March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

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FIG. 1

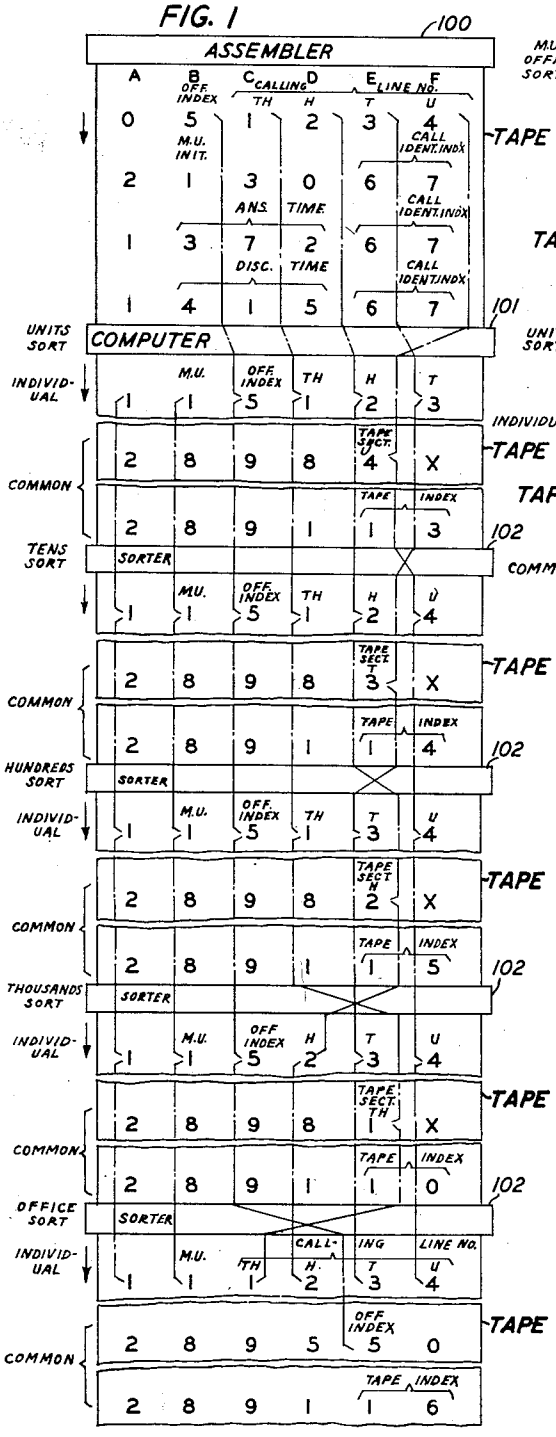

FIG. 2

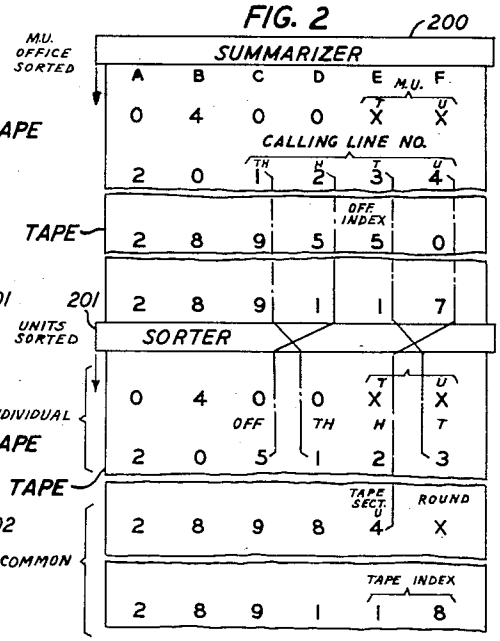

TABLE OF ABBREVIATIONS

ABBREVIATIONS	SIGNIFICANCE
DISC. TIME	DISCONNECT TIME
ANS. TIME	ANSWER TIME
CALL IDENT. INDEX	CALL IDENTITY INDEX
OFF. INDEX	OFFICE INDEX
M.U.	MESSAGE UNIT
TAPE SECT.	TAPE SECTION

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

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FIG. 3

FIG. 4	FIG. 5

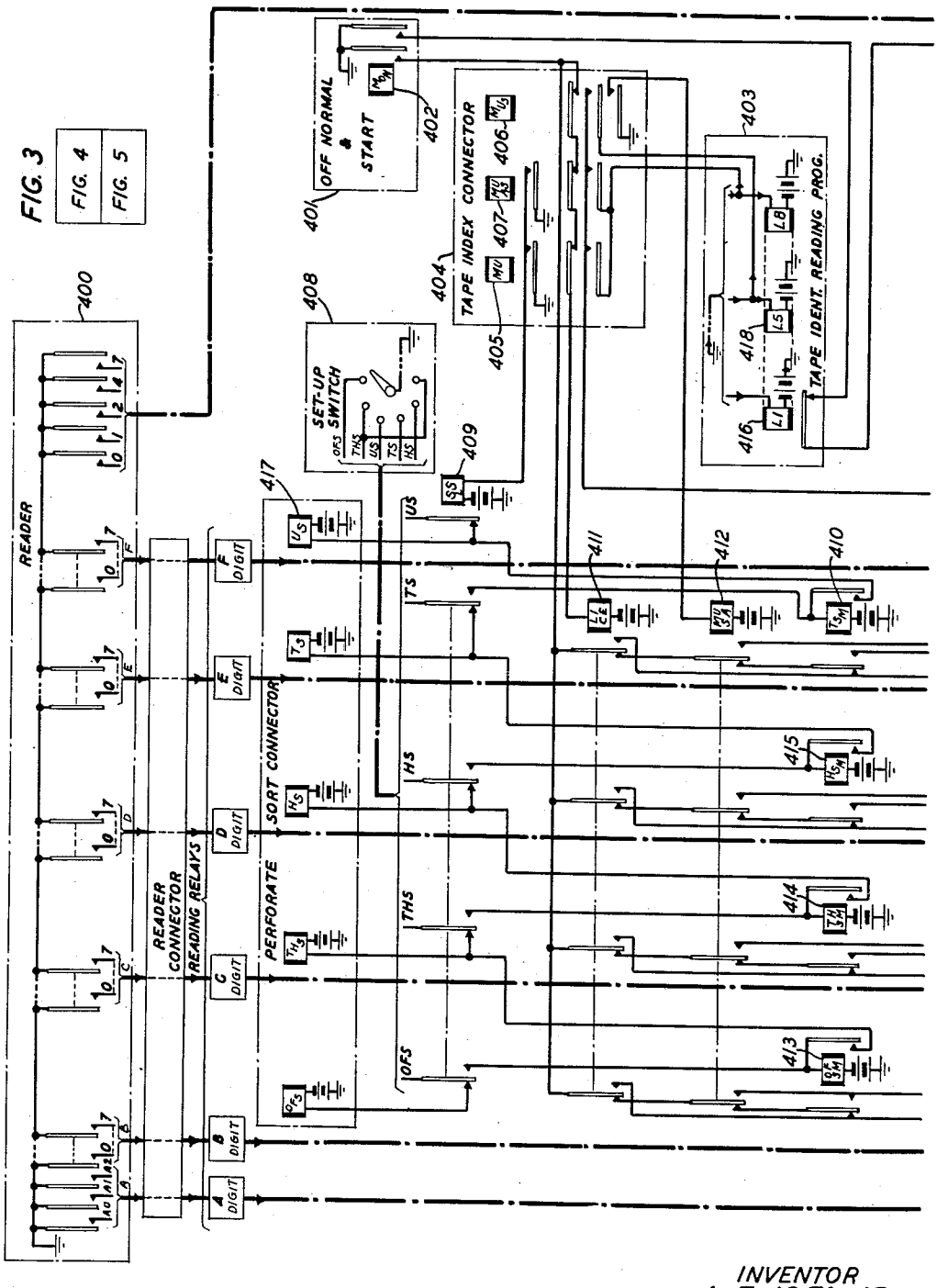

FIG. 4

INVENTOR
A. E. JOEL, JR.
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March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 3

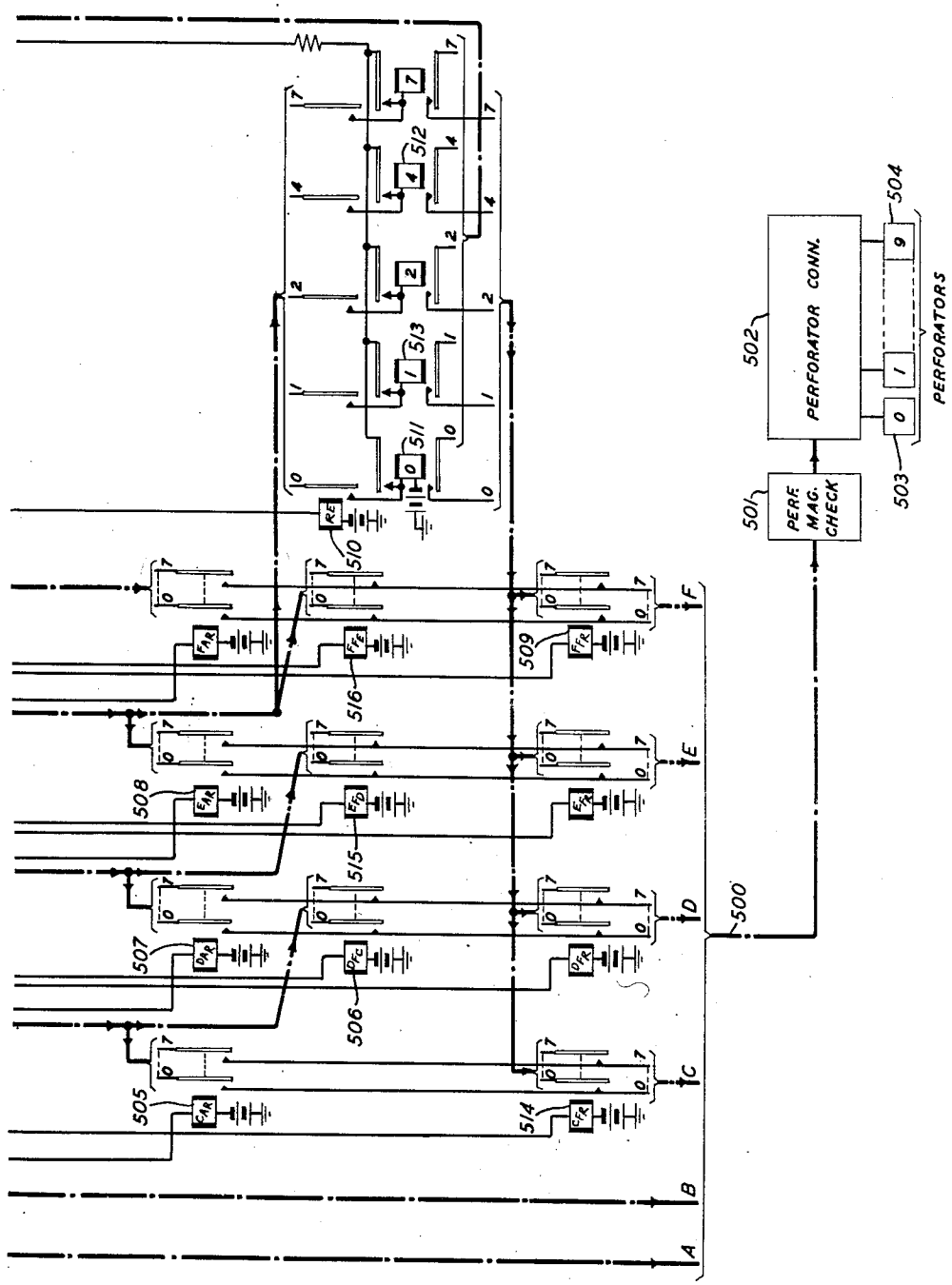

FIG. 5

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

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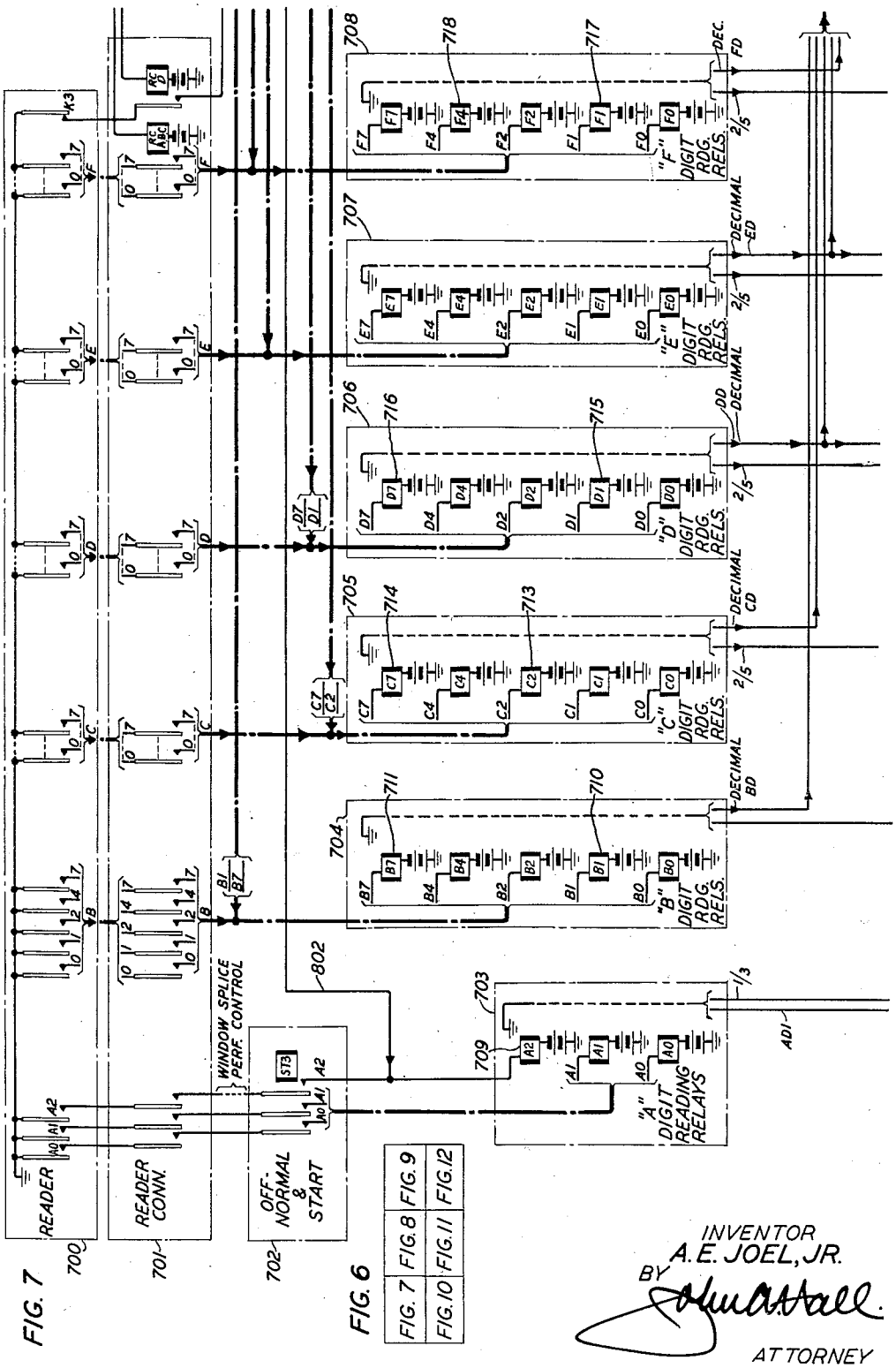

