay 847 is operated, relay 848 will operate in a circuit from positive battery through the operated contacts of relay 847, right-hand winding of relay 848 to negative battery through left-hand break contacts of relay 840. Since relay 847 is operated at this time, relay 1148 cannot operate because its operating circuit is interrupted at the break contacts of relay 847. Similarly, relay 1448 cannot operate because its operating circuit is interrupted at break contacts of relays 1147 and 847. Consequently, it is possible for only one of the transmitters to be connected to the circuits shown in Figs. 15 and 16 even though a number of transmitters have messages for this line and are waiting to transmit these messages to it.

Assume now that the message from station A to station T has been transmitted to the equipment shown in Figs. 15 and 16. At the end of this message, relay 840 will again be released. At this time relay 847 will not be operated. Consequently, relay 1148 will operate in a circuit extending from positive battery through the back contacts of relay 847 and the operated contacts of relay 1147, through the right-hand winding of relay 1148 to negative battery, through back contacts of relay 840. Assume now that at about this time relay 847 is again operated by another message from station A directed to station T the operation of relay 847 at this time will cause the operation of relay 848 as described above. Under these circumstances, both relay 848 and relay 1148 will be operated. However, relay 1148 in operating completes a circuit for maintaining itself operated through its left-hand inner operated contacts and interrupts the locking circuit for relay 848. Both relays 1148 and 848 complete a circuit for the operation of relay 840. Relay 840 operates and removes the negative battery from the operating windings of relays 848 and 1148 whereupon relay 848 will release but relay 1148 will remain operated due to the locking circuit extending from positive battery, through the upper break contacts of relay 1006, through the left-hand winding and left-hand inner operated contacts of relay 1148 to negative battery, through the left-hand inner break contacts of relay 1448, left-hand outer break contacts of relay 2448 and left-hand inner break contacts of relay 2748.

Under these circumstances, the operation of relay 848 completed a circuit for the operation of relay 849 which relay in turn interrupted the operating circuit of relay 708. Relay 708 however, is slow in releasing so that it does not immediately release. The operation of relay 840 and the release of relay 848, as described above, then interrupts the operating circuit of relay 849 which relay releases and reestablishes the operating circuit of relay 708 before this relay releases. Thus selecting relay 703 remains operated and, consequently, the transmitter shown in Fig. 6 will not be started into operation.

Relay 1148 is operated and locked operated as described above and completes a circuit for the operation of relay 1149. Relay 1149 in operating interrupts the operating circuit of the slow-release relay 1008. Since relay 1148 is locked operated it will remain operated and maintain relay 1149 operated so that relay 1008 will release and start the transmission from transmitter 970, by releasing selecting relay 1003.

Consequently, under these circumstances, only one transmitter is again connected to the equipment shown in Figs. 15 and 16.

At the termination of this message, relay 840 will be released and the message awaiting transmission from station A will be transmitted to station T. At the termination of this message, relay 840 will be again released and, if there are no messages awaiting transmission either from station A or the second switching station, relay 1448 will be operated in a circuit extending from positive battery, through the break contacts of relays 847 and 1147, the operated contacts of relay 1447, the right-hand winding of relay 1448 to negative battery through break contacts of relay 840. Relay 1448, in operating, completes an obvious circuit for the operation of relay 1449. Relay 1448 also completes a circuit for the operation of relay 840 which in turn causes busy lamp 864 to light and removes the operating potential applied to the operating windings of the switching relays 848, 1148, 2448 and 2748, thus preventing any of these relays from operating and connecting another transmitter to the equipment associated with the line extending to station T, designated 1627 in Fig. 16.

The operation of relay 1448 extends the transmission circuit of the distributor 1270 from positive battery through contacts 1281, distributor 1273, lead 1244 which extends through Fig. 13, the left-hand outer operated contacts of relay 1448, the right-hand break contacts of relays 2448 and 2748, lead 1540 which extends through Figs. 24, 21, 18, 17, 16 and 15, to negative battery through the lower winding of receiving relay 1547 of the printing reperforator 1569.

The operation of relay 1449, as described above, interrupts the operating circuit of relay 1308. When relay 1308 releases it interrupts the locking circuit of relay 1303 and permits this relay to release. The release of relay 1303 at this time interrupts the operating circuit of tape-withholding magnet 1271 and thus allows this magnet to release so that when the operation of the transmitter 1270 is resumed the tape 1200 will be fed through the transmitter in the normal manner. The release of relay 1303 also interrupts the circuit of relay 1447 which relay releases and extinguishes lamp 1443.

The release of relay 1303 also reestablishes the circuit through the start magnet 1272 and thus

causes this magnet to operate and release the distributor 1273 for rotation. During the first revolution of this distributor signals representing the character T, which controlled the establishment of the transmission circuit to relay 1547 as described above, will be transmitted over the transmission circuit to the relay 1547. Signals representing the message will follow as the transmitter 1270 operates and the tape 1200 passes through and controls the signals transmitted. These signals are received by the receiving relay 1547 of the reperforating device 1569. The reperforating device 1569 is of the same type as shown in Figs. 28 and 29 and indicated graphically at 569, 969, 1269, 1669, 2269 and 2569. This printing reperforator is also provided with a group of contacts; however, only a few of these contacts are used in this circuit.

Here again it is assumed that the "figures" signal followed by an H signal, following the previous message transmitted through this equipment, caused relays 1561 and 1562 to operate and lock operated, or that relay 1562 has been operated by the momentary operation of key 1501. The first switching signal, will interrupt the locking circuit of relay 1562 by causing the reperforating mechanism to momentarily open one of the contacts 1531, 1533, 1534, 1541, 1542, 1543 in response thereto and permit this relay to release. The signals received thereafter by relay 1547 are repeated to the selecting magnet 1548 and cause the printing reperforator 1569 to print corresponding characters on tape 1500 and to perforate this tape in accordance with the received signals. The first spacing signal or "letters" signal received by this magnet will cause contacts 1536 or 1539 to momentarily operate and interrupt the locking circuit of relay 1561. Normally, the switch 1580 will be open, consequently the supply of tape 1500 will be accumulated between the printing reperforator 1569 and the transmitting distributor 1570. Following the message, the "figures" signal followed by an H signal will momentarily close contacts 1538 and 1537 in sequence and cause the operation of relays 1561 and 1562, respectively. Upon the operation of relay 1562 and the release of relay 1560, whenever the line relay 1547 remains in its marking position as a result of no further signals being transmitted to this equipment, battery is connected to the left-hand winding terminal of relay 1551, thus preparing a circuit for the operation of this relay in case the supply of tape 1500 between the printing reperforator 1569 and the transmitting distributor 1570 becomes reduced to a predetermined minimum value.

After a certain quantity of tape 1500 has been accumulated, or at specified times during the day, the operator at the central switching station will initiate a call in the usual manner to the central station T, designated 1627. To accomplish this the operator will signal station 1627 by operating key 1686 which closes the line circuit 1629 extending to station equipment 1625 and cause lamp 1628 to light before the operator at station T. The manner in which the closure of line 1629 causes lamp 1628 to light is described in detail in United States Patent 1,936,200, granted November 21, 1933 to G. A. Locke et al., or a patent of G. A. Locke et al. 2,237,154 dated April 1, 1941, which patents are each hereby made a part of this application to the same extent as if fully set forth herein.

The operation of key 1686 also completes the circuits of the driving motors of the devices 1690 and 1669 over the circuit 1688. The operator at station T will then communicate with the operator at the central switching station and the operator at the central switching station can manually operate the send-receive switch 1695 so as to permit her to operate the transmitting contacts 1694 by operating her keyboard. After the connection to the desired station is established by the operator at station T, the operator at the central switching station may close switch 1580 and complete the circuit of the start magnet 1572 from positive battery through the right-hand operated contacts of relay 1550, switch 1580, the winding of start magnet 1572 to negative battery through the right-hand operated contacts of relay 1697. This magnet then attracts its armature 1579 and releases the transmitting distributor brush arm 1573 whereupon the transmitter 1570 transmits the signals stored in tape 1500 over the line to station T and thence to whatever station is connected thereto.

At any time during the transmission of a message the operator at station T or the attendant or operator at the distant station to which the message is directed may interrupt the transmission from the transmitter 1570 by transmitting a break signal which exceeds the length of two code combinations. This break signal may be transmitted in any of the usual or customary manners employed in breaking as is well understood in the telegraph art.

Upon the reception of such a break signal by the receiving teletypewriter 1690 under these circumstances, the send-receive contacts 1695 are operated by the machine so as to interrupt the circuit for the operation of relay 1697. The operation of contacts 1695 in response to a break signal at least as long as two successive code combinations is clearly described in detail in the above-identified patents to Morton et al. and well understood in the telegraph art.

The release of relay 1697 also interrupts the circuit of the start magnet 1572, thus releasing this magnet and stopping the transmission from the transmitter 1570 at the end of the revolution or cycle then in progress.

The operator at the central switching station will then open switch 1580 and operate contacts 1695 to the sending position and communicate with the distant operator at station T or at the final station to which the message is directed, to determine what additional information is desired or what the cause of the trouble may be. After determining this she may move the tape 1500 back in the transmitter 1570 so that the entire message will be retransmitted to the distant station, after which she will reclose switch 1580 which reestablishes the circuit through the start magnet 1572, thus causing the transmitter 1570 to resume transmission to the distant station.

The above-described break operations may be repeated as often as desirable or necessary during the transmission of each of the messages over the line 1629 to switching station T.

Near the completion of the message if no further signals are received by the printing reperforator 1569 the tape control contacts 1582 will open whereupon relay 1550 will release and interrupt the operating circuit of magnet 1572. The release of magnet 1572 causes the transmission from the transmitter 1570 to stop at the completion of the character then in progress of being transmitted. The release of relay 1550 completes a circuit for the operation of relay 1551. Relay

1551 in turn completes a circuit for the operation of magnet 1549. The operation of magnet 1549 causes additional tape to be perforated with "letters" signals as described above with reference to magnet 549 so that the entire message stored in tape 1500 will be transmitted by the transmitting distributor 1570.

Relay 1551, in operating, also completes an obvious circuit for operating slow-operating relay 1552. Relay 1552 is slow in operating so as to insure that the entire message recorded in tape 1500 will have time to pass through the transmitting distributor 1570 and be transmitted, after which relay 1552 will operate and light lamp 1877. The operator upon noting lighted lamp 1877 will momentarily operate key 1878, which completes a circuit for the operation of relay 1553. Relay 1553, in operating, interrupts the locking circuit for relay 1551, thus permitting this relay to release and in turn release relay 1552 and magnet 1549. The release of magnet 1549 stops the automatic perforation of tape 1500 with "letters" signals and the release of relay 1552 extinguishes lamp 1877. Relay 1553 locks itself up through its right-hand winding, contacts of relays 1560 and 1562, to prevent further feed-out by magnet 1549 until a new message arrives at the device 1569.

After the message has been completely transmitted from the transmitter 1570 the "figures" signal followed by an H signal will be transmitted. This causes contacts 1691 to be momentarily operated. The momentary operation of contacts 1691 in response to a "figures" signal followed by an H signal is clearly described in the above-identified patents to Morton et al.

Inasmuch as relay 1687 is operated at this time this operation of contacts 1691 will serve no purpose at this time. It will, therefore, be necessary for the operator to watch the tape 1500 and determine when the message is completely transmitted or all the messages to any given destination completely transmitted so that the operator may open switch 1580 at the proper time and thus communicate by means of the keyboard of machine 1690. At the end of transmission the operator may send a disconnect or recall signal to station 1627 by restoring key 1686 to normal or by restoring this key to normal and then reoperating it.

In case the operator does not open the switch 1580 at once the tape 1500 will become taut and cause contacts 1582 to open. Contacts 1582 in opening interrupt the circuit of relay 1550, which relay releases and in turn interrupts the circuit of the start magnet 1572. The start magnet then releases and stops the operation of transmitter 1570. The operator when she notes this condition may then operate the keys and apparatus as described above and the circuits will operate in substantially the same manner as described above.

Receiving a message from another type of switching system

In case the operator at station T has a message to transmit to the central switching station or one of the stations connected to it, as for example station A, the operator at station T will test line 1629 to determine whether or not it is busy. If it is not busy she will cause the ringer or other signaling device 1689 to operate in the usual manner as described in the above-identified patent of G. A. Locke et al.

The operator at the central switching station will respond to the operation of this device by operating key 1686. The operation of key 1686 will start the motors of devices 1690 and 1669 and condition device 1690 for communication. The operator at the central switching station will then communicate with the operator at station T or the attendant at the ultimate transmitting station or both, to determine the destination of the message or messages. In case the message or messages are intended only for the central station the operator will leave the circuits in their present condition and receive the message on the teletypewriter 1690. In case some of the messages are intended for other stations the operator will operate key 1556.

The operation of key 1556 interrupts the circuit of relays 1665 and 1687. These relays then release. Relay 1687 is made slow in releasing so as to insure that relay 1665 will release first so its locking circuit will not be completed by the release of relay 1687. The release of relay 1665 renders the teletypewriter 1690 non-responsive to received signals and renders the printing reperforator responsive to any signals received over line 1629.

Prior to the operation of key 1556 the operator at the central switching station will indicate that she is ready to receive the messages over line 1629. Then she will operate key 1556 as described above. The transmitter at the transmitting station can then transmit signals over line 1629 to the central switching station. Relays 1661 and 1662 will have been operated by the "figures" and H signals following the last message received over line 1629. Relays 1647 and 1692 will follow the signals transmitted over line 1629. Relay 1647 in following the received signals repeats them to the selector magnet 1648 and it in turn causes the printing reperforator 1669 to print and perforate tape 1600 in accordance with these signals. The operation of relay 1647 in following these signals causes relay 1660 to operate. The operation of relay 1660 removes battery from the lower winding terminal of relay 1651 and releases this relay, if it has been operated, and prevents its operation, thus stopping or preventing automatic perforation of tape 1600 by magnet 1649. The operation of relay 1660 or the release of relay 1662 does not operate relay 840. Consequently, it is possible for one of the other transmitters to transmit a message to the recording device 1569 at the same time that a message is being received over line 1629 from station 1627.

Inasmuch as relay 1665 is released and maintains the printing magnet 1693 operated, the message will not be recorded by the teletypewriter 1690 or at least the first switching signal will not be recorded by this machine. If, however, any of the messages are intended for the central switching station, the printing reperforator 1669 in responding to the switching signal preceding it will cause relay 1665 to operate and permit the printing magnet 1693 to follow the signals transmitted over line 1629 and thus cause it to record the signals transmitted over this line, in a manner similar to the manner station A transmits signals to the central switching station as described above.

However, under the assumed conditions where the operator at station T has a message intended for station A she will first transmit a number of "letters" signals which will cause contacts 1639 to operate once for each "letters" signal received. This permits relay 1661 to release but relay 1662 remains operated. Following the "letters" signals the operator will transmit a switching signal which under the assumed conditions will be a

letter A. When this signal is received by the printing reperforator 1669 it will cause contacts 1631 to be momentarily opened and thus interrupt the locking circuit of relay 1662, thus permitting this relay to release. The printing reperforator will record all of these signals and the following message signals in tape 1600 as well as print the corresponding characters on the tape 1600.

Following the "figures" and H signals following the last message the operator may send a disconnect signal to station 1627 by restoring key 1686 to normal. The operator will then restore key 1556 to normal and thus return the circuits extending to station 1627 to their normal condition and render them available for the transmission of other messages.

