Aug. 14, 1945. W. M. BACON ET AL 2,381,871

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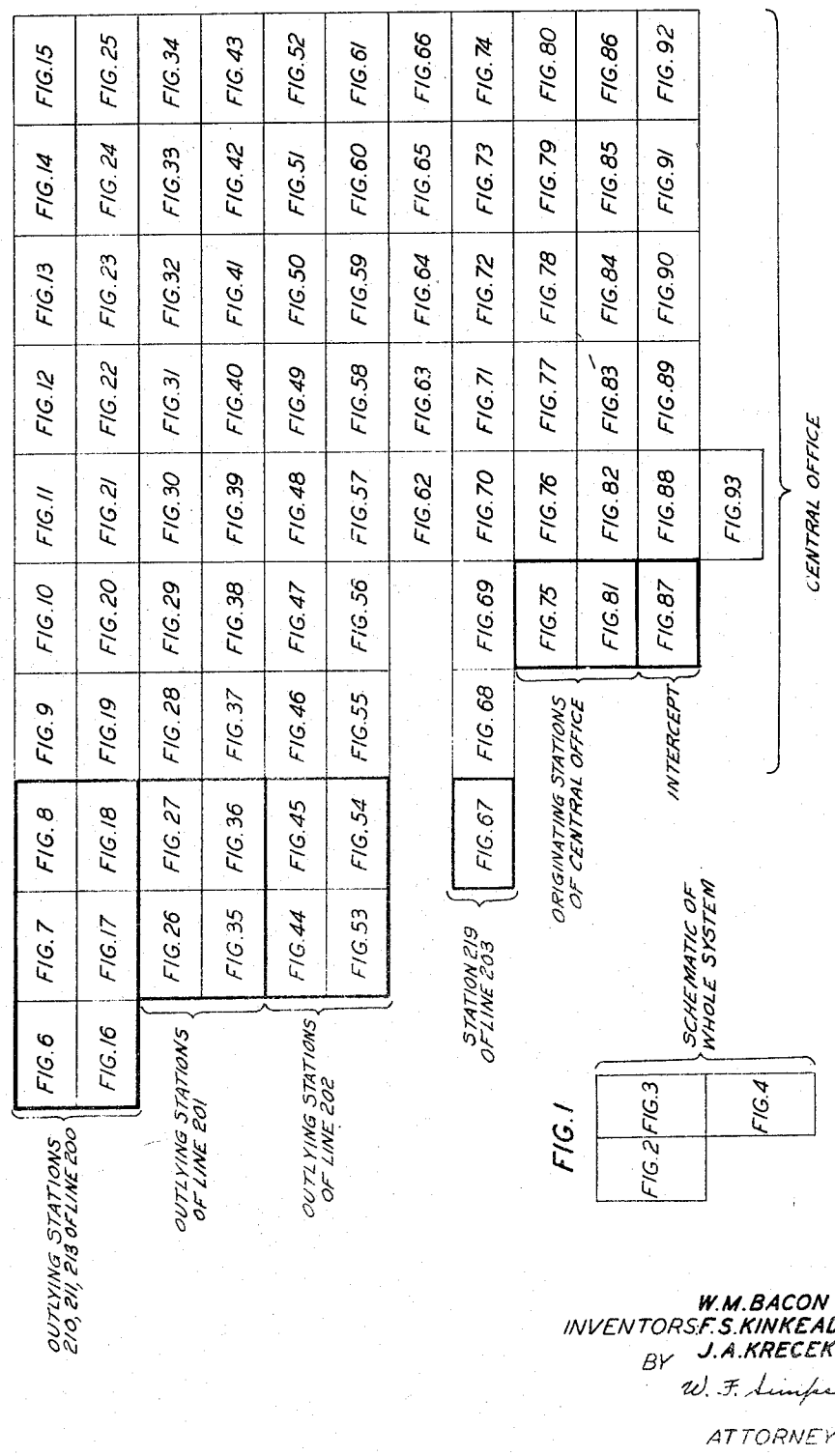

W.M.BACON
INVENTORS F.S.KINKEAD
J.A.KRECEK

BY W. F. Simpson

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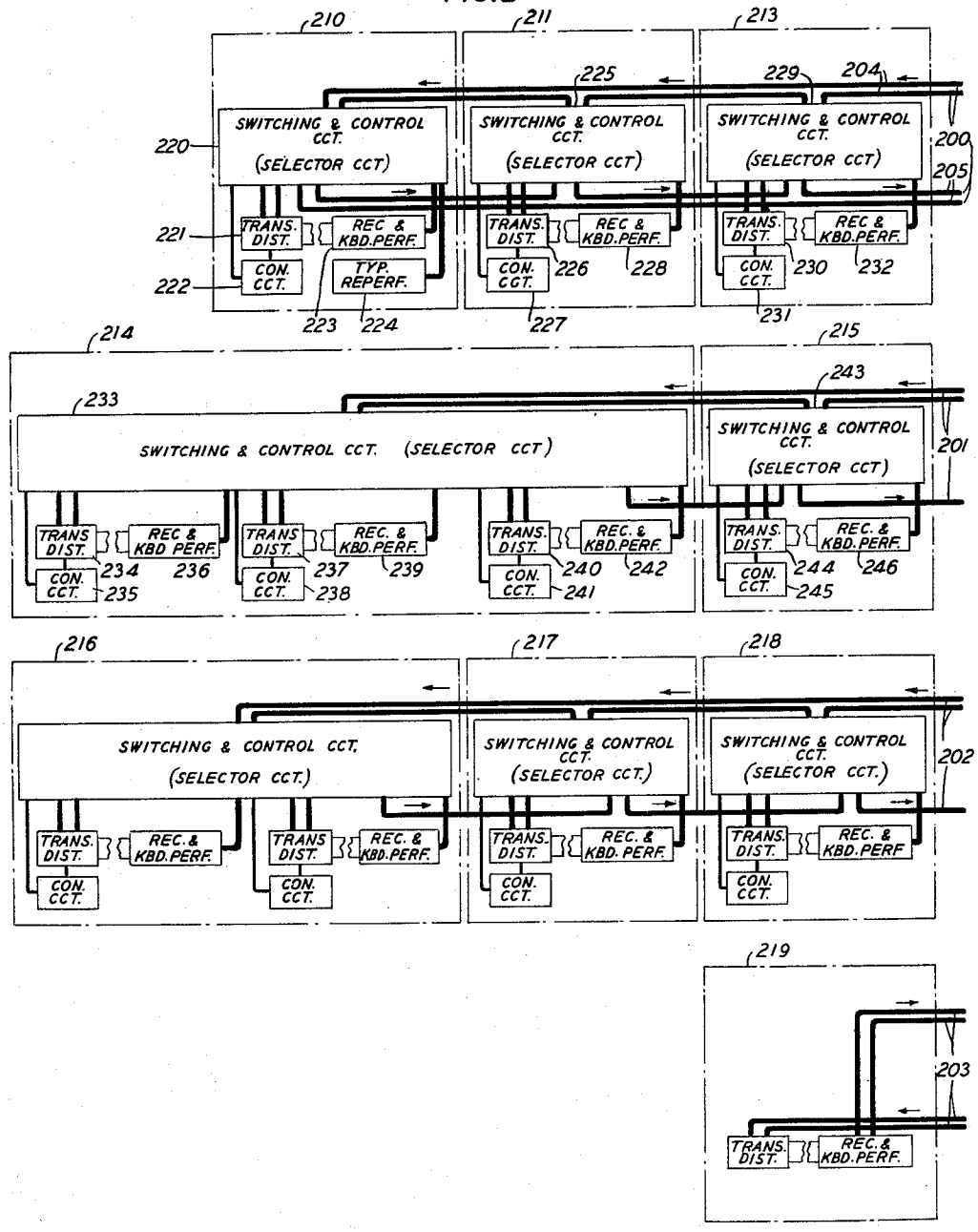
FIG. 2



INVENTORS: W. M. BACON
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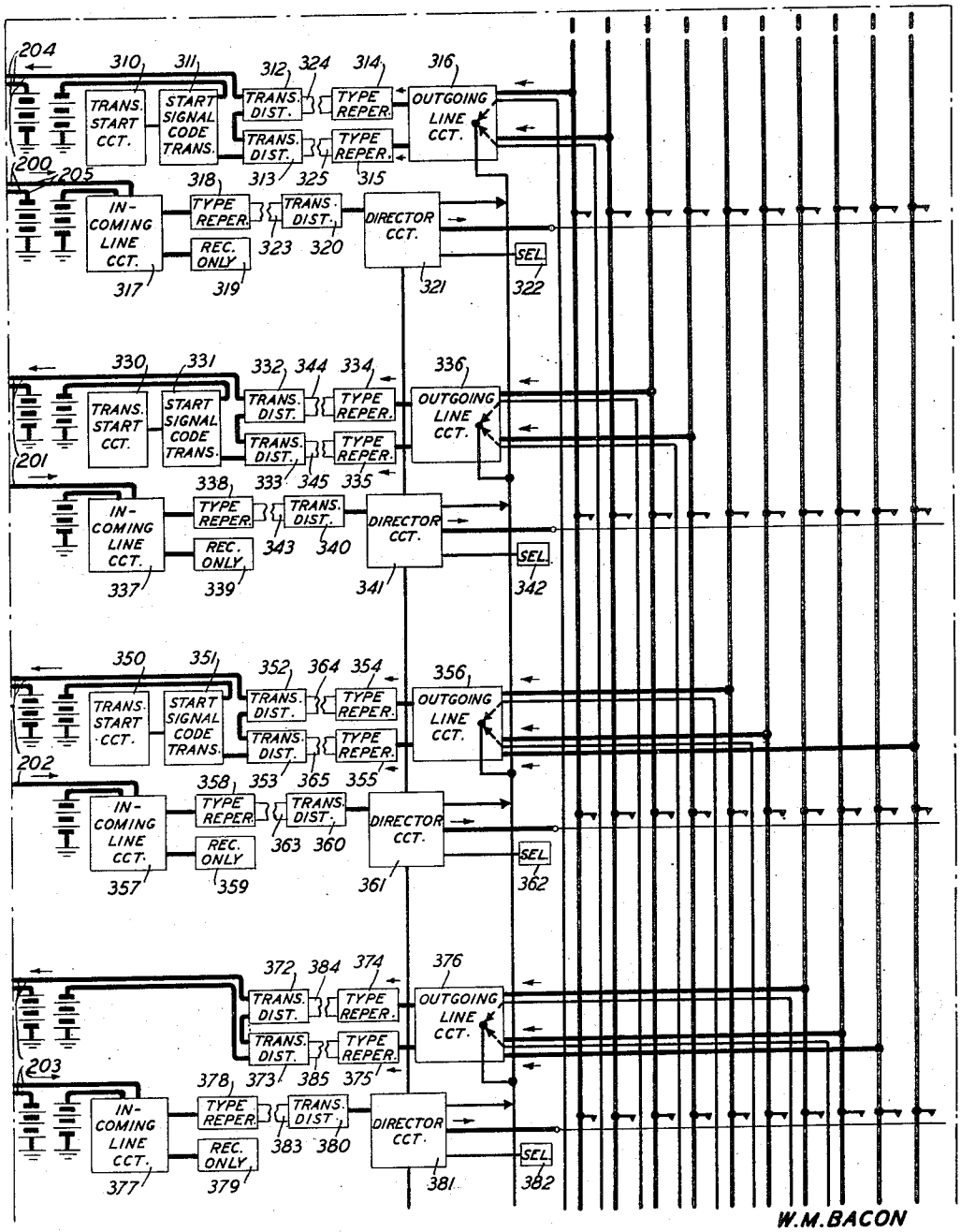
FIG.3



INVENTORS: W.M.BACON
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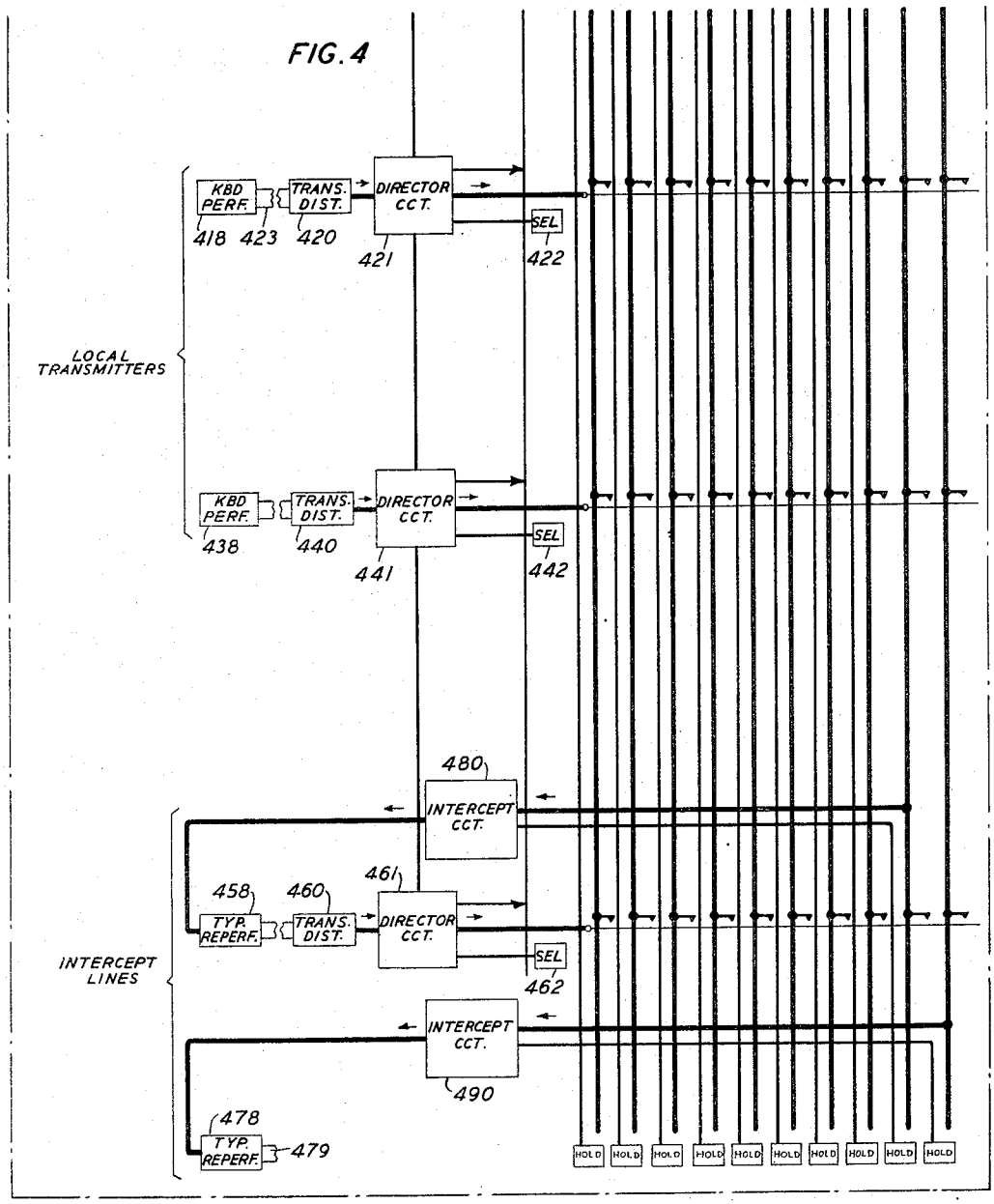
FIG. 4



INVENTORS: W.M.BACON
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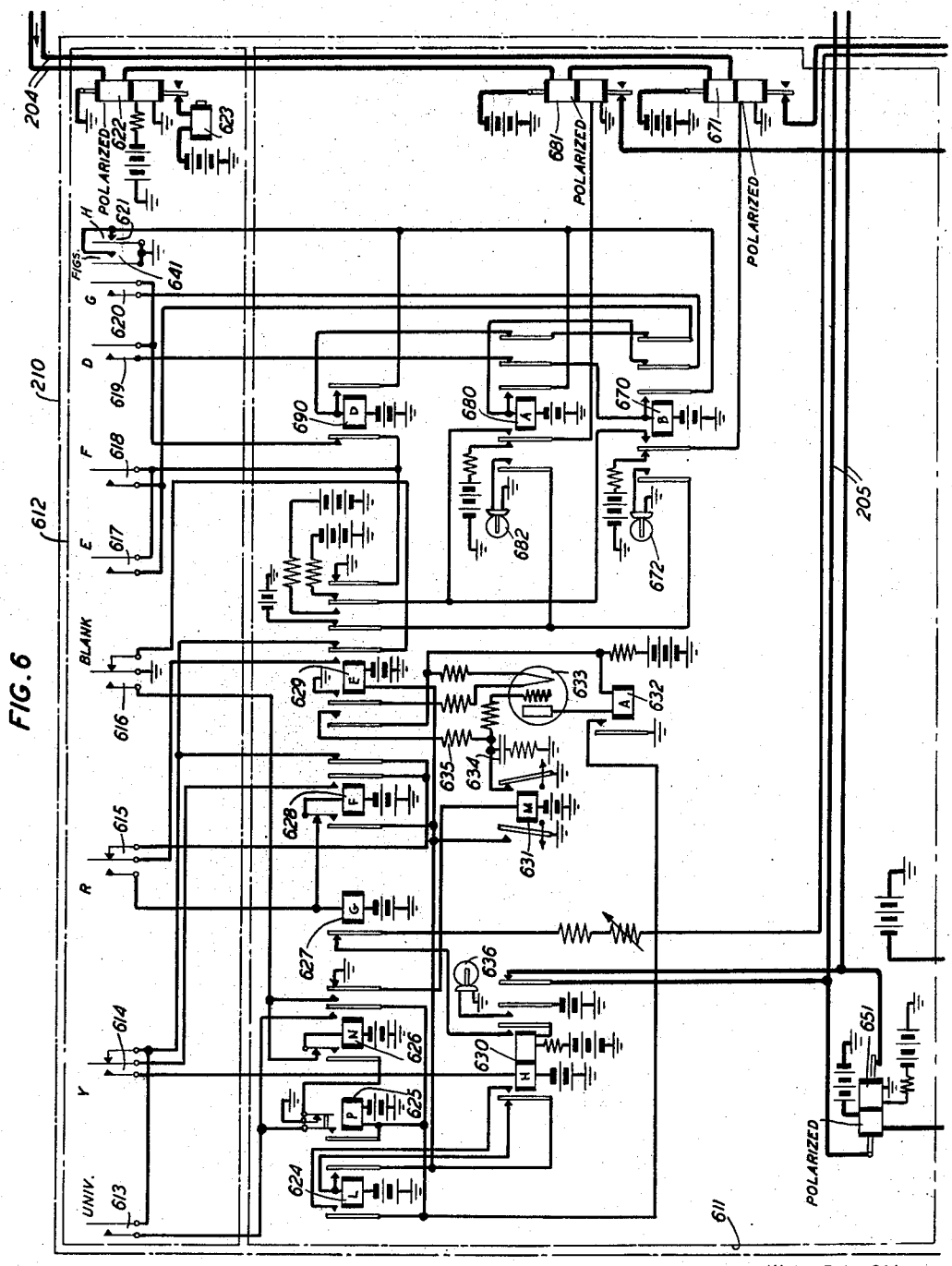

FIG. 6

INVENTORS: W. M. BACON
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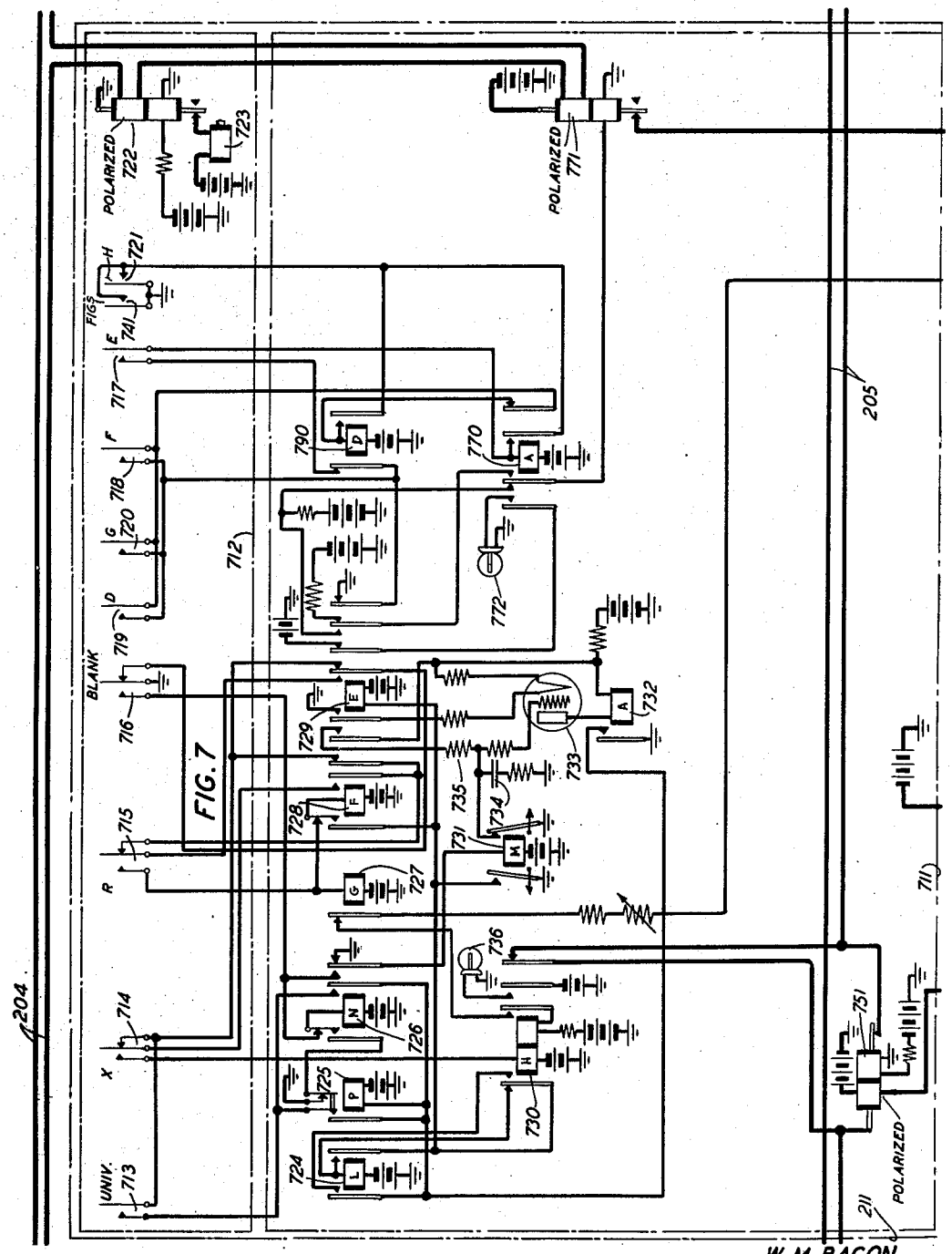

FIG. 7

INVENTORS: W. M. BACON
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J. A. KRECEK

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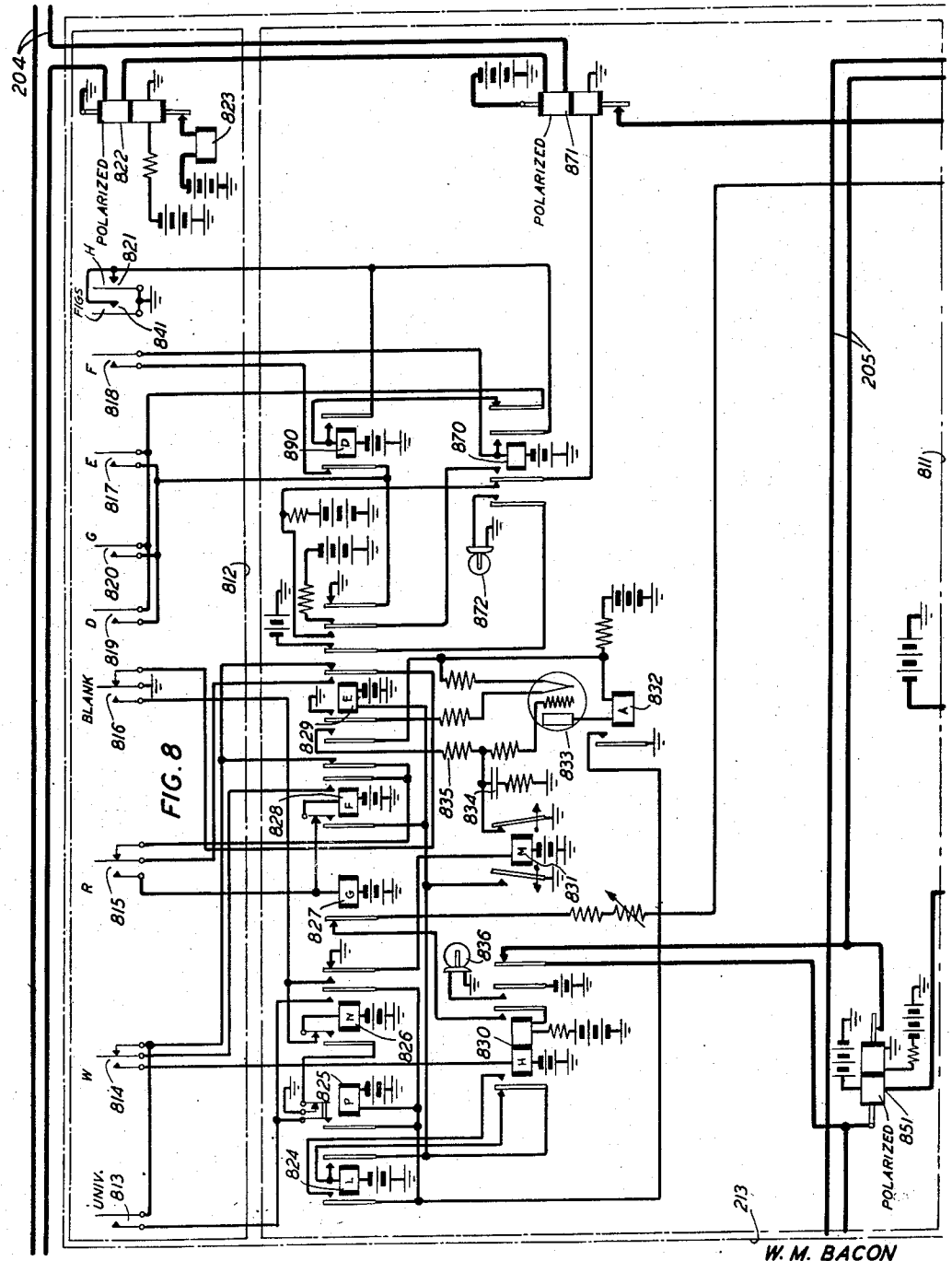

FIG. 8

INVENTORS: W. M. BACON
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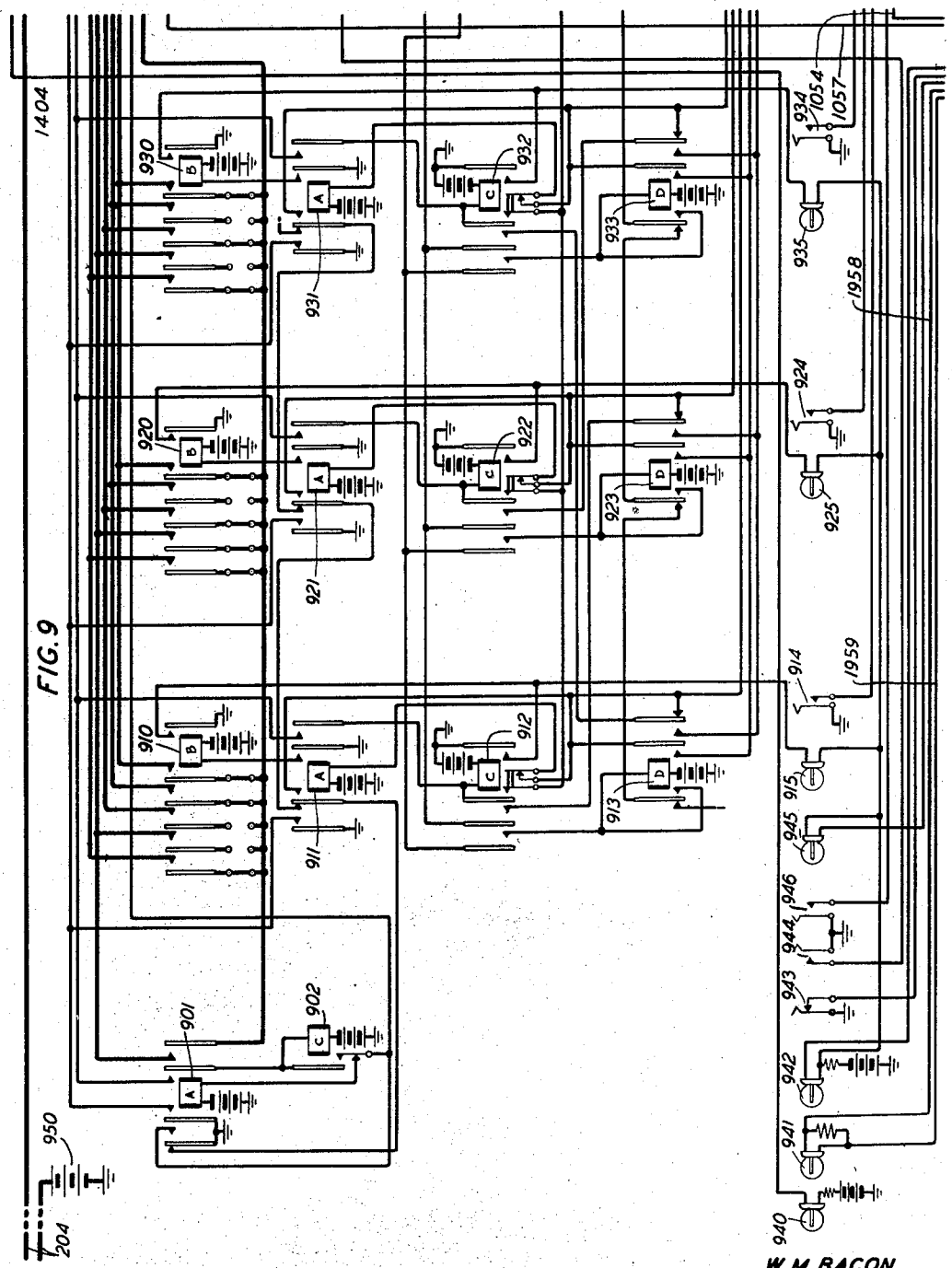

FIG. 9

INVENTORS: W.M.BACON
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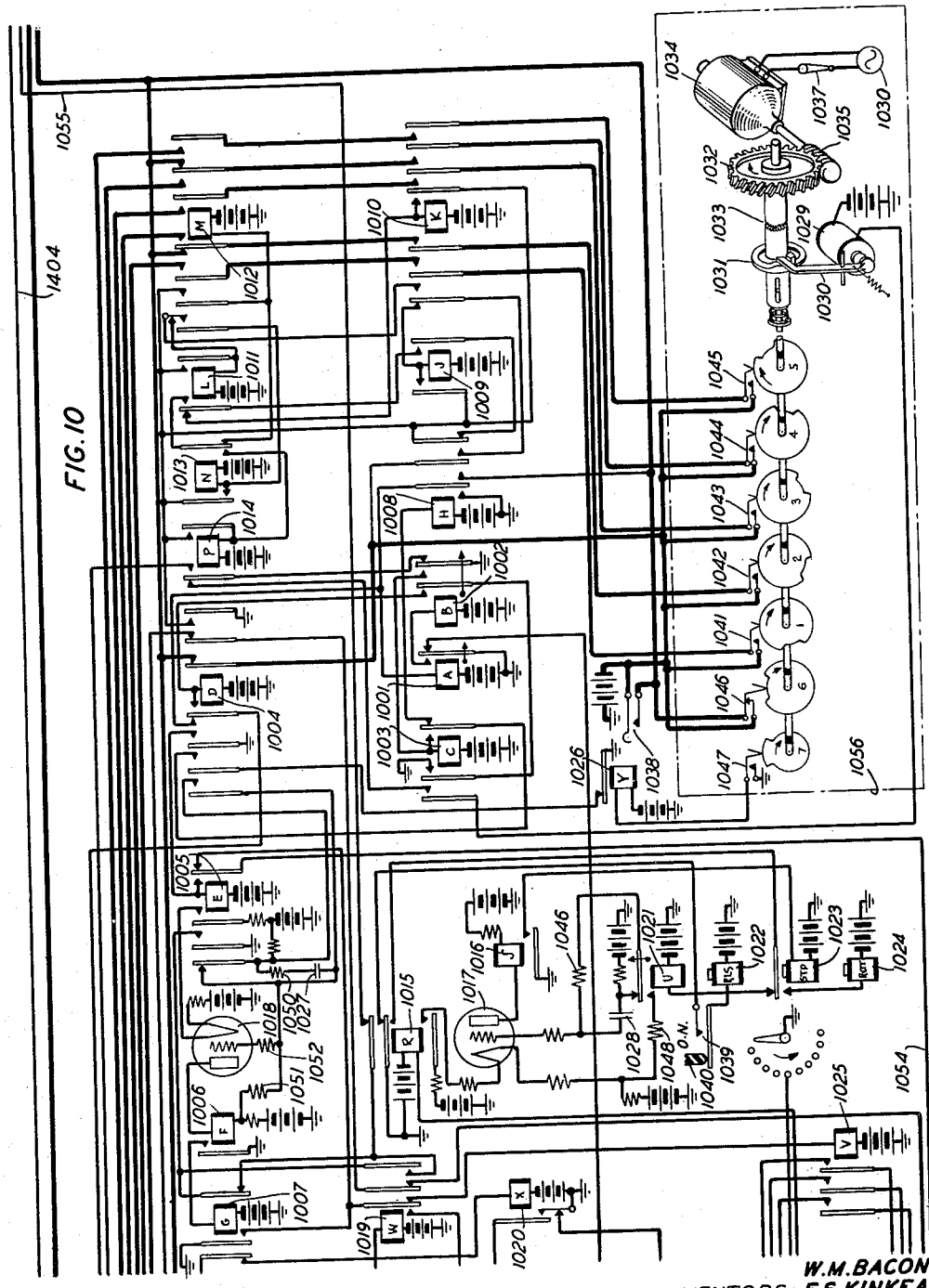

FIG. 10

INVENTORS: W.M.BACON
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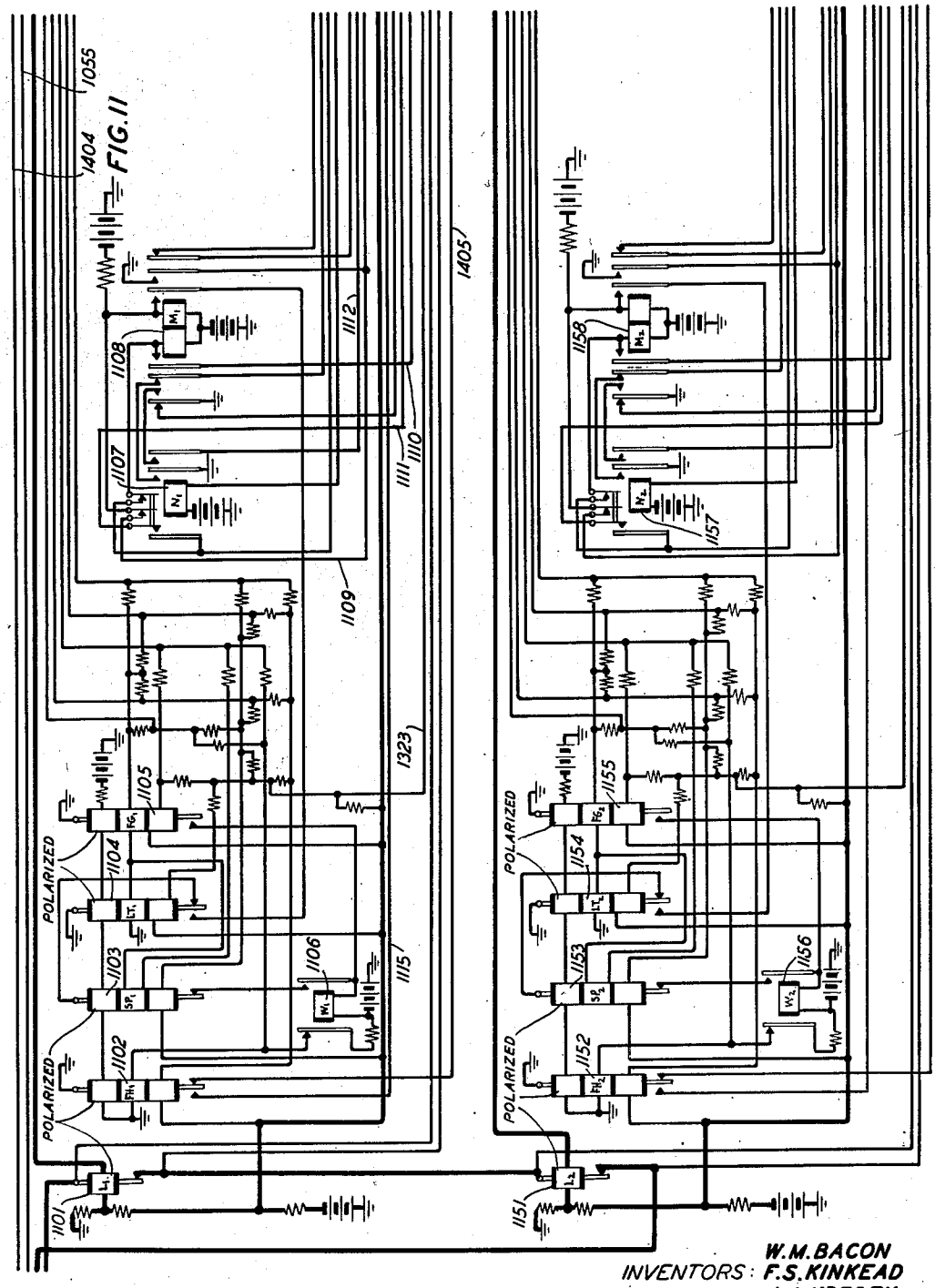

INVENTORS: W.M.BACON
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J.A.KRECEK
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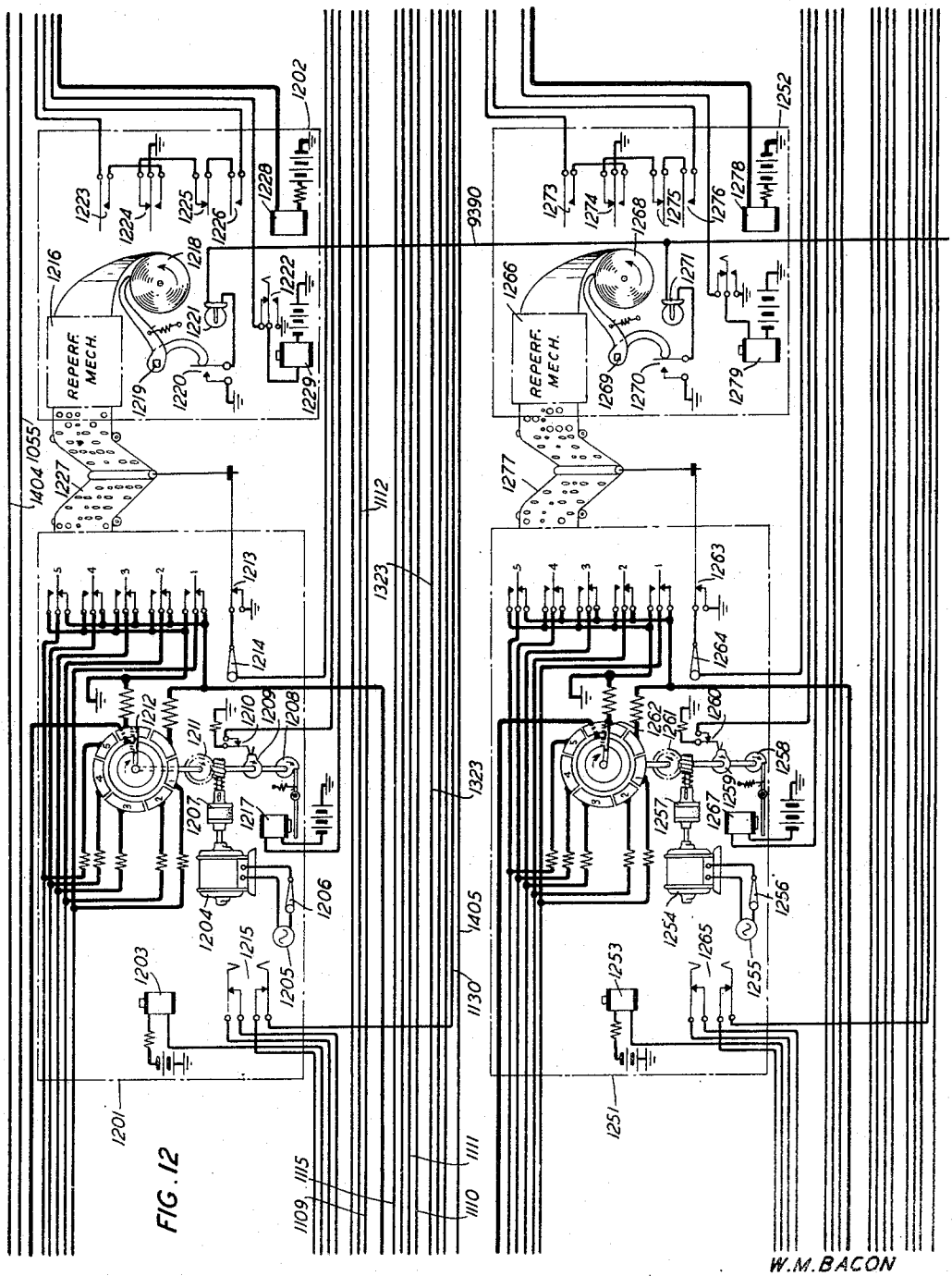

FIG. 12

INVENTORS: W.M.BACON
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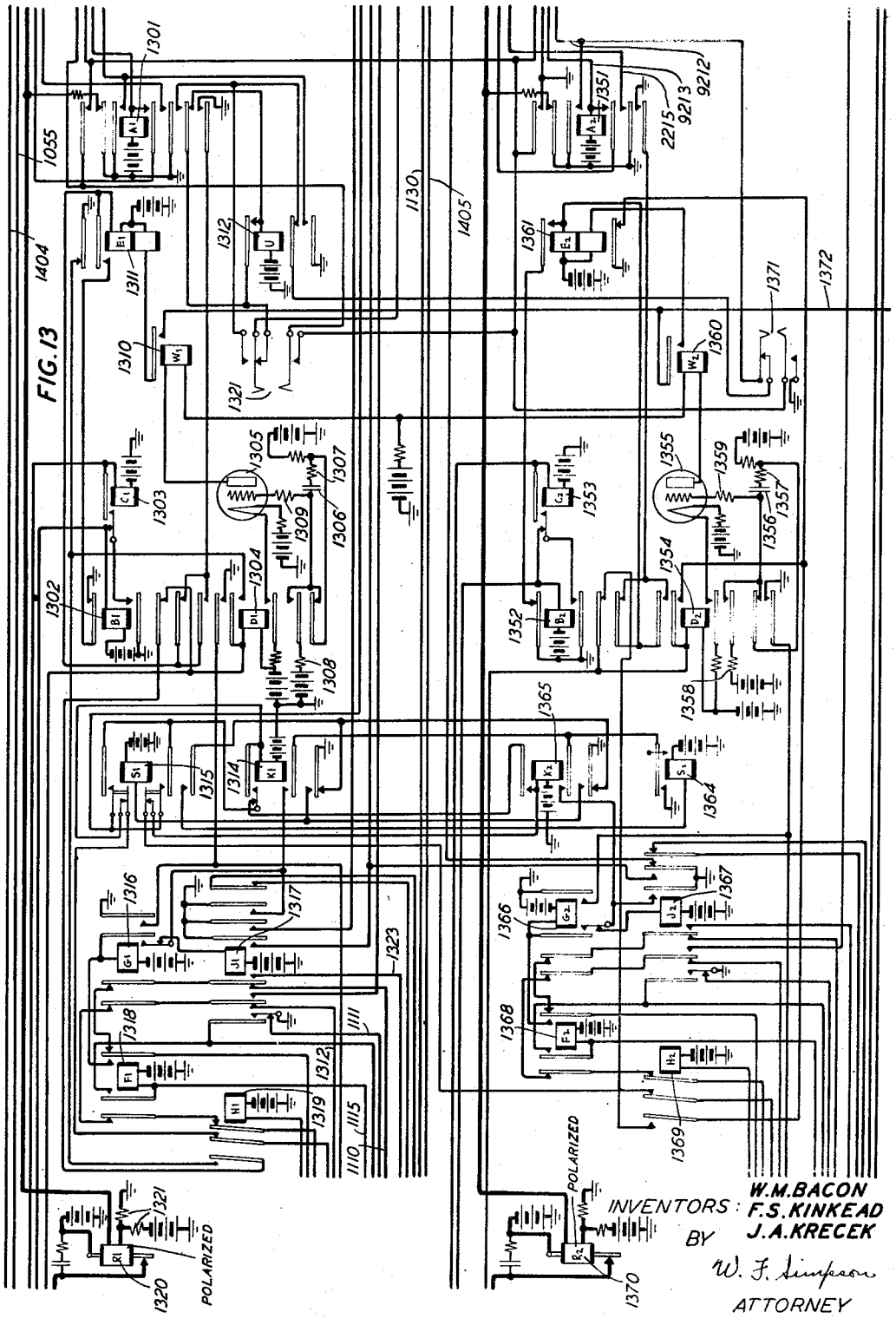

FIG. 13

INVENTORS: W.M.BACON F.S.KINKEAD J.A.KRECEK

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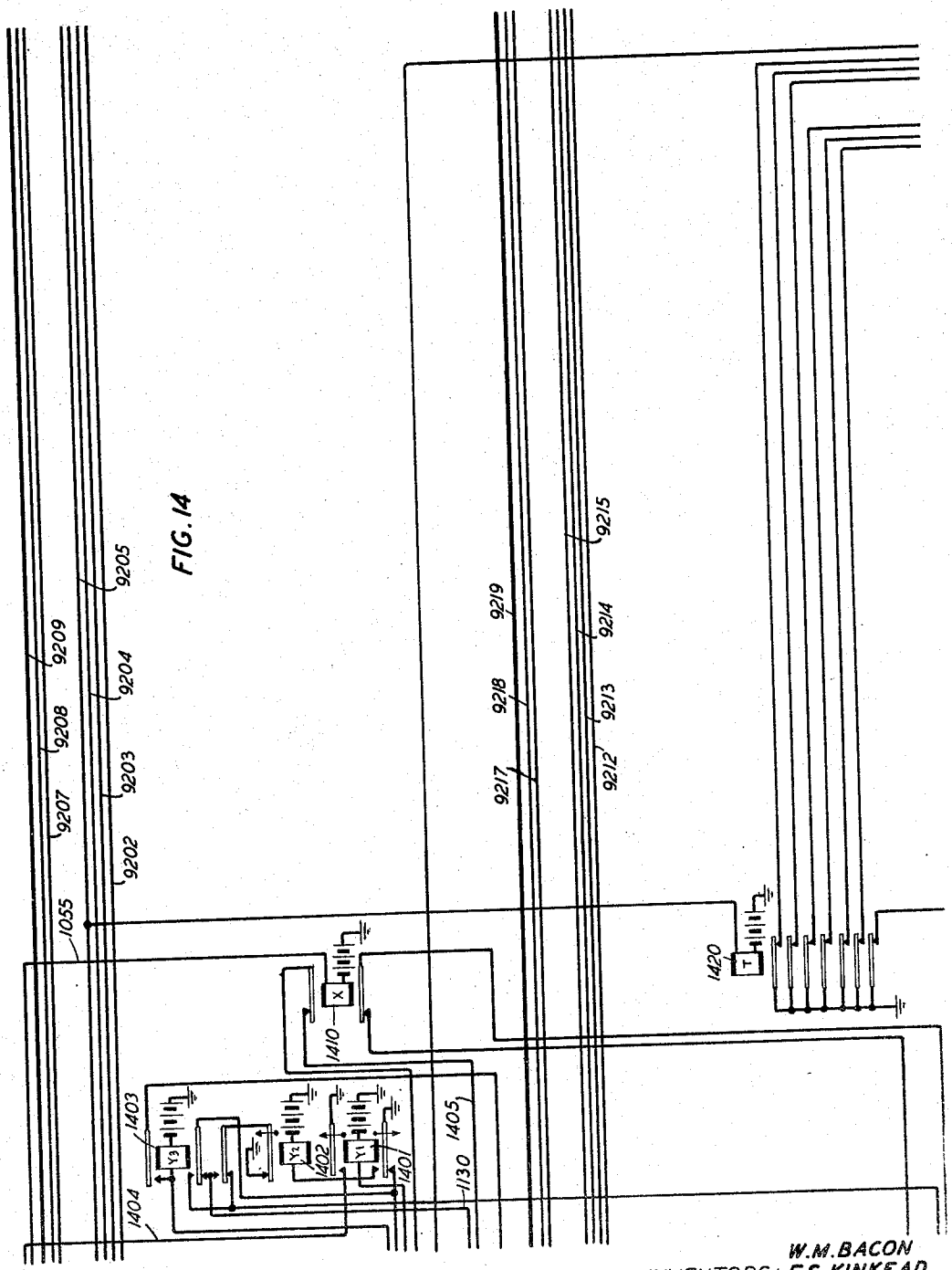
FIG. 14



INVENTORS: W.M.BACON
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J.A.KRECEK

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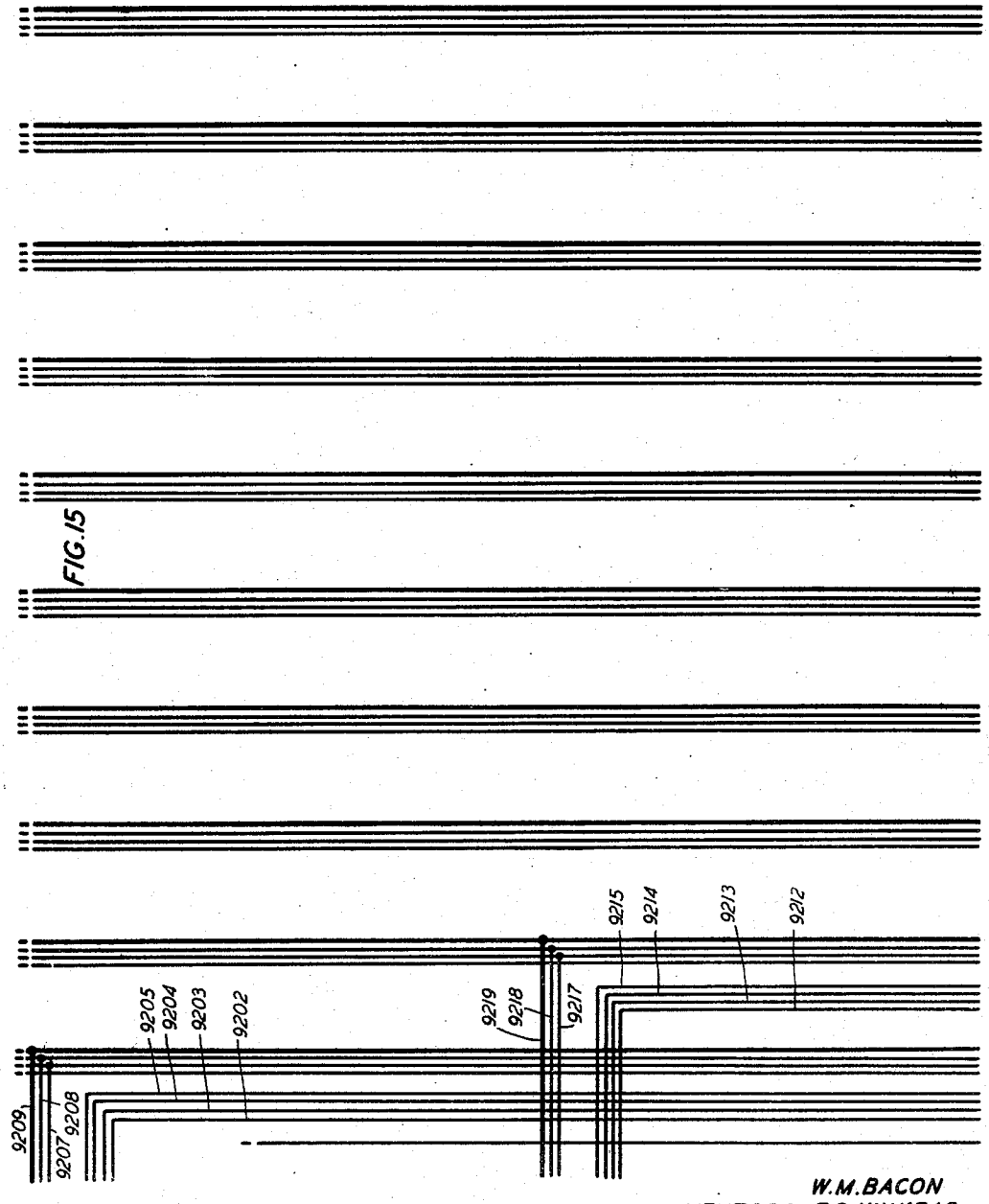
FIG. 15



W.M.BACON
INVENTORS: F.S.KINKEAD
BY J.A.KRECEK
W. F. Simpson.
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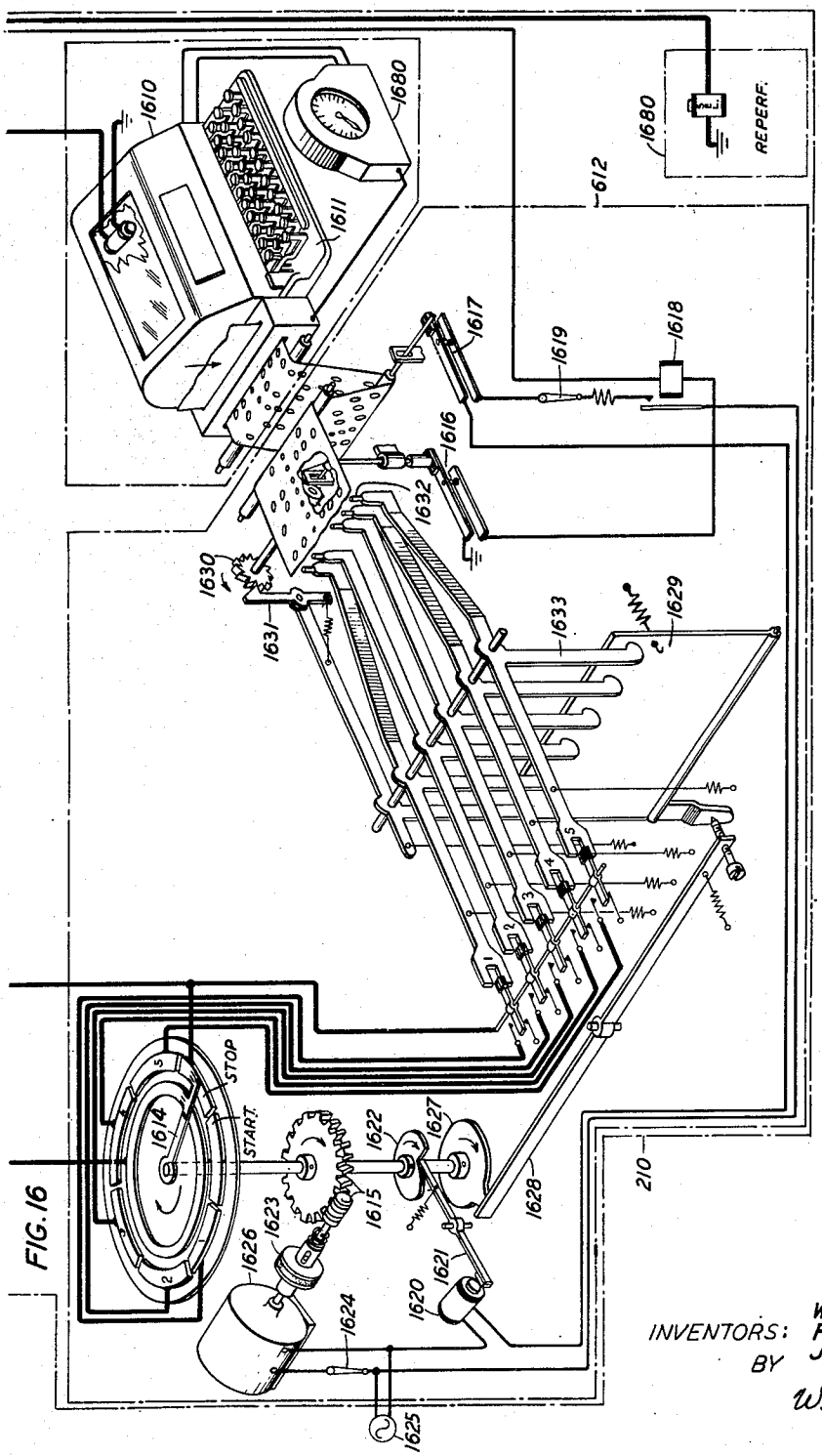

FIG. 16

INVENTORS: W. M. BACON
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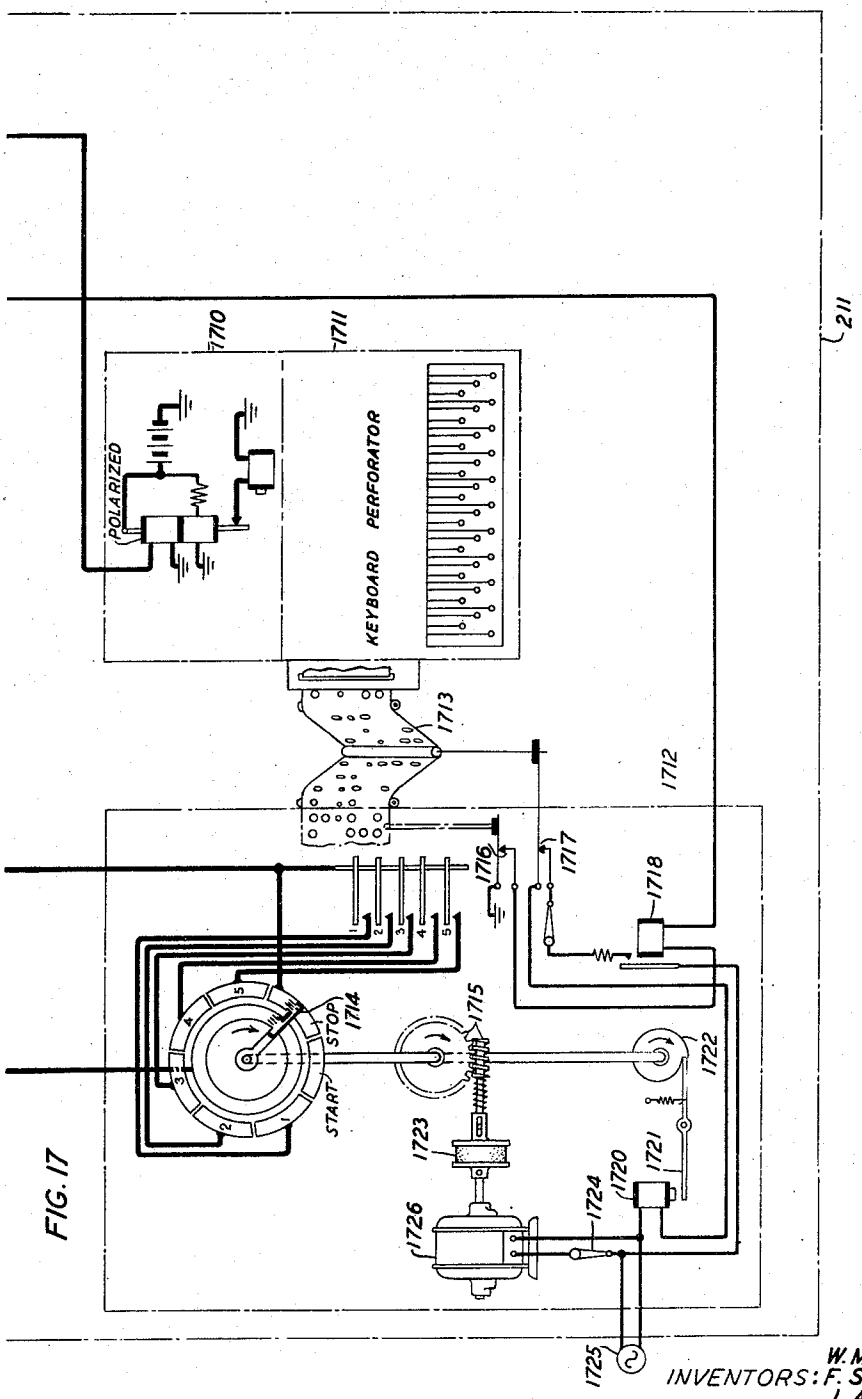

FIG. 17

INVENTORS: W. M. BACON
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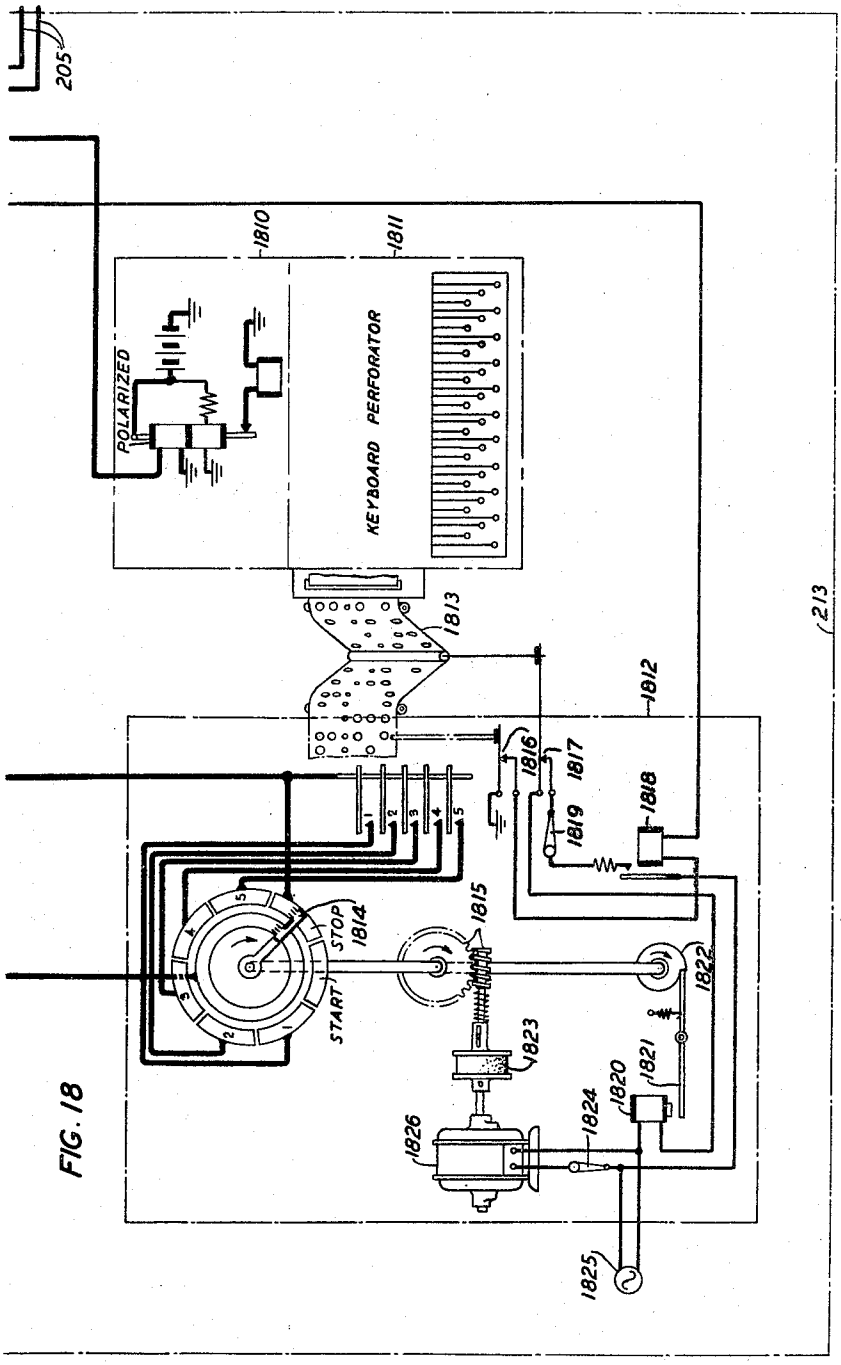

FIG. 18

INVENTORS: W. M. BACON
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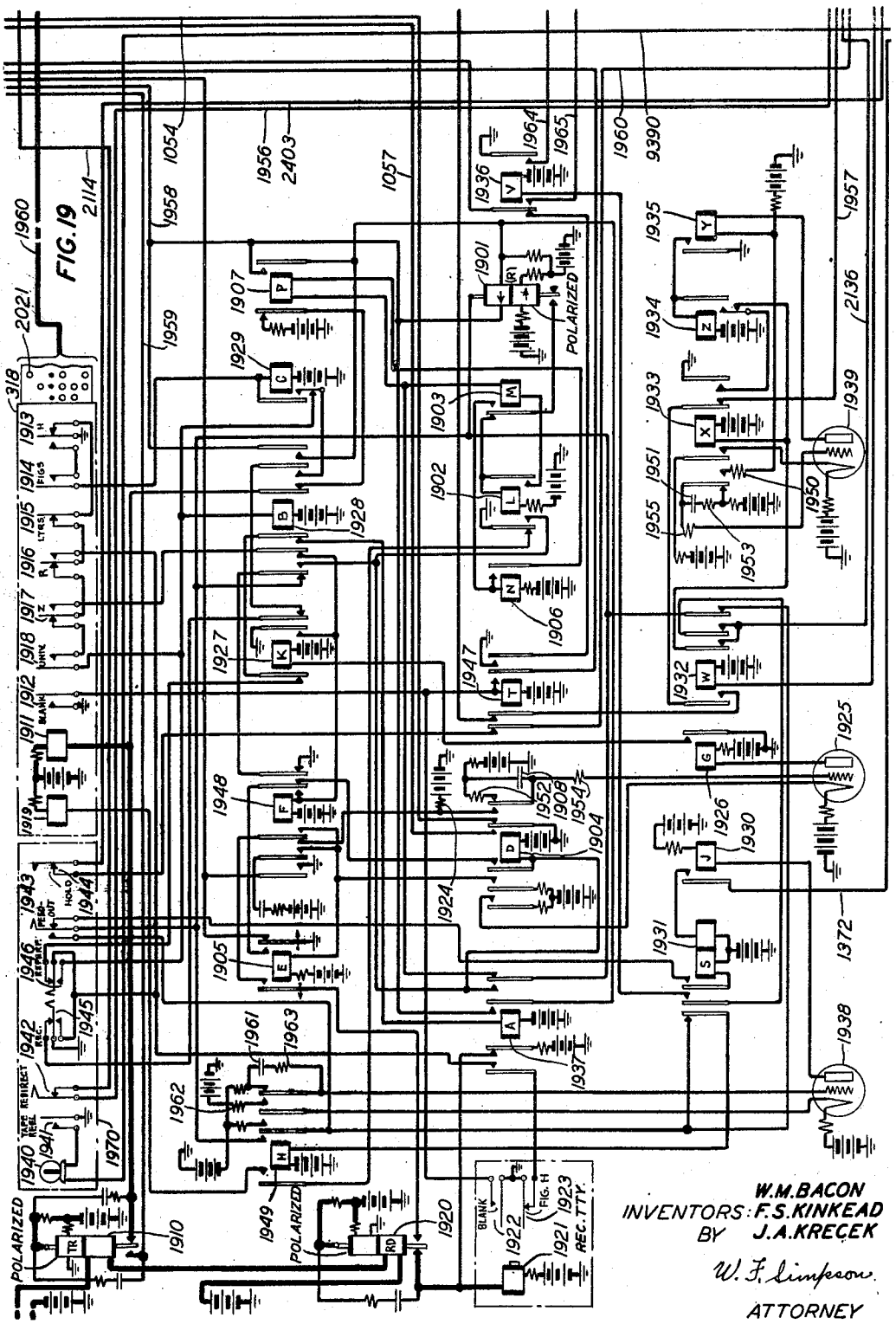

INVENTORS: W.M.BACON F.S.KINKEAD BY J.A.KRECEK

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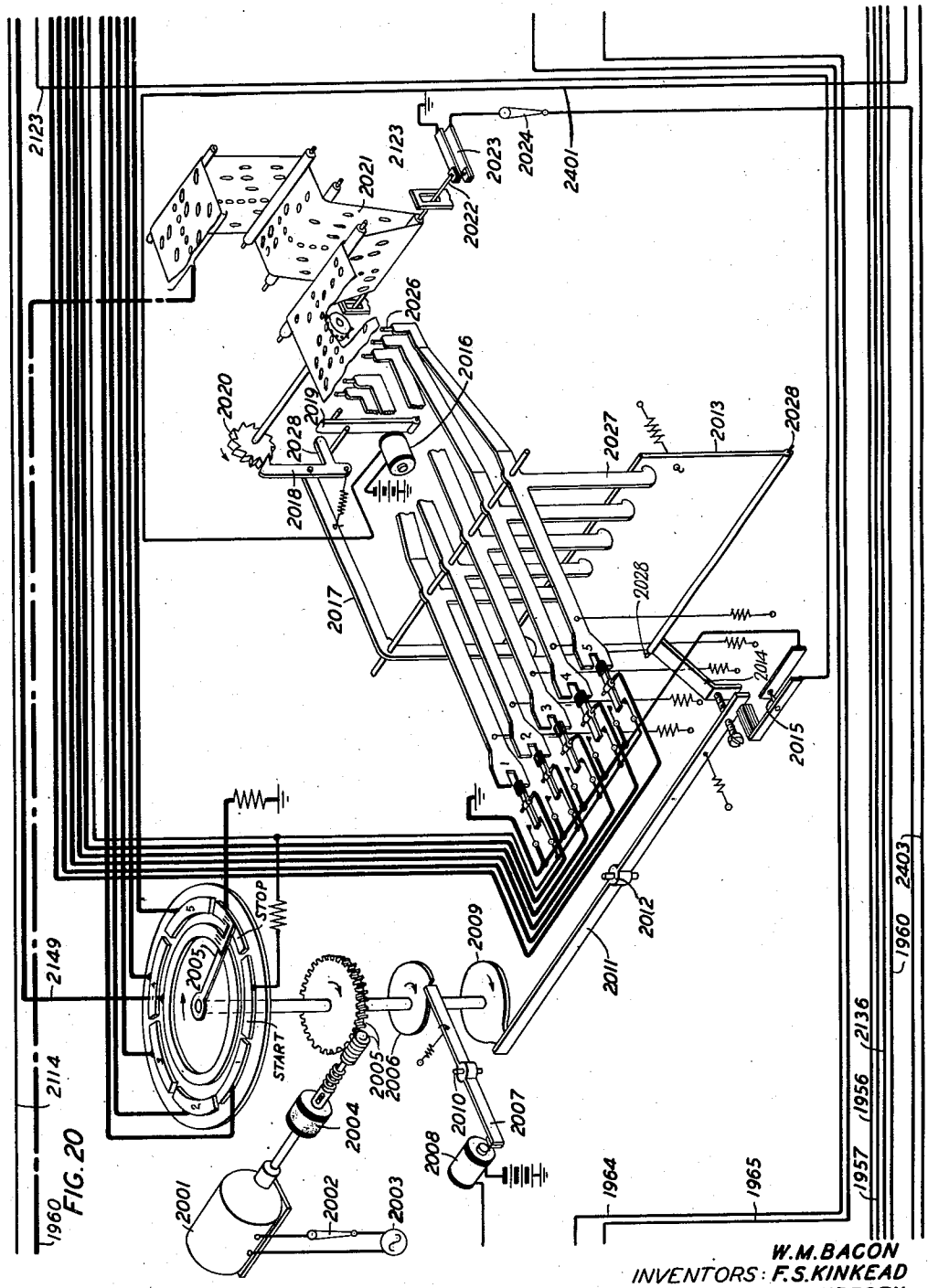

FIG. 20

INVENTORS: W.M.BACON F.S.KINKEAD J.A.KRECEK

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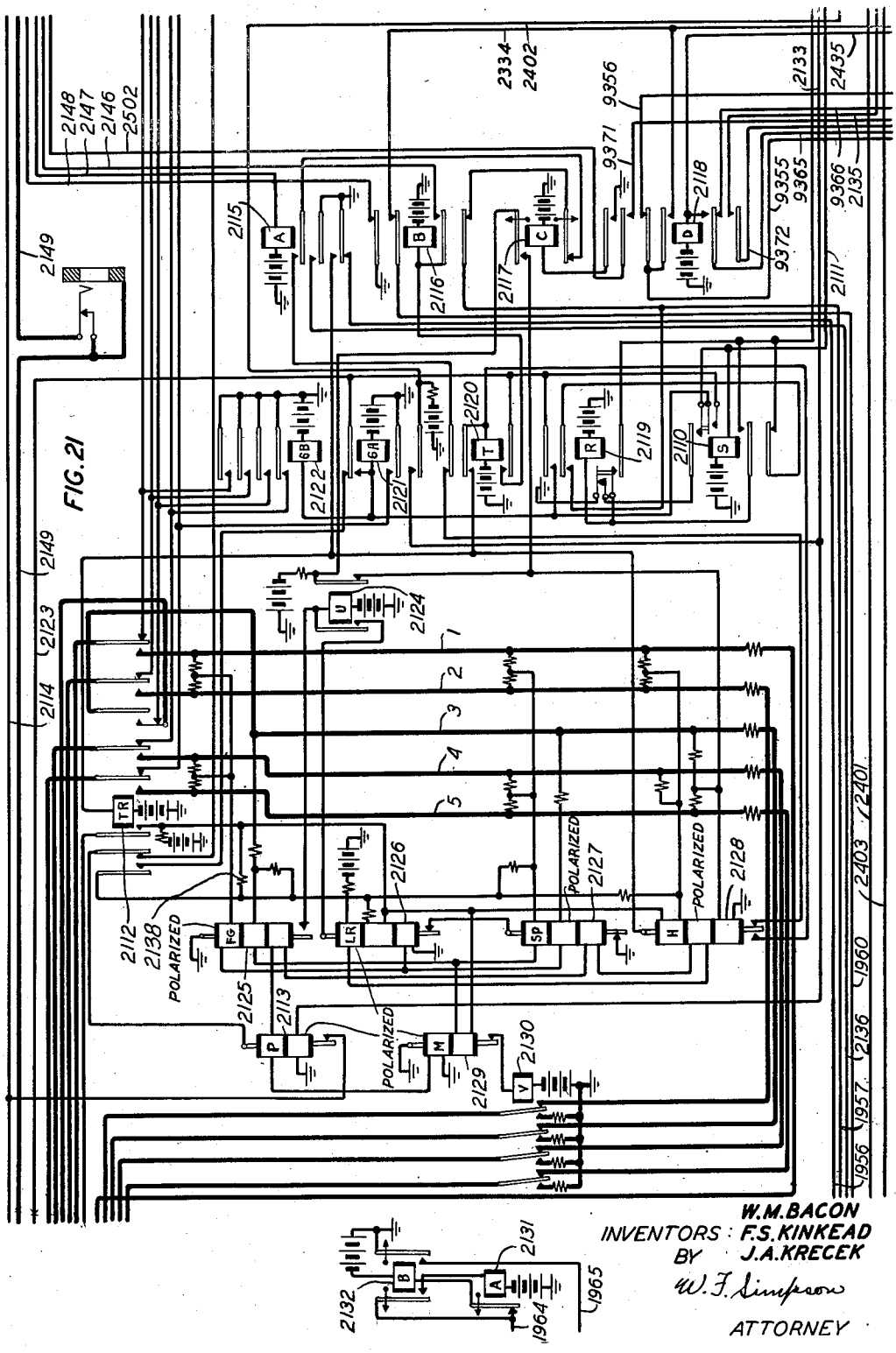

INVENTORS: W.M.BACON
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BY J.A.KRECEK
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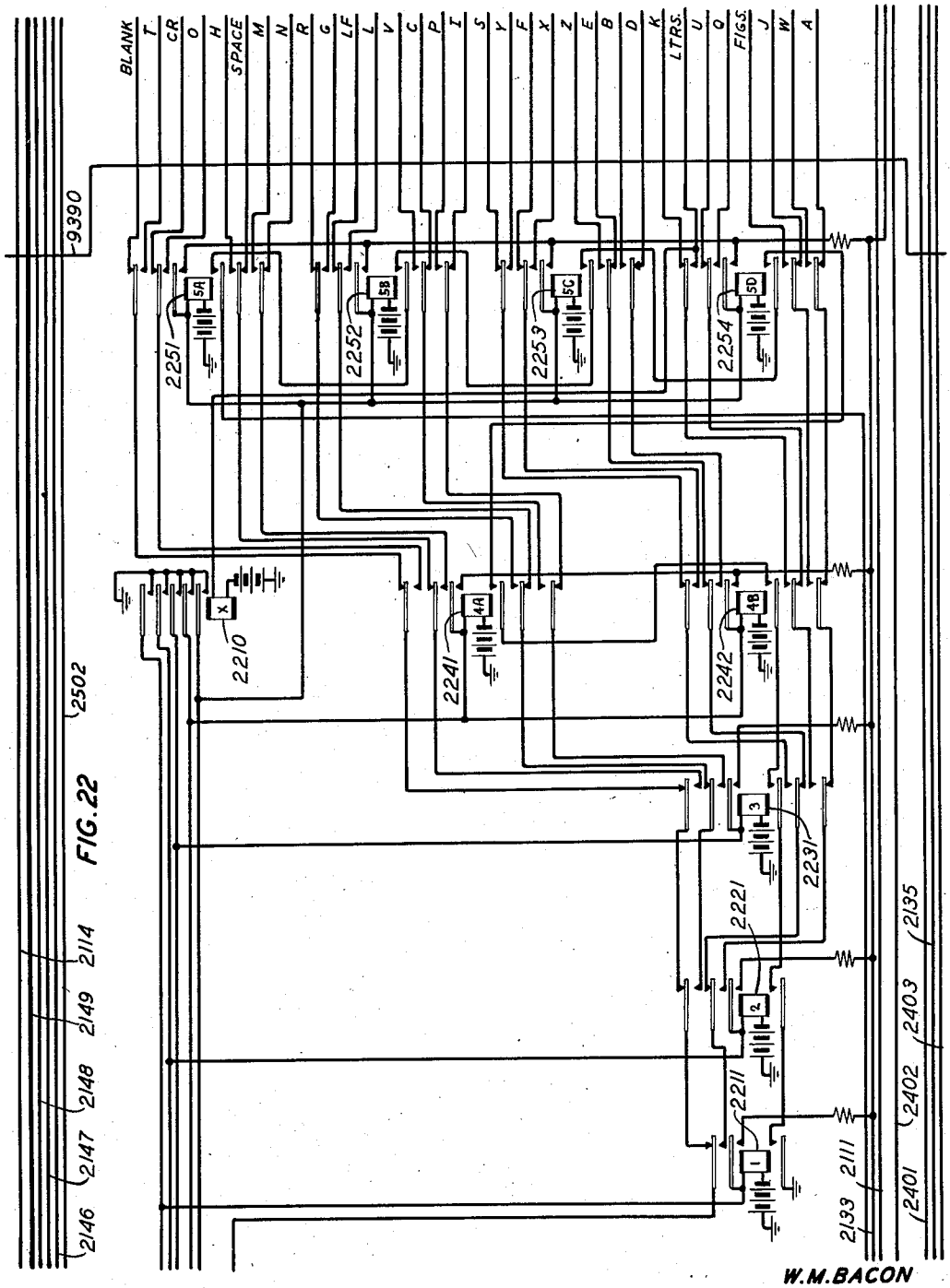

FIG. 22

INVENTORS: W. M. BACON, F. S. KINKEAD, J. A. KRECEK

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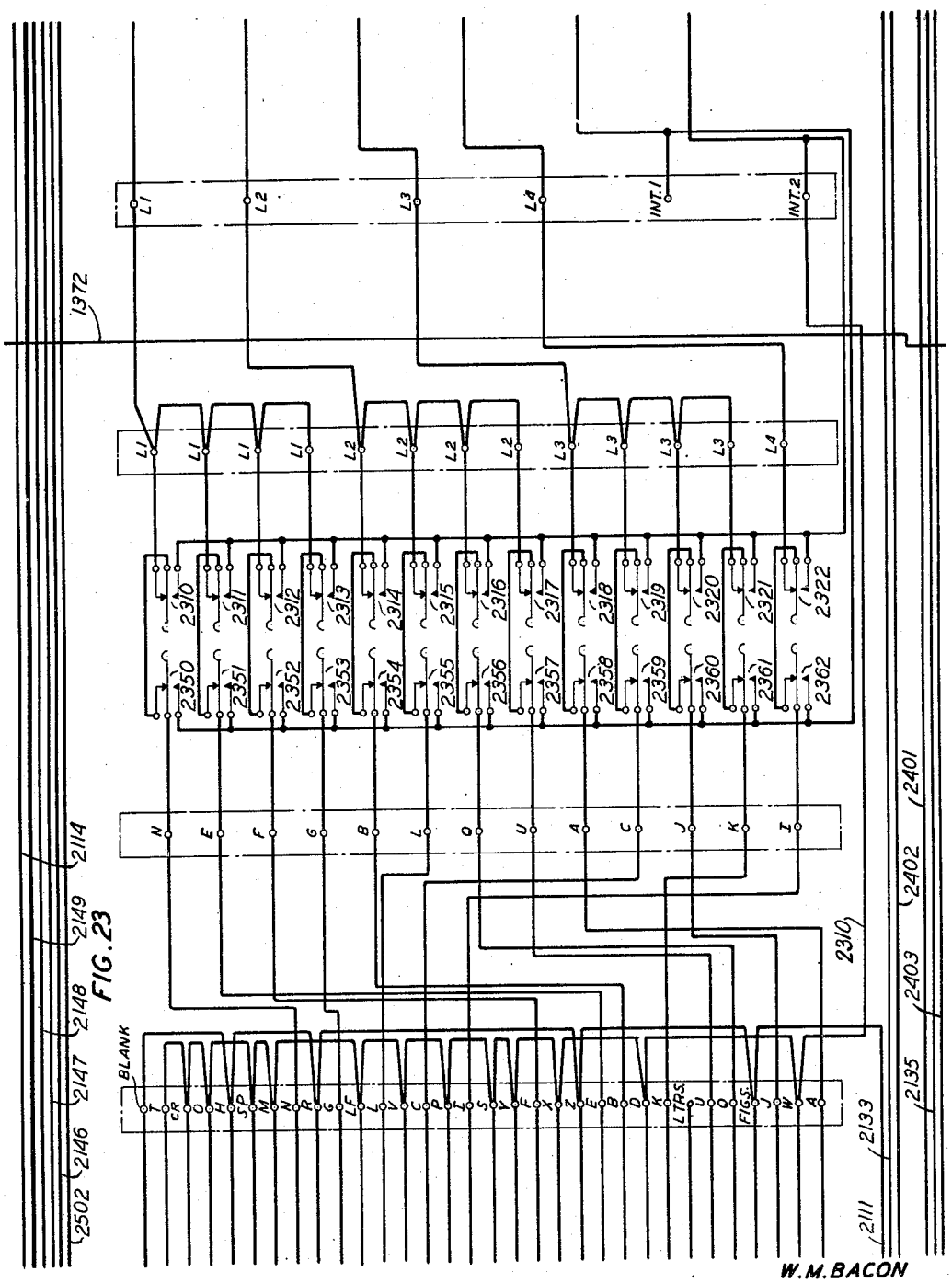

FIG. 23

INVENTORS: W.M.BACON F.S.KINKEAD BY J.A.KRECEK

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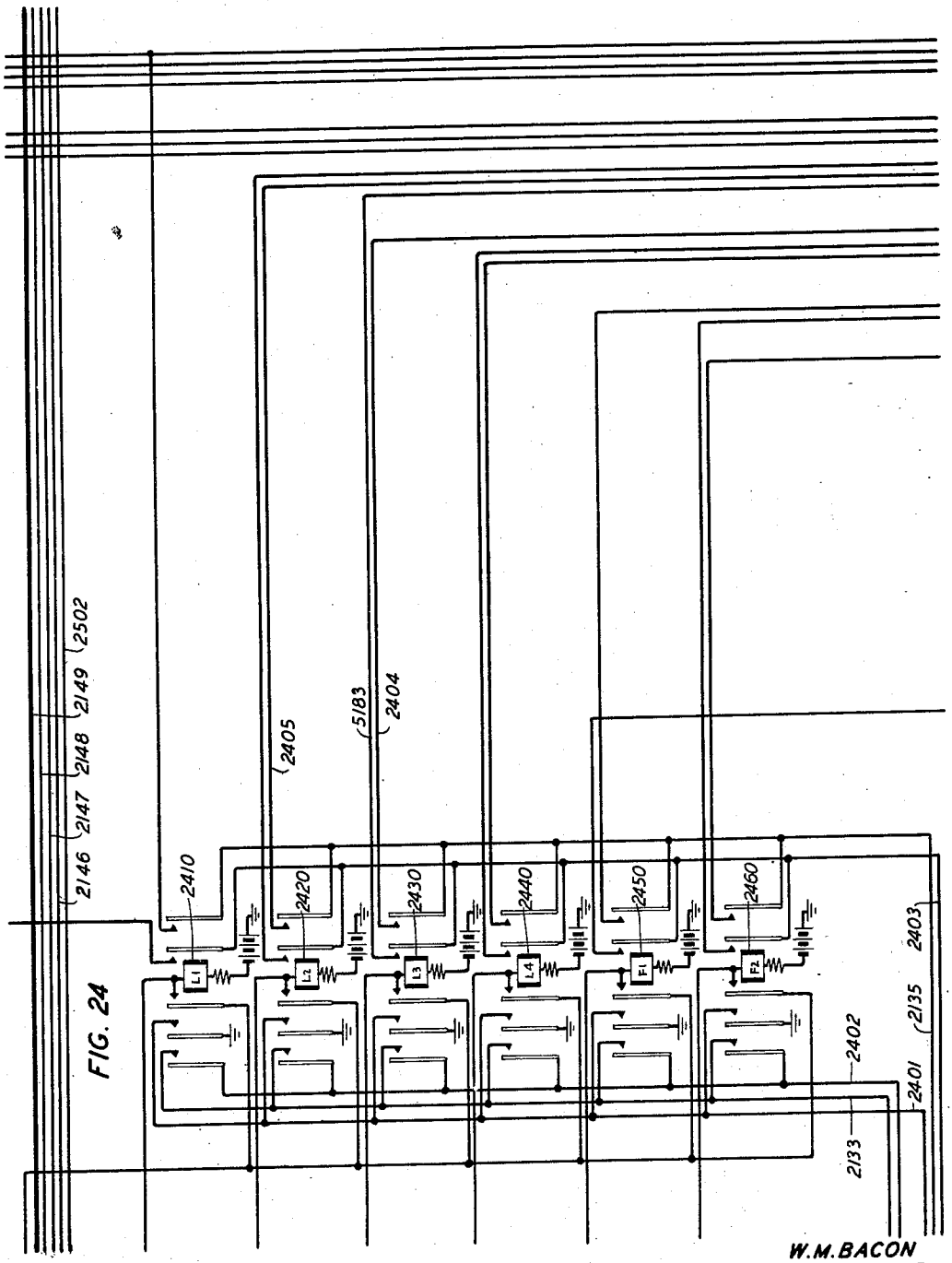