FIG. 7

FIG. 6

FIG. 7	FIG. 8	FIG. 9
FIG. 10	FIG. 11	FIG. 12

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

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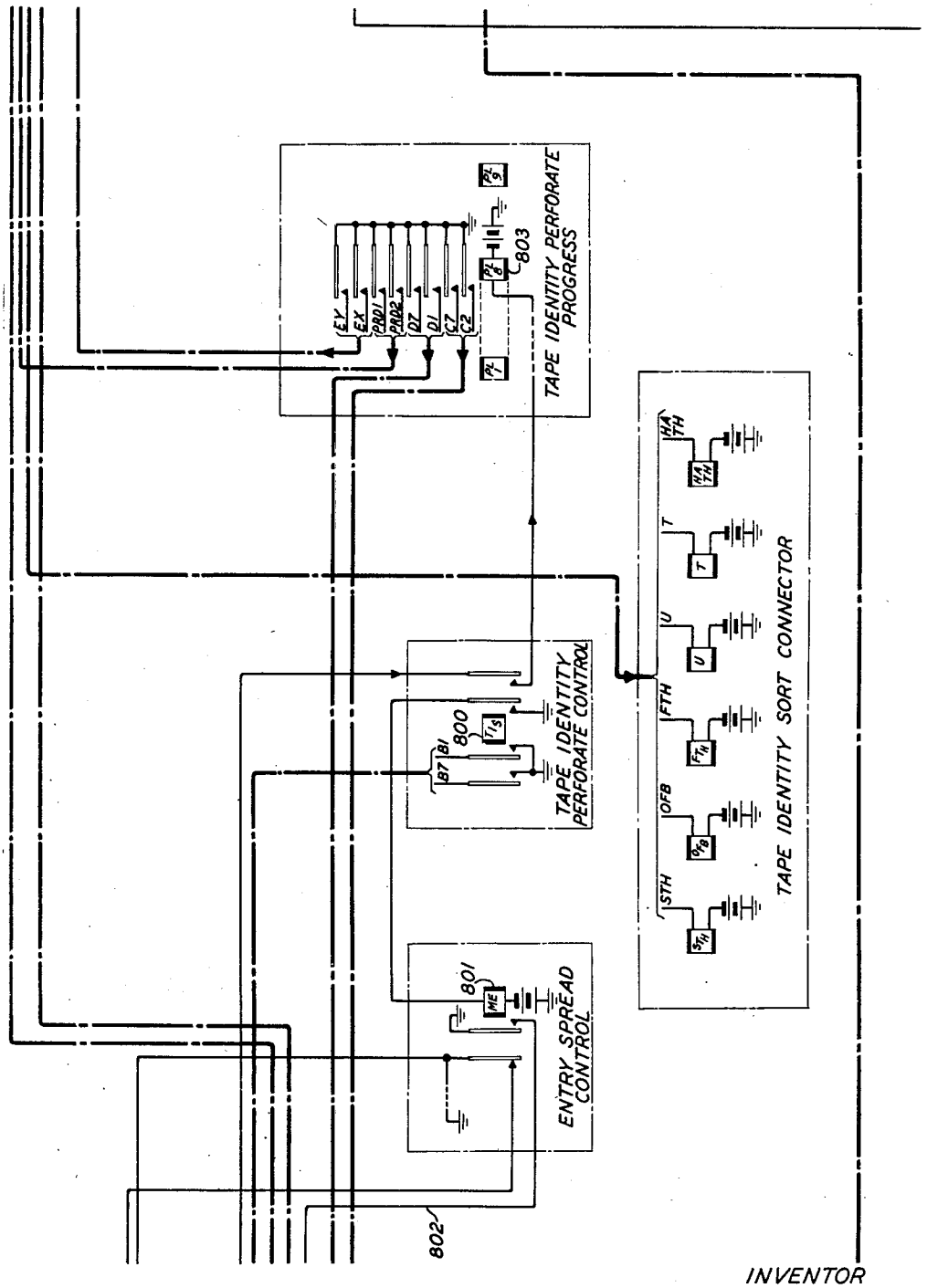

FIG. 8

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

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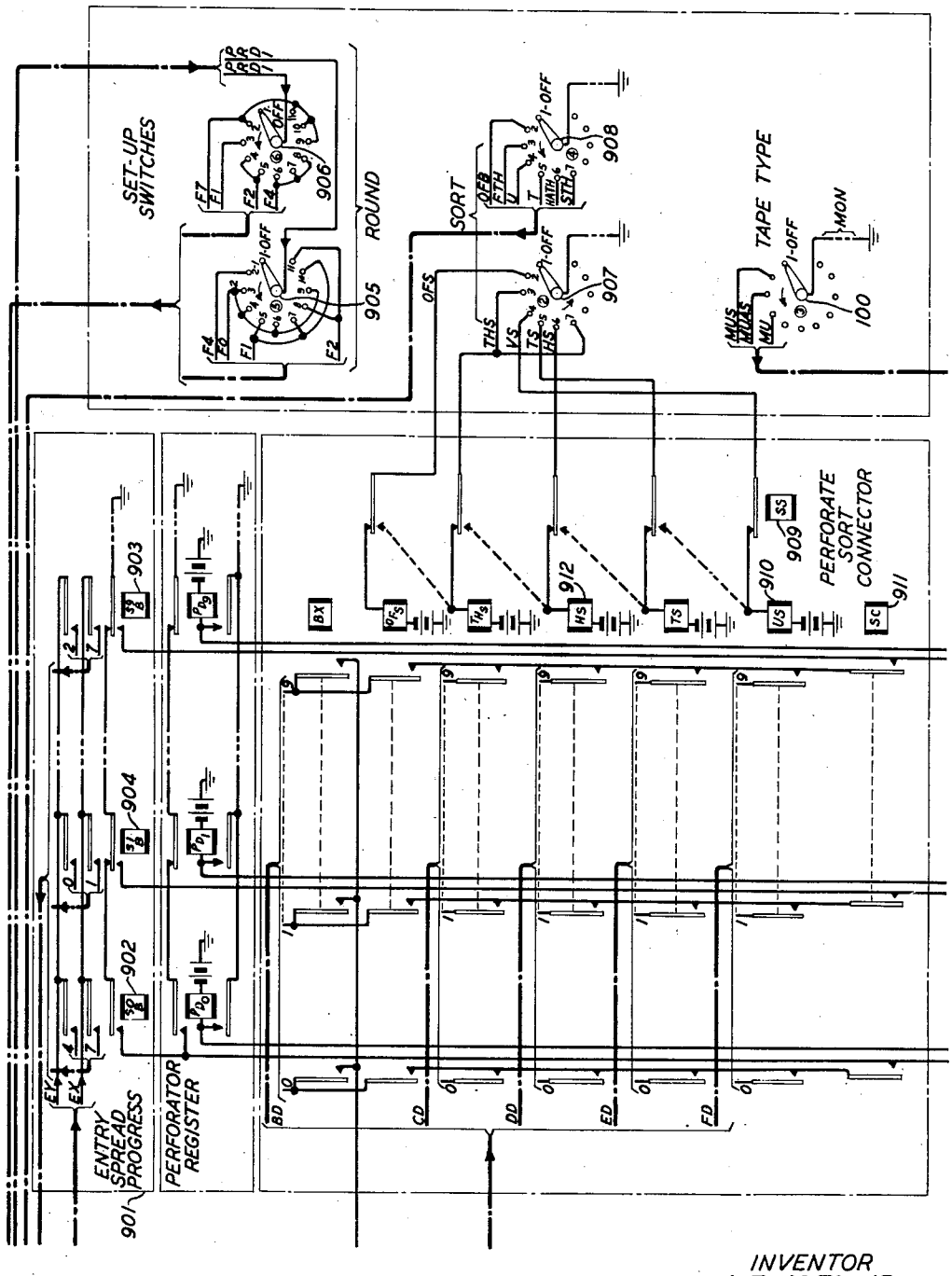