The additional perforated tape 1600 from the printing reperforator 1669 will permit contacts 1682 to close and complete an obvious circuit for the operation of relay 1650. The operation of relay 1650 completes a circuit for the operation of the start magnet 1672 from negative battery through the right-hand outer break contacts of relay 1654, a right-hand operated contacts of relay 1650, switch 1680, winding of magnet 1672 to positive battery through the lower break contacts of relays 1704, 1703, 1702 and 1701 in series. Magnet 1672 will operate in response to current flowing in this circuit and attract its armature 1679 and release the distributor 1673 of the transmitter 1670. All of the "letters" signals and other signals recorded in tape 1600 except switching signals will be passed through the transmitter 1670. Each time a "letters" signal arrives at the control point over the pins corresponding to pins 663 of the transmitter shown in Fig. 6, contacts 1619 will be momentarily opened and interrupt the locking circuit of relay 1707, thus permitting this relay to release. Relay 1706, however, remains operated at this time in a circuit extending from negative battery through the winding of relay 1706, lower operated contacts of relay 1706, to positive battery through the lower break contacts of relays 1704, 1703, 1702 and 1701 in series.

When the first switching code combination or signal arrives at the control point over the controlling pins or fingers, contacts 1611 will be closed and complete a circuit for the operation of relay 1701 from positive battery through the upper inner operated contacts of relay 1706, the upper outer break contacts of relay 1704, operated contacts 1611 to negative battery through the winding of relay 1701.

The operation of relay 1701 completes a circuit for maintaining itself operated under control of relay 1708 which relay is in turn under control of relays 1719, 1729, 1739, 1339 and 1859. Relay 1701, in operating, also completes a circuit for the operation of magnet 1671. The operation of magnet 1671 disengages the feed pawl from its associated ratchet so that tape 1600 will not be advanced at the completion of the revolution of the distributor 1673 then in progress. The operation of relay 1701 interrupts the operating circuit of the start magnet 1672, thus permitting this magnet to release the start latch 1679 and cause the distributor 1673 to stop at the completion of the revolution then in progress. The operation of relay 1701 also interrupts the locking circuit of relay 1706, thus permitting this relay to release.

The operation of relay 1701 also completes a circuit for operating relay 1717. If line 589 is busy or otherwise unavailable, transmitter 1670 and

the circuits thereof remain in this condition until the line becomes idle. When line 589 is idle and assigned for transmission by the switching station the operation of relay 1717 completes a circuit for the operation of relay 1718 from positive battery through the break contacts of relays 1017 and 1317, the operated contacts of relay 1717, the right-hand winding of relay 1718 to negative battery through break contacts of relay 710. Relay 1718, in operating, completes a circuit for maintaining itself operated under control of positive battery both through the upper break contacts of relay 1706 and cam controlled contacts 1620. The operation of relay 1718 also completes a circuit for the operation of relay 1719 which relay, in turn, completes a circuit for the operation of relays 565 and 504 by connecting negative battery to lead 559 which extends from relay 1718 through Figs. 13, 10, 7, 6 and 5 to the lower windings of relays 565 and 504 and thence through the windings of these relays to positive battery.

The operation of relay 1718 extends the transmission circuit from the transmitter 1670 to loop 589. Relay 1718, in operating, completes a circuit for operating busy relay 710 which in turn lights busy lamp 761 and removes negative potential from the operating windings of relays 1018, 1318, 2018, 2318 and 2618 thus preventing any of these relays from operating at this time and interfering with the transmission from transmitter 1670.

The operation of relay 565 completes a circuit for maintaining itself operated under control of contacts 591 of the teletypewriter 590. Relay 565 also prevents the selector magnet 548 from responding to the signals transmitted over loop 589 and permits the printer magnet 593 to follow these signals, as described above. Thus the operation of relay 565 permits a copy of the message transmitted over loop 589 to be recorded by the receiving teletypewriter 590 at the central switching station and prevents the receiving apparatus 569 from responding to the signals transmitted and thus prevents it from recording these signals in tape 500 and also from operating the associated switching contacts.

The operation of relay 504 prevents or stops timing by the timing circuit 510.

The operation of relay 1719 as described above interrupts the circuit of relay 1708 and permits this relay to release. The release of relay 1708 interrupts the locking circuit of relay 1701 and permits this relay to release. The release of relay 1701 interrupts the circuit of magnet 1671, thus permitting this magnet to release and enables the transmitter 1670 to advance the tape through the transmitter in the normal fashion. The release of relay 1701 also releases relay 1717 which, in turn, extinguishes the lamp 1714, and reestablishes the circuit through the start magnet 1672, thus permitting the transmitting distributor 1670 to transmit the message recorded in tape 1600 to station A, designated 585 in Fig. 5.

Here again the operator at station A at any time during the transmission of the message to station A may interrupt the transmission by sending a break signal by the operation of break key 584 for an interval of time which exceeds the time required to transmit two code combinations. This causes the receiving teletypewriter 590 to actuate the send-receive switch 595 and complete an obvious circuit for lighting lamp 596. The operation of the send-receive switch 595 also

completes a circuit for the operation of relay 1654 from negative battery through the lower operated contacts of switch 595, lead 567 which extends through Figs. 6, 7, 10, 13 and 17, through the left-hand outer operated contacts of relay 1719 to positive battery through the winding of relay 1654.

The operation of relay 1654 completes an obvious circuit for lighting lamp 1655 to attract the operator's attention. The operation of relay 1654 also completes a locking circuit for maintaining itself operated under control of key 1656. In addition, the operation of relay 1654 interrupts the circuit of the start magnet 1672, thus stopping the transmission from distributor 1670.

The operation of the send-receive switch 595, as described above, removes the short circuit from around the transmitting contacts 594 controlled by the keyboard of the teletypewriter 590, thus permitting the operator at the central switching station to communicate with the operator or attendant at station A to determine the reason for the break signal. Thereafter the operator at the central switching station may return the send-receive switch and contacts to the position shown in Fig. 5, move tape 1600 back so the message or any portion thereof can be retransmitted to station A, and then momentarily operate the release key 1656 thus releasing relay 1654 and extinguishing lamps 1655 and 596. The release of relay 1654 reestablishes the circuit through the stop magnet 1672 and thus causes the transmitting distributor 1670 to transmit the message to station A.

At the completion of this message a "figures" signal followed by an H signal is recorded in tape 1600. These signals are transmitted by the transmitting distributor 1670 and momentarily operate contacts 1618 and 1617 in succession, which in turn operate the respective relays 1707 and 1706. The operation of relays 1707 and 1706 completes locking circuits for maintaining themselves operated. The operation of relay 1706 removes positive battery from the upper break contacts of relay 1706 connected to the lower terminal of the left-hand locking winding of relay 1718. Relay 1718 does not immediately release, however, because battery is still connected to this winding terminal from contacts 1620. At the completion of the transmission of the H signal, however, contacts 1620 are opened by cam 1674, thus permitting relay 1718 to release. This in turn causes the release of relays 1719 and the reoperation of relay 1708 thus restoring these circuits to their normal condition.

When the "figures" signal followed by the H signal is received by the teletypewriter 590 it causes contacts 591 to be momentarily operated in response to this sequence of the "figures" signal and the H signal. The operation of contacts 591 interrupts the locking circuit of relay 565, thus permitting this relay to release and restore the equipment associated with line 589 to their normal or idle condition.

It should be noted that relay 1719 releases a short interval of time prior to the operation of the contacts 591 by the receiving teletypewriter 590, thus insuring that relay 565 will release when contacts 591 are momentarily operated.

As has already been explained relay 504 will remain energized long enough under these circumstances to lock up over the upper contacts of relay 560, when this relay releases after transmission of the H signal. Thus the loop 589 will next be assigned to station A for transmission.

Transmission from the central switching station

Keyboard perforator 1990 is provided at the central switching station for perforating tape in accordance with messages to be transmitted from the central switching station to any of the outlying stations connected to the system. The perforated tape passes from the key board perforator through the transmitting distributor 1970.

The keyboard perforator may be similar to those described in the above-identified patents to Burcky et al, Lake, and Lake et al. The transmitting distributor 1970 is similar to the transmitting distributor shown in Fig. 6 of the drawing. It responds to the signals recorded in the tape and controls the switching equipment in the same manner as the distributor 670 shown in Fig. 6 and also distributors 970, 1270 and 1670. Also, during the transmission from the transmitting distributor 1970 to any of the outlying stations connected to the central switching station the operator at these stations may interrupt the transmission from the distributor 1970 by the transmission of a break signal which causes the operation of relay 1954 in the same manner as described above with reference to transmission of signals from other transmitters.

Station T is one station of a so-called teletypewriter exchange or manual telegraph switching system which may include any number of central offices interconnected by trunks and to each of which offices any number of subscribers may be connected by long or short subscriber lines or in some cases several subscribers may share a multiparty line according to current practice and as disclosed in the Locke et al Patent 2,237,154 and numerous patents of improvement thereupon; furthermore several subscribers may share a satellite office and the use of trunks therefrom to extend these lines to one or more central offices and through them to subscribers directly or other central offices of the Locke et al. or equivalent system all as disclosed in an application of Fitch et al. Serial No. 173,958, filed November 11, 1937, Patent No. 2,390,656. Any one or more such subscriber's stations may be such a station as disclosed in Figs. 15 and 16 and between such stations alternative routes through the storage switching systems of one or more switching centers such as those of Figs. 2 and 3 or through one or more teletypewrite exchange switching offices may exist. Such arrangements are specifically included as a part of the present disclosure.

Transmitting a message through two switching stations in succession

This invention is also applicable to switching systems employing a plurality of switching stations or centers. In the system shown in Figs. 2 and 4 through 27, inclusive, when arranged as shown in Fig. 31, only two switching stations are indicated. Fig. 2 illustrates in diagrammatic form a switching station similar to that shown in Figs. 4 through 27, inclusive, connected thereto over line 220. It is to be understood that any number of additional switching stations may be connected to either or both of these switching stations shown in the drawing in the same manner. As shown, each station is provided with only one trunk to the other station and with two outlying subscribers' stations. Means are also

shown for transmitting messages from either of the switching stations to a switching station of another type, as for example the central station of a national telegraph switching network of the manual type. Each of these switching stations may be provided with one or more lines extending to local stations or to stations individual to each of the switching stations and may also be provided with one or more trunks to the other switching centers. Additional lines may also extend to the same or other central exchange stations of a different type, as for example a national switching network.

The operation of the apparatus associated with each of the trunk circuits extending to other switching centers operates in substantially the same manner as the apparatus and equipment associated with each of the lines extending to the outlying or subscribers' stations associated with the switching stations. In this case, however, the switching signal combinations which precede the message first control the switching apparatus at the first switching station through which the message is routed, then the same switching combination is repeated over the line or trunk to the second switching station where it controls the routing of the message through the second switching station either to the desired station or through a third or as many additional switching stations as may be necessary or desirable to reach the final station for which the message is intended.

As already stated the trunk circuit **220** between the two switching stations is equipped with suitable repeater equipment at each end. Thus, at the end of the trunk circuit appearing in Fig. 9 the repeater equipment **929** is arranged to supply negative battery under marking conditions to the transmission circuit in the switching station; this battery connection will, of course, be opened by the repeater circuit during a spacing pulse arriving over the trunk circuit **220**. During a message being transmitted through the equipment in Fig. 9 to the distant switching station, shown in Fig. 2, the current and no-current conditions produced in the transmission circuit will be repeated to the trunk circuit by suitable repeating apparatus included in the transmission circuit to the negative battery in the repeater **929**.

The circuit assignment equipments at the two ends of the trunk circuit **220** are alike and are similar to the equipments **410** and **510**, such as are used at the switching station end of loop circuits to subscriber's stations.

Thus, referring to the timing circuit **910** in Fig. 9 the relay **909**, which transmits the assurance pulse, closes a by-path through resistance **902** to negative battery for maintaining the marking condition in the transmission circuit shown in Fig. 9, while the assurance pulse passes over the trunk to the timing circuit at the other end, indicated at **226** in Fig. 2. By this provision the slow release relay **904** will remain locked up over the upper contact of relay **960** after the assurance pulse has been sent. Thus, the distant switching station will appear busy and will have access to the trunk **220**, and the timing circuit **910** will remain in waiting condition until an assurance pulse arrives over the trunk. At such time line relays **947** and **992** will operate to spacing and relay **960** in operating permits relay **904** to release. After the assurance pulse the release of relay **960** removes the busy condition for the trunk from conductor **957** and causes the release of relay **905**. At this time the timing circuit commences its cycle and, when the tube **906** becomes conducting, relays **908** and **909** operate for the transmission of the assurance pulse and the restoration of the timing circuit by operation of relay **904**.

As in the case of the timing circuit **510** for a subscriber's loop each of the timing circuits for a trunk is responsive to end-of-message conditions set up in two different manners, so that counting relays, such as those required at the subscriber's station, need not be included in either of the timing circuits.

Thus when at the end of a message the fig.-H combination arrives over the trunk **220** and is received in the transmission circuit shown in Fig. 9, relay **965** will be in released condition and relay **962** will be operated in response to the fig.-H combination. In this case relay **904** will have time to release before relay **960** releases so that the busy condition will be removed, making the trunk circuit available for a message to the switching station shown in Fig. 2. The circuit **910** will proceed with its timing operation.

At the end of a message sent over trunk **220** to the switching station shown in Fig. 2 relay **962** will be in operated condition. Relay **965** and also relay **904** remain operated over conductor **959** until the switching relays for the calling station have been released. As described in connection with the circuit **510**, relay **904** under this condition, will not have time to release before relay **960** releases and therefore maintains the busy condition on conductor **957** and prevents the timing circuit from operating. Thus at the end of a call to the switching station in Fig. 2 the trunk **220** is made available for a call from that switching station. The fig.-H combination will open the contacts **991** in recorder **990** for the subsequent release of relay **965**.

It should be noted that after power is first applied to the system, relay **904** is not operated by the key **901** in the manner described for relay **504**. This is to avoid putting both timing circuits for the trunk in waiting condition at such time. Therefore, after power has been applied to the system, all the relays in the timing circuit remain released and condenser **907** charges until the tube **906** becomes conducting. The assurance pulse is transmitted and the timing circuit is left in waiting condition. When power is applied at the second switching station, shown in Fig. 2, the timing circuit **229** will send an assurance pulse and normal operating conditions will have been established. Thus, whichever station applies power first will be awaiting the assurance pulse from the other station.

Transmitting a message to a plurality of stations

In case it is desired to transmit a message from any one of the stations of the system to all or any number of other stations of the system the operator at the transmitting station will precede the message by a special switching code combination followed by the code combinations designating each of the stations for which the message is intended. The code combinations representing the various stations to which it is desired to transmit the message may follow the initial special code combination in any order. The message may also be transmitted from any station which may be operatively associated with the system and the operation of the system will be substantially the same.

In order to describe in detail the various elements of the system it will be assumed first that

the message originates at the central switching station shown in Figs. 5 through 27, inclusive, and that it is intended for all of the other stations connected to the system including the other central switching station, and in addition for a station connected to a national telegraph switching network. In case the central switching station is located at general headquarters, as will usually be the case, most of the messages which it is desired to broadcast to all or a number of the other stations of the system will originate at this station. It is to be understood, however, that this message may be transmitted from any other station in the system to all or any number of the other stations connected to the system.

For the purpose of transmitting such a message from the central switching station, the keyboard perforator **1990** will be operated by the operator to perforate tape **1900**. It is further assumed that at the end of the previous message transmitted from the keyboard perforator the "figures" signal followed by an H signal were transmitted through the transmitter distributor **1970**, which caused relays **2007** and **2006** to operate and lock operated or that the operator has operated key **2031** which in turn caused relay **2006** to operate. The operator now perforates a special signal indicating that the message is intended for transmission to a plurality of stations. Assume for example that the letter M, indicating a multiple transmission of the message, is perforated in the tape. This will be followed by the letters A, B, D, E, S and T. The operator may perforate these station designating letters in any desired order, the only requirement being that the designation for each station for which the message is intended be perforated at this time. Following the perforation of all of the designations of all of the stations to which it is desired to transmit the message the operator will transmit a second special signal or code combination, assume, for example, the letter X, indicating that the switching code combinations of all the stations to which it is desired to transmit the message have been perforated in the tape. Following this letter X signal, the operator perforates tape **1900** in accordance with the message it is desired to transmit to these stations. Following the message, the operator will perforate the "figures" signal code combination followed by an H signal code combination in tape **1900**. She will then either tear the tape or, preferably, perforate a number of "letters" signals in the tape to insure that the entire message, including the following "figures" signal and H signal, will be transmitted through distributor **1900** before the supply of perforated tape **1900** causes contacts **1932** to open as described hereinafter.