FIG. 24

INVENTORS: W.M.BACON
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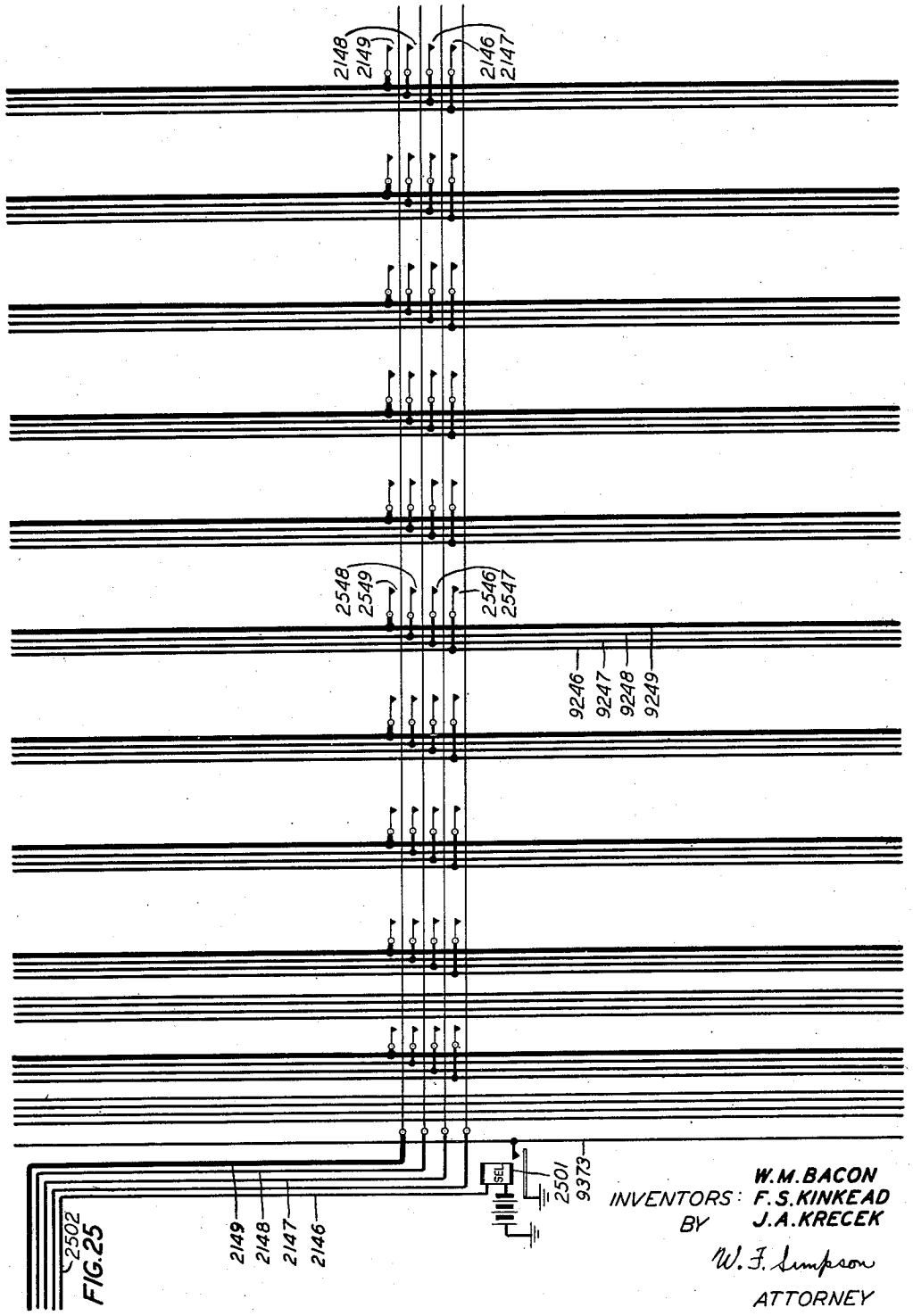

FIG. 25

INVENTORS: W.M.BACON F.S.KINKEAD J.A.KRECEK

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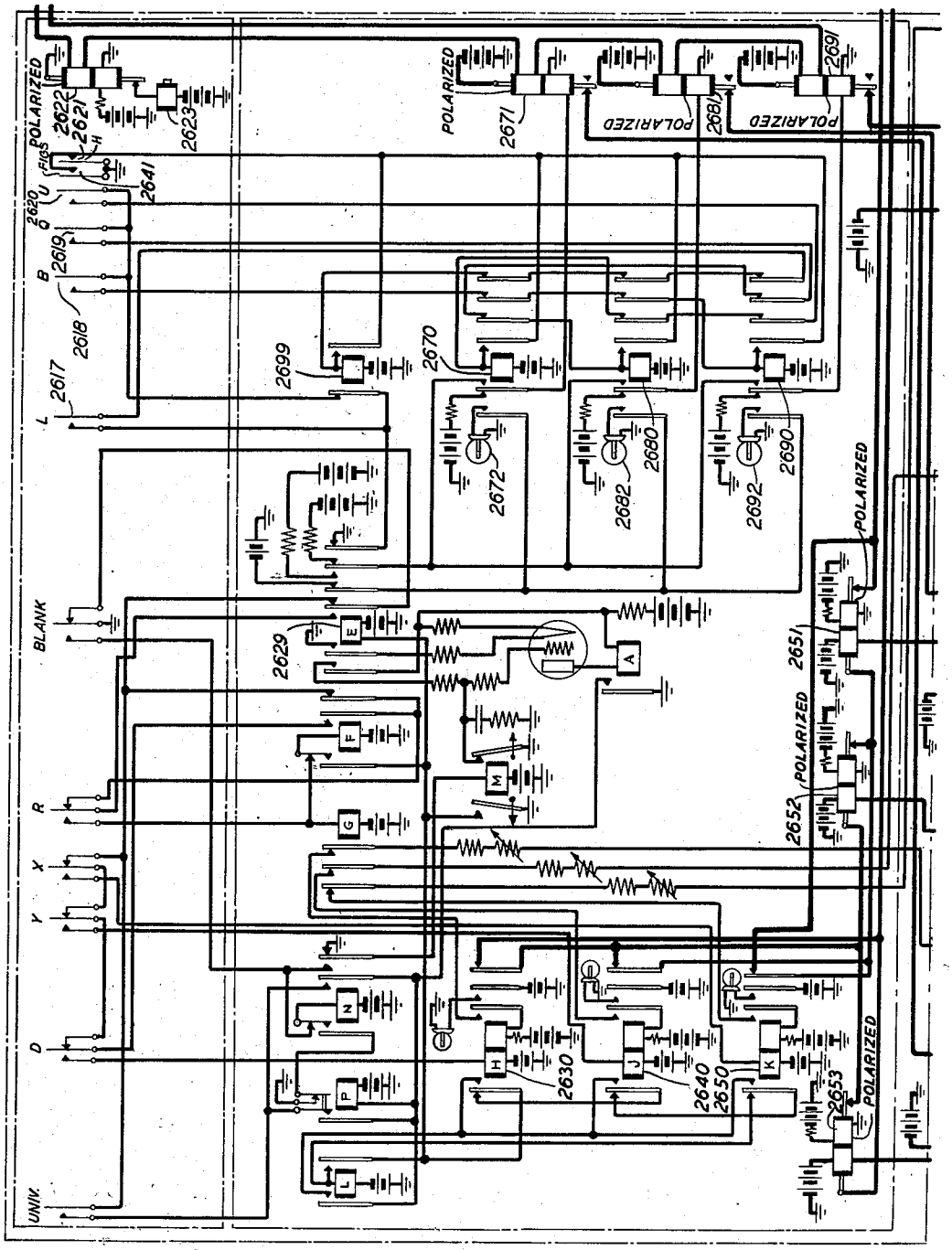

FIG. 26

INVENTORS : W. M. BACON
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J. A. KRECEK

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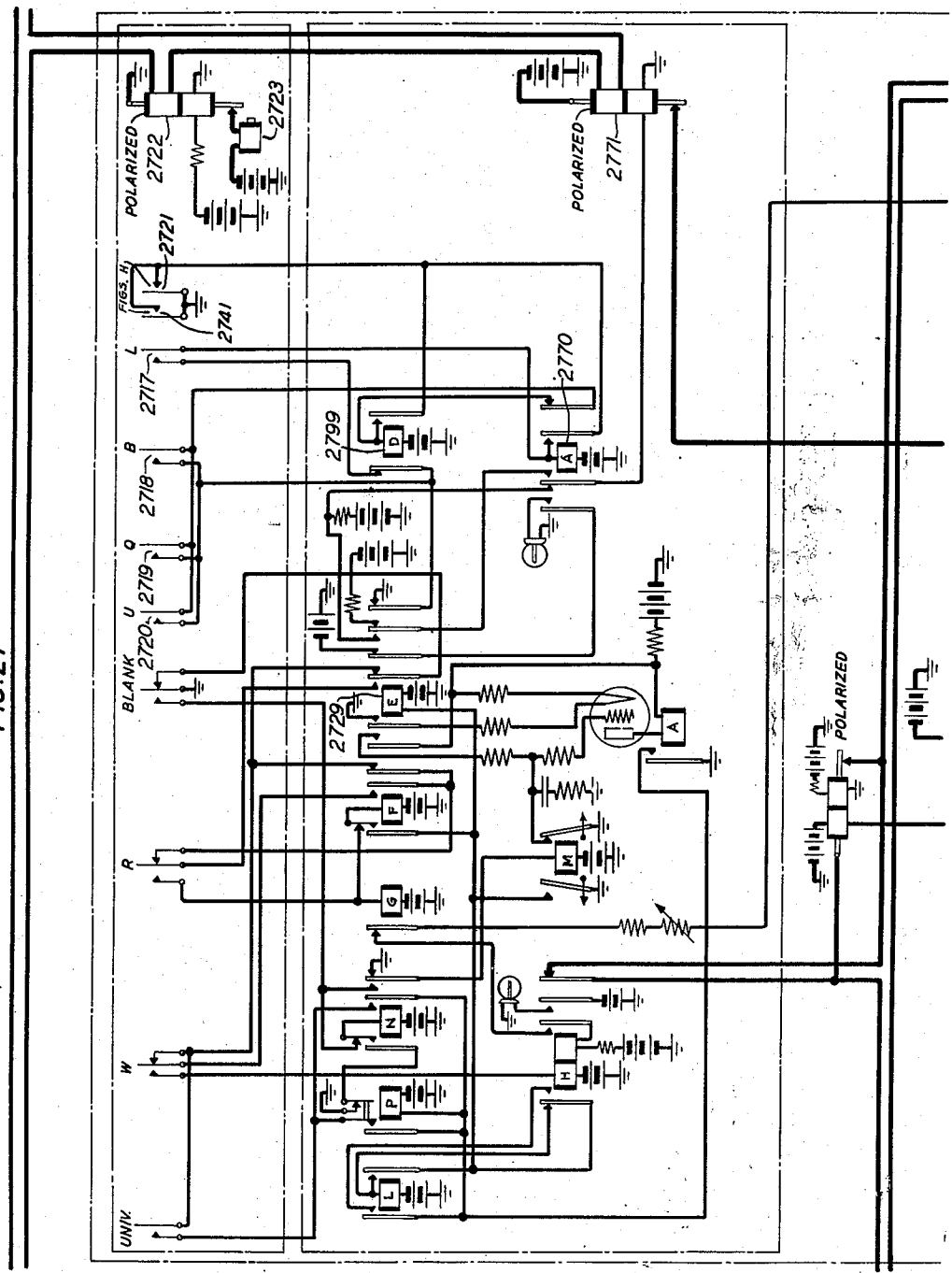

FIG. 27

INVENTORS: W. M. BACON
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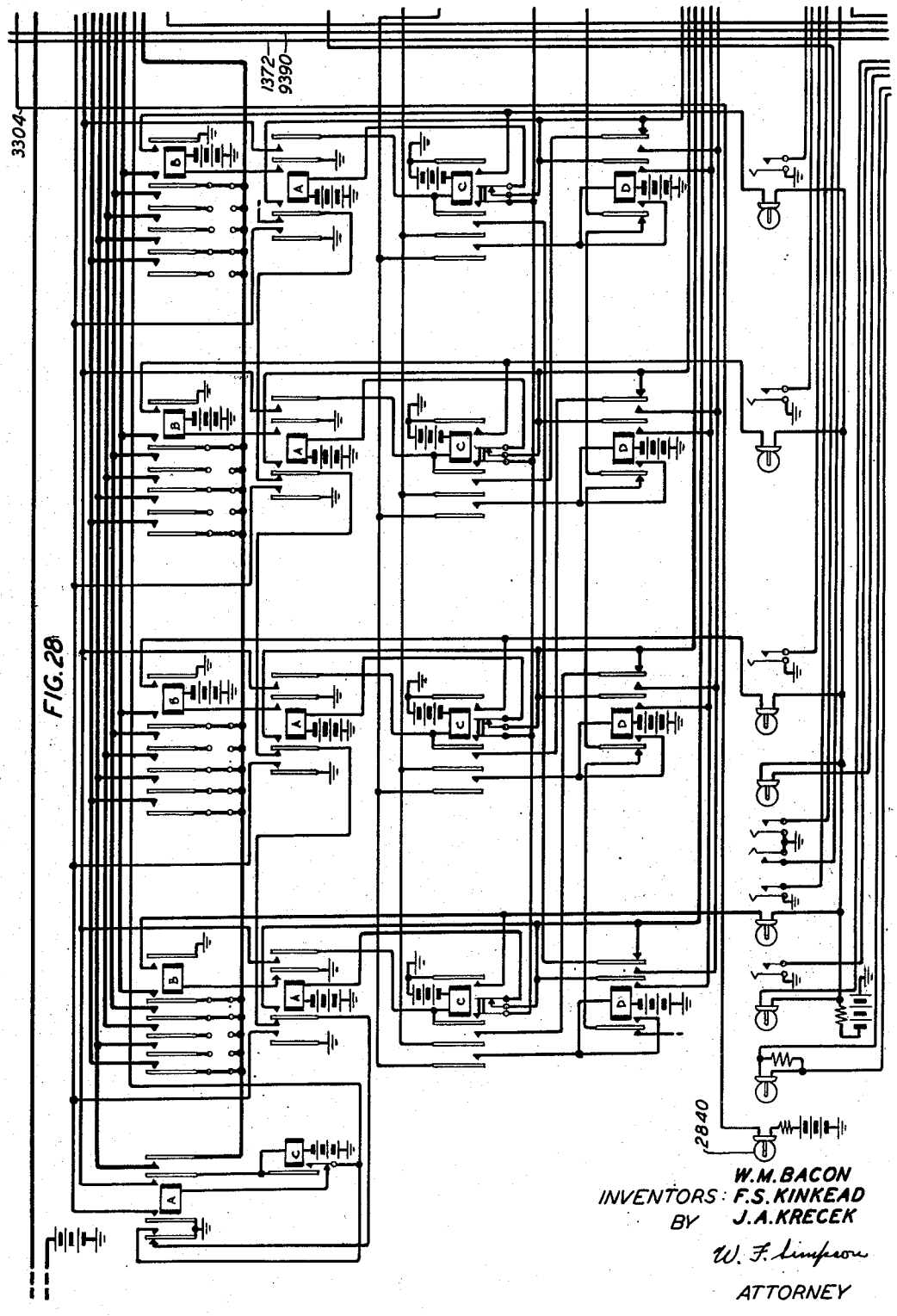

FIG. 28

INVENTORS: W.M.BACON F.S.KINKEAD J.A.KRECEK

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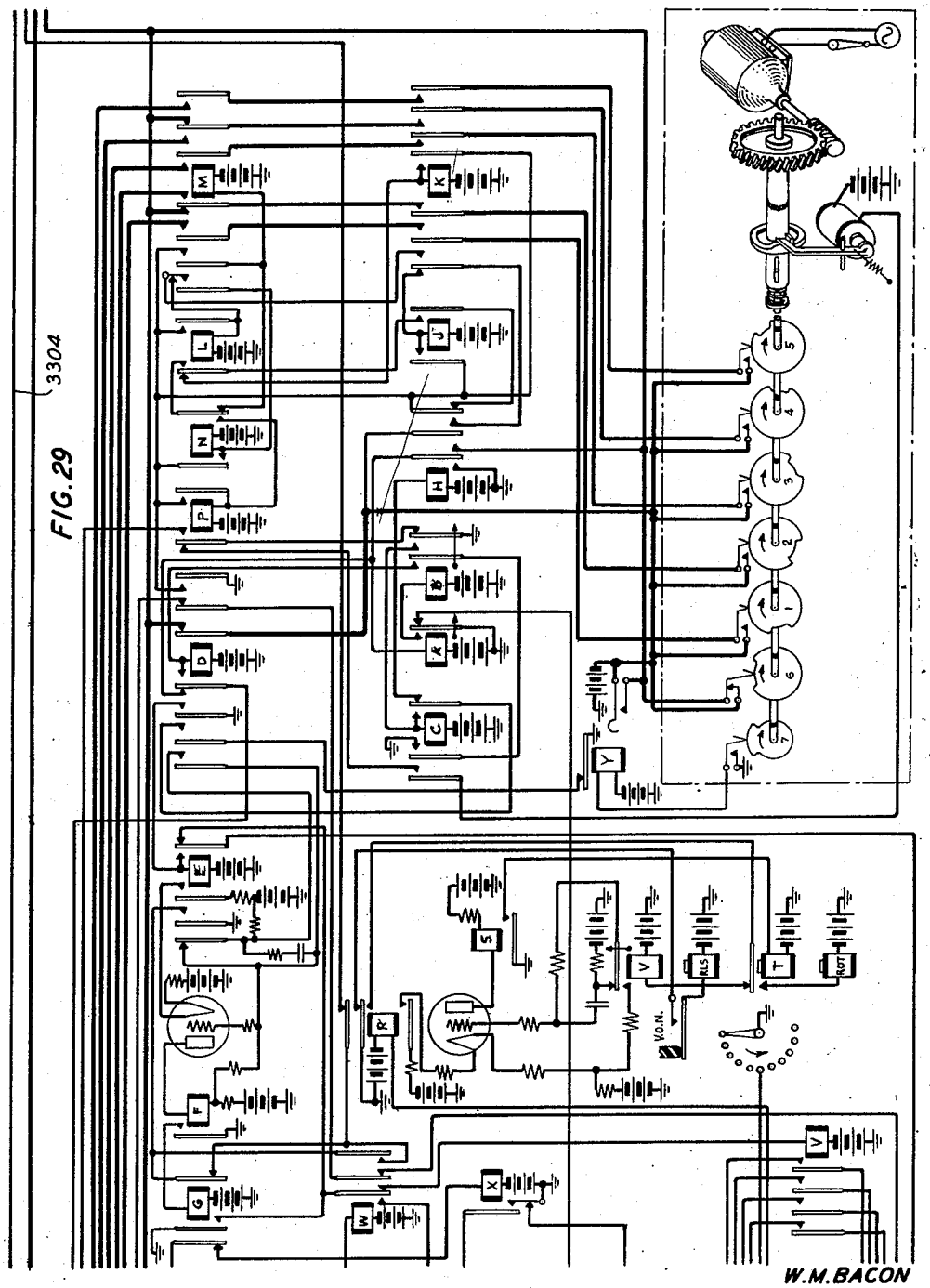

FIG. 29

INVENTORS: W.M.BACON
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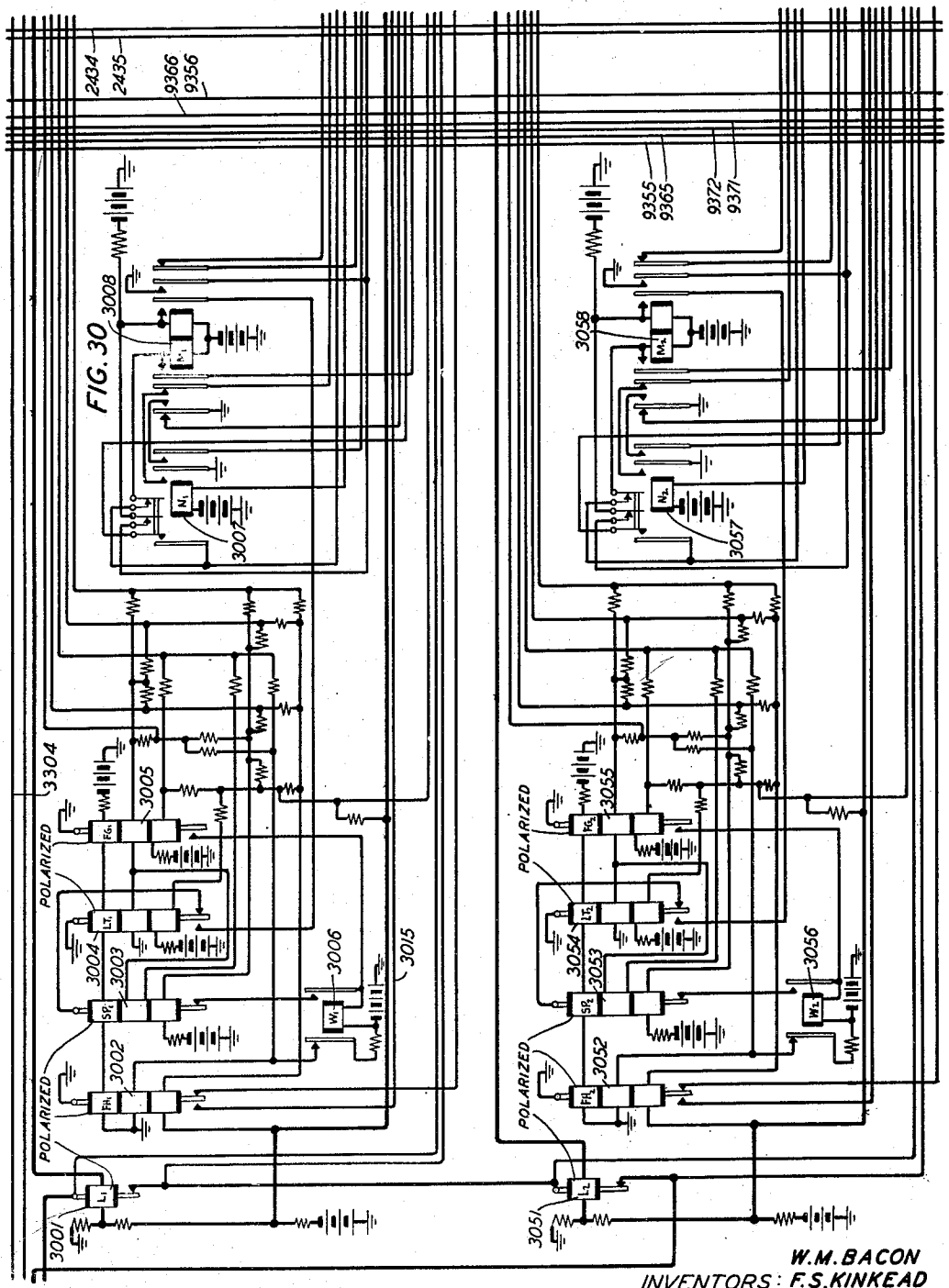

FIG. 30

INVENTORS: W.M.BACON F.S.KINKEAD J.A.KRECEK

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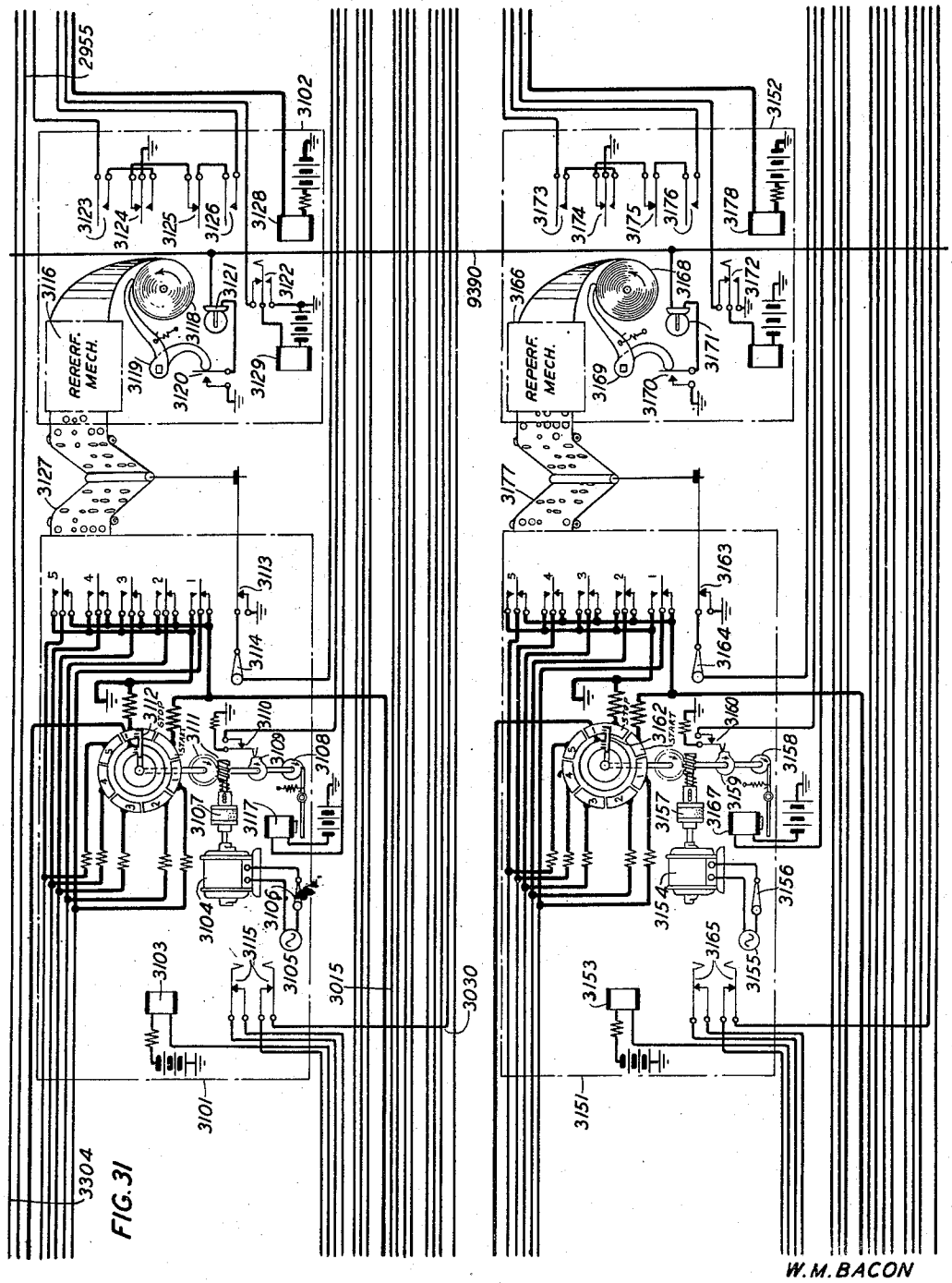

FIG. 31

INVENTORS: W. M. BACON, F. S. KINKEAD, J. A. KRECEK

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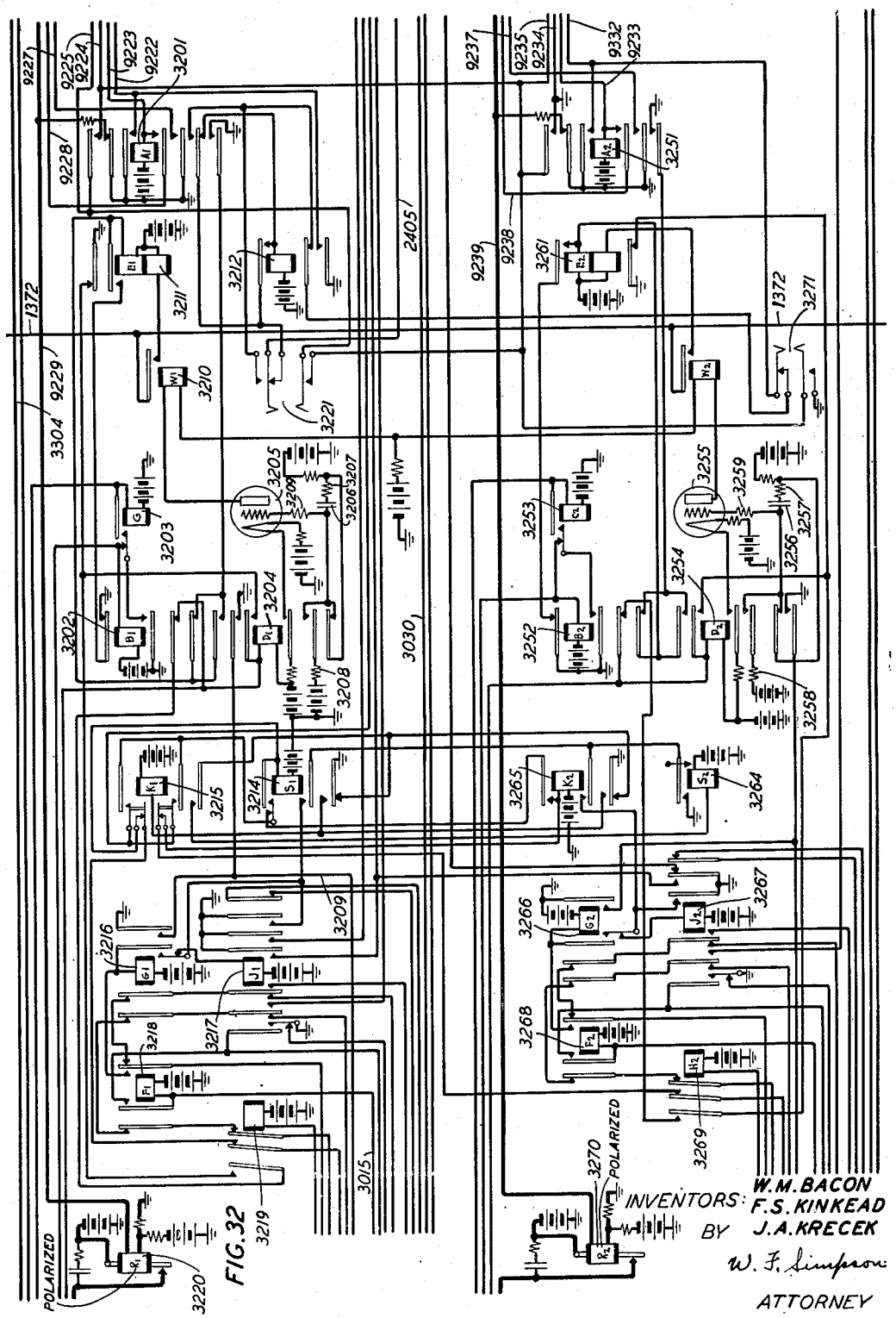

FIG. 32

INVENTORS: W. M. BACON
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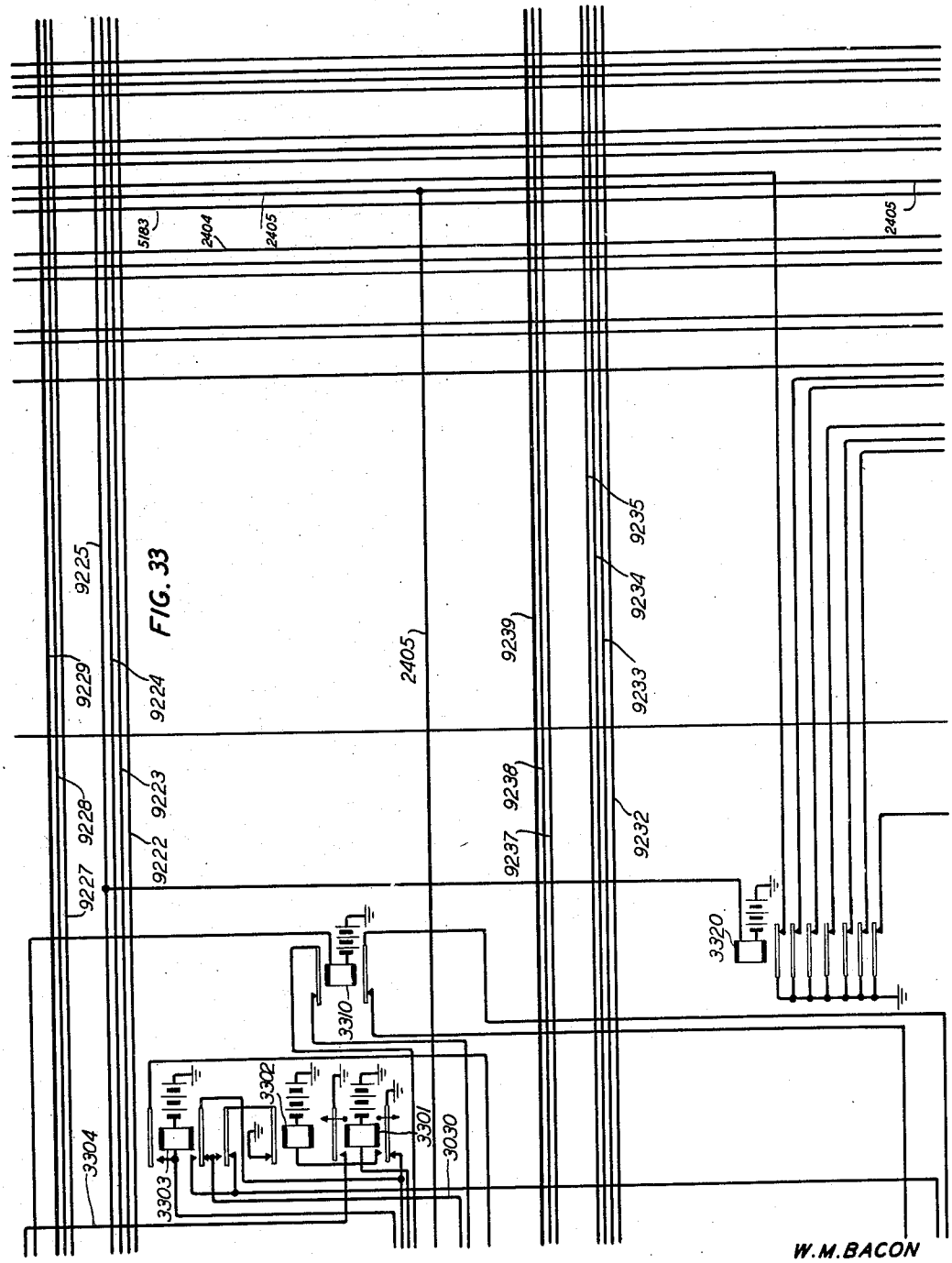

FIG. 33

INVENTORS: W.M.BACON F.S.KINKEAD J.A.KRECEK

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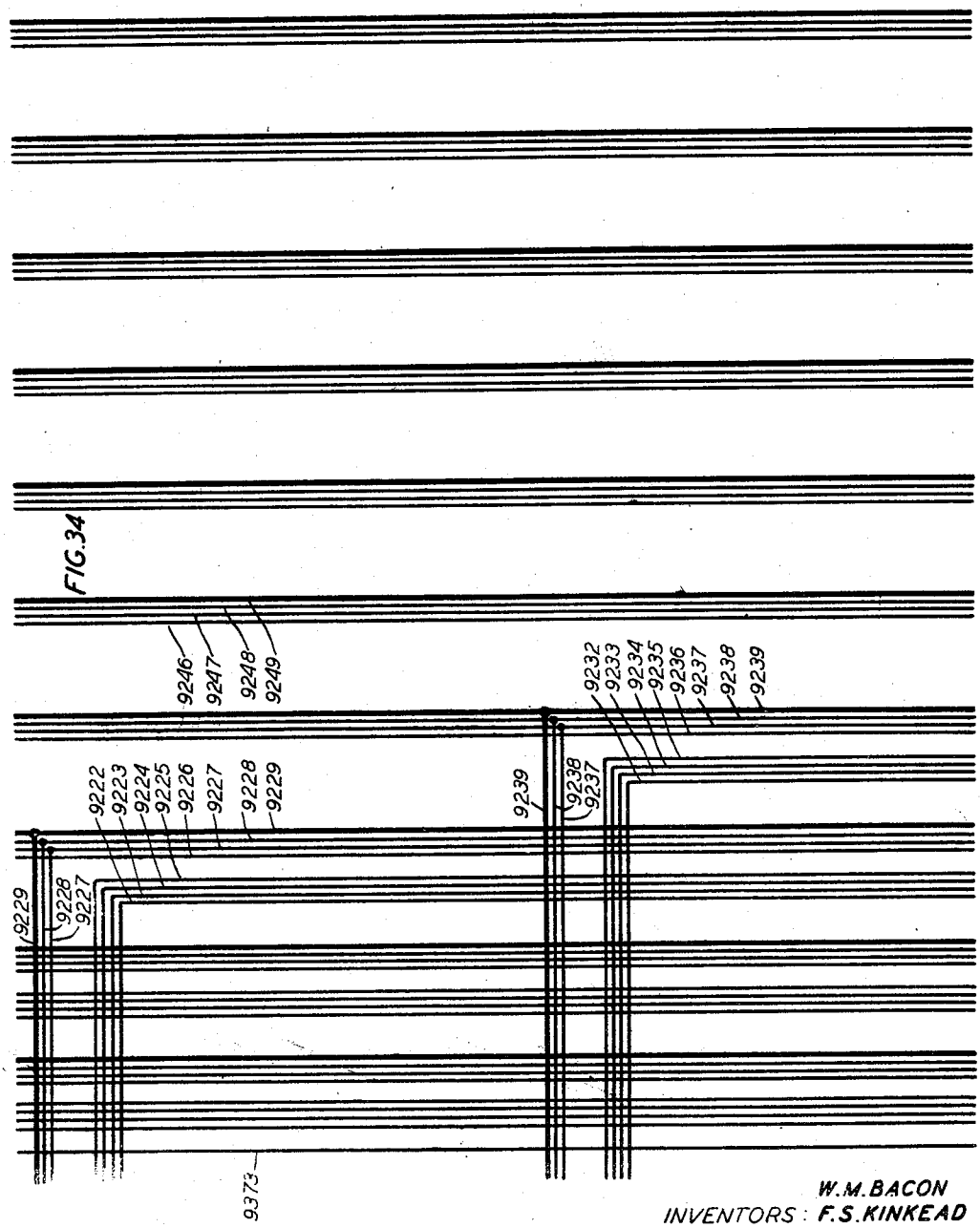

INVENTORS: W.M.BACON
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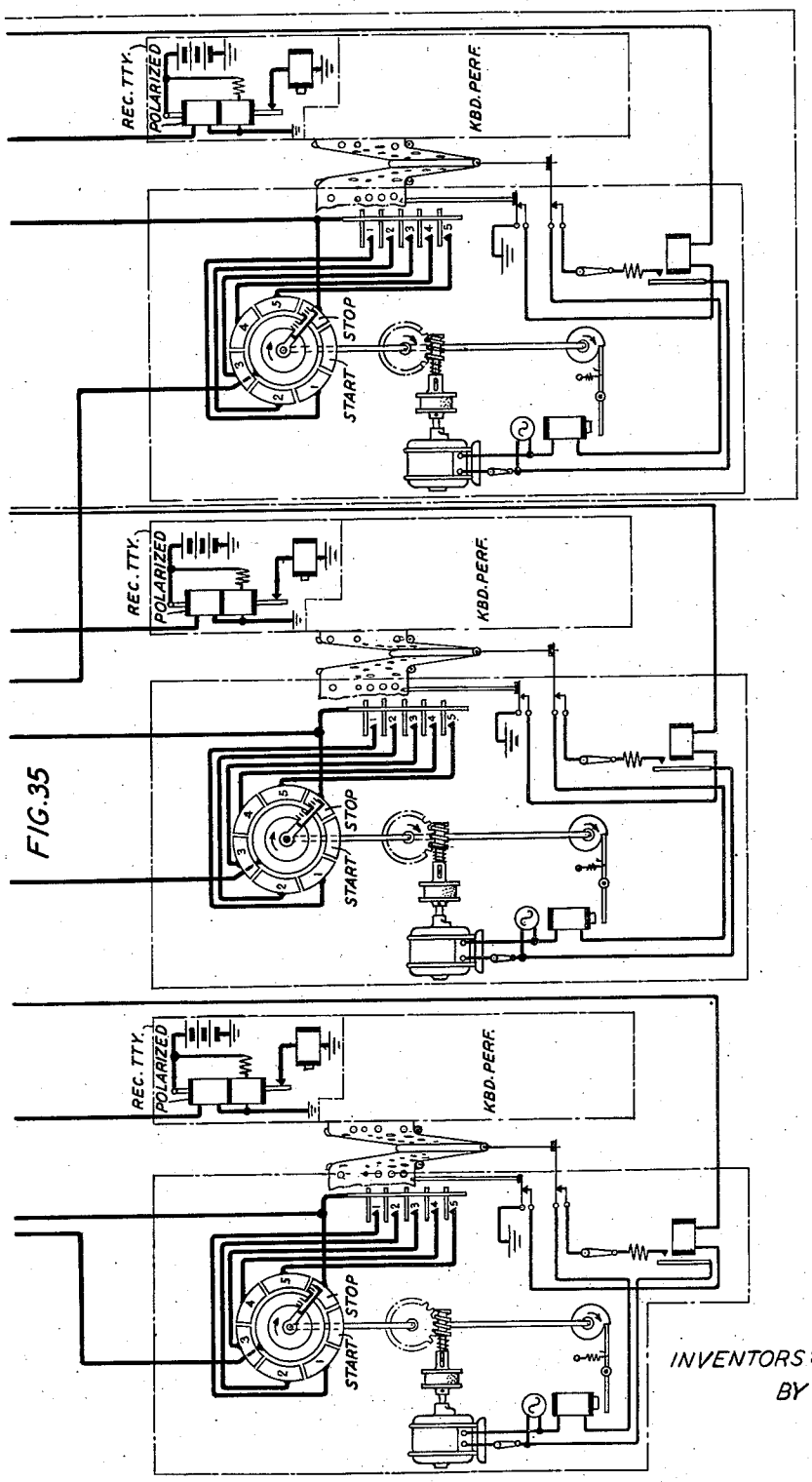

FIG. 35

INVENTORS: W. M. BACON
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J. A. KRECEK
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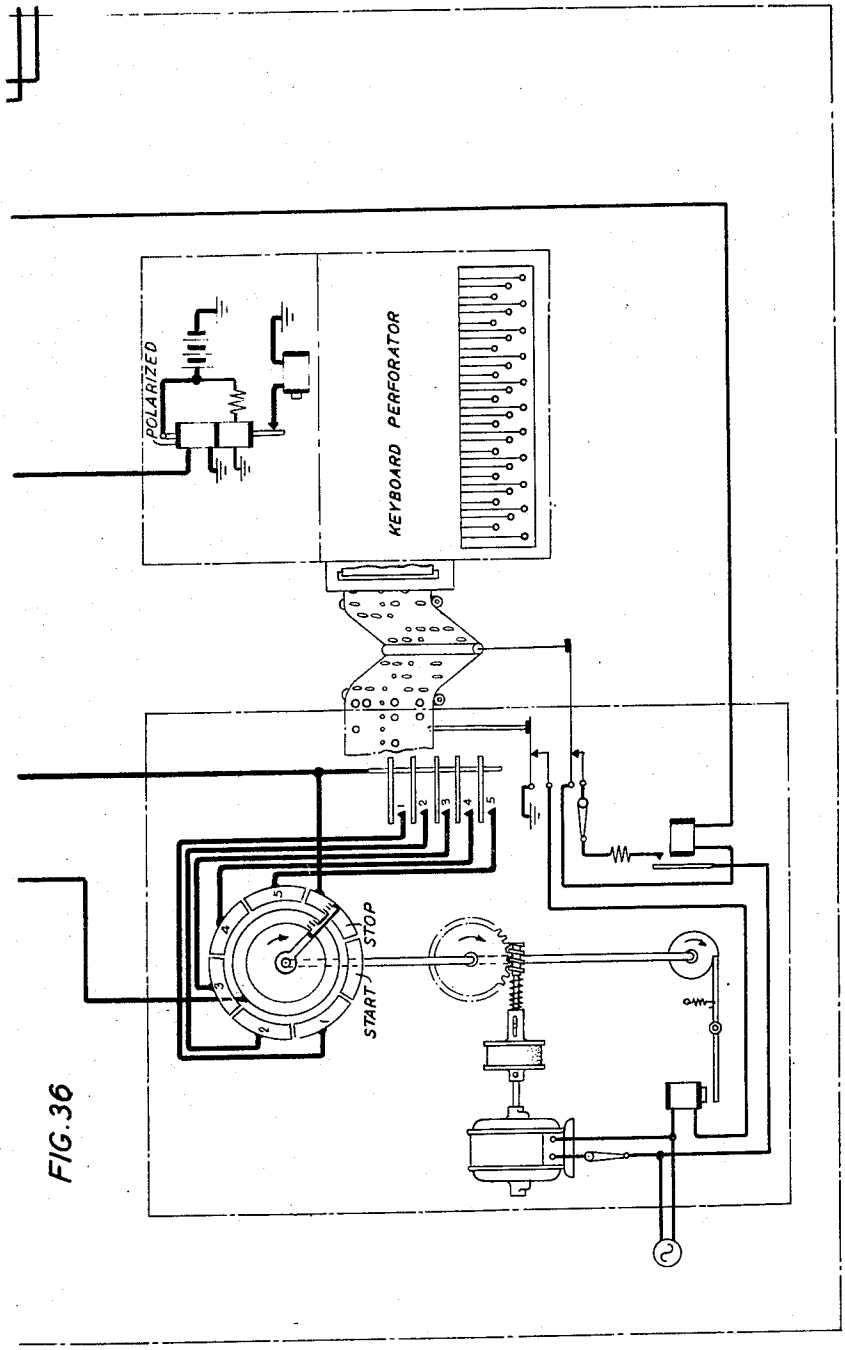

FIG. 36

INVENTORS: W. M. BACON
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J. A. KRECEK

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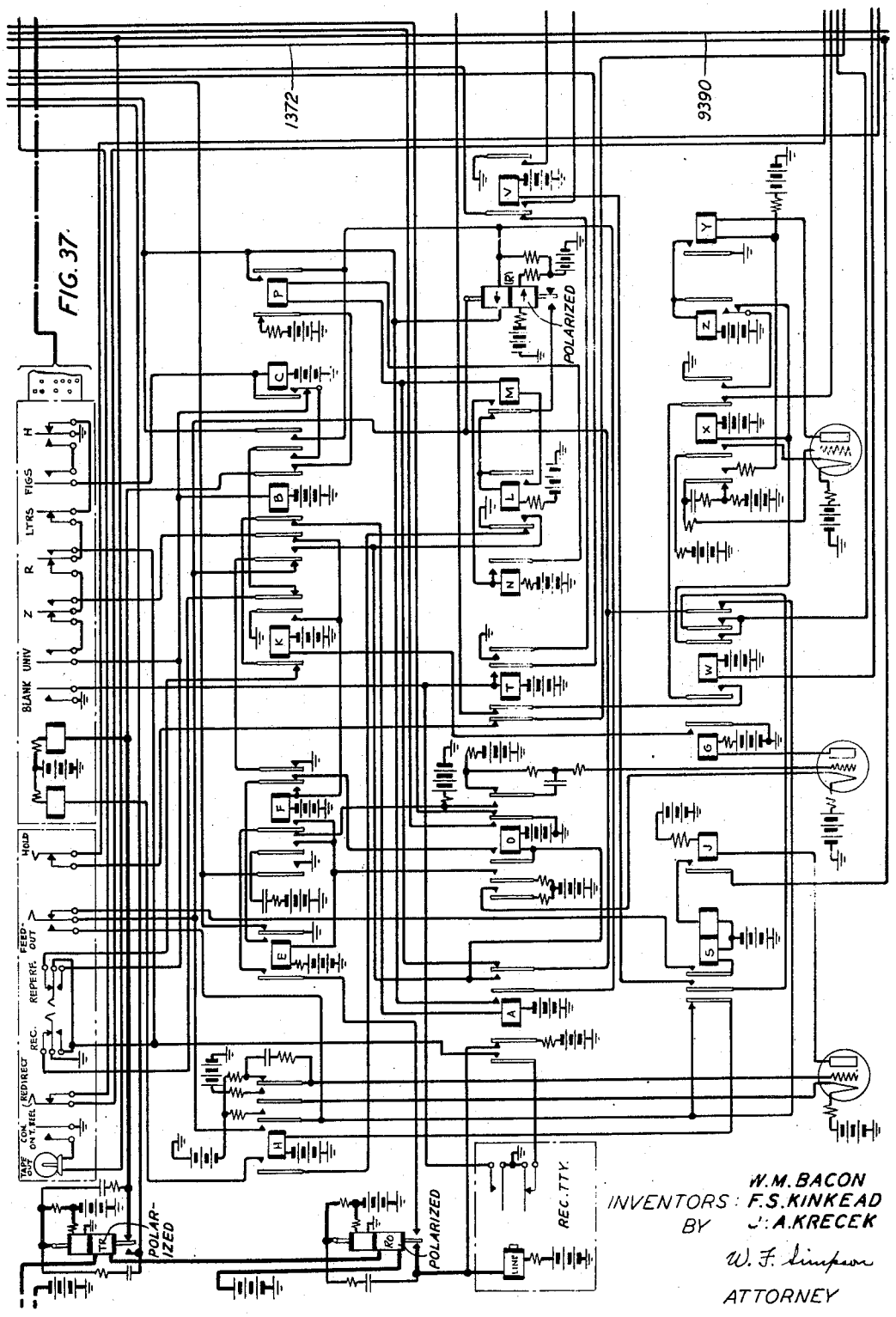

INVENTORS: W. M. BACON
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J. A. KRECEK
BY W. F. Simpson
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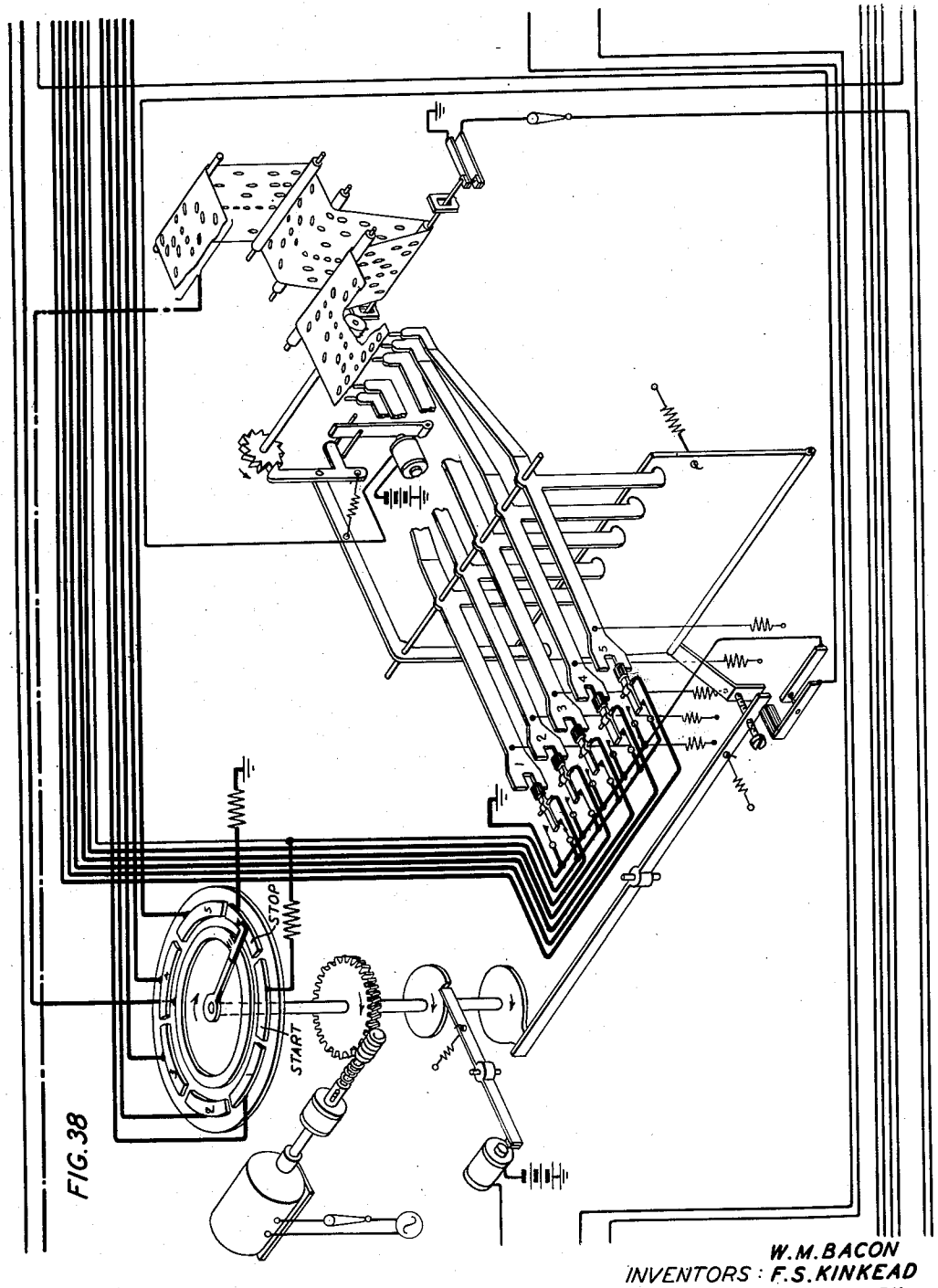

FIG. 38

INVENTORS: W. M. BACON
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J. A. KRECEK

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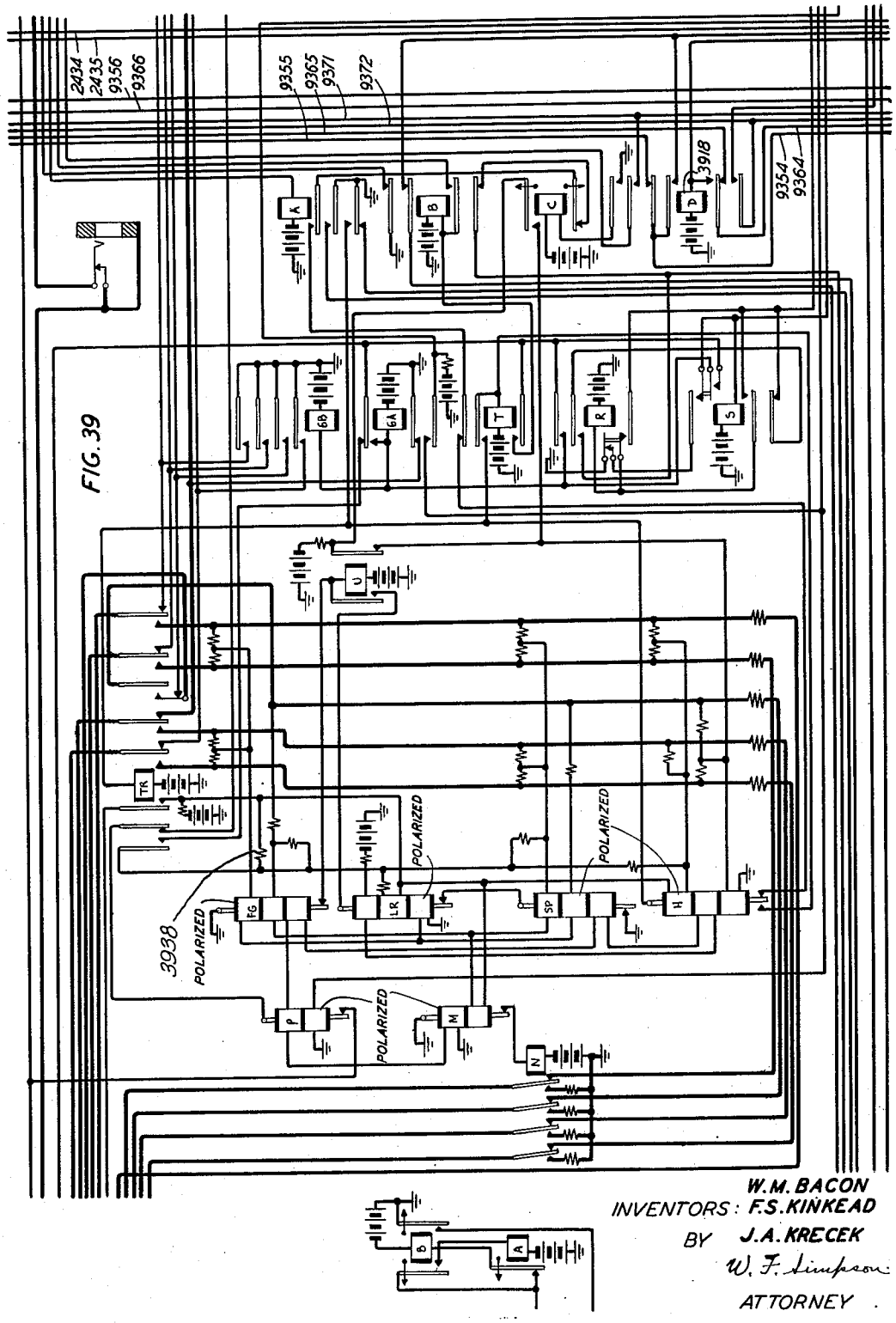

FIG. 39

INVENTORS: W. M. BACON
F. S. KINKEAD
BY J. A. KRECEK
W. F. Simpson
ATTORNEY

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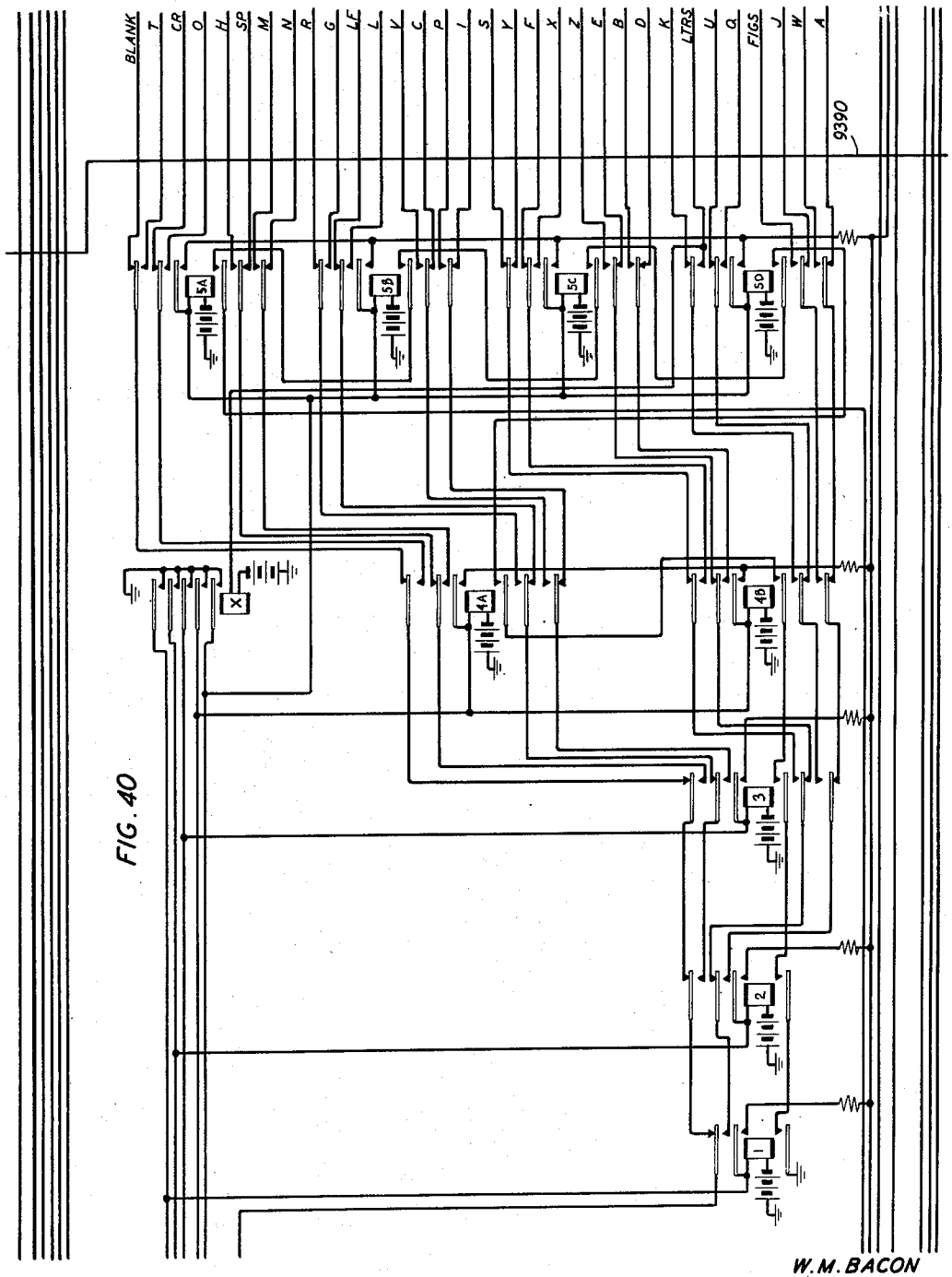

FIG. 40

INVENTORS: W.M. BACON
F.S. KINKEAD
J.A. KRECEK

BY W. F. Simpson.

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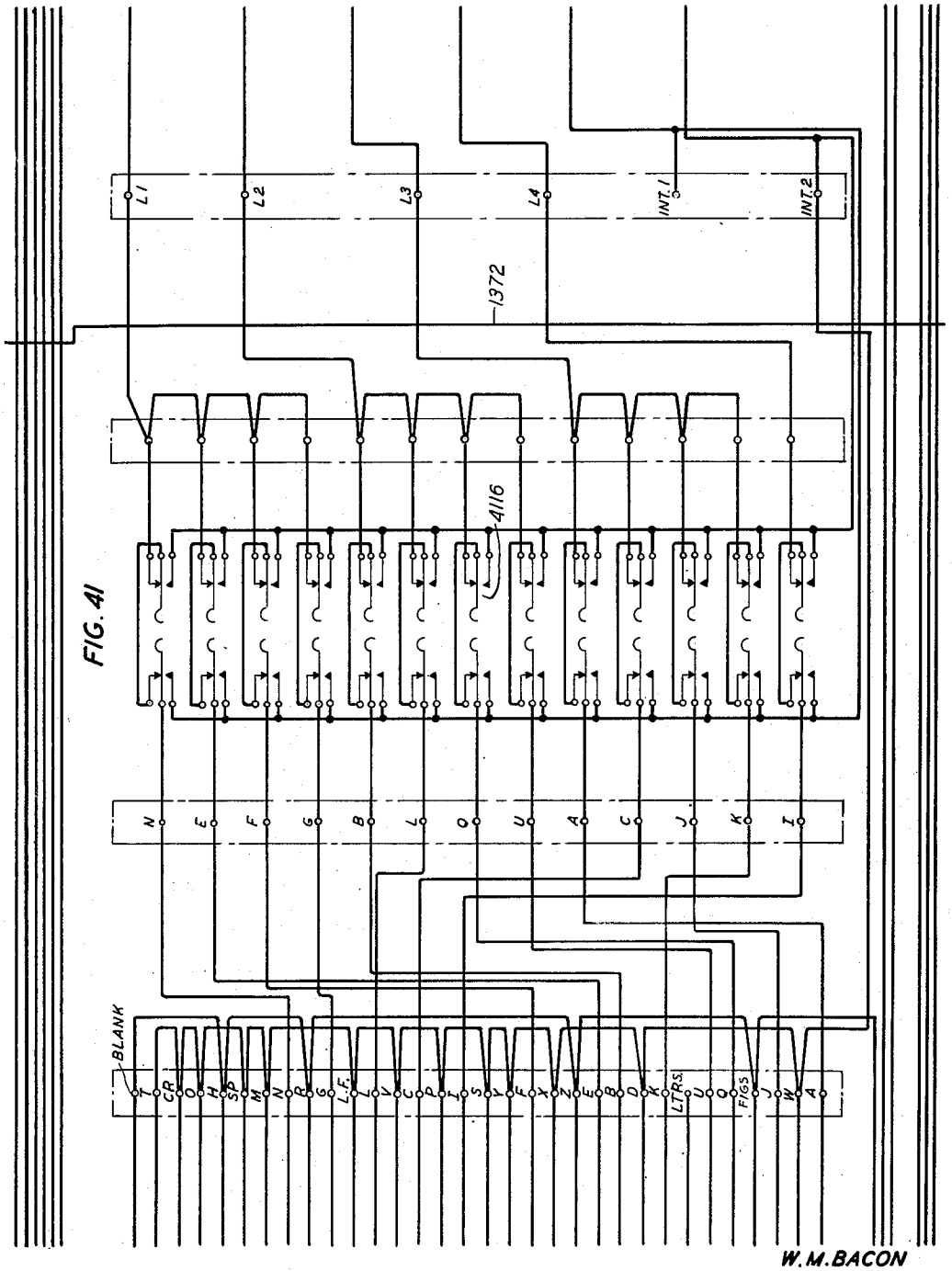

FIG. 41

INVENTORS: W.M.BACON F.S.KINKEAD J.A.KRECEK

BY W. F. Simpson.

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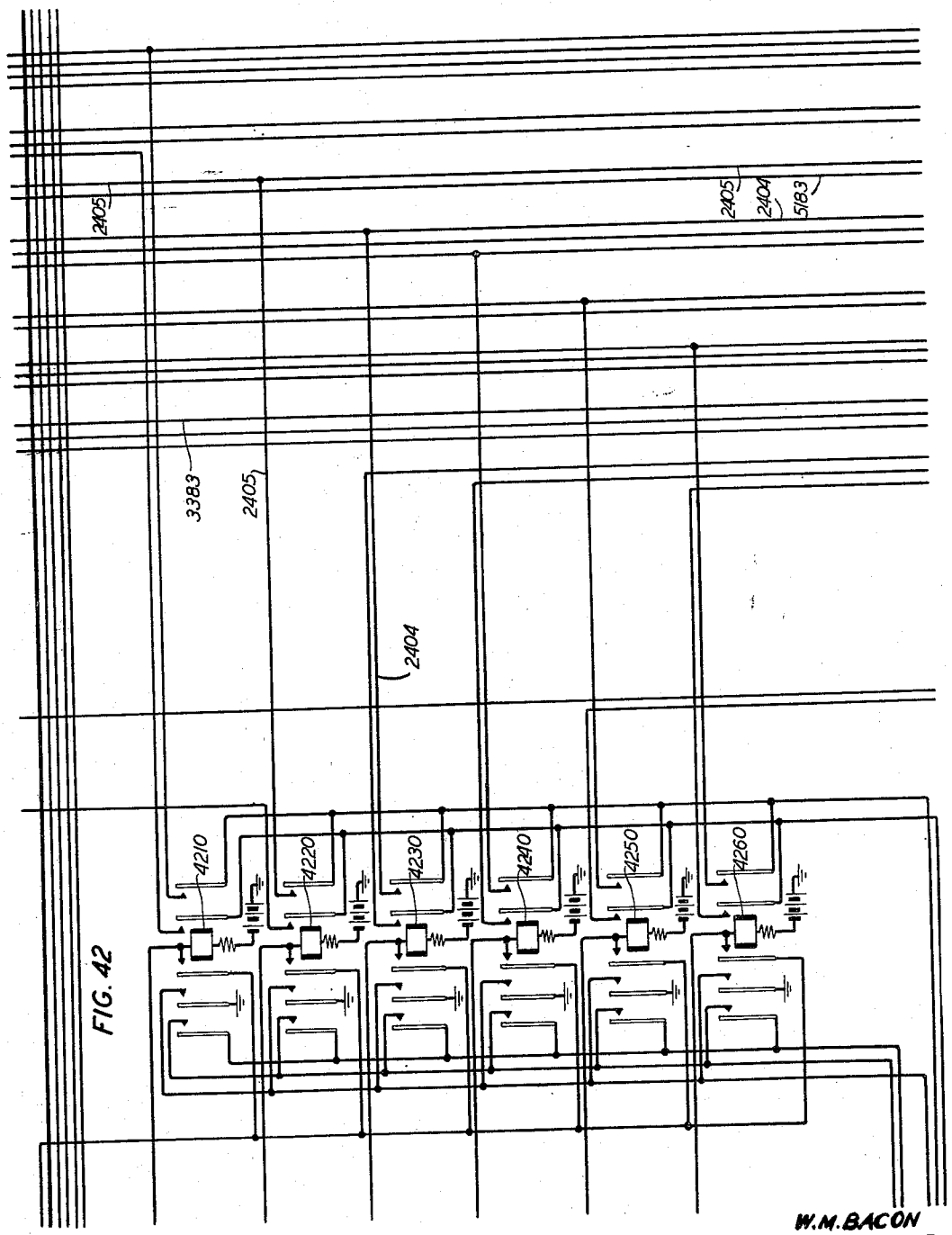

FIG. 42

INVENTORS: W.M.BACON
F.S.KINKEAD
J.A.KRECEK

BY W. F. Simpson

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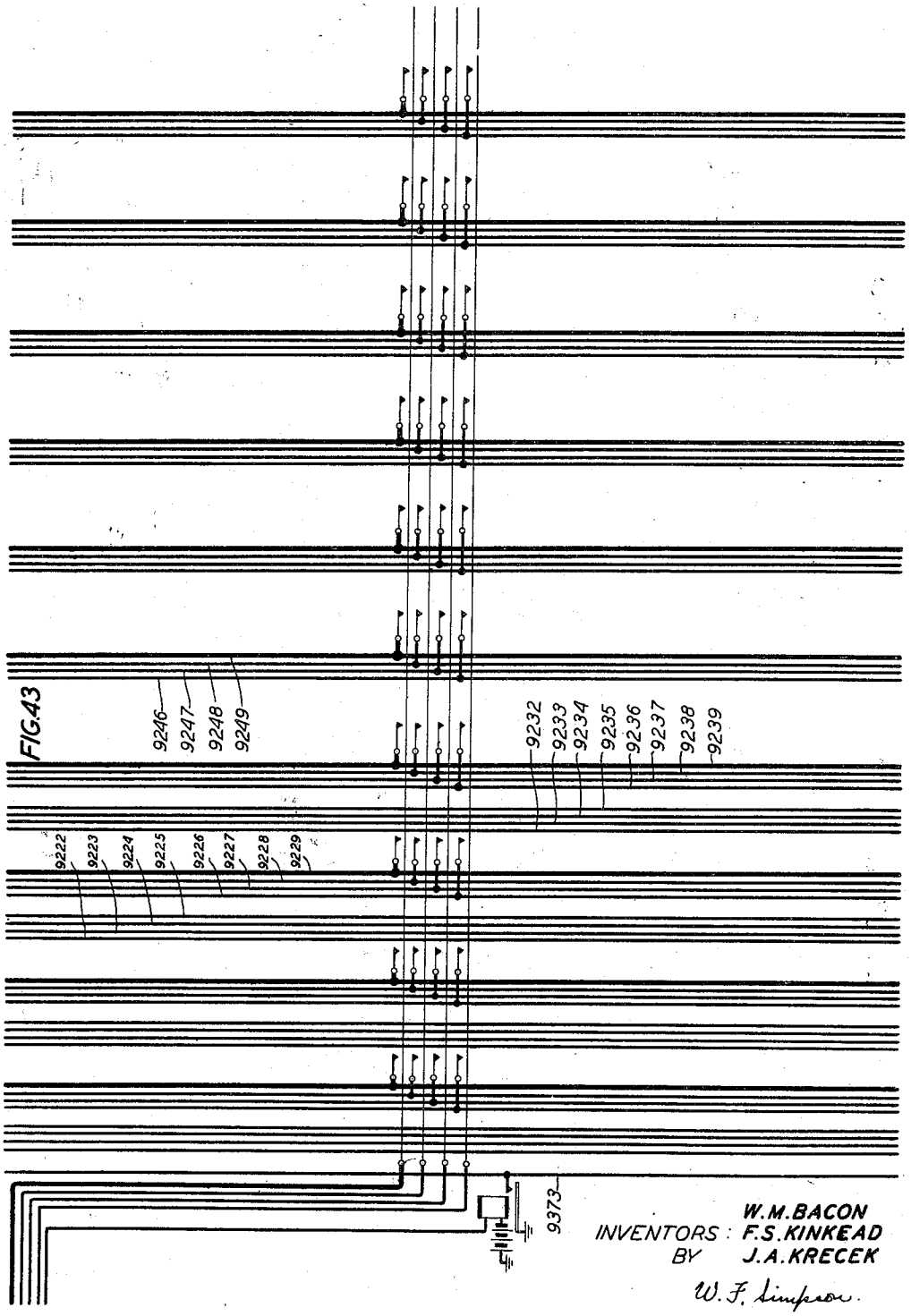

FIG.43

INVENTORS: W.M.BACON F.S.KINKEAD J.A.KRECEK

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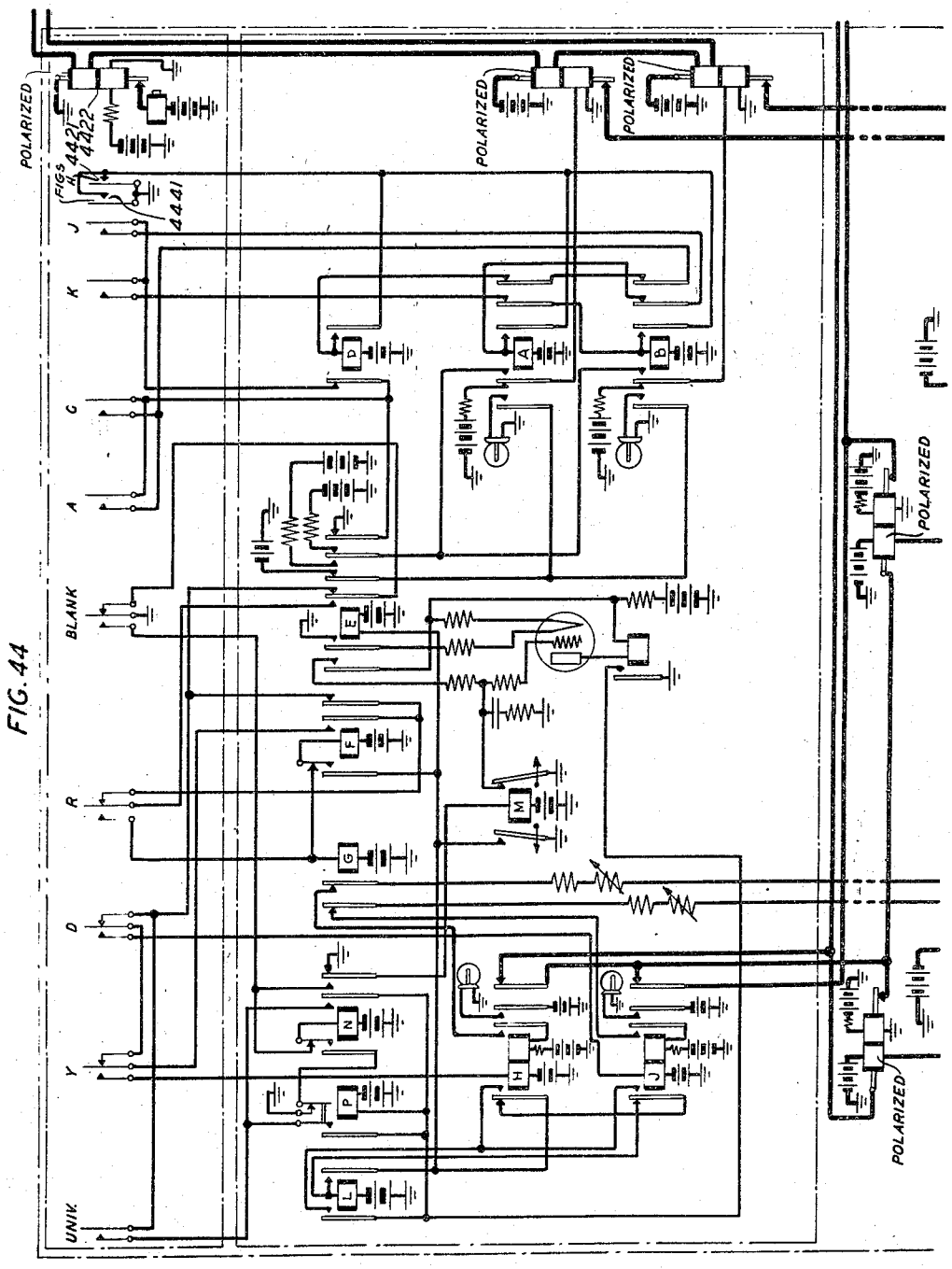

FIG. 44

INVENTORS: W. M. BACON
F. S. KINKEAD
J. A. KRECEK
BY W. F. Simpson
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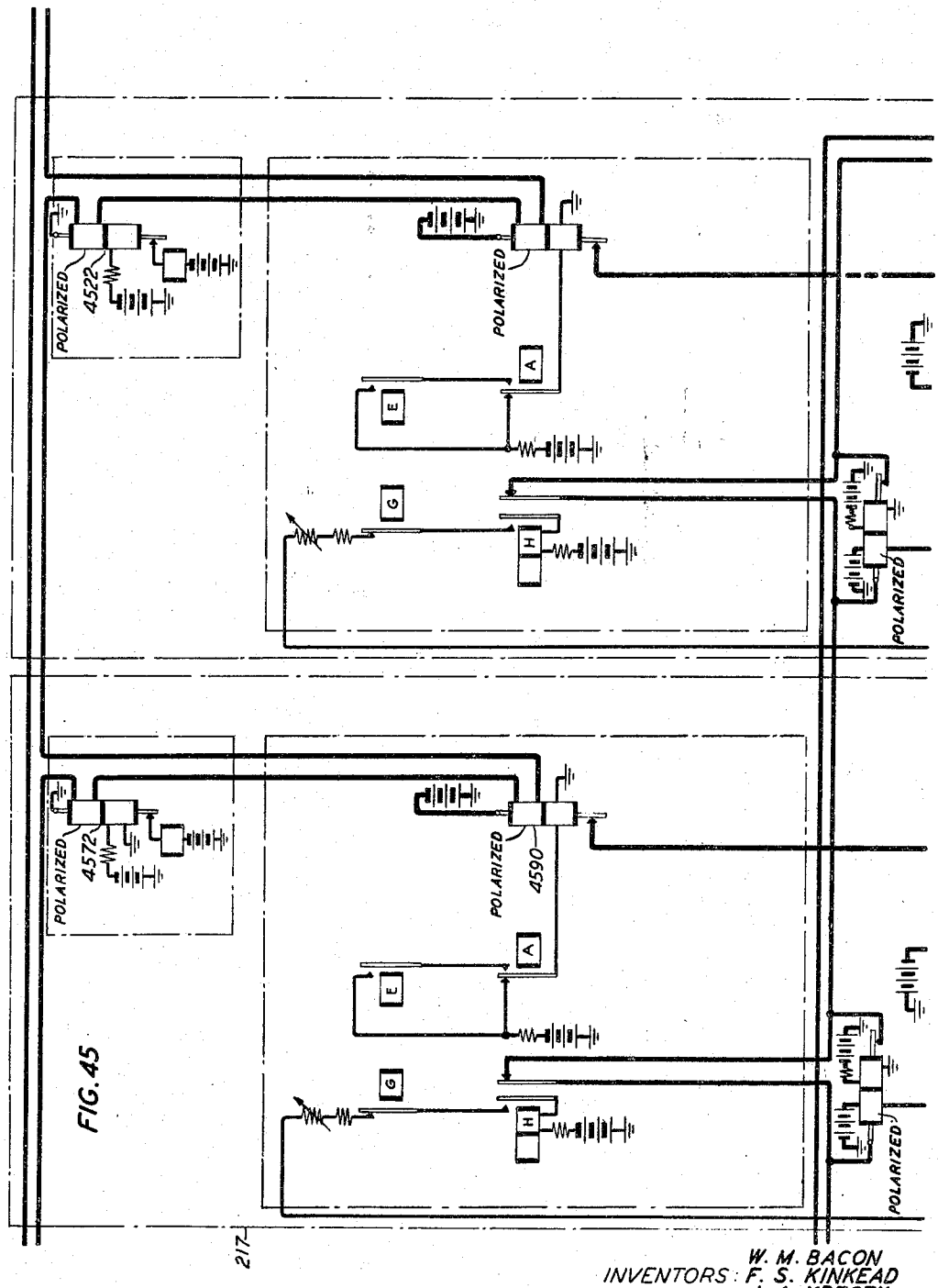

FIG. 45

INVENTORS: W. M. BACON
F. S. KINKEAD
J. A. KRECEK

BY W. F. Simpson

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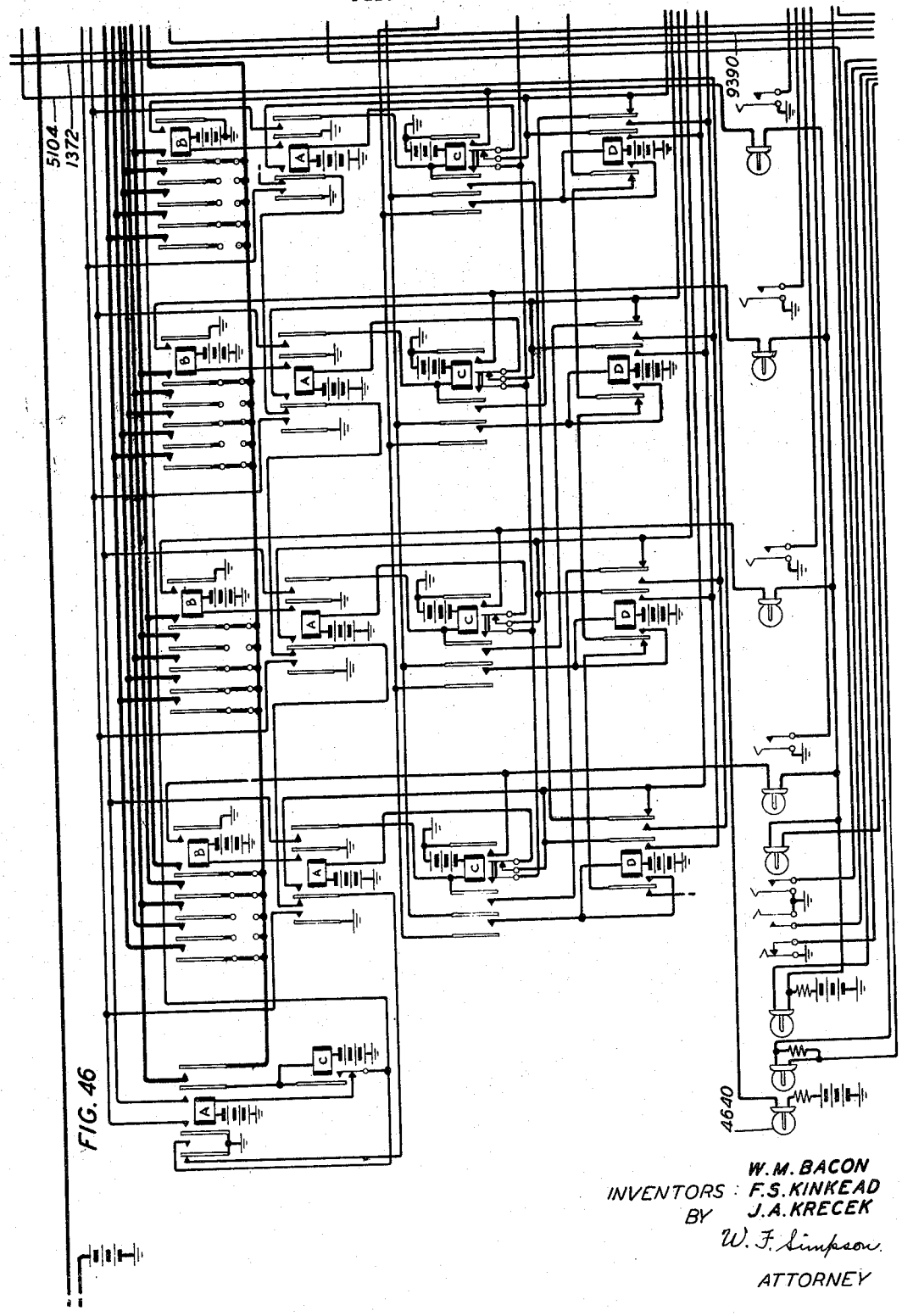

FIG. 46

INVENTORS: W. M. BACON, F. S. KINKEAD, J. A. KRECEK

BY W. F. Simpson

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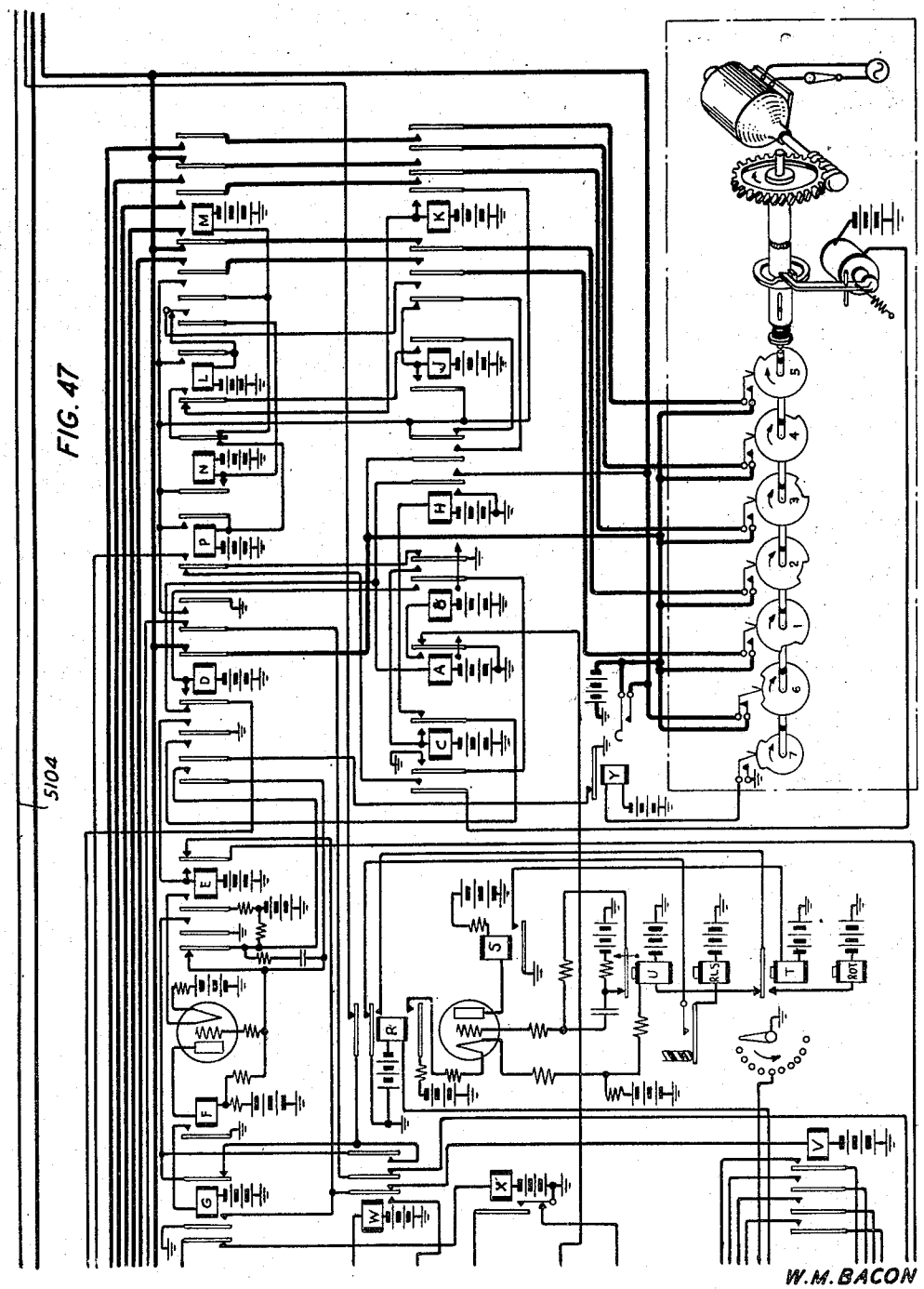
FIG. 47



INVENTORS: W.M. BACON
F.S. KINKEAD
BY J.A. KRECEK

W. F. Simpson.

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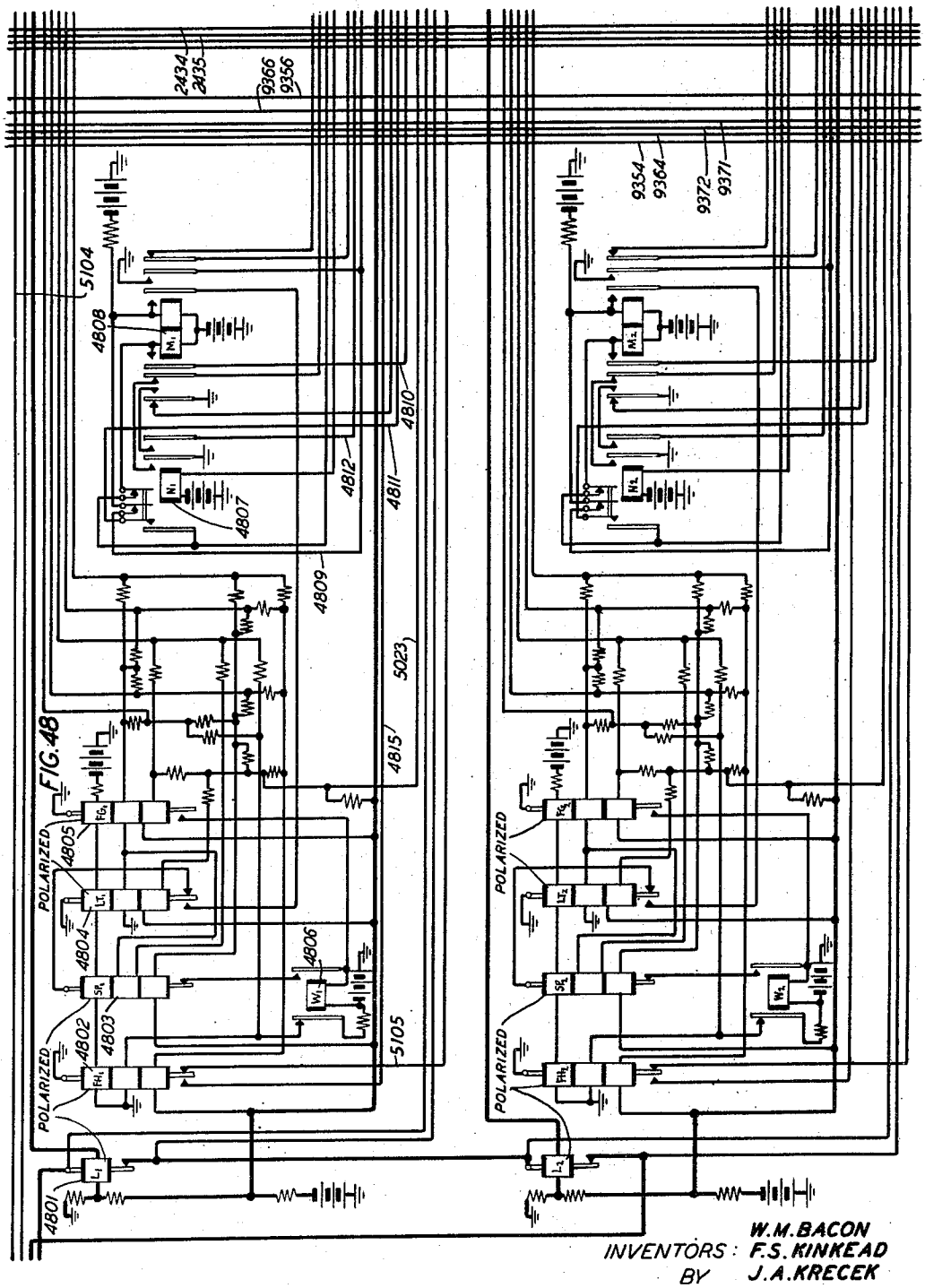

FIG. 48

INVENTORS: W.M.BACON F.S.KINKEAD J.A.KRECEK

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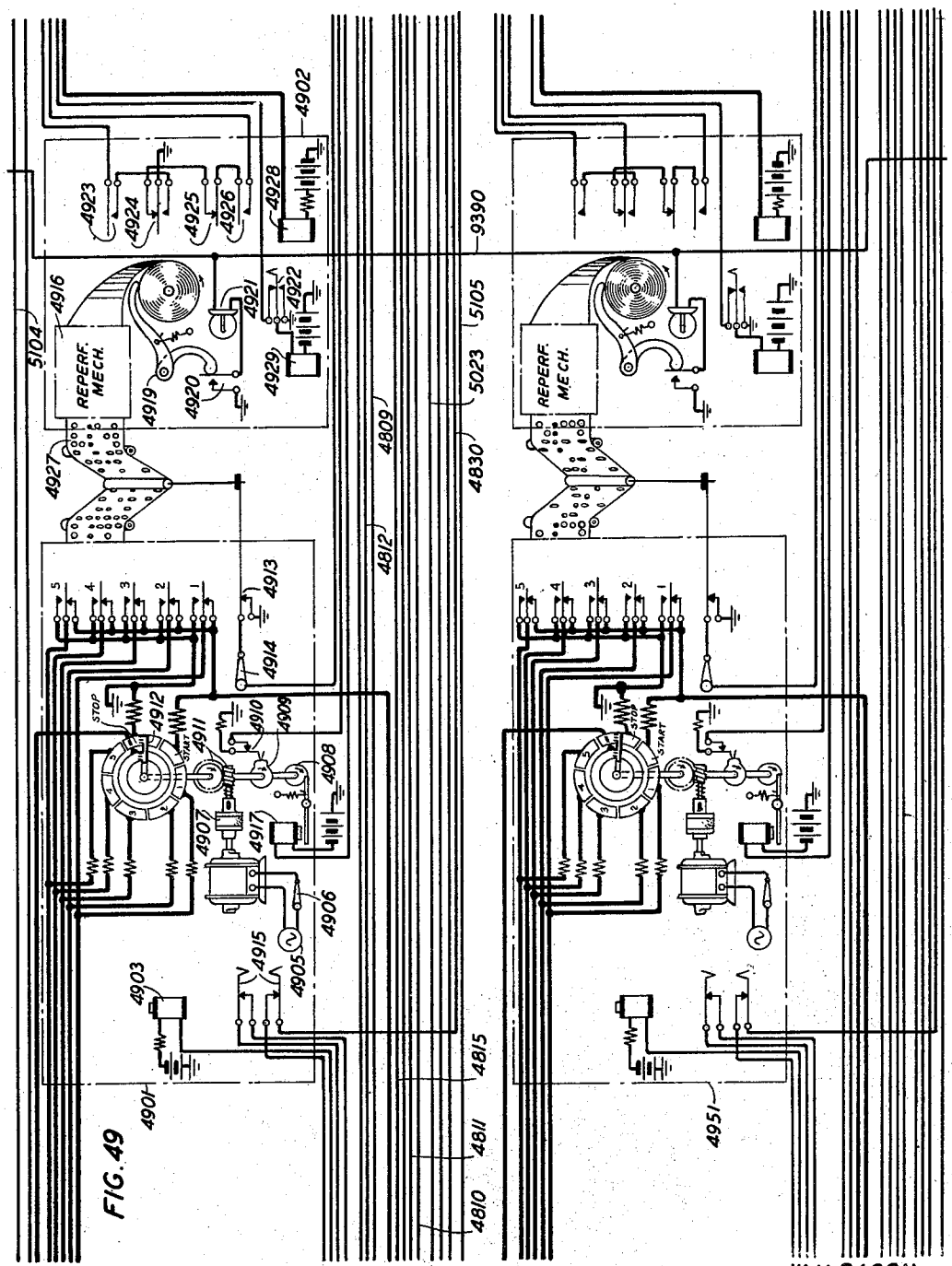

FIG. 49

INVENTORS: W. M. BACON, F. S. KINKEAD, J. A. KRECEK

BY W. F. Simpson.