FIG. 9

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 7

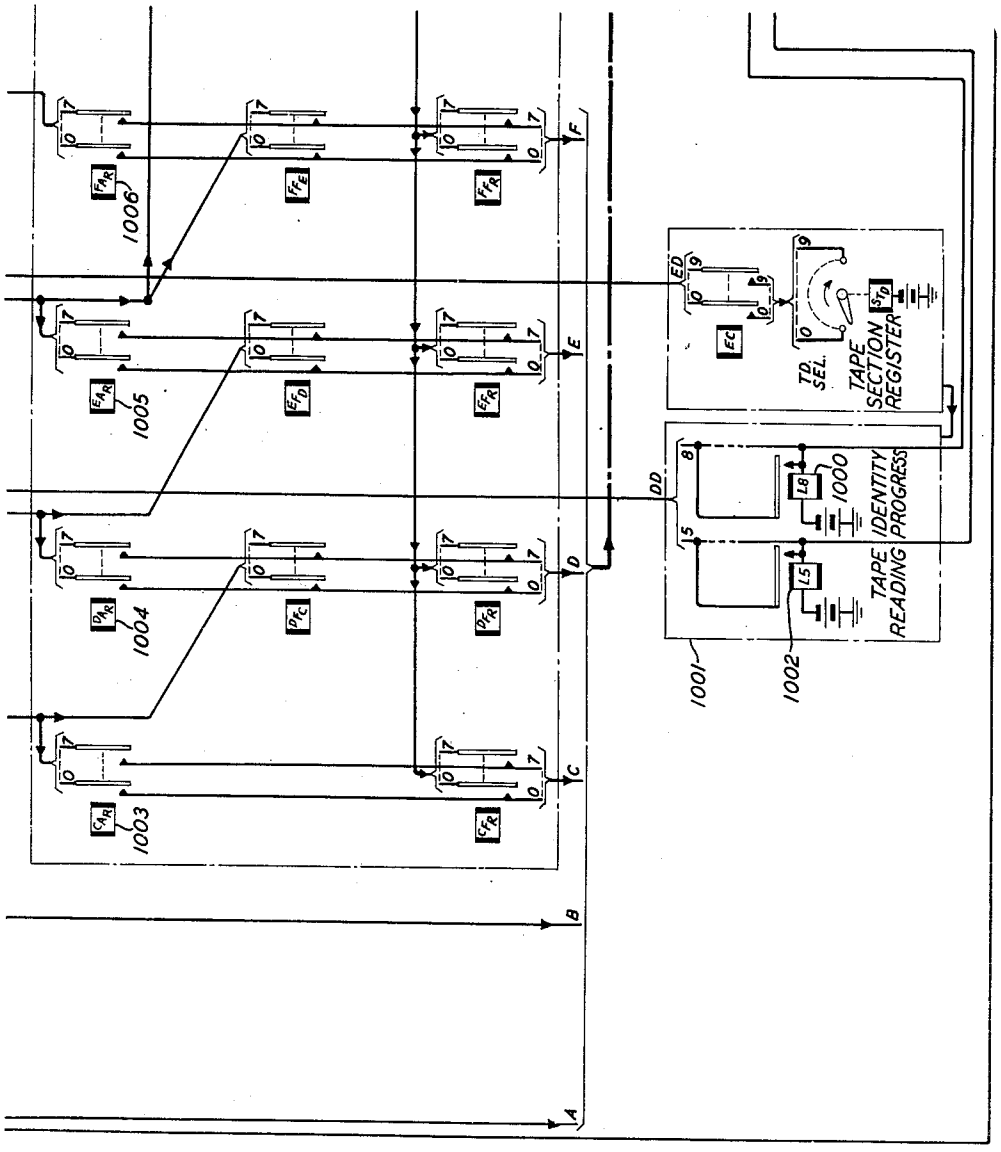

FIG. 10

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 8

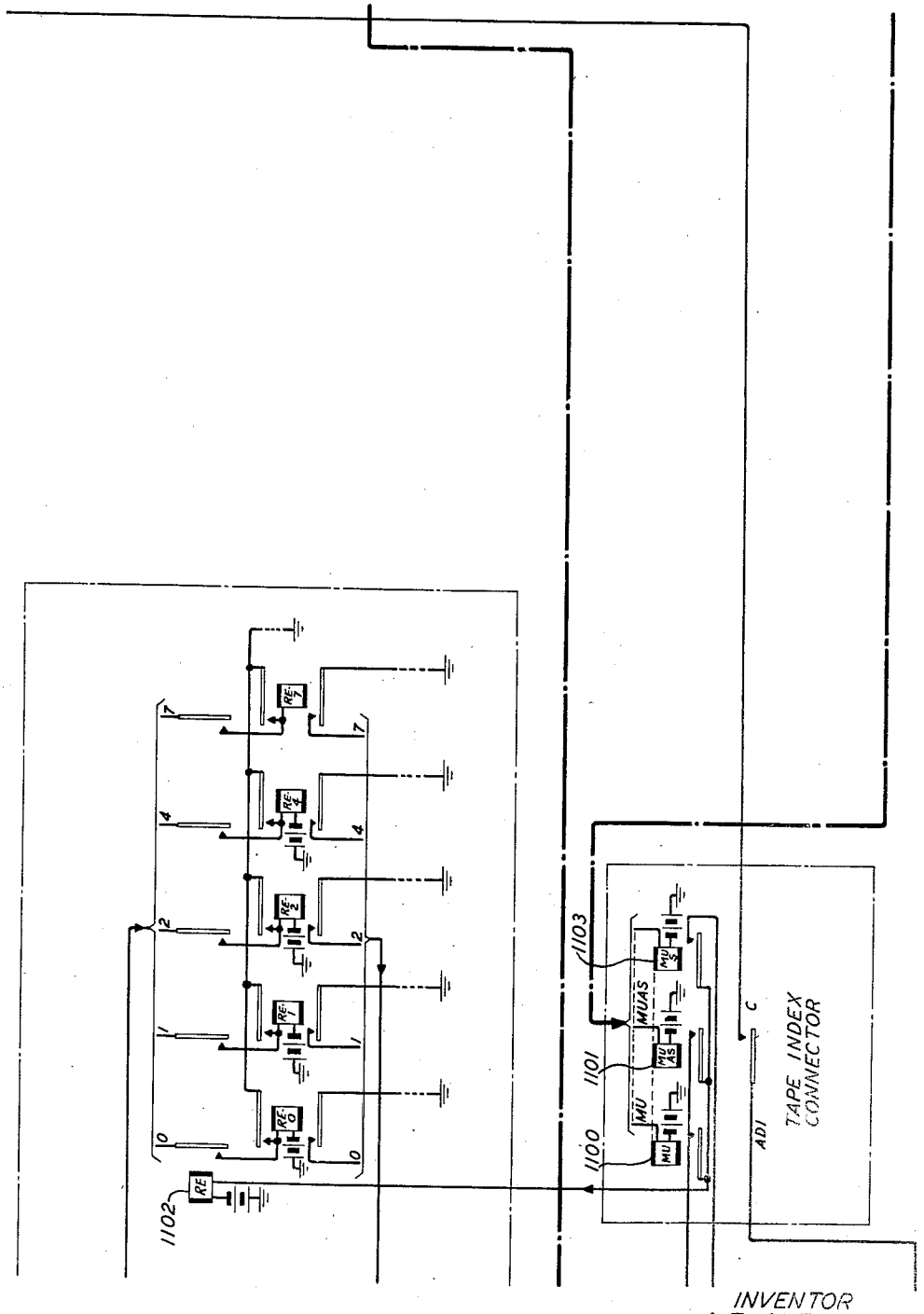

FIG. 11

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 9

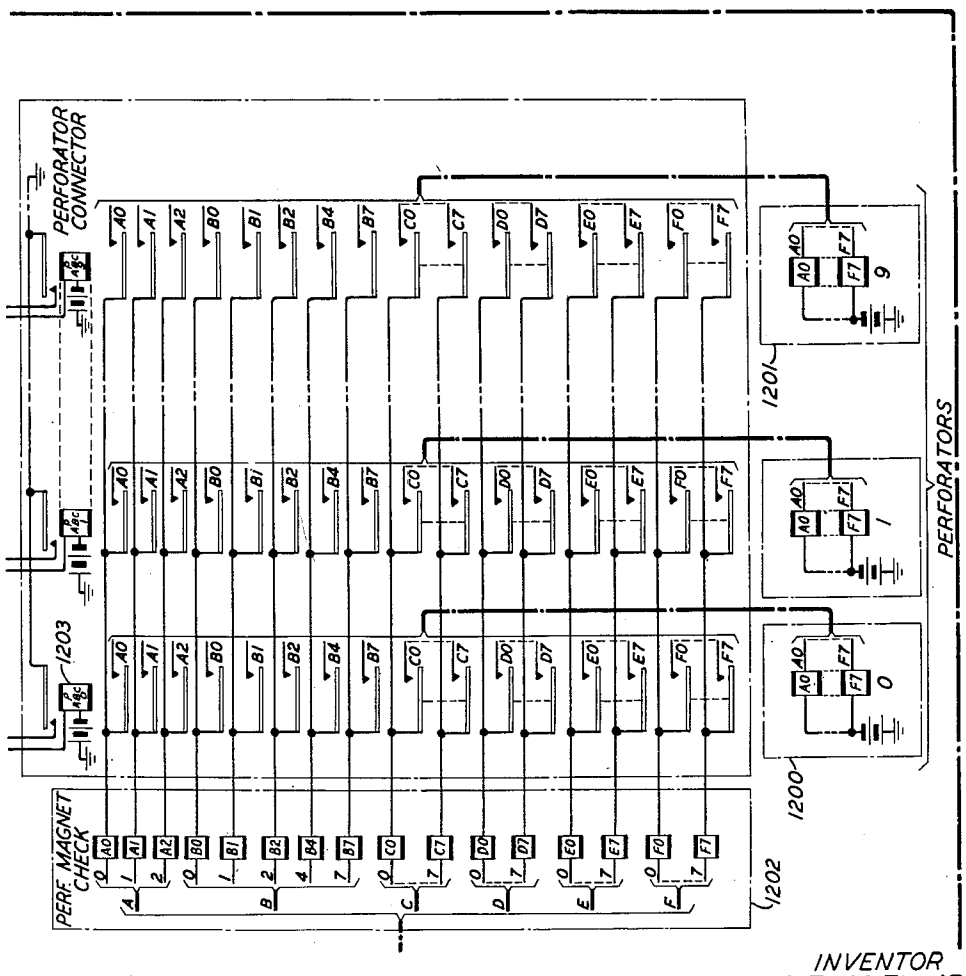

FIG. 12

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 10

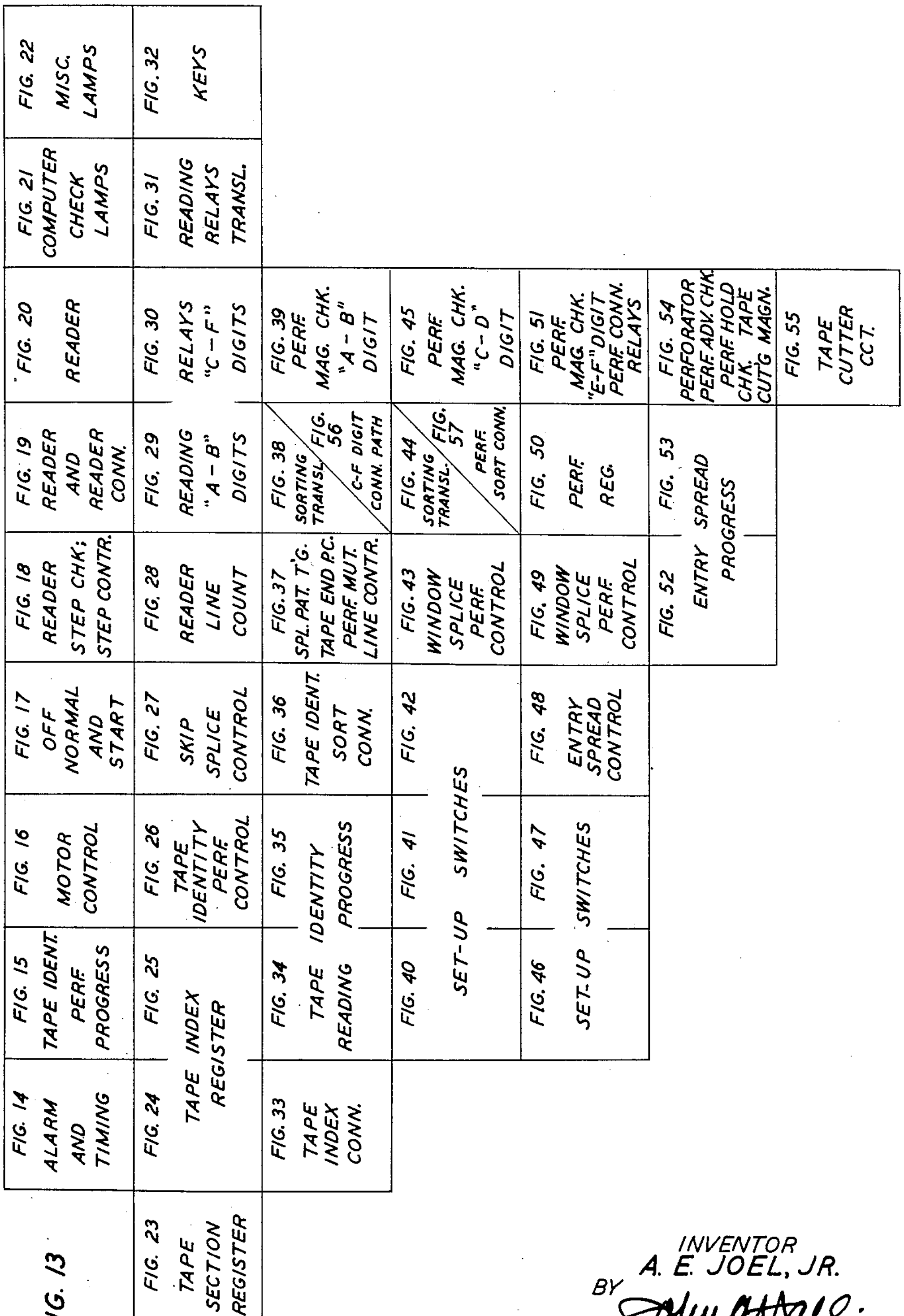

FIG. 13

INVENTOR
A. E. JOEL, JR.
BY John A. Hall
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 11

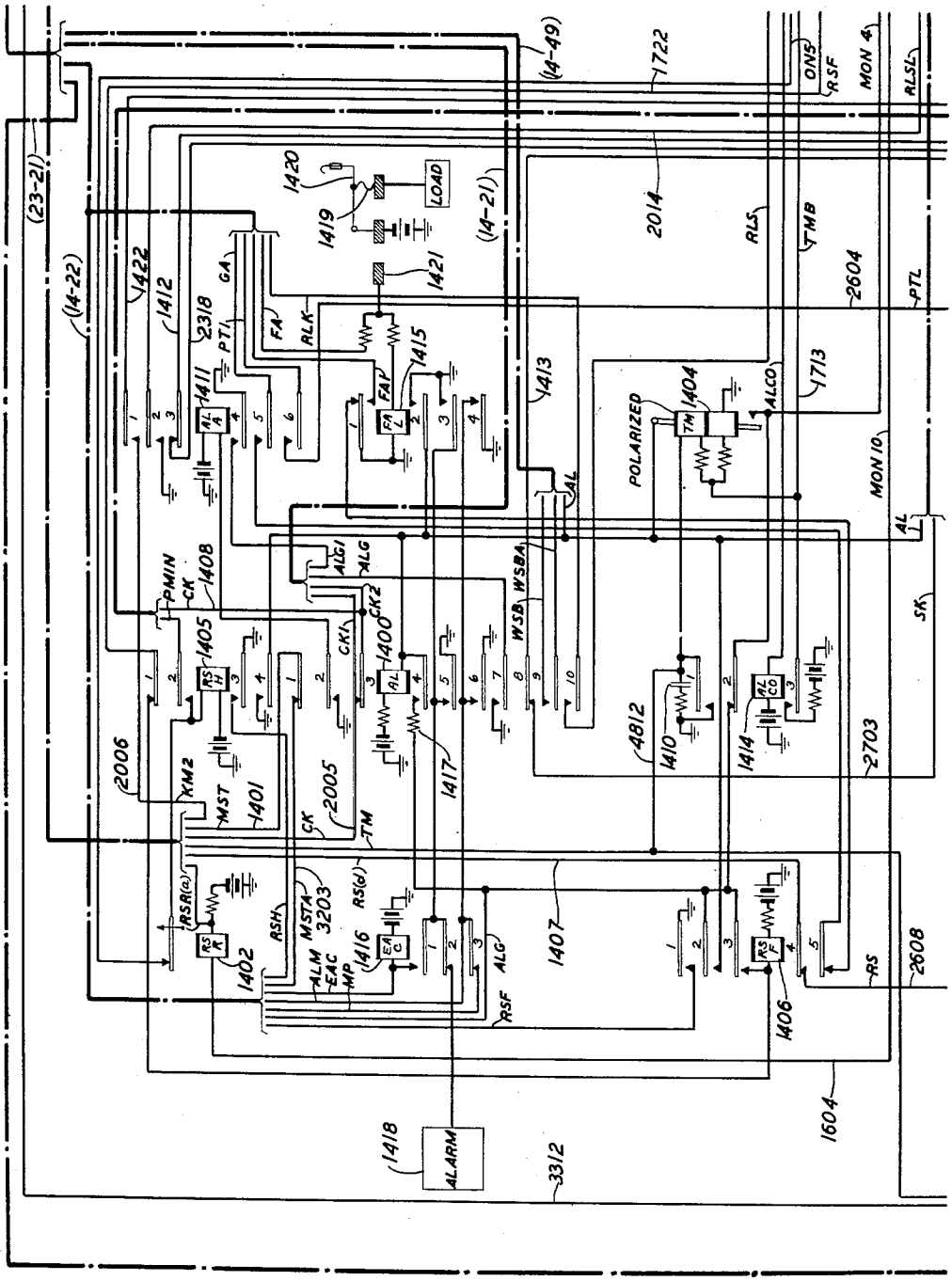

FIG. 14

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 12

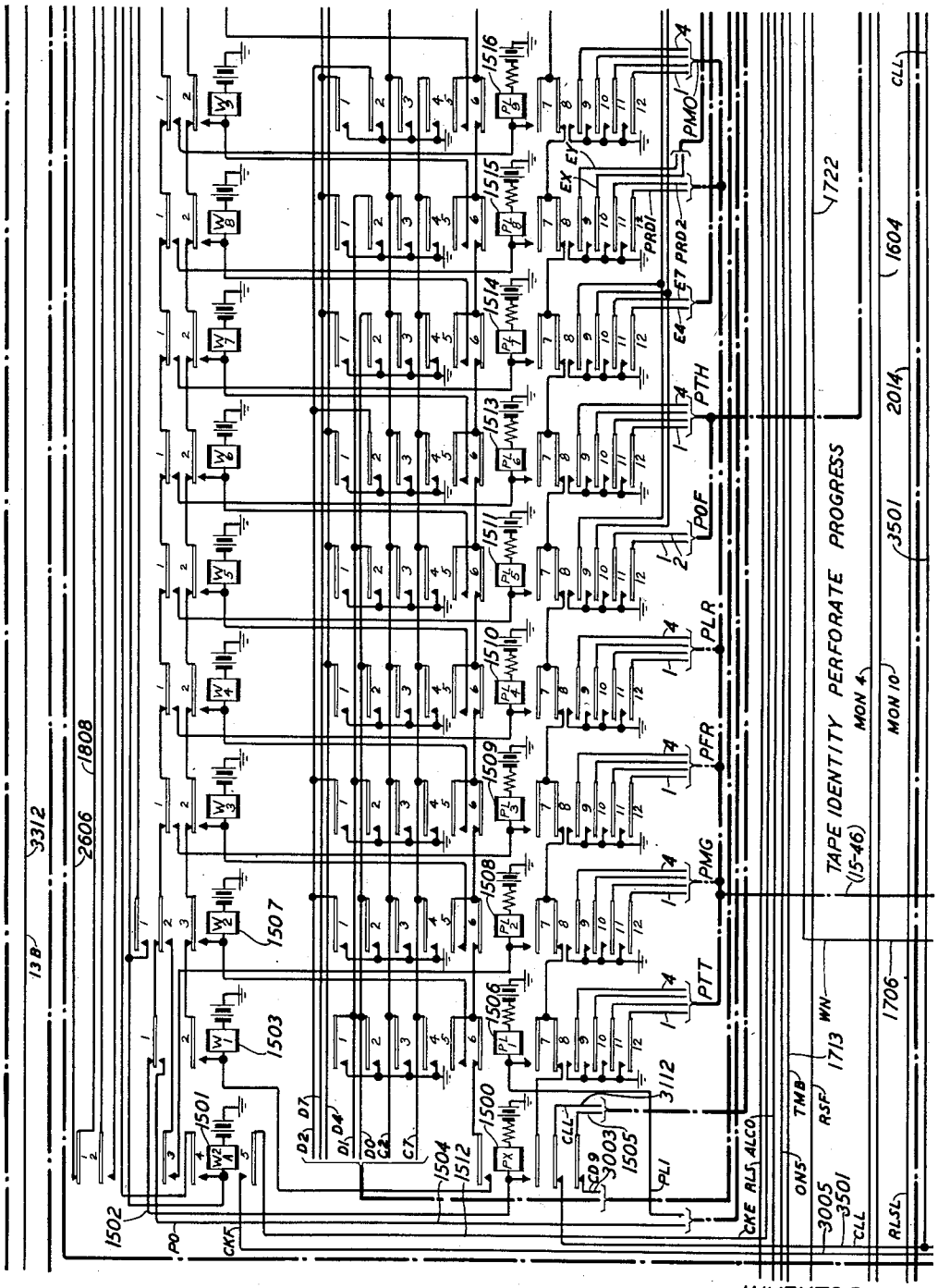

FIG. 15

INVENTOR
A. E. JOEL, JR.
BY John A. Hall.
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 13