The transmitter distributor **1970** began operating as soon as the operator started typing, due to contacts **1962** closing. When the special multiple address signal M arrives at the control point in the transmitter **1970**, it causes contacts **1914** to close momentarily. Contacts **1914**, in momentarily closing, complete a circuit for the operation of relay **2004** from positive battery through the upper inner operated contacts of relay **2006**, operated contacts **1914**, to negative battery through the winding of relay **2004**. Relay **2004**, in operating, completes a circuit for the operation of magnet **1971**. Magnet **1971**, in operating, prevents tape **1900** from being advanced when the transmitter **1970** completes the revolution then in progress. The operation of relay **2004** interrupts the circuit of the start magnet **1972**, thus causing this magnet to release and stop the transmitter **1970**. Relay **2004**, in operating, completes a circuit for the operation of relay **2137** over a circuit traced from positive battery over upper, inner make contacts of relay **2004**, conductor **2011** through Figs. 21, 18, 14 and 11, closed contacts O of relay **860** in released condition, conductor **2012** through Figs. 11, 14 and 18, through winding of relay **2137** to negative battery. Relay **2137** in turn completes a circuit for lighting lamp **2155**. The operation of relay **2004** also completes a circuit for maintaining itself operated under control of relay **2008** which relay is held operated under control of relays **2019**, **2029**, **2039**, **2139** and **2159**. Relay **2004**, in operating, also interrupts the locking circuit of relay **2006**, thus permitting this relay to release.

Assuming that the circuits shown in Figs. 22, 23 and 24, which are arranged to transmit messages to more than one station, are idle, the operation of relay **2137** completes a circuit through the right-hand winding of relay **2138** for causing this relay to operate. The operation of relay **2138** completes a circuit for maintaining itself operated under control of contacts **1920** and the upper break contacts of relay **2006**. The operation of relay **2138** completes an obvious circuit for the operation of relay **2139**.

The operation of relay **2138** extends the transmission circuit of distributor **1970** to the upper winding of the repeating relay **2470**. Relay **2470** repeats the signals to the upper winding of relay **2247** and relay **2247** repeats them to the selector magnet **2248**.

The operation of relay **2138** completes a circuit for the operation of relay **830** and the operation of relay **830**, in turn, causes busy and overflow lamps **863** to light. The operation of relay **830** also removes the operating potential from the operating winding of switching relays **838**, **1138**, **1438** and **1838**, thus preventing these relays from operating and interfering with the transmission of message signals from the transmitter **1970**.

Relay **2139**, in operating, interrupts the circuit of relay **2008**, thus permitting this relay to release and, in turn, release relay **2004**. The release of relay **2004** extinguishes lamp **2135** and releases magnet **1971**. The release of relay **2004** reestablishes the circuit through the start magnet **1972** and causes this magnet to operate and start the transmission from the transmitter **1970**. The release of magnet **1971** permits the transmitter **1970** to feed tape **1900** through it in a normal fashion during the transmission of signals recorded in the tape.

At the end of the previous message transmitted through these circuits, relays **2261** and **2262** were operated by the "figures" signal and the H signal, that is, the signal which normally represents the letter H or else the operator has operated relay **2262** by the operation of key **2201**. Upon receiving the special multiple designation or letter M signal, which is the first character transmitted by the distributor **1970**, the receiving printing reperforator **2269** will print this signal on tape **2200** and perforate the tape in accordance with it. The tape lever contact **2282** will close and operate relay **2250**. The selector mechanism of this reperforating apparatus, in addition, will cause contacts **2234** to momentarily close and complete a circuit for the operation of relay **2263** from positive battery, through the winding of relay **2263**, contacts **2234**, winding of relay **2267** and lower outer operated contacts of relay **2262** to negative battery. Relay **2263**, in operating,

completes a circuit for maintaining itself operated under control of contacts 2235. Relay 2267 is also operated by current flowing in the above-traced circuit for the operation of relay 2263. Relay 2267, in operating, completes a circuit for maintaining itself operated from negative battery through its lower operated contact and winding, to positive battery through contacts 2234 and the winding of relay 2263. Relay 2267 in operating interrupts the locking circuit of relay 2262, thus permitting this relay to release. It should be noted that relay 2267 closes its locking circuit before it interrupts the locking circuit of relay 2262, thus insuring that relay 2267 will fully operate and cause relay 2263 to also fully operate and lock. When contacts 2234 open after their momentary closure they interrupt the locking circuit of relay 2267 which relay then releases. The operation of relay 2263 also connects negative battery to contacts 2231, 2232, 2233, 2234, 2241, 2242 and 2243.

The following signals perforated in the tape 1900 when transmitted to the printing reperforator 2269 represent the various stations connected to the system. Under the assumed conditions where the message is intended for all of the stations connected to the system each one of the above-enumerated contacts will be closed in succession, each contact being closed by its respective code combination received by the printing reperforator 2269.

The letter A will cause contact 2231 to close when it is received by printing reperforator 2269. This completes a circuit for the operation of relay 2363 from positive battery through the winding of relay 2363, right-hand break contact of relay 2361, contacts 2231, to negative battery through the inner upper operated contacts of relay 2263. Relay 2363, in operating, completes a circuit for maintaining itself operated under control of relay 2318 and its also completes a circuit for the operation of relay 2310 which, after a short interval of time, completes a circuit for the operation of start magnet 2272 which starts this transmitter into operation as soon as sufficient tape 2200 is perforated to close contacts 2282. Any "letters" signals left in the tape from a previous message are passed through transmitter 2270 without any effect upon any of the circuits. It should be noted that the repeating relays 2365, 2366, 2375 and 2466 all have their contacts short-circuited and the contacts of relay 2474 are disconnected, so that they are incapable of repeating any signal combinations. The operation of relay 2363 also completes a circuit for the operation of relay 2475. Relay 2475, in operating, completes a circuit for operating relay 2476, which relay, in turn, completes a circuit for maintaining itself operated under the joint control of the lower break contact of relay 2306 and contacts 2220. Relay 2476 also completes a circuit for maintaining relay 830 operated independently of the operation of relay 2138.

The operation of relay 2475 also partly prepares a circuit for the operation of relay 2471 but this relay does not operate at this time.

Assuming that the second directing signal received by device 2269 is the letter B, it will cause contacts 2233 of the printing reperforator 2269 to momentarily close. The closure of contacts 2233 completes a circuit for the operation of relay 2373. Relay 2373 completes a circuit for maintaining itself operated under control of relay 2338. The letter T when received by reperforator 2269 will cause contacts 2232 to momentarily close and they, in turn, complete a circuit for the operation of relay 2464. This relay locks under control of relay 2448. The addresses D, E and S assumed to be assigned to the stations reached over the trunk 220 to the second switching station, i. e., stations D, E and the second switching station, will cause contacts 2241, 2242 and 2243 to close and the closure of any one of these contacts completes a circuit for the operation of relay 2364 which locks operated under control of relay 2328. The succeeding signals representing other stations reached over the trunk 220 cause the other of these contacts to close one after another. However, since relay 2364 is operated, the closure of the succeeding contacts performs no useful function at this time.

Following the last switching signal combination, as pointed out above, the letter X signal will be transmitted to the receiving reperforator 2269 from the transmitter 1970. This will cause contacts 2235 to momentarily open and interrupt the locking circuit of relay 2263, thus permitting this relay to release. The release of relay 2263 disconnects negative battery from the switching contacts, thus rendering the operation of these contacts ineffective should they be operated by any of the succeeding message signals received by the printing reperforator. The following signals received by the reperforator 2269 will comprise the message and will be recorded in tape 2200.

As described above, the operation of the first one of these relays 2363, 2364, 2373 or 2464 causes the transmitting distributor 2270 to operate and advance the tape through it. As soon as the multiple message switching combination M reaches the control point, this transmitter causes contact 2214 to momentarily close and complete a circuit for the operation of relay 2301 from positive battery through the winding of relay 2301, contacts 2214 and upper operated contacts of relay 2306 to negative battery. It should be noted that relays 2307, 2306 have been previously operated by the "figures" signal followed by the H signal at the end of the previous message. The intervening "letters" or "spacing" signals recorded in the tape between this H signal and the succeeding M signal, as described above, may cause either contacts 2219 or 2216 to be momentarily opened and thus release relay 2307. However, relay 2306 remains operated at this time.

The operation of relay 2301, as described above, completes a circuit for maintaining itself operated under control of the start relay 2478. The operation of relay 2301 also interrupts the locking circuit of relay 2306 which causes this relay to release. It should be noted that the locking contact of relay 2301, which is shown as the inner lower contact, should operate first to insure that relay 2301 will fully operate before it causes relay 2306 to release and interrupt the operating circuit of relay 2301. The operation of relay 2301 also interrupts the circuit of relay 2310 which relay releases and in turn interrupts the circuit of the start magnet 2272, thus permitting this magnet to release and stop the transmitter 2270 at the completion of its cycle of operation then in progress. The operation of relay 2301 also completes an obvious circuit for operating magnet 2271. The operation of this magnet disengages the feed pawl from the feed ratchet and prevents the advance of the tape 2200 by the transmitting distributor 2270 as it nears the completion of its cycle of operation then in progress.

The circuits then remain in this condition during the reception of the remainder of the message

by the receiving printing reperforator 2269. At the end of the message the "figures" signal followed by the H signal will be transmitted to device 2269.

On the transmission of the "figures" signal by the transmitting distributor 1970, contacts 1918 momentarily close and complete a circuit for the operation of relay 2007. The following H signal recorded in the tape 1900, as described above, causes contacts 1917 to momentarily close and complete a circuit for the operation of relay 2006. Both relays 2007 and 2006, in operating, complete circuits for maintaining themselves operated. The operation of relay 2006 at this time removes positive battery through its upper break contacts from the locking winding of relay 2138. Relay 2138, however, does not immediately release because a locking battery is still connected to it through contacts 1920. At the completion of the revolution or cycle of the transmitting distributor 1970 during which this H signal is transmitted, contacts 1920 will open and interrupt the locking circuit of relay 2138. Relay 2138 will then release and, in turn, release relay 2139. The release of relay 2138 disconnects the transmission circuit of the transmitting distributor 1970 from the repeating relay 2470. The release of relay 2138 removes battery from the left-hand winding terminal of relay 839. Relay 839 does not release at this time, however, because battery is connected to this winding through the left-hand operated contacts of relay 2476.

The "figures" signal, when received by the printing reperforator 2269, will cause contacts 2238 to momentarily close and operate relay 2261. Relay 2261, in operating, locks operated under control of contacts 2239 and 2236. The following H signal causes contacts 2237 to momentarily close and complete a circuit for the operation of relay 2262 from negative battery through the upper operated contacts of relay 2261, operated contacts 2237, to positive battery through the winding of relay 2262.

The operation of relay 2262 completes a circuit for operating relays 2317, 2327, 2337 and 2447 from negative battery through the middle set of lower operated contacts of relay 2262, over lead 2229, through lower operated make contact of relay 2301, through the windings of the respective relays and operated contacts of the respective selecting relays 2363, 2364, 2373 and 2464 to positive battery.

Assuming now that only the trunk line 220 is idle at this time and that all of the other lines are busy so that the busy relays 710, 730 and 840 as well as 850 are operated, the respective busy lamps 761, 763 and 864 are lighted at this time, indicating that these other lines are busy, but that the busy relay 720 is not operated and busy lamp 762 is not operated.

Under these conditions the operation of relay 2327 completes circuits for the operation of relays 2328 and 2362 in parallel from negative battery through the next to the outermost left-hand break contacts of relay 720 and the right-hand windings of relays 2328 and 2362 in parallel, contacts of relay 2327 to positive battery, through the break contacts of relays 2027, 1727, 1327, and 727. It should be understood that the order in which these break contacts of relays 2627, 2327, 2027, 1727, 1327 and 727 are connected in the chain circuit through these contacts to the positive battery supply may be changed to any desired order. Relay 2328, in operating, interrupts the locking circuit of relay 2364, thus permitting this relay to release, release relay 2327, and extinguish lamp 2326.

The release of relay 2364 removes positive battery connected through its right-hand inner operated contacts to the lead extending to the winding of relay 2475 but since this lead has battery connected to it through the right-hand inner contacts of the other relays 2363, 2373 and 2464, the release of relay 2364 performs no further useful function at this time.

The operation of relay 2328 completes a circuit from negative battery through its left-hand inner contacts and left-hand winding, and the lower break contacts of relay 2306 to positive battery for maintaining itself operated. Positive battery is also applied to the lower terminal of the left-hand winding of relay 2328 through the cam control contacts 2220, when the transmitting distributor 2270 is out of its stop position. The operation of relay 2328 completes an obvious circuit for operating relay 2368, and also a circuit for operating relay 720. The operation or relay 720 lights the busy lamp 762 and interrupts the operating circuit of the other switching relays 728, 1328, 1728 and 2028, thus preventing the connection of any other distributor to the trunk extending to the second switching station.

The operation of relay 2368 also completes a circuit for the operation of relay 965 in a circuit from positive battery through lower winding of relay 965 and over lead 959 which extends from Fig. 9 through Figs. 10, 13, 17, 20 and 23 to the negative battery through the inner left-hand operated contacts of relay 2368.

The operation of relay 965 completes a circuit for maintaining itself operated under control of contacts 991 of the receiving teletypewriter 990. The operation of relay 965 also disables the printing reperforator 969 and prevents it from following any signals transmitted over the trunk 220 extending to the second switching station and permits teletypewriter 990 to respond to and record the signals transmitted over the trunk 220.

The operation of relay 2328 removes the short circuit around the contacts of repeating relay 2366 so that this relay may repeat the signaling impulses transmitted by the transmitting distributor 2270 over line 220 to the second switching station.

Relay 2362 in operating completes a circuit from negative battery through its left-hand winding and left-hand operated contacts to positive battery through any of the right-hand inner operated contacts of relays 2363, 2373 and 2464, for maintaining itself operated under the joint control of these relays. Relay 2362 in operating also interrupts the operating circuit of relay 2364.

The operation of relay 2368 completes a circuit for the operation of relay 2481 over the locking key 2401. The operation of relay 2481 completes a circuit for the operation of relay 2480. Relay 2480 is sufficiently slow in operating to provide time for the operation of relays 2478 and 2471 and the release of relay 2301 as will be described hereinafter.

The operation of relay 2481 completes a circuit for the operation of relay 2478 from negative battery through the winding of relay 2478 to positive battery through the break contacts of relay 2480 and the operated contacts of relay 2481. The operation of relay 2478 completes a circuit for the operation of relay 2471 from positive battery through the left-hand operated contacts of relay 2475, the left-hand winding of relay 2471, the upper operated contacts of relay 2478 to negative

battery. The operation of relay 2471 completes a circuit for maintaining itself operated from positive battery through contacts 2220 and the bottom contacts of relay 2306 in parallel, the right-hand operated contacts and right-hand winding of relay 2471 to negative battery through the left-hand operated contacts of relays 2363, 2364, 2373 and 2464.

Relay 2471, in operating, also connects the contacts of the repeating relay 2474 to the transmission circuit extending through the upper winding of the receiving relay 2247 of the printing reperforator 2269. The operation of relay 2478 interrupts the locking circuit of relay 2301 and permits this relay to release. The release of relay 2301 interrupts the circuit through magnet 2271 which permits the tape 2200 to be advanced through the transmitter 2270 in the normal manner during the operation of the transmitting distributor 2270. A short interval of time after relay 2471 has operated and relay 2301 released relay 2480 will operate and interrupt the operating circuit of relay 2478 which relay then releases. The release of relay 2478 at this time merely prepares a locking circuit for relay 2301 when it is again operated. The release of relay 2478 also permits the release of relay 2471 at a later time when its locking circuit is interrupted. The release of relay 2301 interrupts the negative battery connected to the windings of relays 2317, 2337 and 2447. The consignment release of these switching relays prevents the connection of any other lines to this special repeating circuit until the entire message is transmitted over line 220, as will be described hereinafter. It is to be noted that relay 2475 does not release at this time because it is held operated due to the fact that relays 2363, 2373 and 2464 are locked operated at this time.