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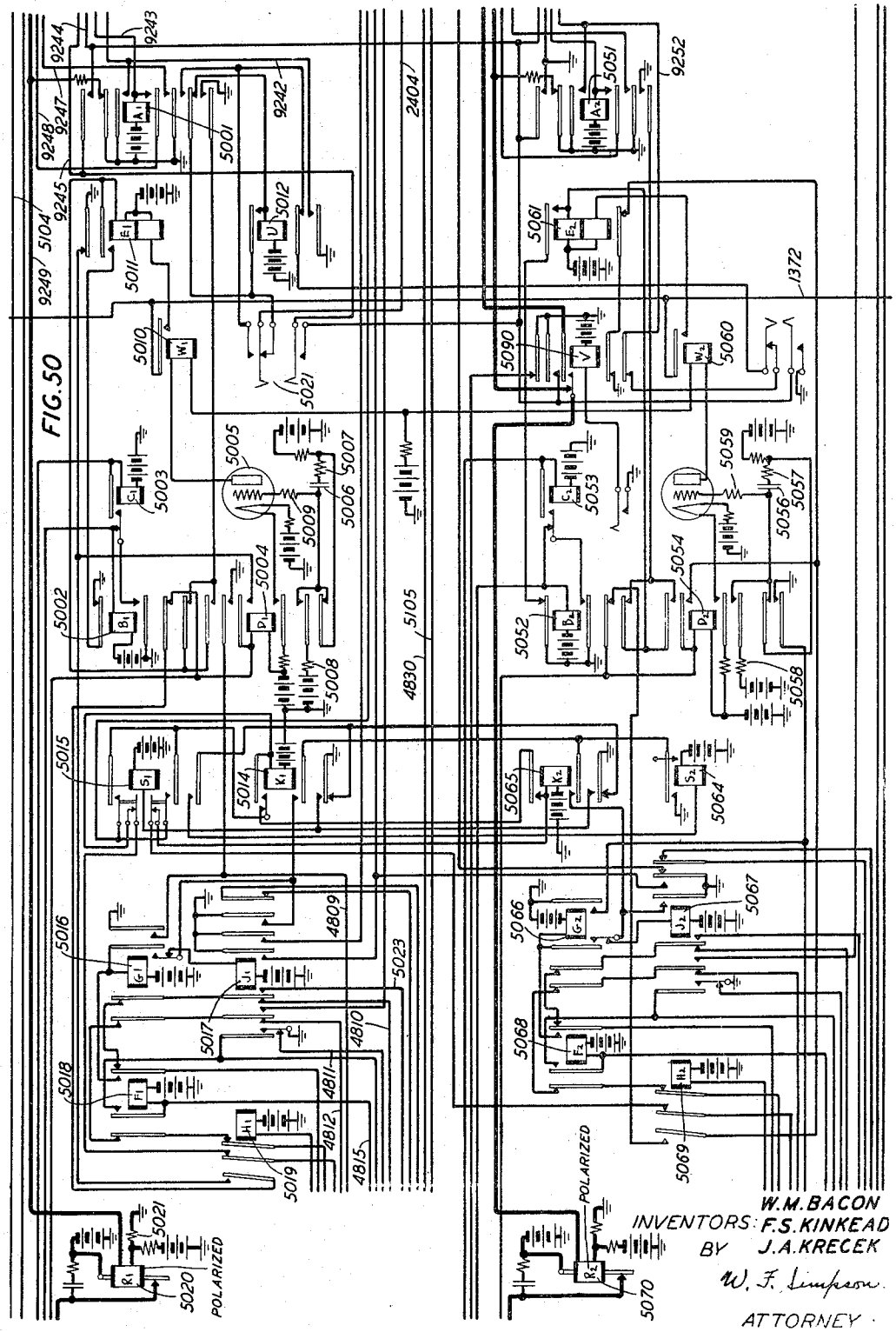

INVENTORS: W.M. BACON, F.S. KINKEAD, BY J.A. KRECEK

W. F. Simpson

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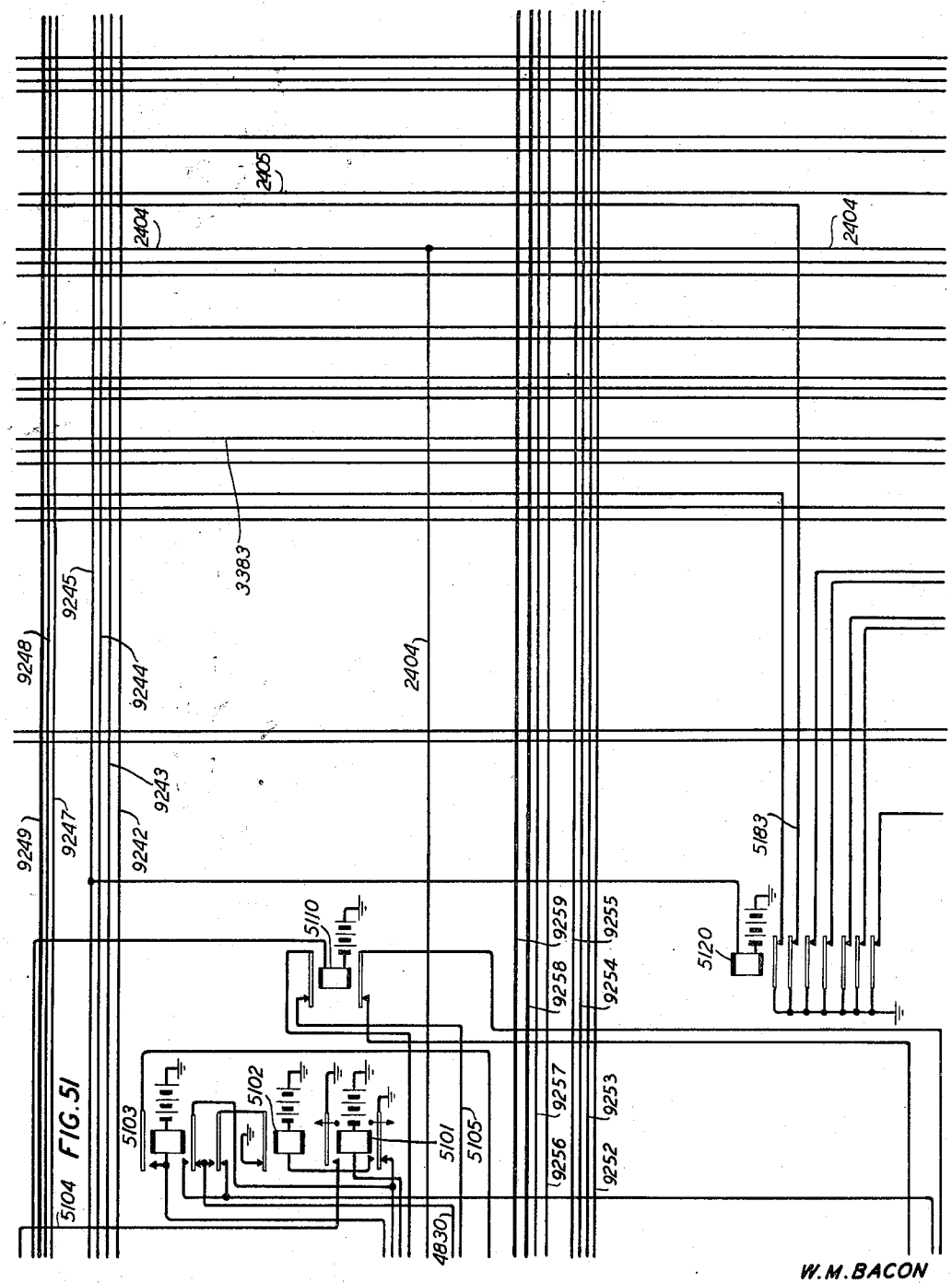

FIG. 51

INVENTORS: W. M. BACON
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BY J. A. KRECEK

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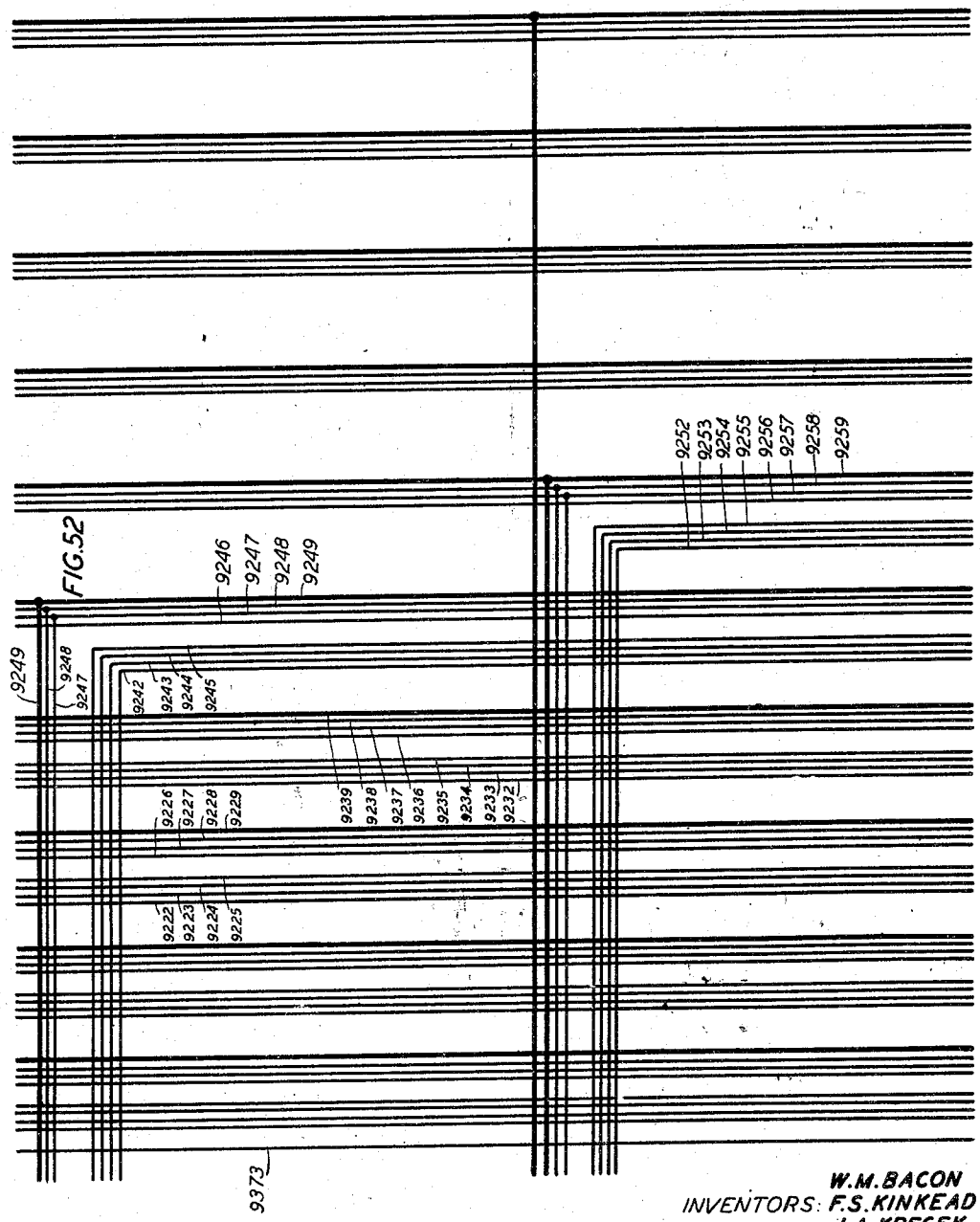

INVENTORS: W.M.BACON
F.S.KINKEAD
J.A.KRECEK
BY W. F. Simpson.
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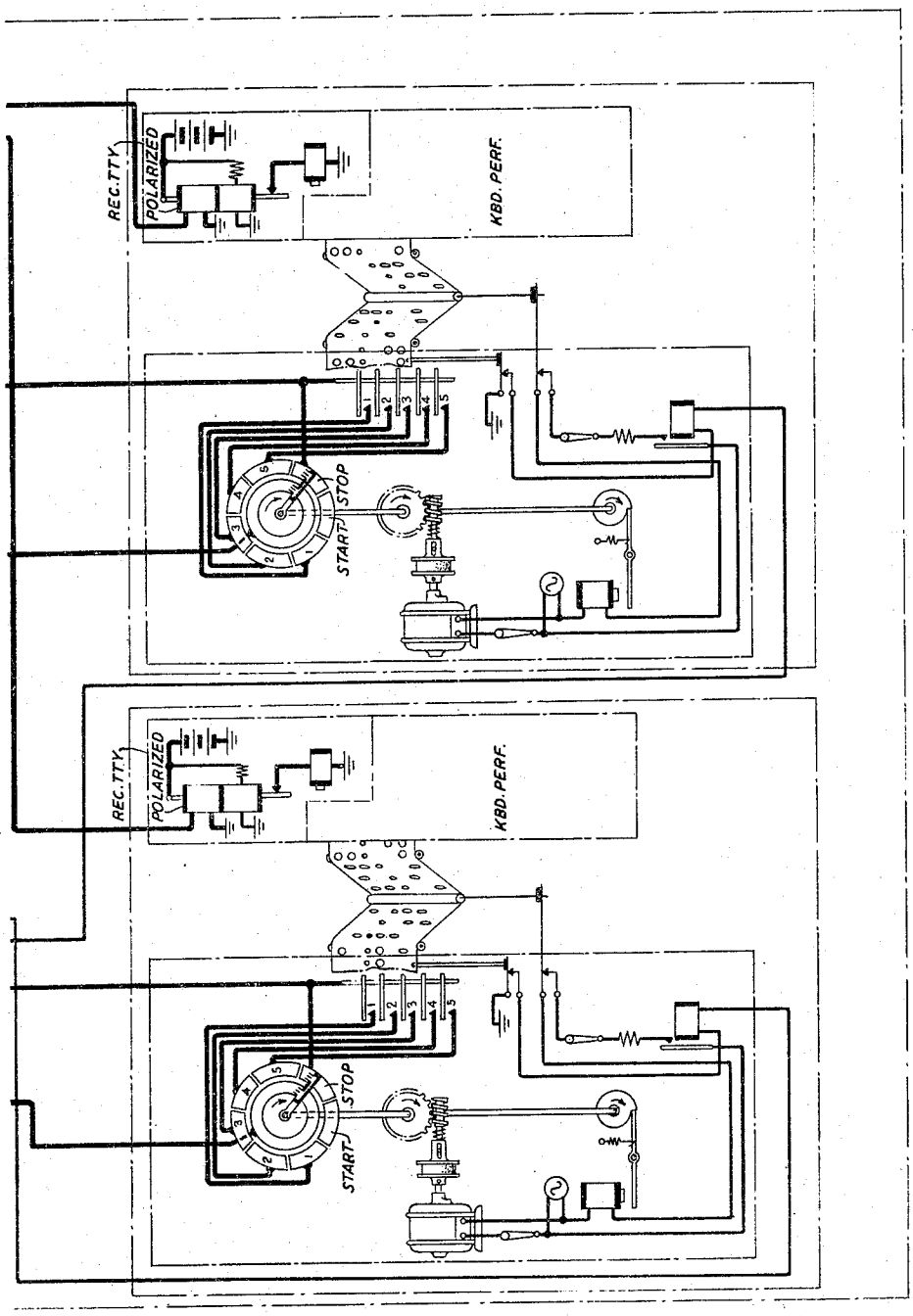

FIG. 53

INVENTORS: W. M. BACON
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J. A. KRECEK

BY W. F. Simpson

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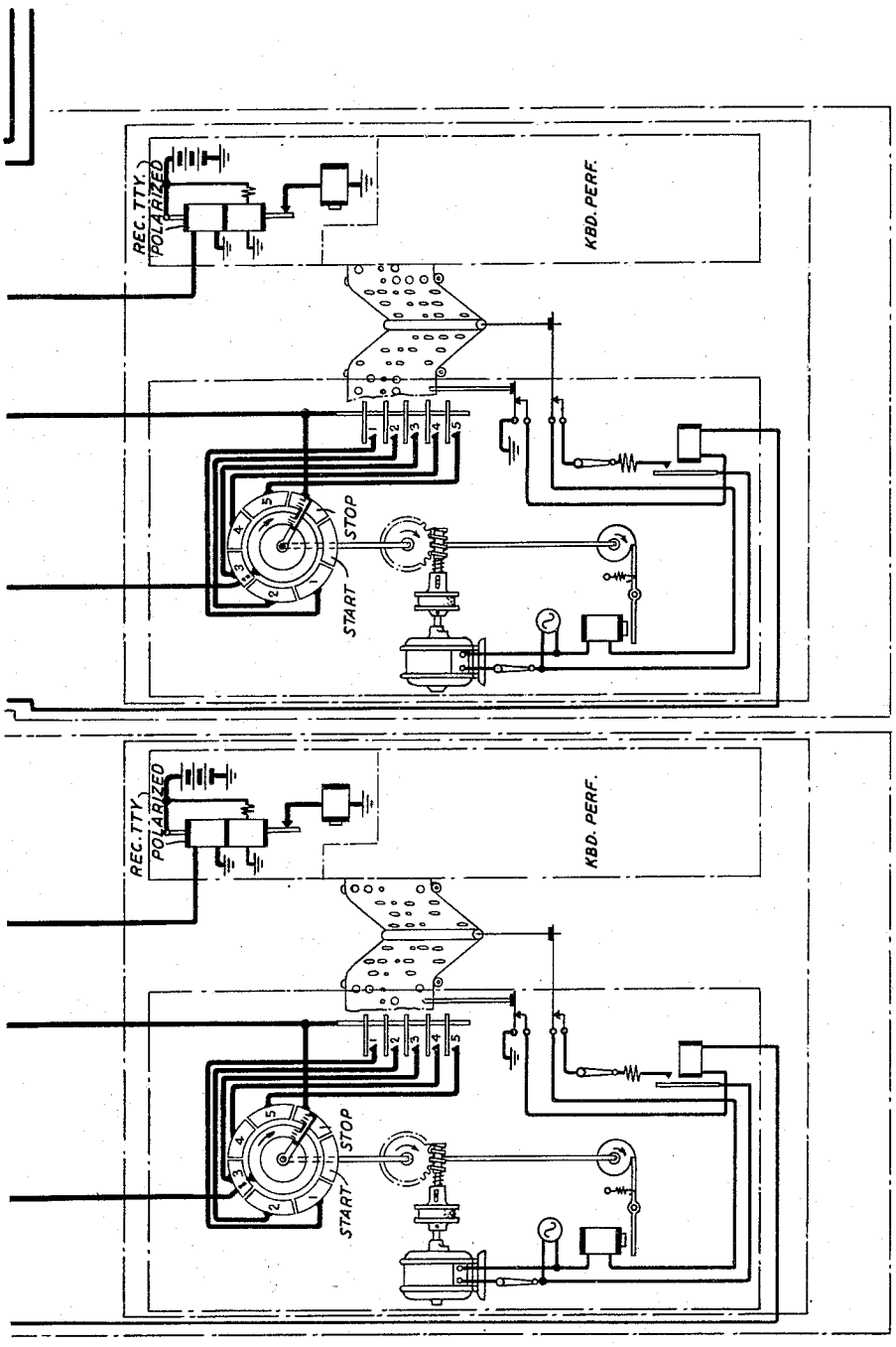

FIG. 54

INVENTORS: W. M. BACON
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J. A. KRECEK

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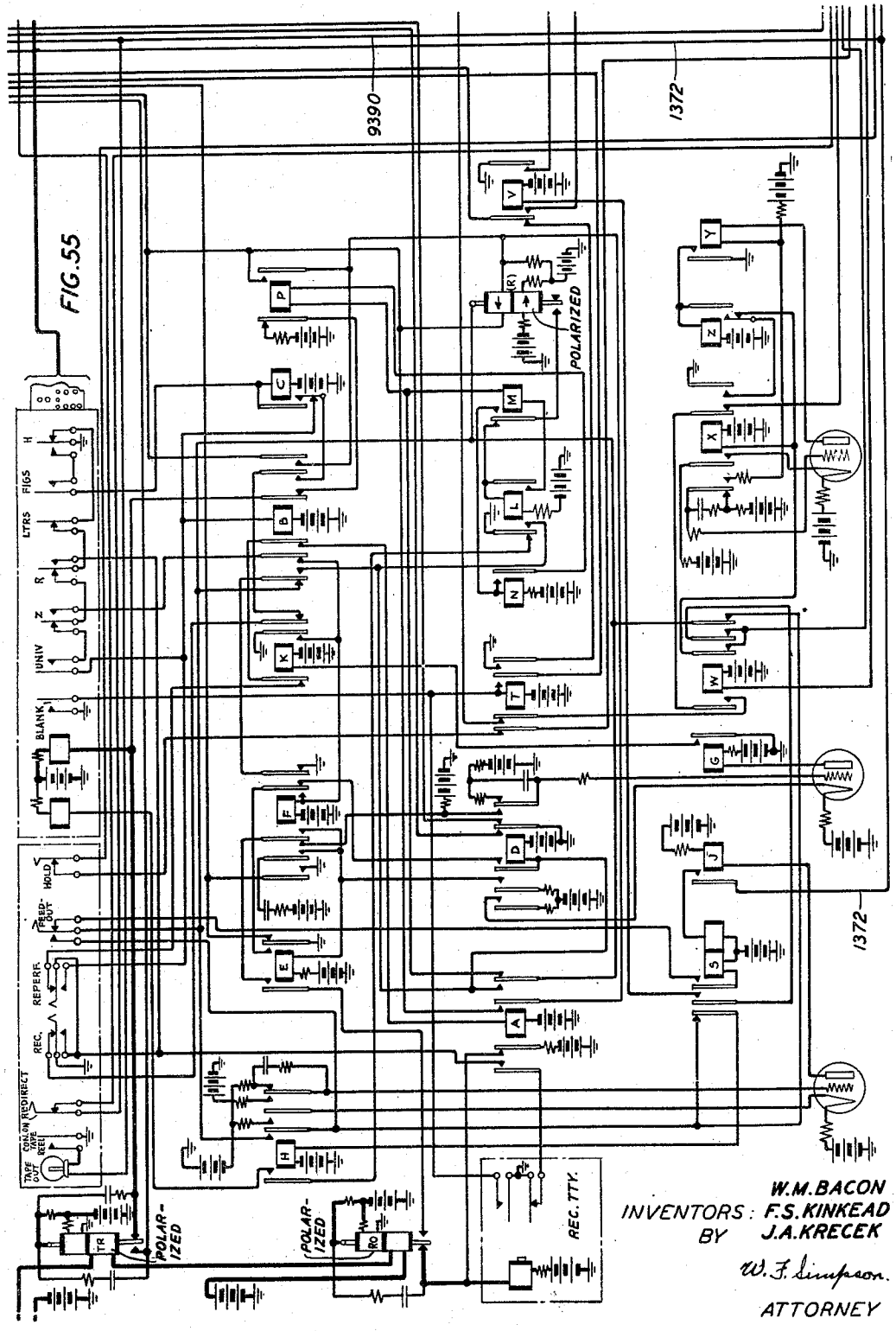

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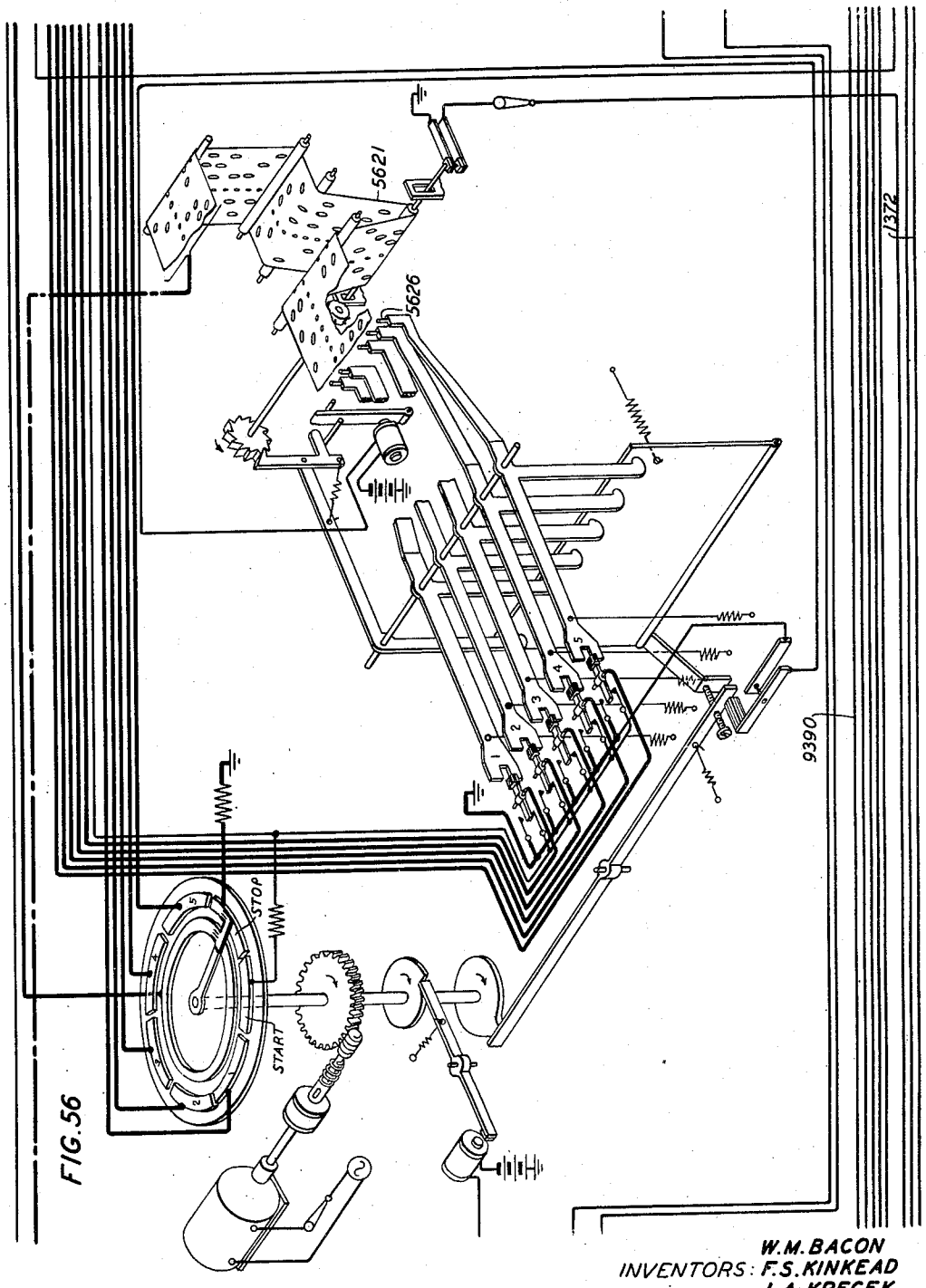

FIG. 56

INVENTORS: W.M. BACON
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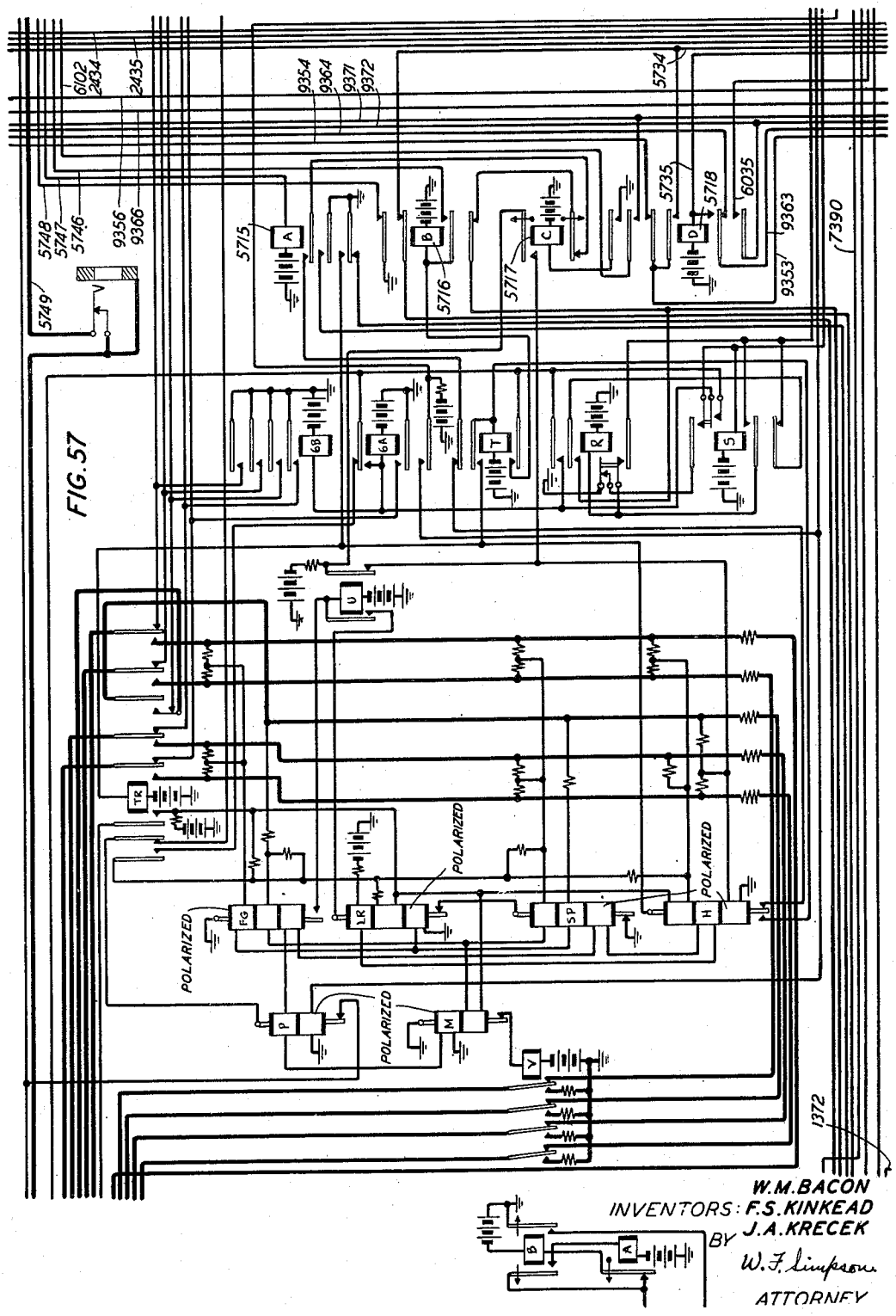

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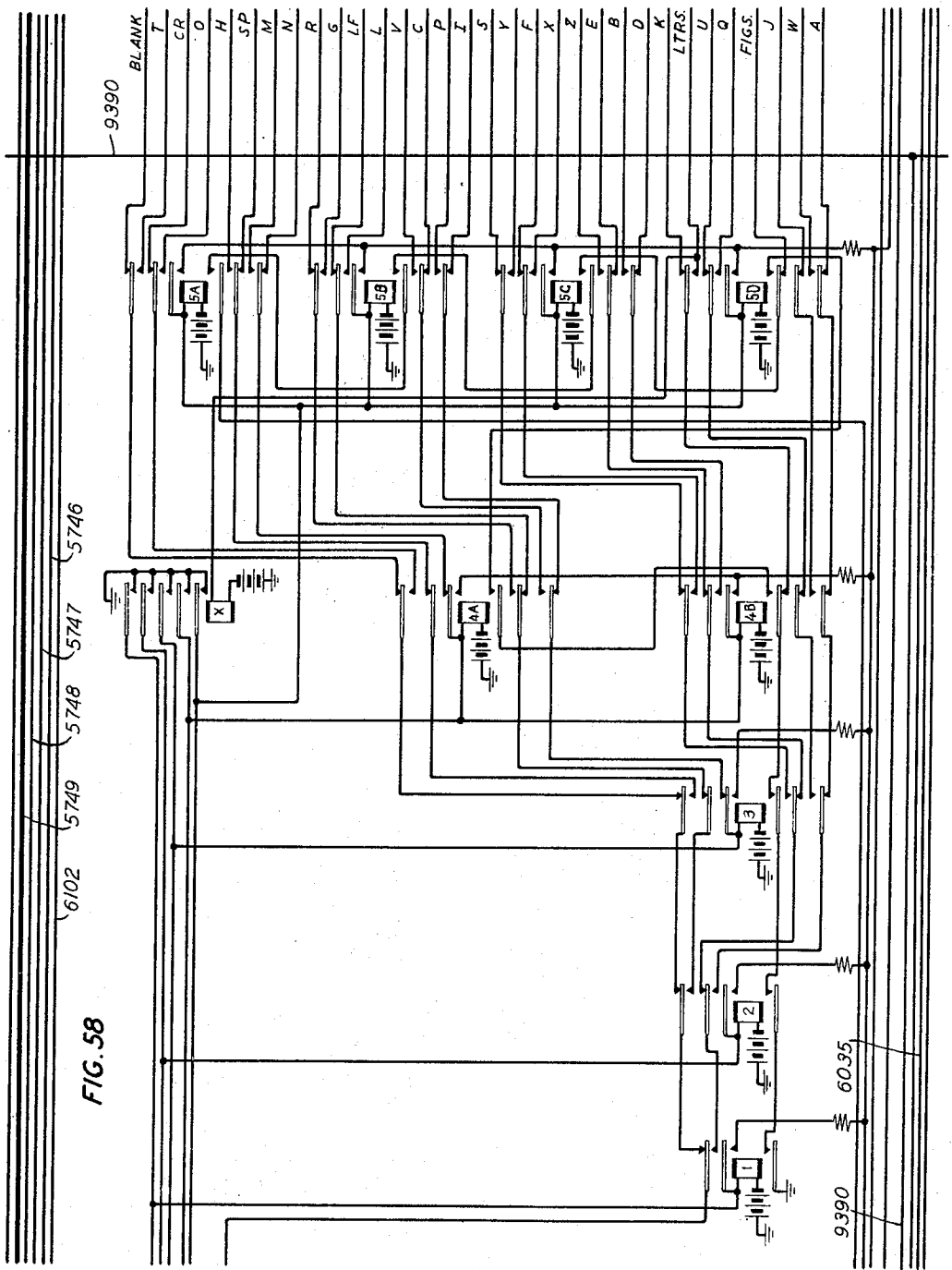

FIG. 58

INVENTORS: W.M.BACON
F.S.KINKEAD
BY J.A.KRECEK

W. F. Simpson.

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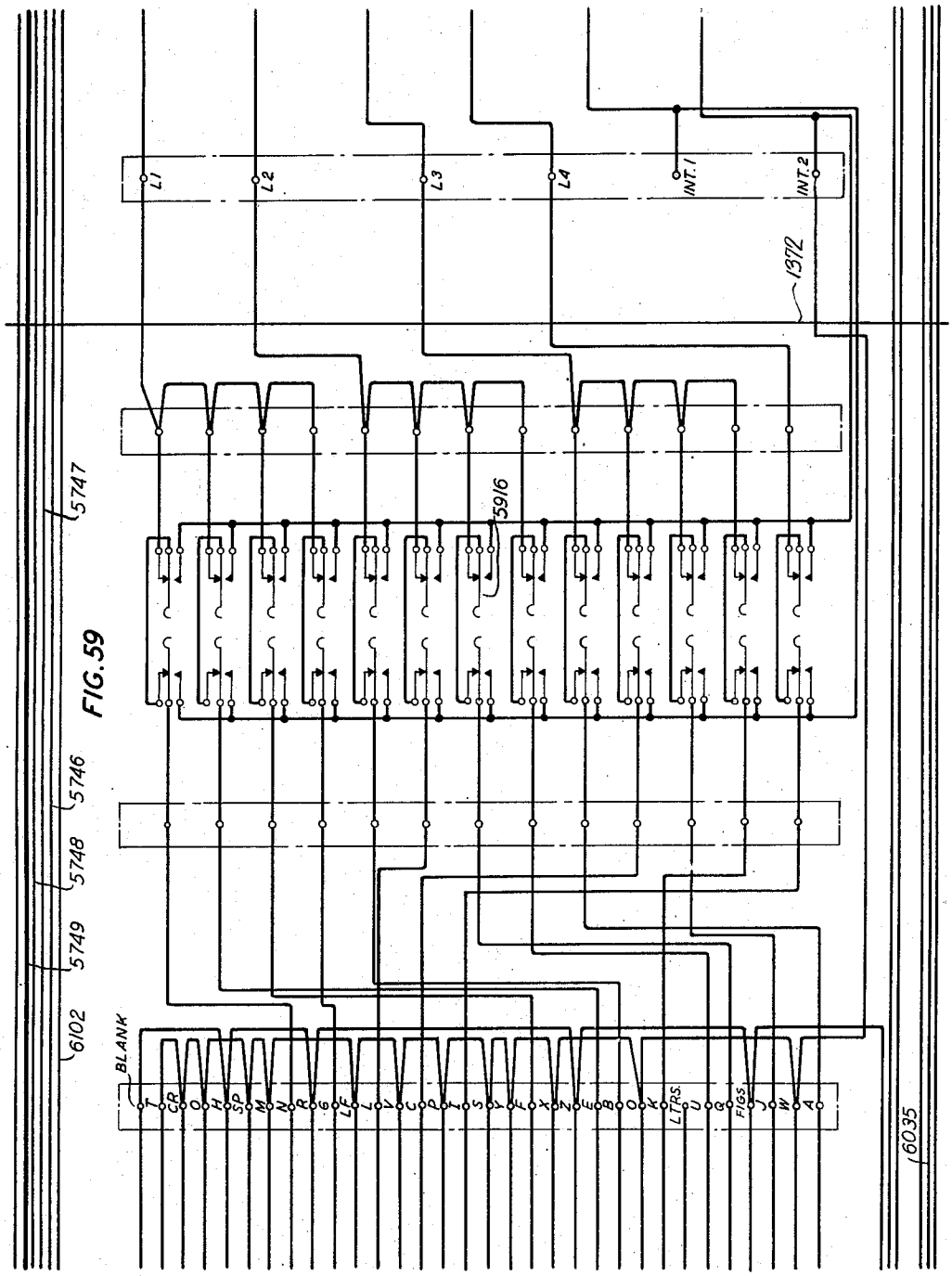

FIG. 59

INVENTORS: W.M. BACON, F.S. KINKEAD, J.A. KRECEK

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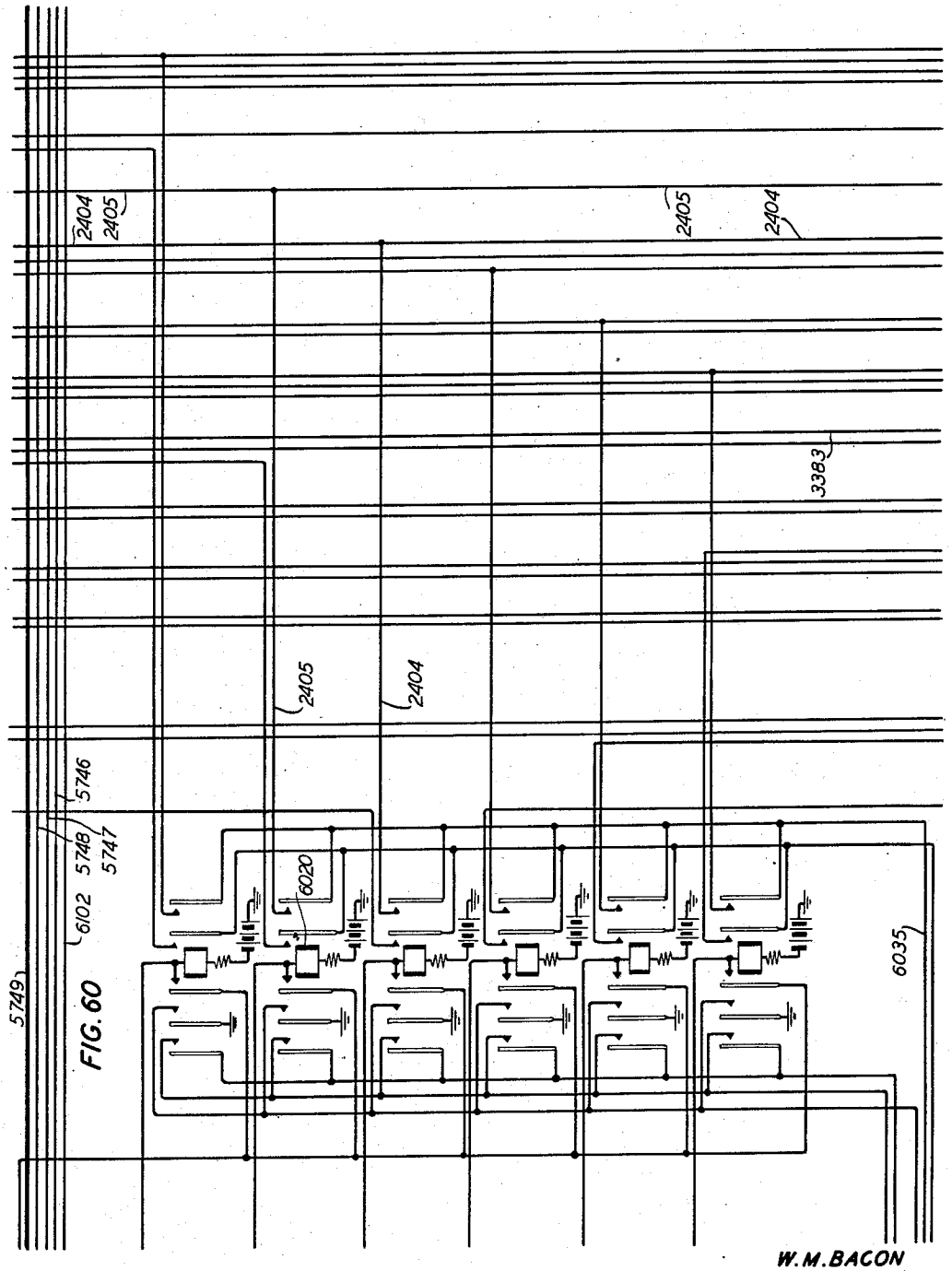

FIG. 60

INVENTORS: W.M.BACON F.S.KINKEAD J.A.KRECEK

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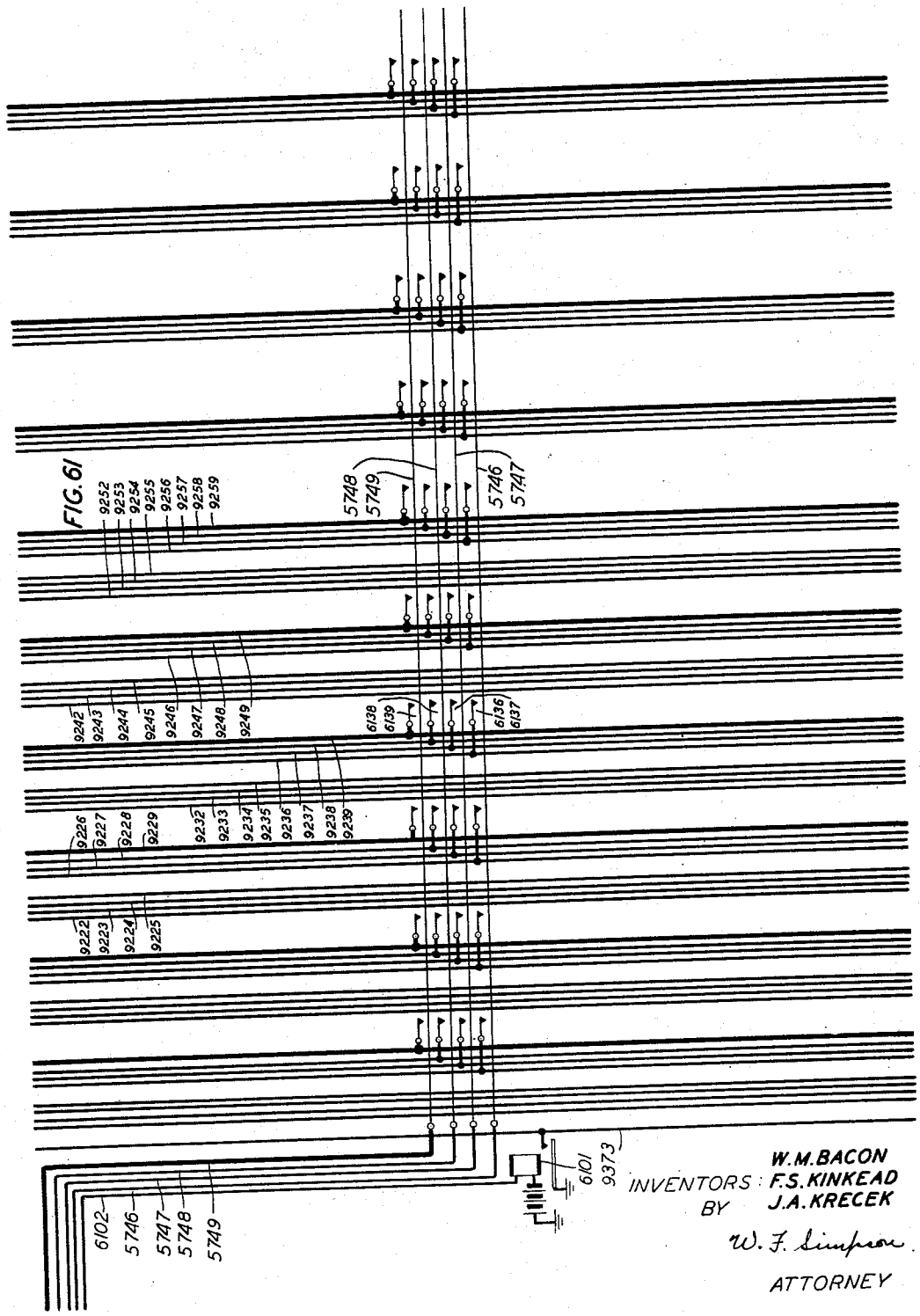

INVENTORS: W.M.BACON F.S.KINKEAD J.A.KRECEK

BY W. F. Simpson

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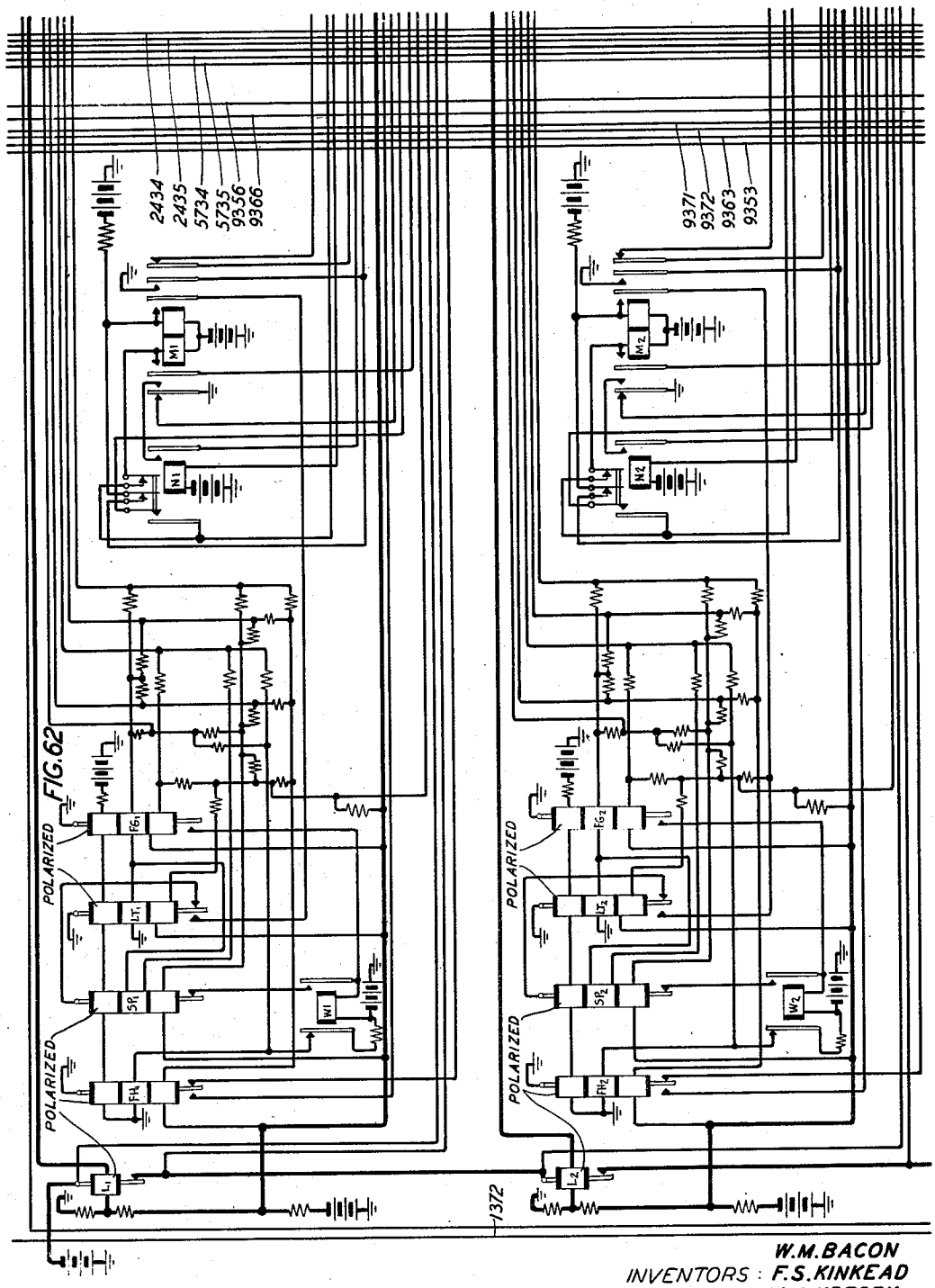

FIG. 62

INVENTORS: W.M.BACON
F.S.KINKEAD
J.A.KRECEK

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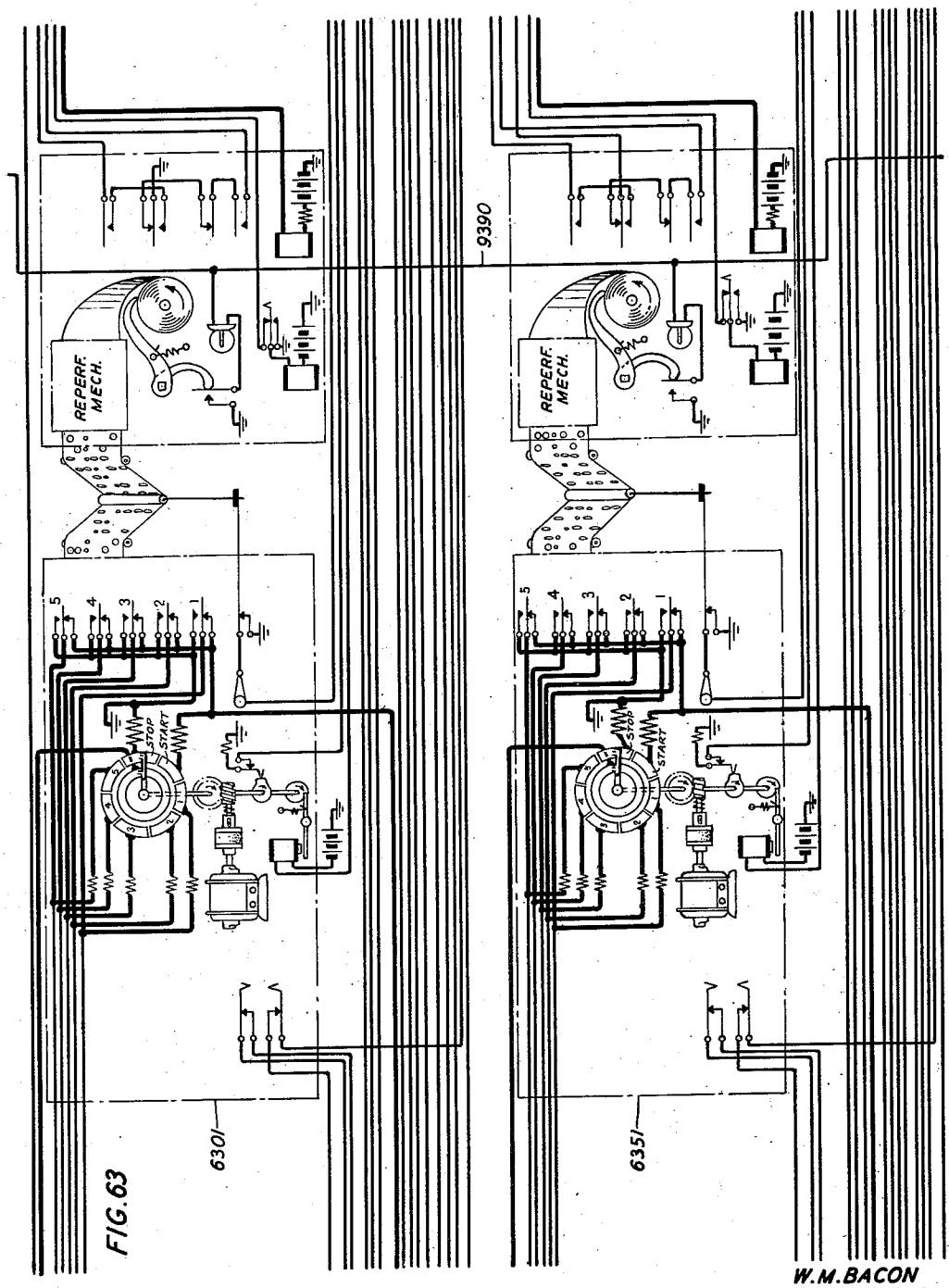

FIG. 63

INVENTORS: W.M.BACON
F.S.KINKEAD
BY J.A.KRECEK

W. F. Simpson

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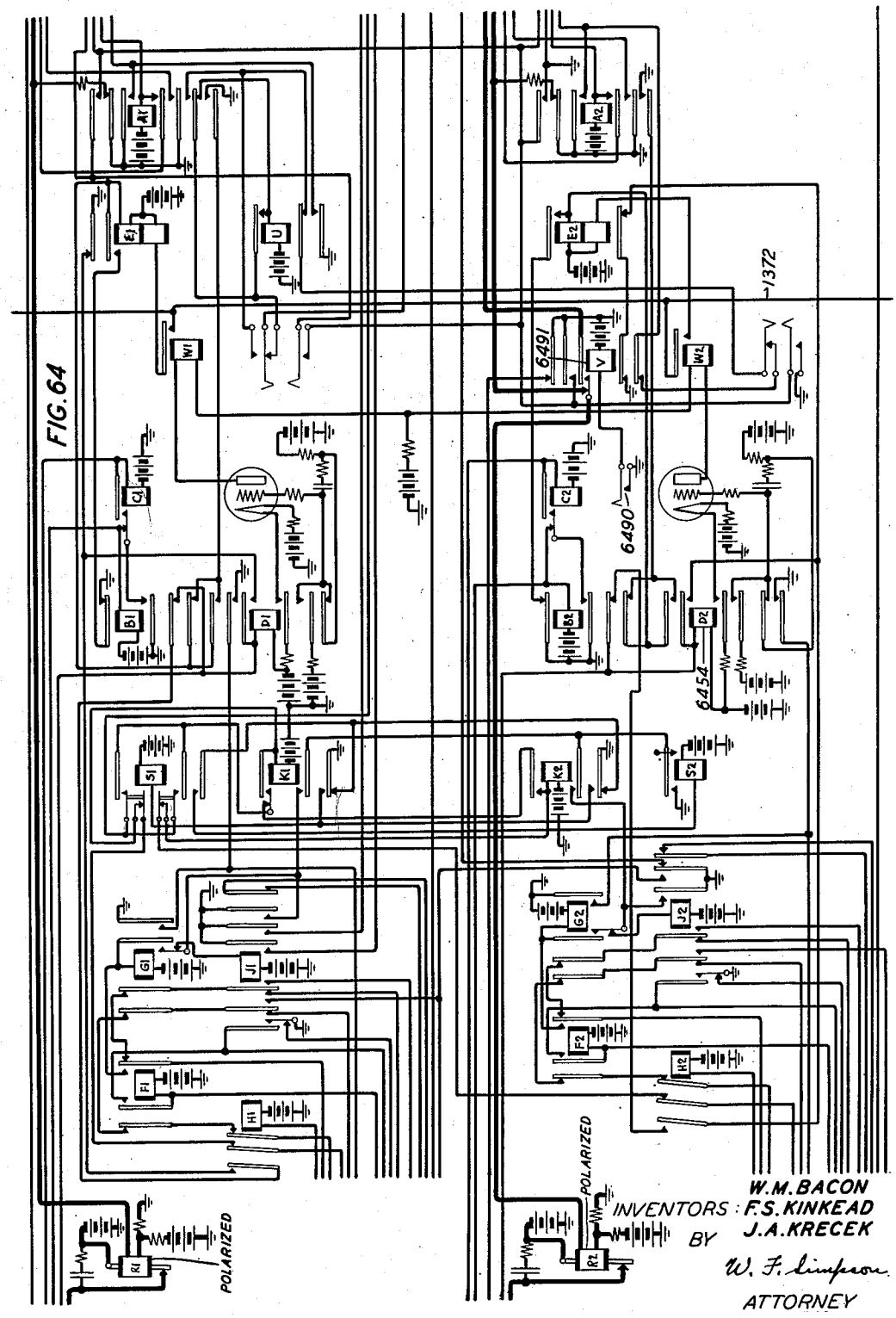

INVENTORS: W.M.BACON F.S.KINKEAD J.A.KRECEK

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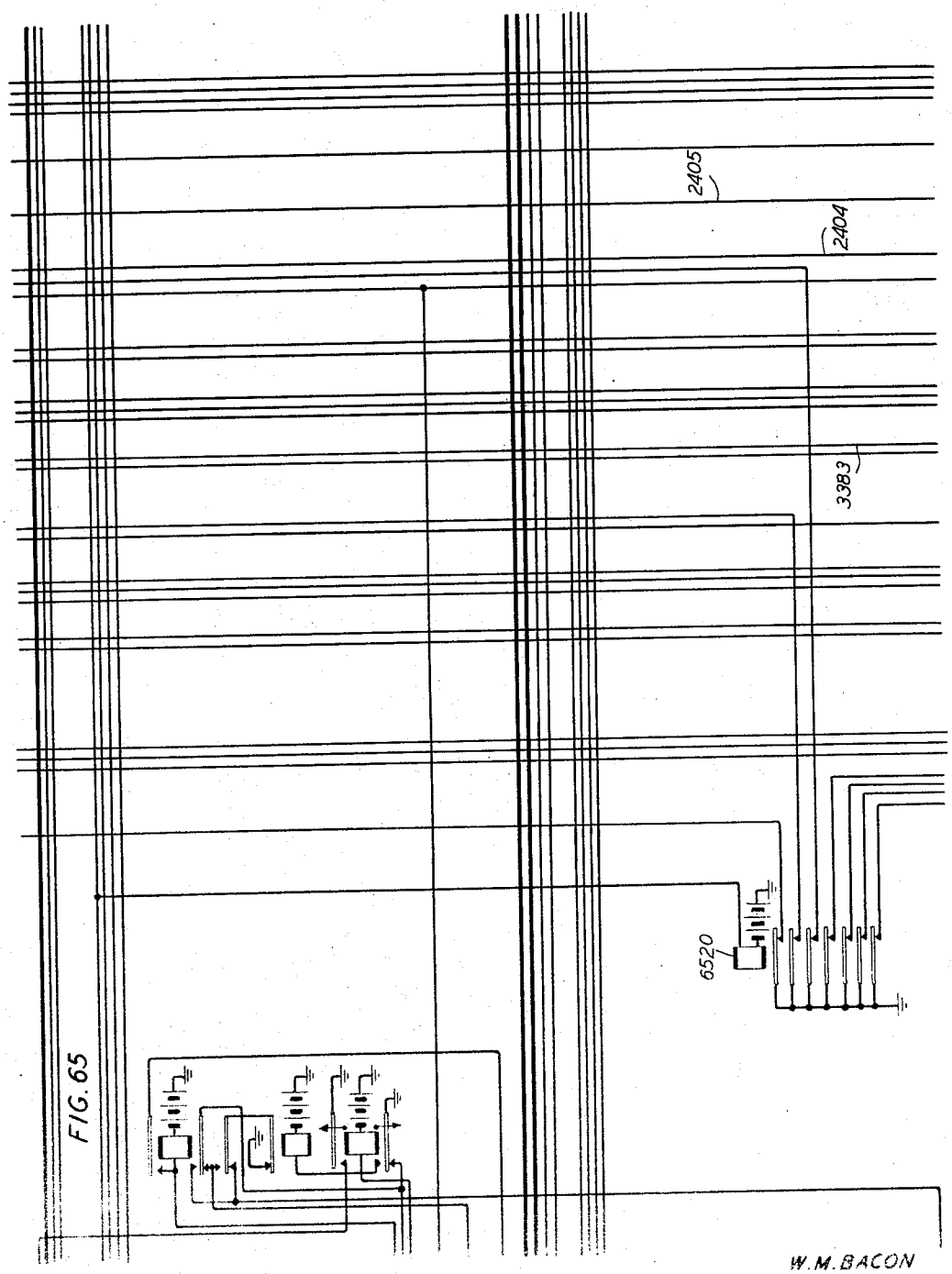

FIG. 65

INVENTORS W. M. BACON
F. S. KINKEAD
J. A. KREGEK

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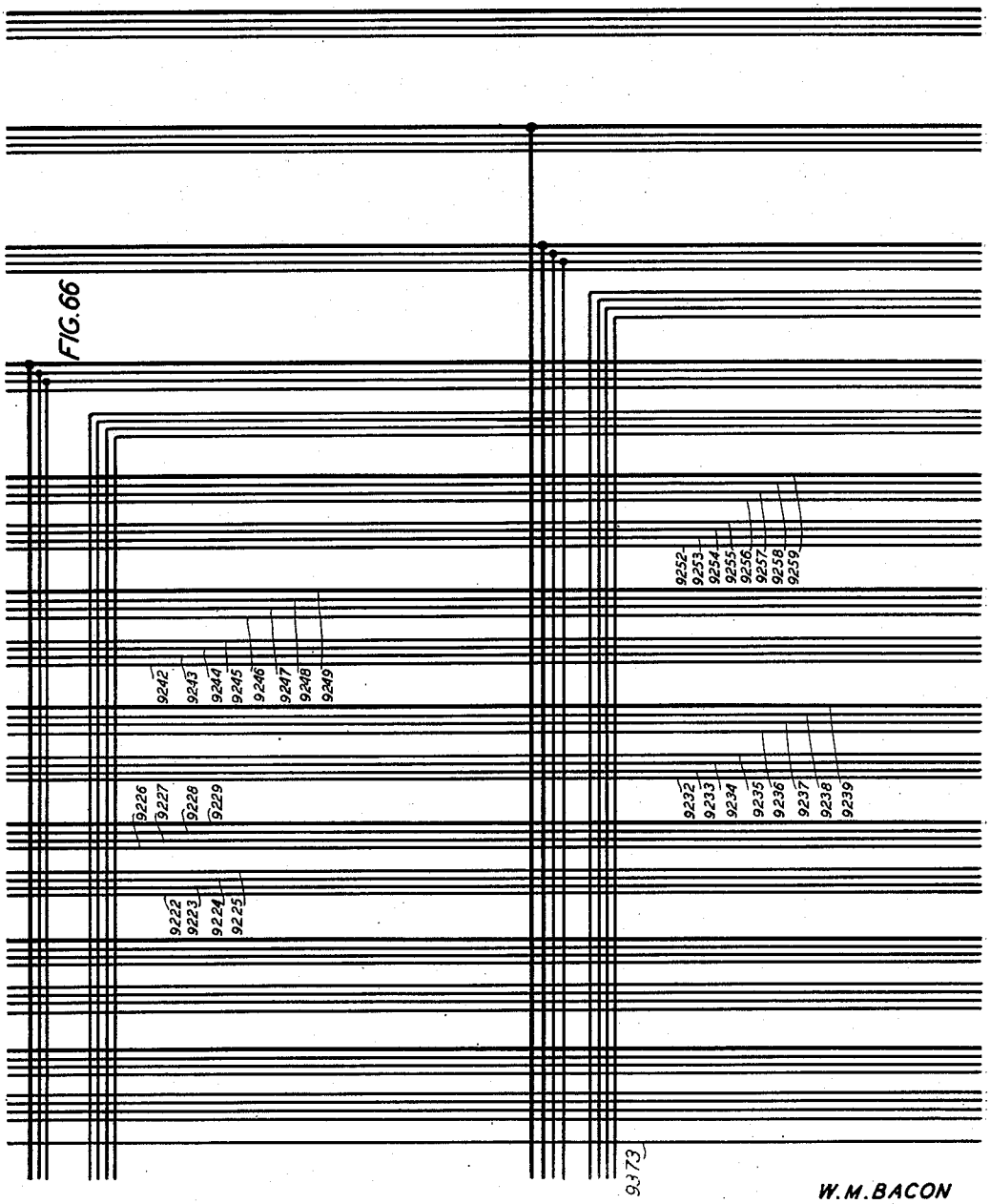

INVENTORS: W.M.BACON
F.S.KINKEAD
J.A.KRECEK

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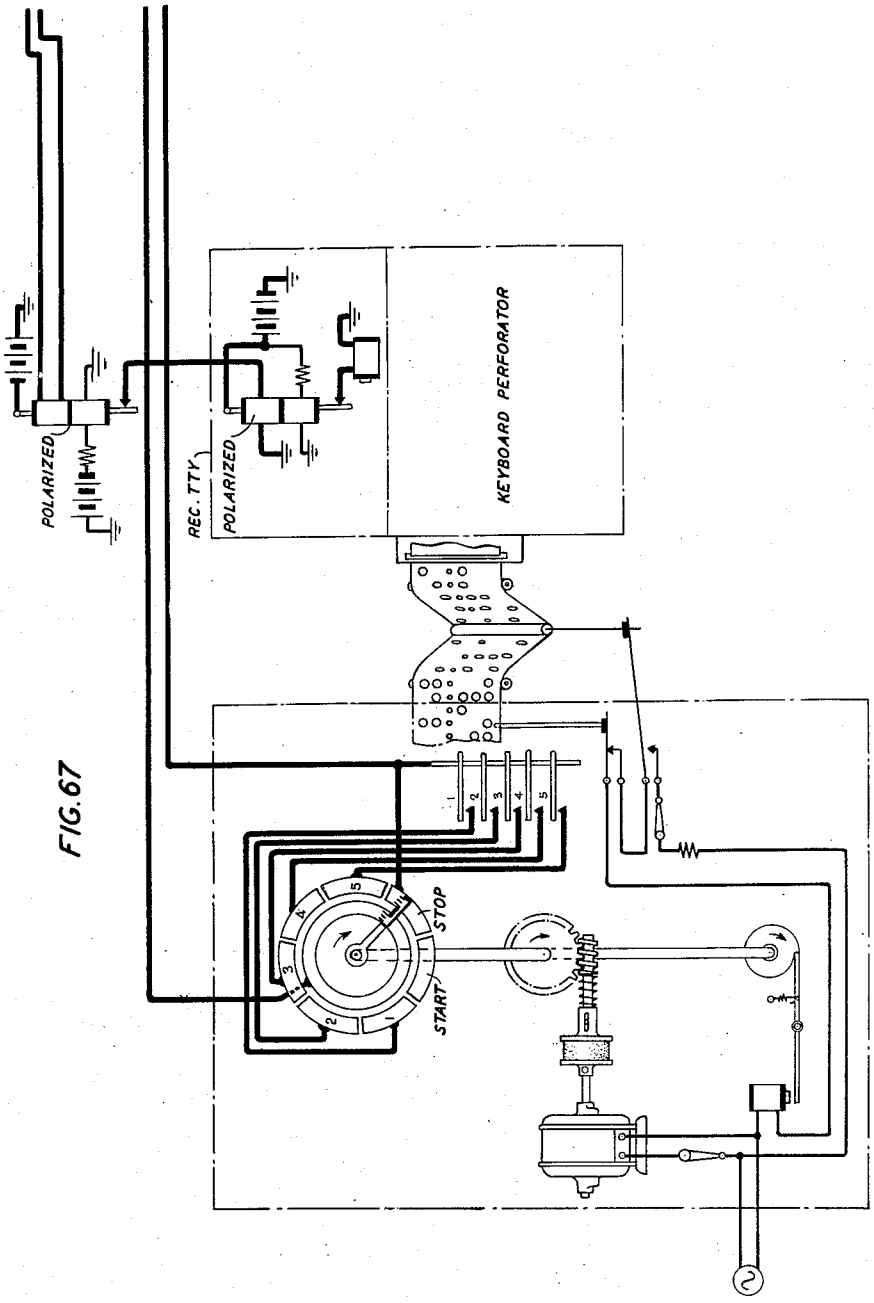

FIG. 67

INVENTORS: W.M.BACON F.S.KINKEAD J.A.KRECEK

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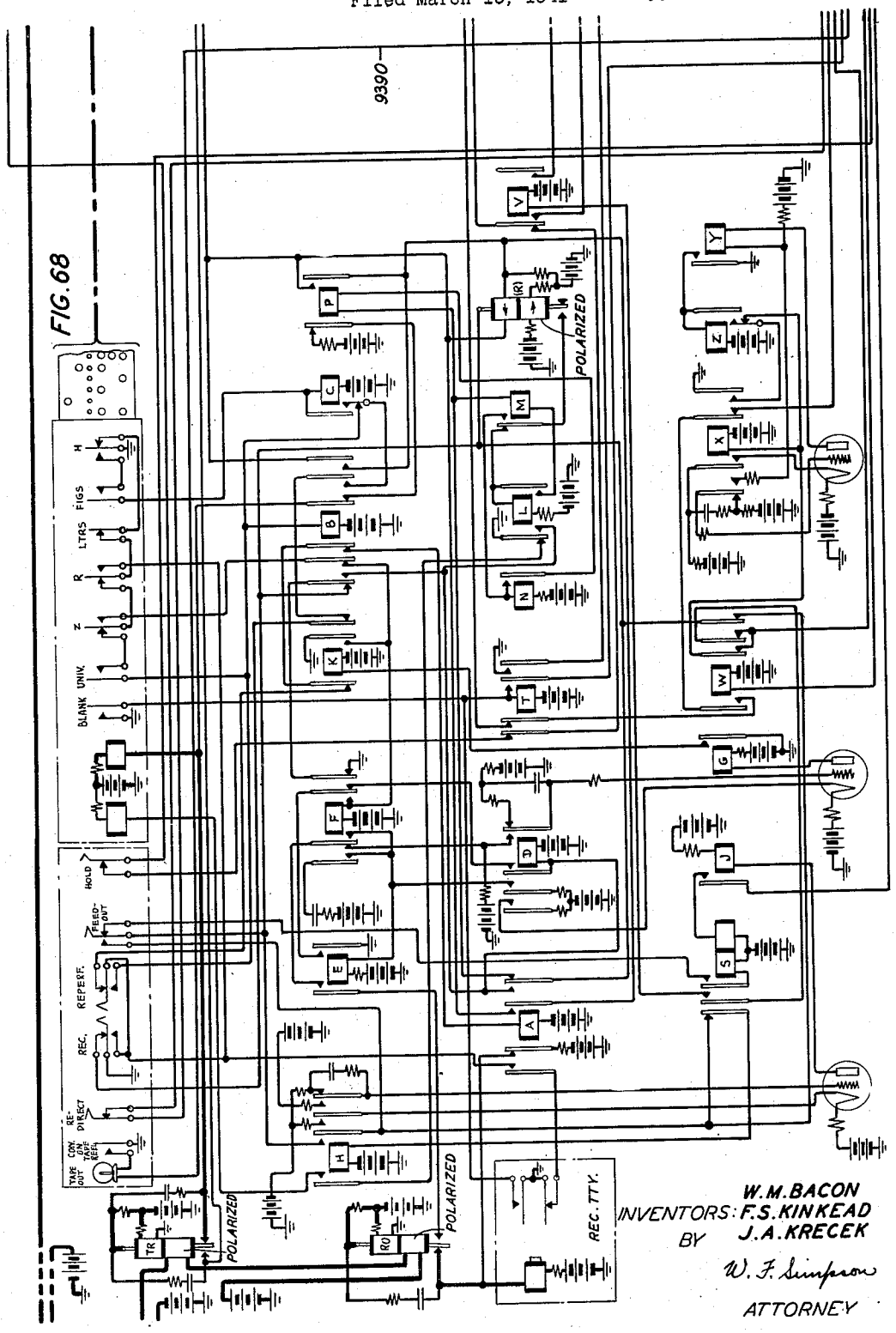

W.M.BACON
INVENTORS: F.S.KINKEAD
J.A.KRECEK
BY W. F. Simpson
ATTORNEY

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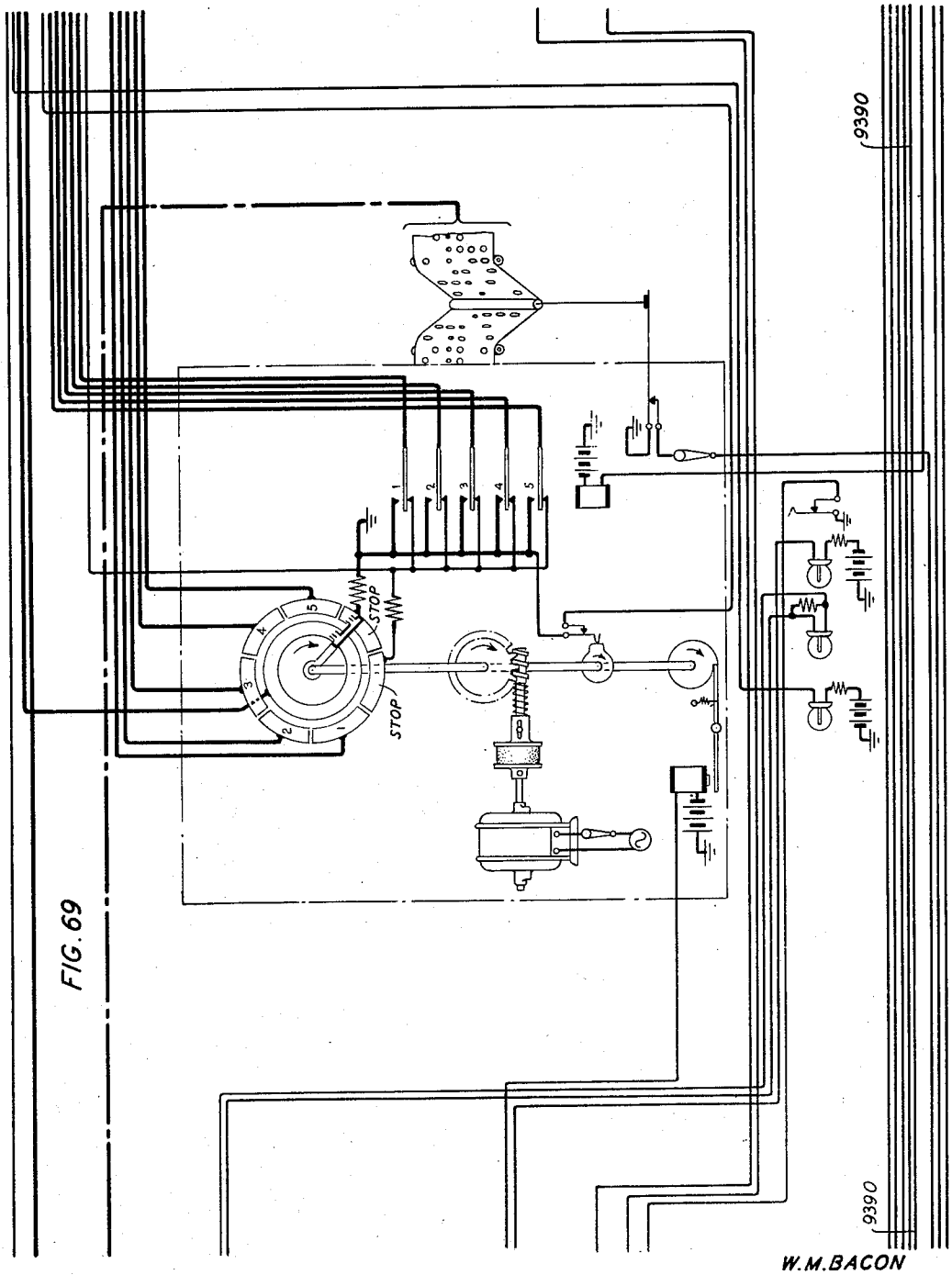

FIG. 69

INVENTORS: W.M.BACON
F.S.KINKEAD
J.A.KRECEK
BY W. F. Simpson.
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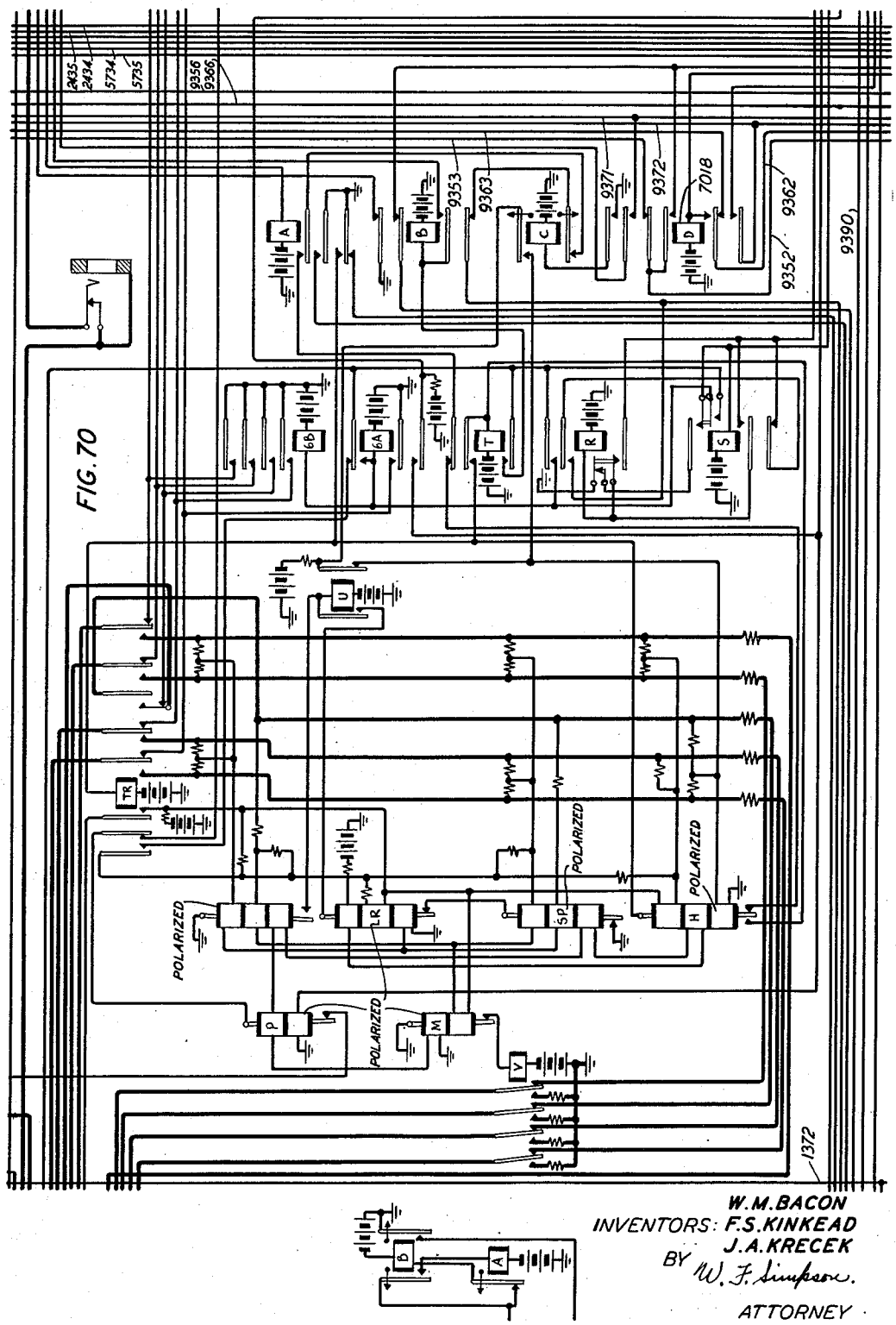

FIG. 70

INVENTORS: W.M.BACON F.S.KINKEAD J.A.KRECEK

BY W. F. Simpson.