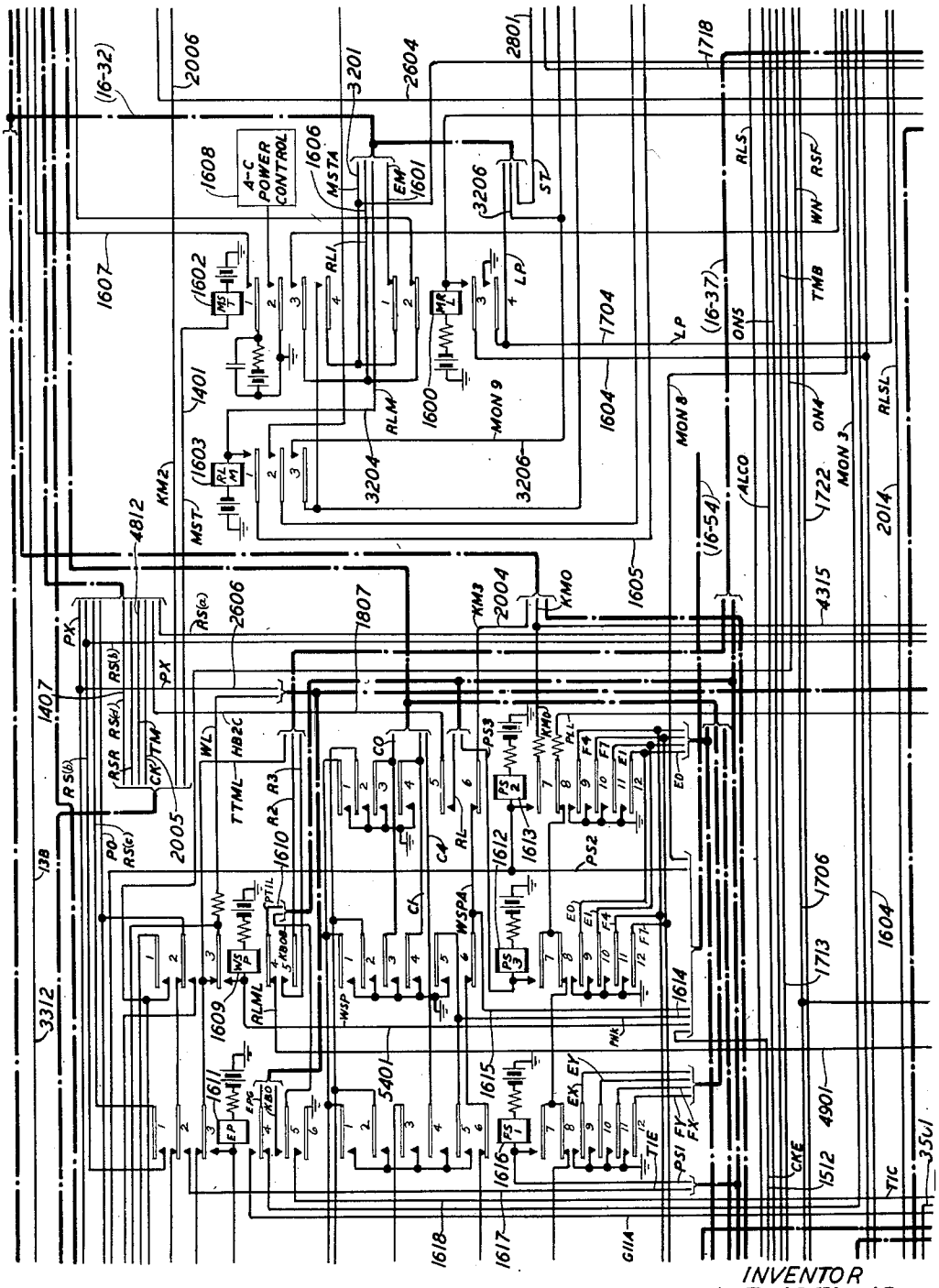

FIG. 16

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 14

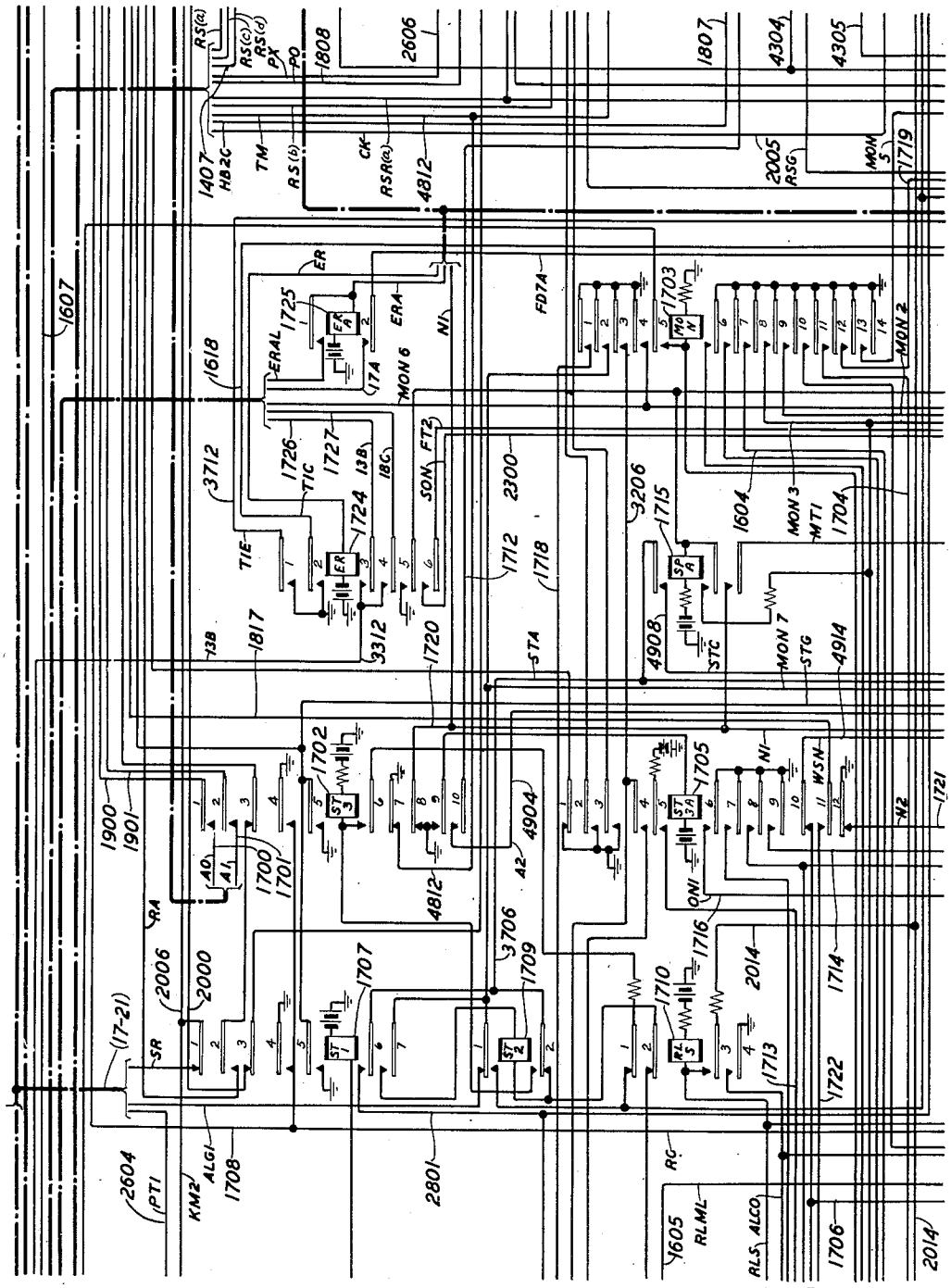

FIG. 17

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 15

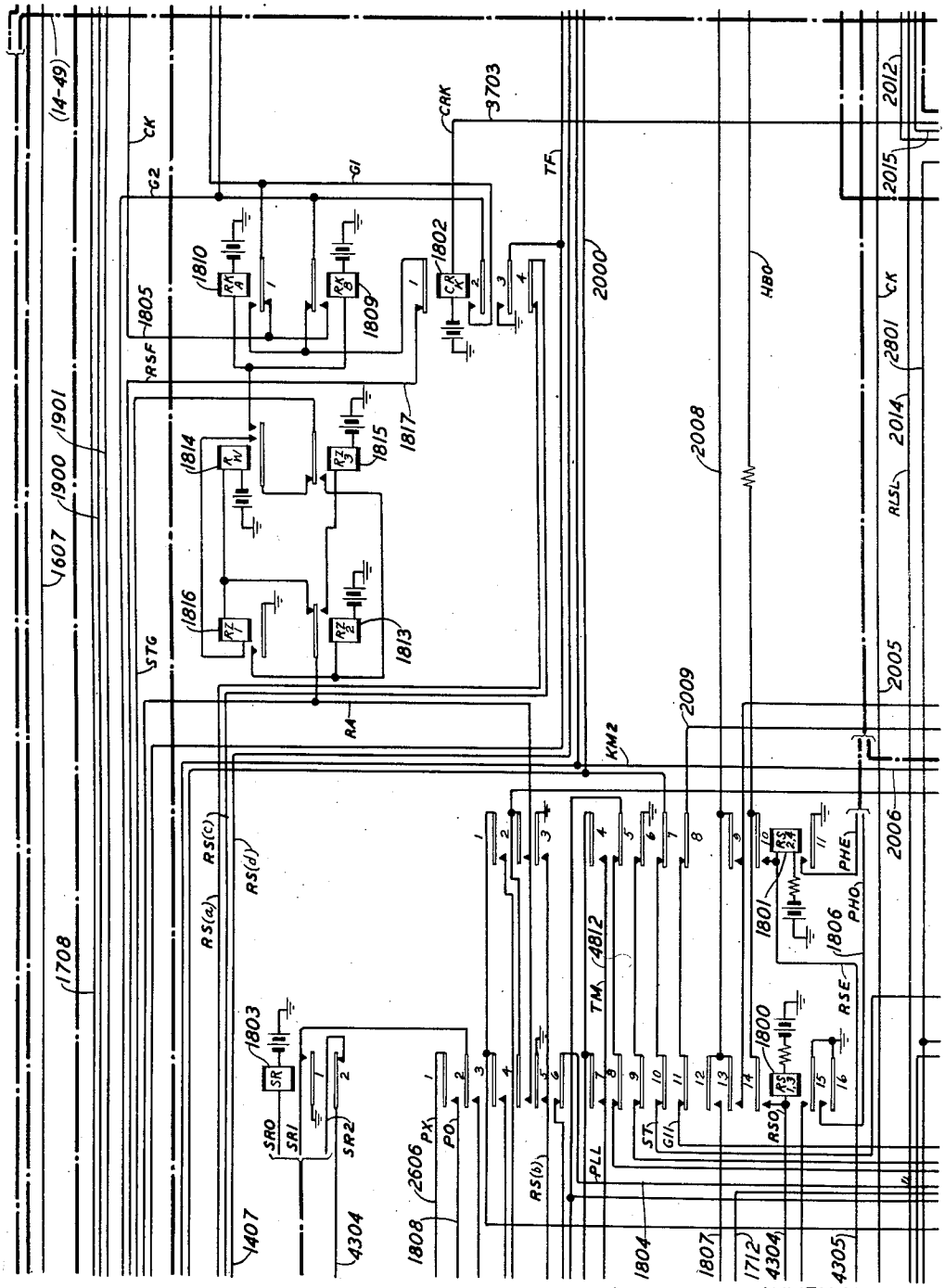

FIG. 18

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 16

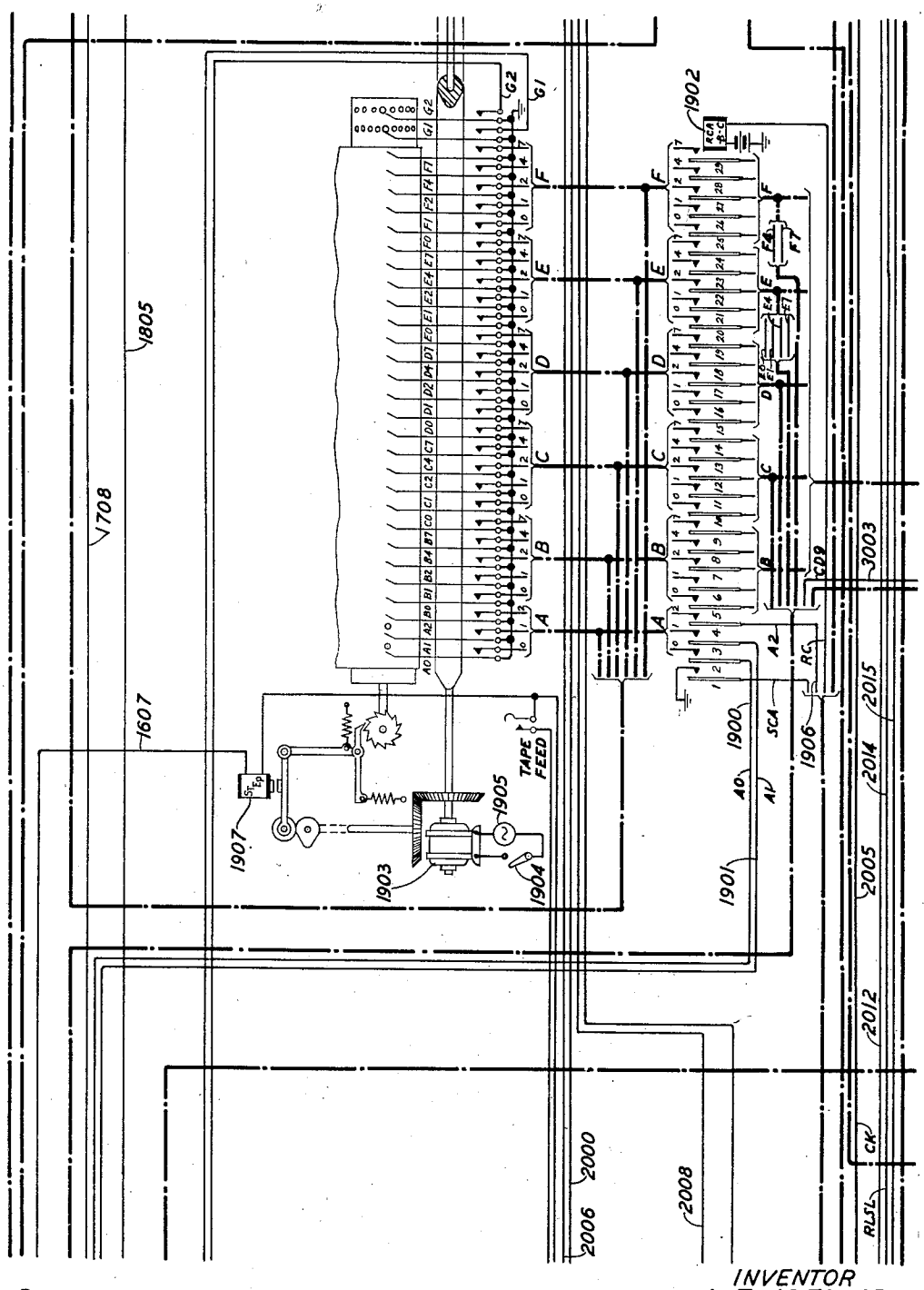

FIG. 19

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 17

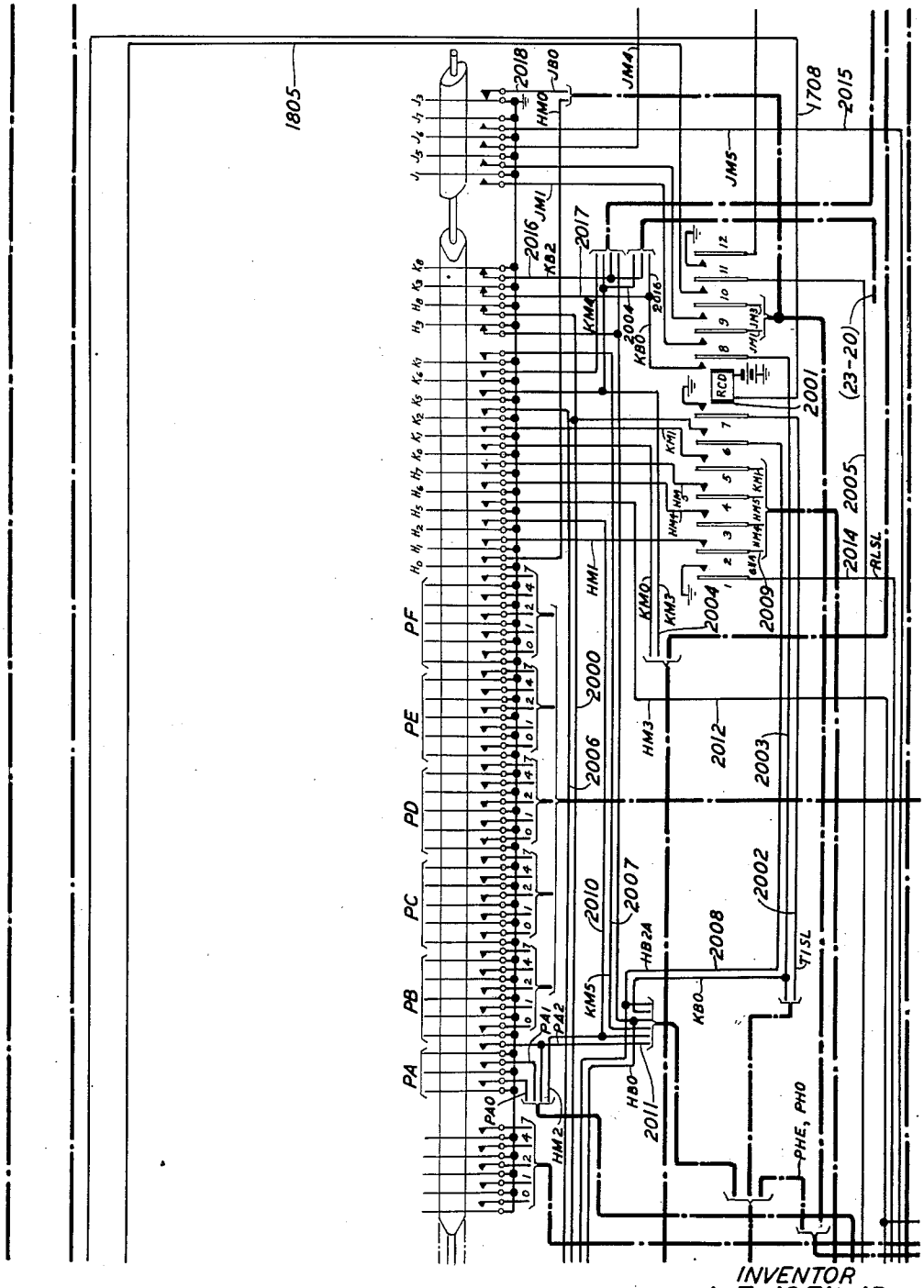

FIG. 20

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 18

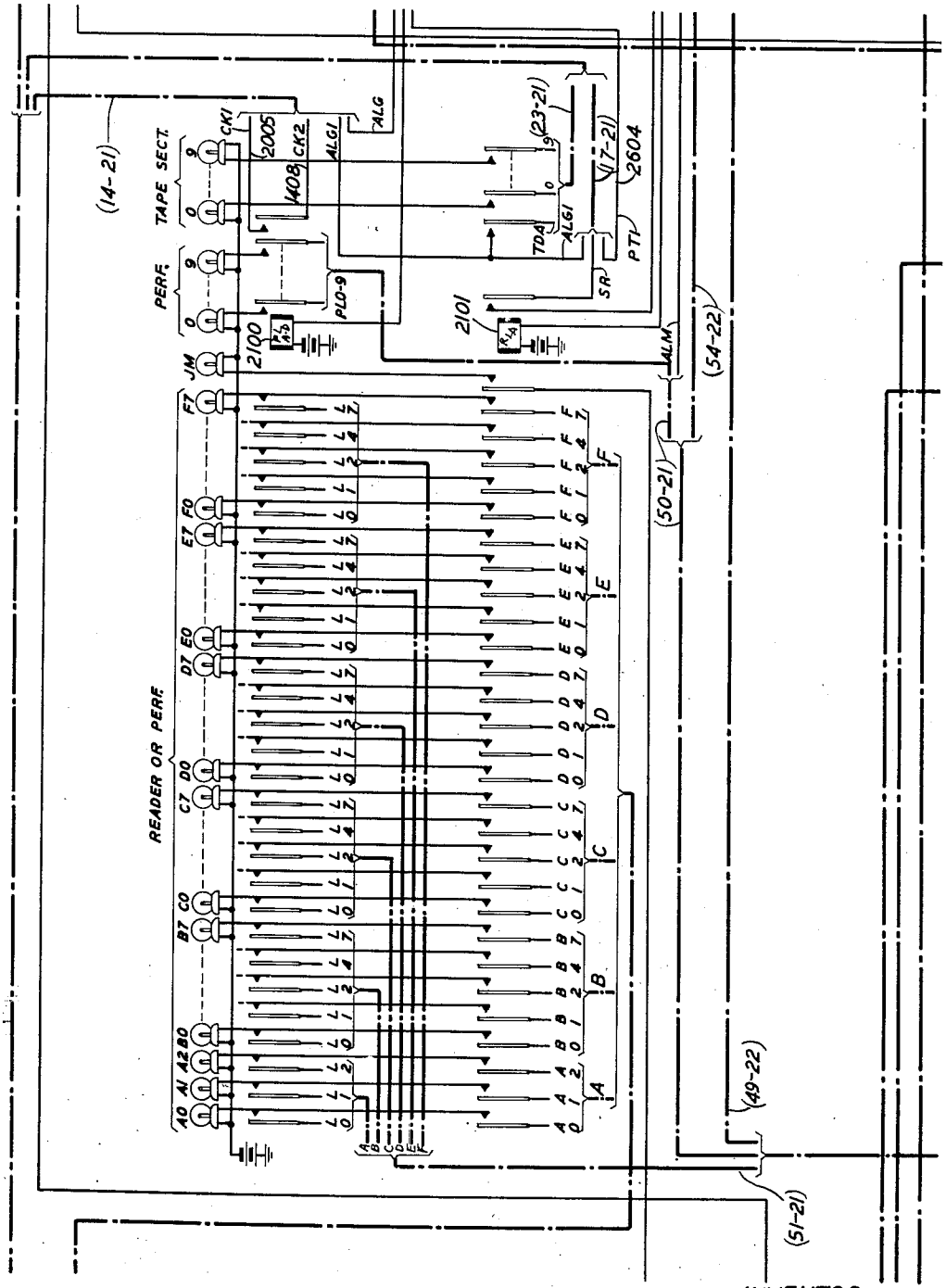