The release of relay 2301 completes a circuit for the operation of relay 2310 to plus battery at uppermost break contacts of relay 2306. Relay 2310 is sufficiently slow in operating to allow time to insure complete operation of the various switching relays before starting transmission. The operation of relay 2310 after this short interval of time completes a circuit for the start magnet 2272 from positive battery through its make contact, winding of start magnet 2272, switch 2280, right-hand operated contacts of relay 2250, to negative battery through the right-hand outer break contacts of relay 2254.

The first signal transmitted by the transmitting distributor 2270 will then be the special multiple switching signal which has been assumed to be the letter M. This signal is transmitted over lead 2309 through the operating windings of the repeating relays 2365, 2366, 2375, 2466 and 2474. All of these relays follow the signals transmitted by the transmitting distributor 2270. However, the contacts of relays 2365, 2375 and 2466 are short-circuited by contacts of the respective relays 2318, 2338 and 2448. Relay 2366 repeats the signals over the trunk 220 while relay 2474 repeats the signals back to the line relay 2247 of the reperforator 2269.

When the M signal is again received the line relay 2247 repeats it to the selector magnet 2248. This causes the M signal to be printed upon tape 2200 and perforated in this tape a second time. It also causes contacts 2234 to again close and operate relay 2263. It will be remembered that relays 2261 and 2262 had been previously operated and locked operated by the "figures" signal followed by the H signal received at the end of the message already recorded in tape 2200 which is now being transmitted by the transmitting distributor 2270. The circuit for the operation of relay 2263 is the same as described above, when this relay operated the first time the letter M signal was received, and extends from negative battery through the lower outer operated contacts of relay 2262, winding of relay 2267, operated contacts 2234, to the positive battery through the winding of relay 2263. Relay 2263, in operating, completes a circuit for maintaining itself operated under control of contacts 2235. Relay 2267 also operates in series with relay 2263 in the above-described circuit and locks operated after which it interrupts the locking circuit of relay 2262 and permits this relay to release. The first subsequent letters signal or spacing signal received by the printing reperforator 2269 causes contacts 2239 or 2236 to open momentarily and release relay 2261.

Thereafter the following switching signals, together with the message as first stored in tape 2200, will be transmitted by the transmitting distributor 2270 and repeated by relay 2366 over line 220. These signals are also repeated by relay 2474 back to the printing reperforator 2269 where they are again recorded in tape 2200 so that they will be available for transmission to the other stations to which the message is intended when they become idle. As the switching signal combinations are again recorded by the printing reperforator 2269 they will cause their respective contacts to again close. Thus, when the letter A is recorded, it will cause contacts 2231 to close. This will again complete a circuit for the operation of relay 2363. However, inasmuch as this relay is already locked operated, the operation of contacts 2231 at this time performs no useful function. The same is true of the operation of contacts 2232 and 2233 in response to the reception and the recording of the characters B and T, respectively. When the switching characters designating stations D, E and S are received by the printing reperforator 2269 and are recorded in tape 2200 by it, the respective contacts 2241, 2242 and 2243 are closed in sequence. It will be recalled that the first one of these contacts to operate, when the message was first recorded by the printing reperforator 2269, completed a circuit for the operation of relay 2364 and that the operation of the other contacts thereafter produced no useful effect. In this case, however, relay 2362 has been operated as described above, so that the operating circuit of relay 2364 is interrupted, consequently the operation of these contacts 2241, 2242 and 2243 is ineffective to operate relay 2364 at this time. Consequently, relay 2364 remains released.

Transmission to second switching station

Upon arrival at the second switching station, the special multiple switching signal M, when received by the typing reperforator 222, will condition the circuit at the second switching station to respond to the following switching signals designating stations D and E and also to the signal S designating the second switching station. Reception of the switching signals followed by the letter X signal, indicating the end of the switching signals, will condition the circuits of the second switching station so that the typing reperforator 222 and also the receiving machine 221 will respond to the message transmitted over the trunk 220. The copy recorded on the receiving teletypewriter 221 will be the copy intended for the second switching station

designated by the letter S under the assumed circumstances.

The message will also be recorded in tape 223 by the typing reperforator 222. The tape 223 then passes through the transmitting distributor 224. When the special multiple switching signal arrives at the control point of this transmitter, it will operate certain of the selecting relays 225 which direct the message to the typing reperforator 272 of the multiple transmission or repeating circuit. After the message is recorded in this typing reperforator, the connection between it and the transmitting distributor 224 will be interrupted and leave the transmitting distributor available for transmission of messages to other stations.

After the message has been recorded by the typing reperforator 272 in the tape 273, this tape will pass through the transmitting distributor 274. When the special multiple switching signal arrives at the control point of the transmitter 274, it will cause the selecting relays 275 to connect the transmitter 274 to lines extending to the desired stations, whereupon the message will be transmitted to these stations. In case certain of the lines are busy, they will not be connected to the transmitter 274 at this time. Instead, the message will be repeated back to the reperforator 272 for storage again in tape 273 so that it will be available for transmission to these lines when they become idle.

The operation of the equipment at the second switching station under these conditions is substantially the same as the operation of the switching equipment at the first switching station under similar circumstances, as will be described in detail hereinafter. Each of the respective receiving and transmitting devices, as well as the switching and selecting circuits, all respond to the various switching information in a similar manner, the only difference being that at one station the message may be routed to an individual line whereas at another station it may be routed to a trunk extending to another station and then routed to its individual line, all in response to the same switching signal. For example, the letters D and E at the first switching station routed the message to the trunk 220, whereas in the second switching station these switching characters D and E will route the message to the respective stations D and E and not to trunk 220. Similarly, if the message had been originally received at the second switching station shown in Fig. 2, the switching designations A and B would route the message to trunk 220, whereas at the first switching station they will route the messages to the respective stations A and B.

As pointed out above the transmission of the message proceeds from the transmitter 2270 both to the distant switching station shown in Fig. 2 and to the typing reperforator 2269. At any time during this transmission the operator at the second switching station shown in Fig. 2 may interrupt the transmission from the transmitting distributor 2270 by transmitting a long spacing or break signal back over the channel 220 by the operation of the key at the second switching station which corresponds to key 989 at the first switching station. If this signal exceeds the length of two code combinations, the receiving teletypewriter 990 connected in series with line 220 extending to the second switching station will cause contacts 995 to be operated. The manner in which these contacts are operated by the receiving teletypewriter 990 in response to a spacing or break signal, which exceeds in length the time required to transmit two code combinations, is clearly described in the above-identified patents to Morton et al. with reference to the send-receive-break mechanisms and switch disclosed therein. The operation of the switch 995 removes the short circuit from the transmitting contacts 994, completes a circuit for lighting lamp 996 to indicate to the operator that the distant operator has transmitted a break signal and wishes to communicate with the operator at the first switching station. The operation of the switch 995 also completes a circuit for the operation of relay 2370 from negative battery through the lower operated contacts of switch 995, lead 967 which extends through Figs. 9, 10, 13, 17, 20 and 23 through the left-hand outer operated contacts of relay 2368 to battery through the winding of relay 2370. The operation of relay 2370 extends the circuit of lead 967 through the left-hand outer operated contacts of relay 2368, left-hand operated contacts of relay 2370 to positive battery through the the winding of relay 2254. Relay 2254 is operated by current flowing in this circuit and completes a circuit for maintaining itself operated from negative battery through the contacts of key 2256, right-hand inner operated contacts of relay 2254, through the winding of relay 2254 to positive battery.

The operation of relay 2254 also interrupts the circuit through the start magnet 2272, thus permitting this magnet to release and stop the transmitting distributor 2270 at the end of the code combination then in progress of transmision. The operation of relay 2254 also completes an obvious circuit for lighting lamp 2255 to indicate to the operator at the switching station that the transmitter 2270 has been the one transmitting to the distant central office. The operator at the first switching station may then communicate with the operator at the second switching station by operating the keyboard or transmitter of teletypewriter 990 to determine what additional service is required or what the trouble may be. Thereafter the operator at the first switching station may manually restore switch 995 to the position shown in Fig. 9. The operator may then operate key 2256 momentarily which interrupts the locking circuits of relays 2254 and 2370 and also the circuit of lamp 996, thus permitting these relays to release and lamp 996 to be extinguished. The release of relay 2254 also reestablishes the circuit through the start switch 2272, thus restarting the transmitting distributor 2270, whereupon this transmitter will complete the transmission of the message back to itself and also to the second switching station over trunk 220.

Retransmission of the message to other stations

After the message which was originally stored in tape 2200 has been fully transmitted by the transmitting distributor 2270 to the distant switching station and also recorded again in tape 2200 by the printing reperforator 2269, the "figures" signal followed by the H signal recorded in tape 2200 following the first recording of the message in tape 2200 will be transmitted by the transmitting distributor 2270. When the "figures" signal is transmitted by the transmitting distributor 2270 it causes contacts 2218 to momentarily close and complete a circuit for the operation of relay 2307. Relay 2307 locks op-

erated under control of contacts 2216 and 2219. Then, when the H signal is transmitted by the transmitting distributor 2270, this transmitter will close contacts 2217 and complete a circuit for the operation of relay 2306 from positive battery through the upper operated contacts of relay 2307, operated contacts 2217, to negative battery through the winding of relay 2306. Relay 2306, in operating, completes a circuit for maintaining itself operated from negative battery through its winding and inner upper contacts of relay 2306 to positive battery through the lower outer break contacts of relay 2301.

The operation of relay 2306 removes positive battery from the locking circuit of relays 2328, 2471 and 2476. None of these relays releases at this time. Relays 2328 and 2471 do not release because negative battery is still connected to their locking circuits by contacts 2220. When the H code combination is completely transmitted contacts 2220 will open and interrupt the locking circuits of relays 2328 and 2471 and permit these relays to release. Relay 2476 does not release at this time because its operating circuit is maintained closed by relay 2475 which also remains operated at this time as pointed out above.

Relay 2328 in releasing releases relay 2368. Relay 2328, in releasing, short-circuits the contacts of repeating relay 2366, thus preventing this relay from repeating any further signals over trunk 220. It should be noted, however, that both the "figures" signal and the H signal are transmitted over trunk 220 before relay 2328 is released because relay 2328 is not released until negative battery is disconnected from the lower winding terminal of the left-hand winding of relay 2328 by contacts 2220 opening after the letters H signal has been completely transmitted by the transmitting distributor 2270. The release of relay 2328 interrupts the operating circuit of relay 720 which releases and in turn extinguishes the busy lamp 762 and prepares operating circuits for the other switching relays enabling other transmitters to be connected to the trunk 220 extending to the second switching station. The release of relay 2471 disconnects the contacts of repeating relay 2474 from the winding of relay 2247.

When the "figures" signal followed by the H signal is received by teletypewriter 990 which, it will be remembered, follows the signals transmitted over trunk 220 during this time, contacts 991 will open for a short interval of time after the completion of the reception of the H signal. This interrupts the locking circuit of relay 965 and allows this relay to release, its operating circuit having been previously interrupted by the release of relay 2368. The release of relay 965 disables the receiving teletypewriter 990 and removes the disabling condition applied to the printing reperforator 969, thus allowing this reperforator to respond to signals received over line 220. All of the circuits associated with the line 220 have now been returned to their normal condition and are now available for the transmission of other messages between the two switching stations, subject to control by the timing circuits 910 and 226.

When the "figures" signal followed by the H signal was transmitted by the transmitting distributor 2270 following the first transmission of the message by distributor 2270, they were relayed to the printing reperforator 2269 and again recorded in tape 2200. When this "figures" signal is received by the printing reperforator 2269 it will cause the contacts 2238 to momentarily close and complete a circuit for the operation of relay 2261. Relay 2261, in operating, completes a circuit for maintaining itself operated under control of contacts 2239 and 2236. When the H signal is received, it will cause relay 2262 to operate in a circuit from negative battery through the upper operated contacts of relay 2261, operated contacts 2237 to positive battery through the winding of relay 2262. The operation of relay 2262 at this time completes a circuit for maintaining itself operated under control of the break contacts of relay 2267.

The special multiple message switch signal combination, that is, the letter M signal, will be perforated in tape 2200 a second time with the second recording of the message in tape 2200 immediately following the "figures" signal and succeeding H signal following the first recording of the message in tape 2200. When this second M signal reaches the control point in the transmitting distributor 2270, it will cause contacts 2214 to momentarily close and complete a circuit for the operation of relay 2301. The operation of relay 2301 completes a circuit for maintaining itself operated under control of the start relay 2478. The operation of relay 2301 interrupts the locking circuit of relay 2306, thus permitting this relay to release and render the further operation of contacts 2221, 2222, 2223, 2211, 2212, 2213, and 2214 ineffective. The operation of relay 2301 also interrupts the circuit of relay 2310 which relay releases and in turn interrupts the circuit of start magnet 2272 and thus stops the transmitting distributor 2270 at the end of the cycle or revolution then in progress. It should be noted that this M signal, transmitted by the distributor at this time, is not transmitted over any of the circuits to any distant line or station because they are not connected to the transmitter at this time.

The operation of relay 2301 also completes a circuit for operating magnet 2271, thus preventing tape 2200 from being advanced near the end of the revolution of the transmitting distributor 2270 then in progress during which the letter M signal was at the control point of the transmitter 2270. The operation of relay 2301 also reestablishes the circuit for reoperating relays 2317, 2337 and 2447 from negative battery through the middle set of lower operated contacts of relay 2262 over lead 2229, through the second set of contacts from the bottom of relay 2301, through the windings of relay 2317, 2437 and 2447 in parallel to positive battery through operated contacts of the respective marking relays 2363, 2373 and 2464. Operation of relay 2317, 2337 and 2447 completes circuits for the operation of the corresponding switching relays 2318, 2338 and 2448, through the break contacts of the corresponding busy relays and the other switching relays controlling these lines to positive and negative battery, if these relays are released.

It should be noted that since relay 2364 is released at this time relay 2327 will not be operated. It should be further noted that the relays 2363, 2373 and 2464 have remained locked operated over break contacts of the respective relays 2318, 2338 and 2448 and thus are still marking the lines that were not reached during the first transmission. Thus operation of switching contacts in the reperforator 2269 in response to the station designating characters fed back by relay 2474 will not affect the marking relays at this time.

It will now be assumed that the lines extending to stations A and B have become idle and that the equipment associated with the line extending to station T is also idle. Under these conditions all the other switching relays associated with these lines will be in their normal condition, so that switching relays 2317, 2437 and 2447 will operate when relay 2301 operates. When relay 2317 is operated it completes a circuit for the operation of relays 2318 and 2361. Relay 2318, in turn, completes a circuit for the operation of relay 2367. Relay 2318 completes a circuit for the operation of relay 710, which relay lights busy lamp 761 and removes the operating potential applied to the operating windings of the other switching relays 1018, 1318, 1718 and 2018. The operation of relay 2318 also completes a circuit for maintaining itself operated under control of the lower break contact of relay 2306 and contacts 2220 controlled by cam 2274. Relay 2318, in operating, also removes the short circuit from the contacts of the repeating relay 2365, thus permitting this relay to transmit signaling impulses over loop 589. The operation of relay 2367 connects negative battery to lead 559 which extends through Figs. 23, 20, 17, 13, 10, 7, 6 and 5 to the windings of relays 565 and 504. Relay 565 operates in this circuit and conditions the teletypewriter 590 to respond to and record the signals transmitted over loop 589 at this time. Relay 565, in operating, completes a circuit for maintaining itself operated under control of contacts 591. The operation of relay 565 also connects positive battery to the left-hand winding terminal of the selector magnet 548 and prevents the operation of magnet 548, the printing and perforating mechanism and the contacts in response to any of the signals transmitted over the loop 589.