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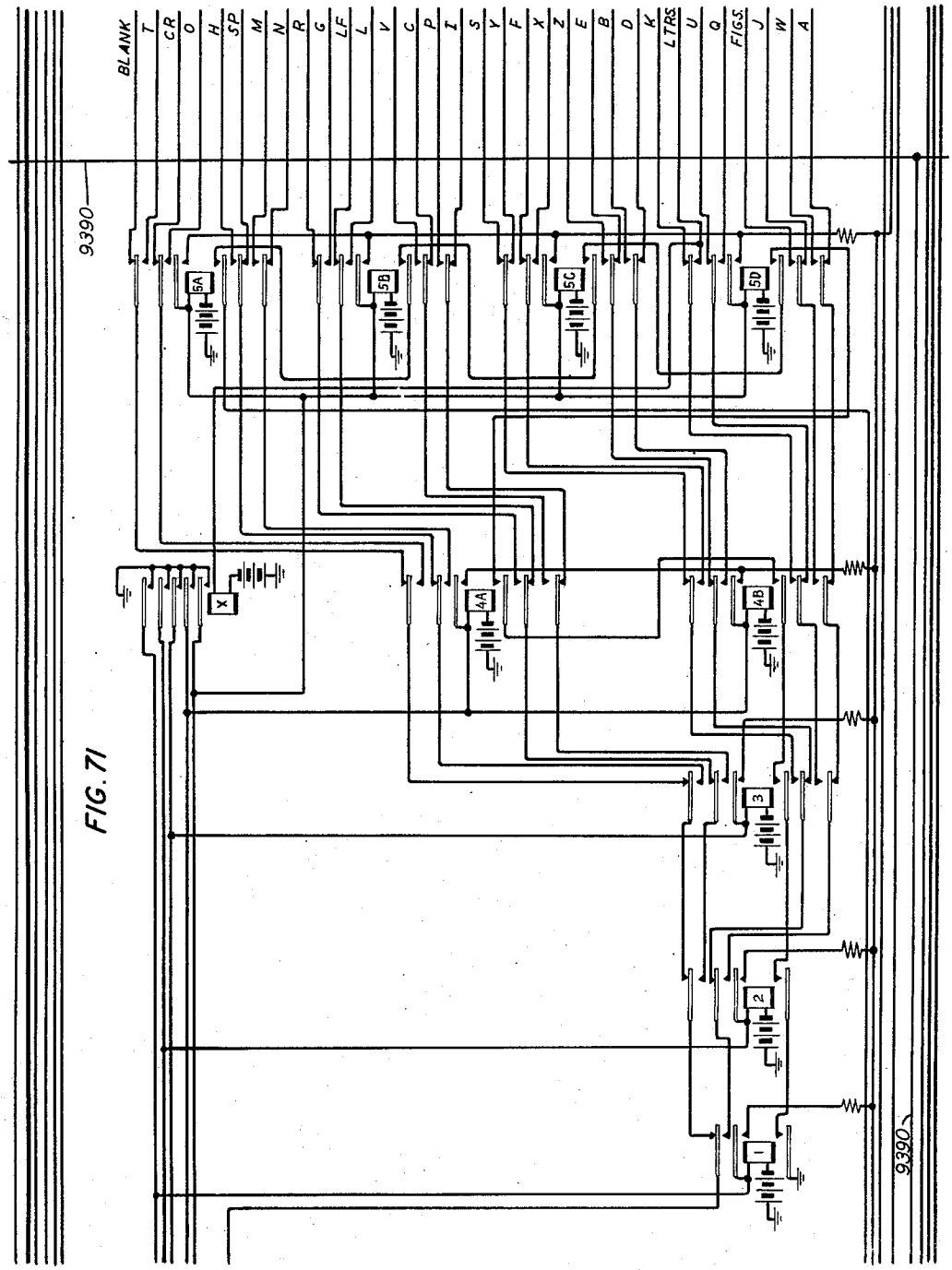

FIG. 71

INVENTORS: W. M. BACON, F. S. KINKEAD, BY J. A. KRECEK

W. F. Simpson.

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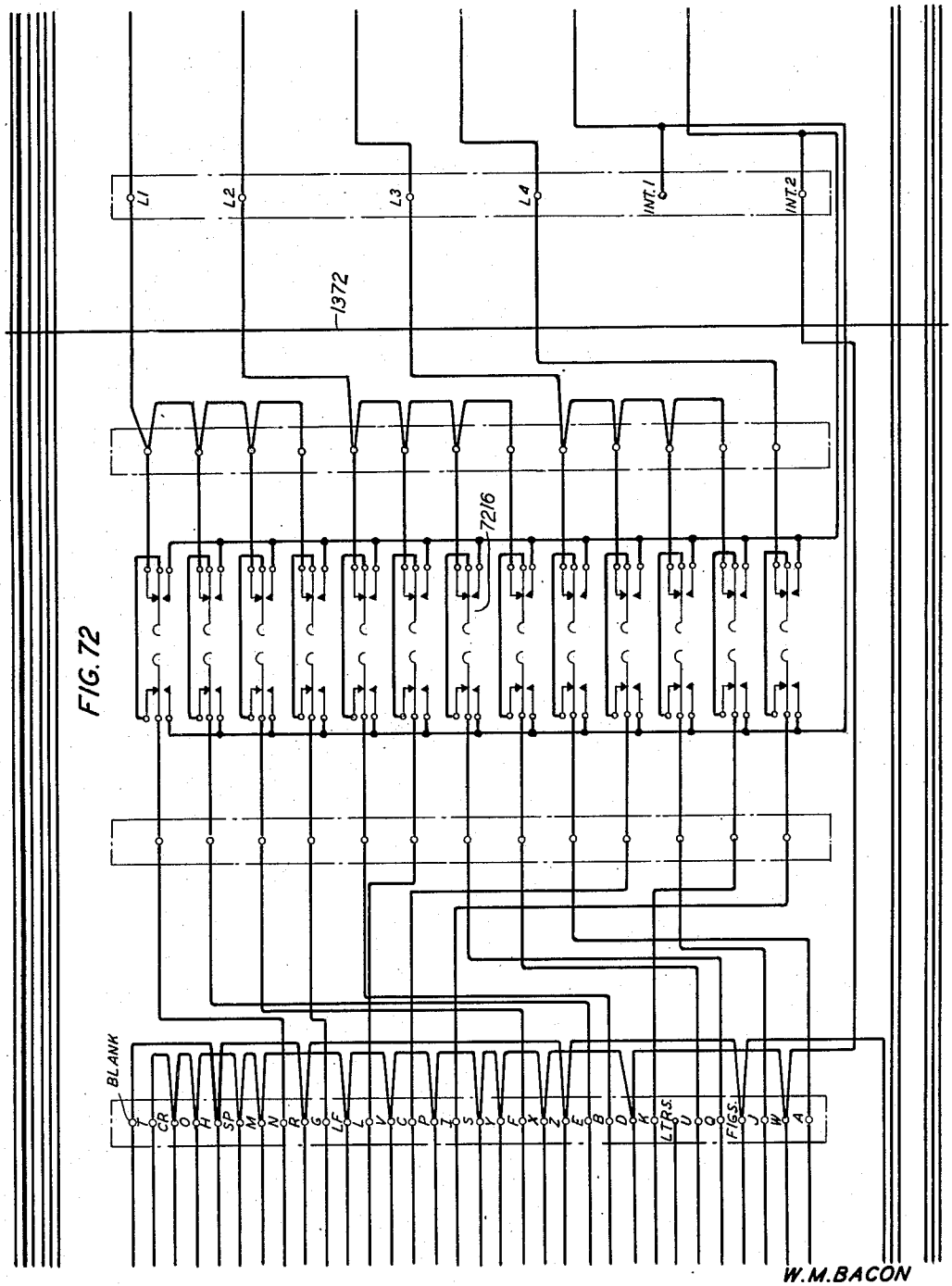

FIG. 72

INVENTORS: W.M.BACON F.S.KINKEAD J.A.KRECEK

BY W. F. Simpson

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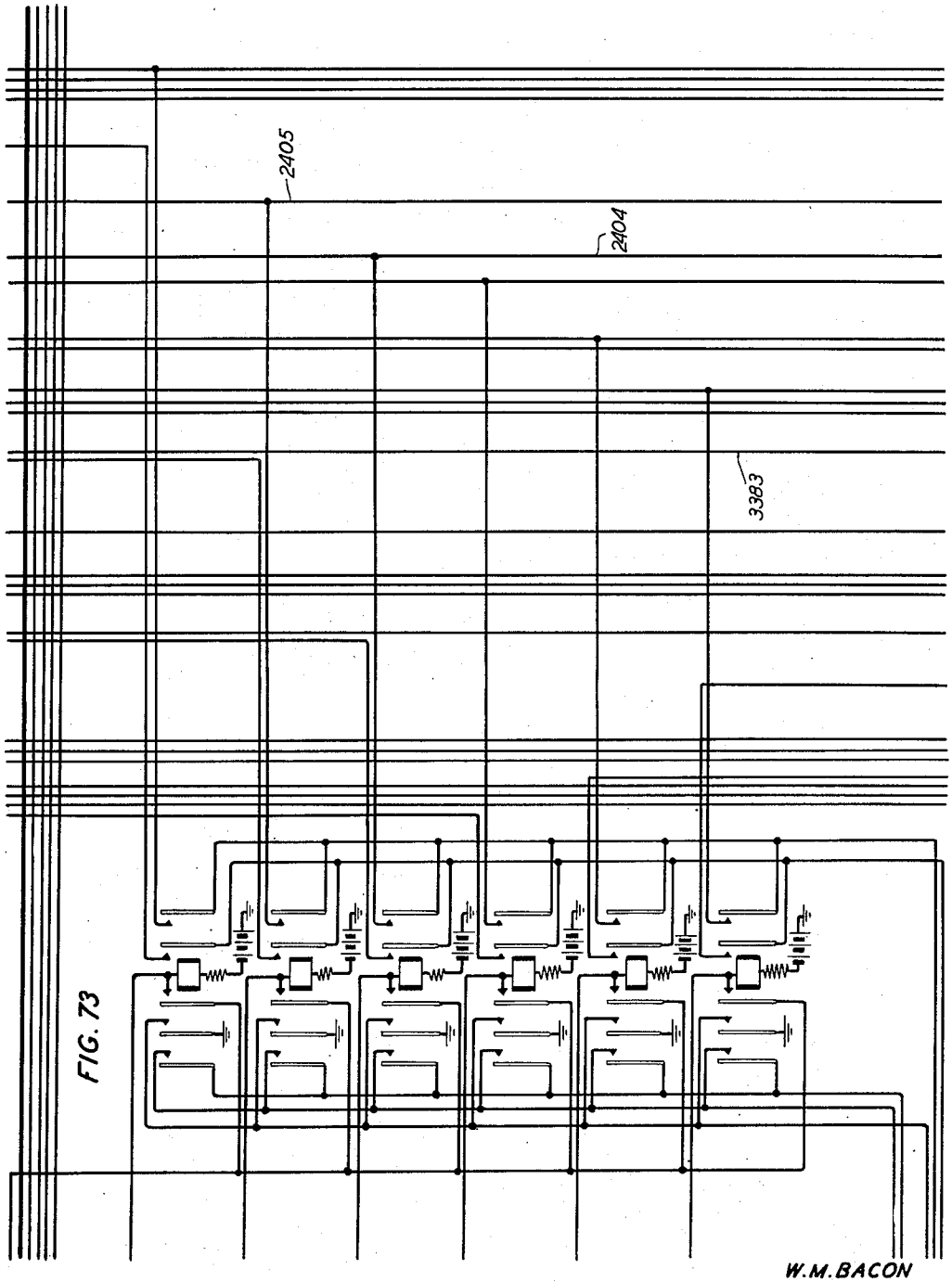

FIG. 73

INVENTORS: W.M.BACON
F.S.KINKEAD
J.A.KRECEK

BY W. F. Simpson.

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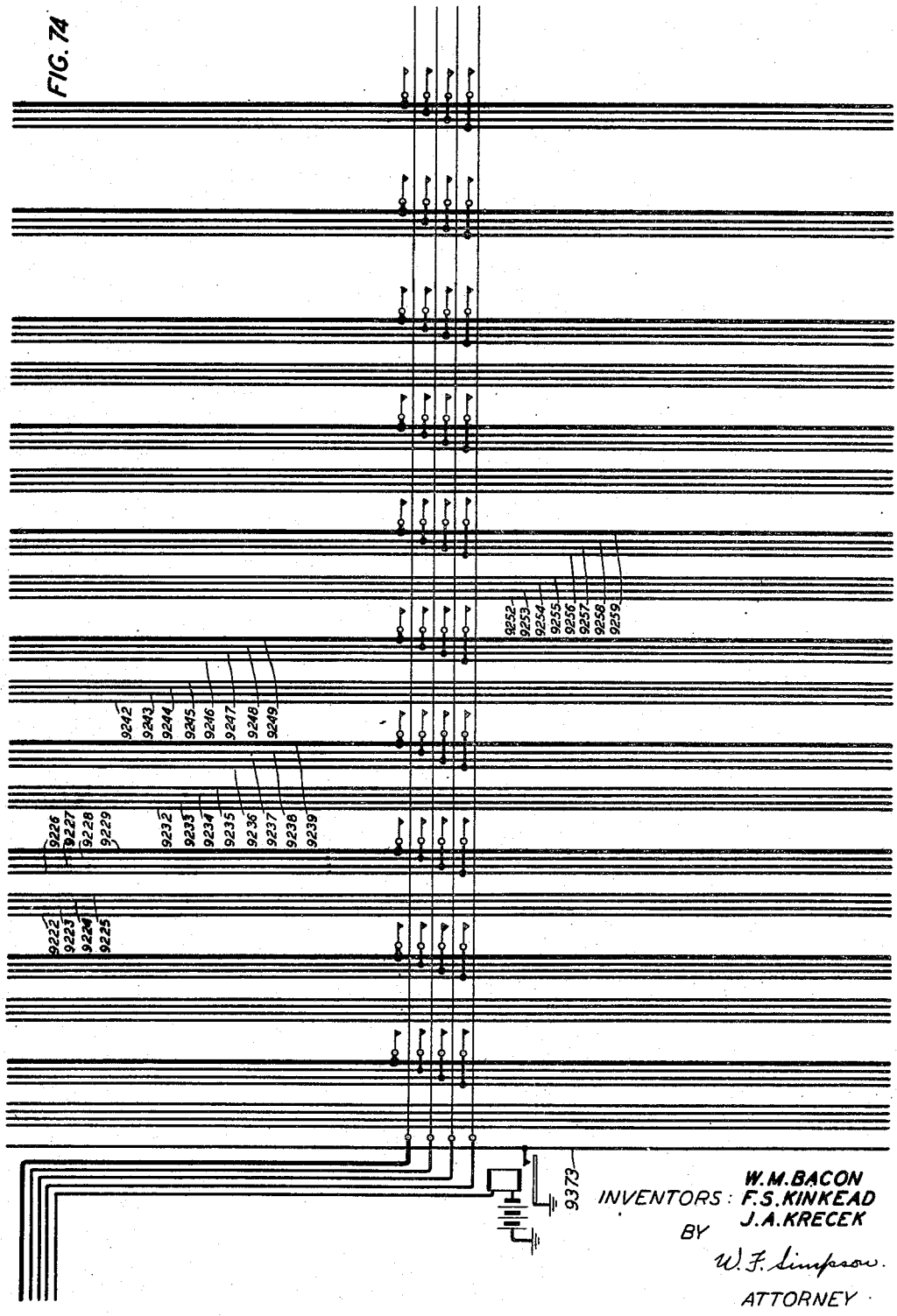
FIG. 74



INVENTORS: W.M.BACON F.S.KINKEAD J.A.KRECEK

BY W. F. Simpson.

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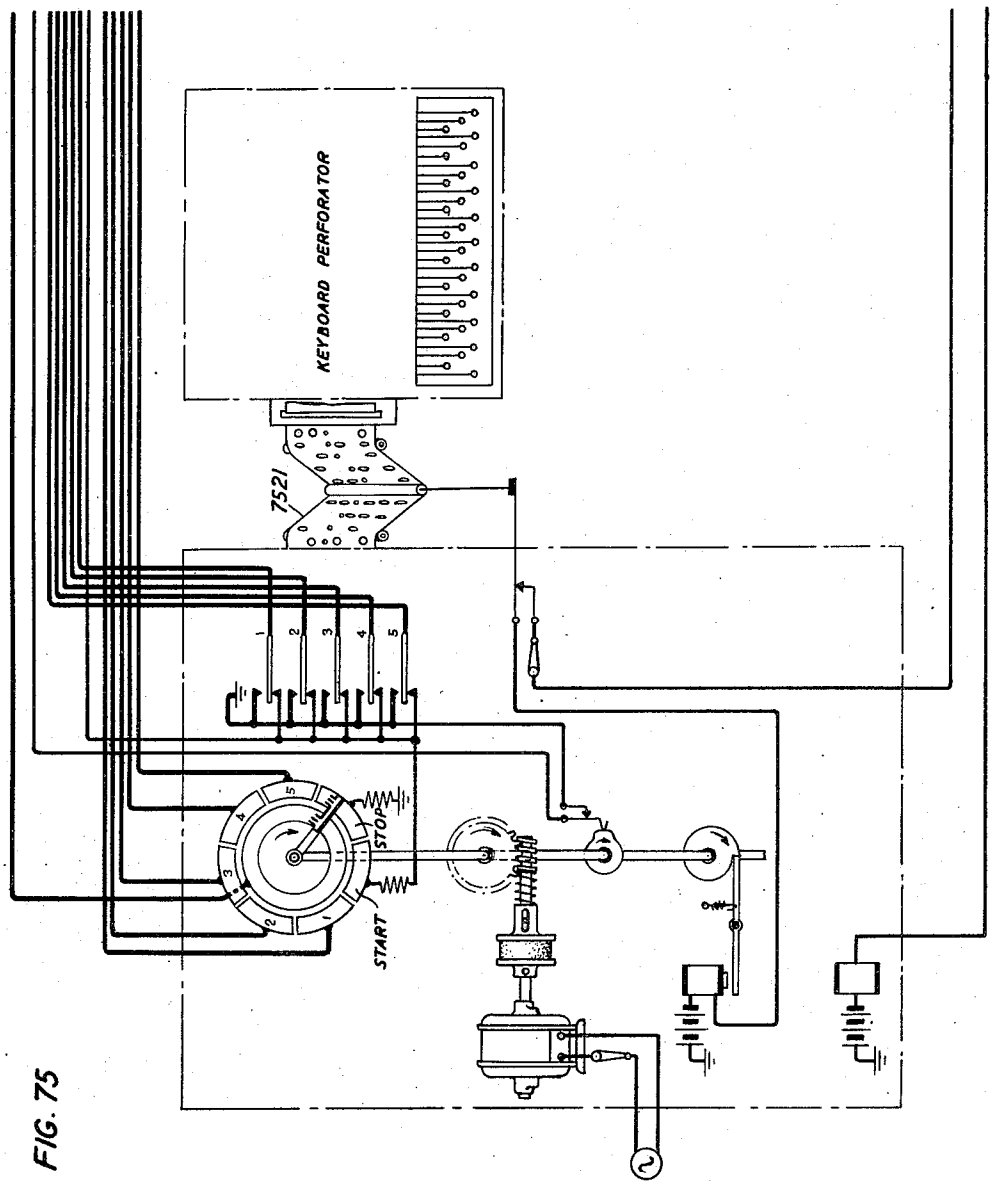

FIG. 75

INVENTORS: W. M. BACON
F. S. KINKEAD
J. A. KRECEK

BY W. F. Simpson.

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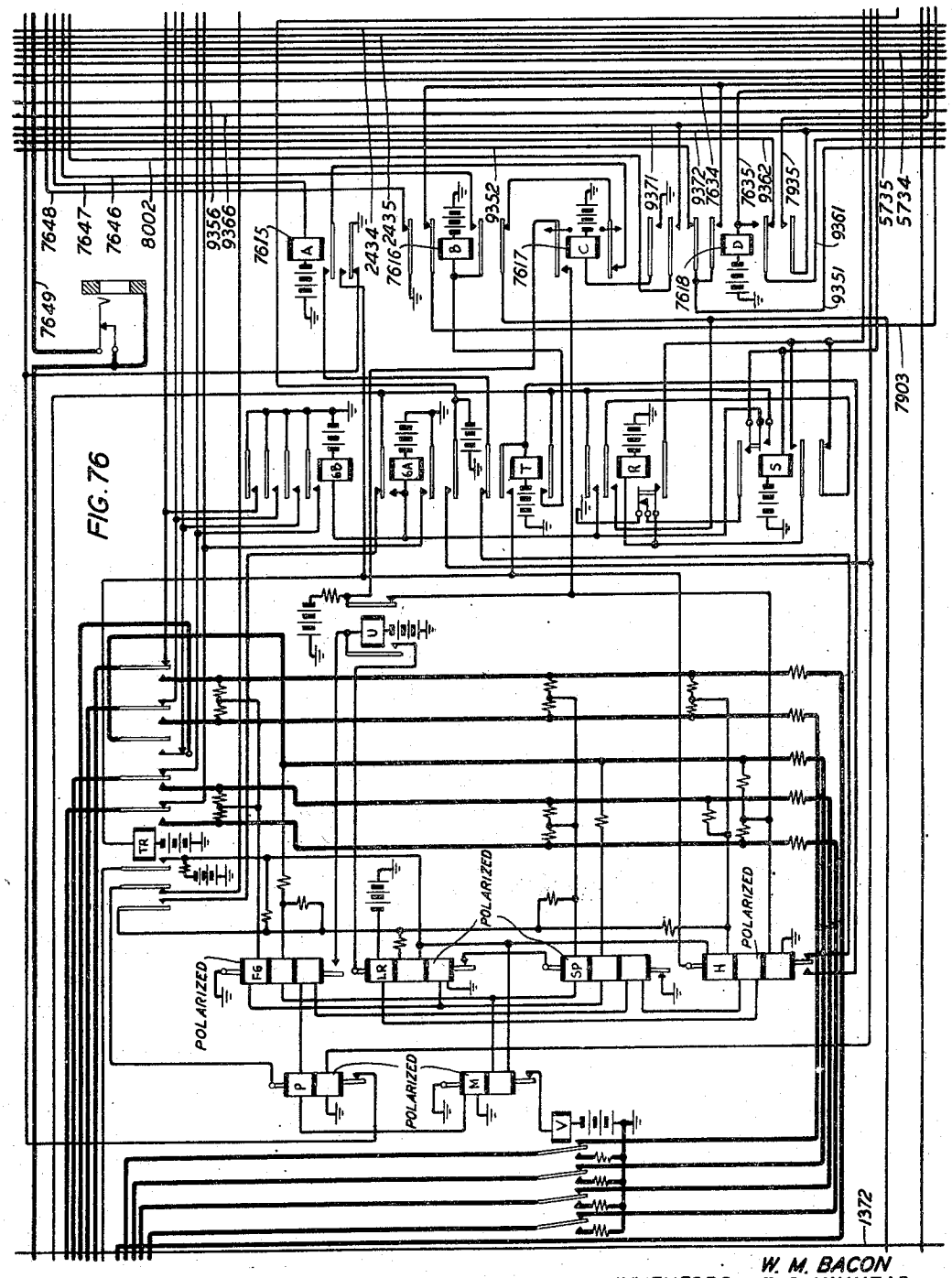

FIG. 76

INVENTORS: W. M. BACON
F. S. KINKEAD
J. A. KRECEK

BY W. F. Simpson

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Aug. 14, 1945. W. M. BACON ET AL 2,381,871

COMMUNICATION SYSTEM

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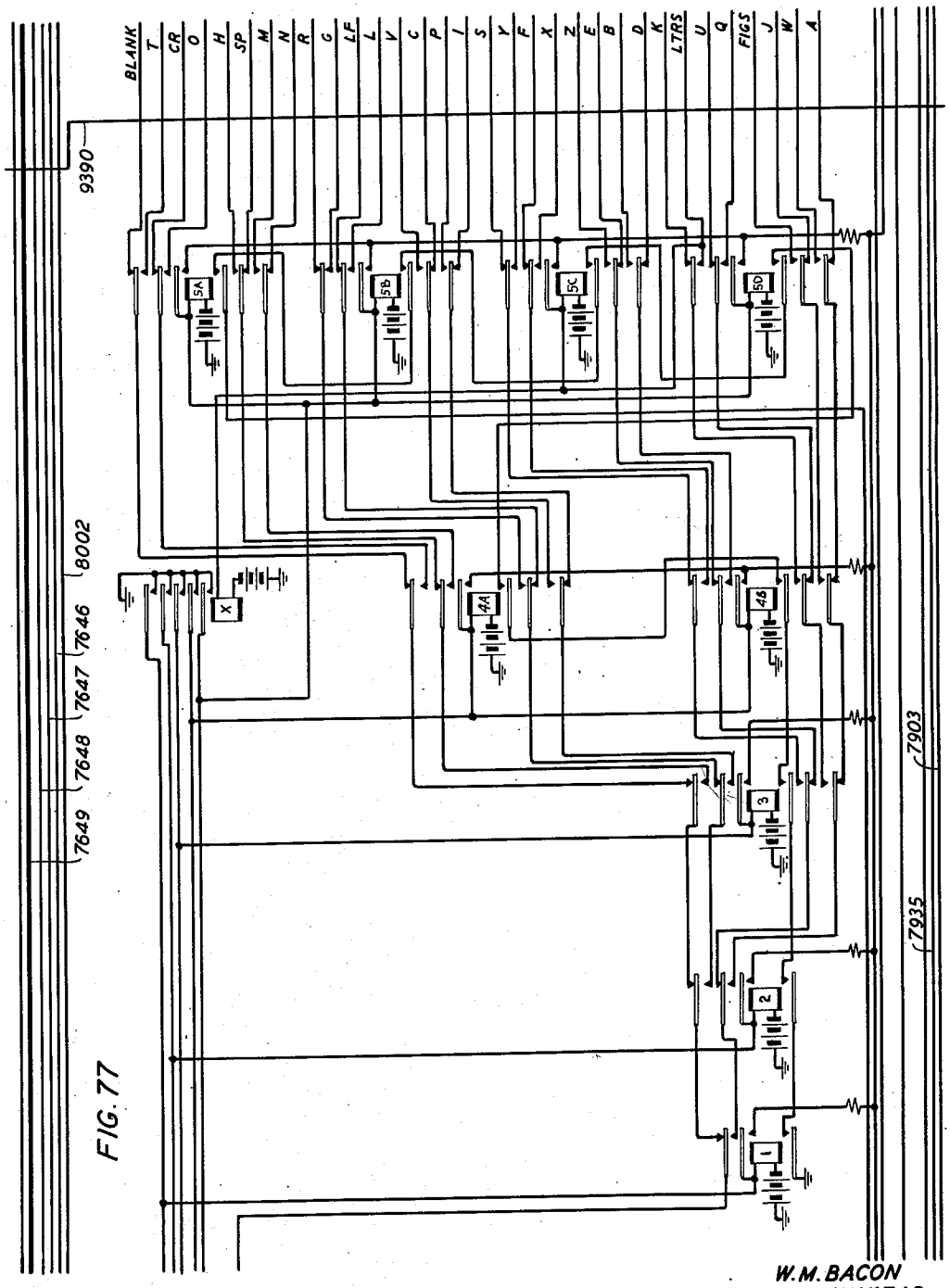

FIG. 77

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COMMUNICATION SYSTEM

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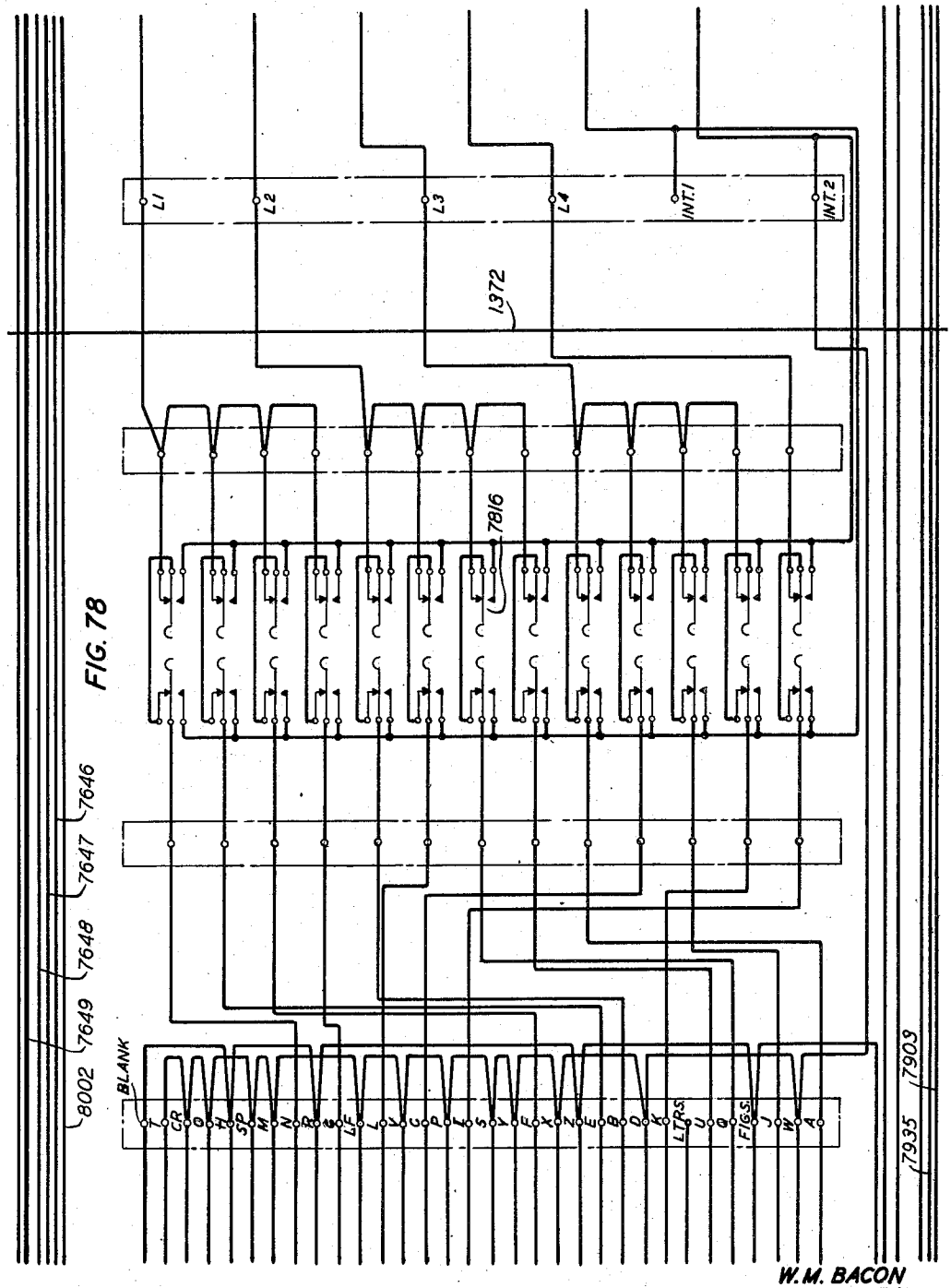

FIG. 78

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COMMUNICATION SYSTEM

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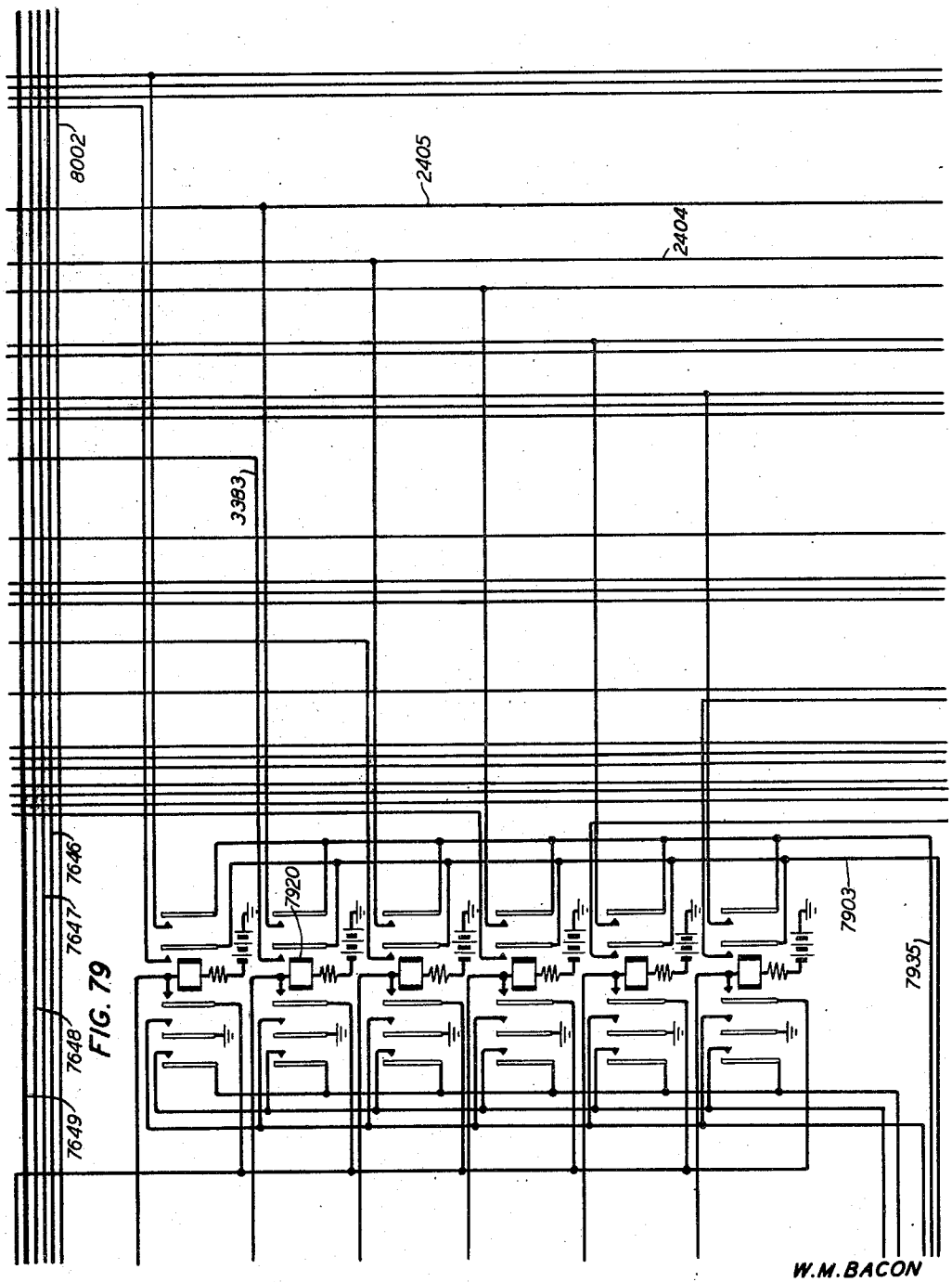

FIG. 79

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COMMUNICATION SYSTEM

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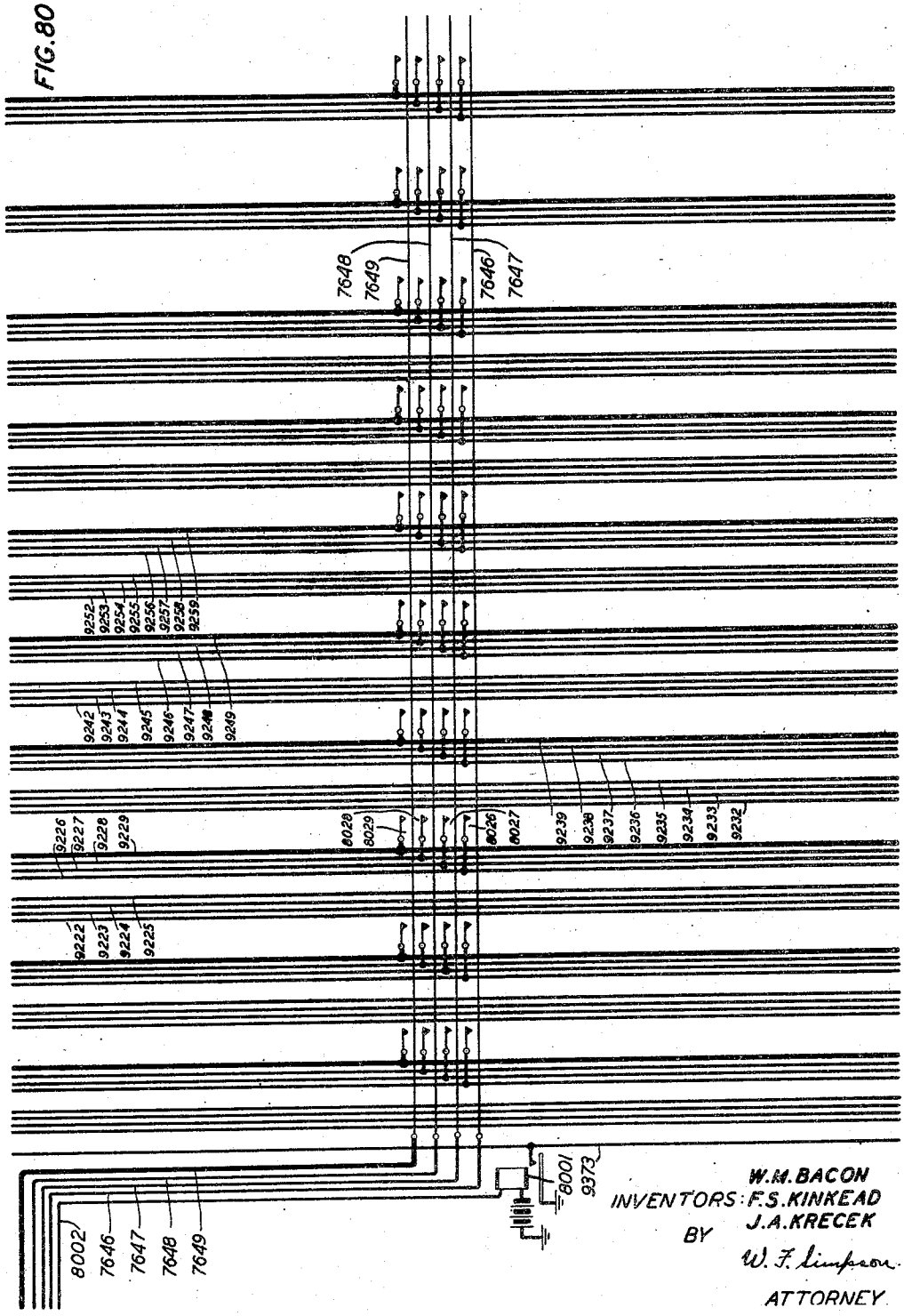
FIG. 80



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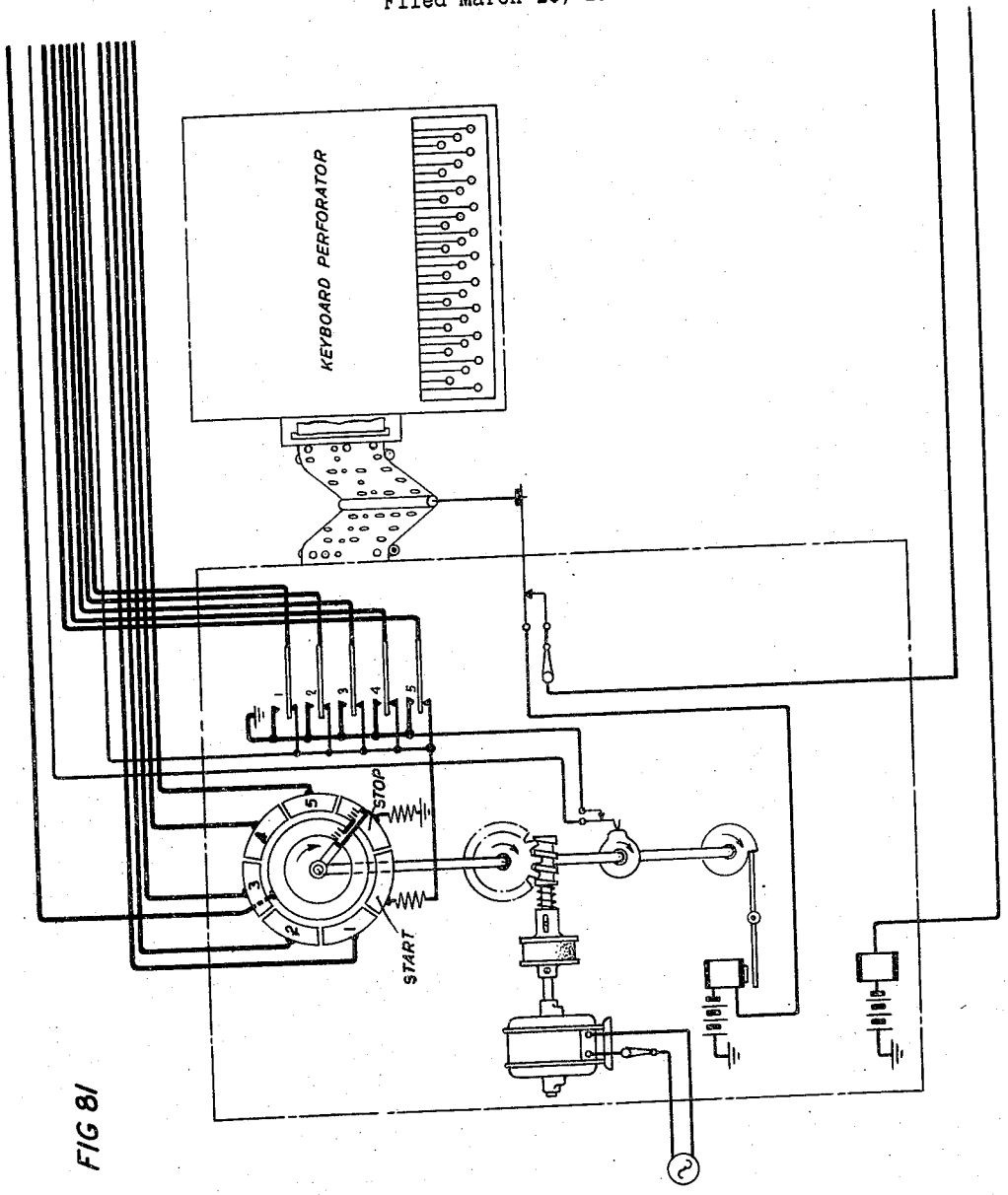

FIG 81

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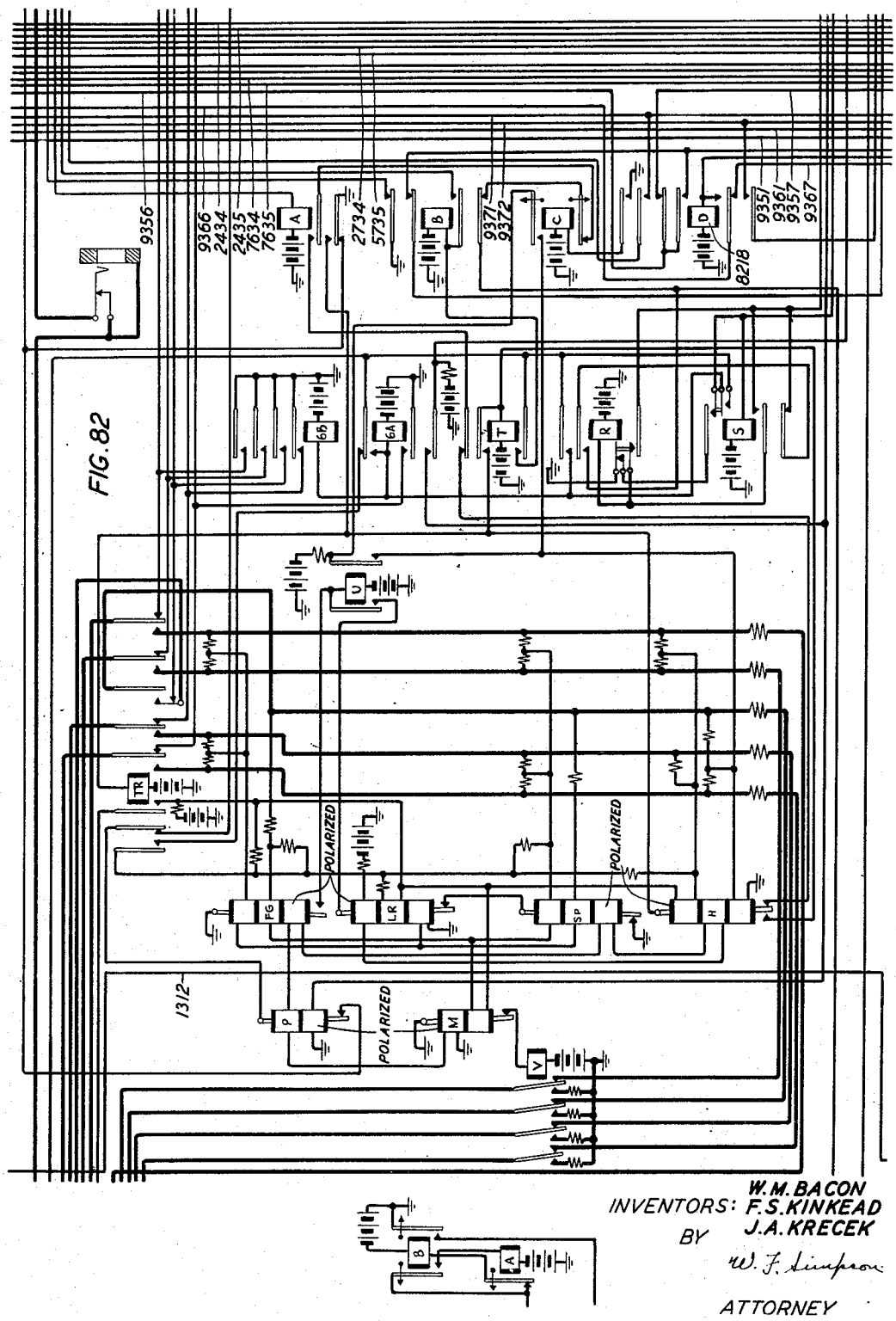

FIG. 82

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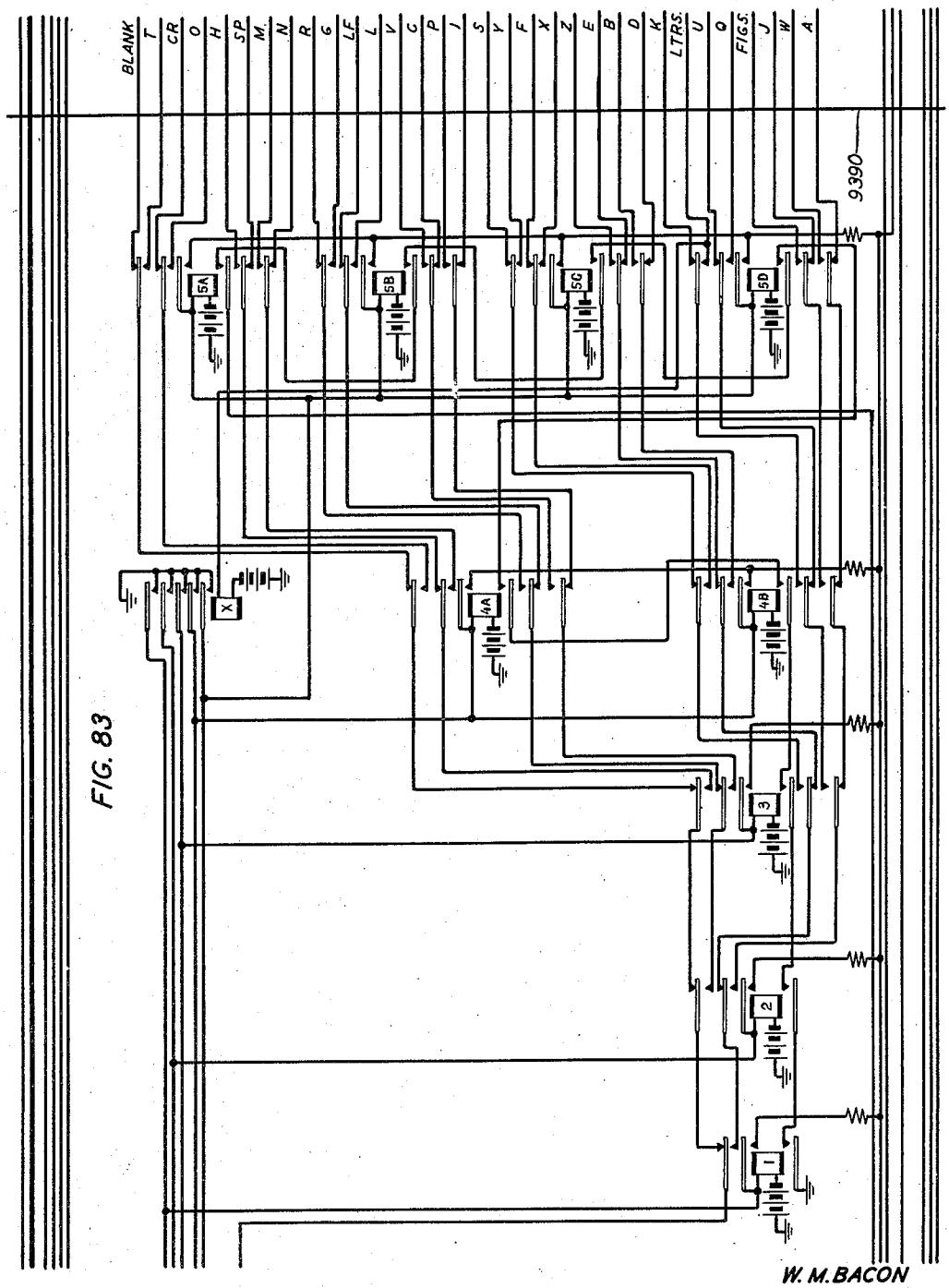

FIG. 83

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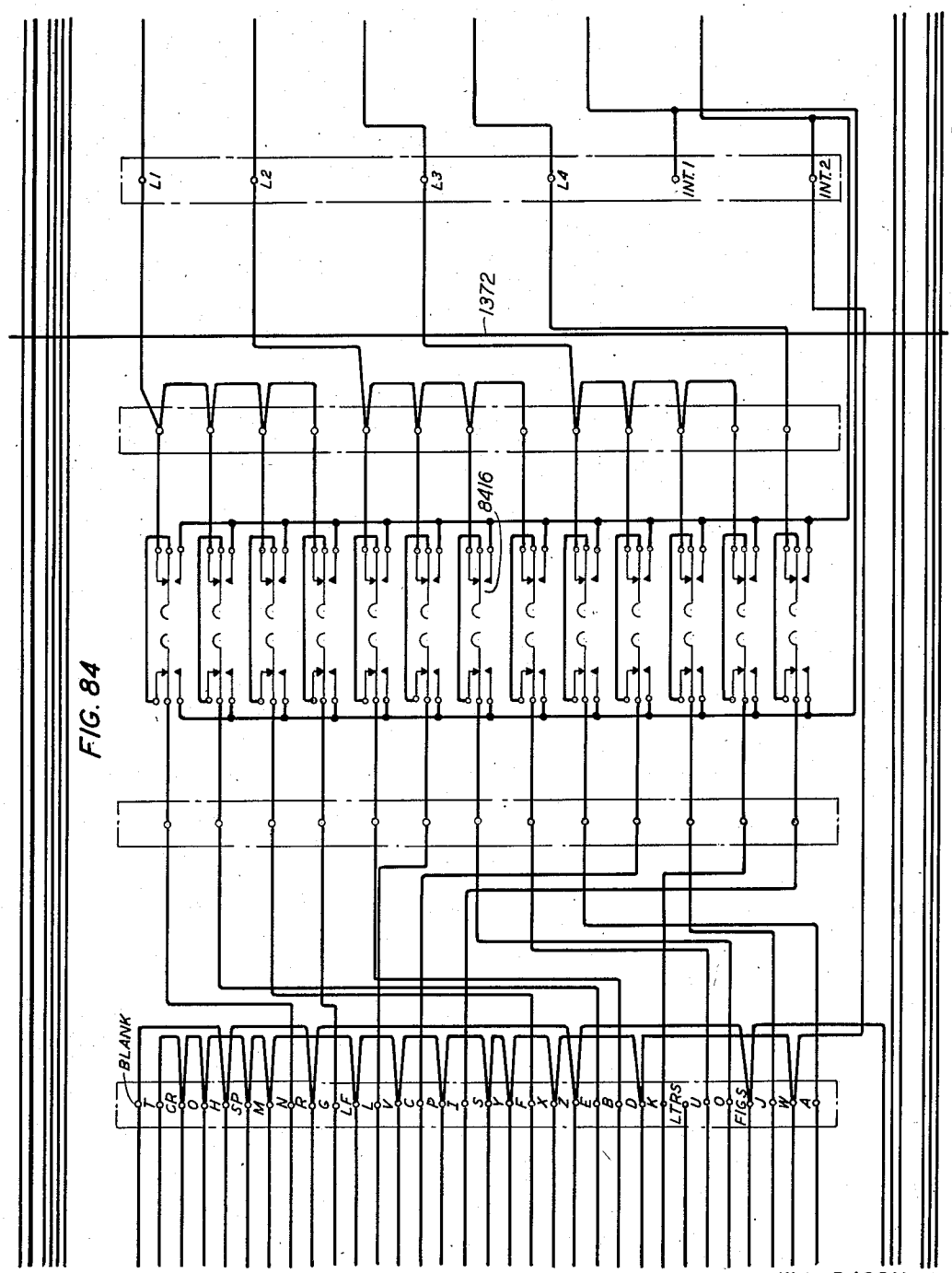

FIG. 84

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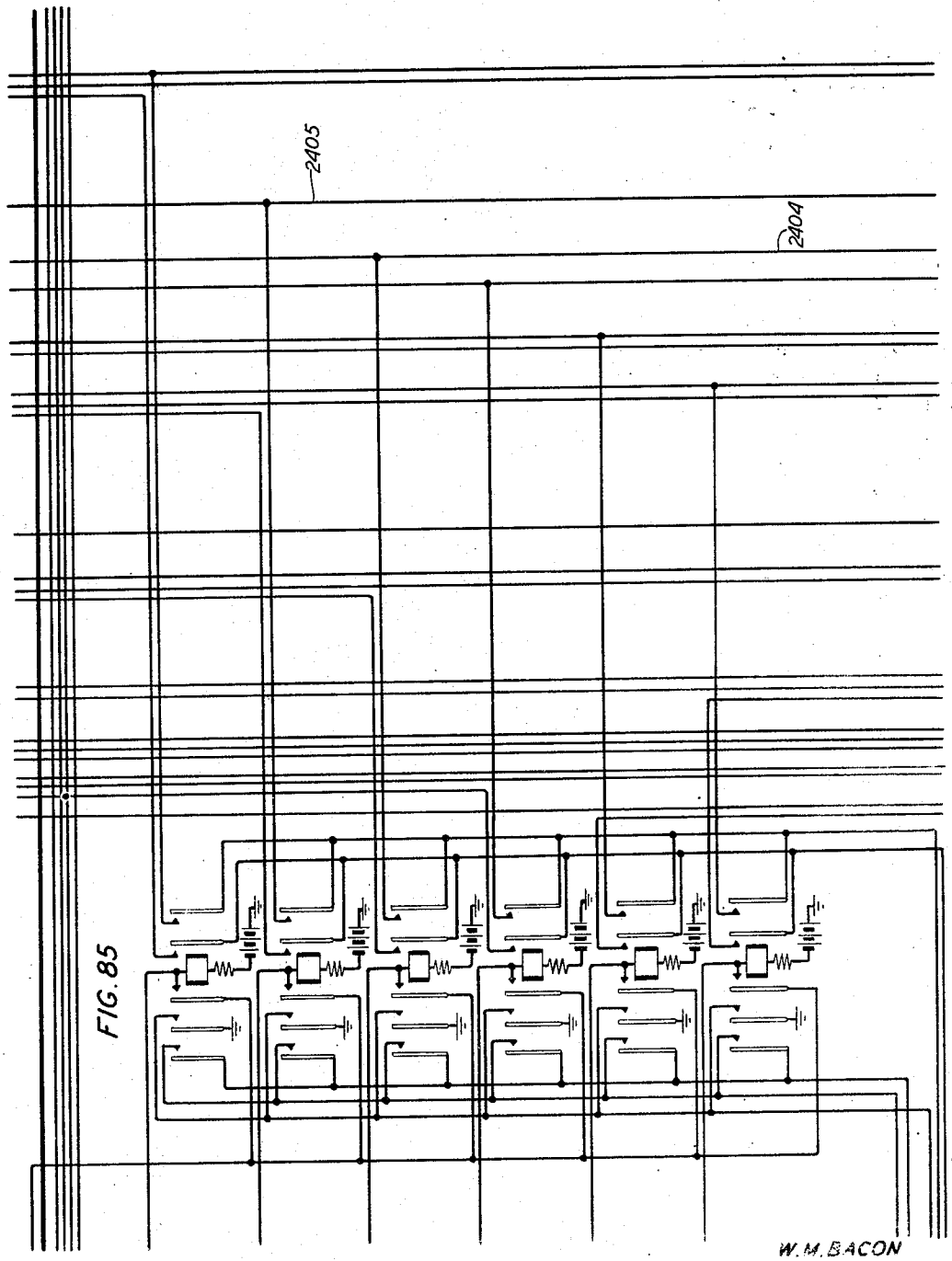

FIG. 85

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COMMUNICATION SYSTEM

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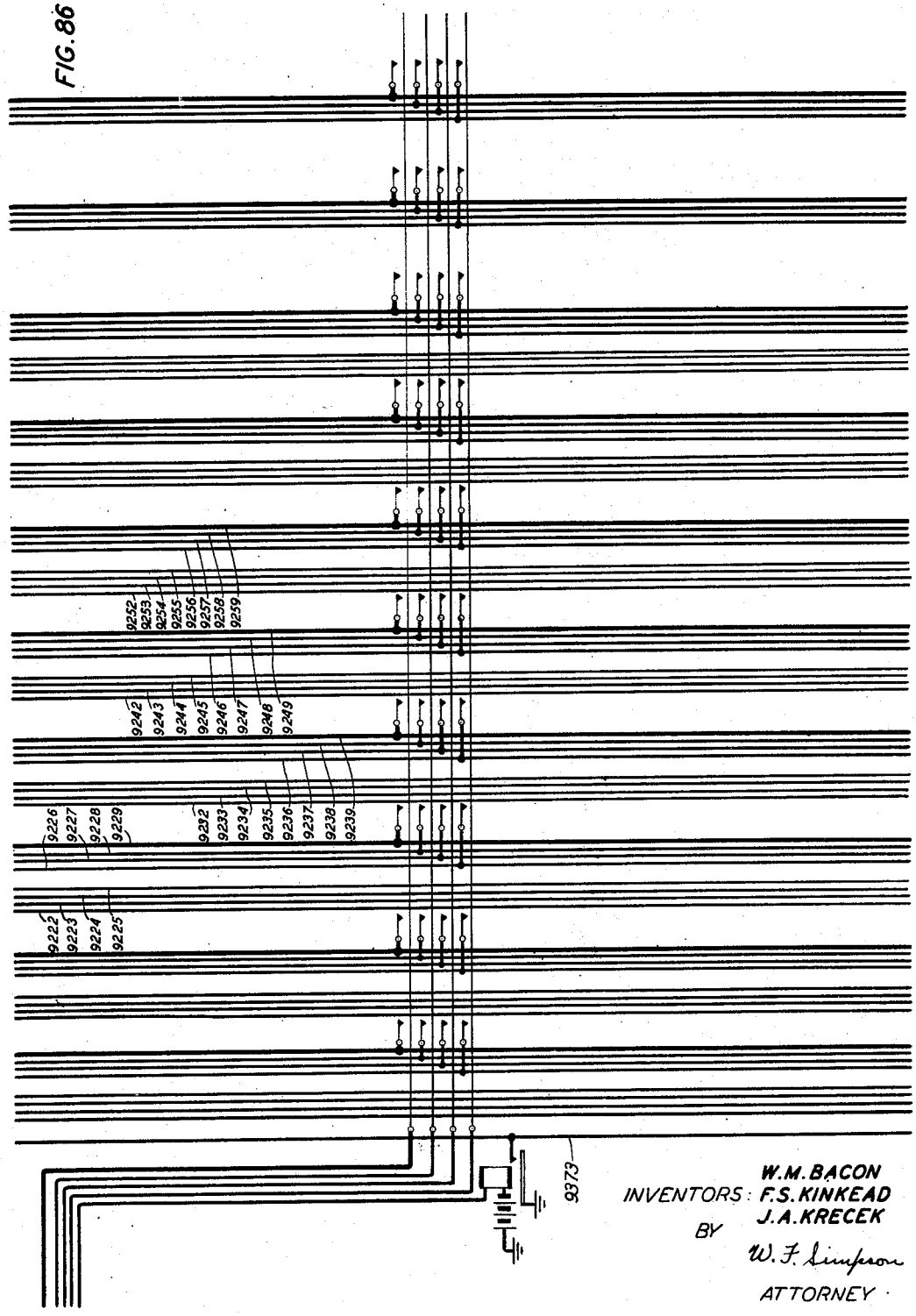
FIG. 86



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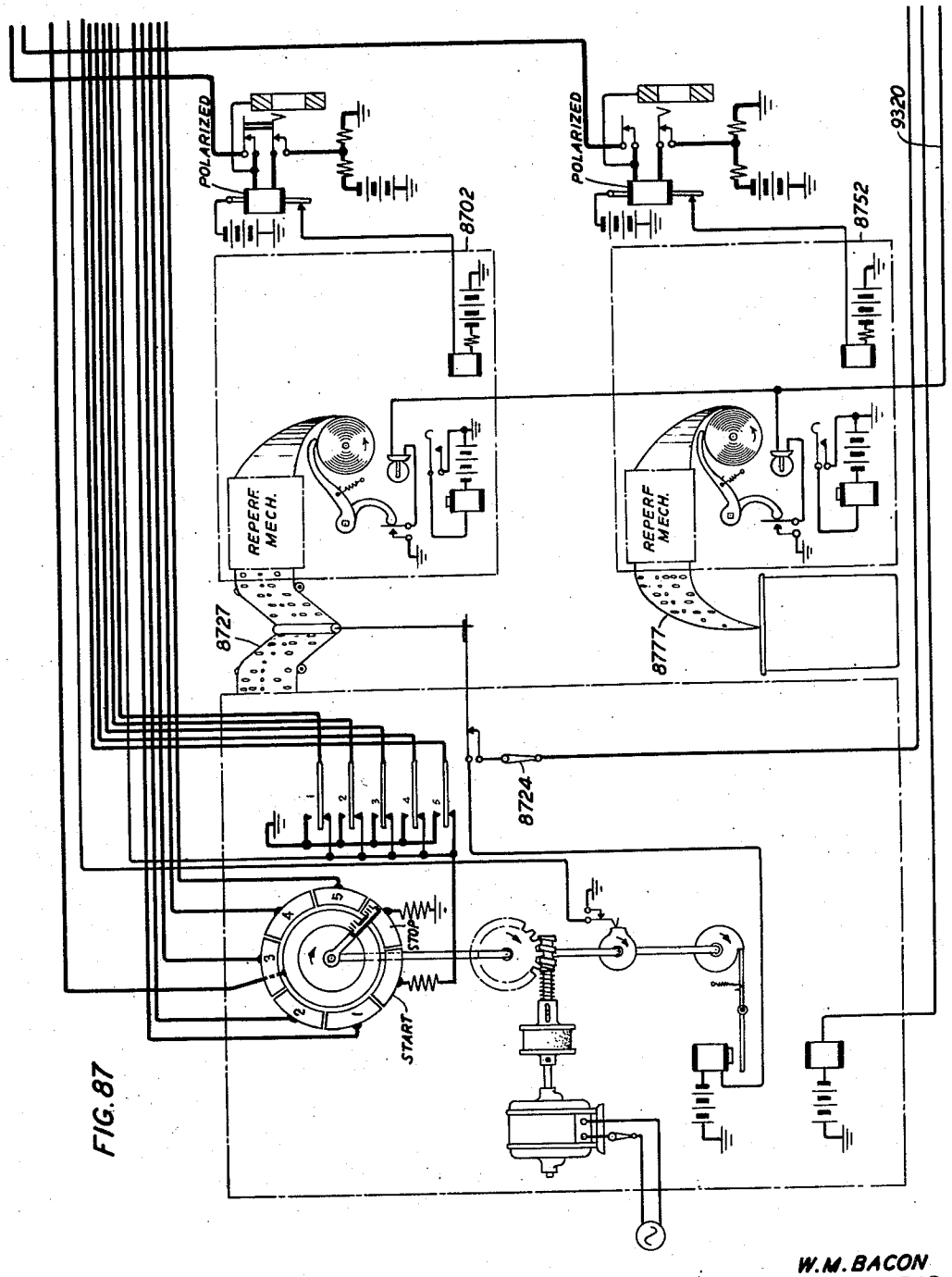

FIG. 87

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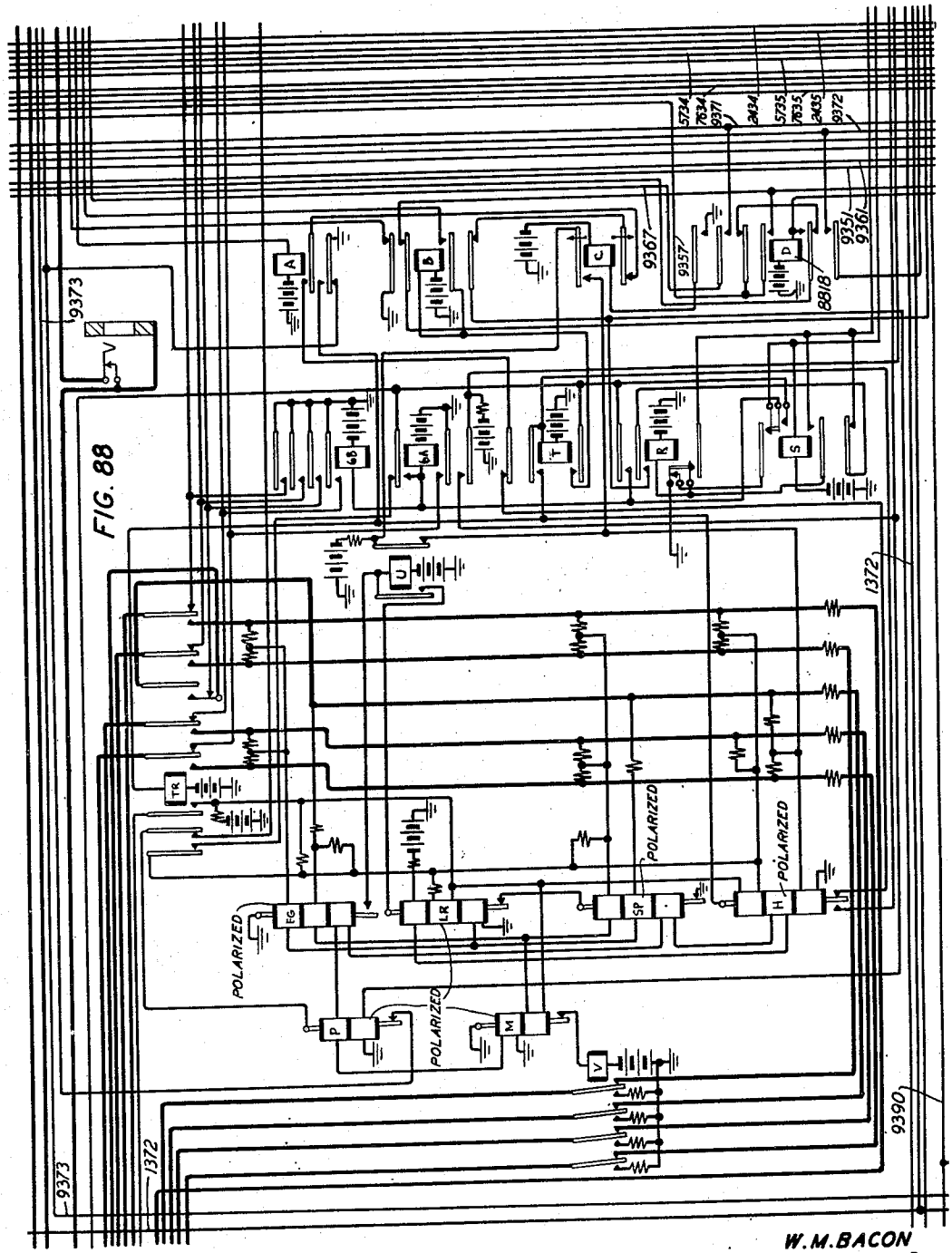

FIG. 88

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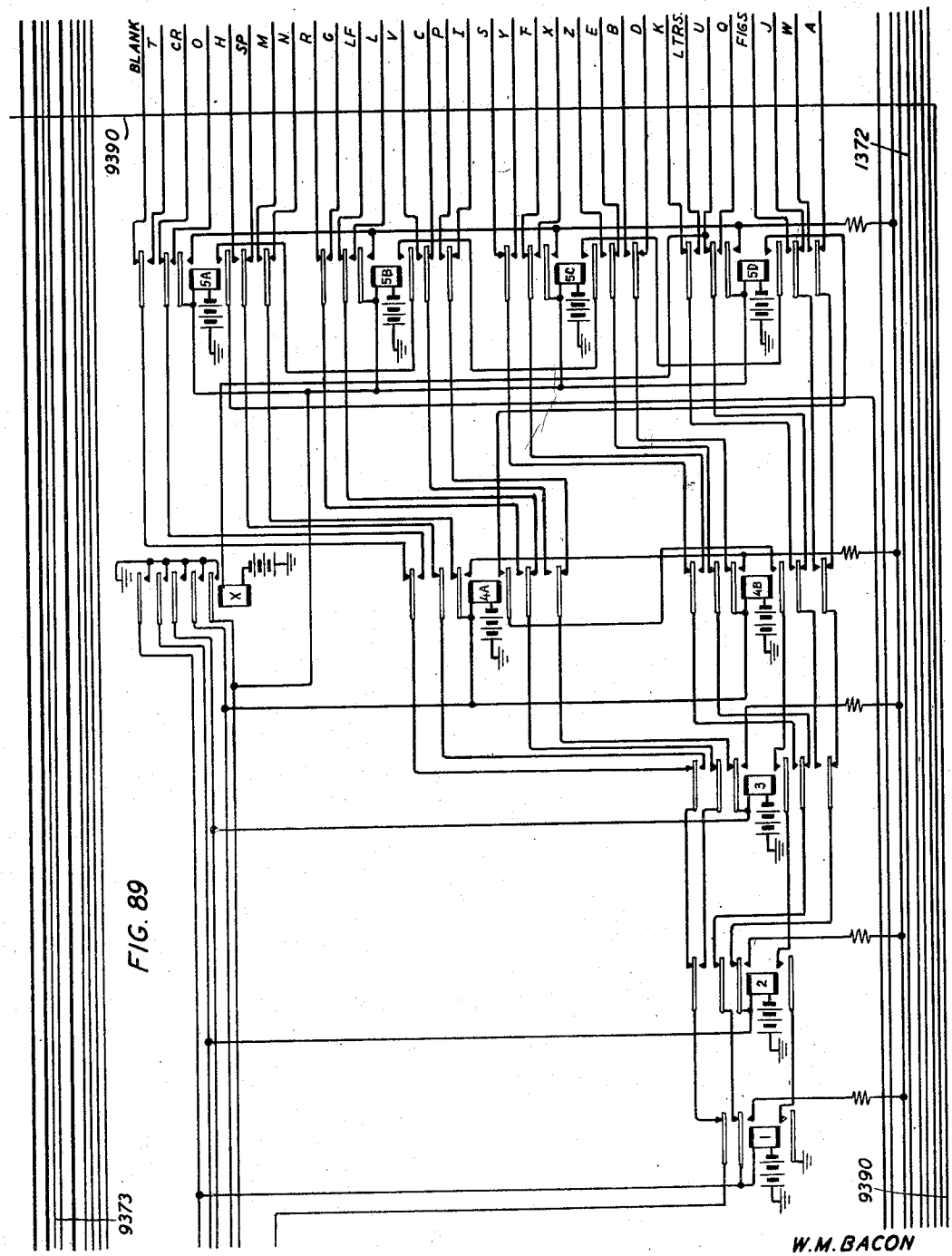

FIG. 89

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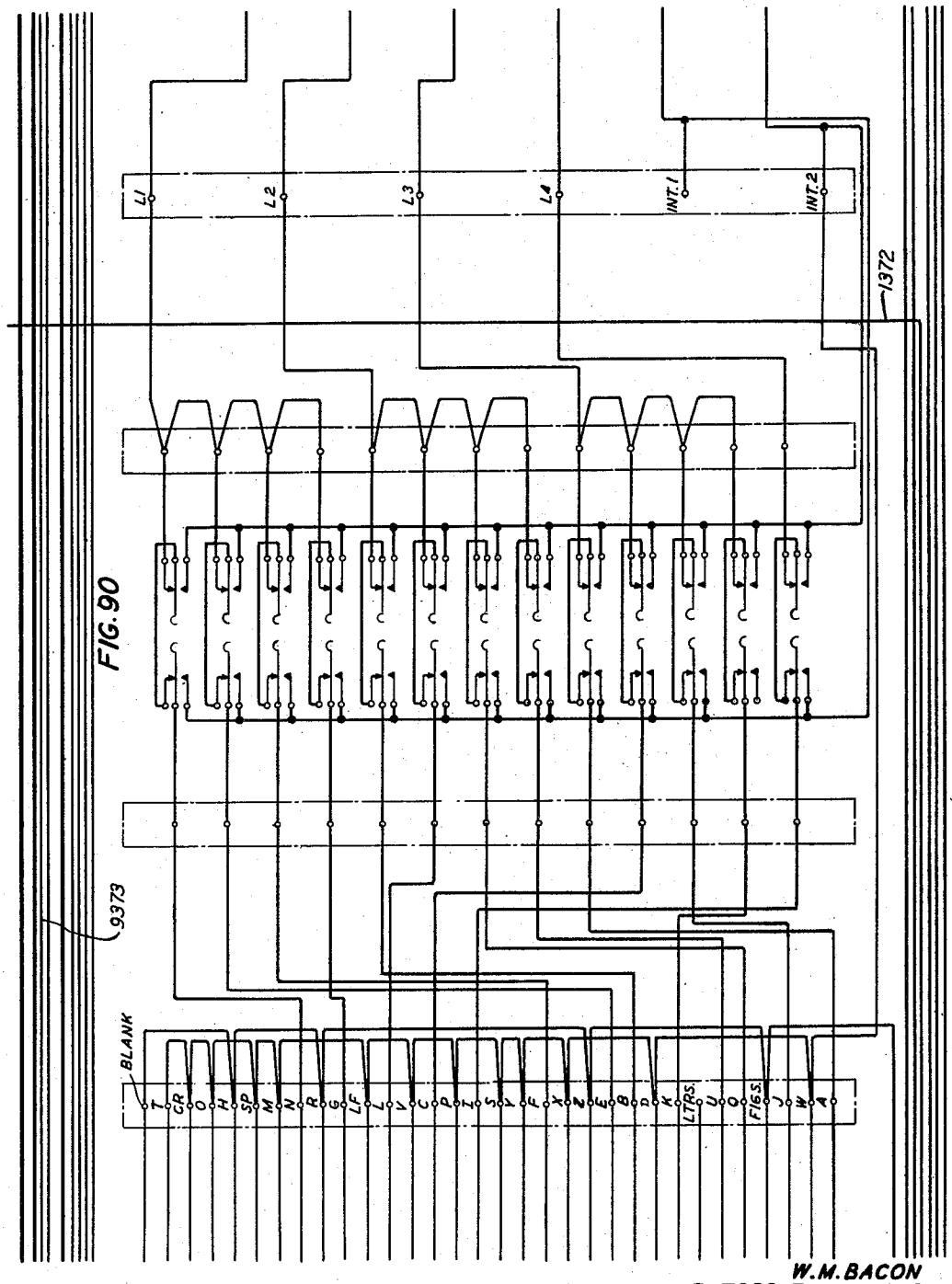

FIG. 90

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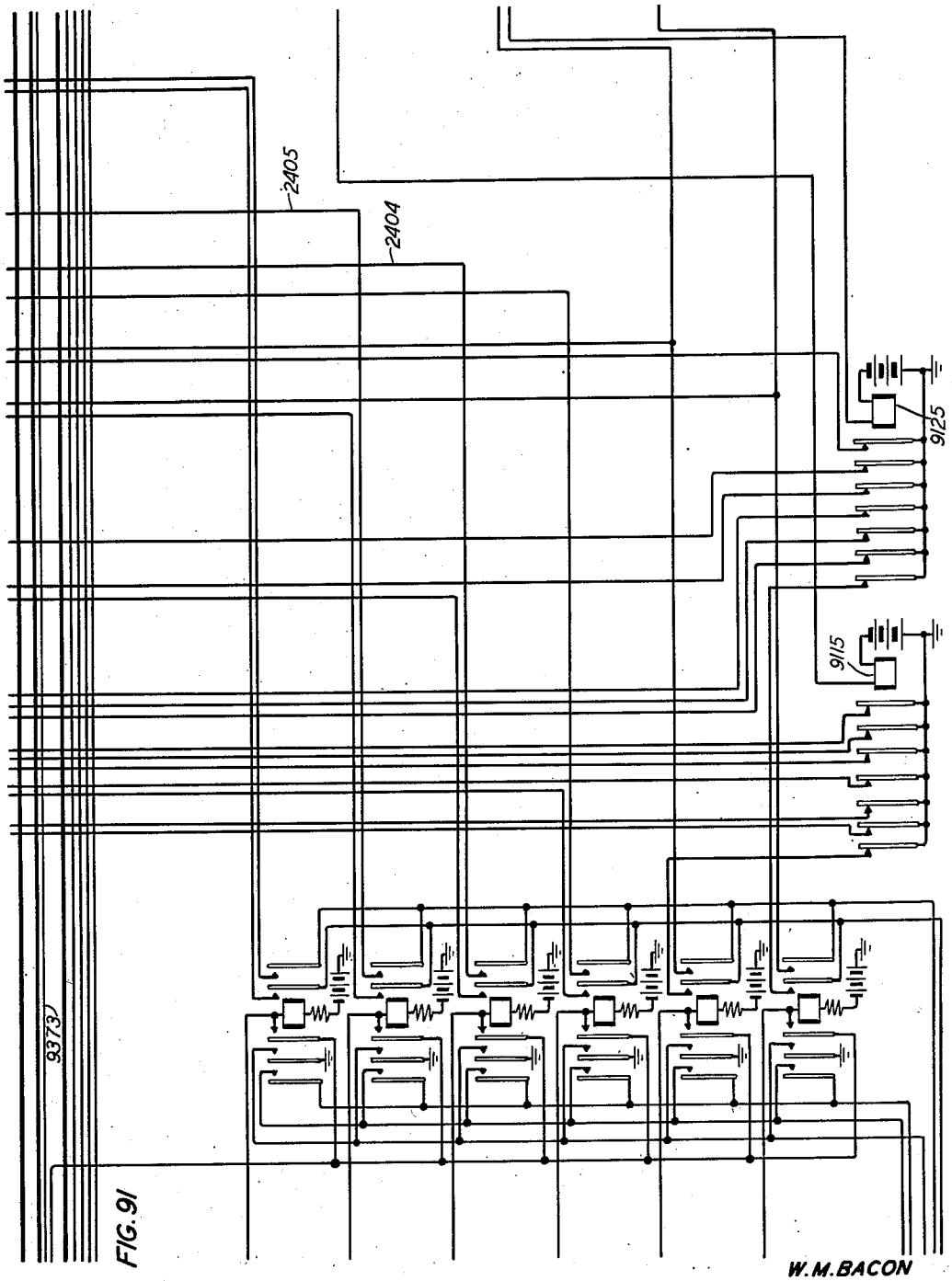

FIG. 91

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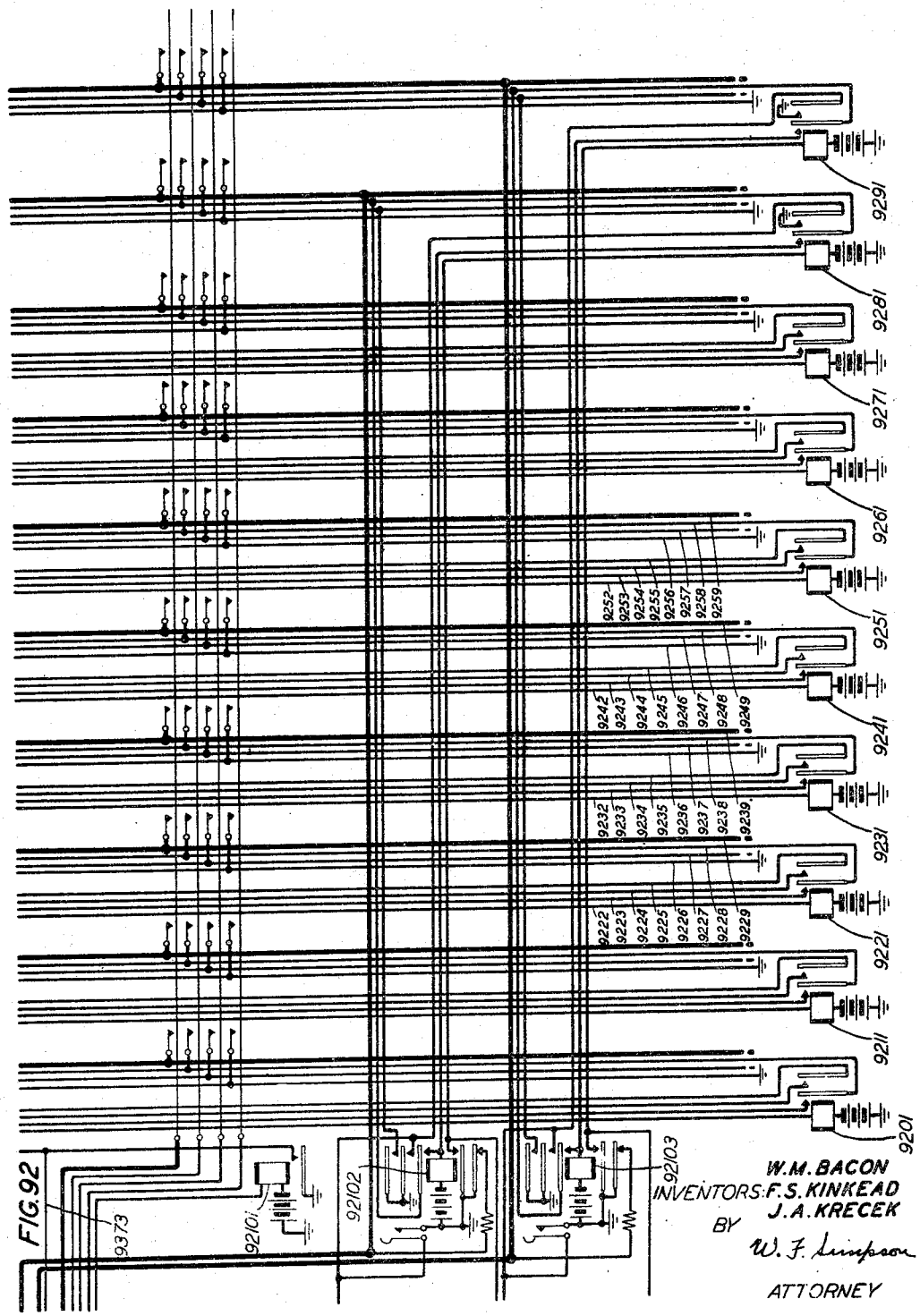

FIG. 92

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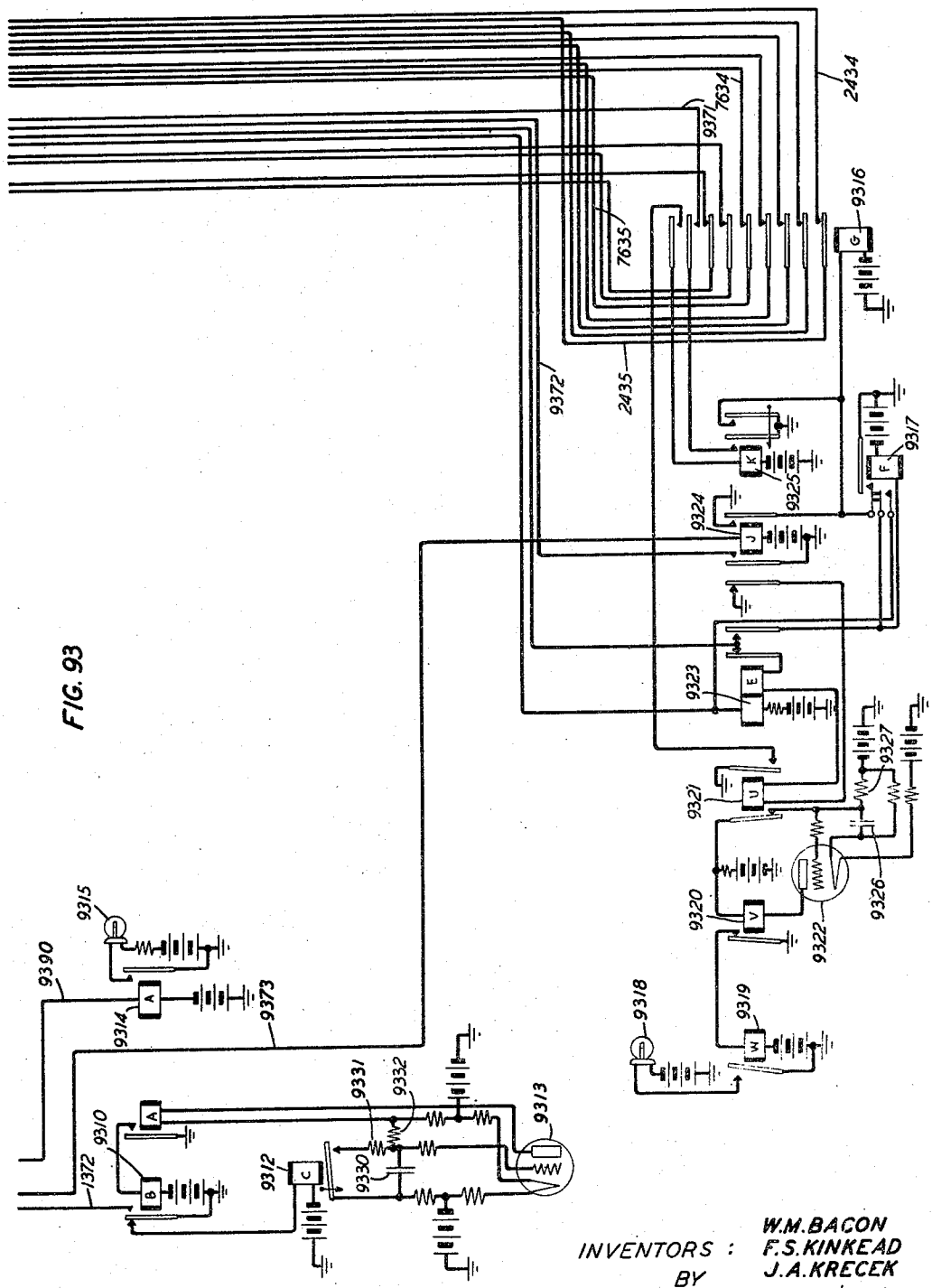

FIG. 93

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COMMUNICATION SYSTEM

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FIG. 95

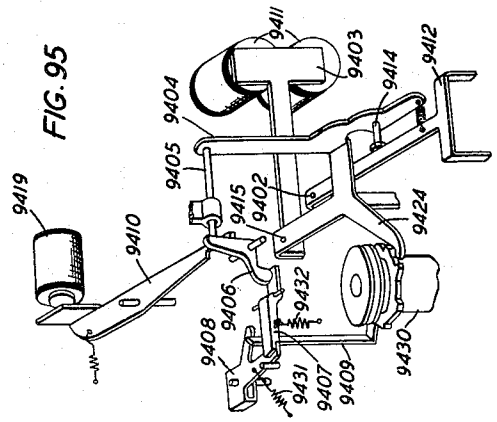

FIG. 97

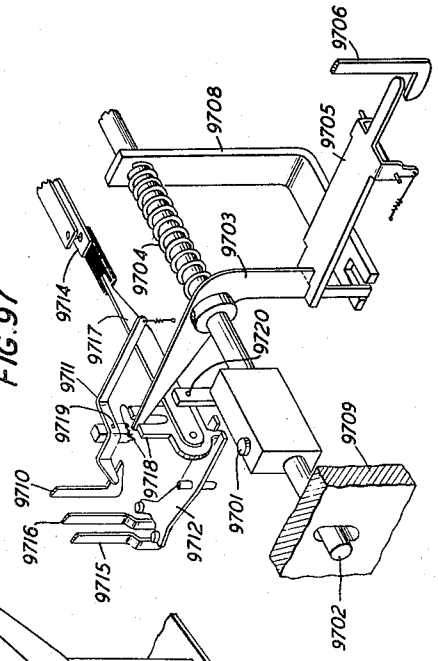

FIG. 94

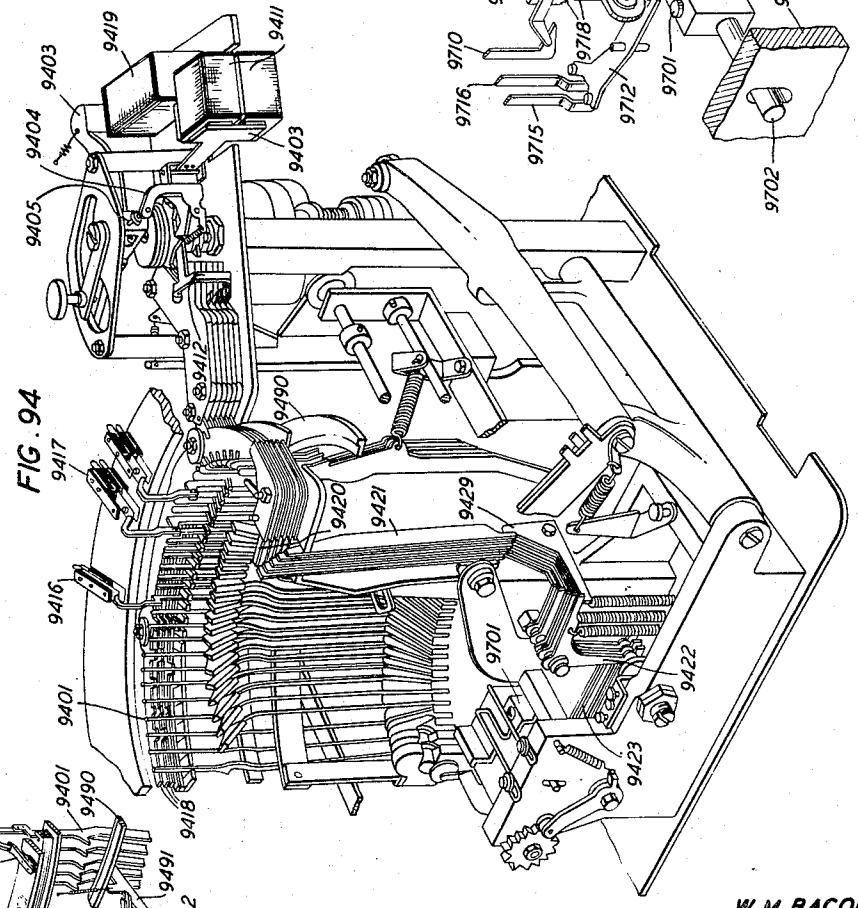

FIG. 96

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Patented Aug. 14, 1945 2,381,871

UNITED STATES PATENT OFFICE

2,381,871

COMMUNICATION SYSTEM

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Application March 15, 1941, Serial No. 383,490

183 Claims. (Cl. 178—4)

This invention relates to telegraph systems and more particularly to switching arrangements for directing telegraph messages.