FIG. 21

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 19

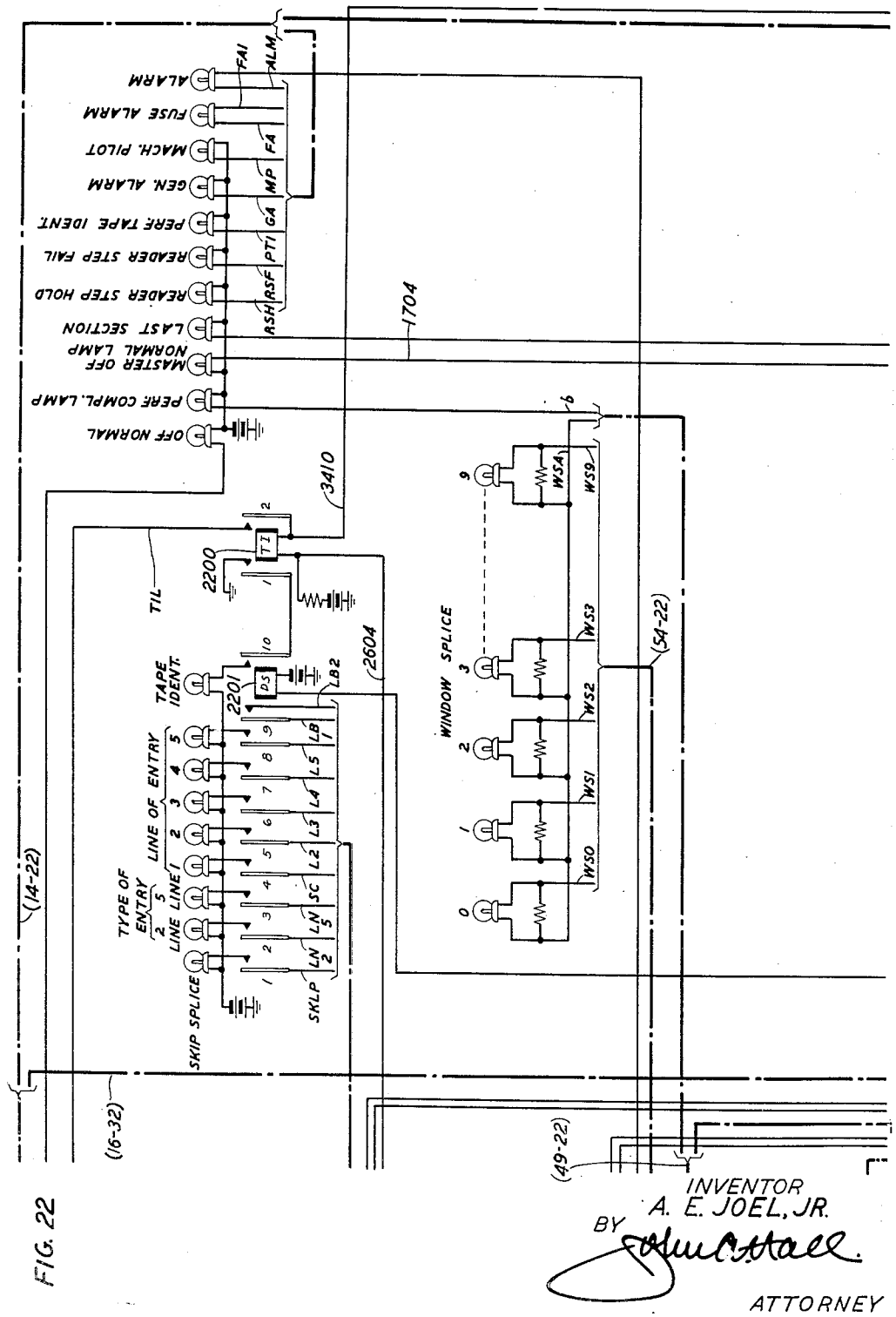

FIG. 22

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 20

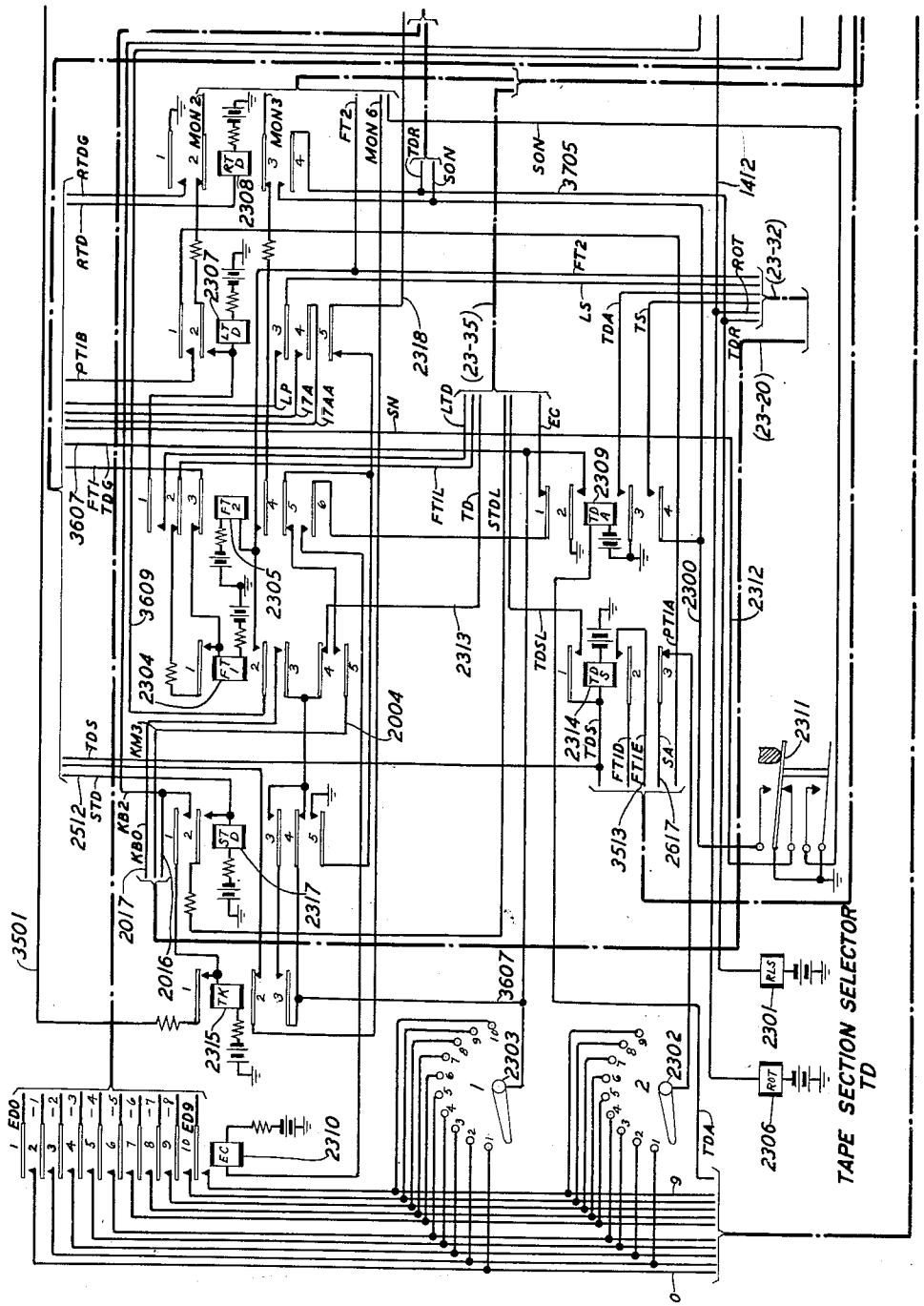

FIG. 23

INVENTOR
A. E. JOEL, JR.
BY John A. Hall
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 21

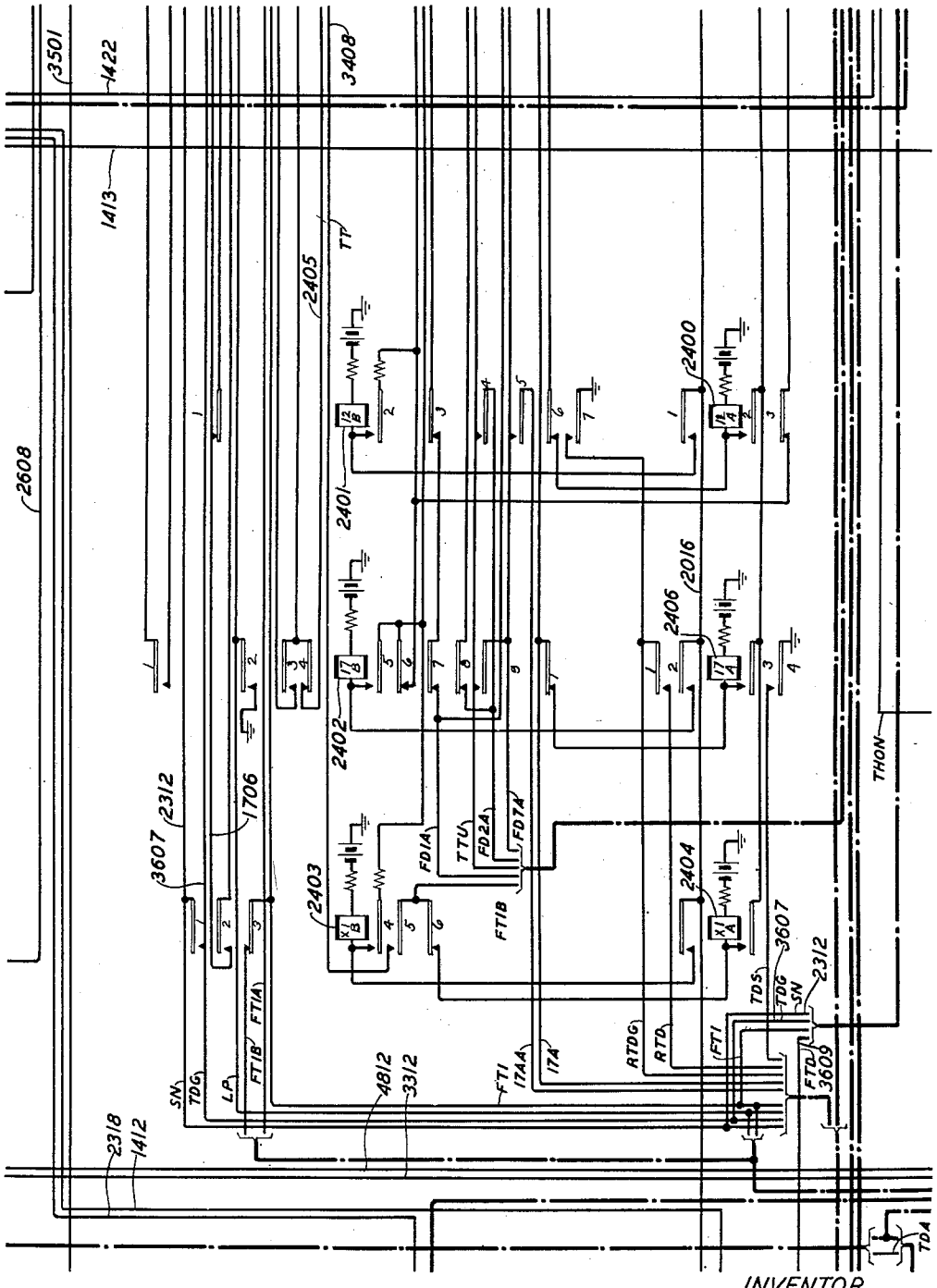

FIG. 24

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 22

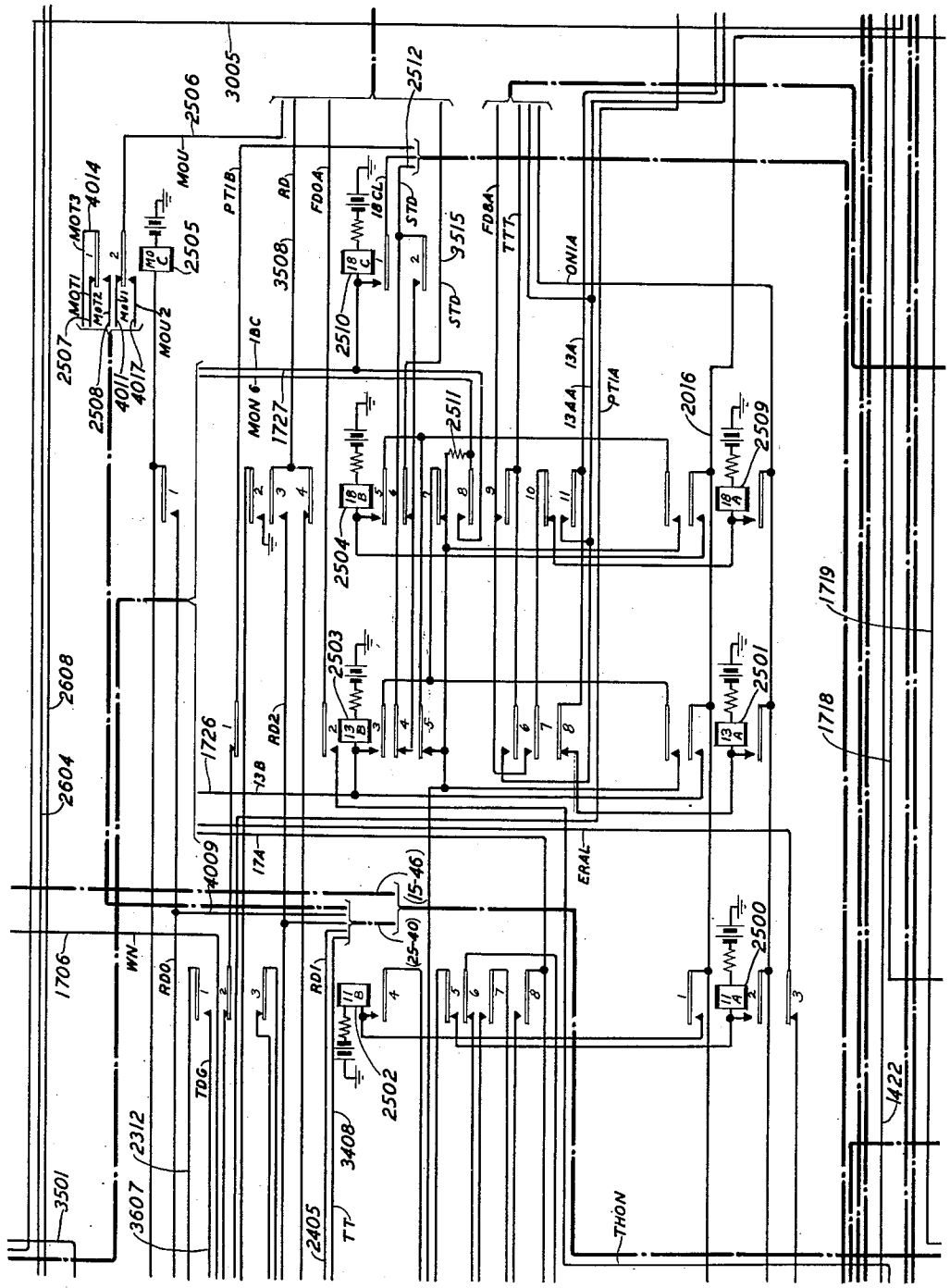

FIG. 25

INVENTOR
A. E. JOEL, JR.
BY John A. Hall
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 23