The operation of relay 2318 also interrupts the locking circuit of relay 2363, thus permitting this relay and relay 2317 to release and extinguish lamp 2316. The operation of relay 2361 interrupts the operating circuit of relay 2363, thus preventing this relay from reoperating. The operation of relay 2361 also completes a circuit for maintaining itself operated under control of relays 2363, 2364, 2373 and 2464.

In a similar manner the operation of relay 2337 completes a circuit for the operation of relays 2338 and 2371. Relay 2338, in turn, causes the operation of relays 2377, 730, 1265 and 404. These relays condition the equipment associated with the loop 1289 extending to station B in the same manner that the equipment associated with the loop extending to station A was conditioned by the operation of the corresponding relays associated therewith. In addition, the operation of relay 2338 removes the short circuit from around the transmitting or repeating contact of relay 2375, thus allowing this relay to repeat signals to station B over loop 1289. The operation of relay 2338 also interrupts the locking circuit of relay 2373, thus permitting this relay and relay 2337 to release and extinguish lamp 2336.

The operation of relay 2447 likewise completes circuits for the operation of relays 2448 and 2462. Relay 2462, in turn, completes a circuit for maintaining itself operated under control of relays 2464, 2373, 2364 and 2363. Relay 2462 also interrupts the operating circuit of relay 2464. The operation of relay 2448 causes the operation of relays 2468 and 840, which relays condition equipment associated with the lines extending to station T to transmit the messages intended for that station.

The operation of relay 2448 also interrupts the locking circuit of relay 2464 and thus permits this relay and relay 2447 to release and extinguish lamp 2446.

It has been assumed that relay 2447 operated last. In case one of the other relays 2317 or 2437 operates last, the operation of the circuits up to this point would be the same. Whichever one of these relays operates last will cause the operation of the respective relay 2318, 2338 or 2448, which relay will cause the release of the respective relays 2363, 2373, or 2464. Whichever one of these relays releases last will remove negative battery from the locking circuit of relay 2471 and will also remove the positive battery connected to the operating circuit of relay 2475, thus permitting this relay to release. The release of relay 2475 interrupts the operating circuits of relays 2471 and 2476. However, relay 2476 does not release at this time.

Whichever of the relays 2363, 2373 or 2464 releases last will also remove positive battery from the locking windings of relays 2361, 2362, 2371, 2462 and allow these relays to release.

When the associated lines are idle, relays 2367, 2377 and 2468 will normally operate at about the same time and whichever one operates first will complete a circuit for the operation of relay 2481. The operation of relay 2481 completes a circuit for the operation of relay 2478 which relay in turn interrupts the locking circuit of relay 2301 and permits this relay to release. The operation of relay 2478 at this time does not cause the operation of relay 2471 because relay 2475 is released. Under these conditions, when the message is again transmitted by the transmitting distributor 2270 it will not be repeated back to the printing reperforator 2269 because it is no longer necessary to tranmit the message to any other stations.

The release of relay 2301 interrupts the operating circuit of magnet 2271 and permits this magnet to release. Consequently, when the transmitter 2270 is started into operation, tape 2200 will feed through the transmitter in the normal manner.

The release of relay 2301 completes a circuit for the operation of relay 2310 which in turn closes an operating circuit for start magnet 2272 from negative battery through the right-hand outer break contacts of relay 2254, right-hand operated contacts of relay 2250, switch 2280, winding of the start magnet 2272 to positive battery through the make contacts of relay 2310. When the transmiter 2270 starts, the first character transmitted will be the special switching signal, designating a message directed to a plurality of stations, that is, the letter M. Following the letter M each of the switching combinations will be transmitted and they will operate their respective contacts 2211, 2212, 2213, 2221, 2222 and 2223 in sequence as these characters are transmitted. The operation of these contacts at this time, however, does not perform any useful function because relay 2306 is released. Following the transmission of these switching combinations and the letter X, indicating the end of the switching combinations, the regular message will be transmitted again by the distributor 2270 as recorded in the tape 2200 the second time. Relays 2365, 2366, 2375, 2466 and 2474 all follow the signals transmitted by the transmitter 2270. The transmitting contacts of relay 2366 are short-circuited by the left-hand outer break contacts of relay 2328 and the contacts of relay 2474 are disconnected at the released contacts of relay 2471. Consequently, the

operation of these two relays at this time does not repeat the signals to any line or circuit. The operation of relays 2365, 2375 and 2466, however, repeat the signals received by them over the respective lines 589, 1289 and lead 1540. The signals are also repeated by the receiving teletypewriters 590, 1290 and 1569. Thus, the message is transmitted to each of these stations for which it is intended, in the normal manner of transmitting messages to them.

Near the end of the transmission of the message the final time the supply of perforated tape 2200 will be sufficiently reduced to cause contacts 2282 to open and interrupt the operating circuit of relay 2250 which causes this relay to release. The release of relay 2250 interrupts the circuit of magnet 2272 causing this magnet to release and stop the transmitter 2270. The release of relay 2250 at this time completes a circuit for the operation of relay 2251 from positive battery through the left-hand break contacts of relay 2253 and 2250, the winding of relay 2251, the upper break contacts of relay 2263, the upper operated contacts of relay 2262, to negative battery through the break contacts of relay 2260. Relay 2251 in operating completes a circuit for maintaining itself operated under control of relays 2253, 2263, 2262 and 2260. Relay 2251 in operating also completes circuits for operation of relay 2252 and feed-out magnet 2249. The operation of magnet 2249 causes the perforating apparatus 2269 to automatically perforate an additional supply of tape 2200 preferably with "letters" signals. Relay 2252 is sufficiently slow in operating to allow the reperforator 2269 to automatically perforate sufficient tape to insure that the entire message will be transmitted by the transmitter. After the lapse of such a minimum time interval, relay 2252 will operate and complete a circuit for lighting lamp 2472. The operator, upon noting the lighted lamp 2472, will momentarily operate key 2473 which completes a circuit for the operation of relay 2253. Relay 2253 in operating completes a locking circuit for maintaining itself operated under control of relays 2263, 2262 and 2260. The operation of relay 2253 interrupts the operating circuit of relay 2251 which relay then releases. The release of relay 2251 in turn causes the release of magnet 2249 and relay 2252. The release of magnet 2249 stops the automatic perforation of the tape by device 2269. The release of relay 2252 extinguishes lamp 2472.

The additional supply of tape automatically perforated by device 2269 causes contacts 2282 to reclose and, in turn, reoperate relay 2250. The reoperation of relay 2250 again completes the circuit of magnet 2272 which reoperates and starts transmitter 2270.

At the completion of the transmission of the message, the "figures" signal followed by the H signal will be transmitted from transmitting distributor 2270. When the "figures" signal is transmitted it causes relay 2307 to operate and to lock operated, as described above, and when the H signal is transmitted it causes contacts 2217 to operate and in turn operate relay 2306. The operation of relay 2306 removes the last battery connection from conductor 2302 and thus interrupts the circuit of relay 2310 which relay in turn interrupts the circuit of the start magnet 2272, thus permitting this magnet to release and stop the transmitting distributor 2270 after the H signal has been completely transmitted. The operation of relay 2306 removes negative battery through its lower break contacts from the locking windings of relays 2318, 2338, 2448 and 2476. These relays do not release at this time, however, because negative battery is still connected to their locking windings through the cam controlled contacts 2220. After the H signal has been completely transmitted by the transmitting distributor, cam 2274 causes contacts 2220 to open and disconnect negative battery from the locking windings of these relays, thus permitting them to release. The release of relay 2476 at this time interrupts the operating circuit of the busy relay 830 and permits this relay to release and extinguish lamps 863.

The release of relay 2318 short-circuits the contacts of the repeating relay 2365, thus preventing the transmission of any further signals by this relay over loop 589. The release of relay 2318 also interrupts the operating circuit of relay 2367. The release of relay 2318 causes relay 710 to release subject to control by the timing circuit 510, as previously described. The release of relay 710 extinguishes the busy lamp 761 and connects negative battery to the operating windings of the other switching relays, thus permitting them to operate and connect other transmitters to this line. The release of relay 2318 also interrupts the operating circuit of relay 565. This relay does not immediately release at this time, however, because it is held operated under control of contacts 591. The release of relay 2318 also interrupts the operating circuit for relay 504, which however does not have time to release under these circumstances before relay 560 releases and keeps it locked operated for assignment of loop 589 to transmission in the direction from the subscriber's station to the switching center. A very short interval of time after the letter H signal, which was preceded by the "figures" signal, has been received by the teletypewriter 590, contacts 591 will open and interrupt the locking circuit of relay 565. The release of relay 565 at this time returns the circuits of the teletypewriter 590 and the printing reperforator 569 to their normal condition so that they will be ready to receive messages transmitted from station A.

The release of relays 2338 and 2448 similarly causes the release of the corresponding relays associated with the other lines to stations B and T and permits them to return to normal and in condition for the transmission of other messages between these stations and the central switching station.

In accordance with a feature of the invention, a delay arrangement is incorporated in the multiple sender circuit, shown in Figs. 22, 23 and 24. An object of this delay feature is to delay the transmission of a message by the transmitter 2270 for a predetermined time interval after the selecting operations have been completed and the message has been recorded on tape 2200 ready for transmission so that in case some of the selected stations or lines are busy at the time of selection and should become idle within the following delay interval, such stations would be seized and included in the transmission of the message. Thus it may be assumed that the message is ready for transmission by the transmitter 2270 to a plurality of stations most of which show a busy condition at the time they are being selected; some of these busy stations may then become idle during the prevailing delay interval and will be seized in the multiple sender circuit; at the end of the

interval the message will be transmitted to all the seized stations and will also be again stored by the reperforator 2269 for retransmission to the remaining stations. When the message is ready for transmission the second time the same delay feature may again function to permit inclusion in the second transmission of busy stations which become idle within the second delay period. The message may, of course, be retransmitted a third or more times, each time with the same delay period, except that the delay period will be discontinued when the last station becomes idle.

This delay feature in the multiple sender circuit is so adjusted that the delay exceeds the time intervals established for the individual line circuits by their associated assurance circuits. Thus, if the assurance time interval be ten seconds the delay interval in the multiple sender may conveniently be made 15 or 20 seconds or even longer, dependent upon the particular traffic conditions. In this manner, line or trunk circuits, which have been selected or marked in the multiple sender and which at the time happen to be made busy due only to the timing condition established by their assurance circuits, could become idle in time to be included in the multiple transmission which at the time is awaiting the delay circuit.

This delay feature is incorporated in the multiple sender, shown in Figs. 22, 23 and 24, by means of a circuit arrangement shown in Fig. 24 and including a timing condenser 2404, an electronic space discharge device 2403, relays 2406 and 2407 and the locking key 2401. The space discharge tube 2403 may be of any well-known type suitable for the present purpose and thus may be a three-element vacuum tube which will be nonconducting for all potentials applied to its control electrode below a predetermined low positive potential and which will be conducting at positive potentials above that value. An intermediate potential is applied to the control element of tube 2403 by the series circuit from negative battery over the break contact of relay 2406 through a resistance network to positive battery 2405. This normal intermediate potential maintains the tube in nonconducting condition. The timing condenser 2404 has normally both sides connected to negative battery and thus is normally discharged. When relay 2406 is operated and removes negative battery from one side of the condenser, the condenser will begin to charge and permit the potential applied to the control electrode to increase and, after a predetermined interval, to reach the predetermined positive potential at which the tube 2403 becomes conducting. When the tube becomes conducting, the cathode anode current will operate relay 2407. In this manner relay 2407 will be operated a predetermined interval after the operation of relay 2406. When relay 2406 releases negative potential is again applied to discharge the condenser 2404 and thus to reduce the potential on the control electrode for rendering the tube nonconducting; under this condition relay 2407 will release.

To permit the timing circuit to function in the multiple sender circuit the locking key 2401 must be operated to open its contacts.

It will now be assumed that a message has been set up for multiple transmission on the keyboard perforator 1990 and that the message is intended for the same stations as in the case fully described above. It will also be assumed that the operations have progressed to the point where all the selecting relays in the multiple sender have been operated for all the stations designated in the tape 1900. It will further be assumed, as before, that only the line S to the second switching station in Fig. 2 is idle and that all the other selected stations are busy, either because their lines are busy transmitting a message in either direction or because the assurance circuits associated with the lines are temporarily making the lines appear busy.

When the letter M arrives in the transmitter 2270, the transmitter will be stopped, and at the completion of the recording in tape 2200 relay 2368 will be operated, as previously described. Relays 2367, 2377 and 2468 will not be operated since they are associated with the busy lines.

Relay 2368, when operated, applies battery over its right make contact to a circuit which, as before described extended over the key 2401 through the winding of relay 2481, but which, now that the key 2401 is open, extends over the left break contacts of relay 2481 through relay 2406. Relay 2406 thus operates and starts the delay circuit in the manner described above. After, say, 20 seconds, relay 2407 is operated when the tube 2403 becomes conducting. Relay 2407 now applies battery directly to relay 2481, which operates and causes the operation of start relay 2478 and the delayed operation of relay 2480. As previously described, the start relay causes the release of relay 2301 which in turn operates relay 2310 and thus causes the transmitter 2270 to start transmission.

However, if it be assumed that line A is indicated busy by its timing circuit 510, this busy condition for line A would be removed after ten seconds, at the most, due to the removal by relay 504 of battery from the conductor 557 and the release of relay 710. As soon as relay 710 releases battery will be applied to all the switching relays and thus also to the relays 2361 and 2318 in the multiple sender. Thus relay 2318 would be operated during the time interval between the operations of relays 2406 and 2407 so that, when transmission is started upon operation of relay 2407, the line relay 2365 for line A will have its contacts included in the transmission circuit 550 to station A. Other lines which for any reason were busy at the time of testing in the multiple sender may also become idle before relay 2407 is operated and thus may be included in the first transmission.

Assuming that, say, station B is still busy when the first transmission by the transmitter 2270 commences, its associated line relay 2375 will then still have its contacts short-circuited by relay 2338 to prevent transmission to station B. With the selecting relay 2373 still operated under this condition, this relay and possibly other similar relays associated with busy lines, will keep relay 2475 operated, so that the message will be transmitted back to reperforator 2269 for retransmission to the busy stations when they become idle.

At the end of the first transmission, relays 2367 and 2368 release in the manner already described and open the locking circuit for relay 2481 extending over the left make contacts of relay 2481, which relay therefore releases and restores its operating circuit over contacts of relay 2407 preparatory to the next transmission.

When the letter "M" appears the second time in the transmitter 2270 the transmitter will be stopped. Relays 2337 and 2447 will be operated when the second recording is completed. Assum-

ing that lines B and T, with which these two relays are associated, are still busy at this time, the circuit will remain in waiting condition. After the line B, for example, becomes idle relays 2338 and 2377 will be operated. Relay 2377 then operates relay 2406 and initiates the timing operation and the subsequent operation of relays 2407 and 2481 for starting the transmission to line B and for again storing of the message in the tape 2200 for retransmission to line T.

Special provision is made for the case where none of the selected lines is busy. In such a case the delay function in the multiple sender obviously would be unnecessary. Thus, in the assumed case of the message being stored the third time in the tape 2200 for retransmission to the last remaining line T, when the line T becomes idle the operation of relay 2448 causes the release of relay 2464. A continuous chain circuit may now be traced for the operation of relay 2481 from plus battery through the winding of relay 2481, outer right break cntacts in series of relays 2464, 2373, 2364 and 2363 to the conductor extending to minus battery at the right-hand contacts of all the relays 2468, 2377, 2368 and 2367. Thus when relay 2468 operates, relay 2481 will be operated immediately independently of the delay circuit. Whereas relay 2406 also will be operated, the consequent timing function will have no effect in this case.