It is an object of this invention to provide an improved and simplified telegraph switching system in which certain telegraph signaling impulses of the same kind as normally employed to transmit messages are employed to direct a message to its proper destination.

In most previous automatic switching systems it has been necessary to prevent the transmission of the messages until the called station and all of the interconnecting lines and circuits are idle. In certain more recent switching arrangements telegraph messages are stored as received at the central switching station until the line to which they are directed is idle. This causes a considerable delay at times where a number of messages are all directed to a particular line which becomes overloaded and unable to handle all the messages as fast as they arrive. This delay not only affects the messages intended for the overloaded line or station, but also all the messages following the messages for the overloaded line which are stored in the storing medium subsequent to the storage of the messages intended for the overloaded line or station.

It is an object of this invention to provide an improved switching arrangement which materially reduces the delay of the subsequent messages by providing a plurality of paths through the switching equipment from the initial storing equipment and apparatus where the messages are first stored to a second group of storage devices individual to outgoing lines.

Another object of this invention is to automatically and selectively transmit messages received from a line operating at one speed to a line operating at the same or a different line speed.

Another object of this invention is to automatically and selectively transmit messages through the switching system at a speed which is independent of speed that they are received.

Another object of this invention is to transmit the messages stored in the second storage devices to the outgoing line in rotation, thus delaying each of the messages a minimum interval of time.

Another object of this invention is to provide a switching system incorporating a plurality of multistation lines to which messages may be selectively directed and from which messages may be selectively received.

A feature of the multiparty lines is that the sending equipment in each of the stations is disassociated from the transmission channel by the switching apparatus controlling this equipment.

It is a further object of this invention to provide control means at the central switching station for automatically, selectively, and in rotation starting transmitting apparatus and associating it with the transmission channel at the various stations of a multistation line.

It is a further object of this invention to automatically disable the automatic starting equipment for any predetermined interval of time in case none of the stations have messages to transmit.

A feature of the multistation lines relates to an arrangement whereby switching equipment located at or near each of the stations is normally conditioned to receive and be actuated by selecting code combinations or telegraph signals which normally precede the message after which this switching equipment is disabled during the transmission of the message.

Another feature of the station circuits is related to arrangements whereby the receiving apparatus is disabled during the reception of signals causing the starting or stopping of the transmitting apparatus associated with the various stations of the multistation line and then automatically reestablishing the receiving circuit to the previous station upon the completion of the transmission of the starting signals.

Another object of this invention is to provide a switching arrangement in which messages intended for any station of the system which may be ineffective for any reason, either due to trouble or absence of the subscriber, may be intercepted at the switching station and stored in a special storing equipment thereat for later manual or automatic transmission to the desired station.

Another object of this invention is to provide a switching system which employs an improved type of switching apparatus commonly referred to as "cross-bar switch."

Another object of this invention is to provide means for causing the switching and control apparatus to disregard certain extraneous and interfering signaling currents sometimes encountered in telegraph networks and prevent them from improperly operating the switching apparatus.

Another object of this invention is to provide busy signals and suitable alarms and other signals to attendants and operators to enable them to properly supervise the operation of the system by indicating various traffic and trouble conditions to them.

Another object of this invention is to provide suitable means to enable the operators and attendants to make certain of the circuits busy; to hold certain circuits in certain conditions or stages of their operation; and to stop the operation of certain of the circuits.

Apparatus is also provided to automatically advance the storing medium past the recording point to insure that all the message signals stored in the storing medium will be transmitted by the associated transmitter.

Another object of this invention is to provide means for causing the transmitter controlled by the storage medium to automatically and selectively discard the signals recorded in said tape during its automatic advance.

In certain switching systems it has been the practice to store received messages and then to manually transfer the recording medium in which the message is stored to the proper transmitter and then cause the message to be automatically transmitted. In accordance with the present invention it is not necessary to manually transfer the storage medium from one transmitter to another. Instead a transmitter is provided for each of the storing devices, which transmitter is automatically connected by means of signals stored in the storage medium to the proper line or station.

Another object of this invention is to provide a switching system in which the same switching characters are employed to direct the message to the proper line and then to the proper station along the line in case the line is a multiline station line. In order to accomplish this, it is necessary to prevent the advance of the recording medium through the transmitter controlled thereby at certain times. A feature of this invention therefore relates to an arrangement for preventing the advance of the storage medium at certain times.

Another object of this invention is to provide an interlocking system between the transmitters associated with the first recording apparatus to prevent more than one of them from being simultaneously connected to any outgoing transmission channel, thus insuring proper connection between each of the transmitters and the desired outgoing channel and circuit. After the connection has been once established, circuits are arranged so that other connections may also be established one at a time without disturbing the previous connections except that the second transmitter cannot be connected to a transmission channel to which another transmitter has been previously connected.

Another object of this invention is to provide an improved and simplified monitoring arrangement for each of the transmitters which will recognize and respond to specific code combinations or signals employed for operating the switching equipment.

Another object of this invention is a circuit arrangement for causing the switching equipment to ignore and discard selectively certain signals or code combinations which have performed their switching functions and the use of which is no longer necessary.

Another object of this invention is to direct messages having unused or unassigned code combinations or signals to special recording apparatus where an attendant may examine the message and make the proper corrections thereto and retransmit it to the proper station.

A feature of the invention relates to an improved recording and storing mechanism in which the received signals are both printed and perforated or stored in a common medium preferably a paper tape.

Another feature of this invention relates to an improved interconnecting arrangement for selectively connecting various receiving devices at the respective stations of a multistation line to the receiving channel of said line in which the receiving channel is not in any way disturbed by the switching relays, resistances or other apparatus and which is free from relay contacts. This is accomplished by permanently connecting a repeater in the receiving channel for each of the stations or receiving apparatus connectable thereto and then selectively conditioning the repeater for transmission to its respective station.

Another object of this invention is to provide means at the central switching station for transmitting messages to any of the other stations connected to the system in a manner similar to the manner in which messages are transmitted from any outlying station to any other outlying station.

Another object of this invention is to provide a special receiving device at the central station for receiving and recording messages intended for transmitters or other types of communication systems.

Another feature of this invention relates to apparatus for disconnecting any connected transmitter when a supply of the storing medium supplying the transmitter becomes exhausted and passes out of the transmitter.

Another object of the invention is to provide means for automatically disconnecting one transmitter and connecting and starting another transmitter in case the transmission from the first transmitter stops for a longer interval of time than some specified time. This prevents any station from holding the transmission circuit for any longer interval of time than actually necessary for the transmission of any message material and leaves the circuit free for the longest interval of time for transmitting message material from the other station connected to the line.

Briefly, in accordance with a preferred embodiment of this invention a central switching station is provided from which extend a plurality of full duplex telegraph lines or circuits. Each of these lines or circuits is capable of transmitting telegraph signaling impulses simultaneously in both directions. Each of these lines extends to one or more of a plurality of outlying stations. Each of the outlying stations is provided with a switching selector which is permanently connected to a receiving channel of the full duplex line. Each of the outlying stations is also provided with a receiving instrument, a keyboard operated perforator for perforating tape in accordance with messages to be transmitted and a tape-controlled transmitter for transmitting messages. The switching selector circuit controls the operation of the receiving telegraph instrument which in the preferred embodiment of this invention is a teletypewriter. The switching selector also controls the transmitting apparatus.

Each of the full duplex lines at the central station is provided with an incoming circuit individual thereto. This incoming circuit includes a receiving teletypewriter and a typing reperforator. The receiving only teletypewriter is provided for recording messages intended for the central switching station, while the typing reperforator is intended to receive and record mes-

sages intended for other stations. Tape from the typing reperforator is supplied to the tape transmitter. This transmitter is associated with a switching circuit called a director, which in turn controls the cross-bar switch for connecting the transmitter to any of the channels of the outgoing circuits associated with any of the full duplex channels. After a connection has been established, the transmitter transmits to one of two typing reperforators associated with the desired full duplex channel at any suitable speed which may be independent of the transmission speed of the received signals and generally will be the same or a higher speed. These second typing reperforators are located at the central switching station. If one of them is busy, the transmitter will transmit to the other and, if both are busy, it will have to wait until one of them becomes idle. The tape from the second typing reperforator controls an associated transmitter which is connected to the outgoing channel of the full duplex line. These transmitters transmit the messages to the outgoing lines at a speed which may be the same as the speed at which the message was received or transmitted through the switching equipment or the message may be transmitted at a speed which is different from and independent of the speed at which the message was received or transmitted through the switching equipment.

The outgoing channel of each of those duplex lines which extend to more than one station is provided with a transmitter start circuit which includes a signal code transmitter for selectively starting the transmitters at the stations to which the full duplex line extends.

In operating the system an attendant at an outlying station will perforate a message in the tape and insert the tape in a tape-controlled transmitter. The attendant at the central station will then cause the transmitter to be started, whereupon the message is transmitted to the central station where it is recorded and stored. The storing medium then passes to the tape-controlled transmitter, which with the aid of the director circuit associated with it is connected to the desired outgoing line circuit. The message is then transmitted to the outgoing line circuit where it is again recorded and later transmitted to the outgoing line of the desired station.

The code combinations or signals which shift receiving machines on the circuit to upper case position are designated herein "figure" or "figures signals"; those which unshift receiving machines are designated "letter" or "letters signals."

The manner of achieving the foregoing objects and features of this invention, the novel features of which are specifically set forth in the claims appended hereto, may be fully understood from reading the following description of an exemplary form of system with reference to the attached drawings, in which:

Fig. 1 illustrates the manner in which Figs. 2, 3 and 4 are to be positioned adjacent one another;

Figs. 2, 3 and 4 when positioned as shown in Fig. 1, illustrate in schematic form the general arrangement of the various apparatus and circuits of the system;

Fig. 5 illustrates the manner in which Figs. 6 through 93, inclusive are positioned to show in detail the apparatus circuits of the system; and

Figs. 94, 95, 96 and 97 show the mechanical construction of certain features of the printing reperforator employed in the system to print and perforate a tape in accordance with the received telegraph signals.

General description

Referring now to Figs. 2, 3 and 4 when arranged as shown in Fig. 1, Fig. 2 illustrates the equipment located at and in the vicinity of various outlying stations of a typical telegraph system in accordance with this invention, while Figs. 3 and 4 illustrate the general arrangement of the equipment and circuits at the central switching station.

The system comprises four full duplex telegraph lines or channels **200**, **201**, **202** and **203**. As shown in Fig. 2, channel **200** extends to stations **210**, **211** and **213**. Each of these lines is provided with a receiving channel and a transmitting channel over which impulses may be simultaneously transmitted as is the usual practice with full duplex channels and well understood in the art.

As shown in Figs. 2, 3 and 4 and also in Figs. 6 through **93**, inclusive the full duplex channels are illustrated by two full metallic one-way telegraph circuits. This has been done so that the invention may be more readily understood without the further complications of the various types of transmission systems commonly employed in telegraph networks for furnishing full duplex telegraph service between various stations and points. It is to be understood, however, that these lines or circuits may include any of the usual types of transmission circuits capable of providing this type of service. Since these transmission circuits operate in their usual and well-understood manner, they have not been shown in detail. It is to be understood, however, that they may include either singly or in combination, any of the following typical types of circuits or channels including telegraph channels of composited telephone and telegraph circuits, full metallic telegraph channels, grounded telegraph circuits, voice frequency carrier current telegraph channels, high frequency carrier telegraph channels, radio channels, etc.

At or near each of the outlying stations a switching and controlling selector circuit including a repeater is connected to the receiving channel of the full duplex line. The selector circuit is arranged to receive all the impulses transmitted over the line and to respond selectively thereto. It controls the switching circuits in such a manner that the switching circuits are unresponsive during reception of message signals, but upon reception of certain preassigned signals they are activated or operatively connected to the selector circuit. The switching circuits and selector are illustrated graphically by the boxes **220**, **225** and **229** and are connected to receiving channel **204** of the full duplex transmission system **200**. This switching and selecting equipment may be located near or at the respective outlying stations. It need not actually be at the same place as the receiving and transmitting equipment, but may be connected to it by means of local telegraph circuits.

At station **211** the selecting or control equipment is connected to a receiving device **228** and to the transmitting device **226** and the control circuit **227**. Associated with the receiving teletypewriter **228** and located in the base thereof is the keyboard perforator which perforates a tape in accordance with the messages to be transmitted. The tape is then inserted in the

transmitting distributor 226 for transmission over transmitting channel 205. Transmitting distributor 226 is connected to this channel. Similar equipment is provided at the station 213. At station 210 an additional reperforator 224 is provided so that certain messages which are intended for other stations and which must be retransmitted from station 210 may be recorded by the reperforator so that they may be automatically retransmitted. To accomplish this, the operator will usually take the perforated tape as perforated by the reperforator 224 and manually insert it in the proper transmitter for transmission to the proper station. Inasmuch as tape may be inserted in any one of a number of circuits all of which will operate in the usual manner, it is not thought advisable to further complicate this disclosure by showing the details of all possible types of such systems or even typical or representative types of such systems over which such messages may be further transmitted.

A somewhat different outlying station arrangement is shown connected to the full duplex channel 201. Here station 215 is similar to stations 211 and 213, but the station equipment shown in the area 214 is somewhat different. Here a single selector and switching equipment 233 is employed for three outlying stations. These stations are located relatively close together so that it is economical to use the single switching and control circuit. Each of the outlying stations is provided with a transmitting distributor, keyboard perforator, and a receiving teletypewriter as well as the required control equipment.

Stations 217 and 218 connected to full duplex line 202 are similar to stations 211, 213 and 215. The equipment in area 216 is similar to the equipment in area 214, except that only two teletypewriter stations are controlled by a single selector circuit and associated switching equipment.

Station 219 is the only station connected to the full duplex channel 203. Consequently, the switching equipment and associated selector are not necessary so that only a receiving teletypewriter, keyboard perforator and tape-controlled transmitter are provided.

At the central switching station the incoming messages from the transmitting channel are received either on a receiving only teletypewriter if they are intended for the central switching station or on a typing reperforator if they are intended for other stations connected to the system. In order to control this equipment an incoming line circuit 317 is provided in which the transmitting channel of line 200 terminates. The tape 323 from the reperforator 313 controls the transmitter 320. Signals recorded in tape 323 together with the tape transmitters 320, director 321 and selector magnet 322 cause the tape transmitter 320 to be connected through the cross-bar switch to the proper outgoing line circuit.

Any suitable type of coordinate switch, of which the cross-bar switch is a preferred exemplary embodiment, may be employed for establishing the connection between the transmitter 320 and the proper outgoing line circuit. The details of the cross-bar switch have not been shown in full since switches of this type are well known in the prior art and the switch incorporated in this invention operates in the usual or customary manner. For a more detailed description of the mechanical and electrical features of a typical switch suitable for use in this invention reference is made to U. S. Patent 2,021,329, granted to Reynolds November 19, 1935.

The outgoing line circuit is provided with two channels for receiving messages. These channels may be operated simultaneously to record different messages. When the first channel is busy recording another message, a second message will be received from the transmitting distributor over the second channel. A typing reperforator is associated with each of these channels. Thus, in Fig. 3, 314 represents the typing reperforator associated with the first channel of the outgoing line circuit 316, while 315 represents typing reperforator associated with the second channel of the outgoing line circuit 316. Assuming that both channels are idle and that a message is directed to some station connected to full duplex line 200, the message will be transmitted over the first channel of the outgoing line circuit 316 and recorded by the typing reperforator 314 in a tape 324. Tape 325 will then control the transmitter 312, causing the message to be transmitted over the receiving channel 204 of transmission system 200 to the desired station.

In addition to the transmitters 312 and 313 connected to the receiving channel 204 of line 200, the transmitter control circuit 310 and associated signal code transmitter 311 are also connected to the outgoing or receiving channel 204 of line 200. The transmitter start circuit 310 and the associated transmitter 311 are provided to selectively start the transmitters 221, 226 and 230 and to operatively associate them with the transmitting channel of full duplex line 200.

The other full duplex lines 201, 202 are similarly provided with terminal equipment at the central switching station. In addition, arrangements are made so that the second channel of the outgoing line circuit connected to line 202 may be dissociated from line 202 and employed to receive other messages which are improperly transmitted or for some reason improperly directed to the correct station.

Line 203 is provided with similar terminal equipment at the central station, except that the transmitter start circuit and its associated transmitter are not provided because only one station is connected to line 203. Consequently there is no need for selectively starting the transmitter from the central station.

In addition, two local keyboard perforators 418 and 438 are provided at the central switching station for perforating the tape in accordance with signals to be transmitted to other stations of the system. This tape controls the associated transmitters 420 and 440. These transmitters are in turn provided with directors 421 and 441, respectively, to enable them to be connected to the desired lines extending to the proper station. Two intercept circuits 480 and 490 are provided for receiving messages which are improperly switched or improperly transmitted over the system. Arrangements are also provided for directing messages intended for any one of the stations, which may be shut down or ineffective due to trouble, to either of these intercept circuits where the messages are recorded on the respective printing reperforators 458 and 478. The tape perforated by the typing reperforator 458 is employed to control transmitter 460. With the aid of the associated director 461 this transmitter may be connected

to any of the outgoing line circuits under control of perforations in the tape. An interlocking circuit is provided between each of the director circuits to prevent more than one of the director circuits setting up a connection through the cross-bar switch at a given instant of time. The circuits are arranged, however, so that once the circuit is established through the cross-bar switch by one director, other director circuits may establish other connections through the switch without disturbing the connections already established. Busy-test arrangements are also provided to indicate whether either or both of the channels of the outgoing line circuits are busy, so that a director will be unable to connect its associated transmitter to a busy channel of an outgoing line circuit.

The system may be more fully understood by briefly describing the course a message will take in traveling through the system from one station to another. Assume, for example, that station 211 has a message intended for station 217. The attendant at station 211 will operate the keyboard 228 to perforate tape in accordance with the message to be transmitted to station 217. Prior to perforating tape in accordance with the text of a message the attendant at station 211 will perforate certain switching characters or code combinations in the tape by operation of the keys of the keyboard perforator in the same manner that she operates these keys in perforating the text of the message. In order to secure the proper operation of the switching system the attendant will first perforate four letter signals in the tape. This will be followed by the figure signal and then an H signal. The purpose of these signals is to insure the proper operation of the switching circuits by causing the circuits to return to their normal condition. Following these signals, the attendant will perforate four more letter signals in the tape, followed by the signal assigned to the called station, which in this case will be the letter A. Following the letter A, another letter signal will be perforated in the tape. If, as will usually be the case, page printing telegraph apparatus is employed these signals will usually be followed by a carriage return signal, line feed signal, then another letter signal, after which the message will be perforated in the tape. Following the message, the figure signal and then the H signal will be perforated in the tape.

If the attendant at station 211 has another message for transmission to the station comprising the receiving teletypewriter 239, the attendant will perforate four letter signals in the tape, followed by the character assigned to that station, which in this case will be the letter Q. Following the letter Q, the operator will again perforate a letter signal in the tape, followed, in systems employing page printing apparatus, by the carriage return signal, the line feed signal, the final letter signal, and then the text of the message. Following the message, the attendant will perforate a figure signal, followed by an H signal in the tape.

If the attendant at station 211 has no further messages for transmission at this time, she will perforate four letter signals in the tape, followed by the letter Z signal and then perforate about seven letter signals in the tape and cut the tape.

After having perforated the tape described above, the attendant will insert the tape in transmitter 226. At some later time the operator at the central switching station will operate certain keys of the transmitter start circuit 310 to cause transmitter 226 to be operatively associated with the transmission channel and to start to transmit the signals recorded in the tape as described above. It may be that the operator at the central switching station had previously operated a special automatic key of the transmitter start circuit 310 which will automatically cause transmitter 226 to start transmission in rotation with the other transmitters 221 and 230 connected to the transmitting channel of the full duplex line 200.

The first letter signals are received by the incoming line circuit 317 and cause typing reperforator 318 to be conditioned for the reception of the incoming message. A number of these first letter signals may be recorded by the typing reperforator 318 and the tape 323. Following the recording of these letter signals the typing reperforator will record the figures signal and the H signal. These signals will also cause the typing reperforator 318 to be rendered non-responsive to incoming signals. The following letter signals will again condition the reperforator 318 for the reception of signals after which it will record at least one or two of the letter signals and the switching and message signals in tape 323. This action is repeated for each message. After the last message the letter signals following the H signal will again cause the reperforator to be conditioned to receive signals from the transmitting channel 205. The following Z signal will cause the perforator to be rendered non-responsive to further signals. After the Z signal has been transmitted the tape will run out of the transmitter 226 at station 211 and cause transmitter 226 to become idle until again started from the central station.

When the Z signal is received by the typing reperforator 318, it in conjunction with circuit 317 will light a lamp to indicate to the operator at the central switching station that the transmission from station 211 is terminated, whereupon the operator will operate certain keys to initiate transmission from other stations connected to line 200. If the operator has operated the automatic start key at the transmitter start circuit 310, reception of the Z signal will in addition to causing a lamp to light cause the transmitter start circuit to function and attempt to cause another transmitter connected to the line 200 to be started.

The tape 323 with these various signals recorded in it will then pass through the transmitting distributor 320. The transmitting distributor 320, together with the director circuit 321 will discard the letter signals and also the figure signal and the H signal. When the first switching signal, the letter A signal, assigned to station 217 arrives at the control point in distributor 320, it will cause director circuit 321 to operate and prevent the advance of tape 323 through the transmitting distributor 320. In addition, the director circuit 321 will cause the transmiter 320 to be connected to the first channel of the outgoing line circuit 356, if this channel is idle. If this first channel is busy, the director 321 will cause transmitter 320 to be connected to the second channel of the outgoing line circuit 356, if it is idle. If both channels of the outgoing line circuit 356 are busy, the director circuit in the transmitting distributor 320 will wait until one or the other of the channels becomes idle. Assuming that the first channel is idle, director 321 will cause transmitter 320 to be connected to the first channel of outgoing line circuit

356. Upon the connection of the transmitter 320 to the first channel of the outgoing line circuit 356, transmitter 320 will start to transmit the first message including the directing signal (letter A) to the printing reperforator 354 connected to the first channel of the outgoing line circuit 356.

Following the message the figure signal followed by the H signal will cause transmitter 320 to be disconnected from the first channel of the outgoing line circuit 356. The following letter signals will be disregarded by transmitter 320 and director 321 and tape 323 advanced until the directing signal Q reaches the control point of the transmitter 320.

When the letter Q signal reaches the control point of transmitter 320, it will cause director 321 to prevent the advance of the tape 323 and also cause director 321 to connect transmitter 320 to the first channel of the outgoing line circuit 336, if this channel is idle. When the connection of transmitter 320 with the first channel of the outgoing line circuit 336 is effected, the directing signal (Q) together with the message will be transmitted to and recorded by the printing reperforator 334 in and upon tape 344. Following the message the figure signal and H signal will cause the transmitter 320 to be disconnected from the first channel of the outgoing line circuit 336. The following letter signals will then be discarded by the transmitter 320 and director 321. The following Z signal is also discarded by this apparatus. In case no further message has arrived over line 200, insufficient tape 323 may have been perforated to permit the end of the last message to be transmitted. In this case reperforator 318 is caused to automatically perforate an additional supply of tape to insure that the entire message will be transmitted.

Returning now to the first message which was recorded by reperforator 354, when the outgoing channel of line 202 becomes idle and the first message reaches the transmitting distributor 352, it will send this message, preceded by the switching character A, over the transmission channel of this line. The code A of this message is received by each of the switching selectors in areas 216, 217 and 218. The first character transmitted is the switching character or letter A. This causes the selector at station 217 to connect the receiving only teletypewriter at that station to the receiving channel of line 202 so that it will receive and record the following message.

The selectors at the other areas 216 and 218 also respond to the switching character or letter A, but they cause the associated equipment to become deactivated in response to this character, so that neither the switching equipment nor any of the receiving or recording apparatus controlled by any of this apparatus will respond or record the message transmitted by the transmitting distributor 352 at this time. After completion of the message the figure signal, followed by an H signal will be transmitted from transmitter 352. The figure signal when followed by an H signal will cause the selector equipment at station 217 to disconnect the receiving equipment from the receiving channel and cause the switching equipment to be energized and ready for the reception of other selecting characters. The selecting equipment at all of the other stations also follows all the signals. However, since the switching equipment has been deactivated or deenergized at these stations, these signals produce no effect upon any of the circuits at these other stations. When the figure signal followed by the H signal is received at these stations, however, the selector equipment causes the switching equipment to be activated so that it may properly respond to the next switching character transmitted over the receiving channel of this line, should this character be one which will cause the selecting equipment to connect the receiving equipment at that station.

In a similar manner the second message which is recorded by the printing reperforator 334 will be transmitted over the receiving channel of the line 201 to the switching and selecting equipments in the area 214 and station 215. This message will again be preceded by a switching signal, which will be the letter Q in this case, which will cause the selecting equipment at station 215 to deactivate the switching equipment, thus rendering it unresponsive to any further signals received by the selecting equipment.

In the area 214 this letter Q signal will cause the selecting equipment 233 to connect or provide a transmission path from the receiving channel of line 201 to the receiving teletypewriter 239. This teletypewriter will then respond to the following message. The selecting and switching equipment 233 in establishing the transmission path to the receiving device 239 will render the switching equipment unresponsive to further signals received by the selecting equipment 233, so that the receiving devices 236 and 242 will not be operatively associated with the receiving channel of line 201. Thus, only one station will receive the message, namely, the station to which it is directed.

Assume now that the station represented by the letter Q at which the receiving device 239 is located is shut down for a day. Under these circumstances, it would be undesirable to transmit any messages to this station at this time since nobody would be present to receive them and determine whether they had been properly received or not. To prevent the transmission of messages to a station at this time the director circuits are provided with certain keys which may be operated under the assumed conditions. A key associated with the station designated by the letter Q will be operated so that all of the messages preceded by the letter Q instead of being directed to that station will be directed to an intercept position as, for example, 490. Under these circumstances when the letter Q arrives at the control point in the transmitter 320 it will cause the director 321 to connect transmitter 320 to the intercept circuit 490 and typing reperforator 478. Upon connection of the transmitter 320 to typing reperforator 478 the message will be transmitted from the transmitter to the typing reperforator and recorded in tape 479. The message will then be readily available for automatic transmission from either the transmitter 420 or 440 or perhaps transmitter 460. Another intercept circuit 480 is also provided to which certain messages may be directed in a similar manner. This intercept circuit is provided with a transmitter 460 and a director 461 in addition to typing reperforator 458. With messages directed to this intercept circuit it is unnecessary for the operator to manually carry the tape to another distributor 420 or 440, since the transmitter 460 may be connected through the director 461 and the crossbar switch to any of the outgoing line circuits.

In case it is desired to transmit a message from the central switching station to any of the outlying stations an operator will operate either

the keyboard perforator **418** or **438** and record the message in perforator tape. This tape, in turn, will control respective transmitters **420** and **440**. These transmitters are provided with the respective directors **421** and **441** for automatically connecting them to the desired outgoing line circuit, so that the message will be transmitted from the transmitters **420** and **440** to the desired station in the same manner as the messages are transmitted from transmitter **320** to the desired circuit.

It should be noted that additional circuit connections are made by means of which the second channel of the outgoing line circuits **356** and **376**, including the typing reperforators **355** and **375**, are dissociated with the outgoing channel of lines **202** and **203**, so that they may be operated as spare intercept equipment for handling intercepted messages.

It is, of course, possible to arrange the circuit so that the second channel on any of the outgoing line circuits may be so operated. However, only the second channel of those lines which are normally not loaded to capacity will be so equipped.

It should be noted that each of the directors is provided with a selector magnet. The selector magnet associated with director **321** is designated **322**. This selector magnet is the horizontal magnet of the cross-bar switch and is always operated when the director **321** establishes connection between the transmitter **320** and another outgoing line circuit. The connection is established by first operating this selector magnet and then causing the director to operate a selected vertical magnet on the cross-bar switch. After operation of the vertical magnet the selector magnet may be released without interfering with the established connection and another selector magnet associated with another director operated to establish another connection. The circuits are so arranged that only one selector magnet can be operated at a time, thus insuring that only one transmitter can be connected to any channel of an outgoing line circuit at a given time.

Under normal operating conditions the time required for establishing a connection when both an idle line is available and the connector switch is not busy due to another connection being established is of the order of one second or less. This is the time required to actually establish connection. After the connection is established it will be maintained during the entire time required for the transmission of the message. However, once a connection is established and all during the time that the connection is maintained, the cross-bar connector switch may be employed to establish and maintain other connections as required by the traffic conditions.

Provision is made between each of the reperforators and its associated transmitter distributor for causing the reperforator to automatically perforate tape at the end of a message if the tape between the transmitter and reperforator becomes taut so that the entire message will be transmitted by the transmitter. At the end of an interval of time sufficiently long to insure that the entire message has been transmitted, the automatic perforation of tape is stopped. In addition, if another message is received by the reperforator during the time it is automatically perforating tape, the automatic perforation of the tape will be stopped by the reception of the first letter signal which precedes the message, thus conditioning the reperforator for the reception of the following switching and message signals.

Reference will now be made to Figs. 6 through 93, inclusive arranged as shown in Fig. 5 which show in detail the circuit arrangement of a typical embodiment of a switching system, in accordance with this invention. Figs. 6, 7, 8, 16, 17, 18, 26, 27, 35, 36, 44, 45, 53, 54 and 67 illustrate in detail the equipment and circuit arrangements employed at the various outlying stations and areas. The remaining figures show equipment and circuit arrangements of the apparatus located at the central switching station.

Figs. 6, 7, 8, 16, 17 and 18 show the equipment located at the outlying stations connected to line **200**, which comprises a transmitting channel **205** and a receiving channel **204**. Figs. 6 and 16 show in detail the equipment located at or near station **210**, while Figs. 7 and 17 show the equipment at or near station **211** and Figs. 8 and 18 show the equipment located at or near station **213**. Figs. 9, 10, 11, 12, 13, 14, 15, 19, 20, 21, 22, 23, 24 and 25 show the equipment at the central station which may be considered individual to the full duplex line **200**. Similar equipment is provided for each of the lines terminating at the central switching point. In general, the top row including Figs. 9, 10, 11, 12, 13, 14 and 15 show in detail the equipment associated with the receiving channel **204** of line **200**, while the second row including Figs. 19, 20, 21, 22, 23, 24 and 25 show the equipment associated with the transmitting or incoming channel **205**.

Similarly, Figs. 26 and 35 illustrate in detail the equipment in area **214** connected to line **201** and Figs. 27 and 36 show in detail the equipment at station **215** also connected to line **201**. Figs. 44 and 53 show the equipment located in the area **216** and Figs. 45 and 54 show in diagrammatic form equipment located at stations **216** and **217**. Fig. 67 shows the equipment located at station **219**. The remaining figures show the terminal equipment for the respective lines terminating at the central switching point.

In general, Figs. 9 and 10 show the details of the start circuit **310** and its associated signal code transmitter **311**. Figs. 11, 12, 13 and 14 show in detail the outgoing line circuit including the typing reperforator and transmitting distributors. Figs. 19 and 20 show in detail the incoming line circuit **317** and associated typing reperforator **318** and receiving only teletypewriter **319**.

Figs. 21, 22, 23 and 24 show in detail the circuit arrangements in the associated equipment of the director circuit.

Figs. 15 and 25 show the circuit of the cross-bar switch and connections between it and the director and outgoing line circuit.

Similar circuits are also provided for lines **201** and **202** terminating at the central switching station. Similar equipment is also provided for line **203** terminating at the central switching station except that no transmitter start circuit is required or provided because only one station is connected to this line. Fig. 93 shows certain alarm and other common equipment provided at the central switching station.

Idle condition

Consider now the normal or idle condition of the system that is the condition of the system when no connections are established between

the various stations and no messages are being transmitted over the system or over various parts thereof.

In general, the relays have been left in or will assume the position as shown in the drawings. For example, assume that power is applied to the apparatus at the various stations and the central switching station. Under these conditions most of the relays and apparatus assume the positions shown. Considering the outlying stations first, relays 671 and 681 at station 210 assume the positions shown due to current flowing from ground through their lower winding to positive battery through the left-hand inner break contacts of relays 670 and 680, respectively. Current flowing through the lower windings of relays 671 and 681 is in such a direction as to operate the relays to their left-hand position and hold them in this position. Current flowing through these windings is also in such a direction as to aid current flowing in the receiving channel of line 204. Consequently, relays 671 and 681 will not follow any of the signals transmitted over the receiving channel 204 of line 200. Relay 771 at station 211 and relay 871 at station 213 are similarly held in their left-hand positions and normally will not respond to any of the signals transmitted over the receiving channel 204. Relay 622 at station 210, relay 722 at station 211 and relay 822 at station 213 are also maintained in their left-hand positions. Current flowing in an obvious circuit in the lower windings of these relays tends to operate the relay armatures to their right-hand position. However, line current flowing through the upper winding of these relays normally tends to overcome the effect of the current flowing through the lower windings of these relays and causes their armatures to move to their right-hand positions. These relays will respond to all the signals transmitted over the receiving channel 204. Relay 651 at station 210 and relay 751 at station 211 and relay 851 at station 213 are operated by current flowing through these left-hand windings which current overcomes the effect of the current flowing through their right-hand windings.

As shown in the drawings, the circuit through the upper windings of relays 622, 722 and 822 as well as through the upper windings of relays 671, 681, 771 and 871 extends from positive battery 950 over the lower conductor, channel 204, through the upper winding of relays 871 and 822 of Fig. 8, upper windings of relays 771 and 722 of Fig. 7, upper windings of relays 671, 681 and 622 to the upper conductor of channel 204, back through Figs. 7, 8, 9 and 10, contacts and armatures of relays 1151 and 1101, normally closed cam-controlled contacts 1046 to negative battery. The armatures of relays 1151 and 1101 are normally maintained in their right-hand positions, thus maintaining the circuit of channel 204 closed, as will be described hereinafter; in addition, the contacts of relays 1101 and 1151 are shunted by contacts of relays 1317 and 1367, respectively. Contacts 1046 are also normally closed, as will appear later.

In order to simplify the description, the receiving channel 204 has been illustrated as a one-way full metallic conducting channel without any repeaters. It is to be understood, however, that this channel may include any suitable type of repeater equipment including regenerative repeaters. It may also include other types of transmission systems, as for example, one of the channels of a full duplex telegraph line, the telegraph channel of a composited telephone and telegraph line, a channel of a voice frequency carrier telegraph system, the channel of a high frequency carrier telegraph system, a radio channel or any combination of the respective types of channels including suitable repeating apparatus including apparatus for relaying signals from one type of system to another. All of these various types of systems when employed, or combinations of them, operate in their usual well-understood manner such that when the line is closed at the transmitting point causing current to flow through it, current will also flow through the portion of the transmission system connected to the receiving relay, thus causing the receiving relay to accurately follow and respond to the signaling conditions transmitted from any transmitter connected to the system.

Selector magnets at each of the outlying stations of the switching selector and also of the receiving only teletypewriter are maintained operated by current flowing through obvious circuits under control of the respective line relays. Relays 631, 731 and 831 at or near the respective stations are normally maintained operated by current flowing in obvious circuits through their windings. The other relays at the outlying station circuits all remain in the position shown till some signals are received, as will be described hereinafter. It is to be understood that the motors controlling the various pieces of equipment including the switching selectors, receiving only teletypewriters and the tape transmitters are connected to a source of power and continuously running. The circuits of the motors for the receiving only teletypewriter and the switching selectors have not been shown or represented in the drawings. It is to be understood that they are present and continually operating, as is the usual practice and well understood in the telegraph art.

The corresponding relays and other apparatus and motors at the other stations shown in Figs. 26, 27, 35, 36, 44, 45, 53, 54 and 67 are similarly energized. Turning now to the central station, most of the relays assume the position shown in the drawings when the power is first applied to the system, as is the usual practice when it is started for a period of operation. Relay 1025 in Fig. 10 will operate in the circuit from negative battery through the winding of relay 1025, right-hand inner break contacts of relay 1019, right-hand break contacts of relay 1005, lead 1054, which extends through Figs. 9 and 19 to ground through the right-hand inner break contacts of relay 1904. The operation of relay 1025 completes certain circuits through the keys 914, 924 and 934, as will be described later. Normally, tapes 1227 and 1277 will be taut when the power is turned on in the morning, so that contacts 1213 and 1263 will be open.

Considering first the first channel of the outgoing line circuit, contacts 1213 being open and switch 1214 normally being closed, circuit through the upper winding of relay 1319 is interrupted, thus preventing relay 1319 from operating. With relay 1319 released, a circuit is completed for the operation of relay 1304 from positive battery through the winding of relay 1304, the inner set of lower break contacts of relay 1302, the outer break contacts of relay 1319 to ground through the upper break contacts of relay 1311. Relay 1304 in operating completes a circuit for main-

taining itself operated from battery through its winding, upper inner operated contacts to ground through the upper break contacts of relay 1311.

Relay 1304 in operating also completes a circuit for energizing the filament of vacuum tube 1305 and removes the short circuit from condenser 1306. The operation of relay 1304 in addition connects a positive potential to the left-hand terminal of condenser 1306 through a high resistance 1308. The grid of tube 1305 is normally biased to a negative potential with respect to the filament through the break contacts to relay 1304. The normal bias between the grid and filament of tube 1305, together with the time constant of condenser 1306 and resistance 1308, is such that tube 1305 will not pass any anode current for an interval of time of at least thirteen seconds after relay 1304 has operated. At the end of the thirteen-second interval, the charge on condenser 1306 will become sufficiently positive to allow sufficient anode current to flow through tube 1305 to operate relay 1310.

In the meantime, however, a circuit for the operation of magnet 1229 is completed from battery through key 1222, lower break contacts of relay 1302, left-hand break contacts of relay 1319 to ground through the upper break contacts of relay 1311. When relay 1304 operates, the operating circuit for magnet 1229 is completed from battery through the winding of magnet 1229, contacts of key 1222, upper inner operating contacts of relay 1304 to ground at the upper break contacts of relay 1311. The operation of magnet 1229 will cause the printing reperforator 1216 to automatically perforate an additional supply of tape, as will be described hereinafter.

The operation of relay 1304 also completes a circuit for the operation of relay 1108 from battery through the right-hand winding of relay 1108, the left-hand break contacts of relay 1107, lead 1109 which extends through Figs. 12 and 13 to ground through the upper operated contacts of relay 1304. Relay 1108 in operating completes a circuit for maintaining itself operated from battery through its left-hand winding and its left-hand innermost contact, lead 1110 which extends through Figs. 12 and 13, left-hand inner break contacts of relays 1317 and 1316 and right-hand break contacts of relay 1318 to ground through cam-controlled contacts 1210.

Relay 1108 in operating completes a second circuit for maintaining itself operated from ground through its right-hand outer operated contacts, left-hand break contacts of relay 1107 to battery through the right-hand winding of relay 1108. Relay 1108 in operating also completes a circuit for operating relay 1107 from battery to the winding of relay 1107, upper break contacts of key 1215, the innermost left-hand break contact of relay 1107, the left-hand operated contacts of relay 1108 to lead 1110, left-hand break contacts of relays 1317 and 1316 and right-hand break contacts of relay 1318 to ground through the cam-controlled contacts 1210. Relay 1107 in operating completes a circuit for maintaining itself operated from battery through its winding, the upper break contacts of key 1215, left-hand operated contacts of relay 1107, lead 1111 to ground through the left-hand outer break contacts of relay 1317.

When the printing reperforator 1216 automatically perforates an additional supply of tape due to the operation of magnet 1229, the tape 1227 will no longer be taut, so that switch 1213 will close and complete a circuit for the operation of relay 1319 from battery through the winding of relay 1319, switch 1214, to ground through contacts 1213. Relay 1319 in operating completes a circuit for operating the start magnet 1217 from battery through the winding of magnet 1217, inner right-hand operated contacts of relay 1319, left-hand outer break contacts of relays 1318 and 1316, left-hand center armature and break contact of relay 1317, lead 1112, which extends through Figs. 12 and 11, the right-hand operated contact of relay 1107 to ground through the left-hand outer operated contacts of relay 1108. The operation of the start magnet 1217 will release the brush arm 1212 and the transmitter 1201 will start to rotate. This will allow pins 1 through 5 to rise and sense the perforations in the tape 1227. Normally under these circumstances all of the pins will go through the perforations because the tape between the reperforator 1216 and the transmitter 1201 will be full of letter signals at this time. The letter signals are represented by a perforation in each one of the five positions on the tape. When the pins 1 through 5 go through perforations in the tape, they will cause the corresponding contacts to be moved to the marking position where ground is connected to the armatures of these contacts. When all five contacts are operated, the circuits through these contacts and relay 1104 will be such that relay 1104 will operate to its left-hand position. When the armature of relay 1104 is in its left-hand position, a circuit is completed for maintaining relay 1108 operated from battery through its right-hand winding and right-hand inner operated contact, to ground through the left-hand contact and armature of relay 1104. A short interval of time after relay 1104 operates, cam 1209 will cause contact 1210 to open. These contacts, however, merely interrupt another locking circuit of relay 1108. Since relay 1108 is maintained operated at this time by a circuit through the left-hand contacts of relay 1104, nothing further happens. Near the end of the revolution of the transmitter 1201 contacts 1210 will again be closed by cam 1209. This reestablishes the locking circuit through contacts 1210 for maintaining relay 1108 operated through its left-hand winding, as described above. The above cycle of operations is then repeated as long as letter signals reach the control point of transmitter 1201. It should be noted that the printing reperforator 1216 is at this time automatically perforating letter signals in the tape, as described above.

Approximately thirteen seconds after relay 1304 operates, relay 1310 operates, due to the action of resistance 1308, condenser 1306 and tube 1305.

The operation of relay 1310 completes a circuit from battery through the lower winding of relay 1311 and the operated contacts of relay 1310 to lead 1372. Lead 1372 extends through Figs. 13, 23, 32, 41, 50, 59, 64, 72, 78, 84, 90, 89, 88 and 93 where interrupted ground is applied to it by the contacts of relay 9310. Relay 9310 is momentarily operated at intervals of approximately five seconds, as will be described hereinafter.

When relay 9310 applies ground to lead 1372, it completes the circuit for the operation of relay 1311. Relay 1311 in operating completes the circuit for maintaining itself operated from battery through its upper winding and upper operated contact to ground through the upper break contact of relay 1302.

Relay 1311 in operating interrupts the lock-

ing circuit of relay 1304 and the holding circuit of magnet 1229, thus permitting this relay and the magnet to release. The release of magnet 1229 stops the printing reperforator 1216 from automatically perforating letter signals in tape 1227. The release of relay 1304 interrupts the filament circuit of tube 1305 and short-circuits the condenser 1306, so that its left-hand terminal will be charged with negative battery potential. Relay 1318 also releases at this time.

Transmitter 1201, however, continues to advance tape 1227 as long as letter signals are perforated in the tape until the supply of tape between the printing perforator 1216 and transmitter 1201 becomes sufficiently reduced to cause contacts 1213 to open. When contacts 1213 open, they interrupt the circuit of relay 1319 and permit this relay to release. The release of relay 1319 interrupts the operating circuit of the start magnet 1217, thus permitting this magnet to release and stop the operation of the transmitter 1201. The release of relay 1319 at this time, however, does not cause the reoperation of relay 1304 or magnet 1229, because relay 1311 is locked operated under control of relay 1302. Consequently, the operating circuit of relay 1304 and magnet 1229 is open at the upper break contacts of relay 1311. The circuit of the first channel will then remain in this condition until a message has been received for some station connected to this line.

If other than letter signals are perforated in tape 1227 the armature of relay 1104 will not be operated to its left-hand position when these other signals arrive over the sensing fingers. Consequently, when the cam-controlled contacts 1210 open and interrupt the locking circuit of relay 1108 through its left-hand winding, relay 1108 will release and interrupt the circuit of the transmitter start magnet 1217. Magnet 1217 will then release and stop the operation of transmitter 1201 at the end of the revolution then in progress. Further operation of the transmitter will be as described hereinafter.

The corresponding relays and apparatus of the second channel in the outgoing line circuit shown in Figs. 11, 12 and 13 will operate in a similar manner. Thus, since tape 1277 is taut contacts 1263 will be open. Consequently, relay 1369 will not operate but relay 1354 and magnet 1279 will operate. The operation of magnet 1279 causes the printing reperforator 1266 to automatically perforate letter signals in the tape 1277. Approximately thirteen seconds later, condenser 1356 will have acquired the required charge to allow tube 1355 to pass sufficient anode current to operate relay 1360. The operation of relay 1360 will connect the lower winding of relay 1361 to lead 1372 and within five seconds ground will be applied to this lead and cause relay 1361 to operate. Relay 1361 in operating completes a circuit for maintaining itself operated under control of relay 1352. The operation of relay 1361 also interrupts the locking circuit of relay 1354 and the holding circuit of magnet 1279, thus permitting them to release. The release of magnet 1279 stops printing reperforator 1266 from automatically perforating letter signals in the tape 1277, while the release of relay 1354 restores the circuits of tube 1335 to their normal and unactivated condition.

The operation of relay 1354, as described above, completes a circuit for the operation of relay 1158 and the operation of relay 1158 in turn completes a circuit for the operation of relay 1157.

When the operation of magnet 1279 causes perforator 1266 to perforate tape 1277 contacts 1263 will close and complete a circuit for the operation of relay 1369. The operation of relays 1369, 1158 and 1157 completes a circuit for the operation of start magnet 1267. The operation of the start magnet 1267 permits transmitter 1251 to rotate and causes the sensing fingers to sense the perforations in the tape 1277. Under the usual conditions these fingers will find a perforation in each one of the five positions of the tape and thus cause all the contacts 1 to 5 to operate. The operation of all of the contacts 1 to 5 will complete circuits which cause the operation of the armature of relay 1154 to its left-hand position where it completes a circuit for maintaining relay 1158 operated.

A short interval of time later contacts 1260 open. However, since relay 1158 is locked operated through the left-hand contact of relay 1154, it remains operated at this time. Near the end of the revolution of transmitter 1251 that is in progress contacts 1260 will close and reestablish the locking circuit through the left-hand winding of relay 1158 before relay 1154 releases. A short time later contacts 1 through 5 will open and cause the armature of relay 1154 to move to its right-hand position. Thus, so long as letter signals are perforated in the tape 1277, relays 1158, 1157 and 1369 are maintained operated and the above cycle repeated. If only letter signals are perforated in the tape 1277, the above cycle of operation is completed until the tape again becomes taut, at which time contacts 1263 open and cause relay 1369 to release. The release of relay 1369 interrupts the circuit through the start magnet 1267 and this permits this magnet to release and stop the transmitter 1251. The apparatus then remains in this condition until signals are received in the second channel.

If other than letter signals are perforated in the tape 1277, relay 1154 will not be operated to its left-hand position when these other signals arrive over the sensing fingers. Consequently, relay 1158 will release and interrupt the circuit of the start magnet 1267 which will in turn release and at the end of the revolution then in progress, stop further operation of the transmitter 1251 at this time. Under these conditions the further operation of the transmitter 1251 will be as described hereinafter.

It should be noted that relay 1101 will follow the letter signals transmitted by transmitter 1201. This relay, however, will not repeat these signals to the receiving channel extending to the outlying station because its contacts are short-circuited by the right-hand outer break contacts of relay 1317, which relay is not operated at this time. Likewise, the right-hand outer break contacts of relay 1367 short-circuit the contacts of relay 1151. Consequently, this relay will not repeat the letter signals recorded in tape 1277 to the outgoing line, even though the armature of relay 1151 will follow these signals.

Referring now to the transmitting channel of line 200, when power is first applied to the subscribers' stations, this channel is maintained in its closed condition because all of the circuits of the start magnets at the outlying stations are interrupted. Consequently, the transmitters are maintained in their rest positions, where they maintain the channel closed. In addition relays 630, 730 and 830 are all released at this time and

maintain the transmitting channel closed. The armature of relay 1910 is therefore maintained in its right-hand position while the armature of relay 1920 is maintained in its left-hand position due to current flowing in the transmitting channel 201 of line 200 through the lower windings of these relays. Current flowing in the upper windings of these relays tends to move these armatures to the opposite positions but the effect of this biasing current is opposed by and overcome by the current flowing over the transmission channel. This channel may likewise include all of the different types of transmission circuits referred to with reference to the receiving channel of line 200. Normally, both channels will be provided with the same type of transmission facilities, one operating in one direction and the other operating in the other direction. However it is not necessary or essential that the same type of transmission be provided for each channel or for each portion of the two channels, so long as they provide full duplex operation. That is, that the channels are capable of simultaneously transmitting messages in both directions.

Most of the relays in Figs. 19, 20, 21, 22 and 24 will remain in the positions shown when power is first applied to the system. However, certain of the relays operate at this time. When power is first applied to the system, a circuit is completed for the operation of relay 2110 from battery through the winding of relay 2110, lead 2111, which extends through Figs. 22 and 23, the upper break contacts of relays 2251, 2241, 2231, 2221 and 2211, the contact and center left-hand armature of relay 2112, the armature and right-hand contact of relay 2113, lead 2114, which extends through Figs. 20 and 19, contacts of key 1492, lead 1956 which extends through Fig. 20, to ground through the lower break contacts of relay 2115. Relay 2110 in operating completes a circuit for maintaining itself operated from battery through the winding of relay 2110, the upper outer operated contact of relay 2110 to ground through the lower break contacts of relay 2119. Relay 2110 in operating completes a circuit for the operation of relays 2121 and 2122 from battery through the windings of relays 2121 and 2122 in parallel, the inner upper operated contacts of relay 2110, lead 2123, which extends for Fig. 20 through normally operated contacts 2015 to ground. The operation of relay 2121 completes a circuit for maintaining relays 2121 and 2122 operated from battery through windings of relays 2121 and 2122 in parallel, the upper operated contact of relay 2121 to ground over lead 2123, and the normally closed contacts 2015. The operation of relays 2121 and 2122 connect ground to the windings of all of the relays 2211, 2221, 2231, 2241, 2242, 2251, 2252, 2253 and 2254, causing these relays to operate. The operation of relay 2221 also connects battery through its lower operated contact to the lower winding of relay 2113, thus causing the armature of this relay to move to its left-hand position and interrupt the operating circuit of relay 2110. Relay 2110 does not release at this time because it is maintained operated by current flowing in its locking circuit described above. The circuit through the upper winding of relay 2113 normally tends to cause the relay to maintain its armature in its right-hand position. However, when current flows through the lower winding of this relay it overcomes the effect of the current flowing through the upper winding of the relay and causes the armature to move to its left-hand position. With relays 2211, 2221, 2231, 2241, 2242, 2251, 2252, 2253 and 2254 all operated, a circuit is completed for the operation of relay 2119 from battery through the winding of relay 2119 and operated contacts of relay 2110 to ground through the inner lower operated contacts of all of the relays shown in Fig. 22, except relay 2210. The operation of relay 2119 interrupts the locking circuit for relay 2110 and permits this relay to release. The operation of relay 2119, however, first prepares a locking circuit for maintaining itself operated before it interrupts the locking circuit of relay 2110. The locking circuit of relay 2119 may be traced from battery through its winding and lower operated contacts to ground, through the lower inner operated contacts of all the relays of Fig. 22 except relay 2210. By extending the circuits for operating and locking relay 2119 through a contact of all of the relays of Fig. 22 except relay 2210, the operation of all these relays is checked, thus insuring that these relays are properly operated. The operation of relay 2119 completes a circuit for maintaining relays 2121 and 2122 operated from battery through their windings in parallel, the upper operated contacts of relay 2119 and lead 2123 to ground through the closed contacts 2015, thus insuring that relays 2121 and 2122 remain operated at this time.

If there is a supply of perforated tape between the tape transmitter shown in Fig. 20 and the printing reperforator 318 at this time, the tape controlled contacts 2023 will be closed so relay 1932 will operate in a circuit, from battery through its winding, contacts of switch 2024 and tape-controlled contacts 2023 to ground. With relay 1932 operated, a circuit is completed for the operation of the start magnet 2008 from battery through the winding of this magnet, the left-hand inner break contacts of relay 1947, left-hand operated contacts of relay 1932, right-hand inner break contacts of relay 1933, lead 1957, the inner upper operated contacts of relay 2119, the lower break contacts of relay 2110 to ground through the lower inner operating contacts of all of the relays of Fig. 22, except relay 2210.

The operation of start magnet 2008 withdraws the stop latch 2007 from engagement with the stop cam 2006 and allows brush arm 2025 to be rotated through gears 2005 and friction clutch 2004 by motor 2001. Cam 2009 also rotates with the brush arm 2025 and permits the lever 2011 to start to rotate in a clockwise direction. The rotation of lever 2011 in the clockwise direction permits plate 2013 to rotate about the axis 2028, also in a clockwise direction. This permits the sensing pins 2026 to raise and sense the tape 2021. These pins raise to the fullest extent, so that in case there are perforations over them the associated contacts controlled by the extensions 1 through 5 will be operated. A short interval of time later contacts 2015 will open, due to the continued rotation of lever 2011.

Normally under the assumed conditions when power is first applied, perforations in the tape 2021 between the transmitter shown in Fig. 20 and the printing reperforator 318 will either be letter signals or one of the following signals: H, R, Z, blank or figures. Assume, first, that letter signals are perforated in the tape 2021 so that there will be a perforation above each one of the fingers 2026. These fingers will go through the perforations in the tape, causing contact levers 1 through 5, inclusive to operate and connect ground to the corresponding leads, which extend

through the right-hand break contacts of relay 2112 to the windings of all of the relays shown in Fig. 22, except 2210. Current flowing in these circuits will hold all of the relays shown in Fig. 22, except relay 2210, operated.

Upon the continued rotation of cam 2009 contacts 2015 will open and interrupt locking circuits of relays 2121 and 2122, thus allowing these relays to release. The release of relay 2121 removes battery from the lower winding of relay 2113 and, since ground is connected to the upper winding of the terminal of each of the relays shown in Fig. 22, except relay 2210, which winding of the terminals are connected through the upper operated contacts of these relays to the lower right-hand winding terminal of relay 2113, no current will flow through this lower winding so that the current flowing through the upper winding of relay 2113 will cause the armature of this relay to operate to its right-hand position, where it completes a circuit for the operation of relay 2210 from battery through the winding of relay 2210, the upper operated contacts of relay 2254, operated contact and lower central armature of relay 2242, lowermost operated contacts of relay 2231, operated contacts and central upper armature of relay 2221, upper outer armature and contact of relay 2211, the left-hand break contact and center left-hand armature of relay 2112, the armature and right-hand contact of relay 2113, lead 2114, through Figs. 20 and 19, contacts of key 1942, lead 1956, which extends through Figs. 20 and 21 to ground through the lower break contacts of relay 2115.

All of the relays of Fig. 22, remain operated at this time so that relay 2119 will also remain operated during this time. Also the transmission circuit extending from the transmitter in Fig. 20 is open at the contacts of the cross-bar switch shown in Fig. 25. Consequently, these latter signals are not transmitted to any circuit. Near the completion of the revolution of the brush arm 2025, contacts 2015 will again close to complete a circuit from ground over lead 2123, which extends to Fig. 21, the upper operated contacts of relay 2119 to battery through the windings of relays 2121 and 2122 in parallel. Current flowing in this circuit causes relays 2121 and 2122 to reoperate and hold all of the relays in Fig. 22 except relay 2210 operated. A short interval of time later as cam 2009 continues to rotate plate 2013 will be rotated in a counter-clockwise direction and engage the extensions 2027 and cause fingers 2026 to be lowered and at the same time advance tape 2021 one step forward through the action of lever 2017, pawl 2018 and ratchet wheel 2020.

When relay 2121 reoperates and connects battery to the lower winding of relay 2113, this causes the armature of this relay to move to its left-hand position and interrupt the circuit through the winding of relay 2210, which thereupon releases.

However, the circuit of the start magnet 2008 is maintained through the operated contacts of relay 2119 and the operated contacts of all of the relays of Fig. 22, except relay 2210. Consequently the start magnet 2008 will maintain the start latch 2007 out of engagement with the cam 2006 so that the above cycle of operations will be continued until the tape between the transmitter shown in the Fig. 20 and the typing reperforator 318 becomes taut and causes contacts 20 and 23 to open and interrupt the operating circuit of relay 1932. The release of relay 1932 interrupts the operating circuit of start magnet 2008, which releases the stop latch 2007 and permits it to rotate in counter-clockwise direction about pivot 2010 and engage cam 2006 at the end of the revolution of the brush arm 2025 then in progress.

In case perforations in the tape are a blank signal, an H signal, an R signal, a Z signal or a figure signal instead of the letter signals, the operation of the circuit is somewhat different. Under these conditions only certain of the sensing fingers 2026 will rise because there will be perforations only above certain of these fingers. Those fingers which go through the perforations will cause the corresponding contacts to close. However, under these circumstances the circuit will not be maintained for all of the relays of Fig. 22, except relay 2210. Consequently, when contacts 2015 open a short interval of time later and release relays 2121 and 2122, certain of the relays in Fig. 22 will release and interrupt the locking circuit of relay 2119.

The release of relay 2121 removes battery from the lower winding of relay 2113 and, with all of the relays of Fig. 22 which are not maintained operated by contacts controlled by members 1 to 5 of the transmitter shown in Fig. 20, released, relay 2113 will operate to its right-hand position where it will complete a circuit for the operation of relay 2110 from battery through the winding of relay 2110, lead 2111, which extends through Figs. 22 and 23 to the terminal corresponding with one of the signals H, R, Z, blank, or figures perforated in the tape and thence through the contacts of the relays shown in Fig. 22 to the upper outer armature of relay 2211, the center set of left-hand contacts of relay 2112, armature and contact of relay 2113, lead 2114, which extends through Figs. 20 and 19, contacts of key 1942, lead 1956, which extends through Fig. 20 to ground through the lower break contact of relay 2115. The operation of relay 2110 completes a circuit for maintaining itself operated from battery through its winding and upper operated contacts to ground through the lower break contacts of relay 2119.

Near the end of the revolution of brush arm 2025, contacts 2015 will close. The closure of contacts 2015 completes the circuit traced above for the operation of relays 2121 and 2122, which relays reoperate and connect ground to the upper winding terminals of all of the relays of Fig. 22, except relay 2210 and thus reoperate all of these relays. A little later the contact fingers 2026 will be withdrawn and restore the contacts controlled by them to their unoperated position and cause the tape 2021 to be advanced another step.

The reoperation of all the relays of Fig. 22, except relay 2210 completes a circuit for the operation of relay 2119, which relay interrupts the locking circuit of relay 2110 and completes a holding circuit for maintaining relays 2121 and 2122 operated. The operation of relay 2119 also reestablishes a circuit through the start magnet 2008 and the above cycle of operations is repeated.

When the supply of perforated tape 2021 between the reperforator 318 of the transmitter shown in Fig. 20 becomes reduced to a predetermined minimum quantity, tape 2021 will become taut and raise member 2022. This causes contacts 2023 to open and interrupt operating circuit of relay 1932. Relay 1932 will thereupon release and interrupt the circuit of the start magnet 2008. Magnet 2008 will then release and permit the stop latch 2007 to rotate in a counter-clockwise direction and engage the stop cam 2006

and stop the transmitter brush arm 2025 at the end of the revolution then in progress. This causes the transmitter, shown in Fig. 20, to come to rest and stop advancing tape 2021 through it.

The release of relay 1932 completes a circuit for the operation of relay 1949 from battery through the winding of relay 1949, the left-hand outer break contacts of relay 1931, right-hand outer break contacts of relay 1932, the left-hand outer break contacts of relay 1928 to ground through the right-hand outer break contacts of relay 1948.

Relay 1949 in operating completes a circuit for maintaining itself operated from battery through its winding, the left outer break contacts of relay 1931, the inner right-hand operated contacts of relay 1949, the left-hand outer break contacts of relay 1923 to ground through the right-hand outer break contacts of relay 1948. The operation of relay 1949 also lights the filament of vacuum tube 1938, removes a short circuit from condenser 1961 and connects positive battery through high resistance 1962 to the lower terminal condenser 1961. Lower terminal of condenser 1961 is connected to the grid of tube 1938. The grid potential of tube 1938 is jointly controlled by the potential of the lower terminal of condenser 1961 and the potential of the filament as determined by the resistances in series with the filament of this tube. The constants of tube 1938 as well as the effective grid potential applied to this tube and the constants of condenser 1961 and resistances 1962 and 1963 are such that tube 1938 will pass substantially no anode current until approximately thirteen seconds after relay 1949 has operated. Consequently, relay 1930 will not be operated by the anode current of the tube 1938 until approximately thirteen seconds after relay 1949 has operated.

In the meantime, operation of relay 1949 completes a circuit for the operation of magnet 1919 from battery through the winding of magnet 1919, the left-hand operated contacts of relay 1949 to ground through the left-hand break contacts of relay 1902. Magnet 1919, in operating, causes the printing reperforator 318 to automatically perforate letters signals in tape 2021. This action will be described hereinafter and continues for a period of time of at least approximately thirteen seconds. After approximately thirteen seconds have elapsed after the operation of relay 1949, relay 1930 will be operated. Relay 1930, in operating, extends the circuit of the right-hand winding of relay 1931 to lead 1372. Lead 1372 extends through Figs. 28, 37, 46, 55, 56, 57, 62, 70, 76, 82, 88 and 93 to the contacts of relay 9310. As explained hereinafter relay 9310 is momentarily operated once every five seconds and connects ground to lead 1372. When relay 9310 operates, it completes a circuit for operating relay 1931. Relay 1931, in operating, completes a circuit for maintaining itself operated from battery through its left-hand winding, and left hand inner operated contacts, break contacts of key 1943 to ground through the left-hand outer break contact of relay 1928 and to right-hand outer break contacts of relay 1948.

Relay 1931, in operating, interrupts the locking and operating circuit of relay 1949 thus permitting this relay to release and interrupt the circuit of magnet 1919. The release of relay 1949 also short-circuits condenser 1961 and restores the circuits of vacuum tube 1938 to normal. This in turn causes relay 1930 to release.

The release of magnet 1919 stops the automatic perforation of letters signals in tape 2021 by the printing reperforator 318.

In the meantime, when the printing reperforator started perforating tape 2021, an additional supply of perforated tape between the printing reperforator 318 and the transmitter shown in Fig. 20 became available so that contacts 2023 close and complete a circuit for the operation of relay 1932. Relay 1932, in operating, again completes the circuit of the start magnet 2008, which releases the brush arm 2028 and causes the transmitter to advance tape 2021 through the transmitter so long as either letters, blank, R, H or Z signals are perforated in tape 2021 as described above. This operation of the transmitter shown in Figure 20 continues either until some other signal perforated in tape 2021 arrives over the sensing fingers 2026 or until the supply of tape 2021 between the printing reperforator 318 and the transmitter shown in Fig. 20 again becomes reduced to a predetermined minimum quantity at which time contacts 2023 again open and interrupt the operating circuit of relay 1932. Relay 1932 in operating interrupts the operating circuit of the start magnet 2008. Magnet 2008 releases and causes the transmitter shown in Fig. 20 to stop the advance of tape 2021 through it. The operation of relay 1932 at this time, however, does not again cause the operation of relay 1949 because the operating circuit of this relay is now open at the left-hand outer break contacts of the operated relay 1931. The circuits then remain in this condition until signals are received by the printing reperforator 318 or until the operator operates the feedout key 1943 as will be described hereinafter.

In case there is no additional supply of perforated tape between the printing reperforator 318 and the transmitter shown in Fig. 20, when power is first applied to the system, contacts 2023 will be open so that relay 1932 will not operate. Instead a circuit will be completed for the operation of relay 1949 as described above when the supply of perforated tape 2021 between the printing reperforator 318 and the transmitter shown in Fig. 20 becomes reduced to a predetermined minimum. Thereafter, the operation of these circuits will continue, as described above, during which an additional supply of tape is perforated by the printing reperforator 318 and the tape advanced through the transmitter shown in Fig. 20 until the supply of tape between the reperforator 318 and the transmitter again becomes reduced to the predetermined minimum quantity after which the circuits remain in the condition described.

The remaining relays and circuits shown in Figs. 19, 20, 21, 22, 23 and 24 remain in this condition until signals are received over the transmitting channel 205 of line 200.

The terminal equipment associated with the other lines 201, 202 and 203 operate in the same manner when power is first applied to the system so that all of the circuits will assume the same condition and await the arrival of signals from their respective lines or from the switching equipment. Inasmuch as the essential features of all of the circuits associated with the other lines terminating in the central switching station are substantially the same as features of the circuits associated with line 200, it is not deemed necessary to include a detailed description of their operation when power is first applied to the system.

Starting transmission

After power has been applied to the system, the operator at the central switching station will normally start the transmission from one of the stations associated with each of the lines terminating at that station over which she has control. The outlying attendants at each of the stations will normally perforate a supply of tape in accordance with the messages to be transmitted and as described above perforate control signals ahead of the message in the tape. After these tapes have been perforated by the attendants at the outlying stations, they will insert them in their respective tape-controlled transmitters so that they will be ready for transmission when the transmission is started from the central station.

Suitable apparatus for perforating tape by the attendents at these stations are described in detail in U. S. Patents 1,965,572, granted to Burkey et al. on July 10, 1934; 1,965,602, granted to Lake July 10, 1934; and 1,969,891, granted to Lake et al. August 14, 1934. The disclosures of these patents are hereby made a part of this application as if fully included herein.

Assume, first, that the attendants at stations 200, 211 and 213 have all prepared tape in accordance with messages they wish to transmit to other stations and have inserted the tape in their transmitters so that they are all ready to transmit when and if started by the operator at the central station. Assume, first, that the operator at the central station desires to start the transmitter 1712 at station 211.

As pointed out above, relay 1025 is operated. In addition, lamp 945 is lighted in a circuit from battery through filament of lamp 945 to ground through the right-hand break contacts of relay 1905. When lamp 945 lights, it indicates to the operator that none of the stations connected to line 200 are transmitting and that she can start the transmitter at any of the stations that she may desire. In order to start the transmitter at station 211, for example, the operator at the central switching station will momentarily operate a non-locking key 924. The operation of key 924 completes a circuit for the operation of relay 921 from battery through its winding, the left-hand break contacts of relay 922, the center operated contacts of relay 1025 to ground through the operated contacts of key 924.

Relay 921 in operating completes a circuit for maintaining itself operated from battery through its own winding, the left-hand break contacts of relay 922, left-hand inner operated contacts of relay 921, left-hand break contacts of relay 911 to ground through the left-hand break contacts of relay 901. Relay 921 in operating also completes an obvious circuit for the operation of relay 920. Relay 920 in operating completes an obvious circuit for operating lamp 925, thus indicating to the operator that an attempt is being made to start the transmitter at station 211.

The operation of relay 921 also completes a circuit for the operation of relay 1001 from battery through the winding of relay 1001, the innermost left-hand break contacts of relay 1004 to ground through the left-hand outer operated contacts of relay 921. The operation of relay 1001 completes an obvious circuit for the operation of relay 1002. The operation of relay 1002 completes a circuit for the operation of relay 1003 from battery through the winding of relay 1003 to ground through the outer right-hand operated contacts of relay 1002. The operation of relay 1003 completes the circuit for the operation of relay 1004 from ground through the left-hand inner operated contacts of relay 1003, the inner operated contacts of relay 1002 to battery through the winding of relay 1004.

Relay 1004 in operating completes a circuit for maintaining itself operated from battery through its winding and left-hand inner operated contacts to ground through the left-hand operated contacts of relay 921. Relay 1004 in operating completes a holding circuit for maintaining relay 1003 operated from battery through the winding and right-hand operated contacts of relay 1003, the left-hand operated contacts of relay 1004 to ground through the break contacts of relay 1026. Relay 1004 in operating also completes an obvious circuit for operating relays 1005. Relay 1005 in operating completes a circuit for maintaining itself operated from battery through its winding and right-hand operated contacts to ground over lead 1054, which extends from Figs. 9 to 19 and through the right-hand inner break contacts of relay 1904. Relay 1005 in operating also energizes the filament circuit of tube 1018. However, the operation of relay 1004 maintains a short circuit around condenser 1027 so that the grid of tube 1018 is maintained negative at this time. Consequently, condenser 1027 will not start to charge and relay 1006 will not operate because the grid of tube 1018 is maintained sufficiently negative to prevent the flow of substantially any anode current through this tube and the winding of relay 1006.

The operation of relay 1005 completes a circuit for the operation of relay 1410 from ground through its center left-hand armature and operated contact, the right-hand break contacts of relay 1007, the upper break contacts of relay 1015, lead 1055, which extends through Figs. 11, 12, 13 and 14 to battery through the winding of relay 1410. Relay 1410 in operating interrupts the start magnet circuit of the distributors 1201 and 1251. However, since these transmitters are not in operation at this time under the assumed conditions this operation of relay 1410 serves no use or function.

The operation of relay 1004, as described above, interrupts the operating circuit of relay 1001. Relay 1001 being a slow-release relay does not immediately release. At the end of a short interval of time between .3 and .4 second, relay 1001 will release and interrupt the operating circuit of relay 1002. Relay 1002 is likewise a slow-release relay and requires approximately .3 to .4 second to release. The preferred combined release time of relays 1001 and 1002 is therefore of the order of .7 second. The release of relay 1002 completes a circuit for the operation of the start magnet 1029 from battery through the winding of magnet 1029, the left-hand outer operated contacts of relay 1003, the left-hand break contacts of relay 1014 to ground through the right-hand outer break contacts of relay 1002. The operation of the start magnet 1029 withdraws the stop latch 1030 from engagement with the stop cam 1031, thus permitting the transmitter shaft carrying cams Nos. 1 through 7 to be rotated through the clutch 1033 and gears 1032 and 1035 by motor 1034. As pointed out above, the circuit of motor 1034 is completed through an operated switch 1037 to a source of power 1030, so that motor is continuously operating.

Upon the release of the cams Nos. 1 through 7, cam No. 6 first opens contact 1046 to transmit

a start impulse on the receiving channel of line 200. This transmission circuit has been traced above so that it need not be repeated here. After the start pulse has been transmitted, cams Nos. 1 through 5 will close their associated contacts 1041 to 1045 in sequence. However, since the circuits through these contacts are opened at the contacts of relay 1010 spacing impulses will be sent during these intervals. In other words, a blank signal code combination will be transmitted, that is a signal code combination in which each of the five elements of the code is spacing. As shown in the circuit arrangement in the drawings, the spacing condition is represented by no current in the transmission circuit or line.

Near the beginning of this first revolution of the transmitter shaft, cam No. 7 will cause contacts 1047 to close and complete an obvious circuit for the operation of relay 1026. The operation of relay 1026 interrupts the locking circuit of relay 1003, which relay then releases. Near the end of this first revolution of the transmitter cams during which the blank code combination is transmitted, cam No. 7 will open contacts 1047 and interrupt the operating circuit of relay 1026 which relay thereupon releases. The release of relay 1026 at this time completes the circuit for the operation of relay 1008 from battery through the winding of relay 1008, the right-hand break contacts of relay 1003, the operated contacts of relay 1004 to ground through the break contacts of relay 1026. Relay 1008 in operating short-circuits the cam controlled transmitting contacts to insure that the transmission circuit will remain closed at this time. Relay 1008 in operating also completes a circuit for the operation of relay 1009 from ground through the right-hand outer operated contacts of relay 1004, the right-hand outer operated contacts of relay 1008, the left-hand outer break contacts of relay 1010 to battery through the winding of relay 1009. Relay 1009 in operating completes the circuit for maintaining itself operated from battery through its winding and left-hand operated contact to ground through the right-hand operated contacts of relay 1004.

Relay 1008 in operating also completes a circuit for the operation of relay 1001 from ground through its right-hand inner operated contacts to battery through the winding of relay 1004. Relay 1001 in operating completes a circuit for the operation of relay 1002. Relay 1002 in operating completes a circuit for the operation of relay 1003. Relay 1003 upon operation completes a circuit for maintaining itself operated from battery through its winding and right-hand operated contacts, left-hand contacts of relay 1004 to ground through the upper break contacts of relay 1026.

The operation of relay 1003 interrupts the operating circuit of relay 1008, which relay thereupon releases. The release of relay 1008 at this time completes a circuit for the operation of relay 1010 from battery through the winding of the relay 1010, the left-hand break contacts of relay 1011 and right-hand operated contacts of relay 1009, the right-hand break contacts of relay 1008 to ground through the right-hand outer operated contacts of relay 1004. Relay 1010 in operating completes a circuit for maintaining itself operated from battery through its winding and right-hand inner operated contacts to ground through the right-hand operated contacts of relay 1004.

The release of relay 1008 interrupts the operating circuit of relay 1001, which in turn releases after approximately .3 to .4 second and in turn releases relay 1002. Relay 1002 releases after a short interval of time approximately .4 second, at which time a circuit for the operation of the start magnet 1029 is completed from battery through the winding of magnet 1029, the left-hand outer operated contacts of relay 1003 and left-hand break contacts of relay 1014 to ground through the right-hand break contacts of relay 1002. The operation of the start magnet 1029 again releases the transmitter shaft carrying cams Nos. 1 through 6, inclusive for rotation through a second revolution. During this second revolution a circuit is established from positive battery through contacts 1042 and 1044 to the transmission circuit through operated contacts of relay 1010 and the break contacts of relay 1012. Thus, during this second rotation of the cam shaft of the transmitter a spacing start pulse is first transmitted followed by No. 1 spacing impulse, then a No. 2 marking impulse, No. 3 spacing impulse, No. 4 marking impulse, No. 5 spacing impulse, followed by a marking space impulse.

This series of impulses constitutes the R signal, the purpose and object of which will be explained hereinafter.

Near the beginning of this second revolution cam No. 7 will cause contacts 1047 to close and operate relay 1026, which relay in operating interrupts the locking circuit of relay 1003, allowing this relay to release. The release of relay 1003 interrupts the operating circuit of the start magnet 1029, allowing this magnet to release and stop the transmitter at the end of this second revolution of the transmitting cams 1 through 7. Near the end of this second revolution cam No. 7 will again cause contacts 1047 to open and release relay 1026. The release of relay 1026 at this time reestablishes the operating circuit of relay 1008 as described above. The operation of relay 1008 at this time again short-circuits the transmitting contacts of the transmitting distributor and completes a circuit for the operation of relay 1011 from battery through the winding of relay 1011, the left-hand outer break contacts of relay 1012, the operated outer left-hand contacts of relay 1010, the right-hand outer operated contacts of relay 1008 to ground through the right-hand outer operated contacts of relay 1004. Relay 1010 in operating completes a circuit for maintaining itself operated from battery through its winding and right-hand operated contacts to ground through the right-hand outer operated contacts of relay 1004.

The operation of relay 1008 completes the circuit for the operation of relay 1001, which relay in turn completes a circuit for the operation of relay 1002. Relay 1002 completes a circuit for the operation of relay 1003, which relay in turn remains operated under control of relay 1026.

The operation of relay 1003 at this time interrupts the operating circuit of relay 1008, which relay then releases. The release of relay 1008 at this time completes a circuit for the operation of relay 1012 from battery through the winding of relay 1012, the right-hand break contacts of relay 1013, the left-hand operated contacts of relay 1011, right-hand operated contacts of relay 1009, the right-hand break contacts of relay 1008 to ground through the right-hand operated contacts of relay 1004. Relay 1012 in operating completes a circuit for maintaining itself operated from battery through its winding and right-hand operated contacts to ground through the right-hand outer operated contacts of relay 1004.

The release of relay 1008 interrupts the operating circuit of relay 1001, which in turn interrupts the operating circuit of relay 1002. Relay 1002 will release about .7 second after relay 1008 has released. The release of relay 1002 reestablishes the operating circuit of magnet 1029, which again operates and releases the cam shaft of the transmitter for a third revolution. During this third revolution the circuit of the contacts 1041 through 1045 extends from negative battery, through the respective contacts 1041 through 1045, leads 1 through 5, the operated contacts of relays 1010 and 1012, and the operated left-hand contacts of relay 920 to the transmission circuit. The wiring of the contacts of relay 920 is such that the marking impulse is transmitted during the first impulse, the spacing impulse during the second and marking impulses during the third, fourth and fifth impulses. This constitutes a signal representing the letter X. The function of the transmission of the X signal at this time will be described hereinafter. It should be noted, however, that arrangements are made so that the wiring of the contacts of relay 920 may be altered so that any suitable code combination may be transmitted during this third revolution of the transmitter cams Nos. 1 through 7 shown on Fig. 10 of the code transmitter 1056.

As before, near the beginning of this third revolution, cam No. 7 causes contacts 1047 to close and complete a circuit for the operation of relay 1026. Relay 1026 in operating interrupts the operating circuit of relay 1003, which relay releases and interrupts the circuit of magnet 1029, thus allowing this magnet to release stop latch 1030, so that it will engage the stop cam 1031 at the end of the third revolution, bringing the transmitting cam shaft of the transmitter 1056 to rest. Near the end of this third revolution, contacts 1047 again open and interrupt the circuit of relay 1026. The release of relay 1026 again completes the operating circuit of relay 1008, which relay in turn operates and completes a circuit for the operation of relay 1013 from battery through the winding of relay 1013, the left-hand outer operated contacts of relays 1012 and 1010, the right-hand outer operated contacts of relay 1008 to ground through the right-hand outer operated contacts of relay 1004. The operation of relay 1013 completes a circuit for maintaining itself operated from battery through its winding and left-hand operated contacts to ground through the right-hand outer operated contacts of relay 1004.

The operation of relay 1008 also completes a circuit for the operation of relay 1001, which relay in turn causes the operation of relay 1002. Relay 1002 in operating completes a circuit for the operation of relay 1003, which relay in operating completes a circuit for maintaining itself operated under control of relays 1026 and 1004. The operation of relay 1003 at this time interrupts the operating circuit of relay 1008, which relay thereupon releases. The release of relay 1008 at this time completes a circuit for the operation of relay 1014 from battery through the winding of relay 1014, the right-hand operated contacts of relay 1013, the left-hand operated contacts of relay 1011, the right-hand operated contacts of relay 1009, the right-hand break contacts of relay 1008 to ground through the right-hand operated contacts of relay 1004. Relay 1014 in operating completes a circuit for maintaining operated from battery through the winding of relay 1014 and its right-hand operated contacts to ground through the right-hand outer operated contacts of relay 1004.

The release of relay 1008 again interrupts the operating circuit of relay 1001, which relay in turn interrupts the circuit of relay 1002. Approximately .7 second later, relay 1002 will release and complete a circuit for the operation of relay 922 from battery through the winding of relay 922, the right-hand outer operated contacts of relay 920, the left-hand operated contacts of relay 1014 to ground through the right-hand break contacts of relay 1002.

Relay 922 in operating completes a circuit for maintaining itself operated from battery through its winding and left-hand inner operated contacts to ground through the break contacts of relay 1001, which is released at this time as described above. The operation of relay 922 also completes a circuit from ground through lamp 925 to battery to maintain this lamp lighted.

The operation of relay 922 interrupts the locking circuit of relay 921, thus permitting this relay to release. The release of relay 921 interrupts the operating circuit of relay 920 and permits this relay to release. The release of relay 921 interrupts the locking circuit of relay 1004 and permits this relay to release. The release of relay 1004 interrupts the locking circuits of relays 1009, 1010, 1011, 1012, 1013 and 1014 and permits all of these relays to release. The release of relay 1004 also removes the short circuit from around condenser 1027 and allows the lower terminal of this condenser to start to charge to a positive potential through a high resistance 1051. It requires an appreciable period of time however, for the positive charge on condenser 1027 to reach a value sufficiently high to allow sufficient anode current to flow through tube 1018 to operate relay 1006. Typically, it requires at least five seconds after the release of relay 1004 before relay 1006 will operate.

If the desired station has not started transmission and signals have not been received by the end of the five-second interval, relay 1006 will operate and cause relay 1007 to operate. Relay 1007 in operating completes a circuit for the operation of relay 1025, which renders the keys 914, 924 and 934 effective, so that the attendant may start the same or another station. In addition, lamps 925 and 945 will remain lighted, which will indicate to the operator that no signals are being received from line 200 and that key 924 was the last one operated in an attempt to start a transmitter at an outlying station.

The operator may then operate any of the other keys and the cycle of operation of the circuits is completed in an effort to start another station.

The operation of relay 1007 also interrupts the operating circuit of relay 1410 and thus permits the circuits of the start magnets of the transmitters 1201 and 1251 to be established should it be desired to transmit a message over the receiving channel 204 of line 200.

Returning now to the operation of the outlying station circuits in response to the above-described signals transmitted over the receiving channel 204 of the full duplex line 200 by the operation of the circuits at the central station in response to momentary operation of key 924, it will be recalled that in response to the operation of this key transmission is first stopped or prevented over the outgoing or receiving channel of line 204. Approximately .7 second later,

a blank code combination was transmitted over the line. After another pause of approximately .7 second, an R combination was transmitted over the line. This is followed by another .7 second pause, after which the letter X code combination was transmitted over the line. At the completion of the final .7 second-interval the transmitting circuits at the central station are restored to substantially their original condition.

All of the line relays of the selectors 622, 722 and 822 follow the signals transmitted over the receiving channel 204 operating line 200. The repeating relays 871, 771, 671 and 681, however, under the assumed conditions will not respond to this blank code combination, but will maintain their armatures in their left-hand positions, thus preventing any of the receiving teletypewriters 1610, 1710 or 1810 or the reperforator 1680 from responding to these code combinations. The line relay 622, 722 and 822 repeat the blank code combination to their respective selector magnets 623, 723 and 823. The selector magnets cause the selector mechanism at each of these stations to close the respective blank contacts 616, 716 and 816 at each of these stations. Considering the circuits at the station shown in Fig. 7 in detail, the operation of contacts 716 completes the circuit for the operation of relay 726 from battery through the winding and left-hand break contacts of relay 726 to ground through the operated blank contacts 716.

The manner in which the selector mechanism causes the blank contacts 716 to be momentarily operated in response to the reception of a blank signal by the selector magnet 723 will be described in detail hereinafter. The operation of relay 726 completes a circuit for maintaining itself operated from battery through its winding and left-hand operated contacts to ground through the break contacts of relay 725. The operation of relay 726 also interrupts the operating circuit of relay 731 and transfers this circuit to the blank contacts 716. When the blank contacts 716 open at the end of their operated interval, relay 731 will start to release. Relay 731, however, is a slow-to-release relay and does not immediately release. If any signals other than a blank signal are received over the receiving channel 204 prior to the release of relay 731, they will cause the selecting mechanism to close the universal contacts 713 and complete a circuit for the operation of relay 725 from battery through the winding of relay 725, the right-hand inner operated contacts of relay 726, operated universal contacts 713, the right-hand inner break contacts of relay 729 to ground through break contacts 716.

The operation of relay 725 interrupts the locking circuit of relay 726 which relay releases and reestablishes the circuit through the winding of relay 731 thus maintaining relay 731 operated. The release of relay 726 and the release of relay 725 after contacts 713 open restore the circuit to its previous condition so it is necessary to receive another blank signal before the apparatus will function to control the transmitters connected to the party line. The circuits and apparatus at the other stations function in a similar manner. If other signals are received during this interval, it is an indication that the blank signal was not transmitted from the transmitter start circuit but was due to some interfering currents or improper operation of the system so the blank signal should be disregarded as it is.

If, however, the blank signal is transmitted from the transmitter start circuit at the central station, then no further signals will be transmitted over the line for about .7 second. During this time the line remains "marking," a condition termed a "pause." At the end of approximately .4 second, relay 731 will release and remove a short circuit from the condenser 734. The release of relay 731 also completes a circuit for the operation of relay 729 from battery, through the winding of relay 729 to ground. The release of relay 731 also completes the circuit for the operation of relay 724 from battery through the winding of relay 724, left-hand break contacts of relay 730 to ground through the left-hand break contacts of relay 731. The operation of relay 724 completes a circuit for maintaining itself operated from battery through its winding and right-hand operated contacts to ground through the left-hand break contacts of relay 731. Relay 729 in operating completes a circuit for lighting the filament circuit of vacuum tube 733 and connects positive battery through high resistance 735 to the grid and upper terminal of condenser 734. Condenser 734 starts to be charged, but requires approximately 3 seconds for it to receive the required positive potential to allow tube 733 to pass sufficient anode current to operate relay 732. If no signals following the "blank" signal are received during this entire time interval, relay 732 will operate to complete a circuit for the operation of relay 725. Relay 725 in operating interrupts the locking circuit of relay 726 and allows this relay to release and reoperate relay 731. The reoperation of relay 731 permits relay 729 to release, which in turn releases relays 732 and 725, thus restoring the circuit to its original condition.

The circuits operate at the other stations 210 and 213 in a similar manner.

However, under the assumed conditions approximately .7 second after blank has been transmitted a letter R signal will be transmitted over the circuit. The .7 second interval allows sufficient time for relay 731 and the corresponding relays 631 and 831 at the respective stations to release and operate relays 729, 629 and 829. When a letter R signal is received by the selector magnet 723, it will cause the selector mechanism to momentarily close contacts 715 at station 211, contacts 615 at station 210 and contacts 815 at station 213. The momentary operation of contacts 715 will complete circuits for the operation of relays 727 and 728. Circuits for the operation of these relays may be traced from battery through the winding of relay 728 and its left-hand back contacts; from battery through the winding of relay 727 through the left-hand contact of contacts 715, the armature contact of contacts 715, the right-hand inner operated contacts of relay 729 to ground through the break contacts 716. Relays 627 and 628, as well as relays 827 and 828 similarly operate at the respective stations 211 and 213. The operation of relay 727 interrupts the operating circuit of relay 730 so if this relay had been previously operated it will be released. The operation of relay 728 completes a circuit for maintaining itself operated from battery through its winding and left-hand operated contacts to ground through the left-hand break contacts of relay 731. The operation of relay 729 removes ground from contacts 717, 718, 719 and 720, thus rendering any subsequent

operation of these contacts at this time ineffective to control any of the switching circuits. Corresponding relays at the other stations operate in a similar manner. The operation of these relays, as described above, takes place during the .7 second-interval, following the reception of the R signal. At the completion of this time interval the X signal, as described above, is transmitted over the receiving channel to all the stations. When the letter X signal is received by the selector magnet 723, it will cause contacts 714 to momentarily operate. The operation of these contacts completes a circuit for the operation of relay 730 from battery through the left-hand winding of relay 730 and operated contacts 714, operated right-hand inner contacts of relay 728, break contacts 715, right-hand inner operated contacts of relay 729 to ground through the break contacts 716. At the other stations 210 and 213 the reception of the letter X signal by the selector magnets 623 and 823 will not cause the selecting mechanism to close any contacts because contacts 614 at station 210 are arranged to be operated in response to the reception of a letter Y signal while contacts 814 are arranged to be momentarily operated in response to the reception of the letter W signal by the selector magnet 823. At these two stations the universal contacts 613 and 813, which operate in response to each code combination received by the selecting mechanism, momentarily close a short interval of time after the other contacts have had an opportunity to close in response to the X signal. Contacts 613, 713 and 813 are provided at each of the stations and momentarily operate in response to the reception of each code combination received by these respective selector magnets 623, 723 and 823. At the station shown in Fig. 7 the circuit through these contacts is interrupted by the operation of contacts 714 in response to the reception of the letter X signal. At the station shown in Figs. 6 and 8, contacts 614 and 814 are not operated. Consequently, the circuits through universal contacts 613 and 813 will not be interrupted. The operation of these contacts at these stations will then complete the circuits for the operation of relays 625 and 825, considering the circuits shown in Fig. 8. For example, the circuit for the operation of relay 825 at this time may be traced from battery through the winding of relay 825, right-hand inner operated contacts of relay 826, operated universal contacts 813, break contacts 814, right-hand inner operated contacts of relay 828, break contacts 815, right-hand inner operated contacts of relay 829 to ground through the break contacts 816. A similar circuit may be traced for the operation of relay 625. At stations 210 and 213 the operation of relays 625 and 825, respectively, interrupt the locking circuits of relays 626 and 826, thus allowing these relays to release. The release of these relays in turn completes circuits for the operation of relays 631 and 831, which relays interrupt the operating circuits of relays 629 and 829 and the locking circuits of relays 628 and 828. These relays then release and restore the circuit to its normal or idle condition.