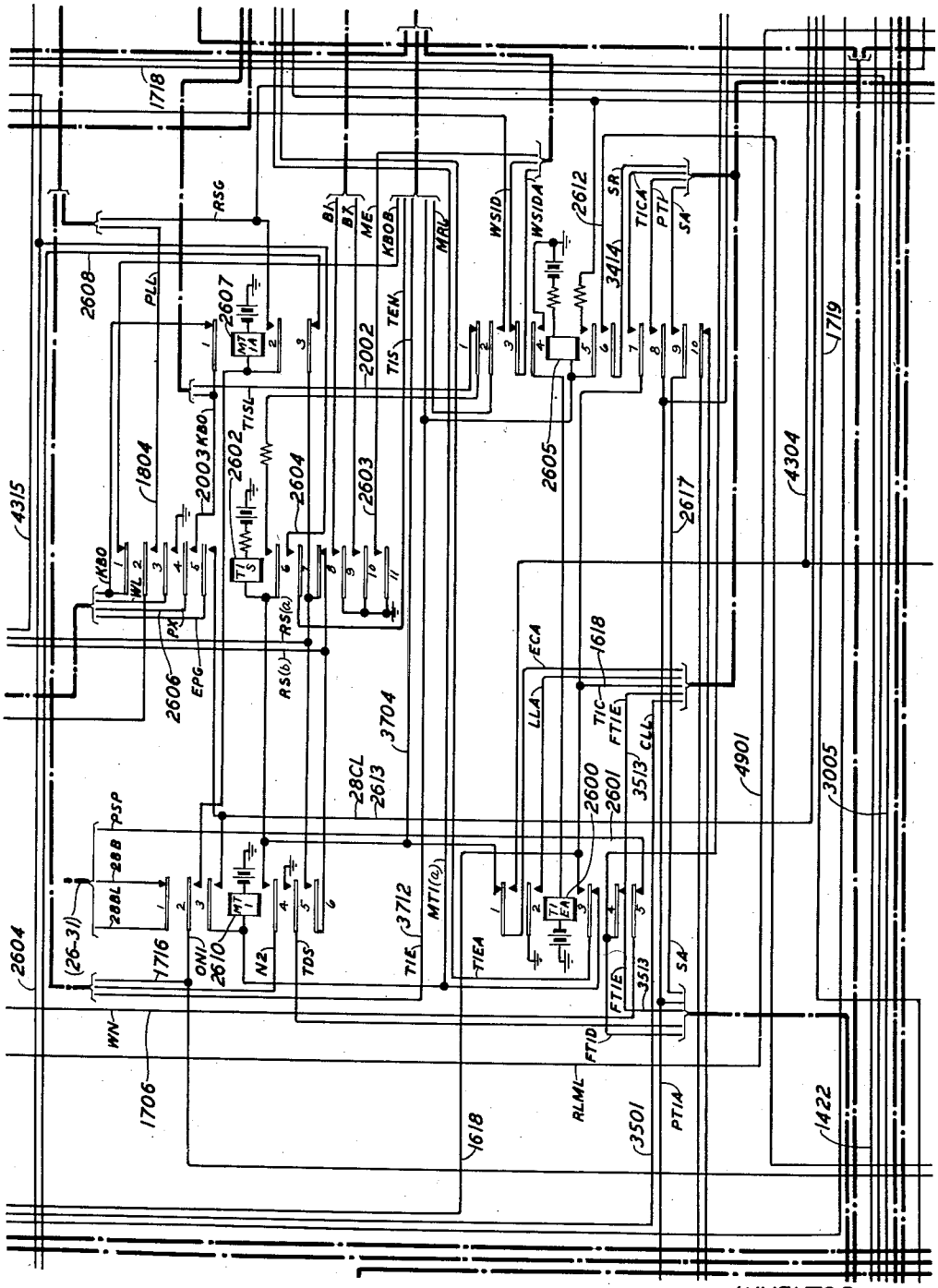

FIG. 26

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 24

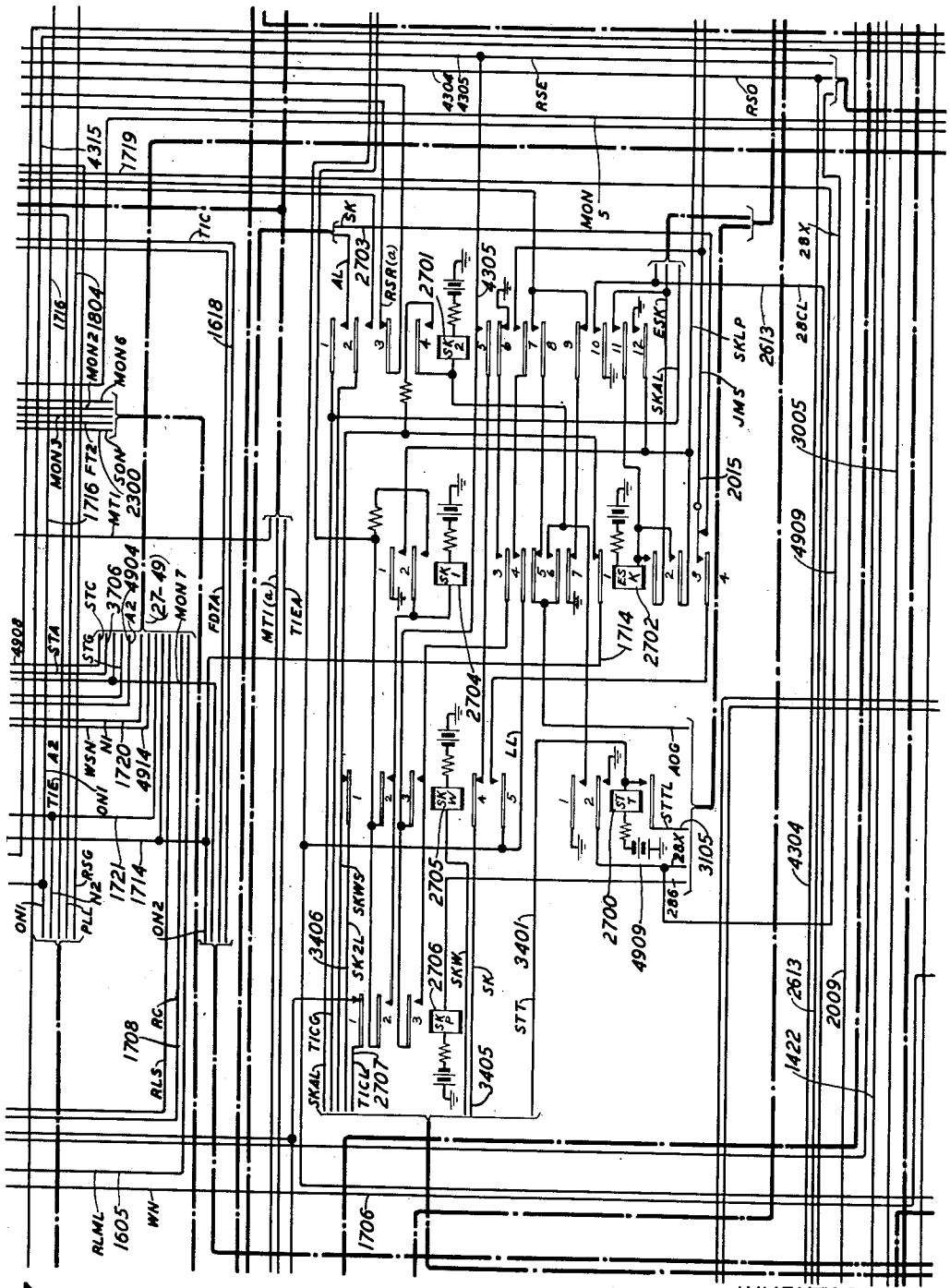

FIG. 27

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 25

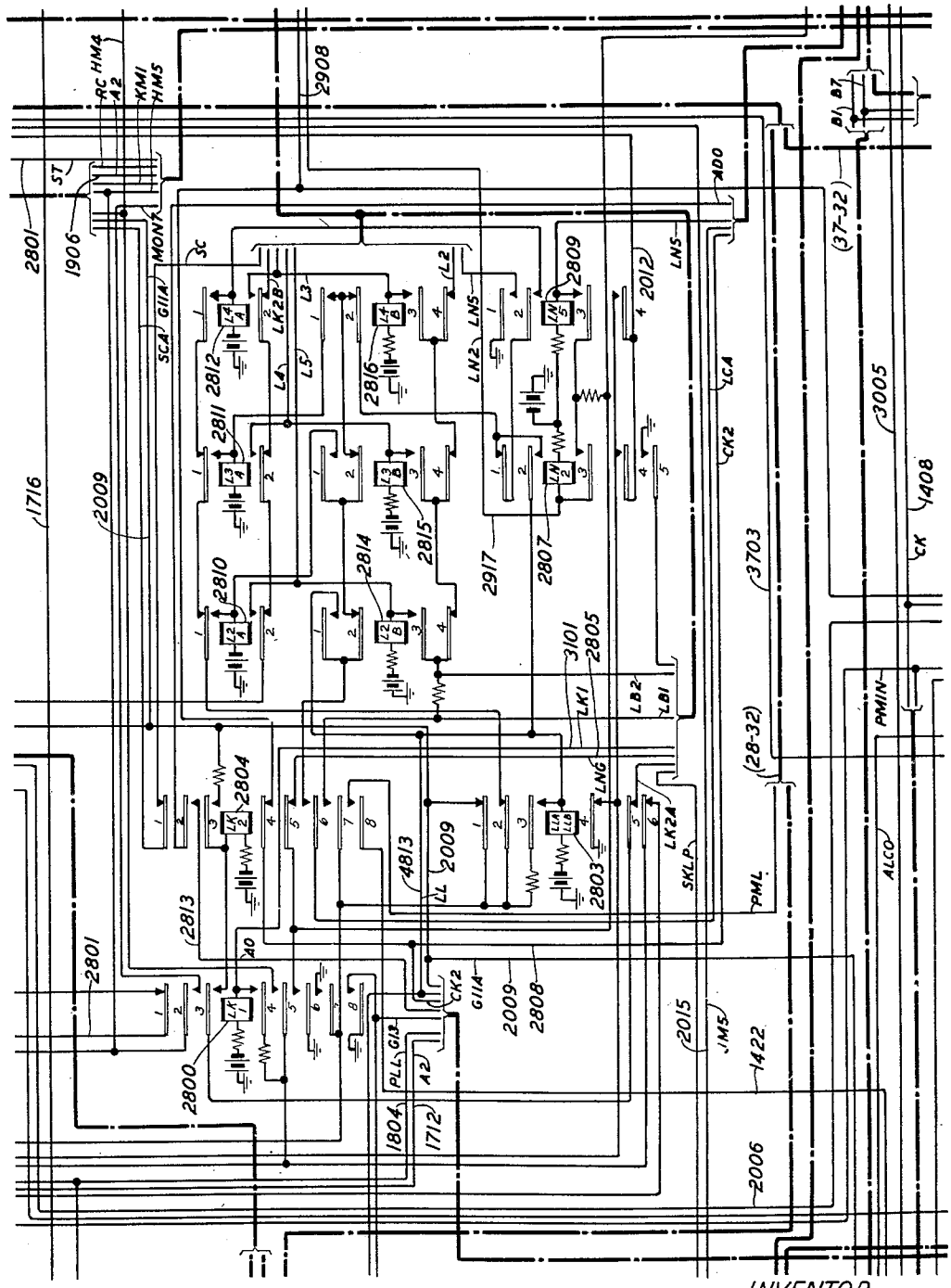

FIG. 28

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 26

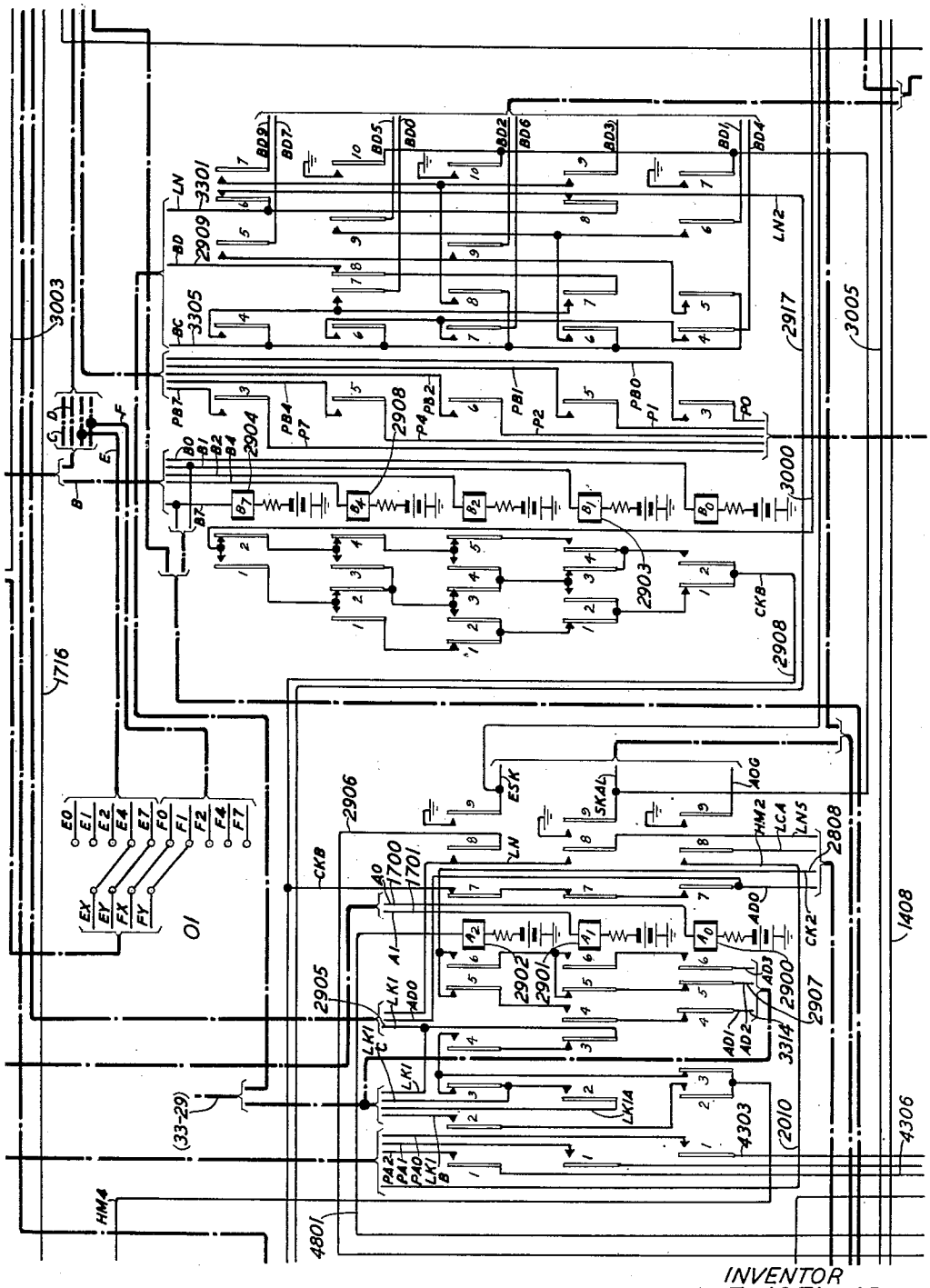

FIG. 29

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 27

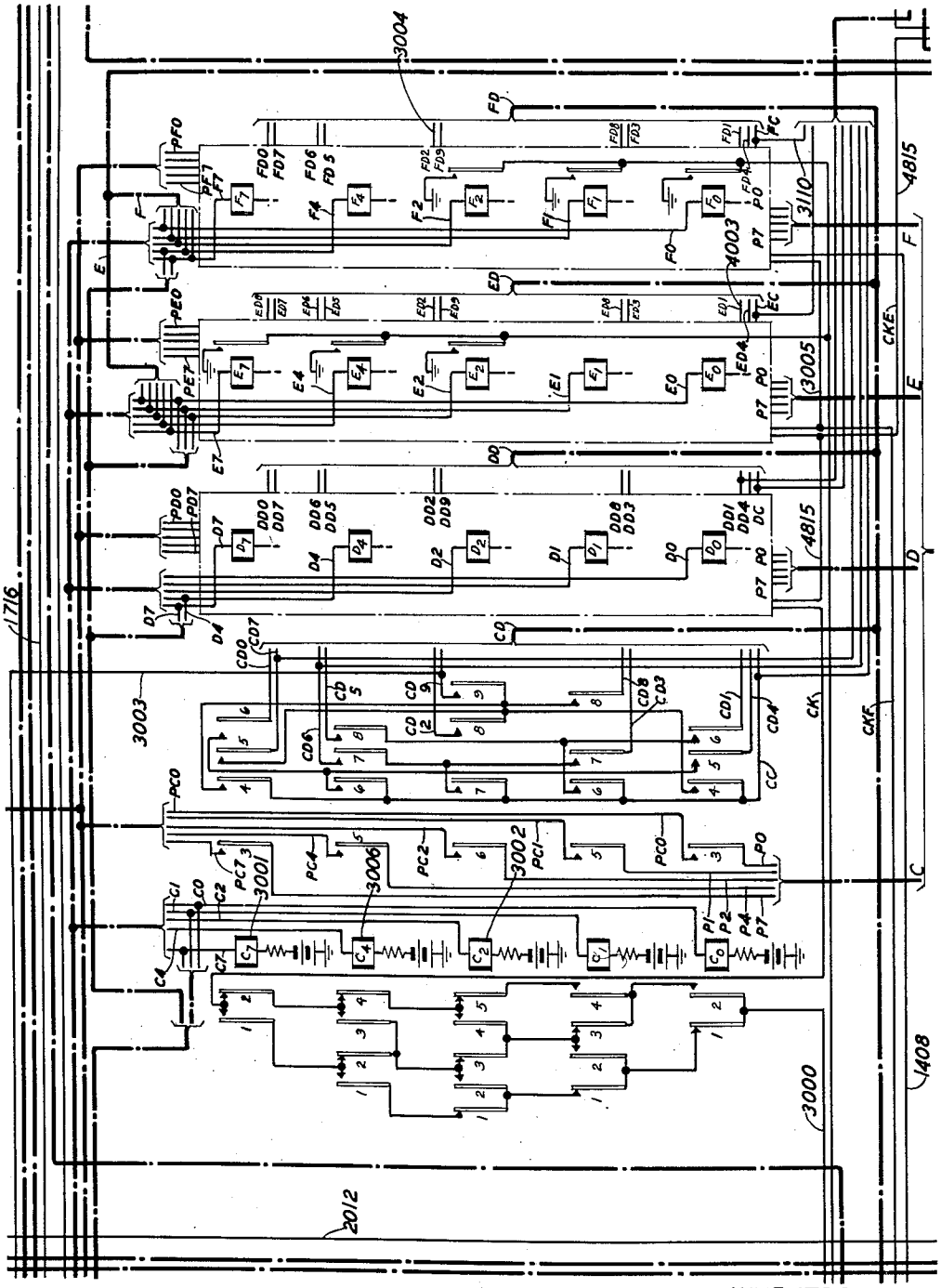

FIG. 30