A locking key 2402 is also provided for applying negative battery continuously to the timing condenser 2404, thereby preventing the condenser from charging and disabling the timing circuit. When the contacts of this key are closed the operation of relay 2481 is made entirely dependent upon the chain circuit over the outer right contacts of all the selecting relays. Thus when both keys 2401 and 2402 are operated into the alternate position of that shown in the drawing, the multiple sender cannot start until all the outgoing channels over which the message is to go have become idle.

The transmitter 2270 may be considered a source of signals controlled by tape 2200. The apparatus shown in Figs. 7, 8, 10, 11, 13, 14, 17, 18, 20, 21, 23 and 24 may be considered automatic switching apparatus for selecting any one or more of a plurality of stations to which the transmitter 2270 will supply signals and the automatic switching apparatus is controlled as to its switching function by code combinations as they are stored in the tape supplying the transmitter 2270. The stations A and B are typical of stations which are selected by the automatic switching apparatus just referred to and to which the signals from the source 2270 are transmitted when the respective stations, to which the signals are to be transmitted, are idle.

Each of the central offices outlined in Figs. 2 and 3 are to be understood as containing a transmitter such as 2270 identified in Fig. 2 as transmitter 274 and in Fig. 3 as transmitter 374.

Reception of a message intended for a plurality of stations from another switching station

Assuming now that one of the stations, say E, at the second switching station desires to transmit a message to some of the stations connected to this second switching station as, for example, station D, and also to the first switching station and stations A and B connected to the first switching station. The operator at station E will first transmit the special multiple switching signal M following the "figures" signal and the H signal at the end of the previous message. Following the M signal, the operator at station E will transmit the various switching characters in any desired order. These should include the letter D, the letter A, the letter B and the letter R which designates the first switching station. Following the letter R, the operator will transmit the multiple message signal X. Following this, the operator will transmit the message intended for all of these stations.

The equipment at the second switching station shown in Fig. 2 will operate under these circumstances as described above with reference to transmission of a multiple message from the first switching station. The message will be transmitted from station E to the second switching station and there recorded by the printing reperforator 232 in tape 233. Tape 233 controls the transmitting distributor 234 which in turn controls the selecting or control relays 235 which direct the message automatically to the printing reperforator 272 of the multiple transmission circuit. Reperforator 272 perforates tape in accordance with the message, which tape in turn controls the transmitter 274 and transmitter 274 controls the selecting relays 275 for directing the message automatically to the desired lines after which the transmitter 274 will transmit the message to such of the selected lines and stations as are idle and available.

It will be assumed that the trunk 220 is idle and has been assigned for transmission in the direction from the second switching station to the first. Thus relay 904 will be operated at this time, and is applying battery to busy lead 957, thereby keeping relay 720 operated and making trunk 220 unavailable to all calls from stations associated with the first switching station.

Under the assumed conditions, the switching designations R, A and B will cause the transmitter 274 to transmit the message over trunk 220 extending to the first switching station. As pointed out above, the entire message including the special multiple transmission switching combination M followed by each of the other switching combinations will be transmitted only once over the trunk 220 to the first switching station. After the directing signals are transmitted, the end of the multiple message signal X will be transmitted following which the message is transmitted, and after the message the "figures" and H signals.

The printing reperforator 969 responds to all of these signals transmitted from the second switching station and causes them to be recorded in tape 900. When the M signal is received by the selector magnet 948, it causes contacts 934 to momentarily close and complete a circuit for the operation of relay 963 from positive battery through the lower winding of relay 963, operated contacts 934, to negative battery through the lower outer operated contacts of relay 962. It will be recalled that upon the reception of the "figures" signal followed by the H signal, following the reception of the preceding message from line 220, relays 961 and 962 were operated and locked operated. The operation of relay 963 completes a circuit for maintaining itself operated from negative battery through its lower outer operated contacts, the upper inner break contacts of relay 964 to positive battery through the lower inner operated contacts of relay 963 and winding of relay 963. Relay 963 in operating also partly prepares a second locking circuit for

maintaining itself operated and then interrupts the locking circuit of relay 962 thus causing this relay to release. The release of relay 962 completes the second locking circuit for maintaining relay 963 operated from positive battery through the upper winding of relay 963, upper operated contacts of relay 963, and the lower break contacts of relay 962. Relay 963 in operating also completes a circuit for connecting negative battery through the upper outer break contacts of relay 964 and the upper inner operated contacts of relay 963 to contacts 930, 934, 935 and 940.

When the letter A switching signal, designating station A, is received, it will cause contacts 941 to momentarily open without any effect at this time. It should be noted that upon the reception of the first spacing signal at the beginning of the message, that is, at the beginning of the reception of the letter M signal, relay 960 was operated from the spacing contact of relay 947. The operation of relay 960 at that time immediately applied battery to busy lead 957, and started the release of relay 904. After release of relay 904, the normal busy condition of lead 957 will be established by relay 760 or other relays, as already described.

The reception of the B switching signal, which directs the message to station B, causes contacts 942 of the printing reperforator 969 to be momentarily opened also without any effect at this time. When the R switching signal is received it causes contacts 940 to be momentarily operated. The operation of these contacts completes a circuit for the operation of relay 965 from negative battery through the upper outer break contacts of relay 964, the inner upper operated contacts of relay 963, the operated contacts 940 to positive battery through the upper winding of relay 965. Relay 965 in operating completes a circuit through its upper winding for maintaining itself operated under control of contacts 991 of the receiving teletypewriter 990.

The operation of relay 965 removes the positive battery connected to the uper winding terminal of selector or printer magnet 993 and thus permits this magnet to follow the signals repeated by the line relay 992 and cause the teletypewriter 990 to record the message received over line 220. The message recorded by this teletypewriter will be the copy of the message intended for and received by the first switching station. The operation of relay 965 at this time, however, does not complete a circuit from positive battery to the left-hand winding terminal of selector magnet 948 because relay 963 is operated. Under the conditions assumed, both the receiving teletypewriter 990 and the printing reperforator 969 will respond to the signals received over line 220, thus permitting a copy to be recorded at the first switching station and the message to be recorded in tape 900 for transmission to stations A and B.

Following the transmission of all the switching signals, the letter X signal will be received, which causes contacts 935 to operate and complete a circuit for the operation of relay 964 from positive battery through the winding of relay 964, operated contacts 935, to negative battery through the lower outer operated contacts of relay 963. Relay 964 in operating completes a circuit for maintaining itself operated under control of the lower outer operated contacts of relay 963. Relay 964 in operating also interrupts the locking circuit through the lower winding of relay 963. Relay 963, however, does not release at this time because a circuit was completed for maintaining it operated when relay 962 released, from positive battery through the upper winding and upper inner operated contacts of relay 963 to negative battery through the lower outer break contacts of relay 962.

The operation of relay 964 interrupts the battery connected to contacts 930, 934, 935 and 940, thus rendering the further operation of these contacts ineffective to alter the switching circuits during the reception of the message. The circuits of the receiving teletypewriter 990 and the printing reperforator 969 remain in this condition during the reception of the message over line 220. It should be noted that the circuit through the winding of relay 951 is interrupted at the lower inner front contacts of relay 962, which relay is released at this time, and the lower outer break contacts of relay 963, which relay is operated at this time, thus preventing relay 951 from operating during the reception of this message and consequently preventing the automatic tape perforating and feed magnet 949 from operating.

When the message is recorded in the tape 900 by the printing reperforator 969 it will cause contacts 982 to close and operate relay 950. Relay 950 in operating completes a circuit for operating the start magnet 972 which will cause the transmitting distributor 970 to advance tape 900 through the transmitter 970. Normally, the first signals recorded in the tape 900 at this time will be "letters" signals, if no previous message has been received over line 220 for some time. If the message in question immediately follows another message, the end of the other message will be transmitted through the distributor 970. In either event the distributor 970 will advance tape 900 through it and if there are "letters" signals recorded in the tape they will produce no effect other than to cause the release of relay 1007. When the M signal reaches the control position in distributor 970 it will cause contacts 914 to close and complete a circuit for the operation of relay 1004. Relay 1004 in operating completes a circuit for maintaining itself operated under control of relay 1008 which in turn is held operated under control of relays 1019, 1039, 1139, 1149 and 1159. Relay 1004 in operating interrupts the locking circuit of relay 1006 and thus permits this relay to release. Relay 1004 in operating also completes a circuit for the operation of magnet 971 which prevents the distributor 970 from advancing tape 900 at the end of the cycle of operation then in progress. Relay 1004 also interrupts the circuit of the start magnet 972, thus permitting this magnet to release and stop the operation of the transmitter 970 at the completion of the revolution or cycle then in progress.

The operation of relay 1004 also causes relay 1137 to operate over the break contacts of contact set C of relay 860. If the multiple transmission circuit shown in Figs. 22, 23 and 24 is idle, relay 830 will be released.

Under these conditions the operation of relay 1137 completes a circuit for the operation of relay 1138. The operation of relay 1138 completes a circuit for maintaining itself operated under control of the upper break contacts of relay 1006 and contacts 920. Relay 1138 in operating completes an obvious circuit for the operation of relay 1139. Relay 1138 in operating completes a circuit for the operation of relay 830 which, in turn, causes the busy lamps 863 to light. The operation of this relay also prevents the operation of any of the other switching relays associated with the multiple transmission circuit, thus

preventing the connection of any other transmitter to this circuit at this time.

The operation of relay 1138 also extends the transmission circuit from transmitting distributor 970 to relay 2470. Relay 2470 repeats the impulses received from the transmitting distributor 970 to the printing reperforator 2269.

The operation of relay 1139 interrupts the circuit of relay 1008 which relay releases after a short interval of time and, in turn, interrupts the locking circuit of relay 1004, thus permitting this relay to release. The release of relay 1004 reestablishes a circuit through the start magnet 972, thus permitting the transmitter 970 to start. The release of relay 1004 interrupts the circuit through magnet 971 so that upon the operation of the transmitter 970 tape 900 will feed through it in the normal manner.

Inasmuch as magnet 971 prevented the advance of tape 900 when the distributor 970 previously came to rest, the first signal transmitted by the distributor 970 will be a letter M signal. This will be followed by all the switching signals and they in turn will be followed by the letter X signal, indicating the end of the switching signals. Following this, the message signals will be transmitted from the transmitting distributor 970 to the printing reperforator 2269 where they will be recorded in tape 2200.

The operation of relay 1139 completes a circuit for the operation of relay 2362 from negative battery through the left-hand winding of relay 2362, over lead 2312 which extends from Fig. 23 through Figs. 24, 21, 18, 14 and 11, to positive battery through the left-hand operated contacts of relay 1139. The operation of relay 2362 interrupts the operating circuit of relay 2364, preventing the operation of this relay as will be described hereinafter.

When the M signal, which is the first signal transmitted by transmitter 970, is recorded by the printing reperforator 2269, contacts 2234 close and operate relay 2263. The switching signals following the M signal cause their respective contacts to close. The letter A signal causes contacts 2231 to close and complete a circuit for the operation of relay 2363. The letter B signal causes contacts 2233 to close and complete a circuit for the operation of relay 2373. The letter D representing station D at the second switching station causes contacts 2241 to close. Normally, the closure of these contacts at this time would cause relay 2364 to operate. However, when the message is received over trunk 220, relay 2362 operates as described above and interrupts the operating circuit of relay 2364; consequently this relay cannot operate at this time. Relay 2364 is prevented from operating because the signals for the letter D when they arrive over the trunk 220 have already directed the message to the proper station D through the switching equipment at the second switching station. Consequently, it is not desirable that they should again select a trunk back to that station and be retransmitted back to it. In other words, they have completed their switching functions at the second switching station shown in Fig. 2, so that it is undesirable to have them control any of the switching equipment at the first switching station. However, in case the message originates at any of the other stations connected to the first switching station, closure of these contacts will cause relay 2364 to operate, as described above, when the message originated at the first switching station.

The operation of the multiple transmission circuit during the reception of the following message and the disconnect signals, "figures" followed by an H signal, is substantially the same as described above when a message was transmitted from the first central switching station to a plurality of other stations. When the multiple message switching combination M arrives at the control position in the transmitter 2270 it causes relay 2301 to operate and after the entire message is recorded in tape 2200 by the printing reperforator 2269, the "figures" signal followed by the H signal will cause relays 2261 and 2262 to operate. The operation of relay 2262 then completes a circuit for operating relays 2317 and 2337. Upon operation of these relays when the resepctive lines are idle and available, and after the delay interval established by relays 2406 and 2407 switching relays are operated to connect the transmitting distributor 2270 to the respective lines. The make-busy relay for each line is operated, which in turn lights the busy lamp, indicating that that line is busy. The operation of the switching relays when any line is idle causes relay 2478 to operate and causes relay 2301 to release and start the transmission of the switching information and the following message signals over the line or trunk to the station to which it is directed. If only one of the lines were idle and only one of the relays 2317 or 2337 operated, relays 2475 and 2478 will cause relay 2471 to operate so that the switching information together with the message is repeated back to the printing reperforator 2269 making it available for transmission to the other station when it becomes idle.

After the message has been transmitted to all of the stations to which it is directed, the multiple transmission circuit will be restored to its normal condition as described above.

Returning now to the operation of the trunk circuit 220 during the reception of the message intended for the first switching station and stations A and B. Immediately following this message the "figures" signal followed by the letter H signal will be received by the printing reperforator 969. Upon the reception of the "figures" signal, contacts 938 are operated which complete a circuit for the operation of relay 961. When the following H signal is received, contacts 937 are operated and complete a circuit for the operation of relay 962. The operation of relay 962 interrupts the locking circuit of relay 963 and permits this relay to release. The release of relay 963 in turn interrupts the locking circuit of relay 964 and permits this relay to release. When the teletypewriter 990 receives this H signal preceded by the "figures" signal at the end of the message, it will cause contacts 991 to operate. These contacts interrupt the locking circuit of relay 965, thus permitting this relay to release. The operation of relays 961 and 962 and the release of relays 963, 964 and 965 restore the equipment associated with the trunk line 220 to its normal or idle condition so that the printing reperforator 969 will respond to further signals received over the line 220 but so that the receiving teletypewriter 990 will not respond to or record these signals until it is again selected by the letter R signal.

When relay 960 completes its release, the busy condition is removed from busy lead 957, relay 905 releases and starts the timing interval by circuit 910, during which the trunk circuit 220 will be available to the first switching station.

Overflow messages

The switching circuits are so arranged that the multiple transmission apparatus may be used to handle overflow messages, that it, in case a number of lines or stations all direct messages to any given line, so that this line remains busy a large percentage of the time and thus delays the transmission of the messages recorded in the tapes **500**, **900**, **1200**, **1600** and **1900** to this station and also the messages to other stations recorded in these tapes subsequent to the messages directed to the busy station for a considerable period of time. Under such circumstances it is desirable to relieve the congestion and permit the messages to the other stations to be transmitted to them and at the same time transmit the messages to this busy station at a later time when it is not so busy. Under such circumstances some of the messages intended for the busy station may be directed to the multiple transmission circuit for storage in tape **2200**. This will permit the messages stored in any of the tapes **500**, **900**, **1200**, **1600** and **1900** following the messages stored in them for the busy station to be more promptly transmitted to the other stations for which they are intended.

To illustrate the operation of the circuits under these circumstances, it is assumed that station A is busy and that station B first transmits a message for station A and then a message for station E. It is further assumed that station A has been and will continue to be busy for a considerable period of time due to the transmission of considerable material from station T, or some outlying station connected to station T, to station A. When the message for station A is transmitted from station B, it is received by the printing reperforator **1269** as described above and stored in tape **1200**. The tape advances through the transmitting distributor **1270** until the switching signal A reaches the control position in the transmitting distributor **1270**. This will cause relay **1301** to operate and lock. The operation of relay **1301**, as described above, will stop the operation of the transmitting distributor **1270**, will prevent the tape from advancing near the completion of the revolution of the transmitter **1270** then in progress, and will cause lamp **1313** to light. The lighting of lamp **1313** will indicate to the operator that a message is waiting for transmission to station A. However, the operator also notes that the busy lamp **761** is lighted at this time due to the fact that the line **589** to station A is busy. If this condition exists for a considerable period of time, that is, if both lamps **761** and **1313** remain lighted or if both of these lamps remain lighted and another one of the lamps, for example **2015**, lights, indicating that another message is waiting for transmission to station A, the operator may cause one of these messages to be stored in tape **2200**.