At the station shown in Fig. 7, the operation of relay 730 in response to the reception of the letter X signal completes a circuit for the operation of relay 725 from battery through the winding of relay 725, the left-hand operated contacts of relays 724 and 730 to ground through the left-hand break contacts of relay 731. The operation of relay 725 interrupts the locking circuit of relay 726 and this permits this relay to release. The release of relay 726 reestablishes the operating circuit of relay 731 and causes this relay to operate and interrupt the circuits of relays 728, 729 and 724 which relays release. Under normal conditions the different signals are transmitted in less than the three-second interval during which condenser 734 is charging so that relay 732 will not operate. If any of the signals are lost or not received within this time interval or if the circuits to do not properly respond to the signals, relay 732 will operate at the end of approximately three seconds and restore the circuits to their normal condition as described above. The circuits at the other station respond in a similar manner to these various conditions.

The operation of relay 730 also completes an obvious circuit for lighting lamp 736 to indicate to an attendant that the transmitting channel is extended to the transmitter at this station. The operation of relay 730 also completes a circuit for maintaining itself operated and for operating relay 1718 at the outlying station. As pointed out hereinbefore, the transmitting and receiving apparatus at the outlying station may be located a short distance from the selecting equipment, such as shown in Fig. 7, or it may be located at the same place. The circuit for operating relay 1718 and holding relay 730 may be traced as follows: from battery through the right-hand winding and right-hand inner operated contacts of relay 730, break contacts of relay 727, winding of relay 1718 to ground through contacts 1716. Contacts 1716 are closed so long as a supply of tape is inserted in the tape transmitter 1712. When the supply of perforated tape runs out of the transmitter 1712, contacts 1716 will open and interrupt the circuit of relays 1718 and 1730, thus permitting these relays to release and restore the circuit to its idle condition.

The operation of relay 750 also removes the short circuit from around the contacts of the repeating relay 751 and thus permits this relay to repeat signals to the transmitting channel 205.

However, under the assumed conditions the supply of perforated tape has been previously inserted in the transmitter 1712. Consequently, both contacts 1716 and 1717 will be closed. The operation of relay 1718 under these conditions completes a circuit for the operation of the start magnet 1720, which withdraws the stop latch 1721 from engagement with stop cam 1722 and permits the transmitter 1712 to operate and transmit the signals stored in the tape 1713 over the transmitting channel 205 to the central switching station.

It should be noted that only one of the transmitters connected to the transmitting channel can be started at any given time, because the same code combination which selects the transmitter at one of the stations, also returns the circuits at the other stations to a normal or idle condition, in which condition they are non-responsive to the signals transmitted over the receiving channel to the various stations.

Transmission of messages to the central switching station

As pointed out above, the operator at each outlying station will perforate certain signals preceding the messages to be transmitted designating the station for which the message is intended. In addition it is desirable to perforate additional signals in the tape preceding the designation signals and the messages each time trans-

mission is started from each station. These additional signals are not necessary under normal operating conditions of the system but they are desirable since they tend to insure proper operation of the switching equipment at the central station under abnormal and trouble conditions of the lines and outlying stations.

Thus, at the beginning of transmission four letter signals are first perforated in the tape followed by the figure signal, and then an H signal. Following these signals four additional letter signals are perforated in the tape, followed by the signal assigned to the desired station, then a letter signal and then when page printing apparatus is employed, a carriage return, line feed, and another letter signal following which the message signals are perforated in the tape. On the completion of each message, a figure signal and then an H signal is perforated in the tape. At the beginning of the next message four letter signals and then the calling signal, followed by another letter signal and then the carriage return signal, the line feed signal and another letter signal are perforated in the tape preceding the second message. These respective signals are perforated in the tape between each of the messages until the figures and then the H signal at the end of the last message have been perforated in the tape. After these signals four additional letter signals will be perforated in the tape, followed by the letter Z signal, which in turn is followed by seven or more letter signals, after which the tape will normally run out of the transmitter and cause relays 1718 and 730 to release as described above.

Turning now to the central office, relays 1910 and 1920 respond to the signals transmitted from the tape controlled transmitter 1712. As shown in the drawings, the transmission circuit extends from negative battery over the lower conductor of the channel 205 of the full duplex line through Figs. 18 and 8, the contacts of relay 851 and the right-hand outer break contacts of relay 830 in parallel, the contacts of relay 751 and the right-hand outer break contacts of relay 730 in parallel, the contacts of relay 651 and the right-hand outer break contacts of relay 630 in parallel, over the upper conductor of channel 205 through Figs. 6, 7, 8, 18 and 19, and through the windings of the line relays 1910 and 1920 to positive battery.

A full metallic conducting channel 205 has been shown in the drawings in order not to complicate the invention with detailed description of all the possible types of transmission systems or even with a detailed description of the representative types of transmission systems, it being understood that any of these systems may be employed either singularly or in combination for the transmission of signals over channel 205. It is also to be understood that any suitable type of repeating apparatus and terminal equipment necessary for the respective transmission systems may be employed in this channel. The various types of transmission systems together with the terminal and repeating equipment is well understood in telegraph art and since they operate in their usual manner will not be described in detail herein. The same type of transmission systems may be used in this channel as referred to above with reference to the receiving channel 204 of the full duplex telegraph line 200 which extends to stations 210, 211 and 213. However, it is not necessary to use the same types of transmission systems for both channels of the full duplex line.

As pointed out above, the first signals transmitted from station 210 by the tape control transmitter 1712 will be a series of four letter signals. Relays 1910 and 1920 will follow these signals and in response to the spacing start signal of the first letter signal the armature of relay 1910 will move to its left-hand position due to the action of the biasing current flowing through its lower winding as is well understood in the art. The armature of relay 1920 will move to its right-hand position. However, since the circuit of the right-hand contact of relay 1920 is open at this time, the operation of the armature of relay 1920 in moving to its right-hand position performs no useful function at this time. The operation of relay 1920 from its left-hand position interrupts one circuit through the winding of the printer magnet 1921. This magnet, however, does not respond to these signals because it is maintained operated in a circuit from positive battery through its winding and the left-hand inner break contacts of relay 1937 to negative battery. Similarly, the operation of relay 1910 to its left-hand position interrupts one circuit through the winding of a selector magnet 1911. Selector magnet 1911, however, is maintained operated in a circuit from positive battery through its winding, the right-hand inner break contacts of relay 1928 to negative battery through the left-hand break contacts of relay 1907.

The operation of relay 1910 to its left-hand position completes a circuit for the operation of relay 1901 to its left-hand position from positive battery through the upper winding of relay 1901, lead 1958 to Fig. 9 through lamp 1941 to negative battery through the left-hand contact and armature of relay 1910. The armature of relay 1901 is normally maintained in its right-hand position by current flowing through its lower winding in an obvious circuit. However, current flowing through the upper winding of this relay in the above-traced circuit is of sufficient magnitude to produce an effect upon the armature of this relay which overcomes current flowing through the lower winding of this relay and causes the armature to move to its left-hand position.

The armature of relay 1901 in moving to its left-hand position completes a circuit for the operation of relay 1902 from battery through the winding of relay 1902, the break contacts of relay 1903, the left-hand contact and armature of relay 1901 to ground through the left-hand outer breaker contact of relay 1928 and the right-hand outer break contacts of relay 1948. Relay 1902 in operating prepares a circuit for maintaining itself operated and for operating relay 1903 as will be described hereinafter.

The operation of relay 1902 completes the circuit for the operation of relay 1904 from battery through the winding of relay 1904 to ground through the left-hand operated contacts of relay 1902.

The operation of relay 1904 completes an obvious circuit for lighting the filament of vacuum tube 1925. Operation of relay 1904 also removes a short circuit from around condenser 1908 and connects the lower terminal condenser 1908 which is connected to grid tube 1905 to positive battery through a high resistance 1924. The operation of relay 1904 also completes an obvious circuit for the operation of relay 1905. Relay 1905 in operating completes a circuit for maintaining relay 1904 operated from battery through the winding and left-hand inner operated contacts of relay 1904, the right-hand inner break contacts of re-

lay 1948 to ground through the right-hand operated contacts of relay 1905. The operation of relay 1905 also interrupts the circuit through lamp 945 and extinguishes this lamp which indicates to the operator that signals are being received over line 200. The operation of relay 1905 also extends a connection from the lower terminal of condenser 1908 through the right-hand outer operated contacts of relay 1904, the left-hand inner break contacts of relay 1948, the left-hand operated contacts of relay 1905 to the right-hand contact of relay 1920. So long as the relay 1920 remains in its right-hand position, it will connect negative battery to the lower terminal of condenser 1908 through the above-traced circuit and maintain a grid tube 1925 at a negative potential. This will prevent any appreciable anode current flowing through tube 1925 and thus prevent the operation of relay 1926 so long as relay 1920 remains in its right-hand position.

The operation of relay 1904 also interrupts the locking circuit of relay 1005 through the right-hand inner break contacts of relay 1904 thus permitting relay 1005 to release and interrupt the circuit through the filament of vacuum tube 1018. The release of relay 1005 also discharges condenser 1027. The extinguishing of the filament circuit of tube 1018 interrupts the circuit of relay 1006 which releases and in turn releases relay 1007 thus restoring these relays of the transmitter start circuit to their normal condition. Operation of relay 1904 in addition completes a circuit for the operation of relay 1020 from battery through the winding of relay 1020, the left-hand break contacts of relay 1007, lead 1057 which extends through Figs. 9 and 19 to ground through the right-hand inner operated contacts of relay 1904.

The operation of relay 1020 completes a circuit for the operation of relay 923 from battery through the winding of relay 923, the left-hand operated contacts of relay 922 to ground through the operated contacts of relay 1020.

At the end of the spacing pulse of the first letter signal relay 1910 will be operated to its right-hand position and the armature of relay 1920 will be operated to its left-hand position. The operation of relay 1910 to its right-hand position interrupts the circuit of the upper winding of relay 1901 and thus permits the current flowing through the lower winding of this relay to operate its armature to its right-hand position. In operating to the right-hand position, the armature of relay 1901 interrupts the operating circuit of relay 1902. Relay 1902, however, does not release at this time and instead it is maintained operated and relay 1903 operated in a circuit extending from battery through the winding and right-hand operated contacts of relay 1902 and winding of relay 1903 to ground through the right-hand outer break contacts of relay 1937, the left-hand outer break contacts of relay 1928, and the right-hand outer break contacts of relay 1948.

The operation of the armature of relay 1920 to its right-hand position disconnects negative battery from the lower terminal condenser 1908. Consequently, lower terminal of this condenser starts to charge through the high resistance 1924 to a positive potential. The time constants of the circuit of condenser 1908 and resistance 1924 is such that it requires approximately 30 seconds for the potential of the lower terminal condenser 1908 to reach a sufficiently positive potential to cause tube 1925 to pass enough current to operate relay 1926. If no further signals are received during this 30-second interval, relay 1926 will operate at the end thereof and complete a circuit for the operation of relay 1927. Relay 1927 in operating completes a circuit for the operation of relay 1948 from battery through the winding of relay 1948 to ground through the right-hand inner operated contacts of relay 1927.

The operation of relay 1948 interrupts the holding circuit of relay 1902 and 1903 and permits these relays to release. The release of relay 1902 and the operation of relay 1948 interrupts the operating and locking circuits of relay 1904 and permits this relay to release. The release of relay 1904 interrupts the operating circuit of relay 1905 and permits this relay to release. The release of relay 1904 also interrupts the filament circuit of tube 1925 and thus extinguishes the tube which in turn causes relay 1926 to release. The release of relay 1926 releases relay 1927 which relay in turn releases relay 1948 and restores the circuit to its original and normal condition.

However, under the assumed conditions, the second letter signal will be transmitted immediately following the first letter signal. This will cause the armature of relay 1910 to again be operated to its left-hand position and the armature of relay 1920 to again be operated to its right-hand position. This occurs long before the end of the 30-second interval referred to above. When relay 1920 moves to its right-hand position it again connects negative battery to the lower terminal of condenser 1908 and charges this condenser to the full negative battery potential in a very short interval of time. Consequently, when relay 1920 again operates to its left-hand position the 30-second interval required to change condenser 1908 will have to start again at this time.

The operation of relay 1910 to its left-hand position at this time again completes the circuit through the upper winding of relay 1901 and causes this relay to operate to its left-hand position. Relay 1901 in operating to its left-hand position now completes a circuit for the operation of relay 1906 from battery through the winding of relay 1906, the operated contacts of relay 1903, contact of armature of relay 1901, and the left-hand outer break contacts of relay 1928 to ground through the right-hand outer break contacts of relay 1948.

At the end of the starting impulse of the second letter combination, the armature of relay 1910 will be again operated to its right-hand position where it will interrupt the circuit through the upper winding of relay 1901 and permit the current flowing through the lower winding of this relay to operate its armature to its right-hand position. In moving to its right-hand position, the armature of relay 1901 interrupts the operating circuit of relay 1906. Relay 1906, however, does not release at this time because it is maintained operated and relay 1907 operates in a circuit extending from battery through the winding and operated contacts of relay 1906, the winding of relay 1907 and the right-hand outer break contacts of relay 1937 and the left-hand outer break contacts of relay 1928 to ground through the right-hand break contacts of relay 1948.

The operation of relay 1907 short-circuits the upper winding of relay 1901 and prevents this relay from further responding to the operation of relay 1910. The operation of relay 1907 also in-

terrupts the holding circuit of the selector magnet 1911 and thus permits this magnet to respond to the succeeding signals received by relay 1910 and repeated to selector magnet 1911.

The operation of the selector mechanism 318 in response to the operation of selector magnet 1911 may be fully understood by reference to Figs. 94, 95 and 96 which show some of the mechanical details of this selector mechanism. This mechanism is arranged to print the characters represented by the received signals on a tape and at the same time perforate the tape in accordance with the marking impulses of the signals. The selector mechanism is similar to that employed in the teletypewriter instruments and is driven by a continuously operated motor which is not shown either in Fig. 19 or in Figs. 94, 95 and 96. It is well understood in the art, however, that printing mechanisms are driven by a continuously operated motor so that it is not thought necessary to further complicate the drawings to show the details of the mechanical linkages between the motor and the selector mechanism.

A suitable teletypewriter mechanism is described in detail in U. S. Patent No. 1,745,633, granted to S. Morton et al. on February 4, 1930, whose disclosure is hereby made a part of this specification as if fully included herein.

The selector mechanism is controlled by a selecting magnet 9411 which is shown in both Figs. 94 and 95 and corresponds to the selector magnet 1911 in Fig. 19. This selector magnet responds to the telegraph signals repeated to it and starts the selector mechanism in accordance with them so that it will cause the proper character to be printed on the tape and the proper perforations to be punched in the tape. In a preferred embodiment of this invention, no paper is completely removed from the tape by the perforations. Instead, tabs are punched in the tape which remain attached to it. This enables the printed symbols to be easily read and prevents them from being mutilated by the perforations.

In addition to printing the characters on a tape and perforating a tape in accordance with the characters, a selector mechanism is arranged to selectively control or close certain contacts in response to reception of specified predetermined "combinations." These contacts are illustrated in Fig. 94 by contact symbols designated 9416 and 9417. These contacts correspond to contacts 1916 and 1917 of Fig. 19. Every time a letter R signal or code combination is received by the selector magnet 1911 or 9411, it will cause contacts 1916 and 9416 to momentarily close in addition to printing the letter R symbols on the tape and perforating the tape in the second and fourth positions. Similarly, every time the letter Z signal is received by the selector magnet, it causes the selector to momentarily close contacts 9417 which correspond to contacts 1917 in Fig. 19 in addition to printing the letter Z on the tape and perforating the tape in the first and fifth positions. It is to be understood that similar contacts may be associated with the so-called pull bars or other elements of selector mechanism which selectively respond to the various combinations received by it. In addition, the selector mechanism is provided with a universal contact 9612 shown in Fig. 96. This contact is mounted on the bracket 9492 and is actuated by lever 9491. Lever 9491 is controlled by the pull bar bail 9490. Contacts 9612 are arranged to close a short interval of time after the pull bar contacts close and open a short interval of time before the pull bar contacts open if any of them are operated by a code combination.

The manner in which the selecting mechanism causes these contacts to close is described in greater detail in U. S. Patents 2,112,234, granted to Beattie et al. on March 29, 1938, and 2,120,235, granted to Beattie et al. on June 14, 1938, whose disclosures are hereby made a part of this application as if fully included herein.

Returning now to the operation of the circuit shown in Fig. 19, the next two code combinations received by relay 1910 will be letter code combinations. These will be repeated to the selector magnet 1911 which will cause this selector to perforate two letter code combinations in the tape 2021. No characters or symbols are printed on the tape by the letter code combinations. The reception of these two letter code combinations by the selector magnet 1911 will cause the letter contacts 1915 to be momentarily opened by each of the code combinations a short interval of time before the universal contacts 1918 are closed and to reclose a short interval of time after the universal contacts open. Thus none of the circuits are altered at this time.

As assumed above, the next code combination will be a figures code combination and this in turn will be followed by the letter H code combination. When the figures combination is received by the selector magnet 1911, it will cause the figures contacts 1914 to close. These contacts are associated with a platen member which stays in the figures on upper case position until returned to the lower case by a letters signal or by a spacing signal.

The manner in which the platen controlled contacts are operated in response to a shift or figure signal and remain operated until the letters signal or unshift signal or a spacing signal is received may be more fully understood by reference to Fig. 97. In Fig. 97, 9701 represents the platen of printing reperforator which is carried on rod 9702. Rod 9702 is supported by brackets 9709 and 9708. As shown in Fig. 97, platen member 9701 has been shifted to the figures position. It is restored to its normal or letters position by the operation of the letters pull bar carrying extension 9710 in an upward direction in response to the reception of a letters signal. The extension 9710 engages the lever 9711 and rotates it about pivot 9719 in response to the reception of a letters or unshift signal. Lever 9711 engages the lever 9717 and rotates it about pivot 9720 in a clockwise direction. This causes contacts 9714 to open. These contacts are the platen control contacts and are similar to contacts 1914 shown in Fig. 19. Rotation of lever 9717 causes its bifurcated end in 9718 to move to the right as viewed in Fig. 97. Bifurcated end 9718 of lever 9717 engages member 9703 which is attached to the platen supporting rod 9702 and moves it to the right and thus moves platen 9701 to its letters position. Member 9703 has an extension which engages with latch 9705 so that when rod 9702 carrying member 9703 is moved to the right it engages latch 9705 and is held in this position. Member 9712 is also positioned by an extension of lever 9717 and permits the selection of either pull bar 9715 or 9716. When the platen member is in the position shown in the drawings, pull bar 9716 may be selected by the selecting mechanism but not pull bar 9715. When the platen member 9701 is moved to its letters position, pull bar 9715

may then be selected but not pull bar 9716. This manner of permitting various pull bars to be selected is described in the above-identified patents.

When a figures signal is received a pull bar carrying extension 9706 is operated in an upward direction. Extension 9706 of the figures pull bar engages latch 9705 and rotates this latch in a counter-clockwise direction as viewed in Fig. 97. This releases member 9703 so that it, together with rod 9702 and platen 9701, is moved to the left by the action of the spring 9704. This causes the rotation of member 9717 in counter-clockwise direction, as shown in Fig. 97, so that contacts 9714 close and remain closed so long as platen member 9701 remains in its shifted or figures position.

When the figures signal is received, it will also cause the universal contacts 1918 to operate and complete a circuit for the operation of relay 1928 from battery through the winding of relay 1928 and operated contacts 1918, break contacts 1917, 1916, 1915 and 1913 to ground. Operation of relay 1928 interrupts the locking circuit of relays 1902, 1903, 1906, and 1907 and permits these relays to release. Operation of relay 1928 maintains a short circuit around the upper winding of relay 1901 so that this relay will not respond to signals received by relay 1910. Relay 1928 in operating completes a circuit for maintaining itself operated from battery through its winding, the break contacts of relay 1929, the center right-hand contacts of relay 1928 and right-hand break contacts of relay 1927 to ground through break contacts of key 1945. The operation of relay 1928 completes the circuit from ground through the right-hand outer break contacts of relay 1948 and the left-hand outer operated contacts of relay 1928 to battery through the relay 1904 and maintaining this relay operated. The operation of relay 1928 also interrupts the circuit of the winding of relay 1937 and thus prevents this relay from operating while relay 1928 is operated. Operation of relay 1928 also interrupts the holding circuit of the selector magnet 1911 and permits this magnet to continue to follow the signal repeated by relay 1910. The operation of relay 1928 also interrupts the circuit from the contacts 1917 thus rendering the operation of these contacts ineffective should they be operated by any Z signals received by the selector magnet 1911.

Then when the H signal is received by selector magnet 1911, it will cause contacts 1913 to be momentarily operated and complete a circuit for the operation of relay 1929 from battery through the winding of relay 1929 and the operated contacts 1914 and 1913. Relay 1929 in operating completes a circuit for maintaining itself operated from battery through its winding and operated right-hand contacts, the right-hand center operated contacts of relay 1928, right-hand outer break contacts of relay 1927 to ground through the break contacts of key 1945. Operation of relay 1929 also interrupts the locking circuit of relay 1928 thus permitting this relay to release and in turn release relay 1929. It should be noted, however, that two letter signals, a figure signal and an H signal have been perforated in the tape 2021.

The next signal to be received by relays 1910 and 1920 will be a letter signal. The spacing start impulse of this letter signal will cause the armature of relay 1910 to move to its left-hand position, where it completes a circuit through the upper winding of relay 1901 for operating this relay to its left-hand position. The operation of the armature of relay 1901 to its left-hand position completes a circuit for the operation of relay 1902. These circuits have been traced in detail above. At the end of the spacing impulse of the first letter signal, the armature of relay 1910 will operate to its right-hand position, where it interrupts the circuit to the upper winding of relay 1901 and causes the armature of relay 1901 to be operated to its right-hand position by current flowing through the lower winding of this relay. The armature of relay 1901 in operating to its right-hand position removes the short circuit from around the winding of relay 1903, thus permitting relay 1903 to operate and relay 1902 to lock operated in a circuit extending from battery through the winding and left-hand operated contacts of relay 1902, winding of relay 1903, right-hand outer break contacts of relay 1937 to ground through the left-hand outer break contacts of relay 1938 and the right-hand outer break contacts of relay 1948. The remaining signal impulses in this letter signal will be marking and consequently the armature of relay 1910 will remain in its right-hand position.

The selector magnet 1911 does not respond to this letter signal because it is maintained operated in a circuit extending through the left-hand break contacts of relays 1928 and 1907. The next signal transmitted from the outlying station will be another letter signal. The spacing start impulse of this second letter signal will cause the armature of relay 1910 to again move to its left-hand position, where it completes a circuit through the upper winding of relay 1901 and causes the armature of this relay to move to its left-hand position. When the armature of relay 1901 moves to its left-hand position at this time, it will complete a circuit for the operation of relay 1906 as described above. At the end of the spacing start impulse relay 1910 will again be operated to its right-hand position, where it interrupts the circuit through the upper winding of relay 1901, thus causing this relay to operate to its right-hand position. Relay 1901 in operating to its right-hand position removes the short circuit from around the winding of relay 1907 and permits this relay to operate in series with relay 1906. It should be noted that relay 1907 does not operate until after the end of the spacing start pulse and since the following pulses will be marking in this second letter signal, selector 1911 will not respond to this second letter signal. The operation of relay 1907 short-circuits the upper winding of relay 1901 so that it no longer responds to the operation of relay 1910, but remains in its right-hand position. The operation of relay 1907 also interrupts the holding circuit of the selector magnet 1911, thus permitting this relay to follow the signals repeated by the repeating relay 1910. The next two signals transmitted from the outlying station will also be letter signals, which signals will be repeated to the selector magnet 1911 and recorded in the tape 2021 by a perforation in each of the five positions. No symbol or character is usually printed on the tape at this time under normal conditions. The printing reperforator 318, however, may be arranged to print any desired symbol at this time, but is normally not so arranged. The reception of these two letter signals by the selector magnet 1911 causes the letters contacts 1915 which are controlled by the pull bar actuated in response to a letter signal to open momentarily in response to each of these

letter signals. This interrupts the circuit to the universal contacts 1918 and thus prevents the operation of any of the relays of the circuits shown in Fig. 19, in response to these two signal combinations. The signal or code combination designating the station to which it is desired to transmit the message will be then transmitted from the outlying station. Assume, for example, that the letter A signal is next transmitted which is assigned to station 217. When this signal is received by relay 1910 and repeated to the selector magnet 1911, it will cause the letter A to be printed upon tape 2021 and an A signal perforated in the tape 2021 in addition will cause the universal contacts 1918 and only these contacts to close, since they close once in response to each code combination. The momentary closure of contacts 1918 completes a circuit for the operation of relay 1928 from battery, through the winding of relay 1928, universal contacts 1918, break contacts 1917, 1916, 1915, and 1913 to ground. Relay 1928 in operating completes a circuit for maintaining itself operated from battery through its winding, the break contacts of relay 1929, the center set of right-hand operated contacts of relay 1928, the right-hand break contacts of relay 1927 to ground, through the break contacts of key 1945. Relay 1928 in operating interrupts the locking circuit of relays 1902, 1903, 1906 and 1907 and permits these relays to release. Relay 1928 in operating, however, maintains a short circuit around the upper winding of relay 1901, so that this relay will not follow the operation of relay 1910. In addition, the operation of relay 1928 interrupts the holding circuit of the selector magnet 1911, thus permitting this magnet to continue to follow the succeeding signals transmitted from the outlying station. The operation of relay 1928 also interrupts the operating circuit of relay 1937, thus preventing this relay from operating so long as relay 1928 is operated. The operation of relay 1928 also interrupts the circuit through contacts 1917, which are actuated by Z signals, so that these contacts will be ineffective should the letter Z be transmitted during the transmission of the following message. The following signals transmitted in the outlying station will then comprise another letter signal, carriage return, line-feed signal, and then the message. During this time, the circuits of the relays of Fig. 19 will remain in the position last indicated.

It should be noted that relay 1920 follows the signals transmitted from the outlying station and maintains the lower terminal of condenser 1908 charged to a sufficient negative potential to prevent the operation of relay 1926. If at any time after the operation of relays 1904 and 1905, as described above, transmission ceases from the outlying stations and the line is maintained in a marking condition, the potential on the lower terminal of condenser 1908 will reach a sufficiently high positive battery or a sufficiently small negative battery to allow relay 1926 to be operated. The operation of relay 1926 causes relay 1927 to operate and return the circuits to their normal or idle condition, as described above.

Assuming that transmission is not interrupted and that at the end of the message a figure signal, followed by an H signal, will be received. This causes the circuit shown in Fig. 19 to operate, as described above. The figure signal causes contacts 1914 to close and remain closed, while the H signal causes contacts 1913 to momentarily close and complete a circuit for the operation of relay 1929. Relay 1929 in operating interrupts the locking circuit of relay 1928, which relay thereupon releases and in turn releases relay 1929. However, relays 1904 and 1905 do not release at this time.

Assuming that the next message is intended for the central switching station, the designation of which is the letter R. When the letter R signal is received by the selecting magnet 1911 after the four letter signals following the H signal at the end of the preceding message it will cause contacts 1916 to momentarily close and complete a circuit for the operation of relay 1937 from battery through the winding of relay 1937, the left-hand inner break contacts of relays 1928 and 1927, the break contacts of key 1946, the operated contacts 1916 and the break contacts 1915 and 1913 to ground.

The operation of relay 1937 interrupts the locking circuits of relays 1902, 1903, 1906 and 1907 and permits these relays to release. The release of relay 1907 completes a holding circuit for maintaining selector magnet 1911 operated, thus preventing it from further following the remaining signals repeated by relay 1910 from the transmitting station. The operation of relay 1937 maintains a short circuit around the upper winding of relay 1901, so that this relay will not follow the operation of relay 1910 in response to the message signals transmitted from the outlying station.

The operation of relay 1937 also completes the circuit for maintaining itself operated from ground, through the break contacts 1923 of the receiving teletypewriter mechanism, the outer left-hand contacts of relay 1937 contacts of key 1946, left-hand break contacts of relays 1927 and 1928 to battery through the winding of relay 1937.

The operation of relay 1937 also interrupts the holding circuit of the printer magnet 1921 of the receiving teletypewriter and thus permits this magnet to respond to the signals repeated by relay 1920. In responding to these signals the printer magnet 1921 will cause the teletypewriter to record the message intended for the central switching station. At the end of this message a figure signal followed by an H signal will then be transmitted from the outlying station. When these two signals have been received by the teletypewriter, it will cause contacts 1923 to be momentarily open and interrupt the locking circuit of relay 1937, which relay will then release and restore the circuit to a condition awaiting reception of further signals from the outlying station. The manner in which contacts 1923 respond to the reception of a figures signal followed by an H signal is described in detail in the above-identified patent to Morton et al.

At the end of transmission from any of the outlying stations the four letter signals will be transmitted following the H signal at the end of the last message. Following the transmission of these signals, the letter Z signal will be transmitted. The operation of the incoming circuit shown in Fig. 19 in response to the four letter signals is the same as described above. Namely, relays 1902, 1903, 1906 and 1907 are operated and in response to the letter Z signal contacts 1917 are momentarily operated and complete a circuit for the operation of relay 1948 from battery through the winding of relay 1948 and the left-hand inner break contacts of relay 1928 to ground through the operated contacts of relay 1917 and break contacts 1916, 1915 and 1913.

The operation of relay 1948 completes a circuit for maintaining itself operated under control of relay 1905. The operation of relay 1948, as described above, interrupts the locking circuits of relays 1902, 1903, 1906 and 1907 and thus permits these relays to release. The release of relay 1902 and the operation of relay 1948 interrupts the operating and locking circuits of relay 1904, thus permitting this relay to release. The release of relay 1904 in turn releases relay 1905 which in turn releases relay 1948 and restores the circuit to its normal condition. At the end of the transmission from the outlying station after the Z signal is transmitted a number of letter signals will run out of the tape-controlled transmitter 1712 and permit contacts 1716 to open and interrupt the circuit of relays 1718 and 730, thus permitting these relays to release. The release of relay 1718 interrupts the circuit of the start magnet 1720 and permits this magnet to release its armature 1721 and stop the transmitter 1712. The release of relay 730 interrupts the circuit of lamp 736 and extinguishes this lamp. The release of relay 730 also restores the transmitter control circuits at station 211 to their normal or idle condition.

The release of relay 1904 interrupts the circuit through relay 1020. Relay 1020 in releasing completes the circuit for maintaining relay 923 operated from battery through its winding and left-hand operated contact and left-hand break contact of relay 933 to ground through the break contacts of relay 1020. The release of relay 1904 also completes a path for the operation of relay 1025 from battery through the winding of relay 1025, the inner break contacts of relay 1019 and the right-hand break contacts of relay 1005 over lead 1054 to ground through the right-hand inner break contacts of relay 1904. Relay 1025 operates and connects the contacts of keys 914, 924 and 934 to the windings of relays 911, 921 and 931, through contacts of relays 912, 922 and 932, respectively.

The operation of relay 1948, as described above, and the subsequent release of relay 1905 completes a circuit through lamp 945 and causes this lamp to light and indicate to the operator that the transmission from the outlying station has been completed. Lamp 925 remains lighted at this time to indicate to the operator the station 211 was the station which had been transmitting. Upon noting lamp 945, the operator may operate one of the other transmitter start keys 914 or 934 in an effort to cause the transmitter at station 210 or 213, as the case may be, to start transmission if the supply of perforator tape has been inserted in it.

Tape feed-out

If at any time after the figures signal followed by the H signal at the end of the first message has been received including the time the second or any other message is being received by the receiving teletypewriter in response to the operation of the selector magnet 1921, the supply of perforated tape 2021 between the reperforator 318 and the transmitter shown in Fig. 20 becomes reduced to a predetermined minimum quantity, this tape will become taut and cause contacts 2023 to open.

Under these circumstances provision is made for causing the reperforator 318 to automatically perforate an additional supply of tape 2021 so that the entire message recorded in this tape may be immediately transmitted by the transmitters shown in Fig. 20 without waiting for the storing of another received message in this tape. In order to start the feed-out action, it is necessary first that the tape 2021 between the printing reperforator 318 and the transmitter shown in Fig. 20 become taut. In the second place, it is necessary that a figure signal followed by an H signal be received by the printing reperforator 318. The reception of the figure signal followed by the H signal causes the reperforator 318 to be disconnected from or disassociated with the transmitting channel 205 of party line 200. If the figure signal followed by the H signal has not been received, the automatic perforation and feed-out of tape will not take place. If the tape becames taut without the reperforator 318 having received a figure signal followed by an H signal, the relay 1926 will operate substantially 30 seconds after the last signal has been received and cause transmission to be initiated from another station as described herein elsewhere.

Assume now that the tape 2021 has become taut and that a figure signal followed by an H signal has been received by the printing reperforator 318 at the end of the previous message, and that no further message has been received which causes the printing reperforator 318 to be connected to the transmitting channel of the party line 200. Under these conditions, when tape 2021 becomes taut and causes contacts 2023 to open, they interrupt the circuit of relay 1932 and permit this relay to release. Release of relay 1932 interrupts the operating circuit of the start magnet 2008 and permits this magnet to release a stop latch 2007 which in turn causes the transmitter shown in Fig. 20 to stop at the end of the transmission of the character then in progress of transmission. The release of relay 1932 at this time also completes the circuit for the operation of relay 1949 from battery through the winding of relay 1949, the left-hand outer break contacts of relay 1931, right-hand outer break contacts of relay 1932 to ground through the left-hand outer break contacts of relay 1928 and the right-hand outer break contacts of relay 1948.

The operation of relay 1949 completes a circuit for the operation of magnet 1919 of the printing reperforator 318 from battery through the winding of magnet 1919, the left-hand operated contacts of relays 1949 to ground through the left-hand break contacts of relay 1902. So long as the magnet 1919 remains operated it causes reperforator 318 to automatically perforate an additional supply of tape.

The manner in which magnet 1919 causes the printing reperforator to automatically feed out and perforate an additional supply of tape may be more fully understood by reference to Figs. 94 and 95. Here magnet 9419 corresponds to magnet 1919 of the printing reperforator 318 shown in Fig. 19. In addition the printing magnet 1911, Fig. 19 is illustrated by magnet 9411 in Figs. 94 and 95. The printing or selecting magnet 9411 controls the selecting equipment in the usual manner as is well understood and described in the above-identified patent to Morton et al. Magnet 9411 and its armature and associated levers and members is frequently called a "holding magnet selector" or "holding magnet." This arrangement is shown and described in greater detail in U. S. Patents 1,937,376, granted November 28, 1933, to Zenner; 2,203,300, granted June 4, 1940, to Hanke; and 2,228,716, granted January 14, 1941, to Zenner, whose disclosures are hereby made a part of this application as if fully in-

cluded herein. It is to be understood however that the reperforator may be operated by the so-called "pulling" magnet as described in the above identified patent to Morton et al. The code combinations are set up on the code bars 9418 in the usual manner to select one of the pull bars 9401 which is then actuated by the pull bar bail 9490 to print the desired character on the tape. 9701 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 9418 through the linkage levers 9420, 9421, 9429 and 9422 to the interponents 9423 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 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 whose disclosures 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 9420, 9421, 9429, 9422 and 9423 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 9411, the receiving cam barrel 9430 is released for rotation for one revolution of rotation for each code combination received representing some character or function to the receiving apparatus. The release of the cam barrel 9430 is accomplished by magnet 9411 releasing its armature 9403. This permits the armature assembly to rotate in a clockwise direction about pivot 9415 and causes extension 9404 to move to the left pushing pin 9405 to the left. When pin 9405 moves to the left it rotates a lever 9406 in a counter-clockwise direction which in turn rotates lever 9407 in a clockwise direction. This releases the stop latch 9408 and permits it to rotate in a counter-clockwise direction as viewed in Fig. 95 under the influence of extension 9409 from the cam barrel 9430 thus permitting the cam barrel to rotate. This operation precedes the reception of each group of impulses representing a character or function as is well understood in the art and described in the above-identified patents.

When magnet 9419 operates it attracts its armature 9410 and causes it to rotate in a clockwise direction which in turn causes the members 9406 to rotate in a counter-clockwise direction and in turn rotate member 9407 in a clockwise direction thus releasing the latch 9408 and permitting the cam barrel 9430 to rotate. Thus, the operation of members 9406, 9407, 9408 and the cam barrel 9430 are operated in the same manner by the operation of magnet 9419 as they are by the release of magnet 9411 preceding the reception of each code combination in response to the reception of the start impulse. So long as magnet 9419 remains operated these members 9406 and 9407 remain in their operated position so that the cam barrel 9430 continues to rotate.

During the rotation of cam barrel 9430, under these circumstances magnet 9411 will be operated. This is due to the fact that relays 1928 and 1907 shown in Fig. 19 are released at this time due to the fact that the reperforator is disconnected from the transmitting channel 205 of the party line 200. Consequently, all of the code bars 9418 will be positioned in their so-called marking positions and in turn will cause the interponents 9423 controlled thereby through the linkages described above to also be positioned in their so-called marking positions where they will all cause corresponding perforations in the tape. This operation continues so long as magnet 9419 remains operated. Upon the release of magnet 9419 its armature will be rotated in a counter-clockwise direction and allow members 9406 and 9407 to return to their normal position under influence of spring 9432 and thus engage a stop latch 9408 and cause cam barrel 9430 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 over the transmitting channel 205.

When magnet 1919, operated as described above, causes the automatic perforation of tape 2021 by the printing reperforator 318, even though no signals are being received by it, the additional supply of tape 2021 provided permits contacts 2023 to close. The closure of contacts 2023 completes the circuit for the operation of relay 1932.

It should be noted that under normal conditions when relay 1932 is released as described above, a circuit will be completed for the operation of relay 1933 as will be described hereinafter. Relay 1933 in operating conditions tube 1939 for operation so that approximately 5 seconds later relay 1935 will operate and in turn operate relay 1934. Relay 1934 in operating interrupts the locking circuit of relay 1933 which relay thereupon releases. Upon the release of relays 1932 and 1933 the circuit of the start magnet 2008 is again completed so that this magnet will operate and release the transmitter shown in Fig. 20; whereupon this transmitter will transmit the remainder of the message stored in tape 2021 as will be described hereinafter.

The operation of relay 1949 also completes the filament circuit of tube 1938 and also connects positive battery through the high resistance 1962 to the lower terminal of condenser 1961. The lower terminal of this condenser is also connected to the grid of tube 1938. Consequently, the potential of the lower terminal of this condenser determines the grid potential of tube 1938. The constants of the high resistance 1962, resistance 1963 and condenser 1961 are such that it requires approximately 13 seconds for the potential of the lower terminal of condenser 1961 to reach the value required to cause tube 1938 to pass sufficient plate current to operate relay 1930. During this entire 13-second interval the printing reperforator 318 has been perforating an additional supply of tape with letter signals.

Upon the operation of relay 1930 the circuit of the right-hand winding of relay 1931 is extended to lead 1372.

Lead 1372 extends from Fig. 19 through Figs. 28, 37, 46, 55, 56, 57, 62, 70, 76, 82, 88, to the front contact of relay 9310 of Fig. 93.

Relay 9310 is periodically operated for a short interval of time approximately every 5 seconds. When power is first applied to the system the circuit is completed for the operation of relay 9312 from battery through the winding of relay 9312 to ground through the break contacts of relay 9310. Relay 9312 operates and renders effective a charging circuit for a condenser 9330 from positive battery through the high resistance 9332 through condenser 9330 to negative battery. It should also be noted that filament circuit of tube 9313 is completed from positive battery to negative battery when power is applied to the system. The right-hand terminal

of condenser 1930 acquires a positive charge in the above-described charging circuit. The constants of the high resistance 9332 and condenser 1930 are so chosen that time constants of the changing circuit of condenser 1930 is such that it requires approximately 5 seconds for the potential of the right-hand terminal of condenser 1930 and thus the grid potential of tube 9313 to reach the potential required to cause tube 9313 to pass sufficient current to operate relay 9311. At the end of this time interval relay 9311 operates and in turn completes an obvious circuit for the operation of relay 9310. Relay 9310 in operating interrupts the operating circuit of relay 9312 and connects ground through its operated contacts to lead 1372. A short interval of time after relay 9310 operates relay 9312 releases. The release of relay 9312 short-circuits condenser 9330 through resistance 9331. The value of resistance 9331 is such that the time constants of the discharge circuit of condenser 9330 is relatively short. After the discharge of condenser 9330, its right-hand terminal again becomes negative and thus applies a negative potential to grid of tube 9313, thus interrupting the anode current of this tube and causing relay 9311 to release and in turn release relay 9310. Upon the release of relay 9310 the above cycle of operations is again repeated. It should be noted that ground is connected to lead 1372 during each cycle during the time relay 9310 is operated.

Returning now to Fig. 19 when ground is applied to lead 1372 by the operation of relay 9310, as described above, a circuit is completed for the operation of relay 1931. Relay 1931 in operating completes the circuit for maintaining itself operated from battery through its left-hand winding and inner operated contacts, the break contacts of key 1943 to ground through the left-hand outer break contacts of relay 1928 and the right-hand outer break contacts of relay 1948. The operation of relay 1931 also interrupts the locking circuit of relay 1949 and thus permits this relay to release. Release of relay 1949 interrupts the operating circuit of magnet 1919 and thus stops the automatic perforation of letter signals in the tape 2021. Release of relay 1949 also restores the circuits of condenser 1961 and tube 1938 to their normal condition so that they will be ready for use after the following message if required.

The tape control transmitter shown in Fig. 20 will transmit the entire message recorded in tape 2021 as will be described hereinafter and then will continue to advance tape through it and discard the letter signals until the supply of tape between the printing reperforator 318 and transmitter shown in Fig. 20 again becomes reduced to the predetermined minimum quantity, at which time contacts 2023 will again open and interrupt the operating circuit of relay 1932. At this time the release of relay 1932 will not cause relay 1947 to operate because the operating circuit of relay 1949 is now interrupted at the left-hand outer contacts of the operated relay 1931. Thereafter, circuits remain in this condition until additional messages are received, after which they operate in the manner described herein.

If at any time during the time magnet 1919 is operated another message should be received for recording by the printing reperforator 318 relay 1902 will operate as described herein and interrupt the circuit of magnet 1919 which will release and condition the reperforator for reception of the message to be stored in tape 2021. It should be noted that following the operation of relay 1902 a number of letters signals are received prior to the reception of message signals. These letter signals provide sufficient time for magnet 1919 to relase and the other circuits and apparatus to be properly conditioned for the reception of the following message.

Automatic operation of the transmitter start circuit

The operator may also operate locking key 944 to the automatic position. If this is done, the circuit is completed for the operation of relay 1019 from battery through the winding of relay 1019 to ground through the operated contacts of key 944.

Assume now that the operator does operate the automatic key 944 at this time or prior to the release of relay 1904 and assume further that the attendants at stations 210 and 213 have not inserted any tape in the tape-controlled transmitters thereat so that the transmitters at these stations cannot be started from the central station.

With relay 1910 operated and relay 1904 released, a circuit is completed for operating relay 931 from battery through the winding of relay 931, the left-hand break contacts of relay 932, the right-hand outer break contacts of relay 933, the center set of left-hand operated contacts of relay 922, inner operated contacts of relay 1019, right-hand break contacts of relay 1005, lead 1054, which extends through Figs. 9 and 19 to ground through the right-hand inner break contacts of relay 1904. Relay 931 in operating completes a circuit for the operation of relay 930, which relay in operating causes lamp 935 to light. Relay 931 in operating completes a circuit for the operation of relay 1001 similar to the circuit described above by the operation of the relay. The operation of relay 1001 interrupts the locking circuit of relay 922, thus allowing this relay to release and interrupt the operating circuit of relay 931. Relay 931, however, does not release at this time because, in operating, it completes a circuit for maintaining itself operated from ground through the left-hand outer break contacts of relay 901, left-hand break contacts of relay 911, left-hand break contacts of relay 921, left-hand inner operated contacts of relay 931, left-hand break contacts of relay 931 to battery through the winding of relay 931.

The operation of relay 1001 completes a circuit for the operation of relay 1002, the operation of which relay in turn completes a circuit for the operation of relay 1003. Relay 1003 in operating completes a circuit for the operation of relay 1004, which relay in turn locks operated from battery through its winding and left-hand inner operated contacts to ground through the left-hand outer operated contacts to relay 931. Relays 1001, 1002, 1003, 1004, 1005, 1008, 1009, 1010, 1011, 1012, 1013 and 1014 operate as described above and first cause the operation of relay 1410, which will stop any transmitter connected to the receiving channel 204. Approximately .4 second later the operation of these relays will cause a blank signal to be transmitted over this channel. After another pause of approximately .7 second, the letter R signal or code combination will be transmitted over this channel. After a further pause of .7 second, the letter W signal will be transmitted

over this channel. These signals will cause outlying station circuits to operate, as described above, except that relay 830 will be operated instead of relay 730. Inasmuch as no tape is inserted in the transmitter at station 213, contacts 1816 will be opened so that relay 1818 will not operate and relay 830 will release when the contacts 814 open.

Approximately .7 second after the W signal has been transmitted, relay 932 is operated in a circuit from battery through the winding of relay 932, the right-hand outer break contacts of relay 931 to ground through the left-hand operated contacts of relay 1014 and the right-hand outer break contacts of relay 1002. Relay 932 in operating completes a circuit for maintaining itself operated from battery through its winding and left-hand inner operated contacts to ground through the break contacts of relay 1001. Relay 932 also interrupts the locking circuit for relay 931 and permits this relay to release. The release of relay 931 in turn permits relay 1004 to release. The release of relay 1004 interrupts the locking circuits of relays 1009, 1010, 1011, 1012, 1013 and 1014 and thus permits these relays to release. Relay 1005, however, is maintained operated in a circuit extending from battery through its winding and right-hand operated contacts, over lead 1054, which extends through Figs. 9 and 19 to ground through the right-hand inner break contacts of relay 1904.

The release of relay 1004, however, does remove a short circuit from around condenser 1027. The lower terminal of condenser 1027 will then start to charge to a more positive potential through high resistance 1051. Inasmuch as no tape was inserted in the transmitter at station 213, no signals will be received from that station. Consequently, relay 1904 will remain released. Relay 1005 will remain operated all during this time. Approximately five seconds later the potential on the lower terminal of condenser 1027 will have reached such value that the grid potential of tube 1018 which is connected to the lower terminal of condenser 1027 will cause sufficient current to flow through tube 1018 to operate relay 1006. Relay 1006 in operating completes a circuit for the operation of relay 1007. The operation of relay 1007 interrupts the operating circuit of relay 1020 and prevents the operation of this relay. The operation of relay 1007 also completes a circuit for the operation of relay 911, from battery through the winding of relay 911, the left-hand break contacts of relay 912 the right-hand break contacts of relay 913, the center left-hand operated contacts of relay 932, inner operated contacts of relay 1019 to ground through the inner operated left-hand contacts of relay 1007.

The operation of relay 911 completes a circuit for maintaining itself operated from battery through its winding and the left-hand break contacts of relay 912 to ground through the left-hand inner operated contacts of relay 911 and left-hand break contacts of relay 901. The operation of relay 911 also completes the circuit for the operation of relay 1001, which relay in operating interrupts the locking circuit of relay 932 and this permits this relay to release.

The operation of relay 1001 starts into action the cycle of operation of the transmitter start circuit shown in Fig. 10, as described above. During this cycle, relay 1410 is first operated to stop either of the transmitters 1201 or 1251 which may be transmitting at this time. Approximately .7 second later, a blank signal is transmitted over the line. About .7 second later a letter R signal is transmitted over the line. This is followed by another interval of .7 second, after which the letter Y signal is transmitted over the channel 204 of the full duplex line 200.

The outlying station circuits respond to these signals in a manner similar to that described above, except that in this case only contacts 614 at station 200 are operated by the Y signal to cause relay 630 to operate. However, inasmuch as no tape is inserted in the transmitter shown in Fig. 16, contacts 1616 will be open, thus preventing relay 1618 from operating and relay 630 from locking operated. Relay 630 will therefore release immediately when contacts 614 return to the normal condition and the transmitter control equipment at each of the stations 210, 211 and 213 will be returned to its normal condition.

It should be noted that when relay 1001 is operated in response to the operation of relay 911, as described above, it causes relays 1002, 1003 and 1004 to operate in turn. The operation of relay 1004 at this time short-circuits the condenser 1027 and charges the lower terminal of this condenser to negative battery potential. This applies the negative battery potential to the grid of tube 1018, which in turn interrupts the current flowing through the tube and causes relay 1006 to release. The release of relay 1006 causes relay 1007 to release, thus restoring the condenser 1027, tube 1018 and relays 1006 and 1007 to their normal or idle condition.

Approximately .7 second after the Y signal code combination is transmitted by the transmitter start circuit shown in Fig. 10, relay 912 is operated in a circuit extending from battery through the winding of relay 912, the right-hand outer operated contacts of relay 911 and the left-hand operated contacts of relay 1014 to ground through the right-hand break contacts of relay 1002. The operation of relay 912 interrupts the locking circuit of relay 911 and permits this relay to release. Relay 911 in releasing interrupts the locking circuit of relay 1002, which relay releases and causes the release of relays 1009, 1010, 1011, 1012, 1013 and 1014. The release of relay 1004 removes the short circuit from condenser 1027 and allows the lower terminal of condenser 1027 to start to charge to a positive potential through the high resistance 1051. Inasmuch as no signals can be transmitted over the line at this time, relay 1904 will remain non-operated and hold relay 1005 operated. Consequently, at the end of approximately five seconds the potential on the lower terminal of condenser 1027 will be such that sufficient current will flow through tube 1018 to cause relay 1006 to operate. The operation of relay 1006 at this time completes an obvious circuit for the operation of relay 1007. Relay 1007 in operating at this time completes a circuit for the operation of relay 1015 from battery through the winding of relay 1015, the outer right-hand operated contacts of relay 923, the center set of left-hand operated contacts of relay 912, the inner operated contacts of relay 1019 to ground through the operated contacts of relay 1007.

It will be recalled that relay 923 operated during the transmission from station 211 and remained locked operated under control of relay 1020, which relay has not been operated since the transmission from station 211 was completed. Consequently, relay 923 still remains locked operated. The operation of relay 1015 at this time interrupts the circuit of relay 1410 and

allows this relay to release. The release of relay 1410 at this time prepares the start magnet circuits for transmitters 1201 and 1251 and will allow either one of these transmitters to resume transmission under control of their associated circuits as will be described hereinafter.

The operation of relay 1015 also completes a circuit for lighting the filament of tube 1017, thus energizing tube 1017. The operation of relay 1015 also completes a circuit for the operation of relay 1021 from battery through the winding of relay 1021 the upper break contacts of relay 1023 to ground through the upper inner operated contacts of relay 1015. Relay 1021 in operating removes the shunt resistance 1046 from around the condenser 1027 and connects positive battery through the high resistance 1048 to the left-hand terminal of condenser 1028, thus tending to charge this terminal and the grid of tube 1017 connected thereto to a positive terminal. The time constant of resistances 1048 and 1046 and condenser 1028 are such as to require approximately two minutes for the potential of the left-hand terminal of condenser 1028 to reach the value required to cause tube 1017 to pass enough current to operate relay 1016. At the end of this time interval relay 1016 will operate and complete an obvious circuit for the operation of relay 1023. The operation of relay 1023 interrupts the circuit of relay 1021 and permits this relay to release. The operation of relay 1023 also completes a circuit for the operation of the rotary magnet 1024, which operates and causes the switch arm 1058 to take one step and come in contact with the first terminal of the switch bank.

The release of relay 1021 short-circuits condenser 1028 and thus connects the left-hand terminal to negative battery potential. The time constant of the circuit from negative battery through resistance 1046 is such that the potential of this condenser becomes the same as the potential of the negative battery almost at once. This causes tube 1017 to cease to conduct current and thus interrupts the operating circuit of relay 1016. The release of relay 1016 interrupts the operating circuit of relay 1023, which relay releases and in turn releases the circuit of the rotary magnet 1024. The release of relay 1023 also reestablishes the circuit through relay 1021, thus causing this relay to be operated. The operating of the relay 1021 at this time removes the shunt from around condenser 1028, which condenser again starts to charge. At the end of approximately two minutes relay 1016 will be operated again and again cause relay 1023 to operate. The operation of relay 1023 causes relay 1021 to release and switch arm 1058 to take a second step.

The above cycle of operations is repeated and every two minutes the switch arm 1058 takes a step. As shown in Fig. 10, after the switch has taken five steps, that is, after ten minutes, the switch arm will step on the fifth terminal of the swtich bank and complete a circuit for the operation of relay 921 from battery through the winding of relay 921, the left-hand break contacts of relay 922, the right-hand inner operated contacts of relay 923 to ground, through the switch arm 1058. The operation of relay 921 completes a circuit for the operation of relay 1001 and relay 1001 in operating interrupts the locking circuit of relay 912. Relay 912 then releases and interrupts the circuit of relay 1015 which in turn releases. The release of relay 1015 reestablishes the circuit of relay 1410 which relay then reoperates and stops either transmitter 1201 or 1251 if either is transmitting at this time. The release of relay 1015 interrupts the filament circuit of tube 1017 and thus restores this tube and associated circuits to normal. The release of relay 1015 also completes a circuit for the operation of release magnet 1022 from battery through the winding of magnet 1022, off normal contacts 1039, to ground through the upper inner break contacts of relay 1015. The operation of the release magnet causes the switch arm 1058 to return to normal as is well understood in the art. When arm 1058 returns to normal contacts 1039 open and interrupt the circuit of magnet 1022 and thus restores this switch and related circuits to normal. A typical switch of this type is shown in Figs. 51 on page 83 of Telephone Theory and Practice, Automatic Switching and Auxiliary Equipment, by Miller, published by McGraw-Hill Book Company in 1933.

The operation of relay 1001 also starts the operation of the automatic start circuit all over again, after which the cycle of operations described above will be repeated. If tape has not been inserted in any of the transmitters at the outlying stations, the automatic start circuit will go through the complete cycle again. That is, it will send out signals in an effort to start the transmitter at station 211, after which it will wait five seconds and, if no signals are received over the transmitting channel, it will send out signals over the receiving channel to start the transmitter at station 213. The circuit will then wait five seconds and if no signals are received over the incoming channel by the end of this time the transmitter start circuit will again send out signals in an effort to start the transmitter at the station 210. If no signals are received within five seconds, the ten-minute timing circuit will again be started into operation, after which the above cycle is again repeated. This cycle will be automatically repeated so long as the automatic key 944 remains operated and until tape has been inserted in one of the outlying transmitters.

If tape is inserted in one of the outlying transmitters, this transmitter will start to transmit and signals will be received at the central switching station within five seconds after the completion of the operation of the automatic start signal. These signals will cause relay 1004 to operate in a manner as described above. The operation of relay 1004 will interrupt the locking circuit of relay 1005 and permit this relay to release. The operation of relay 1004 at this time will also cause relay 1020 to operate. The operation of relay 1020 at this time will interrupt a locking circuit for relay 923 and cause either relays 913 or 933 or even 923 to reoperate through the operated contacts of relay 1020, depending upon which of the stations the transmission is from. At the end of the transmission from that station operation of the transmitter start circuit will be automatically resumed as described above during which signals will be sent out to cause each of the transmitters in rotation to start transmission if tape has been inserted in them by the attendant.

Transmission of the message to the desired outgoing line circuit

Returning now to the message which had been or are being received by the typing reperforator

318, when the messages are received by this instrument it perforates tape 2021 in accordance with the received signals as well as prints the message upon this same tape. When the typing reperforator perforates the tape 2021 in accordance with the received message it produces an additional supply of perforated tape 2021 which permits contacts 2023 to reclose.

It is to be understood that tape 2021 extends from the printing reperforator 318 to the transmitting distributor shown in Fig. 20. This is represented in the drawings by the heavy dot dash line 1960 which extends from the tape 2021 of Fig. 19 to tape 2021 of Fig. 20. The arrangement shown in Figs. 19 and 20 has been adapted merely to show in greater detail the structure of the apparatus and circuits employed at the central station.

When contacts 2023 close they complete a circuit for the operation of relay 1932 from battery through the winding of relay 1932 to ground through switch 2024 and contacts 2023. The operation of relay 1932 completes a circuit for the operation of the start magnet 2008. It will be recalled that relay 2119 has been locked operated when the tape becomes taut if letter signals were stored in the section of the tape 2021 which was passing through the transmitter shown in Fig. 20. In addition, relays 2121 and 2122 will also be locked operated. All of the relays of Fig. 22 were also operated due to the operation of relays 2121 and 2122.

All of the above mentioned relays are also operated in case the transmitter finds a blank signal, an H signal, an R signal, a Z signal or a figure signal perforated in the section of the tape passing through the transmitter. However, under these circumstances, relay 2210 will not be operated at this time.

The operation of the start magnet 2008 attracts the stoplatch 2007 and this disengages it from the stop cam 2006 and thus releases the distributor 2005 which will rotate and cause tape 2021 to advance one step through the transmitter for each rotation of the distributor brush arm 2025. This action of the circuits as described above continues until a character other than letters, blank, R, Z, or figure signals is perforated in the tape 2021 and this other character arrives over the sensing fingers 2026. When this occurs, a circuit will no longer be completed for maintaining relay 2119 operated or for operating relay 2110. Instead a circuit will be completed for operating some one of the relays 2410, 2420, 2430, 2440, 2450 and 2460.

Under the assumed conditions, a letter A signal will be the first significant directing signal perforated in the tape. It will be recalled that two letters were first perforated in the tape followed by a figure signal, then an H signal. These, in turn, were followed by two more letter signals after which the A code combination was received and perforated tape 2021. The letter signal and the figure signal and the H signal code combinations are advanced through the tape transmitter shown in Fig. 20 as described above. However, when the A signal arrives over the sensing fingers 2026, it will cause first two sensing fingers 2026 only to go through the perforations in the tape. Consequently, only the first two contacts are closed a short time after the transmitter starts the rotation when this set of perforations in the tape first arrives over the sensing fingers 2026. Upon the continued rotation of the transmitter, contacts 2015 will open and interrupt the locking circuits of relays 2119, 2121 and 2122 and permit relays 2121 and 2122 to release. The release of relays 2121 and 2122 will cause relays 2231, 2241, 2242, 2251, 2252, 2253 and 2254 to release. The release of these relays interrupts a holding circuit for relay 2119, thus permitting this relay to release. Relays 2211 and 2221, however, are maintained operated due to the operation of the first two contacts in response to the first two sensing fingers 2026 passing through perforations in the first two positions in tape, 2021. The release of relay 2119 and the relays of Fig. 22, enumerated above, interrupts the circuit of the start magnet 2008 and permits this magnet to release the stop-latch 2007 which will then engage the stop cam 2006 and stop transmitter at the end of the revolution then in progress. However, prior to the end of the revolution of the transmitter shown in Fig. 20 all of the relays of Fig. 22 except relays 2211 and 2221 will release. After the last of the relays to release is finally released, relay 2113 will be operated to its right-hand position due to the fact that no battery will be connected to its lower winding.

When relay 2113 operates to its right-hand position, it completes a circuit for the operation of relay 2430 from battery through the winding of relay 2430 to terminal L3, contacts of keys 2318 and 2358, the A terminal, the lower break contacts of relays 2254, 2242, 2231 and the upper operated contacts of relays 2221 and 2211, the left-hand center break contacts of relay 2112, the armature and right-hand contact of relay 2113, lead 2114 which extends through Figs. 20 and 19, and break contacts of key 1942, lead 1956 which extends through Figs. 20 and 21 to ground through the lower break contacts of relay 2115.

Relay 2430 in operating completes a circuit for maintaining itself operated from battery through its winding and inner left-hand operated contacts over lead 2114 which extends through Figs. 23, 22, 21, 20 and 19 through the contacts of key 1942, over lead 1956 which extends through Figs. 20 and 21 to ground through the lower break contacts of relay 2115. The operation of relay 2430 also completes a circuit for the operation of magnet 2016 from ground through the center left-hand operated contacts of relay 2430, over lead 2401 which extends through Figs. 23, 22, 21 and 20 to battery through the winding of magnet 2016. The operation of magnet 2016 causes its armature member 2019 to be rotated in a counter-clockwise direction as viewed in Fig. 20 and to engage the projection 2028 of pawl 2018 so that at the end the revolution of the transmitter then in progress during which the sensing fingers 2026 sensed the letter A perforated in the tape, pawl 2018 will not engage the ratchet wheel 2020 and thus will not cause tape 2021 to be advanced. Under these circumstances, the A signal perforated in the tape remains above the sensing fingers 2026 so that they will again pass through this same perforation in the tape the next time the transmitter is released for operation.

The operation of relay 2430 also completes a circuit for the operation of relay 2113 from ground through the lower winding of relay 2113 over lead 2133 which extends through Figs. 22, 23 and 24 through the left-hand outer operated contacts of relay 2430 to battery over lead 2402 which extends through Figs. 23, 22, and 21 to battery

connected to the lower armature of relay 2121. Relay 2113 is operated to its left-hand position where it interrupts the circuit through the contacts of the relays shown in Fig. 22 extending to all of the relays shown in Fig. 24 and thus prevents the operation of any of these relays due to subsequent signals stored in tape 2021.

The operation of relay 2430 also completes a circuit for the operation of relay 2118 from battery through the winding of relay 2118, lead 2435 which extends from Fig. 21 through Figs. 30, 39, 48, 57, 62, 70, 76, 82, 88 and 93 through the innermost break contacts of relay 9316, back over lead 2434 which extends through Figs. 88, 82, 76, 70, 62, 57, 48, 39, 30 and 21 through the inner upper break contacts of relay 2116, over lead 1960 which extends from Fig. 21 to Figs. 20 and 19 through the left-hand outer break contacts of relay 1947 and key 1944, over lead 2403 which extends from Fig. 19 through Figs. 20, 21, 22, 23, 24 through the right-hand inner operated contacts of relay 2430 and over lead 5183 which extends from Fig. 24 through the Figs. 33, 42 and 51 to ground through the break contact and second armature from the top of relay 5120.

The operation of relay 2118 interrupts a circuit through relay 9321 and permits this relay to release. The release of relay 9321 removes positive battery from the grid a vacuum tube 9322 and the right-hand terminal condenser 9326. The condenser then starts to discharge through high resistance 9327 at a slow rate. The time constants of condenser 9326 and high resistance 9327 are such that it requires an appreciable time for condenser 9326 to discharge sufficiently to cause the tube 9322 to interrupt the current flowing through this tube. This time interval is normally longer than is required to establish a connection through the system as will be described hereinafter. If, for any reason, the connection is not established in the usual time and not established by the time the condenser 9326 is discharged sufficiently to interrupt the current flowing through tube 9322, relay 9320 will release and interrupt the circuit through relay 9319. Relay 9319 will then release and complete a circuit for lighting the trouble lamp 9318 indicating a trouble condition exists and thus drawing attention to it so that it may be corrected.

The operation of relay 2118 as described above completes a circuit for the operation of relay 2117. Relay 2117, in operating, interrupts a possible circuit through the start magnet 2008 and thus prevents the operation of the transmitter shown in Fig. 20 at this time over this circuit. The operation of relay 2117 also completes a circuit for maintaining relay 2128 in the position shown in the drawings from ground through the lower winding of relay 2128 and upper operated contacts of relay 2117 to battery.

The operation of relay 2118 completes a circuit for the operation of relay 9323 from battery through the left-hand winding of relay 9323, over lead 9351 which extends from Fig. 93 through Figs. 88, 82, to Fig. 76 through the upper outer break contacts of relay 7618, lead 9352 which extends to Fig. 70, through the upper outer break contacts of relay 7018, lead 9353 which extends through Fig. 62 to Fig. 57 through the upper outer break contacts of relay 5718, lead 9354 which extends through Fig. 48 to Fig. 39, through the upper outer break contacts of relay 3918, lead 9355 which extends through Fig. 30 to Fig. 21 through the upper inner operated contacts of relay 2118 through the upper break contacts of relay 2116, lead 1960 which extends through Fig. 20 to Fig. 19 through the left-hand outer break contacts of relay 1947, contacts of key 1944, over lead 2403 which extends through Figs. 20, 21, 22, 23, and 24 through the right-hand inner operated contacts of relay 2430, over lead 5183 which extends through Figs. 33, 42 and 51 to ground through the contact and second armature from top of relay 5120.

The operation of relay 9323 completes a circuit for the operation of relay 9317 from battery through the winding of relay 9317, the operated contacts of relay 9323, lead 9361 which extends from Fig. 93 through Figs. 88, 82 to 76, through the lower break contacts of relay 7618, lead 9362 to Fig. 70, through the lower break contacts of relay 7018, lead 9363, through Fig. 62 to Fig. 57, through the lower break contact of relay 5718, lead 9364 which extends through Fig. 48 to Fig. 39, lower break contacts of relay 3918, lead 9365 which extends through Fig. 30 to Fig. 21, through lower inner operated contacts of relay 2118, lead 2435 which extends through Figs. 30, 39, 48, 57, 62, 70, 76, 82, 88 and 93, through the inner operated contact of relay 9316, lead 2434 which extends from Fig. 93 through Figs. 88, 82, 76, 70, 62, 57, 48, 39, and 30 to Fig. 21, through the inner upper break contacts of relay 2116, lead 1960 which extends through Fig. 20, through the left-hand outer break contacts of relay 1947, through contacts of key 1944, lead 2403 which extends through Figs. 20, 21, 22, 23, 24, contacts of relay 2430, over lead 5183 which extends through Figs. 33, 42 and 51 to ground through the break contacts of relay 5128.

The operation of relay 9317 completes circuits for maintaining relays 2118, 9317, and 9323 operated. The locking circuit for maintaining relay 2118 operated may be traced from battery through the winding and lower inner operated contacts of relay 2118, lead 9365 which extends through Figs. 30 and 39, through the lower break contacts of relay 3918, lead 9364 which extends through Fig. 48 to Fig. 57, through the lower break contacts of relay 5718, lead 9363 which extends through Fig. 62 to Fig. 70, lower break contacts of relay 7018 over lead 9362 to Fig. 76, through the lower break contacts of relay 7618, over lead 9361 through Figs. 82 and 88 to Fig. 93 through the operated contacts of relay 9323. At this point the locking circuit of relay 9317 from battery through the winding of relay 9317 joins the locking circuit of relay 2118 and the circuit for both relays extend from this point through the lower operated contacts of relay 9317. At this point the locking circuit of relay 9323 from battery through the winding of relay 9323 joins the locking circuits of relays 2118 and 9317 and the locking circuits for all three relays extend from this point through lead 9351 which extends through Figs. 88 and 82, the upper break contacts of relay 7618, lead 9352 to Fig. 70, the upper outer break contacts of relay 7018, lead 9353 which extends through Fig. 62 to Fig. 57, the upper outer break contacts of relay 5718, lead 9354 which extends through Fig. 48 to Fig. 39, through the upper outer break contacts of relay 3918, lead 9355 which extends through Fig. 30 to Fig. 21, the upper inner operated contacts of relay 2118, the upper break contacts of relay 2116 over lead 1960 extending through Fig. 20, the left-hand outer break contacts of relay 1947, contacts of key 1944, lead 2403 which extends through Figs. 20, 21, 22, 23 to Fig. 24, the right-hand inner

operated contacts of relay 2430 over lead 5183 which extends through Figs. 33, 42 and 51 to ground through the break contacts of relay 5120.

The operation of relay 9317 also completes a circuit for the operation of relay 9316 from battery through the winding of relay 9316 to ground through the upper operated contacts of relay 9317. The operation of relay 9316 interrupts the operating circuit of relay 2118. This relay, however, does not release because it is maintained operated by current flowing in the above-traced locking circuit. The operation of relay 9316, however, interrupts the operating circuit of relays 3918, 5718, 7018, 7618, 8218 and 8818, thus preventing any of these relays from operating during the time relay 9316 is operated. The operation of relay 9316 completes a circuit for the operation of relay 9325 from battery through the winding of relay 9325, the uppermost operated contact of relay 9316 to ground through right-hand break contacts of relay 9321. Relay 9325, however, is a slow operating relay and requires appreciable time to operate. Relay 9325 is made slow in operating to allow sufficient time for relays 8218 and 8818 to release if they had been operated at this time as will be explained hereinafter.

The operation of relay 9325 completes a circuit for maintaining relay 9316 operated from battery through the winding of relay 9316 to ground through the outer operated contacts of relay 9325. The operation of relay 9325 also completes a circuit for the operation of the horizontal magnet 2501 from battery through the winding of magnet 2501 over lead 2502 which extends through Figs. 24, 23, 22 to Fig. 21, through the upper operated contacts of relay 2118 over lead 9371 which extends from Fig. 21 through Figs. 30, 39, 48, 57, 62 70, 76, 82, 88 to Fig. 93 to ground through the operated contacts of relays 9316 and 9325.

The operation of magnet 2501 conditions the cross-bar switch so that when one of the vertical or holding magnets is operated, as will be explained hereinafter, one set of contacts on the horizontal row shown in Fig. 25 will be operated in response to the operation of one of the holding magnets. The detailed operation and structure of cross-bar switches of this kind is described more fully in the above-identified patent granted to Reynolds.

The operation of magnet 2501 in addition to conditioning the cross-bar switch also completes a circuit for the operation of relay 9324 from ground through the operated contacts of magnet 2501, lead 9373 which extends from Fig. 25 through Figs. 34, 43, 52, 61, 66, 74, 80, 86, 92, 91, 90, 89, 88 to Fig. 93 and thence through the winding of relay 9324 to battery. Relay 9324 in operating completes a circuit for maintaining relay 9316 operated. Relay 9324 in operating also completes a circuit for the operation of relay 5012 from ground through the left-hand operated contacts of relay 9324 over lead 9372 which extends from Fig. 93 through Figs. 88, 82, 76, 70, 62, 57, 48, 39, 30 to Fig. 21, through the lower operated contacts of relay 2118, over lead 2135 which extends through Figs. 22, 23, 24 through the right-hand outer operated contacts of relay 2430, over lead 2404 extending through Figs. 33, 42, and 51 to Fig. 50 and thence through the upper break contacts of key 5021 and lower break contacts of relay 5001 to battery through the winding of relay 5012. The operation of relay 5012 completes a circuit for maintaining itself operated from battery through its winding and upper operated contacts, the upper break contacts of key 5021, over lead 2404 to ground through the operated contacts of relay 9324, over the above-traced circuit path. The operation of relay 5012 completes a circuit for the operation of the holding magnet 9241 from ground through the lower operated contacts of relay 5012 over lead 9242 extending through Figs. 51, 52, 61, 66, 74, 80, 86 and 92 to battery from winding of the holding magnet 9241.

The operation of the vertical or hold magnet 9241 in cooperation with the previous operation of the horizontal or selector magnet 2501 of the cross-bar switch causes contacts 2546, 2547, 2548, 2549 to operate and connect leads 9246, 9247, 9248 and 9249 to leads 2146, 2147, 2148 and 2149, respectively, which leads extend from Fig. 25 through Figs. 24, 23, 22 to Fig. 21. The operation of contacts 2548 completes a circuit for the operation of relay 5001 from ground through the upper outer break contacts of relay 2116, lead 2148 extending through Figs. 22, 23, 24, the operated contacts 2548, lead 9248 which extends through Figs. 34, 43, 52, 61, 66, 74, 80, 86 and 92, the inner operated contacts of the hold magnet 9241, lead 9243 which extends from Fig. 92 through Figs. 86, 80, 74, 66, 61, 52 and 51 to battery through the winding of relay 5001. The operation of relay 5001 completes a circuit for maintaining itself operated from battery through its winding and lower inner operated contacts over lead 9248 which extends from Fig. 50 through Figs. 51, 52, 43, 34 and 25, operated contacts 2548, lead 2148 extending through Figs. 24, 23, 22 and 21 to ground through the upper break contacts of relay 2116.

The operation of relay 5001 completes a circuit for holding magnet 9241 operated from ground through the upper inner operated contact of relay 5001, over lead 9242 which extends through Figs. 51, 52, 61, 66, 74, 80, 86 and 92 to battery through the winding of magnet 9241. The operation of relay 5001 also completes a circuit for the operation of relay 2115 from battery through the winding of relay 2115 over lead 2147 extending from Fig. 21 through Figs. 22, 23, 24 and 25 through contacts 2547, over lead 9247 extending from Fig. 25 through Figs. 34, 43, 52 and 51 to Fig. 50 and thence through the lower operated contact and third armature from the bottom of relay 5001 to ground.

The operation of relay 5001 completes a circuit for the operation of relay 5011 from battery through the upper winding of relay 5011, lower break contacts of relay 5002 to ground through the lower operated contacts of relay 5001.

The operation of relay 5001 also interrupts the holding circuit for relay 5020 from the potentiometer comprising resistances 5021, winding of relay 5020 to ground through the upper break contacts of relay 5001. This prepares relay 5020 for repeating the signals received by it over lead 9249 to the typing reperforator selector magnet 4928.

The operation of relay 2115, as described above, interrupts the locking circuit of relay 2430, thus permitting this relay to release. The operation of relay 2115 interrupts the circuit through the contacts of relay 2113 and contacts of relays shown in Fig. 22, thus preventing the operation of any of the relays shown in Fig. 24 and also relay 2410. The release of relay 2430 interrupts the locking circuits of relays 2118, 5012, 9323 and 9317, thus permitting all of these relays to re-

lease. The release of relay 5012, together with the previous operation of relay 5001, transfers lead 2404 from the winding of relay 5012 to lead 9252 for the operating of the holding magnet 9251 should another call be directed to this same line while the first message is being transmitted to it as will be described hereinafter.

The release of relay 2118 interrupts the operating circuit of the cross-bar horizontal selecting magnet 2501 over lead 2502 and thus permits this magnet to release. Contacts 2549, 2548, 2546, 2547, however, do not release at this time because they are held operated by the operation of the holding magnet 9241. The manner in which these contacts are maintained operated at this time is fully described in the above-identified patent to Reynolds. The release of magnet 2501 interrupts the operating circuit of relay 9324 and permits this relay to release.

The release of relays 2118, 9323 and 9324 reestablishes a circuit through relay 9321 from ground through the left-hand break contacts of relay 9324, winding of relay 9321, the right-hand winding of relay 9323, break contacts of relay 9323, lead 9361 which extends through Figs. 88 and 82, lower break contacts of relay 7618, lead 9362, lower break contacts of relay 7018, lead 9363 which extends through Fig. 62, lower break contacts of relay 5718, lead 9364 which extends through Fig. 48, lower break contacts of relay 3918, lead 9365 which extends through Fig. 30, lower break contacts of relay 2118, lead 9366 which extends through Figs. 30, 39, 48, 57, 62, 70 and 76, lower break contacts of relay 8218, lead 9367, lower break contacts and then the upper break contacts of relay 8818, lead 9357 and the upper break contacts of relay 8218, lead 9356 which extends through Figs. 76, 70, 62, 57, 48, 39 and 30, the upper break contacts of relay 2118, lead 9355 which extends through Fig. 30, the upper break contacts of relay 3918, lead 9354 which extends through Fig. 48, the upper break contact of relay 5718, lead 9353 which extends through Fig. 62, the upper break contacts of relay 7018, lead 9352, the upper break contacts of relay 7618, lead 9351 which extends through Figs. 82 and 88 to battery through the left-hand winding of relay 9323. Current flowing in this circuit through the right-hand and left-hand winding of relay 9323 produces opposite effects upon this relay so that they neutralize each other and cause the relay to release and remain nonoperated. Current flowing in this circuit, however, causes relay 9321 to operate and charge the right-hand terminal of condenser 9326 to a positive value, thus maintaining relay 9320 operated. During the normal operation of the circuits, relay 9321 reoperates before the right-hand terminal of condenser 9326 has become sufficiently discharged to cause relay 9320 to release. Thus relay 9320 will remain operated and prevent the trouble lamp 9318 from lighting.

The operation of relay 9321 at this time interrupts the operating circuit of relay 9325. Relay 9325 then releases and interrupts the holding circuit of relay 9316. The release of relay 9316 partially prepares operating circuits for relays 3918, 5718, 7018, 7618, 8218 and 8818 if messages are waiting for transmission by the other circuits at the central switching station as will be described hereinafter.

With the release of relay 9316, the equipment shown in Fig. 93 is released and restored to its normal condition and is available for use in establishing another connection through the system. The use of this equipment for establishing another connection, however, does not interfere with the established connection because, as pointed out above, the contacts 2546, 2547, 2548 and 2549 remain operated during the transmission of this message.

The operation of relay 2115 also completes a circuit for the operation of relay 2112 from battery through the winding of the relay 2112 to ground through the lower operated contacts of relay 2115.

The release of relay 2118, as described above, interrupts the operating circuit of relay 2117. Relay 2117, however, is a slow release relay and does not immediately release. Relay 2117 is made slow in releasing to provide sufficient time for various circuits and relays described above to operate and release. At the end of the release time of relay 2117, this relay will release and establish a circuit through the start magnet 2008 of the transmitter shown in Fig. 20. The operating circuit for the start magnet 2008 may be traced from battery through the winding of magnet 2008, the left-hand inner break contacts of relay 1947, the left-hand inner operated contacts of relay 1932, the right-hand break contacts of relay 1933, lead 1957 which extends through Fig. 20, the lower break contacts of relays 2116 and 2117, inner operated contacts of relay 2115, the upper break contacts of relay 2120, the right-hand contact and armature of relay 2128 to ground through the lower operated contact of relay 2115.

It should also be noted that the release of relay 2430, as described above, interrupts the circuit through magnet 2016 and thus permits this magnet to release its armature 2019. Consequently, when the transmitter shown in Fig. 20 is again released for transmission, tape 2021 will be advanced through the transmitter in the normal manner.

The operation of magnet 2008 will again attract the stop latch 2007 and disengage it from the stop cam 2006 and thus release the transmitter shown in Fig. 20. The release of the transmitter shown in Fig. 20 will cause the sensing fingers 2026 to rise and cause the letter A signal perforated in tape 2021 which is still in the tape above these fingers to be again transmitted. The transmission circuit may now be traced from battery or ground connected to the contacts 1 through 5, inclusive, of the transmitter shown in Fig. 20. Ground is connected to the marking contacts and battery is connected to the spacing contacts through the left-hand inner operated contacts of relay 2112. The armatures of these contacts are connected to the segments 1 through 5 of the transmitting distributor through the right-hand operated contacts of relay 2112 and the operated contacts of relay 2130. The transmission circuit may be traced from transmitting distributor over lead 2149 which extends through Figs. 21, 22, 23 and 24, contacts 2549, lead 9249, which extends through Figs. 34, 43, 52 and 51 to relay 5020 and cause this relay to repeat the signals to the selector magnet 4928 of the printing reperforator 4902. The selector magnet 4928 will cause the received signals to actuate the typing reperforator 4902 and cause it to print the message upon the tape 4927 as well as perforate this tape in accordance with the message signals.

The message stored in the tape 2021 is then transmitted over lead 2149 to the printing reperforator 4902 so long as a supply of perforated tape 2021 is available so that contacts 2023 remain closed. During this transmission, the magnet 2016 will not be operated and, consequently, the tape will advance through the transmitter in normal manner.

During the transmission, relays 2125, 2126, 2127, 2128 and 2129 all are connected through resistances to leads 1 through 5 which are connected to the contacts 1 through 5 of the transmitter shown in Fig. 20 and to the segments 1 through 5 of the distributor. These relays are provided with a biasing circuit which extends from ground through the upper winding of relay 2129, the upper winding of relay 2113, lower winding of relay 2125, lower winding of relay 2127, middle winding of relay 2128 and upper winding of relay 2126 to battery. Current flowing through the bias windings of these relays tends to move the armatures of these relays to opposite position from the position shown in the drawings. Thus, biasing current tends to operate relays 2129, 2113, 2126 and 2128 to their left-hand position while it tends to operate relays 2125 and 2127 to their right-hand positions.

During the time the transmitter shown in Fig. 20 maintains contact 2015 closed, that is, the time during which transmitter brush arm 2025 is at or near the stop position, circuits will be closed for maintaining relays 2129, 2125, 2126, 2127 and 2128 in the position shown in the drawings. This circuit may be traced from ground through contacts 2015, lead 2123, the upper break contacts of relay 2121, the left-hand outer operated contacts of relay 2112, through parallel circuits including resistances and the center winding of relay 2125, the upper winding of relay 2127, and this parallel combination in series with the lower winding of relay 2129 to battery connected to left-hand inner contact of relay 2112. Circuits may also be traced from lead 2123 through the upper break contacts of relay 2121 and the left-hand outer operated contacts of relay 2112, through the parallel combination of the center winding of relay 2126 and the upper winding of relay 2128 to battery connected to the left-hand inner contact of relay 2112. Current flowing through these windings of relays 2125, 2126, 2127, 2128 and 2129 produces an effect which is greater than and opposite to the effect of the current flowing through bias windings of these relays. Consequently, these relays are maintained in the position shown in the drawings at this time. An additional circuit extends from ground through the lower winding of relay 2128 through the right-hand break contacts of relay 2124. Current flowing in this circuit also tends to maintain relay 2128 in the position shown in the drawings. During the remainder of each revolution of the brush arm 2025 when contacts 2015 are opened, battery through a relatively low resistance 2138 is connected to winding terminals of these relays and thus connects battery to both terminals of these windings and reduces the current flowing through them so that these windings are no longer effective due to current flowing in the above-traced circuits to maintain relays in the position shown in the drawings. Most of these relays are provided with additional windings which are connected through resistance to certain of the leads 1 through 5 in such a way so that under most conditions current will always flow through one of the windings in addition to the biasing winding and produce an effect in opposition to the effect of the biasing winding which overcomes the effect of the biasing winding and maintains relays in the position shown in the drawings. This always true except for one particular code combination. Thus relay 2125 is maintained in the position shown in the drawings during the closure of the contacts 1 through 5 of all of the signal combinations except the figures combination. Similarly, relay 2126 is maintained in its right-hand position by the closure of contacts 1 through 5 of the transmitter shown in Fig. 20 for all of the code combinations perforated in the tape 2021 except a letters code combination. Similarly, relay 2127 is maintained in the position shown except when the spacing code combination is transmitted by the transmitters shown in Fig. 20. Relay 2128 is maintained in the position shown except when the letter H combination is transmitted. The manner in which these relays are maintained in the positions shown may be more fully illustrated and understood by reference to relay 2125. Relay 2125 is arranged so that it will close its right-hand contact in response to a figure signal but will remain in the left-hand position during the transmission of all other code combinations by the transmitter distributor shown in Fig. 20. A circuit may be traced from ground through lower winding of relay 2126 and the upper winding of relay 2125 through resistances to each of the leads 1, 2, 4 and 5. The circuit may also be traced from battery connected to the left-hand inner contact of relay 2112 through the lower winding of relay 2129, the middle winding of relay 2125, through a resistance to lead No. 3. Thus, when any of the leads 1, 2, 4 or 5 have battery connected to them by the contacts 1, 2, 4 or 5 of the transmitter shown in Fig. 20, sufficient current will flow through the upper winding of relay 2125 to maintain this relay in its right-hand position. Similarly, when ground is connected to lead No. 3 by the No. 3 contact of the transmitter shown in Fig. 20, sufficient current will flow through the center winding of relay 2125 to maintain this relay in its left-hand position, as shown in the drawings. However, when ground is connected to all of the leads 1, 2, 4 and 5, battery connected to the No. 3 lead by the contacts 1 to 5 of the transmitter shown in Fig. 20, no current will flow through either the upper winding or the center winding of relay 2125. Consequently, current flowing through the lower winding of this relay will cause its armature to move to its left-hand position. The only time during which ground is connected to leads 1, 2, 4 and 5 and battery is connected to lead 3 is during the time the tape controlled contacts are closed for the transmission of a figure signal. That is, during the time the tape controlled contacts are closed for the transmission of a marking impulse during the first and second impulse intervals, a spacing impulse during the third interval and marking current during the fourth and fifth impulse intervals. The windings of the other relays are connected to the leads 1, 2, 3, 4 and 5 through suitable resistances so that these relays similarly respond only to one code combination. It should be noted that the response time is limited to the time during which contacts 1 through 5 of the transmitter distributor are controlled by sensing fingers 2026 so that these fingers may go through perforations in tape 2021. When these fingers are not free to go through the tape 2021, contacts 2015 will

be closed and complete the circuits described above for maintaining these relays in the position shown in the drawings.

Relay **2129** is arranged to be operated to its left-hand position in response to a spacing signal. That is, a signal in which positive battery is connected to all of the segments of the transmitter distributor **1** through **5**. The lower winding terminal of the lower winding of relay **2129** is connected to battery while the upper winding terminal of this lower winding is connected through the center winding of relay **2125** to lead **3** through the upper winding of relay **2127** to leads **1**, **2**, **4** and **5**. Thus during the time battery is connected to all of the leads **1** through **5**, no current will flow through the lower winding of relay **2129**. Consequently, current flowing through the upper winding of this relay will operate it to its left-hand position. During the time ground is connected to any one or more of the leads **1** through **5** for the transmission of all other code combinations, current will flow through the lower winding of this relay and maintain it in the position shown. By appropriately connecting these windings through suitable resistances to the leads **1** through **5** the relay may be made solely responsive to any one of the possible code combinations recorded in the tape.

Suitable resistance is connected between the windings of these relays and the leads **1** through **5** so that the circuits of these relay windings will not interfere with the transmission of signals by the transmitter and also so that the circuits of these various relays will not interfere with each other.

When relay **2129** operates to its left-hand position in response to a blank or a spacing code combination, it interrupts the circuit through relay **2130** whereupon relay **2130** releases and connects ground to segments **2** through **5**. This causes the transmitter to transmit a letter V instead of a blank signal. This is desirable because the switching circuits in the outlying stations respond to a blank signal and cause the switching circuit thereat to function. It is undesirable to so cause them to function during the transmission of a message in response to a blank signal transmitted from any source other than the automatic start circuit shown in Fig. 10, as described above. Consequently, every time an attempt is made to transmit a blank signal from a transmitter, such as shown in Fig. 20, to the printing reperforator **4902** it is changed to the letter V signal which signal is then transmitted to the printing reperforator in place of the blank signal.

As described above, a figure signal followed by an H signal is perforated in the tape **2021** following the message. When the figure signal is transmitted, relay **2125** will operate to its right-hand position where it completes an obvious circuit for operating relay **2124**. Relay **2124**, in operating, completes a circuit for maintaining itself operated from battery through its winding and operated left-hand contacts to ground through armatures and contacts of relays **2126** and **2127**. If either a letters signal or a spacing signal is then received, relay **2124** will be released. If, however, an H signal followed the figure signal, without an intervening letters or spacing signal, relay **2128** will be operated. The operation of relay **2124** interrupts the circuit through the lower winding of relay **2128**, thus permitting this relay to respond to the currents flowing through its other windings. The other windings of this relay as well as its lower winding are connected to leads **1** through **5** so that no current will flow through its upper or its lower winding during the time the tape controlled contacts are closed for the transmission of an H signal. Consequently, biasing current flowing through its middle winding causes the armature of this relay to operate to its left-hand position. In operating to the left-hand position, the armature of relay **2128** interrupts the circuit through the start magnet **2008** and allows this magnet to release and stop the transmitter shown in Fig. 20 at the end of the revolution then in progress of the brush arm **2125** during which the H signal is transmitted to the printing reperforator **4902**.