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 28

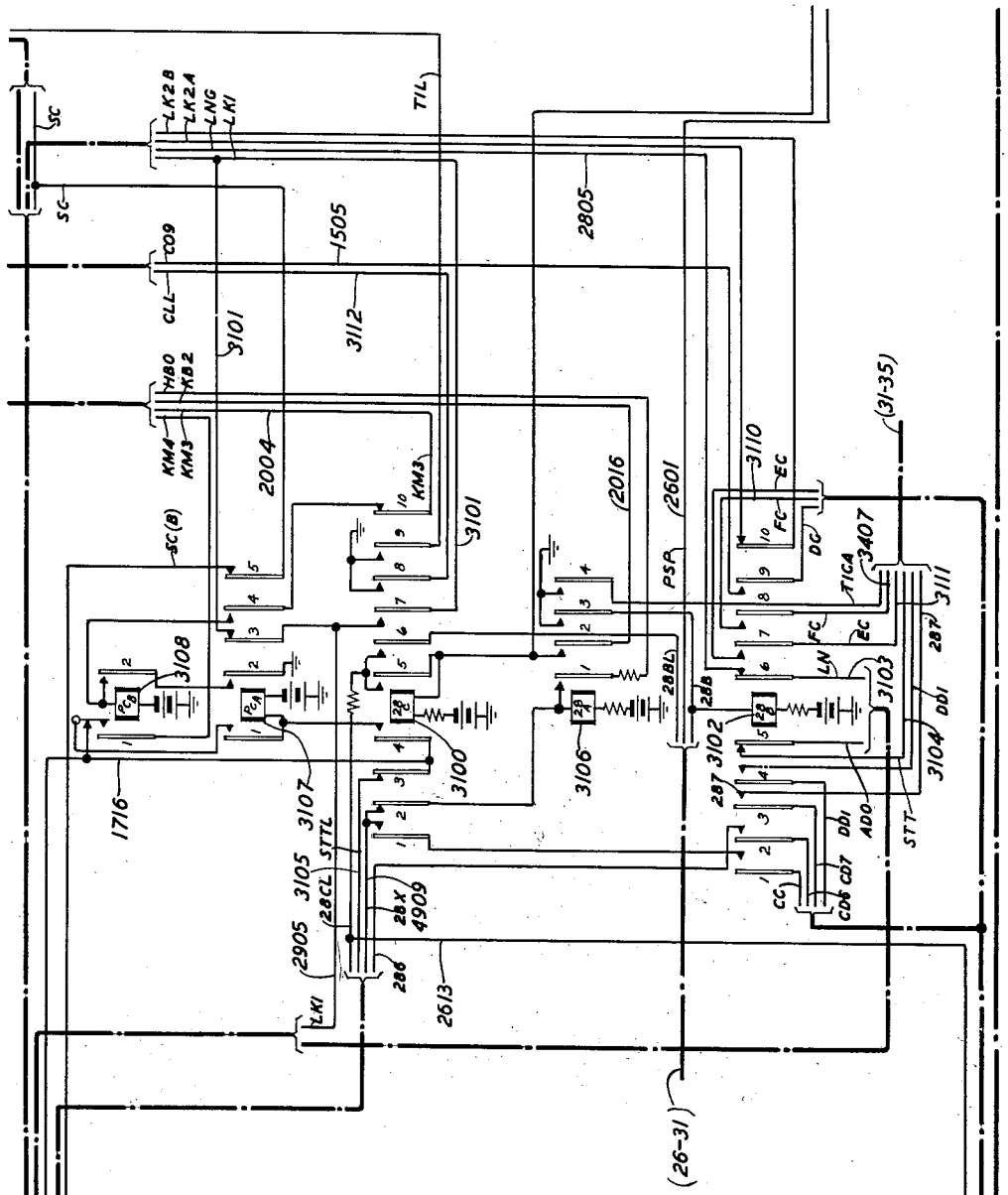

FIG. 31

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 29

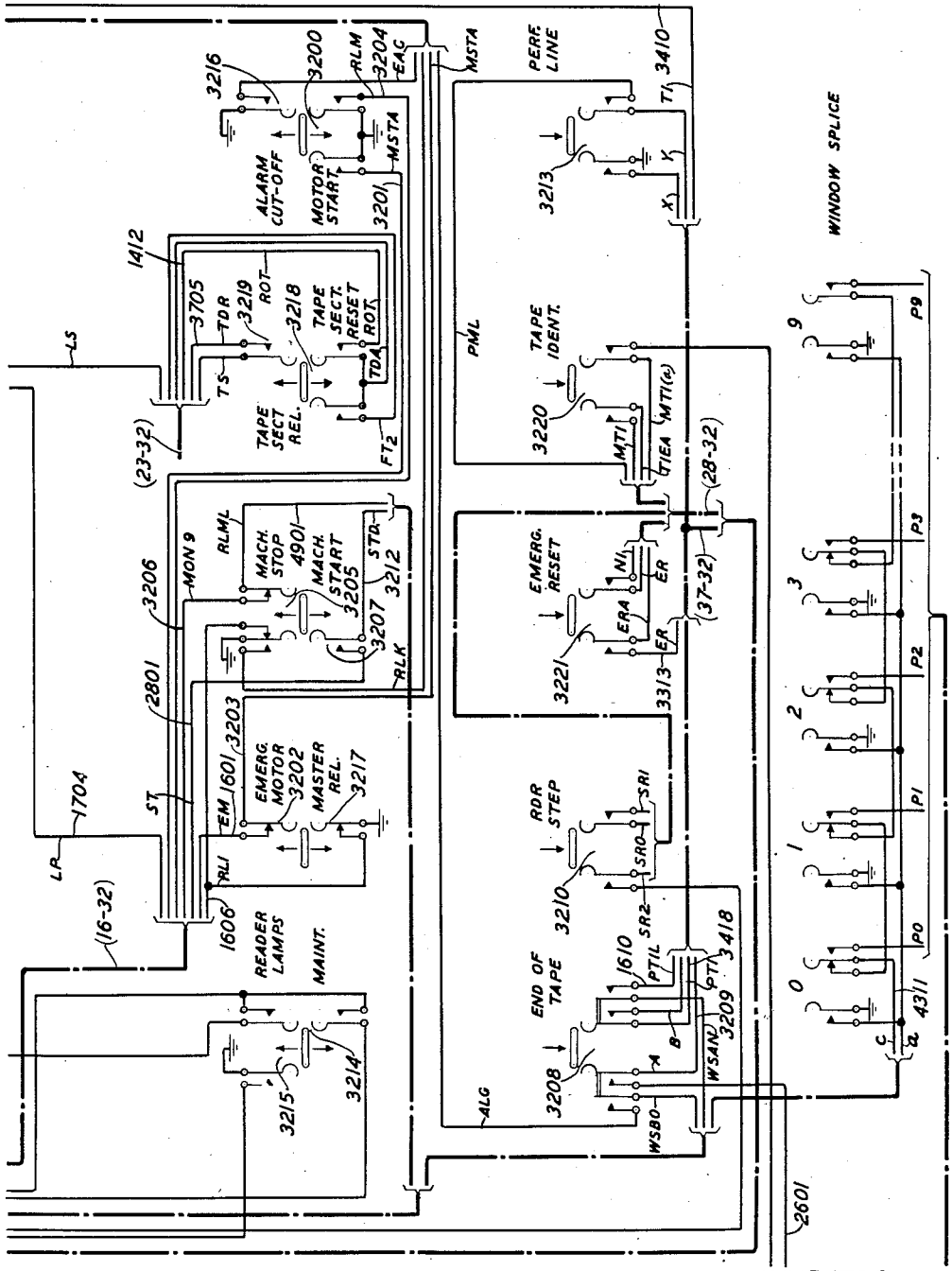

FIG. 32

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 30

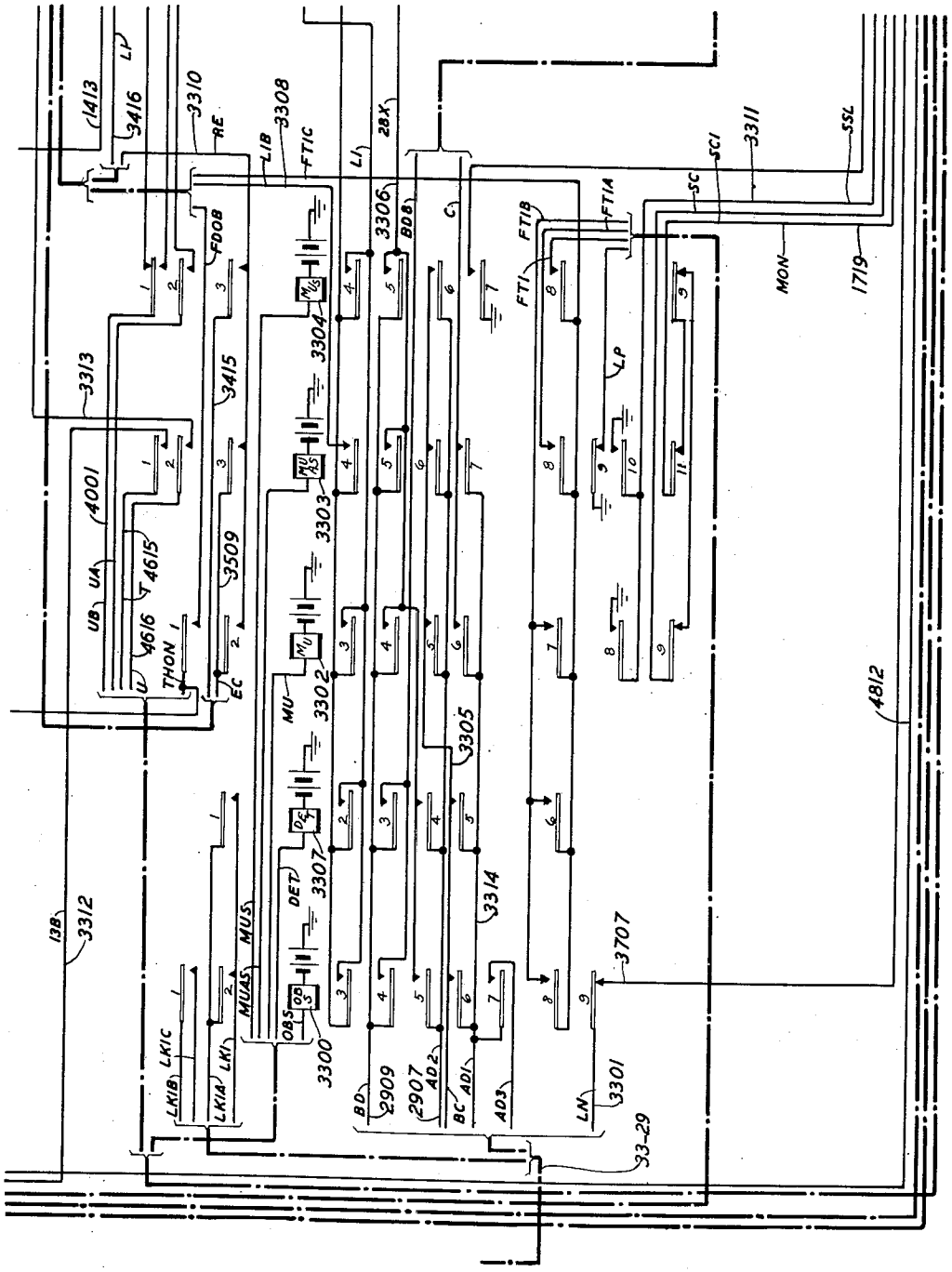

FIG. 33

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 31

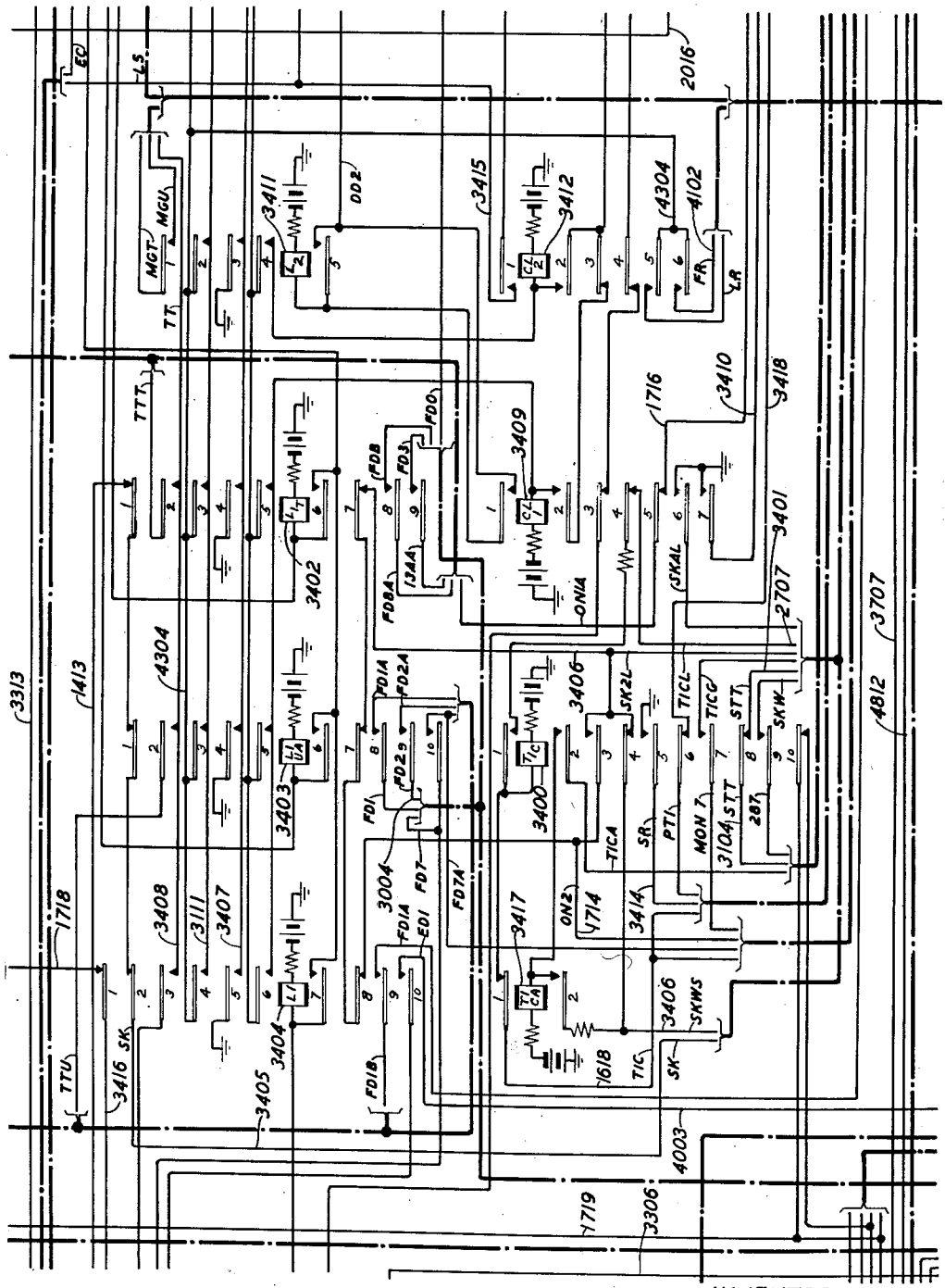

FIG. 34

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 32