As assumed above, immediately following the transmission of the message to station A from station B, station B transmitted a message for station E. So long as station A was busy the message stored in tape **1200** cannot be transmitted to station A, consequently both this message and the following message to station E will be delayed during this time. In a similar manner all of the other messages transmitted from station B will be delayed. If, however, the message intended for station A is stored in the tape **2200** for transmission to station A when station A beomes idle, then subsequent messages in tape **1200** may be transmitted to the proper stations, as for example, the message intended for station E may be transmitted through the switching equipment at the first switching station to trunk **220** to the second switching station and then at the second switching station to station E without waiting until station A becomes idle. This materially reduces the delay in transmission of a message from station B to station E.

To accomplish this the operator upon noting that lamps **1313** and **761** both remain lighted for a considerable period of time and upon the further noting that the multiple transmission circuit is idle, that is, busy lamps **863** is not lighted, will momentarily operate key **1475**. The operation of key **1475** completes a circuit for the operation of relay **1438** from negative battery through the right-hand break contacts of relay **830** to lead **809** which extends from Fig. 8 through Figs. 11 and 14, through the operated contacts of key **1475**, left-hand winding of relay **1438** to positive battery through the upper break contacts of relay **1306**. The operation of relay **1438** connects the transmission circuit of the transmitter **1270** to relay **2470**, which relay in turn repeats the signals transmitted to it from the distributor **1270** to the printing reperforator **2269**.

The operation of relay **1438** completes a circuit for maintaining itself operated under the joint control of the upper break contacts of relay **1306** and the cam control contacts **1220**. Relay **1438** also completes a circuit for the operation of relay **1439**. The operation of relay **1438** completes a circuit for the operation of relay **830** which in turn causes busy and overflow lamps **863** to light, thus indicating that the multiple transmission circuit is busy. The operation of relay **830** also prevents the connection of any of the other transmitters to the multiple transmission circuit at this time. The operation of relay **1439** interrupts the locking circuit of relay **1301** and permits this relay to release. The release of relay **1301** reestablishes the circuit through the start magnet **1272** and permits this magnet to operate and start the transmitting distributor **1270**. The transmitting distributor **1270** will then transmit the message to the printing reperforator **2269**.

When the letter A signal, which will be the first signal transmitted to it, is received by the printing reperforator **2269**, it will close contacts **2231**, which completes a circuit for the operation of relay **2363** from positive battery through the winding of relay **2363**, the right-hand break contacts of relay **2361**, the operated contacts **2231** through the winding of relay **2267** to negative battery through the lower outer operated contacts of relay **2262**. Relay **2267** operates in this circuit and completes a circuit for maintaining itself operated from negative battery through its lower operated contacts and winding, closed contacts **2231** and right-hand break contacts of relay **2361** to positive battery through the winding of relay **2363**. Relay **2267** in operating and after it completes its locking circuit interrupts the locking circuit of relay **2262**, thus permitting this relay to release. Relay **2363** in operating completes a circuit for maintaining itself operated under control of relay **2318**. Tape **2200** upon being perforated by the reperforator **2269** causes contacts **2282** to operate. The closure of these contacts in turn causes the tape to advance through the transmitting distributor **2270** until the letter A signal arrives at the control position in the transmitting distributor, at which time contacts **2211** close and complete a circuit for the operation of relay **2301**. The operation of relay **2301**, as

described above, interrupts the circuit of relay 2310 which relay releases and in turn interrupts the circuit of the start magnet 2272 and permits this magnet to release and stop the transmitting distributor 2270 at the completion of the revolution then in progress.

Then after the "figures" signal, followed by the H signal following the message, is received by the printing reperforator 2269, relays 2261 and 2262 will be operated. Relay 2262 in operating completes a circuit for operating relay 2317. The "figures" signal followed by the H signal transmitted by the transmitting distributor 1270 also causes contacts 1218 and 1217 to close and operate relays 1307 and 1306. The operation of relay 1306 together with the operation of contacts 1220 by cam 1274, at the completion of the revolution of the transmitting distributor during which the H signal is transmitted, interrupts the locking circuit of relay 1438, thus permitting this relay to release and in turn release relay 1439 and restore the switching circuits controlled by transmitting distributor 1270 to their idle condition. Thereafter, the message stored in tape 1200 and intended for station E may be transmitted through the system in the normal manner as described above.

The release of relays 1438 and 1439 does not release relay 830 because a circuit is maintained through the winding of this relay through the left-hand operated contacts of relay 2476. When station A becomes idle and available and none of the other transmitters has messages to transmit to this station, relay 2317 will be operated which causes the transmitting distributor 2270 to transmit the message stored in tape 2229 to station A over loop 599. After the transmission of this message the circuits are returned to their idle condition as described above.

Urgent message

In case a subscriber at any of the stations has an urgent message which he wishes to be transmitted through the system with the least possible delay, he will transmit before the regular switching information a special combination, as for example the letter U. Assume that the subscriber at station A transmits such a symbol immediately preceding the switching combination of the message. The receiving apparatus including the receiving reperforator 569 will respond to these signals in the normal way and control the respective contacts as described above in addition to recording the signals in tape 500. When the urgency signal U is received, contacts 530 will momentarily close and complete a circuit for the operation of relay 566 from positive battery through the winding of relay 566, closed contacts 530 to negative battery through the lower outer operated contacts of relay 562. Relay 566 in operating completes a circuit for maintaining itself operated under control of keys 545 and 873 and completes a circuit for the lighting of lamp 871, indicating that an urgent message is being recorded by the receiving reperforator 569. An attendant may then go to this receiving reperforator and take the perforated tape out of it and insert the portion containing the urgent message in tape 500, ahead of other messages which may be recorded in this tape. The attendant may insert this tape portion in any of the other transmitters, and particularly in the transmitter 1970 for transmitting messages from the central switching station. Of course, the attendant may disregard the urgency lamp 871 in which case the message will arrive at and pass through the transmitter distributor shown in Fig. 6 in its normal sequence.

When the urgency signal arrives at the transmitting distributor shown in Fig. 6 it will cause contacts 610 to operate and complete a circuit for the operation of relay 705 from negative battery through the winding of relay 705, operated contacts 610 to positive battery through the upper inner operated contacts of relay 706. Relay 705 in operating completes a circuit for maintaining itself operated under control of relay 708 which relay is, in turn, controlled by the break contacts of relays 729, 739, 849, 839 and 859. The operation of relay 705 completes a circuit for lighting lamp 870. This indicates to the operator that the urgent message has arrived at the transmitting distributor shown in Fig. 6. If, for example, the urgent message from station A is directed to station B and a message is received from station T, also directed to station B, both lamps 731 and 1734 will be lighted. In addition, the urgency lamps 870 and 871 will be lighted. When relay 739 operates upon line A being cut through to line B it causes the release of relay 705 by interrupting the operating circuit of relay 708 which relay in turn interrupts the locking circuit of relay 705 in addition to releasing the switching relay 702 which would be operated under these circumstances as described above. Relay 705 in releasing extinguishes lamp 870. In order for the operator to extinguish the urgency lamp 871, it is necessary for her to operate either key 545 or 873, which she may do at any time after the lamp 871 lights.

In accordance with a feature of the invention, a plurality of multiaddress senders is provided at the switching station so that when one channel is busy either in sending a multiaddress message or in sending an overflow message, another sender will be available for similar purposes.

A second multiaddress sender is shown in Figs. 25, 26 and 27 which is similar to the one shown in Figs. 22, 23 and 24 both in circuit arrangement and operation. This second sender includes line relays individual to the different line and trunk circuits extending from the first switching station for transmission to any one or more of such lines or trunks of a multiaddress message or an overflow message. The second multiple sender also includes a repeating relay connected to the various switching relays for receiving a multiaddress message from any one of the line or trunk circuits and repeating it to the receiving reperforator in the sender.

Provision is also made at the switching station for directing incoming multiaddress messages to an idle multiple sender rather than a busy one. This arrangement includes relay means for switching the selecting circuits extending from the various transmitter distributors at the switching station from the switching circuit for a busy multiple sender to the switching circuit for an idle multiple sender.

Assuming that a multiaddress message is being transmitted from the keyboard perforator 1990 to a plurality of outlying stations in the manner described above, it will be remembered that when relay 2004 was operated in response to the M signal, the selecting circuit from its inner upper make contact was traced over conductor 2011 over closed contacts in contact set O of relay 860 in Fig. 8 and back over conductor 2012 to the selecting relay 2137 for operation of the switching relay 2138 which cut the transmission circuit through

to the first multiple sender shown in Figs. 22, 23 and 24.

Relay 860 has other similar sets of contacts designated A, S, B, T which are connected in the selecting circuits of the corresponding stations A, S, B, T. Relay 860 will have other similar sets of contacts connected into the selecting circuits of all the other outlying stations connected to the first switching center. Where a large number of sets of contacts is required, other relays similar to relay 860 may be provided for operation of some of these contacts, the windings being connected in series or in multiple in any well-known manner.

When relay 2138 operated, relay 830 was operated, making the first multiple sender busy. Relay 830 in operating opens a normal operating circuit for relay 821, which relay is adjusted to release and close its contact after an interval of at least two character lengths. Then upon the delayed release of relay 821, the operating circuit is closed for relay 860 which operates and locks itself over the normally closed make contact of operated relay 822, which is of similar construction and adjustment as relay 821 for slow release. Due to this operation of relay 860, all of the contact sets are operated to their alternate position, thereby switching all of the selecting circuits away from the selecting relays associated with the first multiple sender and over to the corresponding selecting relays associated with the second multiple sender. Thus, the selecting circuit from relay 2004 now extends over conductor 2011, the alternate contacts of contact set O of relay 860, conductor 2013 to the selecting relay 2157 associated with the switching channel for the second multiple sender. It should be noted that, due to the delayed operation of relay 830, relay 2004 will be released at this time so that the selecting circuit over conductor 2011 from relay 2004 is no longer closed and so that relay 2157 will not be operated. By the operation of relay 860, all of the selecting circuits from the selecting relays responding to the M signal in the different line circuits will be switched over to the corresponding selecting relays for the second multiple sender.

Let it be assumed that a multiple address message next arrives from station A to the transmitter distributor 670 and that the M signal at the beginning of that message operates relay 704, the selecting circuit from relay 704 now extends over the alternate contacts of the contact set A of relay 860 into relay 857 which operates. Relay 857 in turn causes the operation of relays 858, 859 and 850 and the release of relays 708 and 704. The transmission circuit from the transmitter 670 for station A therefore is cut through to the repeating relay 2770 in the second multiple sender for recording on the receiving reperforator 2569. Relay 850 in operating opens at its outermost left break contacts, the noraml operating circuit for slow release relay 822, which commences its release period. Shortly after the release of relay 704, relay 822 completes its release and opens the locking circuit for relay 860. Relay 860, however, remains operated over the contacts of relay 821 so long as the first multiple sender is busy. When the first multiple sender becomes idle, relay 830 releases and operates relay 821 which in turn releases relay 860. The release of relay 860 thus switches all the selecting leads away from the selecting relays for the second multiple sender back to the selecting relays for the first multiple sender. However, if the second multiple sender should become idle before the first multiple sender under the assumed conditions, relay 850 will release and operate relay 822 which in turn re-establishes the locking circuit for relay 860. In this case relay 860 remains operated until another multiple address message arrives and causes the operation of relay 850 for the idle second multiple address sender. When this happens, relay 860 will still remain operated if the first multiple sender is still busy, but will release if the first multiple sender is idle at this time.

As the message recorded in the tape 2500 in the second multiple sender circuit passes through the transmitter 2570, the operations will be similar to those described in connection with the first multiple sender. Thus the M signal will operate relay 2601 and the subsequent selecting signals will operate any of the marking relays 2663, 2664, 2673 and 2764. Upon testing for busy conditions, any of the relay pairs 2661 and 2617, 2662 and 2627, 2671 and 2637, 2762 and 2747 may be operated to cut the transmission circuit from relays 2665, 2666, 2675 and 2766 through by the operation of any of the switching relays 2618, 2626, 2638, 2748. The corresponding relays 2667, 2668, 2677 and 2768 will start the delay circuit by operation of relay 2706. The remaining start circuit responds to the delay circuit as described for the first multiple sender.

In the case of an overflow, the attendant at the switching station may utilize either or both of the multiple senders to relieve the congestion.

Thus, assuming the same condition as has been described above, that the busy lamps 761 for station A and 1313 for station B have been lighted for a considerable period, the attendant may wish to switch the message from station B, intended for the exceptionally busy station A, to one of the multiple senders, thereby permitting the subsequently recorded message from station B to be transmitted to station E. In case, for example, the first multiple sender is busy, the attendant obviously chooses the second multiple sender, the busy condition of the senders being indicated by the lamps 863 being lighted and the lamps 865 and 866 being extinguished. Thus instead of operating key 1475 as described before, the attendant operates key 1476 for cutting the transmitter 1270 through to the idle second multiple sender for storing and retransmission of the message to station A. Thereafter both multiple senders will appear busy.

If both multiple senders are idle when the attendant wishes to store an overflow message, the lamps 823 will indicated to the attendant which one of the two multiple senders happens to be cut in circuit at the moment, one or the other lamp being lighted by relay 860.

More than two multiple senders may be included in each switching station, in which case two or more relays similar to relay 860 would be required, together with additional slow release relays similar to relay 821 operated and locked over circuits similar to those described.

What is claimed is:

1. A channel of telegraphic transmission extended away from a central switching office, means for transmitting over said channel from said office including transmission means, and means for preliminarily associating said transmission means with said channel for transmission, in combination with means alternately assigning said channel for incoming and outgoing transmission and associating completing means for completing association of said transmitter

with said channel only at such intervals as said channel is not assigned for incoming transmission.

2. A telegraphic system comprising a transmitter controlled by a tape storage element, means for storing in said element codes comprising a message preceded by address codes, a sensing point in said transmitter, means for advancing the address codes to the sensing point and sensing the same, means controlled in accordance with the sensing of said tape to seize selectively a channel of transmission, in combination with means capable of rendering said channel unavailable due to its use for other transmission, means operative in the absence of transmission over said channel for rendering said channel unavailable owing to its assignment at the moment for incoming transmission, and means for executing seizure of said channel only if and when neither of said means for rendering unavailable is rendering said channel unavailable.

3. A telegraphic system comprising a transmitter controlled by a tape storage element, means for storing in said element codes comprising a message preceded by address codes and followed by an end-of-message code or group of codes, a sensing point in said transmitter, means for advancing the address codes to said sensing point and sensing the same, means controlled in accordance with the sensing of an address code on said tape element to seize selectively a channel of transmission, in combination with means capable of rendering said channel unavailable due to its use for other outgoing transmission, means operative in the absence of transmission over said channel for rendering said channel unavailable owing to its assignment at the moment for incoming transmission, means for executing the seizure of said channel only if and when neither of said means for rendering said channel unavailable is then rendering said channel unavailable, and means operable under control of an end-of-message code or group of codes following a message to restore said seized channel for use for other incoming or outgoing transmission.

4. In combination, a channel of telegraphic transmission having automatic assigning means for alternately admitting and blocking transmission out over said channel during predetermined periods, a plurality of transmitters, means for preliminarily associating said channel with one of said transmitters, and means for final association of said channel with said transmitter during an admittance period by said assigning means.