The operation of relay **2128** to its left-hand position completes a circuit for the operation of relay **2120** from battery through the winding of relay **2120**, left-hand contact and armature of relay **2128** to ground through lower operated contacts of relay **2115**. The operation of relay **2120** completes a circuit for maintaining itself operated from battery through the winding and upper inner operated contacts of relay **2120** to ground through the lower operated contacts of relay **2115**. The operation of relay **2120** completes a circuit for the operation of relay **2116** when contacts **2015** close from ground through contacts **2015**, over lead **2123**, through the lower operated contacts of relay **2120** to battery through the winding of relay **2116**. Relay **2116**, in operating, completes a circuit for maintaining itself operated from battery through its winding and lower operated contacts over lead **2146** which extends through Figs. 22, 23, 24 and 25, contacts **2546**, lead **9246** which extends through Figs. 34, 43, 52, 61, 66, 74, 80, 86 and 92 to ground. The operation of relay **2116** interrupts the operating and locking circuits of relay **5001** and thus permits this relay to release. The release of relay **5001** interrupts the circuit of the hold magnet **9241** and thus permits this magnet to release. The release of magnet **9241** causes contacts **2546**, **2547**, **2548** and **2549** to open. Opening of contacts **2546** interrupts the locking circuit of relay **2116** and permits this relay to release. The release of relay **5001** also interrupts the operating circuit of relay **2115** and permits this relay to release, thus restoring the circuits shown in Figs. 21, 22, 23, 24 and 25 to their original condition after which they will function to automatically advance letter signals and the other signals referred to above through the transmitter **20**.

Transmission of a message to the outlying station

As described above, the message, including the directing signal which in this case is the letter A, is transmitted to the selector magnet **4928**. The selector then causes the printing reperforator mechanism **4916** to perforate the message in tape **4927** and to print the message upon this tape. Upon the reception of the first code combination which will be the letter A, the printing reporforator will cause the universal contacts **4926** to close. The manner in which the selector magnet causes contacts **4926** to close is the same as described above with reference to the universal contacts of the printing reperforator **318**. The printing reperforator mechanism **4916** is in all respects similar to the printing reperforator **318** and the one illustrated in Figs. 94, 95 and 96 except that only certain of the contacts are employed in the circuit arrangement shown in Fig.

12. The printing reperforator mechanism **4902** or **4916** may be provided with the same contacts as the printing reperforator **318** if it is desired to arrange these machines so that they may be interchangeable. However, it is not necessary that the reperforators shown in Fig. 49 be provided with all the contacts with which the reperforator **318** is provided.

The closure of universal contacts **4926** completes a circuit for the operation of relay **5002** from battery through the winding of relay **5002** to ground through the operated contacts **4926** and the unoperated contacts **4925** and **4924**. Relay **5002**, in operating, completes a circuit for maintaining itself operated from battery through its winding and the break contacts of relay **5003** to ground through the lower inner operated contacts of relay **5002**. The operation of relay **5002** interrupts both the operating and locking circuits of relay **5011**, thus causing this relay to release and prevent its operation after it had been previously operated. The operation of relay **5002** also interrupts the operating circuit of relay **5004**, thus preventing the operation of this relay as long as relay **5002** remains operated.

The perforation of tape **4927** by the printing reperforator **4902** produces an additional supply of perforated tape **4927** which permits contacts **4913** to close. The closure of contacts **4913** completes a circuit for the operation of relay **5019** from battery through the winding of relay **5019** to ground through switch **4914** and closed contacts **4913**.

It is to be understood that the circuit shown in Figs. 48, 49 and 50 have been previously conditioned due to the application of power system and are initially in the same condition as described above with reference to Figs. 11, 12 and 13.

The operation of relay **5019** at this time completes a circuit for the operation of the start magnet **4917** from battery through the winding of magnet **4917**, the inner operated contacts of relay **5019**, the outer left-hand break contacts of relays **5018** and **5016**, the center left-hand break contacts of relay **5017**, lead **4812** which extends through Fig. 49 to ground through the right-hand outer operated contact of relay **4807** and the left-hand outer operated contact of relay **4808**. It will be recalled that relays **4807** and **4808** have been previously operated and locked operated during the advance of letters signals through the transmitter **5001**. Normally, with the tape taut and no messages being transmitted through the system, letters signals will be perforated in the tape **4927** between the transmitter **4901** and the printing reperforator **4902**. When the sensing fingers controlling contacts **1** through **5** of transmitter **4901** go through the perforations in the tape **4927**, they will cause all of the contacts **1** through **5** to be operated. The operation of these contacts causes relay **4804** to operate and close the circuit for maintaining relay **4808** operated.

The manner in which relay **4804** responds to the letters signals perforated in tape **4927** is the same as the manner in which relay **2126** responds to letters signals perforated in tape **2021**, as described above.

The start magnet circuit **4917**, in operating, causes the tape transmitter to advance the tape **4927** through it and these circuits are maintained operated until the letter A signal, in this particular case, or some other signal in the general case, arrives over the sensing fingers of the transmitter **4901**. When this occurs, relay **4804** will not operate. Consequently, when cam **4909** interrupts contacts **4910**, the locking circuit of relay **4808** is interrupted and this relay releases. The release of relay **4808** completes a circuit for the operation of magnet **4903** from ground through the right-hand inner operated contacts of relay **4807**, the center left-hand break contacts of relay **4808** to battery through the winding of magnet **4903**. The operation of magnet **4903** prevents the advance of tape **4927** at the completion of the revolution of the transmitter **4901** then in progress during which the sensing fingers controlling contacts **1** through **5** sense the perforations representing the A code combination. The manner in which magnet **4903** prevents the advance of the tape **4927** is the same as the manner in which the operation of magnet **2016** prevents the advance of tape **2021**, as described above. The release of relay **4808** also interrupts the circuit of the start magnet **4917** and thus stops the operation of the transmitter **4901** at the completion of this revolution. At this time, the A code combination is still above the sensing fingers which control the contacts **1** through **5**.

The release of relay **4808** completes a circuit for the operation of relay **5014** from battery through the winding of relay **5014**, through the upper break contacts of relay **5015**, the center operated contacts of relay **5019**, the right-hand outer break contacts of relay **4808**, the lower break contacts of key **4915** over lead **4930** which extends through Figs. 49 and 50, the lower inner break contacts of relay **5103** to ground through the lower break contacts of relay **5101**. The operation of relay **5014** completes a circuit for operating relay **5015** from battery through the winding of relay **5015** to ground through the lower operated contact of relay **5014**.

The operation of relay **5015** first completes a circuit for maintaining relay **5014** operated from battery through the winding and the upper operated contacts of relay **5014**, the upper operated contacts of relay **5015**, to ground through the lower break contacts of relay **5101**. A short interval of time later, relay **5015** interrupts the operating circuit of relay **5014**. However, relay **5014** does not release because it is maintained operated in the holding circuit above described. The operation of relay **5015** also completes a circuit for the operation of relay **5064** from battery through the winding of relay **5064**, the lower outer operated contacts of relay **5015**, to ground through the lower break contacts of relay **5065**. The operation of relay **5064** completes a circuit for the operation of relay **5017** from battery through the winding of relay **5017**, the inner break contacts of relay **5016**, the lower inner operated contacts of relay **5014** to ground through the operated contacts of relay **5064**.

The operation of relay **5017** completes a circuit for maintaining itself operated from battery through its winding and the right-hand break contacts of relay **5016** to ground through the second operated contacts from the right of relay **5017**. The operation of relay **5017** removes the shunt from around the contacts of relay **4801** through its outer right-hand contacts. The operation of relay **5017** completes a circuit for the operation of relay **5103** from battery through the winding of relay **5103** to ground through the third set of operated contacts from the right of relay **5017**. The operation of relay **5017** also completes a circuit for the operation of relay **5101** from ground through the right-hand inner operated contacts of relay **5017** to battery through

the winding of relay 5101. The operation of relay 5101 completes an obvious circuit for the operation of relay 5102. The operation of relay 5101 completes a circuit for lighting lamp 4640 from ground through the upper operated contacts of relay 5101 over lead 5104 which extends through Figs. 50, 49, 48, 47 and 46 to battery through lamp 4640. The lighting of lamp 4640 indicates to the operator at the central switching station that the outgoing line circuit is busy.

The operation of relay 5017 also extends the circuit of the cam controlled contacts 4910 from ground through contacts 4910, the right-hand break contacts of relay 5018, the left-hand inner break contacts of relay 5016 and the left-hand inner operated contacts of relay 5017 over lead 5023 which extends through Figs. 49 and 48 to a resistance network including the windings of relays 4802, 4803, 4804 and 4805. Current flowing in this circuit maintains the armatures of these relays in the position shown during the time relay 5017 is operated and contacts 4910 closed and thus prevents false operation of these relays during the time the sensing fingers of the transmitter are withdrawn from the tape.

The operation of relay 5017 also interrupts the locking circuit of relay 4807 and thus permits this relay to release. The release of relay 4807 interrupts the circuit of magnet 4903. Consequently, when the transmitter 4901 is again started into operation, the tape 4927 will be advanced through the transmitter in the normal manner.

The operation of relay 5017 also completes a circuit for the operation of the start magnet 4917 from battery through the winding of magnet 4917, the inner operated contacts of relay 5019, the left-hand outer break contacts of relays 5018 and 5016, the center left-hand operated contacts of relay 5017, the upper break contacts of relay 5110, over lead 5105 which extends through Figs. 50, 49 and 48 to ground through the right-hand contact and armature of relay 4802. The operation of the start magnet 4917 causes the tape control transmitter 4901 to start into operation and to transmit the message beginning with the letter A signal to relay 4801. Relay 4801 repeats the message over the receiving channel of the full duplex line 202.

The line relays 4522, 4572 and 4422 respond to all the message signals including the letter A signal and then repeat them to the associated selector magnets. The selector magnet at station 217, shown in Fig. 45, causes the selector to condition the repeating relay 4590 to repeat the signals received from the transmitter 4901 to the receiving equipment at station 217 in a manner which will be more fully described hereinafter with reference to other stations. It is to be understood that the equipment located at station 217 is the same as the equipment located at station 211 and shown in Figs. 8 and 18. It has been considered unnecessary to show all of the circuits for each of the stations, it being understood that the equipment at many of the stations is exact duplicates of the equipment at the other stations which have been shown in full and described in detail hereinafter.

The letter signal transmitted following the A code combination allows sufficient time for various circuits to operate at the outlying station and insures that the circuits will be fully established at the receiving device when the first code combination of the message arrives at the outlying point.

Thereafter a message is transmitted from the transmitter 4901 to the outlying station over the receiving channel. Normally, by the time the tape 4927 has become taut, the entire message including the end of the message signals, figures and H signal will have been recorded by the printing reperforator 4902. If the figures and H signal have not been received and recorded by the printing reperforator 4902 when tape 4927 becomes taut, contacts 4913 will open and interrupt the circuit of relay 5019. Relay 5019 will release and interrupt the circuit of start magnet which in turn causes transmitter 4901 to stop the further transmission of the message recorded in tape 4927. Nothing further happens until these or other signals are received and recorded by the reperforator. When a figures signal followed by an H signal is received, contacts 4923 are operated and remain operated in response to the figures signal until a letters or a spacing signal is received. When the H code combination is received, contacts 4925 momentarily close and complete a circuit for the operation of relay 5003 from battery through the winding of relay 5003 to ground through the operated contacts 4924 and 4923.

The operation of relay 5003 completes a circuit for maintaining itself operated from battery through its winding and operated contacts to ground through the lower inner operated contacts of relay 5002. The operation of relay 5003 interrupts the locking circuit of relay 5002 and permits this relay to release. The release of relay 5002 interrupts the locking circuit of relay 5003 and permits this relay to release. Normally, this action will take place some time before the tape 4927 becomes taut and opens contacts 4913. If it should happen to take place after the tape becomes taut, the circuits will operate in exactly the same manner as described hereinafter, when the tape becomes taut after the figures and an H signal has been received by the printing reperforator 4902, because the circuits wait until both conditions occur and it is immaterial which occurs first.

Assuming that no other message has been received by the printing reperforator 4902 and that a figures and H signal have been received by this printing reperforator and relays 5002 and 5003 released. Then as the transmitter 4901 approaches the end of the message, the tape 4927 will become taut and cause contacts 4913 to open and interrupt the circuit of relay 5019. The release of relay 5019 at this time completes a circuit for the operation of relay 5004 and magnet 4929. These circuits may be traced from battery through the winding of relay 5004 and from battery through the winding of magnet 4929 in parallel, through the center lower break contacts of relay 5002, the outer break contacts of relay 5019 to ground through the upper break contacts of relay 5011. The operation of magnet 4929 causes the printing reperforator 4902 to automatically perforate letters signals in the tape 4927 and thus permits contacts 4913 to reclose and reoperate relay 5019. The operation of relay 5019 again completes a circuit for the operation of the start magnet 4917 which operates and causes the transmitter 4901 to resume the transmission of the message to the outlying station.

The operation of relay 5004 completes a circuit for maintaining itself and magnet 4929 operated from battery through the winding of relay 5004

in parallel with the circuit from battery through the winding of magnet **4929**, the upper inner operated contacts of relay **5004** to ground through the upper break contact of relay **5011**. The operation of relay **5004** also completes a circuit for the operation of relay **4808** from ground through the center set of upper operated contacts of relay **5004**, over lead **4809** which extends through Fig. 49 to Fig. 48 through the left-hand break contacts of relay **4807** to battery through the right-hand winding of relay **4808**. The operation of relay **4808** at this time completes a circuit for maintaining itself operated from battery through its right-hand winding, the left-hand break contacts of relay **4807** to ground through the right-hand center operated contacts of relay **4808**.

The operation of relay **5004** completes a circuit for lighting the filament of vacuum tube **5005**, removes a short circuit from the condenser **5006** and connects the left-hand terminal of this condenser to positive battery through the high resistance **5008**. Approximately thirteen seconds later, the potential upon the left-hand terminal condenser **5006** and grid of tube **5005** will be such that tube **5005** will cause sufficient current to flow through it to operate relay **5010**. The operation of relay **5010** connects the lower winding of relay **5011** to lead **1372** to which interrupted ground is connected by relay **9310**, as described above. When ground is connected to this lead, a circuit will be completed for the operation of relay **5011**. Relay **5011** in operating interrupts the operating and locking circuits of relay **5004** and magnet **4929**. The release of magnet **4929** stops the automatic perforation of letters signals in the tape **4927** and the release of relay **5004** interrupts the filament circuit of tube **5005** and discharges condenser **5006**. The interruption of the filament circuit of tube **5006** causes relay **5010** to release and thus restore the circuits of tube **5005** to their normal condition.

The operation of relay **5011** completes a circuit for maintaining itself operated from battery through its upper winding and upper inner operated contacts to ground through the upper break contacts of relay **5002**.

During the time interval during which magnet **4929** was operated, sufficient tape **4927** will be perforated with letters signals to insure that the end of the message including the figures signal followed by the H signal will pass the sensing fingers of the tape control transmitter **4901**.

When the figures signal arrives at the control point over the sensing fingers, it will be transmitted over the receiving channel to the distant station. During the transmission of this code combination, the figures relay **4805** is operated to its left-hand position where it completes an obvious circuit for the operation of relay **4806**. The operation of relay **4806** completes a circuit for maintaining itself operated from battery through its winding and right-hand operated contacts to ground through the unoperated contacts of relays **4803** and **4804**.

The operation of relay **4806** removes battery from the right-hand winding terminal of the center winding of relay **4802** and thus permits this relay to be operated to its left-hand position in response to an H signal. It should be noted that if a letters signal or a spacing signal follows the figures signal before an H signal, the locking circuit of relay **4806** will be interrupted and permit this relay to release and reestablish the circuit through the center winding of relay **4802**. This circuit prevents relay **4802** from responding to a subsequent H signal should one be received. However, at the end of a message, the H signal will be received immediately following the figures signal so relay **4806** will remain operated and relay **4802** operated to its left-hand position during the transmission of this H signal to the outlying station.

The operation of relay **4802** interrupts the operating circuit of the start magnet **4917** and thus permits this magnet to release and stop the operation of the transmitter **4901** at the end of the transmission of the H code combination. The operation of relay **4802** completes a circuit from ground through its armature and left-hand contacts over lead **4815** which extends through Figs. 49 and 50 to battery through the winding of relay **5018**. Relay **5018** is operated by current flowing in this circuit and completes a circuit for maintaining itself operated from battery through its winding and left-hand operated contacts to ground through the outer left-hand operated contacts of relay **5017**.

The operation of relay **5018** extends the circuit from contacts **4910** to the winding of relay **5016**. Then near the end of the transmission of the H signal cam **4909** will cause contacts **4910** to close and complete the circuit for the operation of relay **5016**. Relay **5016**, in operating, completes a circuit for maintaining itself operated from battery through its winding and right-hand inner operated contacts to ground through the operated contacts of relay **5017**. Relay **5016**, in operating, interrupts the locking circuit of relay **5017** and permits this relay to release. The release of relay **5017** then short-circuits the contacts of relay **4801** and interrupts the operating circuit of relay **5101** permitting this relay to release and in turn release relay **5102**. The release of relay **5017** also interrupts the operating circuit of relay **5103**, but relay **5103** does not release at this time because it is locked operated in a circuit extending from battery through its winding and upper operated contacts to ground through the center right-hand break contacts of relay **5067**.

The release of relay **5017** also interrupts the locking circuits of relays **5018** and **5016**, thus permitting these relays to release. The release of relays **5016**, **5017** and **5018** completes the circuit for the operation of relay **4807** from battery through the winding of relay **4807**, the upper contacts of key **4915**, the left-hand inner break contacts of relay **4807**, the left-hand inner operated contacts of relay **4808**, lead **4810** which extends through Figs. 49 and 50 through the left-hand inner break contacts of relays **5017** and **5016**, right-hand break contacts of relay **5018** to ground through the closed contacts **4910**. Relay **4807** operates and completes a circuit for maintaining itself operated from battery through its winding, the upper contacts of key **4915**, the right-hand operated contacts of relay **4807**, over lead **4811** which extends through Fig. 49 to ground through the left-hand outer break contacts of relay **5017**.

The operation of relay **4807** also interrupts its operating circuit but only after an interval of time after it completes this locking circuit, thus insuring that the relay will fully operate and remain operated under the control of relay **5017**. The operation of relay **4807** completes a circuit for the operation of the start magnet **4917** from ground through the outer left-hand operated contacts of relay **4808**, the outer right-hand operated contacts of relay **4807**, over lead **4812** which ex-

tends through Fig. 49 through the center left-hand break contacts of relay 5017, the left-hand outer break contacts of relays 5016 and 5018, the inner operated contacts of relay 5019 to battery through the winding of start magnet 4917. The operation of magnet 4917 at this time causes the operation of the tape control transmitter 4901 and since letters signals are perforated in the tape after the H signal by the automatic operation of the printing reperforator 4902 in response to the operation of the magnet 4929, as described above, relay 4804 will operate in response to each of the letters signals perforated in tape 4927 and maintain relay 4808 operated as described above and cause the transmitter 4901 to automatically advance tape 4927 through this transmitter until it becomes taut and causes contacts 4913 to open and interrupt the operating circuit of relay 5019 which in turn causes this relay to release and interrupt the operating circuit of magnet 4917, thus stopping the operation of the transmitter 4901.

When the figures signal followed by the H signal is transmitted over the receiving channel of line 202, the selector magnets of the switch selector of each of the outlying stations receives these two signals and in response to them causes the repeating relay which was repeating the signals to the local receiving apparatus at the selecting station to be rendered non-responsive to further signals transmitted over these channels. These signals also condition the switching equipment at each of these stations so that this equipment will be responsive to the switching or directing signal or code combination transmitted over the line which will proceed the next message. The operation of the circuits at the various outlying stations under these conditions will be described more fully hereinafter.

Returning now to the second message recorded in tape 2021, it will be recalled that following the first message and the figures and H signals a number of letters signals were transmitted from the outlying subscriber and a number of them recorded in tape 2021 by the printing reperforator 318. Following these letters signals the letter Q signal was received and recorded in tape 2021.

The transmitting distributor shown in Fig. 20 will cause the letters signals following the figures and H signals to be automatically advanced through this transmitter as described above. The circuits causing the operation of this transmitter under these conditions were fully described above and need not be repeated here. Following these letters signals the letter Q signal will arrive over the sensing fingers 2026 and interrupt the automatic operation of the transmitter shown in Fig. 20.

Assume that simultaneously with the arrival of the Q signal over the sensing fingers 2026 a Q signal also arrives over the sensing fingers 5626 due to the operation of some station connected to the full duplex line 202. The operation of the equipment associated with line 202 will be similar to the operation of the equipment associated with line 200 as described above. The operator at the central switching station will operate appropriate keys to cause the outlying transmitters to be selectively started to transmit messages to the central station in accordance with the messages perforated in tapes inserted in these transmitters by the attendants at the outlying stations.

Assume further that simultaneously with the arrival of the Q signals over sensing fingers 2026 and 5626 a letter Q signal also arrives over the sensing fingers (not shown) which has been perforated in tape 7521 by an operator at the central switching station.

Assume further that these three Q signals which arrive simultaneously over the sensing fingers of the respective tape controlled transmitters are each directing signals and each precede a different message intended for the station designated by the letter Q.

The letter Q signal comprises a marking first, second and third impulse, a spacing impulse for the fourth impulse and a marking impulse for the fifth impulse. This signal is represented by perforations in tape 2021 in the first, second, third and fifth positions. When this combination arrives over the sensing fingers 2026 it will cause contacts, 1, 2, 3 and 5 to be operated to their marking positions where circuits will be completed for the operation of relays 2211, 2221, 2231, 2251, 2252, 2253, and 2254. These circuits will be completed during the rotation of the brush arm 2056 during which the sensing fingers 2026 will go through these perforations. After contacts 2015 open, shortly after the beginning of this revolution, relays 2241 and 2242 will release and interrupt the locking circuit for relay 2119, thus permitting this relay to release. The release of relay 2119 interrupts the circuit of the start magnet 2008 and permits this relay to release and stop the transmitter at the end of the revolution of this transmitter during which the sensing fingers 2026 go through the perforations in the tape representing the letter Q signal.

The release of relays 2241 and 2242 interrupts the circuit through the lower winding of relay 2113 and permits this relay to operate to its right-hand position where it completes a circuit from ground through the bottom break contacts of relay 2115 over lead 1956, which extends through Fig. 20 to the contacts of key 1942, lead 2114, which extends through Fig. 20, to the contacts of relay 2113, the center left-hand break contacts of relay 2112, through the operated contacts of relays 2211, 2221, 2231, the break contacts of relay 2242 and operated contacts of relay 2254, over lead Q, through keys 2356 and 2316 to battery through the winding of relay 2420. Relay 2420 operates in this circuit and completes a circuit for maintaining itself operated under control of ground connected to the lower break contact of relay 2115 over lead 2114 described above. The operation of relay 2420 also completes a circuit for the operation of magnet 2016 from battery, through the winding of magnet 2016, over lead 2401 which extends through Figs. 21, 22 and 23, to ground through the center left-hand operated contacts of relay 2420. The operation of magnet 2016 interposes its armature 2019 in the path of extension 2128 of feed pawl 2018 and disengages this pawl from the feed ratchet 2020, thus preventing the advance of the tape 2021 as the brush arm 2025 nears the end of the revolution in progress during which the sensing fingers 2026 went through the perforations in tape 2021 representing the letter Q signal. Simultaneously with the operation of relay 2420, relays 6020 and 7920 are operated due to the simultaneous arrival of letter Q signals at the control point in the transmitters shown in Figs. 56 and 75. The operation of the circuits of these transmitters is similar to the operation of the circuit as described above and need not be repeated in detail.

The operation of relays 2420, 6020 and 7920

completes or partially completes circuits for the operation of relay 9323. The circuit for the operation of relay 9323 due to the operation of relay 7920 may be traced from battery through the left-hand winding of relay 9323 over lead 9351, which extends through Figs. 88 and 82, the upper inner operated contacts of relay 7618, the upper inner break contacts of relay 7616, over lead 7903, which extends through Figs. 77 and 78, through the right-hand inner operated contacts of relay 7920, over lead 3383, which extends through Figs. 79, 73, 65, 60, 51 and 42 to ground through the break contacts of relay 3320. The path for the operation of relay 9323 from the operated contacts of relay 2420 is similar to the path traced above for the first message for the operation of this relay except that the ground is now supplied through the break contacts of relay 3320 instead of 5120. However, the operation of relay 7018 interrupts this circuit at its upper break contacts.

A similar path may be traced through the operated contacts of relay 6020 for the operation of relay 9323 except for the fact that the operation of relay 7018 also interrupts this possible circuit at its upper break contacts.

The operation of relay 9323 and the operation of relay 7920 completes a circuit for the operation of relay 9317 from battery, through the winding of relay 9317, the operated contacts of relay 9323, lead 9361 which extends through Figs. 88 and 82, the lower operated contacts of relay 7618, lead 7635 which extends through Figs. 82 and 88, the upper break contacts of relay 9316, lead 7634, which extends through Figs. 88 and 82, the upper break contacts of relay 7616, lead 7903 which extends through Figs. 77 and 78, through the left-hand inner operated contacts of relay 7920, over lead 3383 which extends through Figs. 73, 65, 60, 51 and 42, to ground through the break contacts of relay 3320.

The operation of relay 9317 completes a circuit for maintaining itself operated from battery through its winding and lower operated contacts to ground over lead 9361 as described above. Relay 9317 in operating interrupts the circuit of relay 9321 permitting this relay to release and also completes a circuit for maintaining relay 7618 operated from battery through the winding of relay 7618 and its lower operated inner contacts, lead 9361 which extends through Figs. 82 and 88, through the operated contacts of relay 9323, the lower operated contacts of relay 9317, lead 9351 which extends through Figs. 88 and 82, the upper operated contacts of relay 7618, the upper inner break contacts of relay 7616, over lead 7903 which extends through Figs. 77 and 78, the right hand inner operated contacts of relay 7920, over lead 3383 which extends through Figs. 73, 65, 60, 51 and 42, to ground through the break contacts of relay 3320.

Relay 9317 in operating completes an obvious circuit for the operation of relay 9316. The operation of relay 9316, however, interrupts the operating circuits of relay 2118 and 5718, thus causing these relays to release. Consequently, only one of these relays, namely, 7618, will remain operated. It should be noted that the locking circuit of these relays and the other relays extend through the back contacts of relay 7618. Likewise, the locking circuit of relay 2118 extends through the back contacts of relay 5718. The locking circuit extends through the contacts of these relays which prevents double connections by assigning a definite order in which transmitters attempting to seize paths are enabled to seize and use the cross bar switch for establishing paths for their respective next messages. This is true regardless of whether the respective next messages of the transmitters are to be routed over the cross bar switch to the same or different outgoing lines. Thus, for example, the message from the transmitter shown in Fig. 75 uses the cross bar switch first under the assumed conditions. By suitably arranging the circuits through the break contacts of the various relays 2118, 3918, 5718, 7018, 7618, 8218 and 8818 any desired order of using the cross bar switch may be assigned to the various transmitters. As shown in the drawings, these transmitters are assigned use of the cross bar switch in the following order: 7618, 7018, 5718, 3918, 2118, 8218, and 8818.

The operation of relay 9316 completes a circuit for the operation of relay 9325 from battery, through the winding of relay 9325 and the upper operated contacts of relay 9316 to ground through the right-hand break contacts of relay 9321. Relay 9325, however, does not immediately operate because it is made slow in operating to allow sufficient time for the other relay, 2118 and 5718, to release. After a sufficiently long interval of time to insure that these relays have fully released, relay 9325 operates and in operating completes a circuit for maintaining relay 9316 operated. The operation of relay 9325 also completes a circuit for the operation of a selecting magnet 8001 from ground, through the inner operated contacts of relay 9325, upper operated contacts of relay 9316, over lead 9371 which extends through Figs. 88 and 82, the upper operated contacts of relay 7618, over lead 8002 which extends through Figs. 77, 78 and 79, to battery through the winding of the selector magnet 8001. The operation of the selector magnet 8001 completes a circuit from ground over lead 9373 which extends through Figs. 86, 92, 91, 90, 89 and 88, to battery through the winding of relay 9324. Relay 9324 operates due to current flowing in the above traced circuit, and completes a circuit for maintaining relay 9316 operated. Relay 9324 in operating completes a circuit for the operation of relay 3212 from ground, through the left-hand operated contacts of relay 9324, lead 9372 which extends through Figs. 88 and 82, the lower operated contacts of relay 7618, lead 7935 which extends through Figs. 77 and 78, the outer right-hand operated contacts of relay 7920, lead 2405 which extends through Figs. 73, 65, 60, 51, 42, and 33, through the upper break contacts of key 3221, the lower break contacts of relay 3201, to battery through the winding of relay 3212.

It should be noted that only one selector magnet 8001 was operated at this time because only relay 7618 is operated when relay 9325 operates, the other relays 2118 and 5718 having released prior to the operation of relay 9325.

The operation of relay 3212 completes a circuit for the operation of the cross-bar vertical magnet 9221 from ground, through the lower operated contacts of relay 3212, over lead 9222 which extends from Fig. 32 through Figs. 33, 34, 43, 52, 61, 66, 74, 80, 86 and 92, to battery through the winding of the hold magnet 9221. The operation of the hold magnet 9221 causes the cross-bar switch contacts 8046, 8047, 8048 and 8049 to operate. The operation of the hold magnet 9221 also completes a circuit for the operation of relay 3201 from battery, through the winding of relay 3201, over lead 9223 which extends through Figs. 33, 34, 43, 52, 61, 66, 74, 80, 86 and 92, the inner operated contacts of magnet 9221, lead 9228

which extends through Fig. 88, operated cross-bar contacts 8028, lead 7648 which extends through Figs. 79, 78 and 76, to ground through the upper break contacts of relay 7616. Relay 3201 in operating completes a circuit for maintaining itself operated from battery, through its winding and lower inner operated contact, over lead 9228 which extends through Figs. 33, 34, 43, 52, 61, 66, 74 and 80, the operated cross-bar contacts 8028, over lead 7648 which extends from Fig. 80 through Figs. 79, 78, 77 and 76, to ground through the upper break contacts of relay 7616. Relay 3201 in operating also connects a holding ground to lead 9222 for maintaining the holding magnet 9221 operated.

The operation of relay 3201 also completes a circuit for the operation of relay 7615 from battery, through the winding of relay 7615, over lead 7647 which extends through Figs. 77, 78, 79 and 80, the operated cross-bar contacts 8027, lead 9227 which extends through Figs. 74, 66, 61, 52, 43, 34, 33 and 32, to ground through the operated contacts of relay 3201. The operation of relay 7615 interrupts the operating and locking circuits of relay 7920, thus permitting this relay to release. The release of relay 7920 interrupts the locking circuit of relays, 3212 and 7618 and permits these relays to release. The release of relays 7920 and 7618 interrupts the operating circuit of relay 9323 and operating locking circuits of relay 9317, thus permitting these relays to release. The release of relay 7618 also interrupts the circuit of the cross-bar horizontal magnet 8001 and permits this magnet to release. The release of the selector magnet 8001 interrupts the circuit of relay 9324.

The release of relays 9323 and 9324 reestablishes a circuit through the winding of relay 9321, thus permitting this relay to operate and charge condenser 9326, thus preventing the alarm circuit from functioning. The circuit for the operation of relay 9321 at this time may be traced from ground through the left-hand break contacts of relay 9324, winding of relay 9321, the right-hand winding and break contacts of relay 9323, lead 9361 which extends through Figs. 88 and 82, the lower break contacts of relay 7618, lead 9362, the lower break contacts of relay 7018, lead 9363 which extends through Fig. 62, the lower break contacts of relay 5718, lead 9364 which extends through Fig. 48, the lower break contacts of relay 3918, lead 9365 which extends through Fig. 30, the lower break contacts of relay 2118, lead 9366 which extends through Figs. 30, 39, 48, 57, 62, 70 and 76, the lower break contacts of relay 8218, lead 9367, the lower break contacts of relay 8818, the upper break contacts of relay 8818, lead 9357, the upper break contacts of relay 8218, lead 9356 which extends through Figs. 76, 70, 62, 57, 48, 39, 30 and 21, the upper break contacts of relay 2118, lead 9355 which extends through Fig. 30, the upper break contacts of relay 3918, lead 9354 which extends through Fig. 48, the upper break contacts of relay 5718, lead 9353 which extends through Fig. 62, the upper break contacts of relay 7018, lead 9352, upper break contacts of relay 7618, lead 9351 which extends through Figs. 82 and 88, to battery through the left-hand winding of relay 9323. Thus the continuity of this chain circuit through the break contacts of all of these relays is checked, thus insuring that all of these relays are released. Upon the operation of relay 9321 the circuit of relay 9325 is interrupted, thus permitting this relay to release. The release of relay 9325 at this time interrupts the circuit of relay 9316 which in turn releases.

The release of relay 9316 at this time reestablishes the operating circuits for relays 2118 and 5718.

The reoperation of relay 5718 again completes a circuit for the operation of relay 9323 and interrupts the operating circuit of relay 9321. The operation of relay 9323 completes a circuit for operating relay 9317 and for maintaining relay 5718 operated. The operation of relay 9317 also completes a circuit for the operation of relay 9316. The operation of relay 9316 interrupts the operating circuits of relays 2118 and 5718. Relay 5718, however, is maintained operated in the circuit extending through the lower operated contacts of relay 9317 as described above. The locking circuit of relay 2118, however, is interrupted at the operated contacts of relay 5718. Consequently, this relay will again release. The operation of relay 9316 completes a circuit for the operation of relay 9325. Relay 9325, however, is slow in operating, so it does not immediately operate. After a short interval of time sufficiently long to insure that relay 2118 will release, relay 9325 operates and completes a circuit for the operation of the selector magnet 6101 from ground, through the inner operated contacts of relay 9325, the upper operated contacts of relay 9316, over lead 9371 which extends through Figs. 88, 82, 76, 70, 62 and 57, the operated contacts of relay 5718, over lead 6102 which extends through Figs. 58, 59 and 60, to battery through the winding of magnet 6101, thus causing the selector magnet to operate. It should be noted that since only the one relay, 5718, is operated at this time, only one of the selector magnets of the cross-bar switch will be operated.

The operation of this magnet completes a circuit for the operation of relay 9324 from ground, through the operated contacts of magnet 6101, over lead 9373 which extends through Figs. 61, 66, 74, 80, 86, 92, 91, 90, 89, 88 and 93, to battery through the winding or relay 9324. Relay 9324 in operating now completes a circuit for the operation of magnet 9231 from ground, through the left-hand operated contacts of relay 9324, over lead 9372 which extends through Figs. 88, 82, 76, 70, 62 and 57, the lower operated contacts of relay 5718, lead 6035 which extends through Figs. 58, 59 and 60, the outer right-hand operated contacts of relay 6020, over lead 2405 which extends through Figs. 51, 42, and 33, the upper break contacts of key 3221, the lower operated contacts of relay 3201, the lower break contacts of relay 3212, the upper break contacts of relay 3271, over lead 9232 which extends through Figs. 33, 34, 43, 52, 61, 66, 74, 80, 86 and 92, to battery through the winding of vertical cross-bar magnet 9231.

The operation of the vertical hold magnet 9231 of the cross-bar switch closes the cross-bar contacts 6136, 6137, 6138 and 6139. In addition, operation of the holding magnet 9231 completes a circuit for the operation of relay 3251 from battery, through the winding of relay 3251, over lead 9233 which extends through Figs. 33, 34, 43, 52, 61, 66, 74, 80, 86 and 92, through the inner operated contacts of the vertical magnet 9231, over lead 9238 which extends through Figs. 86, 80, 74, 66, 61, contacts 6138, lead 5748 which extends through Figs. 60, 59 and 57, to ground through the upper break contacts of relay 5716.

The operation of the hold magnet 9231 also completes a circuit for the operation of relay 3320 from battery, through the winding of relay 3320, lead 9225, the upper operated contacts of relay 3201 in parallel with the outer operated contacts of hold magnet 9221 over leads 9224 and 9225 which extend through Figs. 33, 34, 43, 52, 61, 66, 74, 80, 86, and 92, over lead 9235 which extends through Figs. 33, 34, 43, 52, 61, 66, 74, 80, 86 and 92, the outer operated contacts of vertical magnet 9231, lead 9234 which extends through Figs. 86, 80, 74, 66, 61, 52, 43, 34 and 33, to ground connected to the upper outer front contact of relay 3251. The operation of relay 3320 at this time causes the line circuit 201 to test busy should any further calls be directed to this line. The operation of this relay prevents the operation of any of the relays similar to 2118, including 3918, 5718, 7018, 7618, 8218 and 8818, if any of the associated transmitters have messages directed to and waiting for transmission to any station over line 201.

The operation of relay 3251 completes a circuit for maintaining the vertical magnet 9231 operated in a circuit extending from battery through the winding magnet 9231 over lead 9232 which extends through Figs. 86, 80, 74, 66, 61, 52, 43, 34, and 33 to ground through the inner upper operated contacts of relay 3251. The operation of relay 3251 also completes a circuit for the operation of relay 5715 from battery, through the winding of relay 5715, over lead 5747 which extends through Figs. 58, 59, and 60, the operated cross-bar contacts 6137, lead 9237 which extends through Figs. 51, 43, 34, 33 and 32, to ground through the lower operated contacts of relay 3251. The operation of relay 5715 interrupts the operating circuit of relay 6020, thus permitting this relay to release. The release of relay 6020 in turn causes relay 5718 to release. The release of relay 5718 causes relays 9323 and 9317 to release. The release of relays 9323 and 9317 reestablishes the chain circuit through the winding of relay 9321 as described above and upon the completion of this chain circuit relay 9321 operates and interrupts the circuit of relay. 9325. Relay 9325 releases and interrupts the circuit of the horizontal selector magnet 6101, which magnet in turn releases and interrupts the circuit of relay 9324 over lead 9373. The release of relay 9324 interrupts the operating circuit of relay 9316. Relay 9316 releases at this time but it does not reestablish the operating circuit of relay 2118 because relay 3320 operated as described above. Until relay 3320 releases, therefore, the message from the transmitter shown in Fig. 20 cannot be transmitted to the line equipment associated with line 201. It is necessary for this transmitter to wait until one channel of this line equipment becomes conditioned to receive a message which is indicated by the release of relay 3320.

When either of the messages are completely transmitted either relay 3201 or 3251 and the respective hold magnets 9221 or 9231 will release and the release of either of these relays and respective magnets will interrupt the circuit of relay 3320, thus permitting this relay to release and complete a circuit for the operation of relay 5718, whereupon the message stored in the tape controlling transmitter as shown in Fig. 20 will be connected to one or the other channel of the outgoing line circuit connected to the receiving channel of full duplex line 201. The operation of the circuits under these conditions are substantially the same as described above so that their detailed operation will not be repeated here.

Returning now to the operation of the outgoing line circuits associated with the full duplex line 201, it will be recalled that upon the operation of relay 3201 and relay 7615, as described above, the transmitting circuits shown in Figs. 75 and 76 and the first channel of the outgoing line circuits shown in Figs. 30, 31, 32 and 33 will be conditioned so that the message stored in the tape 7521 controlling transmitter shown in Fig. 75 will be transmitted to the printing reperforator 3102 where it will be recorded by it in tape 3127. Similarly, upon the operation of relays 3251 and 5715, the circuits of the transmitter shown in Fig. 56 and of the outgoing line circuit shown in Figs. 30, 31, 32 and 33 will be conditioned to transmit and receive the second message. The printing reperforator 3151 will record this second message in tape 3177, both by perforating the tape in accordance with the signals received and printing the corresponding characters upon the tape.

Assuming that the message from the transmitter shown in Fig. 75 will start to transmit first, when the tape 3127 is perforated by the perforator 3102 in response to the signals transmitted by the transmitter shown in Fig. 95, this will cause an additional supply of perforated tape and cause contacts 3113 to close. Upon the closure of these contacts, a circuit is completed for the operation of the transmitter start magnet 3117 which causes the transmitter to automatically advance tape 3127 through the transmitter as long as letters signals are perforated in the tape 3127. Letters signals will usually have been previously perforated after a message has been recorded in the tape and the tape has become taut as under assumed conditions.

When the Q signal arrives over the control point in the tape control transmitter 3101, it will permit relay 3008 to release because relay 3004 will not be operated by the Q signal. The release of relay 3008 interrupts the circuit of the transmitting start magnet 3117 and allows this magnet to release so that it will stop transmitter 3101 at the end of the revolution then in progress. The release of relay 3008 also completes the circuit for the operation of magnet 3103 from ground through the inner right-hand operated contacts of relay 3007, the left-hand inner break contacts of relay 3008 to battery through the winding of magnet 3103. The operation of magnet 3103 prevents the advance of the tape 3127 near the completion of the revolution of the transmitter brush arm 3112 so that the letter Q signal remains above the sensing fingers of the transmitter 3101.

The release of relay 3008 under the assumed conditions completes a circuit for the operation of relay 3214 from battery through the winding of relay 3214, the upper break contacts of relay 3215, the center operated contacts of relay 3219, the right-hand outer break contacts of relay 3008, the lower contacts of key 3115, lead 3030 which extends through Fig. 32, the lower inner break contacts of relay 3303 to ground through the lower break contacts of relay 3301.

The operation of relay 3214 completes a circuit for the operation of relay 3215. The operation of relay 3215 first completes a circuit for maintaining relay 3214 operated from battery through the winding and upper operated contacts of relay

3214, the upper operated contacts of relay 3215 to ground through the lower break contacts of relay 3301. Relay 3215 in operating, also completes a circuit for the operation of relay 3264 from ground through the lower break contacts of relay 3265 and the lower operated contacts of relay 3215 to battery through the winding of relay 3264.

The operation of relay 3264 completes a circuit for the operation of relay 3217 from ground through the operated contacts of relay 3764, the lower inner operated contacts of relay 3214, the right-hand break contacts of relay 3216 to battery through the winding of relay 3217.

The operation of relay 3217 interrupts the locking circuit of relay 3007 and permits this relay to release, thus interrupting the circuit of magnet 3103 which releases and permits the transmitter 3101 to advance the tape through it in a normal manner when it is started into operation. The operation of relay 3217 completes a circuit for maintaining itself operated under control of relay 3216. The operation of relay 3217 also completes a circuit for the operation of relay 3303. The operation of relay 3303 interrupts the locking circuit of relay 3214 and causes this relay to release which in turn causes relays 3215 and 3264 to release. The operation of relay 3217 also completes a circuit for the operation of relay 3301 and the operation of relay 3301 completes a circuit for the operation of relay 3302. The operation of relay 3301 also completes a circuit for lighting the busy lamp 2840 over lead 3304 which extends through Figs. 32, 31, 30 and 29, thus indicating to the operator that the receiving channel of the full duplex party line 201 is busy.

The operation of relay 3217 also completes a circuit for the operation of the transmitter start magnet 3117 and thus releases the distributor of transmitter 3101 for operation. The operation of relay 3217 removes the short circuit from around the contacts of relay 3001 which permits this relay to repeat the signals from transmitter 3101 over the receiving channel of the full duplex party line 201. The operation of relay 3217 also conditions the monitoring relays 3002, 3003, 3004 and 3005 so that these relays will properly follow the signals transmitted by the transmitter 3101. These circuits remain in this condition during the transmission of the message to the outlying station over the receiving channel of the party line 201.

In the meantime, the message from the transmitter shown in Fig. 56 has been transmitted to and received by the printing reperforator 3152. The printing reperforator 3152 has printed the message upon tape 3177 and perforated this tape in accordance with the message signals. The additional supply of perforated tape will cause contacts 3163 to close which, in turn, will cause the transmitter 3151 to automatically advance the tape 3177 as long as letters signals perforated in the tape pass under the control fingers of the transmitter 3151. The circuits for causing this automatic advance of the tape operate in the same manner as described above so that their detailed operation need not be repeated. When the letter Q signal arrives over the control point of this transmitter, relay 3058 will release when contacts 3160 open. The release of relay 3058 at this time interrupts the operating circuit of the transmitter start magnet 3167 which will cause the transmitter 3151 to stop at the end of the revolutions of the brush arm 3162 then in progress during which the sensing fingers sense the letter Q perforated in tape 3177. The release of relay 3058 also completes the circuit for the operation of magnet 3153 which will prevent the advance of the tape 3177 when near the completion of the revolutions of the brush arm 3162 during which the sensing fingers sense the letter Q perforated in the tape 3177.

Under these circumstances, however, the release of relay 3058 will not complete a circuit for the operation of relay 3265 because relay 3301 is maintained operated due to the operation of relay 3217. During the remainder of the transmission of the message from the transmitter 3101, the circuits remain in the condition described. It should be noted, however, that the operation of relay 3301 interrupted the locking circuit of relay 3214, thus permitting this relay to release. The release of relay 3214, in turn, causes the release of relays 3215 and 3264.

As described above, in response to the figures signal followed by an H signal at the end of the message being transmitted by transmitter 3101, relay 3005 will momentarily operate its armature to its left-hand position and complete a circuit for the operation of relay 3006. Relay 3006, in operating, completes a circuit for maintaining itself operated under control of the spacing relay 3003 and letters relay 3004. The operation of relay 3006 also conditions relay 3002 so that it will respond to the following H signal should this signal be perforated in the tape. The operation of relay 3002 in response to the H signal interrupts the circuit through the start magnet 3117 which will cause the transmitter 3101 to stop at the end of the transmission of the H signal. The operation of relay 3002 also completes a circuit over lead 3015 which extends through Fig. 31 for the operation of relay 3218. Relay 3218, in operating, completes a circuit for maintaining itself operated under control of relay 3217. Then when the brush arm 3112 approaches the end of the revolutions during which the H signal is transmitted, contacts 3110 close and complete a circuit for the operation of relay 3216.

The operation of relay 3216 interrupts the locking circuit of relay 3217, thus permitting this relay to release. The operation of relay 3216 also completes the circuit for the operation of relay 3008, which relay, in turn, locks operated.

The release of relay 3217 short-circuits the contacts of relay 3001 so that this relay is unable to repeat signals over the receiving channel of the full duplex party line 201. The release of relay 3217 also prepares a circuit for the automatic advance of the letters signals stored in tape 3127. The release of relay 3217 also interrupts the operating circuit of relay 3301, which relay, in turn releases. The release of relay 3217 also interrupts the operating circuit of relay 3303. Relay 3303, however, does not release at this time because it is maintained operated under control of the right-hand center break contact of relay 3267, which relay has not as yet operated. Consequently, relay 3303 will remain operated at this time.

The release of relay 3301 also interrupts the operating circuit of relay 3302. Relay 3302, however, is a slow-release relay and does not immediately release.

The release of relay 3301 also completes a circuit for the operation of relay 3265 from battery through the winding of relay 3265, the lower break contacts of relay 3215, the center left-hand operating contacts of relay 3269, the right-hand outer

break contacts of relay 3058, the lower break contacts of key 3165, through the lower inner operated contacts of relay 3303 to ground through the lower break contacts of relay 3301. Relay 3265 is made sufficiently fast in operating and relay 3302 sufficiently slow in releasing so that relay 3265 will operate and lock operated and cause the operation of relay 3215 before relay 3302 releases. This arrangement prevents the reoperation of relay 3214 should its circuit otherwise be completed due to the fact that at least the beginning of the message from the transmitter shown in Fig. 20 may have been transmitted to and recorded in the tape 3127 at this time. As pointed out above, the operation of relay 3265 causes the operation of relay 3215, which relay, in turn, first completes a circuit for maintaining relay 3265 operated and then interrupts the operating circuit of this relay. The operation of relay 3215 also completes a circuit for the operation of relay 3264. The operation of relay 3264 then completes a circuit for the operation of relay 3267. The operation of relay 3267 interrupts the locking circuit of relay 3303 and permits this relay to release. The operation of relay 3267 completes a circuit for the operation of relay 3301, which relay, in turn, causes the operation of relay 3302. The operation of relay 3301 again completes the circuit of busy lamp 2840 to indicate to the operator that the receiving channel of the full duplex party line 201 is busy. The operation of relay 3301 also interrupts the locking circuit of relay 3265, thus permitting this relay to release which, in turn, causes the release of relays 3215 and 3264.

The operation of relay 3267 completes a circuit for maintaining itself operated under control of relay 3266. The operation of relay 3267 also conditions the monitoring relays 3052, 3053, 3054, and 3055 for monitoring signals transmitted by the tape control transmitter 3151. The operation of relay 3267 also interrupts the short circuit around the contacts of relay 3051 and completes a circuit for the operation of the transmitter start magnet 3167, thus permitting this transmitter to start and transmit the message stored in tape 3177 over the receiving channel of the party line 201. Thereafter the circuits remain substantially in this condition until this message has been fully transmitted over the receiving channel.

At the end of the message transmitted from the transmitter 3151, relay 3055 will respond to the figures signal by removing its armature to its left-hand position where it completes a circuit for the operation of relay 3056. Relay 3056, in operating, completes a circuit for maintaining itself, operated under control of relay 3053 and 3054. Relay 3056, in operating, also conditions relay 3052 for responding to the H signal. Relay 3052 responds to the following H signal by moving its armature to its left-hand position. In moving to the left-hand position, the armature of relay 3052 interrupts the operating circuit of magnet 3167 and thus permits this magnet to release. The release of magnet 3167 causes the transmitter 3151 to stop at the end of the transmission of the H signal. The operation of relay 3052 completes a circuit for the operation of relay 3268, which relay locks operated under control of relay 3267. As the transmission of the H signal nears completion, the cam 3159 will cause contacts 3160 to close and complete a circuit for the operation of relay 3266. The operation of relay 3266 interrupts the locking circuit of relay 3267 and permits this relay to release. The operation of relay 3266 also completes a circuit for the operation of relay 3058, which relay, in turn, locks operated. The release of relay 3267 prepares a circuit for the automatic advance of tape 3177 as long as letters signals are perforated in the tape following the figures signal as described above. The release of relay 3267 also interrupts the operating circuit of relay 3301 and permits this relay to release. The release of relay 3301 interrupts the operating circuit of relay 3302 and permits this relay to release. Relay 3302, however, is slow in releasing and does not immediately release.

Under the assumed conditions with the messages waiting in tape 3127 for transmission, a circuit is completed upon the release of relay 3301 for the operation of relay 3214 as described above. Thereafter the circuit operates as described above and transmits the next message stored in tape 3127. As long as messages are received by and continue to be stored in the tapes 3127 and 3177 the messages will be transmitted alternately from these tapes over the receiving channel of the line 201.

In case the third message, that is, the message from the transmitter shown in Fig. 20, has been received by the reperforator 3152 and no other message had been received by reperforator 3102 by the time the second message, that is, the message from the transmitter shown in Fig. 56, has been transmitted by the transmitter 3151, then upon the release of relay 3301 and after the release of relay 3302 a circuit will be completed for again operating relay 3265 from battery through the winding of relay 3265, the lower break contacts of relay 3215, the center left-hand operated contacts of relay 3269, the right-hand break contacts of relay 3058, the lower break contacts of key 3165, lower break contacts of relay 3303 to ground through the break contacts of relay 3302. The operation of relay 3265 again starts the above cycle of operation of the second channel of the outgoing line circuit so that this message will be transmitted over the receiving channel of line 201 to the outlying station.

In case all of the messages have been received by the reperforator 3102, then at the end of the transmission of each message over the outgoing line circuit relay 3214 would be reoperated upon the release of relay 3302 in a manner similar to the reoperation of relay 3265 as described above. This operation of the circuits will cause each of the messages to be transmitted in turn over the receiving channel of the outgoing line circuit.

Provision is also made for preventing improper operation of the circuits in case the directing signal arrives over the control channels of both transmitters 3101 and 3151 simultaneously and causes the simultaneous operation of relays 3214 and 3265. Assuming that both of these relays do simultaneously operate, the operation of either relay completes a circuit for the operation of relay 3215. The operation of relay 3215 completes locking circuits for both of these relays and then interrupts their operating circuits. However, the locking circuit of relay 3265 is interrupted at the upper break contacts of relay 3214 which are operated at this time. Consequently, when relay 3215 operates and interrupts the operating circuit of relay 3265, this relay will release and only relay 3214 remain locked operated. After relay 3265 has released, a circuit will be completed for the operation of relay 3264. This insures that only one of the relays 3214 or 3265 will be operated when relay 3264 later operates and causes

the operation of either relay 3217 or 3267. Thus it is impossible for both relays 3217 and 3267 to operate.

Thus the circuits are so arranged that as long as messages are perforated in both tapes 3127 and 3177, the messages will be transmitted over the receiving channel of the party line first from one tape and then from the other. When messages are stored in only one of these tapes, messages from this tape will be transmitted in succession to the outlying stations. If, however, a message is in the meantime received and stored in the other tape, it will be transmitted following the message then in progress of transmission from the first tape.

It is to be noted that, should the tape become taut, during the transmission of the message over the receiving channel after it has been completely recorded in the tape, that is, after a figures and an H signal have been received by the typing reperforator recording the message, the typing reperforator will be caused to automatically reperforate letters signals in the tape to enable the transmitter to fully transmit the complete message over the outgoing line circuit and then cease operating so that any messages stored in the other tape may be then transmitted without waiting for the reception of another message. The detailed circuit operations which cause the printing reperforators to automatically perforate letters signals in the tape under this set of circumstances has been described.

Consider now the messages transmitted over the receiving channel of the party line 201. Each of the receiving relays 2622 and 2722 of the control selectors connected to the line respond to all of the signals transmitted over the line. These receiving relays repeat the signals to the respective selector magnets 2623 and 2723, which magnets, in turn, control selectors. It should be noted that the upper windings of repeating relays 2671, 2681, 2691 and 2771 are connected to the receiving channel of this line. For the sake of simplicity, this receiving channel is shown as a full metallic series circuit. However, any suitable type of transmission circuit may be employed and it may include any necessary repeaters and other apparatus usually employed in telegraph transmission lines and systems. Normally repeating relays 2671, 2681, 2691 and 2771 are maintained in the position shown in the drawing by current flowing through their lower windings. These relays are maintained in this position independently of the current flowing the receiving channel of the party line. Consequently, these relays do not normally respond to signals transmitted over these lines.

The control selector is provided with a number of contacts which are actuated by a selecting mechanism in response to the reception of certain specific code combinations, as described above. The selectors are also provided with other contacts which close once for each code combination independent of the character of the code combination.

When the Q signal, as described above, is transmitted over the receiving channel, the selector magnets 2623 and 2723 respond to it and cause the contacts 2619 and 2719 to close. The closure of contacts 2719 completes a circuit for the operation of relay 2799 from ground through the right-hand outer break contacts of relay 2729 through the operated contacts 2719 and right-hand outer break contacts of relay 2770 to battery through the winding of relay 2799. Relay 2799, in operating, completes a circuit for maintaining itself operated through its winding and right-hand operated contacts to ground through contacts 2721.

Relay 2799 also interrupts a circuit through the contacts 2717 and thus prevents the operation of relay 2770 which prevents the conditioning of relay 2771 for repeating signals. Consequently, relay 2771 is maintained in the position shown where it maintains the receiving equipment at the associated station in the idle condition.

Contacts 2619 are also momentarily closed by the Q signal when it is received by the selector magnet 2623. Momentary closure of these contacts completes a circuit for the operation of relay 2680 from battery through the winding of relay 2680, the inner right-hand break contact of relay 2670 and the center right-hand break contact of relay 2690 through the momentarily operated contacts 2619 through the left-hand break contacts of relay 2699 to ground through the right-hand outer break contacts of relay 2629. Relay 2680, in operating, completes a circuit for maintaining itself operated from battery through its winding and right-hand inner operated contacts to ground. The operation of relay 2680 also interrupts the operating circuits of relay 2670 and 2690 and thus prevents the operation of these relays in response to the reception of any other signals received by the selector magnet 2623. The operation of relay 2680 also completes a circuit for lighting lamp 2682 which will indicate to the attendant that the receiving equipment associated with station Q has been selected and is receiving the messages transmitted over the receiving channel of the party line 201. The operation of relay 2680 also conditions the repeating relay 2681 so that it will repeat the signals received over the receiving channel. This is accomplished by connecting negative battery to left-hand terminal of the lower winding of relay 2681 in place of the positive battery previously connected thereto. When negative battery is connected to the lower winding of relay 2681, it tends to cause the armature of this relay to operate to its left-hand position. The effect of this current, however, is normally overcome by the effect of the line current flowing through the upper winding of this relay. Consequently, as long as the line current flows through the upper winding of the relay, the relay is maintained in the position shown. However, when the line current is interrupted, current flowing through the lower winding of the relay due to the application of negative battery thereto causes its armature to move to its right-hand position and thus repeat the signal impulse to the receiving equipment at the station represented by the letter Q. The circuits are then maintained in this condition as long as this message is being transmitted.

During the transmission of the message to this or any other station, the operation of a transmitter start circuit may be initiated either automatically, or manually by the operator, as described above. In either event, transmitter start circuit first interrupts the transmission at the end of the code combination then being transmitted and transmits the transmitter start pattern comprising a blank signal, a pause, the R signal, another pause, the selecting signal for selectively testing and starting a conditioned transmitter followed by another pause, after

which the transmission of the message is resumed.

The selecting equipment at the control centers responds to the blank signal by causing the blank contacts to close, as described above. The receiving equipment at station Q will disregard this blank signal. That is, it will not record this signal by printing any symbol representing it and will not perform any of the usual functions, such as line feed, carriage return, shift, or unshift and so forth.

As described above, if the pause (mark) does not occur, in consequence of which signals immediately follow the blank signal, the effect of the blank signal is canceled due to the operation of the universal contacts of the selector mechanism at the respective stations or control points. These additional signals will be recorded at the station receiving the message and nothing else will happen as a result of the interposed blank signal.

However, as indicated above, if a blank signal is transmitted from the transmitter start circuit, a pause of predetermined minimum length will follow it. Near the end of this pause the control circuits at the various control centers will cause any associated receiving equipment controlled from that point to be disassociated from the party line. Thereafter, when the remaining portion of the start pattern is received at the respective control points it will actuate the selectors thereat, but these additional signals will not be repeated to the receiving instruments controlled by them. After the transmitter start pattern has been fully received, previously established circuits from each of the control points to recording instruments controlled thereby will be reestablished prior to the time the transmitter start circuit permits transmission of the interrupted message to be resumed.

Thus, the operation of the transmitter start circuit causes the transmission of the message to be interrupted and control code combinations transmitted over the channel and the transmission of the interrupted message resumed without causing loss, addition, or mutilation of any characters of a message in the progress of transmission at the time of the initiation of the operation of the transmitter start circuit.

At the completion of the transmission of the message, the figures signal followed by an H signal is transmitted over the receiving channel. When the figures signal is received by the selecting magnets **2623** and **2723** they cause the respective selecting apparatus to open contacts **2641** and **2741** respectively. These contacts are controlled by a member similar to the platen member as described in the above identified patents to Battie et al., and remain open until either a letter or a spacing signal is received by the magnets **2623** and **2723**. When the H signal is received by magnets **2623** and **2723** they cause the respective selectors to momentarily open contacts **2621** and **2721** respectively. The momentary opening of contacts **2621** when contacts **2641** are also open interrupts a locking circuit of relay **2680** and permits this relay to release. The release of this relay restores the circuits shown in Fig. 26 to their normal condition at which time they are ready for the reception of another directing signal for establishing a connection to any desired one of the receiving apparatus associated with this party line. It should be noted that the release of relay **2680** disconnects negative battery from the lower winding of relay **2681** and connects positive battery thereto which tends to hold this relay in its left-hand position independently of the line current flowing in the receiving channel of the party line **201**.

The momentary opening of contacts **2721** when contacts **2741** are also open interrupts the locking circuit of relay **2799** and thus permits this relay to release and reconnect ground to the switching contacts **2717**, thus rendering the circuit shown in Fig. 27 ready for the reception of the switching character which will operate one of the contacts **2717**, **2718**, **2719** or **2720** and cause the desired receiving equipment to be associated with the receiving channel of the party line **201**.

As shown in Fig. 63 the transmitters **6301** and **6351** are not provided with a tape feed with hold magnet corresponding to magnets **1203** and **1253** of transmitters **1201** and **1251**. These magnets are not required for the transmitters which transmit to line **203** because it is not necessary to transmit switching signals over this line since only one station is connected to this line. However, these transmitters may be provided with such a magnet and the related circuits so that it would operate in the same manner as the other transmitters or the circuit of the magnet may be left open or its armature blocked non-operated as would be obvious to a person skilled in the art.

The interception of messages

The circuits and equipment at the central station have been arranged to provide for intercepting messages to any of the stations connected to the system. Provision has been made to intercept messages to any individual station, or stations, independently of the line to which the stations are connected or associated with. Thus, a message for a station on a party line may be intercepted at the central station while messages for all of the other stations on the same party line are transmitted over the line to the proper station. The terminals of the unassigned code combinations in each of the directors are all connected together and connected to one or the other of the routing relays which direct calls to the intercept positions. In the specific embodiment of the invention shown in the drawings the terminals corresponding to the codes representing T, carriage return, O, space, M, line feed, V, P, S, Y, X, D, and W are all strapped together because they correspond to the respective unassigned message directing characters. These conductors are then connected to one of the relays which route messages to one or the other of the intercept positions or machines. In the specific embodiment of this invention shown in the drawing conductor **2310** which connects these terminals together is shown connected to the winding of relay **2460**. Consequently, messages preceded by any of the above-mentioned unassigned code directing characters will be automatically routed to the No. 2 intercept machine. These messages could equally well be routed to the No. 1 intercept machine by connecting lead **2310** to the winding of relay **2450**. It is also within the scope of this invention to connect the leads in the other directors corresponding to lead **2310** so that part of the messages will be directed to one of the intercept circuits and another portion of the messages to another of the intercept circuits. Thus the circuits have been arranged so that if a message is improperly addressed or directed by transmitting a character preceding it which has not been assigned to any station, this

message will be automatically routed to an intercept position where it is recorded by printing on a tape and perforations in the tape. An attendant at the central station can then read the tape and, if possible, determine the proper station for which the message was intended, after which the operator may supply the proper directing signals by splicing the tape and then allow the message to proceed or the operator may retransmit the message from a local keyboard perforator 413 or 438 to the desired station. As shown in the drawings, two intercept positions are provided. In addition, each of the director circuits associated with the tape controlled transmitters at the central station shown in Figs. 20, 38, 56, 69, 75, 81 and 87 are each provided with a plurality of keys. Each of these director circuits is provided with two keys for each station of the system. By operating one of the keys a message directed to a corresponding station is directed to the first intercept position instead of to the station, and by operating the second key the message is directed to the second intercept position. Of course, as many intercept circuits may be provided as desirable or necessary without departing from this invention. In addition a single key may be provided for each station and these keys control the necessary relays to properly condition the switching circuits.

For example, assume that it is desirable to intercept the messages intended for the station Q on any given day or time. This being the case, if it is desired to direct these messages intended for station designated by the letter Q to the No. 2 intercept position the key 2316 will be operated in the first director circuit while keys 4116, 5916, 7216, 7816, 8416 and 9016 will all be operated in the other director circuits. When these keys are all operated, all messages preceded by the letter Q signal will be directed to the No. 2 intercept position. In the case of such messages switched by the first director circuit, i. e., the director circuit shown in Figs. 20, 21, 22, 23 and 24, the director will cause relay 2460 instead of relay 2420 to operate. That is, the first director will cause relay 2460 to operate instead of relay 2420. In a similar manner, the second director will cause relay 4260 to operate instead of relay 4220. The operation of relay 2460, for example, causes the transmitter shown in Fig. 20 to be connected to the printing reperforator 8752 which receives the message and records it in tape 8777. The operation of the circuits of the other directors are substantially the same as described above. However the intercept circuits are much simpler than the outgoing line circuits to which the messages are momentarily directed. Only one choice is provided, that is, messages either directed to the No. 1 or the No. 2 intercept position. If that intercept is busy, the message must wait until it becomes idle even though the other intercept circuit may be idle at that time. Furthermore, the second intercept position is not provided with any automatic transmitting apparatus.

It is to be understood however that the intercept circuits may be equipped with the same apparatus as the outgoing line circuits and that certain of the outgoing line circuits may be provided only with equipment similar to the intercept circuits. In addition, the intercept reperforator may function as a receiving portion of a station and be located at a distance from the switching station.

All the messages received by the printing reperforator 8752 are stored in tape 8777. It is then necessary for the operator at the central switching station to examine this tape and if the messages are all properly recorded therein and preceded by the proper switching or directing characters the operator will insert it either in one of the tape transmitters shown in Figs. 75 or 81 or else the tape transmitter shown in Fig. 87. It is of course, possible for the operator to insert this tape in any of the other tape control transmitters which receive messages from, or transmit messages directly to, outlying stations. However, to do this would normally delay the messages received from the outlying station. Consequently, the operator will normally insert the tape in one of the transmitters referred to.

It is also possible for the operator to direct these messages to the No. 1 intercept position by operating key 2356 instead of key 2316. The operator would likewise operate the corresponding keys of all the other directors if it is desired to direct all of the other messages intended for station Q to the same intercept position.

It is, of course, possible to throw keys corresponding to key 2316 in part of the director circuits and keys corresponding to key 2356 in the remainder of the director circuits so that part of the messages intended for station Q will be directed to each of the intercept circuits.

The operation of key 2356 causes the director to operate relay 2450 in response to the letter Q signal preceding the message. This directs the message to the first intercept circuit. The operation of the circuits is substantially the same as described above with reference to the directing of a message to any of the other outgoing line circuits except that the outgoing circuit in this case is much simpler than the outgoing line circuits. Relays 92102 and 92103 perform the same functions as relays 1301 and 1351 of the first outgoing line circuit. These relays are operated when a connection is established to the first or second intercept circuit, respectively, and serve to condition the receiving reperforators of these intercept circuits for the reception of the message. They also cause the operation of the crossbar vertical magnets 9281 and 9291 when the respective first or second intercept positions are seized. In addition, they cause the operation of the respective make-busy relays 9115 and 9125 which prevents any other message from being directed to the respective intercept circuits during the time these circuits are busy receiving a previous message.

Assume the operator at the central switching station has key 8724 of the transmitter associated with the first intercept circuit open. This will prevent the operation of the tape control transmitter associated with the first intercept circuit so that the operator will have an opportunity to examine the tape to determine if the message was preceded by the proper switching characters. It should be noted that all of the unused leads extending from the first director circuit to which ground is connected by the director in response to specific code combinations and which are not assigned to one of the outlying stations are all connected to the winding of relay 2460. The corresponding leads of the other directors are similarly connected to corresponding relays of these other directors. Consequently, all of these messages will be directed to the second intercept circuit and recorded in tape 8727. This intercept circuit is not shown provided with an automatic tape control transmitter because the operator

must examine the message and usually correct it. If an automatic transmitter is provided for the transmission of messages from the intercept circuit, the operator, after the message has been corrected, may close the key **8724** and cause the message to be automatically transmitted to the proper station. The operation of the automatic transmitter shown in Fig. 87 and its associated director circuits shown in Figs. 88, 89, 90, 91 and 92 is similar to the operation of the circuits of the other director circuits which have been described in detail hereinbefore. Consequently, it is not necessary to describe the operation of this director circuit in detail, it being understood that it operates in an analogous manner.

As shown in the drawings the messages preceded by improper or mutilated directing signals, that is, directing signals which are not assigned to any of the stations of the system will be routed to the No. 2 intercept circuit, which intercept circuit is not provided with an automatic transmitter. As pointed out herein, this circuit may also be provided with an automatic transmitter and associated switching equipment. However, since the messages which are improperly addressed would not be properly transmitted to their destination but would come right back to the same or another one of the intercept circuits; and since messages which are improperly addressed and messages which for some reason or other are not properly directed through the system automatically will require the attention of an operator before they can be properly retransmitted through the system, it has not been thought necessary to provide an automatic transmitter and switching equipment for retransmitting the messages directed to this intercept position. In the case where messages are properly addressed and would be properly directed through the switching equipment to the station of address except for the fact that some one or more of the intercept keys have been operated causing the message to be directed to the intercept position, these messages do not require the assistance of an operator and may be transmitted by means of an automatic transmitter and associated switching equipment. Properly addressed messages may be directed to the intercept position for a number of reasons, as for example, due to the fact that their stations of address are not operating or unattended at certain particular times during the day, due to the fact that certain of the stations are not operating or unattended on some days, or due to the fact that the hours of business at various stations of the system are not all the same. For any of these or other reasons the operator may operate the key associated with the respective intercept circuit so that during these times during which it is desired to intercept the messages for any given station or stations the messages directed to any of these stations will be accumulated by the intercept circuit. At a later time the operator will then operate the keys in the proper manner to cause these messages to automatically be transmitted to their stations of address.

A convenient method of operating the apparatus disclosed herein is to employ the intercept circuits as a means for relieving congestion of traffic directed to any particular line. For example, if some line becomes heavily overloaded so that the two recording devices associated with the line are incapable of handling all of the business, messages directed to other lines are received after messages directed to the overloaded line will be delayed. In order to reduce the delay of the messages directed to other lines the operator can operate the various intercept keys so that messages directed to certain of the stations of the overloaded line will be directed to either or both of the intercept positions, or the operator may direct messages received from certain lines which are directed to the overloaded line to the intercept position or positions as the case may be or the operator may operate some of the keys according to the first plan and other keys according to the second plan. In any case the operator need not operate the key associated with the intercept position to cause the messages to be accumulated. Instead, she will operate the keys associated with the director individual to the intercept circuit such as intercept circuit No. 1 so that the messages will be transmitted to that line as soon as either one of the reperforator devices assigned to that line become idle. It should be noted, however, that these intercept circuits are assigned the last position on the sequence circuit in using the cross-bar switch. Consequently, so long as any other director has messages directed to the overloaded line the messages directed to the intercept circuit will accumulate. However, as soon as a lull in transmission of messages to the overloaded line occurs the messages accumulated in the intercept circuit will be automatically directed to one or the other of the reperforator devices individual to the overloaded line. It is to be understood, of course, that, if desired, the messages may be directed to either of the intercept circuits.

Messages which are intended for transmission over other types of systems, as, for example, messages which may be transmitted over national networks or local circuits may be directed to either intercept circuit. Inasmuch as these messages require the attention of an operator they will usually be directed to the No. 2 intercept circuit, as illustrated in the drawings. Thereafter, the operator may take the message and physically or manually transport it to a suitable transmitting point in the other system or circuit. In other words, it is desirable to segregate messages which require the attention of an operator and those which do not require the attention of an operator, as pointed out above. Above typical examples of uses of the intercept circuits are not in any way intended to be exhaustive, but are intended merely to show a few of the more typical and more common manipulative procedures in using these circuits.

Alarm and other features of the system

Provision has been made to enable the operator at the central switching station to employ as intercept machines certain of the receiving reperforators associated with the second channel of outgoing lines which are normally not heavily loaded. For example, in the case of line **203** to which only one station is connected, during most of the time a single channel in the outgoing line circuit will be sufficient to handle all of the traffic through the switching equipment at the central station. If for any reason trouble develops in one of the printing reperforator machines, the machine in trouble may be replaced by the machine in the No. 2 intercept position. In addition, under these circumstances key **6490** may also be operated. This causes the operation of relay **6491** which disconnects the printing re-

perforator on the second channel of the outgoing line circuit associated with line 203 from this line and connects it to the cross-bar switch in such a way that messages intended for the No. 2 intercept position will be received by this printing reperforator. The operation of this relay also switches certain circuits so that the line will test busy and relay 7320 operated during the transmission of any message to the first channel of this outgoing line circuit shown in Fig. 64. This means that as long as the first channel is busy receiving the message intended for this line no other messages intended for this line can be transmitted through the switching equipment at the central station. The operation of relay 6491 also interrupts the operating and locking circuit of relay 6454, thus preventing this relay from operating and causing the printing reperforator from automatically perforating the tape during this time.

In order to enable the operator or attendant and maintenance force to readily control the switching equipment and various apparatus, a number of keys and lamps are provided. A number of these are located on a panel on the cabinet containing the different pieces of equipment. Box 1970 shows a lamp and the keys located on the cabinets containing the incoming reperforators.

Each of the tape supply reels for the various reperforators is provided with a contact device which causes the contact to close and light a lamp in case the supply of tape for the respective machines becomes low or exhausted, thus indicating to the attendant that it is necessary to provide an additional supply of tape for the respective printing reperforators. For example, if the supply of tape on reel 1218 becomes low or exhausted contacts 1220 will close and complete a circuit for lighting lamp 1221 and operating relay 9314 in a circuit from ground through operated contacts 1220, lamp 1221, over lead 9390 which extends to Fig. 93, and through the winding of relay 9314 to battery. Relay 9314 completes a circuit for the operation of the pilot lamp 9315 which gives an additional indication to the attendant that the supply of tape for some reperforator is running low. Lead 9390 extends to each of the reperforators and provides a similar indication when the supply of tape for each of the reperforators becomes low or exhausted.

Provision is also made for manually connecting either the receiving only teletypewriter or the printing reporforator to the incoming line for the reception of all the signals transmitted over this line when it is so desired. By operating key 1945 associated with line 200 or corresponding key associated with the other incoming lines it is possible to connect a receiving only teletypewriter to the transmitting channel of the full duplex party line 200. If the signals are being received by the printing reperforator 318 when the key 1945 is operated, operation of this key interrupts the locking circuit relay 1928 and permits this relay to release. Release of relay 1928 then establishes an operating circuit for relay 1937 from battery through the battery of relay 1937 through the left-hand inner break contacts of relay 1928, left-hand break contacts of relay 1927, through the break contacts of key 1946, to ground through the operated contacts of key 1945. Relay 1937 in operating completes a circuit above described for maintaining itself operated on the control of contacts 1923.

If key 1945, which is a locking key, is left operated, each of the succeeding messages will be recorded on the receiving only teletypewriter as described above irrespective of the switching signals which precede each message because relay 1937 will remain operated. It should be noted that the operation of relay 1937 interrupts the holding circuit of the printer magnet 1921 of the receiving only teletypewriter, thus permitting this magnet to follow the signals and cause the teletypewriter to record the received messages.

If key 1945 is only momentarily operated, which in turn causes the operation of relay 1937 and is thereafter released, only the remainder of the message then in progress of being received by the printing reperforator 318 or the next message to be received, if no message is being received at this time, will be recorded on the receiving only teletypewriter. At the end of this message the contacts 1923 will be momentarily opened by the receiving only teletypewriter in response to the figure signal followed by the H signal transmitted at the end of the message. The momentary opening of contacts 1923 interrupts the locking circuit of relay 1937 and permits this relay to release. Thereafter the operation of the circuit is as described above so long as keys 1945 and 1946 remain in their normal positions.

The operation of key 1946, if operated during the reception of a message by the receiving only teletypewriter, will interrupt the operating circuit of relay 1937 and thus permit this relay to release. The release of relay 1937 completes the holding circuit for the printer magnet 1921 of the receiving only teletypewriter and thus maintains this magnet operated and the receiving only machine at rest. The release of relay 1937 removes the short circuit from around the upper winding of relay 1901 which allows this relay to respond to the operation of relay 1910 to its left-hand position which causes the connection of printing reperforator 318 to the receiving channel as described above. If key 1947 is left operated all of the succeeding messages will be recorded on the printing reperforator 318 irrespective of the switching signals which precede each message. They will also be perforated in the tape 2021 as described above. The operation of printing reperforator 318 under these conditions will be the same as described above except that the relay 1929 will be operated by the reception of the letter R signal and by all other signals except letter Z signal, figure signals and the H signal. Consequently all of the messages transmitted over the incoming line will be received and recorded by the printing perforator 318. The figure signal followed by the H signal at the end of each message will cause the printing perforator 318 to be disconnected from the receiving channel of the party line and then the letter signals preceding the next message will cause the reperforator to be reconnected to the transmitting channel and record the following message.

If key 1946 is only momentarily operated, then released, it will cause relay 1937 to release and a perforator 318 to be connected to the receiving channel during the remainder of the message then in progress of transmission over the system. After completion of this message and the reception of the figure signal followed by the H signal the circuits will be returned to their normal conditions and will function as described above in response to the various code combinations transmitted over the system.

If both keys 1946 and 1947 are operated and left operated relay 1928 will be maintained op-

erated so that the printing reperforator 318 will remain operatively associated with the transmitting channel 205 of the full duplex party line 200 at all times and record all signals transmitted thereover.

A director circuit hold key 1944 is also provided for preventing the director from connecting a transmitter shown in Fig. 20 to any other lines so long as key 1944 is operated. The operation of key 1944 interrupts the operating circuit 2118 and thus prevents the operation of this relay. So long as relay 2118 is prevented from operating the director circuit is unable to connect the transmitter shown in Fig. 20 to any of the outgoing line circuits. Thus the messages stored in tape 2021 are not retransmitted by the transmitter shown in Fig. 20. The key 1944 is provided to stop the automatic operation of the director circuit so that its operation may be closely observed by the operator or attendant or maintenance force responsible for the operation of the system. Upon releasing or restoring key 1944 to normal the circuit of relay 2118 may be established whereupon this relay will operate to connect the transmitter shown in Fig. 20 to the proper outgoing line circuits as described above.

A redirect key 1942 is also provided. In case the holding key 1944 has been previously operated or in case the line to which a message is directed is busy for a period of time it may be desirable to check the operation of the director circuit or to direct the message to another receiving instrument as, for example, one of the intercepted positions. If it is desirable to direct a message to an intercepted position after the selection has been made by the director but before the transmitter shown in Fig. 20 has been connected to the selected outgoing line circuit, the proper key shown in Fig. 23 will be operated and then redirect key 1942 operated. The operation of key 1942 releases the previously selected route relays shown in Fig. 24 by interrupting the locking circuit of these relays. Thereafter upon the release of key 1942 the circuit is reestablished through the selecting relays of the director shown in Fig. 22 for again operating one of the route relays shown in Fig. 24.

A transmitter stop key is provided for each channel of the outgoing line circuit. The operation of the transmitter stop key 1215 in the first channel of the outgoing line circuit for line 200 will not stop the transmission of any message from the associated transmitter in progress of transmission at the time of the operation of this key. However, the operation of this key will prevent starting of transmission from the associated transmitter 1201 of any succeeding message stored in the tape 1227. The operation of this key will also release relay 1107 and thus prevent the automatic discard of the letter signals and the automatic advance of tape 1227 through the transmitter 1201 so long as letter signals are perforated in the tape 1227. Upon release of key 1215 the automatic advancing of tape 1227 and the discard letter signals is resumed and circuits are reestablished to enable the transmitter 1201 to transmit the next message stored in tape 1227 in its turn.

A key is also provided for causing each of the printing reperforators associated both with the incoming line and the outgoing line circuits to automatically perforate letter signals in the tape and thus advance the tape through these reperforators. In the outgoing line circuits the operation of this key 1222 in the first channel of the outgoing line circuit associated with line 200 causes magnet 2229 to operate, which releases the printing and perforating mechanism as described above and causes the mechanism to automatically perforate tape. In the case of the outgoing circuits when key 1222 or 1272 is operated the associated magnet is also operated independently of the condition of the circuits.

In the case of the reperforators associated with the incoming line circuits the automatic advancing or feed-out key is only effective to cause the automatic perforation of tape during time when no messages are being received by the printing reperforators, that is, this key is effective only during the time that the printing reperforator is not connected to the line. Upon the operation of key 1943 during the time no messages are being received by the printing reperforator 318, a circuit is completed for the operation of relay 1949 from ground through the right-hand outer break contacts of relay 1948 and left-hand outer break contacts of relay 1928 through the operated contacts of key 1943 and the outer break contacts of relay 1931 to battery through the winding of relay 1949. Relay 1949 in operating completes a circuit for maintaining itself operated from battery through its winding, the left-hand break contacts of relay 1931, the right-hand inner operated contacts of relay 1949 to ground through the left-hand outer break contacts of relay 1928 and the right-hand outer break contacts of relay 1948. Relay 1949 in operating also completes a circuit for the operation of magnet 1919 from battery through the winding of relay 1919, the left-hand operated contacts of relay 1949 to ground through the left-hand break contacts of relay 1902. The operation of magnet 1919 causes the printing reperforator 318 to automatically perforate letter signals in tape 2021 as described above.

Relay 1949 in operating conditions the vacuum tube 1938 by lighting its filament circuit and connecting the positive potential to the lower terminal of condenser 1961 through high resistance 1962. The lower terminal of condenser 1961 is connected to the grid of vacuum tube 1938 and controls the potential of this grid. The time constants of condenser 1961 and resistances 1962 and 1963 are such that it requires approximately 13 seconds for the potential of the lower terminal of this condenser, and thus the potential of the grid of tube 1938, to acquire a potential, that is sufficient to permit sufficient current to pass through tube 1938 to operate relay 1930. At the end of approximately 13 seconds after relay 1949 has operated, relay 1930 will operate and connect the right-hand winding of relay 1931 to interrupted ground over lead 1372. Lead 1372 extends from Fig. 19 through Figs. 28, 37, 46, 55, 56, 57, 62, 70, 76, 82, 88 to interrupted ground through the front contacts of relay 9310. Relay 9310 connects ground to this lead at approximately 5 second intervals as described above. During the application of ground to this lead during the next 5 second interval the circuit will be completed for the operation of relay 1931 from battery through its right-hand winding and its operated contacts 1930 to the interrupted ground through the front contacts of relay 9310 over the above-traced lead 1372. The operation of relay 1931 completes a circuit for maintaining itself operated under control of key 1943 and relays 1948 and 1928. The operation of relay 1931 also interrupts the locking circuit of relay 1949, thus permitting this relay to release. The release of relay 1949 interrupts the circuit of magnet 1919 of the printer reper-

forator 318, permits this magnet to release and stop the automatic perforation of tape. The above cycle may be repeated by the momentary operation of key 1943 as described above so long as no messages are being received by the printing reperforator 318 over the transmitting channel of line 200. The reoperation of key 1943, which is a non-locking key, interrupts the locking circuit of relay 1931 and causes the reoperation of relay 1949. Thereafter the above cycle of operation and automatic perforation of tape 2021 is repeated.

Should a message be received in this interval of time during which magnet 1919 is operated, relay 1902 will be operated as described above and immediately interrupt the operating circuit of magnet 1919 permitting this magnet to release and stop the automatic perforation of letter signals in tape 2021.

Provision is also made for receiving signals over the incoming line at one speed and transmitting them from the transmitting distributor shown in Fig. 20 at a different speed. In the preferred embodiment of this invention transmission speed from the transmitting distributor will be the same or at a higher speed than the speed of the received signals. In order to prevent excessive wear in the tape control contacts 2023 and associated relay contacts a delay circuit is provided which comprises the tube 1939, condenser 1951 and high resistance 1950. When the supply of perforated tape 2021 is reduced to a predetermined minimum due to the transmitter shown in Fig. 20 operating at a higher speed than the reperforator 318, contacts 2023 will open and interrupt the circuit of relay 1932 thus causing relay 1932 to release. Release of relay 1932 interrupts the circuit of the start magnet 2008 and permits this magnet to release and stop the transmitting. The release of relay 1932 also completes a circuit for the operation of relay 1933 from battery to the winding of relay 1933, the right-hand inner break contacts of relay 1932 over lead 2136 which extends through Figs. 20 and 21 to ground through the center set of operated contacts of relay 2115. It will be recalled that during the time the transmitter shown in Fig. 20 is connected to an outgoing line circuit and transmitting a message thereto, relay 2115 will be operated as described above.

The operation of relay 1933 completes a circuit for maintaining itself operated from battery through its winding and the break contacts of relay 1934 to ground through the outer right-hand operated contacts of relay 1933.

The operation of relay 1933 also completes the filament circuit of vacuum tube 1939 and connects positive battery to the upper terminal of condenser 1951 through high resistances 1950. The time constant of condenser 1951 and resistances 1950 and 1953 is such that the potential on the grid of tube 1939 prevents sufficient current from flowing through the tube to operate relay 1935 until some predetermined time interval after the operation of relay 1933. In a preferred embodiment of this invention this time interval is between 2 and 5 seconds, depending upon the relative speeds of the transmission from the transmitting channel of the party line and the speed of transmission from the transmitter shown in Fig. 20. In case the transmission speeds are substantially the same, the shorter interval of time is preferred, while the greater the difference in the transmission speeds the greater the desirable interval of delay. Assuming that approximately 5 seconds after the operation of relay 1933 the potential of the grid of tube 1939 will be such as to permit sufficient current to flow through the winding of relay 1935 to operate this relay. The operation of relay 1935 completes a circuit for the operation of relay 1934. Relay 1934 in operating completes a circuit for maintaining itself operated under control of relay 1932 and interrupts the locking circuit of relay 1933. Release of relay 1933 interrupts the locking circuit of relay 1934 and permits this relay to release. The release of relay 1933 reestablishes a circuit through the starting magnet 2008 of the transmitter shown in Fig. 20. The operation of the start magnet 2008 causes the transmitter shown in Fig. 20 to resume operation.

It should be noted that from the time relay 1932 releases until relay 1933 releases the circuit of the start magnet 2008 is open so that the transmitter shown in Fig. 20 will not be transmitting at this time. However, the printing reperforator 318 will be perforating an additional supply of tape in accordance with the received signaling impulses during this time. Consequently a supply of perforated tape is accumulated during this period which permits contacts 2023 to reclose and to complete the circuit for reoperation of relay 1932. Upon the release of relay 1933 transmission from the transmitter shown in Fig. 20 is resumed and the above cycle repeated when the supply of perforated tape 2021 is again reduced to a predetermined minimum due to the faster operation of the transmitter shown in Fig. 20. Thus instead of starting and stopping this transmitter after each character is received, the delay interval causes the transmitter to stop only at infrequent intervals during the transmission of a message. This greatly reduces the wear on contacts 2023 as well as the contacts on relay 1932.

A further alarm circuit is provided to indicate a trouble condition of some nature which prevents the transmitter shown in Fig. 20 from completely transmitting a message. Assume, for example, that the supply of perforated tape 2021 has been reduced to a predetermined minimum which causes contacts 2023 to open, and assume further that no further signals are received by the printing reperforator 318 and that a figure signal followed by an H signal at the end of the previous message has been received by this printing reperforator. Under these circumstances when contacts 2023 open and interrupt the operating circuit of relay 1932 this relay will release. As pointed out above, the release of relay 1932 at this time will cause the operation of relay 1933. The release of relay 1932 at this time will also complete a circuit for the operation of relay 1949 from battery through the winding of relay 1949, the left-hand outer break contacts of relay 1931, the right-hand outer break contacts of relay 1932, to ground through the left-hand outer break contacts of relay 1928 and the right-hand outer break contacts of relay 1948. The operation of relay 1949 at this time conditions tube 1938 as described above and completes a circuit for maintaining itself operated and completes a circuit for the operation of magnet 1919 from battery through the winding of magnet 1919, right-hand operated contacts of relay 1949 to ground through the left-hand break contacts of relay 1902. Magnet 1919 then causes a printing reperforator 318 to automatically perforate letter signals in tape 2021 as described above. At the end of approximately 13 seconds relay 1930 will operate and within 5 additional seconds ground will be applied to lead 1372 as described above

and cause the operation of relay 1931. Relay 1931 in operating interrupts the locking circuit of relay 1949, permits this relay to release and interrupts the circuit of magnet 1919, thus stopping the automatic perforation of tape by reperforator 318.

The additional supply of perforated tape due to this operation of the printing reperforator causes contacts 2023 to reclose and relay 1932 to reoperate. At the end of the interval of time determined by the constants of condenser 1951 and resistances 1950 and 1953, relay 1933 will release and reestablish the circuit through the start magnet 2008 of the transmitter shown in Fig. 20. This transmitter will then normally transmit the remainder of the message and the figure signal following the H signal at the end of the message. These signals will cause the director to disconnect this transmitter from the outgoing line circuit to which the message is transmitted. In so disconnecting the transmitter from the outgoing line circuit relay 2115 will normally be released.

However, in case some trouble develops so that the entire message is not completely transmitted and relay 2115 released at the end of the 13 second interval plus a portion of the 5 second interrupter interval, then relay 1931 operates, it completes a circuit for the operation of relay 1936 from battery through the winding of relay 1936, the center set of operated contacts of relay 1931, the center set of break contacts of relay 1932 over lead 2136 which extends through Fig. 20 to ground through the center set of operated contacts of relay 2115. Relay 1936 in operating connects ground to lead 1964 extending through Fig. 20 and the break contacts of relay 2132 to battery through the winding of relay 2132. The operation of relay 2132 completes a circuit for the operation of relay 2131 from battery through the winding of relay 2131 and the left-hand operated contacts of relay 2132 to ground over lead 1964 through the right operated contacts of relay 1936. The operation of relay 2131 interrupts the operating circuit of relay 2132. Relay 2132 is slow in releasing so that it does not immediately release. After a short interval of time relay 2132 releases and in turn interrupts the operating circuit of relay 2131. Relay 2131 is slow in releasing and requires an appreciable interval of time for it to release. When relay 2131 releases, it again closes the operating circuit of relay 2132 and the above cycle of operations is repeated. During the time of each cycle of operation of relays 2132 and 2131 that relay 2132 is operated, ground is connected to lead 1965. Since relay 1936 is operated at this time the connection of ground to lead 1965 by relay 2132 completes a circuit for lighting lamp 942. During the time relay 2132 is released the circuit of lamp 942 is interrupted; thus lamp 942 flashes once for each cycle of operation of relays 2132 and 2131. This indicates to the operator that the transmitter shown in Fig. 20 is not functioning properly so that she can clear the trouble or call the services of the maintenance force to determine what is the trouble. When the message is completely transmitted from the tape transmitter shown in Fig. 20 and this transmitter is disconnected from the outgoing line circuit to which it transmitted the message, relay 2115 will release and interrupt the circuit of relay 1936 and thus permit this relay to release. The release of relay 1936 interrupts the operating circuits of relays 2132 and 2131 permitting these relays to release and thus restore the circuit to its original condition.

Provision is also made for indicating a trouble condition to the operator in case blank signals are received from the outlying subscriber's station. As described above, blank signals are employed for conditioning the selecting equipment located near the outlying subscribers' stations. It is, therefore, highly desirable that no blank signals be interposed with message signals because these blank signals when transmitted over the outgoing line, that is, the receiving channel of the full duplex party line, cause the selecting equipment at these stations to be conditioned for controlling transmitters located at these stations and also temporarily interrupt the communication path to the receiving equipment. Thus if such signals are transmitted over the receiving channel of the outgoing line falsely during the transmission of a message from any source other than the automatic start circuit they will cause the message to be mutilated and the operation of the transmitters interfered with.

To indicate the arrival of blank signals over the transmitting channel both the receiving only teletypewriters and the printing reperforators are provided with contacts which are actuated by the reception of the blank signal. Contacts 1922 of the receiving only teletypewriter are momentarily closed in response to the reception of a blank signal by this teletypewriter and contacts 1912 are momentarily closed by the printing reperforator 318 in response to the reception of a blank signal, that is, a signal in which all five of the selecting impulses are spacing. Closure of either of these contacts completes a circuit for the operation of relay 1947. Relay 1947 in operating completes a circuit for maintaining itself operated under control of key 943. The operation of relay 1947 also completes the circuit for lighting lamp 942. At this time lamp 942 remains lighted and does not flash. This indicates to the operator that a blank signal has been received from the transmitting channel of the associated party line. The operation of relay 1947 interrupts the circuit of the start magnet 2008 of the transmitter shown in Fig. 20 and thus stops the transmission of the message by this transmitter. The operation of relay 1947 also interrupts the operating circuit of relay 2118 and thus prevents the operation of this relay to connect the transmitter shown in Fig. 20 to any line if it is not so connected when the blank signal is received. The operator may examine the tape in an effort to determine the cause of the trouble and upon the operation of a key 943, relay 1947 is released and the respective circuits restored to their normal operating conditions. It is usually impractical to have an operator correct a single blank code combination recorded in tape 2021 so that the director circuit is arranged to change the blank signal into a V signal. The V signal will then be transmitted to the outgoing line circuit and thereafter over the receiving channel to the distant station. This V signal will be an extraneous or false character in the message but it will not interfere with the operation of the switching circuits at the stations to which this receiving channel extends. The manner in which the blank signal is changed into a V signal may be readily understood by reference to Fig. 21. Here relay 2119 is normally maintained in its right-hand position by current flowing through its

lower winding. Current flowing through the upper winding of this relay normally tends to operate the relay to its left-hand position but the effect of this current is normally overcome by the effect of the current flowing through the lower winding of this relay. The lower winding of relay 1929 is so connected to the leads 1 through 5, inclusive, that so long as ground is connected to any of these leads by the contacts 1 to 5 of the transmitter shown in Fig. 20 sufficient current flows through the lower winding of relay 2129 to maintain this relay in its right-hand position. It should be noted that ground is connected to this winding through the auxiliary contacts 2115 when the transmitter shown in Fig. 20 is near its stop position. Thus under normal operating conditions of the transmitter, shown in Fig. 20, relay 2129 is maintained in its right-hand position.

So long as relay 2129 is maintained in its right-hand position an obvious circuit is maintained for operating relay 2130. During the time relay 2130 is operated the leads 2 through 5, inclusive, from contacts 2 through 5 of the transmitter shown in Fig. 20 are connected to segments 2 through 5, inclusive, of the transmitting distributor shown in Fig. 20.

Upon sensing fingers 2026 finding a blank code combination in tape 2021 so that none of the contacts 1 through 5 is operated to its marking position and thus ground is not connected to any of the leads 1 through 5, the current flowing through the lower winding of relay 2129 falls to such a low value that the current flowing through the upper winding of this relay causes its armature to move to its left-hand position where it interrupts the circuit of relay 2130. Relay 2130 then releases and connects ground to the segments 2 through 5 of the distributor shown in Fig. 20 instead of battery from the contacts 2 through 5 of the transmitter shown in Fig. 20. Thus during the transmission of this code combination a spacing first pulse is transmitted followed by four marking impulses instead of five spacing impulses. Thus the blank code combination which comprises five spacing impulses is transformed into the letter V code combination which comprises a spacing first modulation followed by four marking impulses.

It is to be understood, of course, that the blank signal could be converted into any suitable code combination instead of the letter V signal. Similarly, any of the other false or improper switching or conditioning signals, if necessary or desirable, may be transformed into other signals which do not interfere with the operation of the switching circuits. The letter V signal has been chosen merely for purposes of illustration. The letter V signal is then recorded by the printing reperforator in the outgoing line circuits and later transmitted to the outlying stations. It will be recorded at these stations and appear as an extraneous signal in the message. It will not, however, cause any improper operation of the switching circuits located at the outlying stations nor will it interfere with the operation of the switching equipment at the central station.

Provision is also made to enable the operator at the central station to stop the transmission of messages from any or all of the transmitting devices located at the outlying stations without attempting to start the transmitting equipment located at any one of the stations. In order to accomplish this the transmitter stop key 946 is provided. Prior to operating this key to stop any transmitting equipment which may be transmitting, the operator must restore the automatic start key 944 to its normal position which permits relay 1019 to release. Then when the operator operates key 946 a circuit is completed for the operation of relay 901 from battery through the winding of relay 901, the break contacts of relay 902, the center set of right-hand break contacts of relays 1004 and 1019, to ground through the operated contacts of key 946. The operation of relay 901 initiates the operation of the automatic transmitter start circuit shown in Fig. 10 and described above. In this case, however, instead of transmitting the code combination assigned for starting some one station following a pause after the R signal which stops all of the transmitters, the carriage return signal which comprises a spacing signal transmitted during the first, second, third and fifth impulse intervals, the marking signal during the fourth impulse interval. Reception of the carriage return signal restores all of the printing selectors to their normal condition without starting any transmitter.

What is claimed is:

1. In a communication system, a switching station, a plurality of communication paths extending from said station, a plurality of storage devices associated with and individual to each of said plurality of paths, switching apparatus located at said switching station, a plurality of transmitting devices connected to said switching apparatus, means for simultaneously establishing a plurality of communication paths through said switching apparatus, each of said paths extending from one of said transmitting devices to one of said storage devices, means for simultaneously transmitting messages from said transmitting devices to said storage devices over said plurality of paths, and means for thereafter transmitting said messages in succession over said communication path extending from said switching station.

2. A telegraph system comprising a switching station, a plurality of telegraph transmitting devices connected thereto, a plurality of telegraph communication paths extending from said switching station, a plurality of signal storing devices individual to each of said plurality of telegraph communication paths extending from said station, switching equipment located at said switching station capable of providing a communication path from each of said transmitting devices to each of said storage devices, means for simultaneously establishing a plurality of said transmission paths from a plurality of said transmitting devices to a corresponding plurality of said storage devices, means for simultaneously transmitting signals over all of said established communication paths through said switching equipment, and means for thereafter transmitting said signals in succession over said communication path extending from said switching station.

3. In a telegraph switching system a switching station, a plurality of telegraph lines terminating at said station, a telegraph signal storage device individual to each of said lines for storing signals received therefrom, a telegraph transmitting apparatus individual to each of said storing devices, a plurality of other storage devices individual to each of said telegraph lines and means responsive to stored signals for individually connecting each of said telegraph transmitters to any one of said other storage devices, means for simultaneously establishing a plurality of said con-

nections between said transmitting devices and said other storing devices, means for simultaneously transmitting messages over said established connections, and a second group of transmitting devices for transmitting messages stored in said other storage devices in succession over said telegraph communication paths extending from said station.

4. In a telegraph communication system, a central switching station, a plurality of party lines extending from said switching station to a plurality of outlying stations, means for transmitting permutation code groups of signaling impulses from said outlying to said central stations, storage devices at said central station individual to each of said lines for storing the permutation code groups of message signals received therefrom, telegraph transmitting apparatus controlled by said stored signals, a plurality of other storage devices individual to each of said lines, means responsive to said stored permutation code signals for individually connecting each of said transmitting devices to one of said other storage devices, means for preventing the connection of any other transmitting devices to any previously connected storage device, means for simultaneously establishing a plurality of said connections between said transmitting devices and said other storage devices, means for simultaneously transmitting messages over said plurality of established connections, means for transmitting the messages from said second group of storage devices individual to each of said lines over said lines in succession, and means responsive to other storage permutation code signals for disconnecting said telegraph transmitting apparatus from said one of said other group of storage devices.

5. A telegraph communication system comprising a central switching station, a plurality of transmitting devices connected to said station, a plurality of telegraph lines extending from said station, switching equipment located at said station, a plurality of outlying telegraph stations connected to each of a group of said lines extending from said station, telegraph transmitting and receiving apparatus located at each of said outlying stations, means at said central station for establishing connections between said transmitting devices and said telegraph lines to said switching equipment, and means under control of said central station for automatically starting the transmitting apparatus located at each of said outlying stations in rotation.

6. In a telegraph system, a main station, a plurality of other telegraph stations, a telegraph communication path extending between all of said stations, transmitting and receiving apparatus located at each of said stations, and means at said main station for automatically and selectively starting the transmitting apparatus at each of said other stations one at a time and in a predetermined order.

7. In a telegraph system, a main station, a plurality of other telegraph stations, transmitting and receiving apparatus located at all of said stations, a telegraph transmission path extending between all of said stations, apparatus at said central station for automatically and selectively conditioning the transmission apparatus at one of said stations for transmission, means for initiating the operation of a time interval measuring device after conditioning said transmission apparatus, apparatus responsive to telegraph signals transmitted from said conditioned transmitting apparatus for disabling the said interval measuring device, and means jointly responsive to said time interval measuring device and predetermined telegraph signals for conditioning the transmitting apparatus at another of said stations and disabling said previously conditioned transmitting apparatus.

8. In a telegraph communication system, a control station, a plurality of other telegraph stations, a full duplex line extending between all of said stations, telegraph transmitting apparatus located at said other stations, telegraph switching apparatus located near said other stations, means for controlling said switching apparatus over said full duplex line, means at said control station for transmitting said switching signals over said duplex line for selectively conditioning said transmitting apparatus at any one of said stations for transmission over said full duplex line, manual means for initiating the operation of said transmission means at said control stations, and automatic means for initiating the operation of said control means at predetermined intervals of time.

9. A telegraph communication system comprising a control station, a plurality of other telegraph stations, a full duplex telegraph line extending to all of said stations, telegraph transmitting apparatus located at said other stations, telegraph switching apparatus located adjacent said other stations, means for controlling said switching apparatus over said full duplex line, means at said control station for transmitting switching signals over said duplex line for selectively conditioning said transmitting apparatus at any one of said stations for transmission over said full duplex line, manual means for initiating the operation of said transmission means at said control station, automatic means for initiating the operation of said control means at predetermined intervals of time, means responsive to reception of signals from any of said conditioned transmitting apparatus for preventing the operation of said automatic means, and means responsive to the transmission of switching signals for conditioning each of the tranmitting apparatus located at all of the other stations connected to said line for disabling said automatic means for a predetermined interval of time.

10. In a telegraph system, a central station, a party line connected to said central station, a plurality of stations associated with said party line, switching apparatus controlled by signals received over said line located near each of said stations, tape-controlled telegraph transmitting apparatus at said stations, apparatus for conditioning said transmitting apparatus for transmission over said party line controlled by said switching apparatus located near each of said stations, means at said central station for transmitting switching code combinations over said party line for controlling all of said switching apparatus to condition said transmitting apparatus, means at said central station responsive to signals received from said party line, time controlled apparatus at said central station, means for automatically initiating the operation of said means for transmitting switching code combinations jointly controlled by said time-controlled apparatus and said means responsive to received code combinations, and means for automatically changing said switching code combinations in a predetermined order so that the transmitting apparatus at each of said stations is conditioned for transmission in a predetermined order.

11. In a telegraph system, a main station, a plu-

rality of other stations, a telegraph communication path extending between said stations switching apparatus located near said stations, selecting apparatus responsive to signals transmitted over said path for controlling said switching apparatus, means responsive to a predetermined signal transmitted over said path for energizing said switching apparatus after a predetermined interval of time and for a predetermined further interval of time, means responsive to signals received during said first interval of time for rendering said switching apparatus non-responsive to said selecting apparatus, and means responsive to the absence of signals for a time exceeding said second interval of time for rendering said switching apparatus non-responsive to said selecting apparatus.

12. In a telegraph system, a telegraph line, switching apparatus connected to said line, means responsive to a predetermined telegraph code combination for operatively controlling said switching apparatus for response to further code combinations transmitted over said line, and means responsive to telegraph signals received over said line during a fixed interval of time after reception of said predetermined code combination for cancelling the effect of said code combination.

13. In a telegraph system, a main station, a plurality of outlying stations, a telegraph communication path extending to all of said stations, telegraph transmitting apparatus, telegraph receiving apparatus and telegraph selecting apparatus located at each of said stations, a first group of switching devices locted at each of said outlying stations for operatively associating said receiving equipment with said communication path, a second group of switching devices for controlling said transmitting apparatus, means responsive to a predetermined code combination for operatively connecting said first group of switching devices at each of said stations to said selecting device, means responsive to other code combinations for operatively associating the receiving device at one of said stations with said communication path and for interrupting said operative connection between said first switching devices and said selecting equipment at all of said stations, means responsive to a second predetermined code combination for operatively connecting said second group of switching devices to said selecting apparatus at all of said stations and for interrupting said operative connection between said receiving device and said path after a predetermined interval of time, and means responsive to the reception of signals during said interval of time for cancelling the effect of said second predetermined code combination.

14. In a telegraph system, a main station, a plurality of outlying stations, a telegraph communication path extending to all of said stations, telegraph transmitting apparatus, telegraph receiving apparatus and telegraph selecting apparatus located at each of said stations, a first group of switching devices located at each of said outlying stations for operatively associating said receiving equipment with said communication path, a second group of switching devices for controlling said transmitting apparatus, means responsive to a predetermined code combination for operatively connecting said first group of switching devices at each of said stations to said selecting device, means responsive to other code combinations for operatively associating the receiving device at one of said stations with said communication path and for interrupting said operative connection between said first switching devices and said selecting equipment at all of said stations, means responsive to a second predetermined code combination for operatively connecting said second group of switching devices to said selecting apparatus at all of said stations and for interrupting said operative connection between said receiving device and said path after a predetermined interval of time, means responsive to the reception of signals during said interval of time for cancelling the effect of said second predetermined code combination, means operative at the end of a second interval of time for cancelling the effect of said second predetermined code combination, and means responsive to the reception of signals over said channel for rendering said second cancelling means ineffective.

15. In a telegraph system, a central station, a group of outlying stations all geographically separated from each other and from said central station, a telegraph channel extending from said central station to all of said outlying stations, selecting equipment controllable over said telegraph channel located near each of said outlying stations, telegraph receiving apparatus located at each of said outlying stations, switching apparatus also located near each of said outlying stations, means responsive to different predetermined signals transmitted over said telegraph channel for operatively associating the receiving apparatus at only one of said stations with said telegraph channel, and means at all of the other of said stations responsive to said same predetermined signals for rendering the switching equipment at all of said other outlying stations non-responsive to further message signals transmitted over said telegraph channel, and means responsive to other predetermined telegraph signals for interrupting said operative association between said selected receiving apparatus and said channel and for conditioning said switching apparatus at all of said stations for response to further signals transmitted over said channel.

16. A telegraph system comprising a plurality of geographically separated stations, a telegraph transmission path extending to all of said stations, a telegraph receiving apparatus located at each of said stations, a permutation code selector connected to said path and located near said stations, repeating apparatus connected between said path and said receiving apparatus, means for normally disabling said repeating apparatus, and means controlled by said permutation code selector for conditioning said repeating apparatus for repeating telegraph signals from said path to said receiving apparatus.

17. In a telegraph system, a plurality of geographically separated telegraph stations, a telegraph communication path extending to all of said stations and remaining in a fixed state of continuity, telegraph receiving apparatus located at each of said stations, telegraph repeating apparatus connected between said path and said receiving apparatus normally non-responsive to signals transmitted over said path, other telegraph receiving equipment located near said repeating apparatus, and means responsive to predetermined signals transmitted over said path for conditioning said repeating apparatus for repeating signals from said path to said receiving apparatus.

18. In a telegraph system, a record-controlled telegraph transmitter, a plurality of two-position elements controlled by the signals stored by the controlling record, a monitoring device for monitoring the signals transmitted by said transmit-

ter comprising a single relay having a plurality of windings, and a network connected between said windings and said plurality of elements for rendering said relay responsive to only one specific setting of said elements.

19. In a telegraph system, a group of two-position contacts, means for positioning said contacts in either of said positions in response to permutation code telegraph signals, a plurality of monitoring relays, and a network connected between the windings of said relays and said contacts for causing each of said monitoring relays to respond to a single permutation code setting of said contacts which is different for each of said monitoring relays.

20. In a permutation code telegraph system in which each character is represented by a code combination of a fixed number of signaling impulses of at least two different kinds, a plurality of two-position contact members equal to said fixed number of impulses, a monitoring relay provided with a biasing winding tending to operate said relay in one direction, a winding of said relay connected to the same potential as is connected to said contact members when they are in one position, a third winding of said relay connected to the same potential as is connected to the said contacts when they are in the second position, and a resistance network connected between said second and third windings and said contacts which causes current to flow through at least one of said second and third windings holding the relay in its other position for all but one permutation and setting of said contacts and for reducing the current flow through both of said second and third windings when said contacts are set in accordance with said one code combination so that said relay is operated by the current flowing in said biasing winding.

21. A telegraph communication system comprising a control station, a plurality of outlying stations, a telegraph line extending to all of said stations, means at said control station for receiving a preassigned control signal over said telegraph line, and means at said control station responsive to the reception of said preassigned code signal for preventing the further transmission of said preassigned signal and for transmitting a second preassigned signal in place thereof.

22. In a telegraph system, a control station, a plurality of other stations, a communication path extending between said stations, means at said control station for transmitting a conditioning permutation code combination to said other stations, means at said control station responsive to reception of said conditioning code combination, and circuit instrumentalities controlled thereby for transmitting a different permutation code combination over said line each time said conditioning code combination is received over said communication path.

23. In a telegraph system, a telegraph transmitter, a record for controlling said transmitter, contacts controlled by said record for controlling signals transmitted by said transmitter, a plurality of relays operated by circuits extending through said contacts, other relays controlled by said first group of relays for selectively connecting said transmitter to one of a plurality of telegraph transmission paths, means for operating all of said first group of relays, means responsive to the simultaneous operation of all of said relays for initiating the operation of said transmitter including apparatus for positioning said contacts in accordance with signals stored in said record, and means responsive to the proper response of said first group of relays to the position of said contacts for establishing an operating connection between said plurality of relays and said other relays.

24. In combination, a telegraph signal storing medium, a plurality of two-position contacts, one relay controlled by each of said contacts, other means for simultaneously operating all of said relays, apparatus responsive to the simultaneous operation of all of said relays for setting said contacts in accordance with signals stored in said storing medium, and means responsive to the correct response of said relays to the setting of said contacts for completing a circuit controlled by said relays.

25. In a telegraph system, a fixed number of permutation elements capable of assuming either one of two positions, a plurality of selectable devices, a plurality of selecting members, means for simultaneously operating all said selecting members, means responsive to the simultaneous operation of all of said selecting members for establishing an operative connection between said permutation elements and said selecting members, and means responsive to the operation of said selecting members through said operative connection of said permutation elements for selecting one of said plurality of selectable devices.

26. In a telegraph system, a telegraph line, a receiving relay connected to said line, a telegraph receiving device and a telegraph signal storing device, means responsive to the reception of telegraph signals over said line for automatically connecting said storage device to said line, means responsive to the reception of predetermined signals for disconnecting said storage device from said line and connecting said receiving device thereto, means responsive to reception of certain preassigned signals for disconnecting said devices from said line, and manual apparatus for connecting said storage device to said line independently of received signals.

27. In a telegraph system, a telegraph line, a receiving relay connected to said line, a telegraph receiving device and a telegraph signal storing device, means responsive to the reception of telegraph signals over said line for automatically connecting said storage device to said line, means responsive to the reception of predetermined signals for disconnecting said storage device from said line and connecting said receiving device thereto, means responsive to reception of certain preassigned signals for disconnecting said devices from said line, and manual apparatus for connecting said receiving device to said line independently of received signals.

28. In a telegraph system, a central switching station, a plurality of outlying stations, telegraph lines extending from said central station to said outlying stations, means at said central station for directing selectively through said central switching station over a single transmission path therein messages received from said outlying stations to other of said outlying stations in accordance with switching code combinations assigned to said outlying stations, and means responsive to switching code combinations not assigned to outlying stations for directing messages over single transmission paths within the station and causing recording of the message at the central switching station.

29. In a telegraph system, a switching station, a plurality of outlying stations, telegraph lines extending to said outlying stations, switching ap-

paratus at said switching station for directing messages to said outlying stations in accordance with received telegraph signals preceding said messages, and manually operable means cooperating with said switching apparatus for conditioning said switching apparatus to selectively direct all the messages directed to any line to be recorded at said switching station.

30. In a telegraph system, a switching station, a plurality of other stations, telegraph lines extending from said switching station to said other stations, switching apparatus at said switching station for selectively routing messages to said other stations in accordance with telegraph signals preceding said message, a plurality of manually operable devices each designating one of said other stations and cooperating with said switching apparatus for routing messages, and means responsive to the operation of any one of said manually operable devices for causing said switching apparatus to reroute all of the messages directed to said one of said lines to receiving apparatus at said switching station.

31. In a telegraph system, a switching station, a plurality of telegraph lines extending from said switching station, a plurality of other stations associated with each of certain of said lines, means at said switching station and said plurality of stations associated with each of said lines for selectively directing messages to said stations in accordance with telegraph signals preceding said messages, a plurality of manually operable switching devices designating the individual stations associated with said lines, and means responsive to the operation of said manually operable devices for causing said switching apparatus to redirect only the messages directed to the stations designated by said operated manual switching devices to a receiving device at said switching station.

32. In a telegraph system, a switching station, a plurality of telegraph lines extending from said switching station, a plurality of other stations associated with each of certain of said lines, means at said switching station and said plurality of stations associated with each of said lines for selectively directing messages to said stations in accordance with telegraph signals preceding said messages, a plurality of manually operable switching devices each designating the individual stations associated with said lines, means responsive to the operation of one of said devices for causing said switching apparatus to redirect only the messages directed to the specific stations designated by said operated switching device to a receiving device at said switching station, and apparatus cooperating with said receiving device for automatically directing the messages to said specific outlying stations through said switching equipment.

33. In a telegraph switching system, a switching station, a plurality of lines extending therefrom, a plurality of telegraph stations connected to one or more of certain of said lines, switching apparatus at said central station for directing messages to said line or lines in accordance with telegraph signals preceding said messages, and intercepting means at said central station for intercepting only messages directed to any specified station of said plurality of stations connected to one of said lines.

34. A telegraph switching system comprising a switching station, telegraph transmitting and receiving apparatus located thereat, a plurality of telegraph lines extending therefrom, a plurality of other stations connected to certain of said lines, directing equipment at said switching station for selectively controlling the transmitting apparatus located thereat and directing the messages transmitted thereby to any of said lines in accordance with telegraph signals preceding the message, a plurality of manually operable switching devices each designating one of the stations, and means responsive to the operation of said manual device for altering the connections of said directing equipment for redirecting messages directed to any one of said stations to other receiving apparatus at said switching station.

35. In a telegraph system a switching station, a plurality of transmission paths, a switching apparatus at said switching station, a plurality of telegraph transmitting apparatus connected to said switching apparatus, directing equipment for selectively connecting some one of said transmitting apparatus to some one of said plurality of transmission paths, manual switching means for preventing the completion of said connection, and other manual switching means for causing said directing equipment to reselect one of said paths in accordance with the telegraph signals preceding said message.

36. In a telegraph system, a tape controlled transmitter, the tape having telegraph code signals recorded therein, means selectively responsive to predetermined code signals in said tape for causing said signals to be discarded, said predetermined code signals including a code signal assigned the specific function of conditioning a receiving recorder of code signals, and means responsive to other signals recorded in said tape for rendering said discarding means ineffective.

37. In a telegraph sytem an automatic transmitter for transmitting signals over paths in accordance with codes, means for controlling the transmitter by a control form which includes directing code, end-of-message codes and other codes at times specifically assigned control functions, means conditioned upon said other codes following end-of-message codes and preceding directing codes for preventing the further transmission of said other codes beyond said transmitter.

38. In a telegraph system a tape controlled transmitter, the tape having telegraph code signals recorded therein, means selectively responsive to predetermined code signals in said tape for causing said signals to be discarded, another transmitter in said system, apparatus responsive to one of said predetermined code signals for controlling the starting of said other transmitter and means responsive to other signals recorded in said tape for rendering said discarded means ineffective.

39. In a telegraph system a tape controlled transmitter, the tape having telegraph code signals recorded therein, means selectively responsive to predetermined code signals in said tape for causing said signals to be discarded, other transmitters in said system, a test circuit, apparatus responsive to one of said predetermined code signals for initiating the operation of said test circuit for testing one of said other transmitters for storage message signals.

40. In a telegraph system, a plurality of receiving devices, a tape in which telegraph code combinations are punched, a telegraph transmitter controlled by said tape, means selectively responsive to a predetermined group of said signals recorded in said tape for causing said transmitter to advance said tape through said transmitter

without transmitting said corresponding signals over any operating transmission circuit, means responsive to another group of impulses recorded in said tape for selectively connecting said transmitter to an operative telegraph transmission path providing for ultimate transmission over a path extending to a plurality of telegraph receiving devices, and other means also responsive to said other group of impulses recorded in said tape for connecting said transmitter to a specified receiving device.

41. In a telegraph system, means for recording telegraph signals by permutation code impressions in a tape, telegraph transmitting apparatus controlled by said impressions in said tape, means jointly responsive to recording specified signals in said tape and a predetermined minimum supply of said tape between said recording device and said transmitter for causing said recording device to automatically impress in said tape predetermined code combinations having at least one impression representing a signal element, and means responsive to the recording of said specified signals in said tape and to said predetermined code combination automatically impressed in said tape for causing said transmitter to automatically discard said predetermined code combinations automatically impressed in said tape.

42. In a telegraph system, a cross-bar switch, a plurality of telegraph communication paths connected to said cross-bar switch, a telegraph transmitter connected tosaid cross-bar switch, a telegraph signal recording medium, means for controlling a telegraph transmitter in accordance with the signals recorded in said medium, and means selectively responsive to signals stored in said recording medium for controlling said cross-bar switch to selectively connect said transmitter to one of said communication paths.

43. In a telegraph system a cross-bar switch, a plurality of communication paths connected to said cross-bar switch, storage means for storing telegraph code combinations, a telegraph transmitter connected to said storage means to transmit signals stored therein, and connections for the control of said switch by and in accordance with signals stored in said storage means for controlling the selective connection of said transmitter over said cross-bar switch to one of said paths.

44. In a telegraph system, switching apparatus having rows of contacts in electrical coordinate relation, a plurality of communication paths connected to said switching apparatus, storage means for storing telegraph code combinations, a telegraph transmitter connected to said storage means for transmitting the code combinations stored therein, and connections for the control of said switching apparatus by and in accordance with signals stored in said storage means for controlling the selective connection of said transmitter to one of said paths over said switching apparatus having rows of contacts in electrical coordinate relation.

45. A telegraph switching system comprising a co-ordinate switch, a plurality of tape controlled telegraph transmitters, each individual to a row of contacts on said switch, a plurality of communication paths each individual to other rows of contacts of said switch in co-ordinate relation to said first group of rows of contacts, a perforated tape for controlling each said telegraph transmitter, and means responsive to signals perforated in tape of one of said transmitters for actuating said switch to connect the corresponding transmitter to any of said communication paths.

46. A telegraph system comprising a cross-bar switch, a tape controlled telegraph transmitter individual to a row of contacts on said switch, a plurality of communication paths each individual to a row of contacts on said switch coordinate to said first row of contacts, means for establishing a communication path from said transmitter to any of said paths through said switch, and means responsive to predetermined signals recorded in the tape controlling said transmitter for releasing said connection.

47. In a telegraph system, a communication path, a plurality of tape controlled telegraph transmitters one of which is located remote from another thereof and all connected to said path in the tapes of which message matter may be stored, means for automatically, successively, and indefinite sequence testing said transmitters for the presence of stored message matter, and causing transmission thereof therefrom if any message matter is found to be so stored upon test.

48. In a telegraph system, a tape, means for storing signals in said tape, telegraph transmitter controlled by signals stored in said tape, means for passing said tape from said storing means to said transmitter, means responsive to the quantity of said tape between said transmitter and said storing means for controlling the operation of said transmitter, and means responsive to said controlling means for preventing the operation of said transmitter for a predetermined interval of time after the operation of said transmitter is interrupted by said control means.

49. In a telegraph system, a plurality of telegraph stations, a telegraph line extending to said stations, transmitting apparatus located at each of said stations, means for operatively associating each of said transmitters with said telegraph line for transmission thereover one at a time, and means responsive to a steady signaling condition applied to said line by any of said transmitters for a predetermined interval of time for disassociating from said line any operatively associated transmitter.

50. In a telegraph system, a plurality of telegraph stations, a telegraph line extending to said stations, transmitting apparatus located at each of said stations, means for operatively associating each of said transmitters with said telegraph line for transmission thereover one at a time, and means responsive to a steady signaling condition applied to said line by any of said transmitters for a predetermined interval of time for disassociating from said line any operatively associated transmitter and for operatively associating another transmitter with said line for transmission thereover.

51. In a telegraph system, a telegraph transmission path, a tape controlled telegraph transmitter, a tape for said transmitter, means for operatively connecting said transmitter with said telegraph path, and means responsive to the end of said tape passing a predetermined point in said transmitter for disconnecting said transmitter from said path.

52. In a telegraph system, incoming channels supplying signals intended for transmission over outgoing channels, and means for preventing delay of signals comprising two paths permanently identified with at least certain of the outgoing channels over which signals intended for any one

outgoing channel may be simultaneously conveyed.

53. A system of communication having, in combination with a transmitting unit and a plurality of terminal units, an intermediate relaying unit geographically remote from said transmitting unit automatically operative upon delivery of message-matter thereto by the transmitting unit to relay the same to one of the terminal units selectively, characterized in that the intermediate relaying unit has associated therewith cyclically operable control apparatus and the transmitting unit has associated therewith controlled apparatus, whereby transmission from the transmitting unit is automatically repeatedly initiated under control of the control apparatus associated with the intermediate relaying unit.

54. A system of communication having, in combination with a transmitting unit and a plurality of terminal units, an intermediate relaying unit automatically operative upon delivery of message-matter thereto by the transmitting unit through an intervening channel of telegraphic transmission to relay the same to one of the terminal units selectively, characterized in that the intermediate relaying unit has associated therewith control apparatus and the transmitting unit has associated therewith controlled apparatus, for automatically initiating transmission from the transmitting unit at intervals under control of the control apparatus associated with the intermediate relaying unit.

55. A system of communication having, in combination with a transmitting unit and a plurality of terminal units, a relaying unit having a storage medium on which message-matter sent from the transmitting unit may be recorded, means operable automatically upon the recording of message-matter on said storage medium to initiate the transfer thereof to one of said terminal units selectively, control means associated with the relaying unit and controlled means associated with the transmitting unit for initiating transmission from the transmitting unit, and means whereby said control means is actuated automatically to initiate transmission from the transmitting unit at intervals.

56. A system comprising a plurality of outlying stations, means for selectively transmitting code combinations representing messages from certain of said stations to others thereof including a telegraph exchange station through which said messages are relayed automatically, said exchange station including mechanism operable to convert said combinations from electrical to mechanical form and vice versa, means at said exchange station operating under the control of different code combinations initially transmitted with a message to select one of a plurality of paths for the transmission of the message combinations, and solely automatically operable means at the exchange station for initiating transmission successively from successive ones of said outlying stations.

57. A system of communication which comprises a plurality of message-originating transmitters, a channel of transmission common to a plurality of said originating transmitters and terminating at an intermediate relaying station, means for storing the messages mechanically at the intermediate relaying station, and selecting devices at the intermediate relaying station operative under control of each message for directing the message to a station of address, in combination with control equipment at the intermediate relaying station for successively and automatically assigning transmission periods one at a time to said plurality of message-originating transmitters to which said channel is common.

58. A system comprising a plurality of geographically separated message-initiating transmitters, a channel of transmission common to said transmitters, message recording equipment associated with said channel for recording messages transmitted from any of a plurality of said transmitters, and control equipment associated with said channel at one station for automatically and successively initiating transmission from said plurality of transmitters under the control of said one station.

59. A system comprising a plurality of message-originating transmitters associated with a common channel of transmission, receiving devices associated with and individual to said plurality of said transmitters, a receiving device common to said plurality of transmitters and associated with said channel of transmission, a control point including control equipment for successively and automatically assigning times of transmission from said transmitters to said common receiving device, in combination with a transmitter at said control point and means for delivering messages selectively from said transmitter at said control point to said plurality of receivers.

60. A system comprising a plurality of geographically separated message-initiating transmitters, a channel of transmission common to said transmitters, message receiving equipment associated with said channel for receiving messages transmitted from any of a plurality of said transmitters, control equipment associated with said channel for automatically and successively sending signals to initiate transmission from said plurality of transmitters, and means responsive to signals received by said receiving equipment for initiating the operation of said automatic control equipment.

61. A system comprising a plurality of geographically separated message-initiating transmitters, a channel of transmission common to said transmitters, message receiving equipment associated with said channel for receiving messages transmitted from any of a plurality of said transmitters, control equipment associated with said channel for automatically and successively initiating transmission from said plurality of transmitters, and means responsive to the cessation of the reception of signals by said receiving equipment for a predetermined interval of time for initiating the operation of said control equipment.

62. A system of communication having, in combination with a tape controlled transmitting unit and a plurality of terminal units, an intermediate relaying unit connected over a telegraph line to said transmitting unit and automatically operative upon delivery of message-matter thereto by the transmitting unit to relay the same to one of the terminal units selectively, characterized in that the intermediate relaying unit has associated therewith control apparatus for sending start signals and the transmitting unit has associated therewith controlled apparatus responsive to said start signals, whereby transmission from the transmitting unit is automatically repeatedly initiated under control of the control apparatus associated with the intermediate relaying unit.

63. A system of communication having, in combination with a tape controlled transmitting unit and a plurality of tape controlled outgoing

line units, an intermediate tape controlled relaying unit having directing means automatically operative upon delivery of message-matter thereto by the transmitting unit to relay the same to one of the outgoing line units selectively, characterized in that the intermediate relaying unit has associated therewith control apparatus and the transmitting unit has associated therewith controlled apparatus, for automatically initiating transmission from the transmitting unit at intervals under control of the control apparatus associated with the intermediate relaying unit.

64. A system of communication having, in combination with a plurality of permutation code transmitting units and a plurality of terminal units, a relaying unit having a storage medium on which message-matter codes interspersed with message address codes sent from a transmitting unit may be recorded, means operable automatically upon the recording of message address codes on said storage medium to initiate the transfer of subsequent message-matter codes to one of said terminal units selectively, control means associated with the relaying unit and controlled means associated with each transmitting unit for initiating transmission of address codes and message-matter codes from the transmitting unit, and means whereby said control means is actuated automatically to initiate transmission from the transmitting unit incident to cessation of or absence of transmission from another transmitting unit.

65. A system comprising a plurality of outlying stations and means for selectively transmitting code combinations representing messages from certain of said stations to others thereof including a telegraph exchange station through which said messages are relayed automatically, said exchange station including tape controlled transmitters operable to convert said combinations from mechanical to electrical form and electrically operable devices for recording signals in or upon tape, means operating under the control of certain of said combinations to select one of a plurality of paths for the transmission of the combinations as code representing currents, and solely automatically operable means at the exchange station for successively causing the conversion of stored message codes at successive ones of said outlying stations into code-representing electrical currents and their transmission to said central station.

66. A system of communication which comprises a plurality of message-originating transmitters, a channel of transmission common to a plurality of said originating transmitters and terminating at an intermediate relaying station, means at the intermediate relaying station operative under control of each message for relaying the messages selectively according to their respective addresses into a channel directed toward a station of address, in combination with control equipment at the intermediate relaying station for successively and automatically detecting cessation of incoming transmission upon said channel from one transmitter and incident to such cessation enabling another temporarily idle of said message-originating transmitters to transmit over said channel.

67. A system comprising a plurality of geographically separated message-initiating transmitters each having means for supplying it with message material in recorded form, a channel of transmission common to said transmitters, message receiving equipment associated with said channel for receiving messages transmitted from any of a plurality of said transmitters, control equipment associated with said channel at one point and a plurality of means operably controlled thereby, one for each said transmitter, for automatically and successively initiating transmission from said plurality of transmitters, and means responsive to signals received by said receiving equipment for initiating the operation of said automatic control equipment.

68. A system comprising a plurality of geographically separated message-initiating transmitters, channels including a two-way channel of transmission common to said transmitters, a message recording instrumentality associated with said channel for making a record of messages transmitted from any of a plurality of said transmitters, control equipment associated with said channel for automatically and successively initiating transmission from said plurality of transmitters, means responsive to the cessation of the reception of signals by said receiving device for a predetermined interval of time for initiating the operation of said control equipment and means operating under control of the record for selectively relaying messages recorded therein over one or more of said channels.

69. A system comprising a plurality of geographically separated message-initiating transmitters, a channel of transmission common to said transmitters, message receiving equipment associated with said channel for receiving messages transmitted from any of a plurality of said transmitters, control equipment associated with said channel for automatically and successively initiating transmission from said plurality of transmitters, and means responsive to a specific code or sequence of code signals received by said receiving equipment for initiating the operation of said automatic control equipment.

70. A system comprising a plurality of geographically separated message-initiating transmitters, a channel of transmission common to said transmitters, message receiving equipment associated with said channel for receiving messages transmitted from any of a plurality of said transmitters, control equipment associated with said channel for initiating transmission from one or another of said plurality of transmitters, said control equipment including means responsive to the cessation of the reception of signals by said receiving device for a predetermined interval of time for causing operation of said control equipment to initiate transmission from another of said transmitters.

71. A system comprising a plurality of geographically separated message-initiating transmitters, supply means for furnishing message material in stored form for transmission by said transmitters, a channel of transmission common to said transmitters, receiving means for receiving such message material transmitted over said channel, control equipment for putting one of said transmitters in transmitting relation to said channel, devices monitoring said channel and operable upon absence or cessation of transmission by said one transmitter to actuate said control equipment, and controlled means operable incident to said actuation temporarily to remove said one transmitter from transmitting relation to said line and place another transmitter in transmitting relation thereto.

72. A system comprising a plurality of geographically separated message-initiating transmitters, supply means for furnishing message

material in stored form for transmission by said transmitters, a receiving device common to said transmitters for receiving messages transmitted thereby, control equipment for putting one of said transmitters in transmissive relation to said receiving device, message receiving equipment cooperating with said receiver and operable upon absence, cessation or termination of transmission by said transmitter to actuate said control equipment, and control means operable incident to each said actuation to remove any transmitter from transmissive relation to said receiving device and put another transmitter in such transmissive relation.

73. A combination according to the foregoing claim 72 having cyclic means whereby a plurality of said transmitters are cyclically put in said transmissive relation.

74. In a system of telegraph transmission in which messages are directed by codes at the head end thereof, a station for originating a message, a line to another station, a reperforator at said other station for initially recording a message transmitted from said originating station, said reperforator being normally disassociated from said line, and means operative by reception over said line of a code or a plurality of codes prior to a directing code or codes for associating said reperforator with said line for the recording of a directing code whereby said reperforator is protected against recording line hits as directing codes.

75. In a system of telegraph transmission in which messages are directed by codes which precede the message, a station for originating the message, a line to another station, a reperforator at said other station for initially recording a message transmitted at said originating station, said reperforator being normally disassociated from said line, and means responsive to the reception of a code signal repeated a predetermined number of times prior to said directing codes for associating said reperforator with said line for recording said directing codes and the following message whereby said reperforator is protected against recording line hits as directing codes.

76. In a system of telegraph transmission in which messages are directed by codes at the head end thereof from a station for originating said messages over a line to a recording device individual to said line at another station, means for protecting said recording device from recording interference as directing codes which comprises apparatus for normally disassociating said recording device from said line, and means controlled by the signal conditions applied to said line prior to the transmission of said directing codes for associating said recording device with said line for the recording of said directing message codes.

77. In a system of telegraph transmission in which messages are directed by codes preceding the messages, a station for originating a message, a line from said station to another station, a reperforator individual to said line for initially recording a message transmitted from said originating station, apparatus for normally disassociating said reperforator from said line, and means operative by the reception of a predetermined pattern of a plurality of signaling conditions transmitted over said line for associating said reperforator with said line for the recording of directing code whereby said reperforator is protected against recording line hits as directing codes.

78. In a multi-station telegraph system, a switching center and a plurality of other stations, telegraph lines or channels connecting said other stations to said switching center, printers at said stations for communicating over said lines or channels, receiving devices including tape reperforators at said switching center for storing message signals from the other stations, means to operatively associate a tape reperforator temporarily with a line or channel to receive a message from a station on said line or channel, means operable from said other station to release the reperforator and means to automatically release the reperforator if the operator at said other station fails to release said reperforator.

79. In a multi-station telegraph system, a main office and a plurality of other stations, telegraph lines or channels connecting said other stations to said main office, means including switching means at said main office operable to intertransfer messages from one to another of said lines or channels, means including printers at said stations for effecting communication over said lines or channels, receiving devices including tape reperforators at said main office for storing message signals from the other stations, means to receptively associate a tape reperforator temporarily to a line or channel when transmission is initiated from a station on said line or channel, means operable at the station initiating transmission to control the dissociation of the reperforator and means to automatically disassociated the reperforator if the calling station operator fails to operate said means.

80. In a multistation telegraph system, a central station and a plurality of subscriber stations, telegraph lines or channels from said subscriber stations to said central station, printers operatively associated with said lines or channels, signal storage units at the central station for storing signals received from said subscriber stations, manually operable means at each of said subscriber stations for preparing messages for transmission to said central station, means responsive to reception of said prepared messages for operatively associating an idle signal storage unit to the line to one of said subscriber stations, and means effective when no signals are received from said subscriber station for a predetermined period of time for automatically releasing the operatively associated signal storage unit.

81. In a telegraph switching system, a main office and a plurality of outlying stations, telegraph lines or channels from each of said outlying stations to said main office, switching means at the main office for intertransferring messages from one to another of said lines or channels, permutation code controlled recorders operatively associated with said lines or channels, signal storage units at the main office for code signals from the branch stations, operator controllable means at each outlying station for initiating message sending to the main office, means responsive thereto for receptively connecting an idle signal storage unit to the sending outlying office and means effective when no signals are received from the calling outlying office for a predetermined period of time for automatically releasing the connected signal storage unit.

82. In a telegraph system a tape, means for storing signals in said tape, telegraph transmitter controlled by said signals stored in said tape, means for passing said tape from said storage means to said transmitter, means responsive to a predetermined minimum quantity of tape between said transmitter and said storing means

for stopping the operation of said transmitter, a retarding relay controlled by said responsive means for preventing the restarting of said transmitter during the retarded interval of said relay.

83. In a telegraph system, means for storing telegraph signals, a telegraph transmitter controlled by said stored signals, instrumentalities responsive to a reduction of the stored signals to a predetermined minimum for stopping the operation of said transmitter, a time delay device, an operative connection between said instrumentalities and said time delay device for initiation of the operation of said time delay device, and means controlled by said time delay device for preventing the starting of said transmitter during the delay interval of said delay device.

84. In a telegraph system, a cross-bar switch, a signal transmitter operated by stored signals, means for storing a plurality of successive messages to be transmitted by the transmitter, certain of said messages being destined for different stations of address, directing codes at the head end of each message and an end-of-message code or codes being at the rear end thereof, means operable in accordance with the directing codes for selectively establishing paths over said cross-bar switch, devices operable incident to each end-of-message code to stop transmission from said transmitter and means operable thereafter incident to the selective establishment of a path over said cross-bar switch to initiate further transmission from said transmitter.

85. In a telegraph system, an automatic transmitter, a line, arrangements for starting transmission from said automatic transmitter by remote control over said line from a distant point comprising a transmitter starting circuit associated with the transmitter, sending apparatus for sending a pattern comprising a plurality of code combinations separated by a pause from said distant point to actuate said circuit to its start condition, and means operative in response to reception immediately following said pause of any signal other than the normal next signal of said pattern for preventing the actuation of said circuit to its start condition.

86. A telegraph system comprising a switching station, a plurality of telegraph transmitting instrumentalities and a message interceptor at said switching station, a plurality of telegraph lines extending from said switching station, a plurality of other stations connected to said lines, a director for each said transmitting instrumentality for selectively controlling the associated transmitting instrumentality for directing the messages transmitted thereby to any said other stations in accordance with the first code signals of a series of code signals, a plurality of operable switching devices, each individual to one of said other stations and all associated with one of said transmitting instrumentalities, and means responsive to the operation of any one of said switching devices for redirecting the transmission from said one transmitting instrumentality of all messages directed to the station individual to said device to said message interceptor.

87. A system for selectively conditioning apparatus associated with a channel of telegraphic transmission by telegraphic codes transmitted over the channel to condition the apparatus, which comprises; means for transmitting a signal pattern including a pause, a code combination for unconditioning all conditioned apparatus, and a code character for selectively conditioning one apparatus; selectively controlled devices actuated by reception of the entire pattern for conditioning an apparatus, and canceling means preventing the conditioning of any apparatus operated by reception after the pause of any code combination other than the one code combination assigned for unconditioning all apparatus.

88. A system for selectively conditioning apparatus associated with a channel of telegraphic transmission by telegraphic codes transmitted to condition the apparatus, which comprises; means for transmitting a signal pattern including a pause, a code combination for unconditioning all conditioned apparatus, and a code character for selectively conditioning one apparatus; selectively controlled devices actuated by reception of the entire pattern for conditioning an apparatus; and cancelling means for cancelling the effect of and response to the preceding portion of the pattern by reception after the pause of any code combination other than the one for unconditioning all said apparatus.

89. A method of selectively conditioning apparatus connected to a channel of telegraphic transmission by code combinations transmitted over the channel which comprises transmitting a pattern of code combinations for selectively conditioning one apparatus, selectively conditioning the apparatus by reception of the entire pattern within a predetermined period of time, and preventing the conditioning by expiration of the time prior to reception of the entire pattern.

90. A method of selectively conditioning apparatus connected to a channel of telegraphic transmission by code combinations transmitted over the channel which comprises transmitting a pattern of code combinations for selectively conditioning one apparatus, selectively conditioning the apparatus by reception of the entire pattern within a predetermined period of time, and canceling the effect of and response to the preceding portion of the pattern by expiration of the time prior to reception of the entire pattern.

91. In a telegraph system, a switching station, a plurality of sources of messages incoming to said station accompanied by individual address signals, a station of address for said messages, selective devices operating in accordance with the address signals for controlling direction of the messages through said switching station toward the station of address, control means for temporarily conditioning said selective devices whereby messages directed to said station of address may be diverted to a supplemental path, a storage instrumentality in said path for storing said diverted messages including signals of address, and transmitting-on means automatically operable under control of the messages stored in said instrumentality for causing selective devices to selectively control direction of said messages to said station of address.

92. In a telegraph system, a switching station, a plurality of sources of messages incoming to said station accompanied by individual address signals, a station of address for said messages, selective devices operating in accordance with the address signals for controlling direction of the messages through said switching station toward the station of address, control means for temporarily conditioning said selective devices whereby messages directed to said station of address may be diverted to a supplemental path, a storage instrumentality in said path for storing said diverted messages including signals of address, and means whereby together with means for at times conditioning said transmitting-on

means to suspend retransmission of stored messages and at other times to recondition said transmitting-on means to proceed with further retransmission of stored messages.

93. In a telegraph system, a switching station, a plurality of sources of messages each combined with address signals; a station of address for said messages; selective devices operative in accordance with the address signals for controlling transmission of currents representing the messages to a recording device at their station of address; and control means for conditioning the selecting devices whereby messages from a selected portion less than the whole of said sources may be redirected to another recording device.

94. In a telegraph system, a switching station; a plurality of sources of messages each combined with address signals; a station of address for said messages, selective devices operative in accordance with the address signals for controlling transmission of currents representing the messages to a recording device at their station of address; control means for conditioning the selecting devices whereby messages from a selected portion less than the whole of said sources may be redirected to another recording device; and a retransmitter for retransmitting signals under control of said last named recording device together with circuit connections whereby said retransmitter functions in said system as a source of messages, each combined with address signals.

95. In a telegraph system, a switching station, a plurality of sources of incoming messages including individual address signals; a plurality of stations of address for the messages reached by a channel at least in part common thereto and leading from the switching station; selective devices operative in accordance with the address signals for controlling transmission of currents representing the messages to recording devices at their respective stations of address; and control means for conditioning the selective devices whereby messages for a selected number less than the whole of said stations of address may be redirected to recording means elsewhere.

96. In a telegraph system, a switching station, a plurality of sources of incoming messages including individual address signals; a plurality of stations of address for the messages reached by a channel at least in part common thereto and leading from the switching station; selective devices operative in accordance with the address signals for controlling transmission of currents representing the messages to recording devices at their respective stations of address; control means for conditioning the selective devices whereby messages for a selected number less than the whole of said stations of address may be redirected to storage means elsewhere, and a signal retransmitter controlled by and in accordance with signals stored in said storage means, together with circuit connections whereby said storage means and retransmitter is or may be conditioned to function as one of said plurality of sources of incoming messages.

97. In a telegraph system, a switching station, a plurality of sources of incoming messages including individual address signals, a plurality of stations of address for the messages reached by a channel at least in part common thereto and leading from the switching station, selective devices operative in accordance with the address signals for controlling transmission of currents representing the messages to recording devices at their respective stations of address, control means for conditioning the selective devices whereby messages for a selected number less than the whole of said stations of address may be redirected to recording means elsewhere, in combination with other stations of address for messages from the plurality of sources, and control means for conditioning said selective means in a manner whereby messages from a selected portion of said sources to any of said other stations of address may be redirected to another recording device.

98. In a telegraph system, a switching station, a plurality of sources of incoming messages including individual address signals, a plurality of stations of address for the messages reached by a channel at least in part common thereto and leading from the switching station, selective devices operative in accordance with the address signals for controlling transmission of currents representing the messages to recording devices at their respective stations of address, control means for conditioning the seelctive devices whereby messages for a selected number less than the whole of said stations may be redirected to recording means elsewhere, in combination with other stations of address for messages from the plurality of sources, control means for conditioning said selective means in a manner whereby messages from any selected portion of said sources to any of said other stations of address may be redirected to another recording device, and a signal retransmitter controlled by and in accordance with signals stored in said last-named recording device, together with circuit connections whereby said recording device and retransmitter is or may be conditioned to function as one of said plurality of sources of incoming messages.

99. In a telegraph system, a switching station; a plurality of sources of series of signals forming messages, each message combined with address signals; a plurality of stations of address for said messages; selective devices operative in accordance with the address signals for controlling transmission of currents representing the messages over paths leading toward the respective stations of address; control means for conditioning the selecting devices whereby messages for any station of address received from a selected portion of said sources may be redirected to an intercept recorder; and control means whereby messages for another station of address from independently selected portions of said sources may be redirected to a different intercept recorder.

100. In a telegraph system, a switching station, a plurality of sources of messages each normally accompanied by address signals, a station of address for said messages, a plurality of single channel transmission paths having stages of storage and retransmission through said switching station over any one of which messages may be directed to said station of address, selective devices operated in accordance with the address signals for controlling direction of messages over said paths, a supplemental path including more stages of storage and retransmission than the others, and control means for automatically causing messages directed to said station of address to proceed thereto via said supplemental path.

101. In a telegraph system, a switching station, a plurality of sources of messages each normally accompanied by address signals, a station of address for said messages, a path including at least one stage of storage and re-

transmission through said switching station over which any one of said messages may be directed to said stations of address, selective devices operated in accordance with the address signals for controlling direction of messages over said path, a supplemental path having a different number of stages of storage and retransmission, and control means for causing messages to be directed under the control of their original address signals over said supplemental path to their station of address.

102. In a telegraph system, a switching station, a source of message codes each combined with address signal codes, a station of address for said messages represented by the message codes, selective devices operative in accordance with the address codes for controlling direction of the message codes exclusively over one or more primary paths through said switching station toward the station of address, and control means for temporarily conditioning said selective devices whereby all of said message codes may be directed exclusively, during such conditioning, over a secondary path through said switching station toward said station of address.

103. In a telegraph system, a switching station, a source of codes interspersed with address codes, a recorder for storing both kinds of codes in a storage form as a succession of codes, a transmitter controlled thereby having sensing means for sensing the codes in succession, advancing means operative upon the presentation of each message code to advance the next code to the sensing means, advance preventing means operative upon the presentation for sensing of an address code to said sensing means to withhold operation of said advancing means, path selecting means operable incident to and operative under control of the sensing of said address code to selectively determine a path of further transmission for currents representing the address code, and relay means operative upon the determination of said path for causing the resensing of said code and transmission of currents in accordance therewith.

104. In a telegraph system, a switching station, a source of message codes interspersed with address signal codes, a recorder for storing both kinds of said codes in a storage form adapted to contain successive codes, a transmitter controlled thereby having sensing means for sensing the codes in succession, advancing means operative upon the presentation of each message code to advance the next code to the sensing means, means operative upon the presentation of an address code to said sensing means to determine the address nature of said code and to temporarily withhold operation of said advancing means, means operable incident to the sensing of said address code to selectively determine a path of further transmission for a subsequent message code and means operative upon the determination of said path for causing the resensing of said code and transmission in accordance therewith.

105. In combination, a storage tape for code signals arranged in succession therein, a transmitter having sensing elements for sensing each code as presented thereto, tape advancing means for advancing each code to the sensing elements, means operated normally upon completion of each sensing of a code to advance the tape, means operated by a certain sequence of codes to prevent operation of said tape advancing means upon sensing one code, means operated under control of said one code to select a path automatically and means operative upon selection of said path to transmit currents representing said code over said path and to advance said tape.

106. In a telegraph system, a switching station, a source of codes comprising messages each combined with address codes representing a station of address, selective devices operating in accordance with the address codes for controlling direction of the signals over a path leading toward the station of address, said selective devices being controlled by a signal storage form containing the successive codes, a transmitter controlled thereby having sensing means for sensing the codes in succession, advancing means normally operative incident to completion of sensing of each code to advance the next code to the sensing means, an advance preventer operative upon the presentation of an address code to said sensing means to withhold operation of said advancing means, means operable incident to the sensing of said address code to cause said selective devices to selectively determine a path of further transmission, means operative upon the determination of said path for causing the resensing of said code and permitting of further operation of said advancing means and transmission in accordance with succeeding codes of said form.

107. In a telegraph system, a plurality of automatic telegraph transmitters, signal sources for supplying said transmitters with control forms having message codes and directing codes, coordinate switch directing means for selectively establishing paths from said transmitters over said switch according to said directing codes, a sequence circuit for permitting the establishing over contacts of said switch of one path at a time and means in said sequence circuit for controlling said directing means to prevent the establishing of a second path until the first path is fully established.

108. A system of communications which comprises a plurality of message-originating transmitters in combination with control equipment for manually at will initiating the transmission of any one of said transmitters, equipment for thereafter successively and automatically assigning periods of operation one at a time to said plurality of message-originating transmitters and manually controlled apparatus for initiating the operation of said equipment for successively and automatically assigning periods.

109. In a telegraph system, a switching means comprising an array of contacts arranged in a plurality of groups of series, selective magnets for conditioning respective series of one group of said series of said contacts, each of said series corresponding to an automatic storage transmitter controlled by a sequence of stored message codes and directing codes, holding magnets for each series of another group of series of said contacts which series are coordinately arranged with the series of said one group, means for storing codes for such control, means whereby any storage transmitter having a message to direct actuates its respective selecting magnet, means selectively operative under control of the stored directing codes to select and actuate a holding magnet whereby a signal path or set of paths common to said two series of contacts is closed to establish a transmission path from said automatic storage transmitter over said path of transmission for

conducting currents controlled by said message codes.

110. In a system according to the foregoing claim 109, circuit means operative to prevent two selecting magnets from being operated at the same time.

111. In a combination according to claim 109, circuit means operative to release the selecting magnet used in establishing a path upon the establishment thereof while maintaining the established path and to permit the operation thereafter of any selecting magnet.

112. In a system according to claim 109, a disconnect arrangement for releasing holding magnet actuated under control of any one transmitter in response to a stored disconnect code pattern in a sequence of codes supplied to said one transmitter.

113. The method of selectively connecting one of a plurality of transmitters to a channel of transmission by telegraphic codes transmitted to control the transmitters which comprise transmitting a signal pattern including a pause, a character for freeing all of said transmitters from the channel, and a selecting character for connecting a selected transmitter by reception of the entire pattern, and preventing the connection by the reception after the pause of any signal other than the one character for freeing all transmitters from the channel.

114. The method of selectively connecting one of a plurality of transmitters to a channel of transmission by telegraph codes transmitted to control the transmitters which comprises transmitting a signal pattern including a pause, a character for freeing all of said transmitters from the channel and a selecting character for connecting a selected transmitter in response to the reception of the entire pattern, cancelling the effect of and the response to the preceding portion of the pattern by reception after the pause of any signal other than the one for freeing all transmitters from the channel.

115. The method of selectively connecting one out of a plurality of transmitters to a channel of transmission by telegraphic codes transmitted to control the transmitters which comprises transmitting a signal pattern including a pause, a character for freeing all of said transmitters from the channel and a selecting character for connecting a selected transmitter upon the reception of the entire pattern and preventing the connection of any transmitter to the channel by the reception after the pause of any character other than the one for freeing all transmitters from the line.

116. The method of remotely conditioning apparatus to the desired one of a plurality of conditions by telegraphic codes transmitted to the apparatus which comprises transmitting a signal pattern including a pause of a predetermined minimum duration, conditioning the apparatus to the desired condition by reception of the entire code pattern including the pause, and preventing the conditioning by reception of any pattern having a pause of less than the predetermined minimum duration.

117. The method of remotely conditioning apparatus to a desired one of a plurality of possible conditions by telegraphic codes transmitted to control the apparatus which comprises transmitting a signal pattern including a pause of a predetermined minimum duration, conditioning the apparatus to the desired condition by reception of the entire code pattern including the pause and canceling the effect of and response to the preceding portion of the pattern by interruption of the pause before its minimum duration.

118. A method of remotely conditioning apparatus to a desired one of a plurality of possible conditions by telegraph codes transmitted to control the apparatus which comprises transmitting a signal pattern including a pause of predetermined minimum duration, conditioning the apparatus to the desired condition by the reception of the entire code pattern including the pause and preventing the conditioning by reception of any pattern having signals or characters subtracted from or added to or departing from signification portions of the pattern.

119. The method of remotely conditioning apparatus to the desired one of a plurality of possible conditions of telegraphic codes transmitted to control the apparatus which comprises transmitting a signal pattern including a pause of predetermined minimum duration, conditioning the apparatus to the desired condition by reception of the entire code pattern including the pause and cancelling the effect of and response to any preceding portion of the pattern by reception of a signal foreign to a characteristic part thereof.

120. In a telegraph system having a central switching station, a channel of transmission leading therefrom to an outlying station or stations, a plurality of originating sources capable of originating messages destined randomly for said outlying station or stations and other stations, message storing devices and retransmitters actuated thereby in said central station for storing said messages, means for preventing the delay of other messages by messages destined for said outlying station or stations comprising a plurality of storage devices exclusively associated with said channel of transmission to store messages simultaneously directed thereto, and circuit paths for storing messages in a plurality of said exclusively associated storing devices.

121. In a telegraph system a control station, a plurality of other stations, record controlled transmitters located at said other stations, a testing circuit for testing said transmitters for a supply of record material for transmission, means for causing said testing circuit to operate automatically under control of signals transmitted by said transmitters and means for interrupting the automatic operation of said test circuit and causing it to test any desired one of said transmitters.

122. In a telegraph system a plurality of storage transmitters for transmission over a common channel, a control circuit for testing said storage transmitters in rotation for stored material for transmission and apparatus for seizing control of said channel and disassociating an operating transmitter therefrom at any time and independent of the presence of any stored message signals in said transmitter.

123. A telegraph system comprising a control station, a plurality of other stations, telegraph lines extending from said control station to a plurality of said other stations, switching equipment for directing telegraph messages toward the stations connected to said line and apparatus for causing a portion of the messages directed to one of the stations of said line to be transmitted to an intercept circuit and other apparatus for directing another portion of the messages intended for said one station to another intercept circuit.

124. In a telegraph system, a switching station, a plurality of outgoing transmission paths ex-

tending therefrom to stations of address, a plurality of storage transmitters each supplied with message codes and address codes, a plurality of storage repeaters individual to each of a plurality of said outgoing paths, selective devices operative in accordance with the address signals for controlling the transmission of currents representing messages from said transmitters to said storage repeaters for permitting the simultaneous transmission of a plurality of messages from said transmitters to the storage repeaters individual to one of said paths, and switch means for reducing the number of storage repeaters individual to any of said paths and causing said selective devices to automatically control the transmission of messages from all of said transmitters to the remaining storage repeaters individual to said paths.

125. In a telegraph system, a switching station, a plurality of outgoing transmission paths extending therefrom to stations of address, a plurality of storage transmitters each supplied with message codes and address codes, a plurality of storage repeaters individual to each of a plurality of said outgoing paths, selective devices operative in accordance with stored address signals for controlling the transmission of currents representing messages from said transmitters to said storage repeaters for permitting the simultaneous transmission of a plurality of messages from said transmitters to the storage repeaters individual to one of said paths, and switch means for controlling said selective devices so they will automatically direct the transmission of some messages directed to one of said outgoing paths to an additional storage repeater for the later transmission over said outgoing path.

126. In a telegraph system, a switching station, a plurality of outgoing transmission paths extending therefrom to stations of address, a plurality of storage transmitters each supplied with message codes and address codes, a plurality of storage repeaters individual to each of a plurality of said outgoing paths, selective devices operative in accordance with the address signals for controlling the transmission of currents representing messages from said transmitters to said storage repeaters for permitting the simultaneous transmission of a plurality of messages from said transmitters to the storage repeaters individual to one of said paths, and switching apparatus for assigning an additional storage repeater for receiving a portion of the message currents directed to said one path by said selective devices.

127. In a telegraph system, a switching station, a plurality of outgoing transmission paths extending therefrom to stations of address, a plurality of storage transmitters each supplied with message codes and address codes, a plurality of storage repeaters individual to a plurality of said outgoing paths, selective devices operative in accordance with the address signals for controlling the transmission of currents representing messages from said transmitters to said storage repeaters for permitting the simultaneous transmission of a plurality of messages from said transmitters to the storage repeaters individual to one of said paths, and switching apparatus for transferring one of said storage repeaters from one of said lines to receive a portion of the messages directed to another line and for controlling said selective devices to automatically control the transmission of currents to the remaining storage devices individual to said one line and controlling the transmission of message currents directed to said other line to the storage repeaters individual thereto and to said transferred storage repeater.

128. In a telegraph system, a source of telegraph signals, a storage repeater for relaying said signals comprising a recording device for recording said signals in physical form, a storage transmitter controlled by signals stored in physical form, a time delay device, an indicating device actuated by said time delay device, and means responsive to the recording of predetermined signals to initiate the operation of said time delay device and other means responsive to the transmission of said predetermined signals to interrupt the operation of said time delay device and restore it to its unoperated condition.

129. In a telegraph system, a storage transmitter supplied with series of stored signals forming messages and addresses therefore, a transmission path, selective switching apparatus for extending said path to said transmitter selectively in accordance with the address portions of said stored signals, a time delay device, an indicating device for indicating abnormal operating conditions controlled by said time delay device, apparatus responsive to an idle condition of said path and to the operation of said switching apparatus for initiating the operation of said timing device, and means responsive to the extension of said path to said transmitter to arrest the operation of said timing device.

130. In a permutation code telegraph system in which each character, symbol, or function is represented by a code combination of a fixed number of signaling impulses of at least two different kinds, a plurality of two position contact members equal in number to said fixed number of signaling impulses for completing circuit paths in both positions thereof, a single electrical relay having winding terminals and an armature, electrical current paths for said relay extending in a fixed state of continuity from winding terminals of said relay to each of said contacts and to at least one source of substantially unvarying unidirectional electrical energy, said contact paths including means for causing the armature of said relay to assume one position in response to any one predetermined setting of said contacts and for causing said armature to assume another condition for all other settings of said contacts.

131. In a telegraph system, a signal controlled apparatus, a plurality of two position permutation elements controlled by said apparatus, a single electrically controlled device, electrically conductive control paths extending in a fixed state of continuity from said device to at least one source of potential and to each of said two position elements, said path including means for causing said device to assume one condition in response to any one predetermined permutation setting of said elements and to assume another condition in response to all other possible permutation settings of said elements.

132. In a permutation code signaling system, a plurality of transfer switches having two positions each of which is individual to one significant element of a permutation code, apparatus for positioning each of said switches in either one or the other of its positions in response to the corresponding elements of permutation codes, an electrical relay provided with a plurality of control elements, conductive circuit connections extending between said elements and all of said switches, said connections including means for causing said relay to assume one condition in response to any predetermined set of positions

of said switches and to assume another position in response to other positions of said switches.

133. In a permutation code signaling system, a plurality of transfer switches having two positions each of which is individual to one significant element of a permutation code, apparatus for positioning each of said switches in either one or the other of its positions in response to permutation codes, circuit connections for applying a first potential to said switches when they are in one of said positions, other circuit connections for applying a second potential different from said first potential to said switches when they are in their second position, an electrical relay provided with at least two control elements, means for causing said relay to assume one of its positions, circuit connections between said control elements and said switches for applying electrical conditions to said control elements for overcoming the effect of said means when said switches are in all but one of their possible permutative settings.

134. In a permutation code signaling system, a transfer switch having two positions for each significant element of a permutation code, apparatus for positioning each of said switches in either one or the other of its positions in response to permutation codes, circuit connections for applying a first potential to said switches when they are in one of said positions, other circuit connections for applying a second potential different from said first potential to said switches when they are in their second position, an electromagnetic relay, means for causing the armature of said relay to assume one of its positions, at least two windings for said relay, circuit connections from a first terminal of a first winding of said relay to said first potential, a circuit connection from a first terminal of said second winding to said second potential, circuit connections between the second terminals of said first and second windings to said switches for causing currents to flow through said windings to cause said relay to assume another position when said switches are positioned in all but one of their permutative settings.

135. In a permutation code signaling system, a transfer switch having two positions for each significant element of a permutation code, apparatus for positioning each of said switches in either one or the other of its positions in response to permutation codes, circuit connections for applying a first potential to said switches when they are in one of said positions, other circuit connections for applying a second potential different from said first potential to said switches when they are in their second position, an electromagnetic relay, means for causing the armature of said relay to assume one of its positions, at least two windings for said relay, circuit connections from a first terminal of a first winding of said relay to said first potential, a circuit connection from a first terminal of said second winding to said second potential, circuit connections between the second terminals of said first and second windings to said switches for causing currents to flow through said windings to cause said armature to assume another position when said switches are positioned in all but one of their permutative settings and for causing substantially the same potential to be applied to both terminals of the respective windings of said relay when said switches are positioned in one predetermined permutative setting.

136. In a permutation code selector system in which each character, symbol or function to be selected is represented by a permutation of a fixed number of code units of two different kinds, devices available in a number equal to the power of two represented by the number of code units to be selected each having two conditions, means normally biasing each device to a selected condition, two position elements corresponding in number to the code units conditioned to one of two conditions each by its respective code unit, control paths having a fixed state of continuity each conductively extending between said elements and each of said devices, said paths including means to control currents flowing therein so that for one selected setting of said elements the bias means of one only of said devices is not overcome and of all the others, if any, is overcome.

137. In a telegraph system having a central station, a two-way transmission channel leading from said station, a plurality of outlying stations associated with said path in such manner that any one of said stations can transmit toward said central station simultaneously with transmission from said central station to one of said way stations, automatic transmitters at said central station and outlying stations respectively in combination with control means automatically conditioned at intervals to cause the operation in sequence of automatically operable means for interrupting message transmission from the automatic transmitters at the central station, automatically operable means for sending control pulses during said interruption to initiate transmission from a transmitter at an outlying station toward said central station, and automatically operable means for resuming transmission, all without introduction of a message error.

138. In a telegraph system, a plurality of tape controlled telegraph transmitters each assigned an individual starting pattern for initiating transmission therefrom, a telegraph transmission path extendable to all of said transmitters, a transmitter start circuit for transmitting in rotation the transmitter start patterns assigned to each of said transmitters for extending said path to the respective transmitters and causing the transmission therefrom.

139. In a telegraph system, sources of message signals preceded by address characters, a plurality of switching devices each controlled by the same address characters and apparatus cooperating with the last switching device for absorbing said address characters.

140. In a telegraph system, a plurality of switching devices for selectively directing messages in accordance with address characters preceding each message, control equipment for controlling two of said switching devices under control of the same address character and apparatus for discarding an address character coincident with the second use of said character.

141. A telegraph recording device for recording permutation code telegraph signals in mechanical form in recording medium, means for recording a predetermined permutation code signal in said medium independently of received signals, manually operable switching apparatus for causing the operation of said means during only the time said manually operable switch apparatus is maintained operated and apparatus responsive to received signals for disabling said manually controlled operable means.

142. In a telegraph system, a plurality of tele-

graph stations, a telegraph transmission line extending to a plurality of said stations, telegraph apparatus located at each of said stations, permutation code selecting equipment connected to said line, control apparatus for controlling the telegraph apparatus at said stations, an operative connection between said selective equipment and said control apparatus, apparatus responsive to predetermined code combinations received in a predetermined order over said line for rendering said operative connection effective, circuits responsive to code combinations other than the succeeding said predetermined code combinations in said predetermined order for cancelling the effect of the first code combination of said predetermined code combinations.

143. In a telegraph system, a communication line extending from a first station to a plurality of other stations, telegraph apparatus at said first station for transmitting and receiving over said line, telegraph receiving apparatus located at a plurality of said stations for receiving over said line, telegraph transmitting apparatus located at a plurality of said stations for transmitting over said line, means for establishing an operative connection at at least one of said other stations between the receiving apparatus located thereat and said line, control equipment at said one station for sending control signals over said line to control the operation of the transmitters at said plurality of stations, said control signals including a signal not recorded by any of said receiving apparatus followed by a pause in the transmission, and apparatus operated near the end of the pause following said code combination for disassociating the received apparatus at any of said stations from said line.

144. In a telegraph system, a plurality of telegraph stations, a telegraph transmission line extending to a plurality of said stations, telegraph transmitting apparatus located at a plurality of said stations, telegraph receiving apparatus at a plurality of said stations, first control apparatus for selectively and operatively associating said receiving apparatus with said channel, apparatus for operatively associating said transmitting apparatus with said channel in response to predetermined code combinations followed by pauses of predetermined length, and control equipment for operatively disassociating said receiving apparatus from said channel in response to a predetermined one of said code combinations followed by a pause of a predetermined minimum duration.

145. In a telegraph system, a plurality of telegraph stations, a telegraph transmission channel extending to said stations, telegraph transmitting apparatus located at a plurality of said stations, telegraph receiving apparatus located at a plurality of said stations, control equipment for selectively and operatively associating said receiving apparatus with said telegraph channel, a system for selectively associating said telegraph transmitting apparatus with said channel, one at a time, comprising means for transmitting a signal pattern including a code combination not recorded by said receiving apparatus, followed by a pause, apparatus responsive to reception of a pause of predetermined minimum duration following said code combination not recorded by said receivers for disassociating previously associated receivers from said channel, and apparatus operative after the reception of the start pattern for again operatively associating a previously associated receiver with said channel.

146. In a telegraph system, a communication line extending from the first station to a plurality of other stations, telegraph apparatus at said first station for transmitting and receiving over said line, telegraph apparatus located at a plurality of said stations for communicating over said line, means for establishing operative connections at at least one of said other stations between said apparatus located thereat and said line, control equipment at said one station for sending control signals including a signal not recorded by any of said apparatus immediately followed by a predetermined pause during which no signals are transmitter over said line to control the operation of the telegraph apparatus at said plurality of stations, and apparatus operated near the end of the pause following said code combination for disassociating previously associated telegraph apparatus at any of said stations from said line.

147. In a telegraph system, a plurality of telegraph stations, a multiple-station telegraph transmission channel extending to a plurality of said stations, telegraph transmitting apparatus located at a plurality of said stations, telegraph receiving apparatus at a plurality of said stations, first control apparatus for selectively and operatively associating said receiving apparatus with said channel, apparatus for transmitting predetermined groups of control signals followed by pauses of predetermined length over said channel for operatively associating said transmitting apparatus with said channel, and control equipment for operatively disassociating said receiving apparatus from said channel in response to a predetermined one of said code combinations followed by a pause of a predetermined minimum duration.

148. In a telegraph system comprising a message initiating transmitter, a channel of transmission, message receiving equipment associated with said channel for receiving messages from said channel, control equipment associated with said channel remote from said transmitter for associating said transmitter with said channel and initiating the operation thereof, and apparatus responsive to the cessation of the reception of signals by said receiving equipment for a predetermined interval of time for disassociating said transmitter from said channel.

149. In a telegraph system, a message initiating tape controlled telegraph transmitter, apparatus responsive to the insertion of a control tape in said transmitter for conditioning said transmitter for transmission, a channel of transmission extending to said transmitter, message receiving equipment associated with said channel for receiving messages therefrom, control equipment remote from said transmitter associated with said channel for operatively associating said transmitter with said channel and initiating the operation thereof when conditioned for transmission, and means responsive to the end of said tape passing a predetermined point in said transmitter for disassociating said transmitter from said channel.

150. In a telegraph system, a plurality of telegraph transmission paths, a telegraph repeater normally non-responsive to telegraph signals associated with each of said paths, a telegraph communication line extending in a fixed state of continuity to said repeaters, and apparatus responsive to predetermined permutation code combination signals received over said line for

selectively conditioning one of said repeaters for repeating signals from said line to the associated transmission path.

151. In a system for controlling and directing the transmission of messages to different circuits by permutation code combinations, a single relay device for monitoring the permutation code combinations and responsive in one manner to any predetermined code combination and responsive in a different manner to all other permutation code combinations and apparatus responsive to said single device for controlling the transmission of succeeding code combinations.

152. In a telegraph system for controlling and directing the transmission of stored messages to different circuits by permutation code combinations, a monitoring device for monitoring the stored signals comprising a single relay responsive in one manner to any one predetermined code combination and responsive in another manner to all other code combinations, and apparatus controlled by said relay for stopping the transmission of message signals in response to said one code combination.

153. A system of communication having, in combination, a transmitting unit and a plurality of terminal units, an intermediate relaying unit geographically remote from said transmitting unit automatically operative upon delivery of message matter thereto by said transmitting unit to relay the same to one of said terminal units selectively characterized in that said transmitting unit has associated therewith apparatus responsive to a predetermined plurality of signals for initiating the operation of said transmitting unit and further characterized in that said intermediate relaying unit has associated therewith apparatus for cyclically transmitting said plurality of signals for repeatedly and automatically initiating the operation of said transmitting unit under control of the control apparatus associated with the intermediate relaying unit.

154. A communication system having in combination with a transmitting unit and a plurality of terminal units an intermediate relaying unit geographically remote from said transmitting unit for selectively relaying messages from said transmitting unit to said terminal unit characterized in that the transmitting unit has associated therewith apparatus responsive to a predetermined group of a plurality of signals including permutation code combinations of signals for controlling the operation of said transmitting unit and further characterized in that said intermediate relaying unit has associated therewith cyclically operable control apparatus for cyclically transmitting groups of predetermined control signals including permutation code combinations of signals for automatically and repeatedly controlling the operation of said transmitting unit under control of the control apparatus associated with the intermediate relaying unit.

155. In a telegraph system, a tape controlled transmitter, apparatus for recording message code signals in a tape and for recording a plurality of control signals in said tape, apparatus responsive to said control signals, and equipment for preventing transmission by said transmitter when stored control signals to which said equipment has responded pass through said transmitter.

156. In a telegraph system, a tape controlled transmitter, means for recording and storing in a tape message code signals and control code signals, apparatus responsive to certain of said control code signals, and other apparatus for selectively preventing the transmission by said transmitter of certain of said control code signals recorded in said tape to which said apparatus has responded when said signals pass through said transmitter.

157. In a telegraph system, a record controlled transmitter, means for recording in a record medium for controlling said transmitted message code signals and control code signals, apparatus responsive to certain of said code control signals before they are recorded in said record medium and equipment responsive to said control signals to which said apparatus responded before said signals were recorded in said record medium for preventing the transmission of said signals by said transmitter.

158. In a telegraph system, a tape controlled transmitter, apparatus for recording signals in a tape for later control of said transmitter, another transmitter in said system, apparatus operative incident to the recording of a predetermined signal in said tape for initiating the operation of said other transmitter and other apparatus responsive to said predetermined signal for preventing the transmission thereof by said first transmitter.

159. In a telegraph system, a plurality of telegraph repeating instruments, apparatus for normally preventing the operation of said repeating instruments and means responsive to permutation code signals for selectively rendering ineffective said apparatus for preventing the operation of said repeating instruments.

160. In a telegraph system, a plurality of geographically separated repeating devices, biasing means for each of said devices, circuit connections for said biasing means for normally maintaining said biasing means at a value which prevents the operation of said repeating devices, and apparatus responsive to predetermined telegraph signals for selectively changing said circuit connections of at least one of said biasing means to render the associated repeating device operative.

161. In a telegraph system, a plurality of repeating devices, a telegraph transmission path extending in a fixed state of continuity through each of said repeating devices, apparatus for rendering said repeating devices non-responsive to signals transmitted over said telegraph path, selecting devices associated with said repeating devices responsive to signals transmitted over said path for selectively disabling said apparatus.

162. In a telegraph system, a pluralty of repeating devices, a telegraph transmission path extending to said devices, control apparatus associated with said repeating devices responsive to permutation code signals, an operative connection between said control apparatus and said repeating devices for selectively conditioning said repeating devices for operation in response to predetermined permutation code signals.

163. In a permutation code telegraph system in which each character, symbol, or function is represented by a code combination of a fixed number of signaling impulses of a plurality of different kinds, a plurality of elements equal in number to the number of said impulses capable of assuming positions equal to the number of different kinds of said impulses, a single electric relay, control elements for said relay equal in number to the

number of different kinds of impulses, electric circuits for said relay extending in a fixed state of continuity from said control elements to all of said members and to at least one source of electrical energy for actuating the armature of said relay to one position in response to any one predetermined setting of said members and for causing the armature of said relay to assume another position for all other settings of said members.

164. In a telegraph system, a signal control apparatus, a plurality of two-position elements controlled by said apparatus, a single electrically controlled device, two control members for said device, control circuits extending in a fixed state of continuity from said control members to at least one source of electrical energy and to each of said two-position elements, circuit paths extending from said control members through said two-position elements in both positions thereof to actuate said device in one manner in response to any one predetermined setting of said elements and to actuate said device in a different manner in response to all other settings of said elements.

165. In a telegraph system, a communication path, a plurality of tape controlled telegraph transmitters at least certain of which are located remote from others of said transmitters, apparatus for associating said transmitters with said path one at a time, means for automatically, successively and in definite sequence testing said transmitters for the presence of control tape therein, and apparatus for initiating transmission from the respective transmitters when a control tape is found upon test to be present therein.

166. In a telegraph system, a telegraph transmission path, a plurality of tape controlled telegraph transmitters certain of which are located remote from others thereof, switching equipment for operatively connecting each of said transmitters to said path one at a time, apparatus responsive to signals transmitted over said path for controlling said switching equipment, apparatus for automatically, successively and in definite sequence transmitting signals over said path for testing each of said transmitters one at a time and in rotation for the presence of a controlling tape inserted therein, and apparatus jointly responsive to said testing and to the presence of a tape in said transmitters for initiating transmission therefrom.

167. In a telegraph system, a telegraph transmission path, a plurality of tape controlled telegraph transmitters, tapes for controlling said transmitters, means for operatively connecting said transmitters with said telegraph path one at a time, and means responsive to the end of a tape passing a predetermined point in an operating transmitter for disconnecting said operating transmitter from said path.

168. In a telegraph system, a telegraph transmission path, a plurality of tape controlled telegraph transmitters located remote one from another, control equipment operative over a telegraph transmission path for operatively associating each of said transmitters with said path one at a time and in a definite sequence, apparatus responsive to the absence of tape in said transmitter for causing said control apparatus to skip over the respective transmitter, apparatus responsive to the presence of tape in any transmitter for interrupting the operation of said control apparatus and initiating transmission from the respective transmitter, and equipment responsive to the end of said tape passing a predetermined point in said transmitter for again initiating the operation of said control apparatus.

169. In a telegraph system, monitoring equipment comprising a plurality of transfer switches, permutation elements for controlling said transfer switches, a single electrically controlled device, at least two control members for said device, control circuits extending from one or the other of said control members to each of said transfer switches, said circuits including means for completing conducting paths through said transfer switches to said control members in both positions of said transfer switches, said control circuits including at least one source of electrical energy for causing said device to respond in one manner to one predetermined permutation setting of said transfer switches and to cause said device to respond in a different manner in response to all other possible permutation settings of said transfer switches.

170. In a tape reperforator, means responsive to received regular signals for regularly feeding the tape, local manually operable means for producing auxiliary tape feed-out, means responsive to received special signals for automatically producing auxiliary tape feed-out, and means responsive to the resumption of reception of regular signals for promptly restoring control of the tape feed to said regular feeding means.

171. In a tape reperforator, means responsive to received regular signals for regularly feeding the tape, local manually operable means for producing auxiliary tape feed-out, means jointly responsive to received special signals and to the utilization of all except a predetermined minimum quantity of the tape perforated by said perforating mechanism for automatically producing auxiliary tape feed-out, and means responsive to the resumption of reception of regular signals for promptly restoring control of the tape feed to said regular feeding means.

172. A system for selectively conditioning apparatus associated with channel of telegraphic transmission by telegraphic codes transmitted to condition the apparatus, which comprises means for receiving a signal pattern, apparatus operated incident to reception of a particular part of the pattern to initiate measurement of a predetermined time interval, and canceling means operative upon termination of said time interval prior to the reception of a definite later portion of the pattern to cancel the effect of the portion of said pattern already received.

173. A system for selectively conditioning apparatus associated with a channel of telegraphic transmission by telegraphic codes transmitted to condition the apparatus, which comprises means for receiving a transmitted signal pattern including a predetermined code combination, a timer operated incident to reception of an early part of the pattern to start measurement of a time interval, canceling means operative at the end of said interval to cancel the conditioning effect of the portion of said pattern already received, and apparatus responsive to the reception of said pattern combination during said interval for preventing the operation of said canceling means.

174. A system for selectively conditioning a plurality of telegraph devices for operation over a channel of telegraphic transmission by telegraphic codes transmitted to condition one of at least a group of said devices which comprises means for receiving over the channel a signal pattern including a code combination for unconditioning all of the conditioned devices of at least

said group of said devices, and a code combination for selectively conditioning one of said devices for operation over said channel, a timer operated incident to the reception of an early part of the pattern to start measurement of a time interval, canceling apparatus operative at the end of said interval to cancel the conditioning effect of the portion of said pattern already received, apparatus responsive to said unconditioning code combination for unconditioning all of said devices in at least said one group thereof, other apparatus responsive to said code combination for selectively conditioning one of said devices for selectively operatively associating the selected device with said channel, and apparatus operative incident to the operation of said last-mentioned apparatus for preventing the operation of said canceling means.

175. In a teletypewriter system, an instrumentality for selectively reperforating tape in accordance with incoming codes, said instrumentality having a plurality of contacts selectively operable by the selector mechanism thereof, means controlled by one of said contacts responsive to a disconnect signal received by said reperforator for rendering said reperforator unresponsive to subsequently received signals, and means operable upon occurrence of a taut tape condition during the continuance of said unresponsive condition to feed additional tape.

176. In a printing telegraph system, a selector controlled tape reperforator having a plurality of contacts operable by the selector mechanism thereof, means controlled by one of said contacts responsive to a disconnect signal received by said reperforator for rendering said reperforator unresponsive to subsequently received signals, and means operable upon occurrence of a taut tape condition during the continuance of said unresponsive condition to feed additional tape.

177. In a printing telegraph system, a selector controlled tape reperforator having a plurality of contacts operable by the selector mechanism thereof, means controlled by one of said contacts responsive to an end-of-message signal sequence received by said reperforator for rendering said reperforator unresponsive to subsequently received signals, means operable upon occurrence of a taut tape condition during the continuance of said unresponsive condition to feed additional tape, and means operable after feeding out sufficient tape to cause tape feeding to cease.

178. In a printing telegraph system, a selector controlled tape reperforator having a plurality of contacts selectively operable by the selector mechanism thereof, means controlled by one of said contacts responsive to a disconnect signal received by said reperforator for rendering said reperforator unresponsive to subsequently received signals, and means operable upon occurrence of a taut tape condition during the continuance of said unresponsive condition to feed out tape perforated with letters signals.

179. In a printing telegraph system, a selector controlled tape reperforator having a plurality of contacts operable by the selector mechanism thereof, means controlled by one of said contacts responsive to a disconnect signal received by said reperforator for rendering said reperforator unresponsive to subsequently received signals, means operable upon occurrence of a taut tape condition during the continuance of said unresponsive condition to feed additional tape, and means operable after feeding out sufficient tape to cause tape feeding to cease.

180. In a printing telegraph system, a tape reperforator in combination with a transmitter operable under control of the perforated tape, said reperforator having a plurality of contacts operable by the selector mechanism thereof, means controlled by one of said contacts responsive to a disconnect signal received by said reperforator for rendering said reperforator unresponsive to subsequently received signals, and means operable upon occurrence of a taut tape condition between said reperforator and transmitter during the continuance of said unresponsive condition to successively actuate the tape punch elements according to all-marking condition and feed-out tape thus punched.

181. In a printing telegraph receiving system, a receiving recorder for recording signals on a flexible medium, means for advancing said medium with respect to said recorder, a plurality of contacts operable by the selector magnets of the said recorder, means controlled by one of said contacts responsive to a disconnect signal received by said recorder for rendering said recorder unresponsive to subsequently received signals, and means controlled incident to rendering said recorder unresponsive to establish a contact condition, and means operable upon occurrence of exhaustion of available recorded medium during the continuance of said unresponsive condition to advance the medium with respect to said recorder.

182. A telegraph switching system comprising a coordinate switch, a plurality of tape controlled telegraph transmitters, each individual to a row of contacts on said switch, a plurality of communication paths each individual to other rows of contacts of said switch in coordinate relation to said first group of rows of contacts, a perforated tape for controlling each said telegraph transmitter, means set into operation by one said transmitter under control of said tape to seize temporary exclusive control of said switch, and means responsive to signals perforated in the tape of one of said transmitters for actuating said switch to connect the corresponding transmitter to any of said communication paths.

183. A telegraph system comprising a crossbar switch, tape controlled telegraph transmitters individual to each of a plurality of rows of contacts on said switch, a plurality of communication paths each individual to a row of contacts on said switch coordinate to said first row of contacts, means actuatable by one of said transmitters provided with a message directed to one of said paths to seize exclusive temporary control of said switch, means controlled by said seizing transmitter during said control for establishing a communication path from said transmitter to any of said paths through said switch, means for releasing said switch for seizure and similar use by other transmitters during the maintenance of said communication path, and means responsive to predetermined signals recorded in the tape controlling said transmitter for releasing said connection.

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