5. A telegraph exchange system comprising a channel for two-way communication with a distant station, a plurality of signal sources, switching equipment to selectively associate any one of said sources with said channel for transmission of messages, and control means responsive to seizure of a channel by one of said sources and subsequent transmission thereover to immediately after transmission of an outgoing message apply a busy condition to the channel against seizure by said sources and thereby render it available for incoming transmission, said control means including signal responsive means to remove the busy condition from the channel immediately after reception of the last element of the incoming transmission to pemit seizure of the channel by one of said sources, said control means also including timing means to again apply a busy condition to the channel after a predetermined interval following reception of the last incoming signal when the channel has not been seized during the interval.

6. A switching system including a channel of telegraphic transmission connected between an outlying station and a switching office, automatic means for alternately assigning said channel, when idle, for incoming and outgoing transmission, a plurality of transmitters at said switching office, means operable whereby any of said transmitters may seize said channel, when idle and assigned to outgoing transmission, to send message material thereover, and means operable at the termination of sending said message material to restore said channel to the control of said automatic means.

7. A half-duplex, start-stop telegraph system comprising two stations and a channel of transmission interconnecting said stations, each of said stations having means operative to time a period following the reception of a message, means for sending to the distant station at the expiration of said period one start-stop signal and means to receive at the expiration of another of said periods a corresponding start-stop signal from the distant station, and relay means cooperative with said timing means for permitting the alternate transmission and reception of said start-stop signals until a message is available for transmission at one of said stations, in combination with a plurality of transmitters at one of said stations, and means whereby to selectively seek said channel and associate one of said transmitters with said channel of transmission for transmitting a message thereover.

8. A telegraph system comprising two sending and receiving stations, a half-duplex channel for transmission alternately in opposite directions between said stations, assignment means at both stations adapted to cooperate over said channel for automatically assigning the channel after predetermined non-transmitting periods of time for transmission alternately in opposite directions, said assignment means at each station including control means responsive to incoming signals to permit transmission of outgoing signals over said channel only after reception of a specific signal sequence incoming over the channel.

9. A telegraph system comprising two sending and receiving stations, a half-duplex channel connecting said stations, means at each station for transmitting message signals, means at each station for transmitting control signals, and assignment means at both stations responsive to incoming control signals to automatically assign said channel for transmission of outgoing signals at each cessation of incoming message signals as well as upon receipt of a control signal.

10. A telegraph system comprising two sending and receiving stations, a half-duplex channel for transmission alternately in opposite directions between said stations, assignment means at both stations responsive to incoming signals to automatically assign said channel to transmission only of outgoing signals at each cessation of incoming signals, and transmitting means at both stations for automatically and periodically transmitting direction assignment signals over said channel in the absence of message transmission.

11. A telegraph system comprising two sending and receiving stations, a half-duplex channel for transmission of messages alternately in opposite directions between said stations and transmission conditioning means at both stations adapted

to cooperate over said channel to reverse the direction of availability of said channel for transmission immediately upon termination of a message and to automatically condition the channel for transmission alternately in opposite directions at predetermined time intervals in the absence of messages to be transmitted.

12. A telegraph system comprising two sending and receiving stations, a half-duplex channel for transmission of messages alternately in opposite directions between said stations and transmission conditioning means at both stations adapted to cooperate over said channel to reverse the direction of transmission over the channel immediately upon termination of a message and to automatically condition the channel for transmission alternately in opposite directions at predetermined time intervals in the absence of messages to be transmitted, each of said conditioning means including control means operative at the end of incoming messages to immediately assign the channel for outgoing transmission and operative at the end of outgoing messages to prevent outgoing transmission by the station, and timing means for establishing intervals in alternation with the other station.

13. A transmission channel, a telegraph station connected to said channel and comprising transmitting means, receiving means responsive to signals passing in either direction over said channel and including contact means responsive to end-of-message codes passing in either direction over said channel for momentary operation from normal condition, and control relay means operative into alternate positions by successive operations of said contact means and so connected as in one position to start transmission by said transmitting means and as in the other position prevent the transmission.

14. A transmission channel, a telegraph station connected to said channel and comprising transmitting means, receiving means responsive to signals passing in either direction over said channel and including contact means responsive to end-of-message codes passing in either direction over said channel for momentary operation from normal condition, control relay means operative into alternate positions by successive operations of said contact means and connected in one position to start transmission by said transmitting means and in the other position to prevent the transmission, and timing means responsive to assignment codes passing in one direction over said channel for, after a predetermined interval, operating said control relay means into said one position for starting of said transmission.

15. A system comprising a plurality of channels of telegraphic transmission, a machine sender of telegraphic codes, means capable of selective operation automatically under control of address codes to designate two or more of said channels selectively for use by said sender, means for seizing said designated channels as they become available for use by said sender, in combination with a timing means for determining the time after the first seizure within which such transmission is delayed for seizure of additional designated channels, and means for initiating transmission over seized channels only at the expiration of the time determined by said timing means.

16. In a telegraph system comprising a transmitter of the type operated by stored message material in the form of code combinations, storing means for storing and supplying said transmitter with groups of code combinations in which each group includes address codes and message codes, a plurality of channels of transmission outgoing from said transmitter, means for selectively associating said transmitter under selective control of one or more of said address code combinations with one or more of said outgoing channels and for seizing said channels, timing means operable to time-off a time interval for delaying transmission by said transmitter over said channels after said seizure, and means operated under control of said timing means after the expiration of a predetermined time for initiating such transmission.

17. A telegraphic machine sender operable under control of and in accordance with stored message material, means capable of selective operation to associate said sender with a plurality of channels for transmission of the same message thereover, seizing means automatically operable to seize said channels for such transmission from time to time as they become available to said sender, timing means for timing a waiting period for allowing said channels to become able during said interval for the succeeding reable to discontinue the waiting period if and when all of said channels to be seized are immediately or become available.

18. A telegraph switching system comprising a plurality of transmitting channels, a transmitter for retransmission of stored messages over said channels, selecting means responsive to selecting codes of a message for selecting one or more of said channels, switching means for operatively associating said transmitter with selected available channels and with other selected channels which become available during an immediately subsequent interval, means for starting the retransmission, timing means responsive to said switching means for establishing said interval of predetermined duration, and control means responsive to a condition of all selected channels being available to permit immediate starting of retransmission and responsive to a condition by at least one selected channel remaining not available to prevent starting of retransmission over the available channels until after said interval.

19. A system comprising a plurality of chanels of telegraphic transmission, a machine sender of telegraphic codes, means capable of selective operation to designate selectively two or more of said channels for use by said sender, means for seizing said designated channels as they become available for use by said sender, in combination with timing means for determining a time after the first seizure within which such transmission is delayed for seizure of additional selected channels, means for initiating transmission over seized channels only at the expiration of the time determined by said timing means, and means automatically controlled incident to such transmission to cause subsequent seizure of designated ones of said channels, if any, not seized during said predetermined time and to cause transmission of the transmitted material over said subsequently seized channels.

20. A telegraph switching system comprising a plurality of transmitting channels, a transmitter for retransmission of stored messages over said channels, selecting means responsive to selecting codes of the messages for selecting one or more of said channels, switching means for operatively

associating said transmitter with selected available channels and with other selected channels which become available during an immediately subsequent interval, means for starting the retransmission, timing means responsive to said switching means for establishing said interval of predetermined duration, repeating means responsive to said selecting means under the condition of at least one channel remaining not available at the end of said intervals for causing the message to be stored again for subsequent retransmission to channels which were not available for the first retransmission and as they become available during said interval for the succeeding retransmission and control means for permitting the last retransmission to start immediately upon the last selected channel becoming available.

21. A telegraph system comprising a central switching office and a plurality of outlying stations with channels of telegraphic transmission connecting each outlying station with said central switching office, means associated with each such channel of transmission for allocating times for transmission to said central office and times for transmission away from said central office, and means at said central office for selectively choosing one or more than one of said channels for transmitting a message thereover, in combination with means whereby, upon said choosing, transmission of said message away from said central office awaits the operation of said allocating means to assign a time of transmission away from said central office over that chosen channel.

22. In combination, a channel of telegraphic transmission, a telegraphic transmitter, connecting means operable to give said transmitter preliminary access to said channel for transmission thereover, timing means individual to the channel for measuring a time after operation of said connecting means, a second timing means individual to the transmitter for measuring a time after operation of said connecting means, and means for initiating transmission by said transmitter over said channnel upon completion of measurement of said times by whichever of said timing means completes its measurement last.

23. A telegraph communication system including a plurality of sending and receiving stations, automatic selective switching equipment and a plurality of transmission paths to said plurality of stations from said equipment, said equipment comprising a plurality of signal sources each connected with one of said paths and responsive to messages from the connected path for repeating signals over the other said paths, a plurality of multichannel transmitting circuits each adapted to be associated with any one of said sources for transmission of signals at one time over any one or more selected paths, each of said paths including timed transmission assignment means for in the absence of transmission over the path automatically rendering the path alternately idle and busy for outgoing messages at predetermined intervals, and each of said transmitting circuits including selective means responsive to selective signals from said sources to associate the transmitting circuit selectively with one or more of said paths, switching means for conditioning the transmission circuit for transmission over the associated paths, and timed start means responsive to said conditioning to start the transmission over an idle selected path after a predetermined interval and while another selected path is busy.

24. A telegraph communication system in accordance with claim 23 in which each of said transmitting paths includes other start means responsive upon said conditioning to start transmission immediately when all the selected paths are idle.

25. A telegraph communication system including a plurality of sending and receiving stations, automatic selective switching equipment and a plurality of transmission paths to said plurality of stations from said equipment, said equipment comprising a plurality of signal sources each connected with one of said paths and responsive to messages from the connected path for repeating signals over the other said paths, a plurality of multichannel transmitting circuits each adapted to be associated with any one of said sources for transmission of signals at one time over any one or more selected paths, each of said paths including timed transmission assignment means for in the absence of transmission over the path automatically rendering the path alternately idle and busy for outgoing messages at predetermined intervals, each of said sources including first selective means responsive to selecting signals from the connected path to associate the source selectively with any other one of said paths and with said transmission circuits, first switching means for conditioning the source for repeating signals over the selected path when the path is idle, said equipment further comprising transfer means responsive to busy condition of said transmitting circuits for transferring the association of said sources from a busy one to an idle transmission circuit, each of said transmitting circuits including second selective means responsive to selecting signals from said sources to associate the transmitting circuit selectively with one or more of said paths, second switching means for conditioning the transmission circuit for transmission over the selected paths, timed start means responsive to said conditioning to start the transmission over an idle selected path after a predetermined interval and while another selected path is busy, and other start means reponsive upon said conditioning to start transmission immediately when all the selected paths are idle.

26. A telegraph communication system in accordance with claim 25 in which each of said transmitting circuits further includes signal storing means responsive to said timed start means for storing the signals from said sources and for supplying the stored signals to the transmission circuit for a repeated transmission only over selected paths that were busy at the time of said start of transmission, the repeated transmission also being under control by said switching and start means.

27. A transmitter and means for storing message material for transmission thereby, means for designating a plurality of paths for transmission of said message material, means whereby any one or more such paths may be unavailable, means for seizing paths so designated as they become available, time measuring means, and means for initiating transmission by said transmitter over paths seized after measurement of a predetermined time after seizure of any designated path without awaiting the becoming available of any other or others.

28. In a communication system, a channel of transmission, means operable to condition said channel for seizure for message transmission use by certain message transmitters at recurrent intervals and blocking its such seizure at intervening recurrent intervals, means associated with one or more said transmitters whereby when any

one of them is supplied with message matter to be directed over said channel it seeks to seize said channel for transmission of said message matter, and time measuring means to control the period of waiting for seizure of said channel by any such transmitter, and means operated at the expiration of a measured time by said measuring means to discontinue said waiting, said time measuring means being designed to measure times greater than one of said recurrent blocking intervals.

29. A telegraph system comprising two sending and receiving stations, a transmitter at each station and a receiver at each station for receiving message material from the transmitter at the other station, a half-duplex channel for transmission of messages one way at a time in opposite directions between said stations, assignment means at both stations adapted to cooperate over said channel in the absence of transmission of message material by either of said transmitters for automatically rendering the channel available for transmission first in one direction and then in the other, means for estopping the operation of said assignment means during message transmission, and means including contacts controlled by end-of-message signals for immediately rendering the channel available for transmission by the station which last received.

30. A telegraph system comprising two sending and receiving stations, a half-duplex channel for transmission of messages alternately in opposite directions between said stations and assignment means at both stations adapted to transmit impulses over said channel at predetermined time intervals in the absence of messages to be transmitted, means controlled by reception of said impulses to automatically remove the channel of transmission from the receiving condition at the terminal of reception of said impulses and condition it to transmitting condition, a message transmitter of telegraphic impulses normally unassociated with said channel, means operable at random times with respect to the operation of said assignment means for preliminarily associating said transmitter with said channel, and means for preventing said transmitter from applying impulses to said channel until said assignment means assigns the channel to condition for transmission away from said transmitter.

31. A telegraph system comprising two sending and receiving stations, a half-duplex channel for transmission of messages alternately in opposite directions between said stations, assignment means at both stations adapted to cooperate over said channel at predetermined time intervals and in the absence of messages to be transmitted to automatically assign the channel to transmission alternately in opposite directions, said assignment means at each station including timing means for establishing said intervals in alternation with the other station, means suspending the operation of said assignment means during transmission of message material, at least one of said stations having a plurality of transmitters having access to said channels to seize the same for transmission, and means operable incident to said channel being assigned for transmission toward said station to busy said channel and prevent access thereto by any of said transmitters.

32. A telegraph system comprising two sending and receiving stations, a half-duplex channel for transmission of messages alternately in opposite directions between said stations, assignment means at both stations adapted to cooperate over said channel to automatically assign the channel for transmission alternately in opposite directions at predetermined time intervals solely in the absence of messages to be transmitted, transmitting means for sending an assignment signal to the other station at the end of alternate intervals, and means operable incident to transmission of a message terminated by a transmitted end-of-message signal to cancel a time interval and to assign the channel immediately for transmission in a direction reverse to the direction of transmission of said message.

33. A telegraph system comprising two sending and receiving stations, a half-duplex channel for transmission of messages alternately in opposite directions between said stations, timed assignment means at both stations adapted to cooperate over said channel to automatically assign the channel for transmission alternately in opposite directions after predetermined waiting time intervals in the absence of messages to be transmitted, said assignment means at each station including timing means for establishing said intervals in alternation with the operation of said timing means at the other station, at least one of said stations further including transmitting means for sending a special assignment signal to the other station at any time when the channel is available to it for transmission, and means including means at the station receiving said special signal responsive thereto to cancel the timing operation of said timing means and immediately reverse the direction of assignment of said channel for transmission.

34. A multiple telegraph sender operated under control of previously stored codes including directing codes and message codes, a plurality of telegraph channels to which said sender has selective access, means actuated by the directing codes to associate said sender selectively with certain of a plurality of channels of transmission, and a timing circuit operatively associated with said sender to compel said sender, upon such association, to await a predetermined time after such association for an available condition of said channels before initiation of transmission thereover, and a controller to initiate signal transmisson over such of said selected channels as are available upon the expiration of said time.

35. In combination, a plurality of channels of transmission, a plurality of transmitters, means operable selectively to preliminarily associate any of said transmitters with any of said channels for transmission thereover, timing means associated with and individual to one of said channels for controlling completion of said association, timing means individual to one of said transmitters for also controlling completion of said association, and means for initiating transmission over said one channel by said one transmitter when association of said transmitter with said channel has been completed.

36. A channel of telegraphic transmission comprising two sending and receiving instrumentalities, one of each being at each terminus of said channel, said channel being half-duplex for transmission of messages alternately in different directions between said terminals but not simultaneously in both directions, said sending instrumentalities including means for sending a special code sequence either as an end-of-message sequence or for control purposes over said channel, means responsive to said sequence

to temporarily estop transmission from the terminal transmitting said sequence, means responsive to said sequence to immediately render said channel available to the distant transmitting instrumentality for reverse transmission, in combination with sending means at each terminal of said channel and responsive means at each terminal operable after a timed period of non-transmission to alternately render said channel available for transmission by one instrumentality and to estop transmission thereover by the other.

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