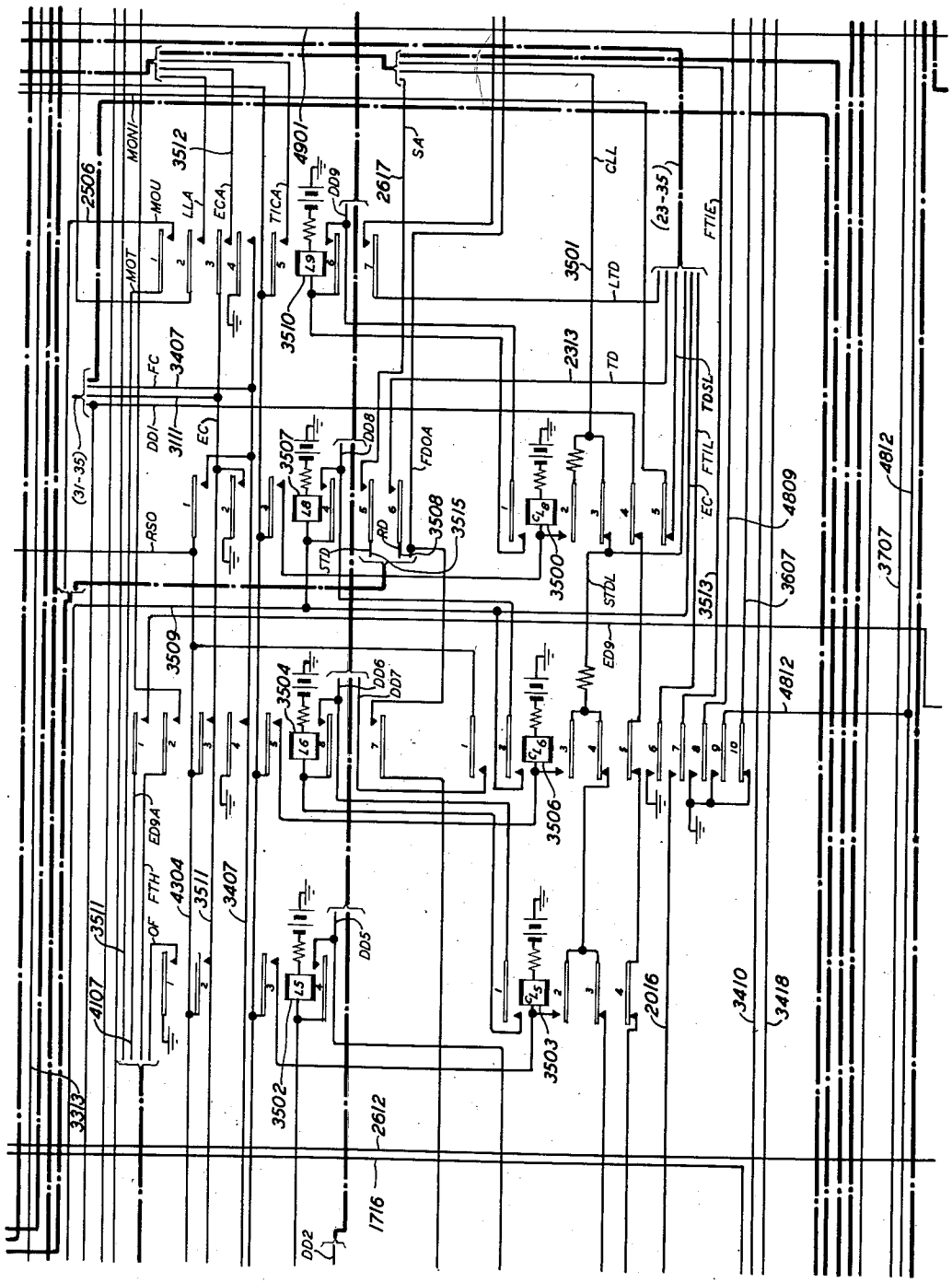

FIG. 35

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 33

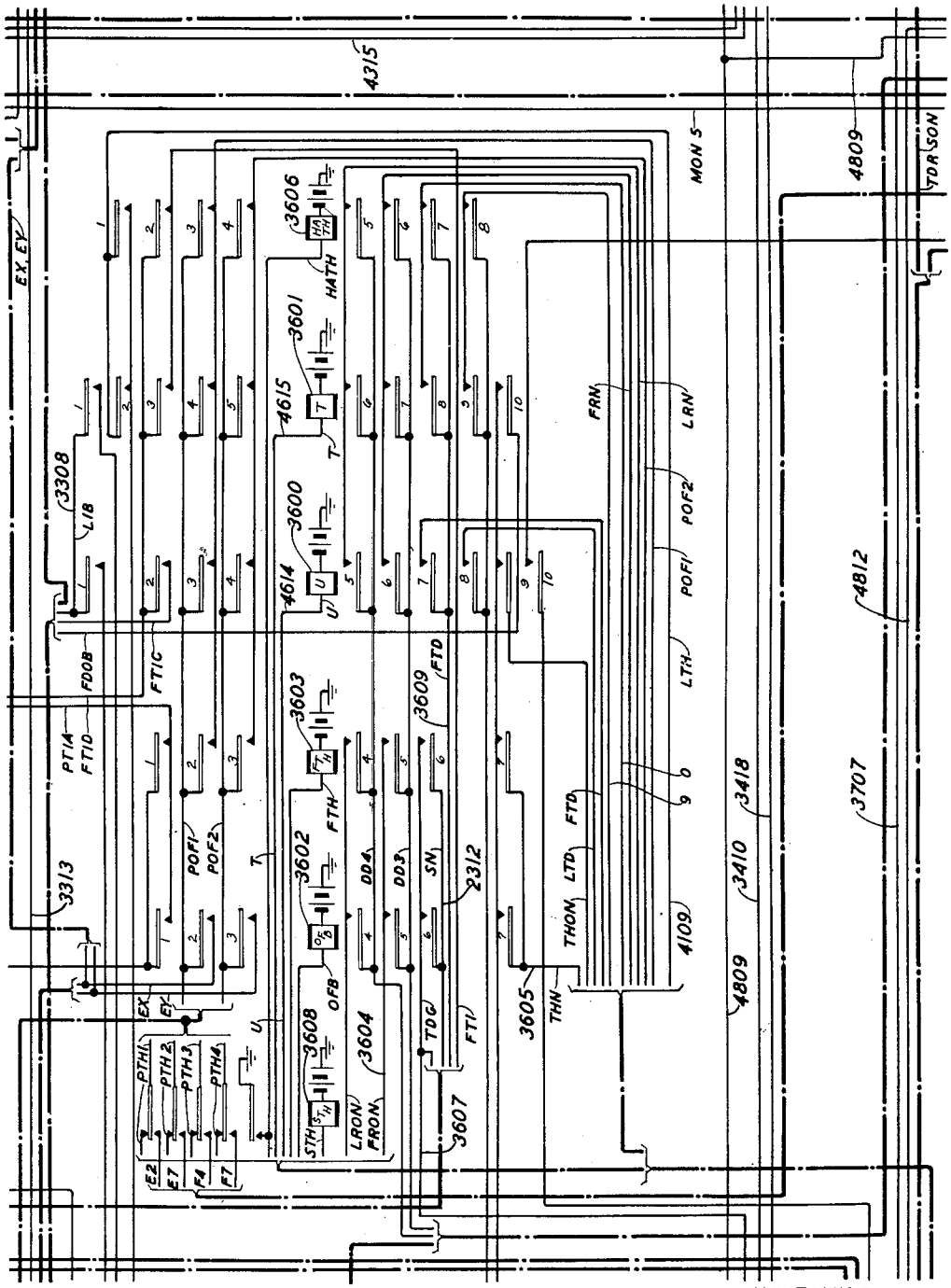

FIG. 36

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 34

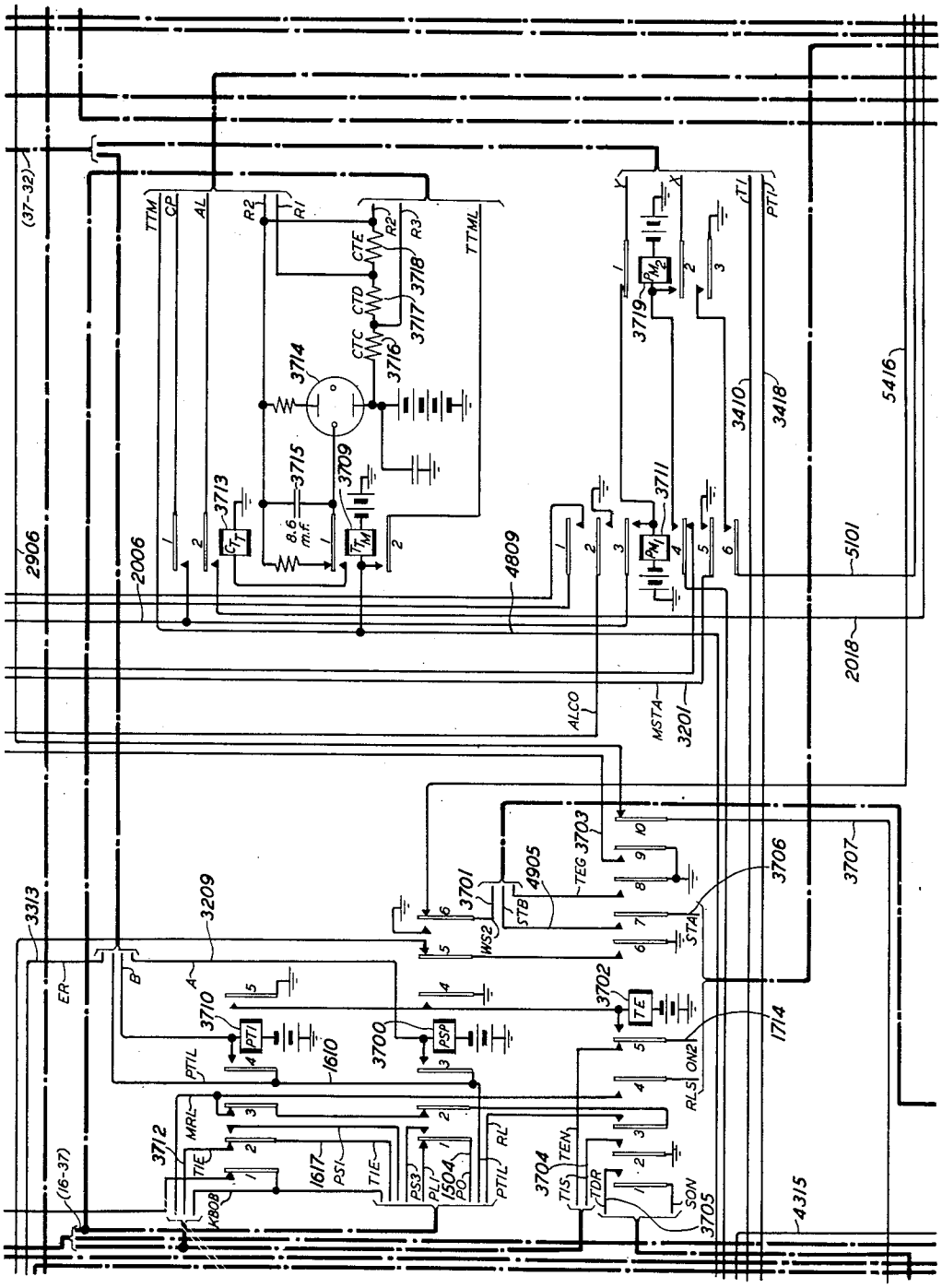

FIG. 37

INVENTOR
A. E. JOEL, JR.
BY John A. Hall
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 35

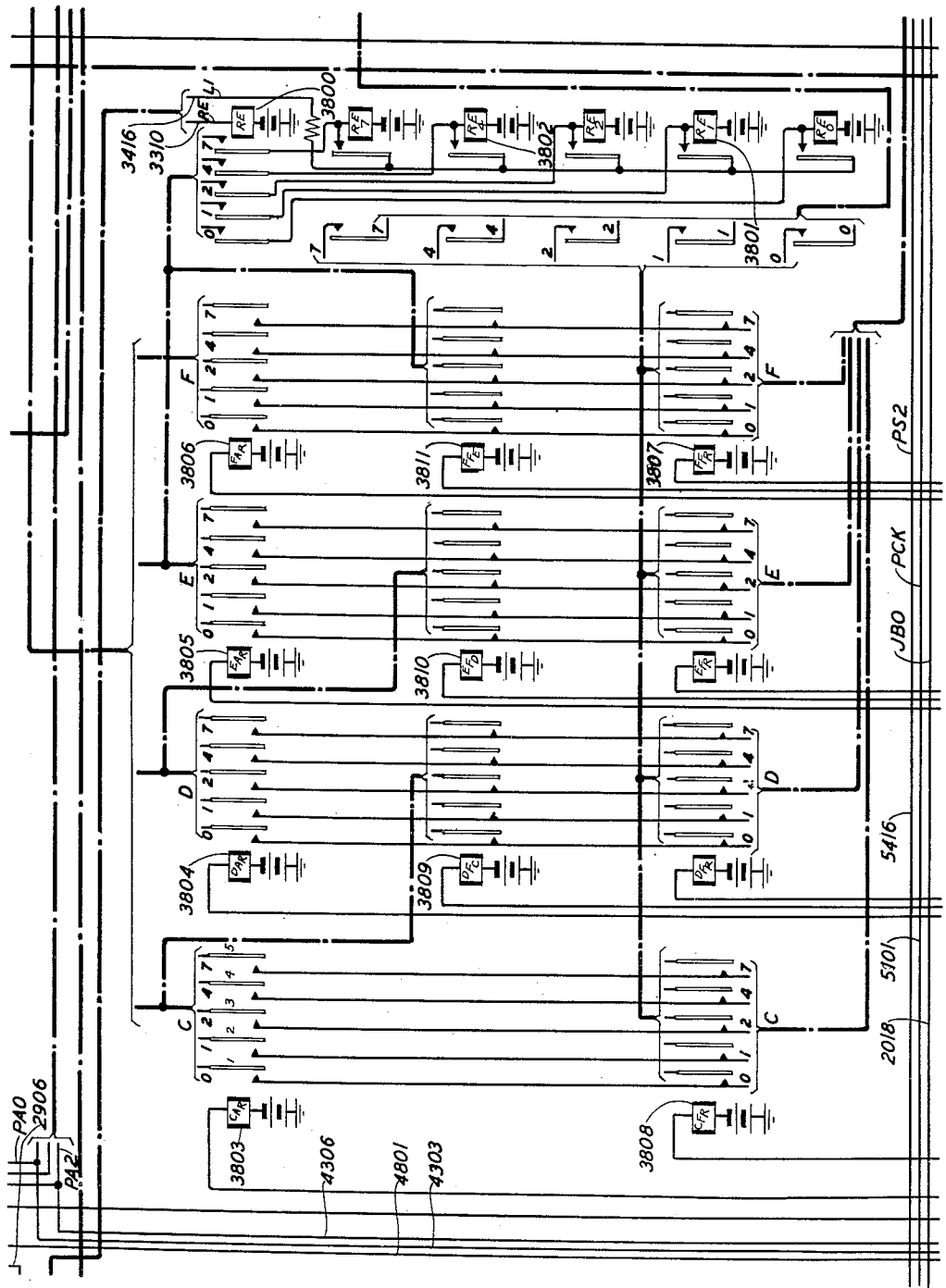

FIG. 38

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 36

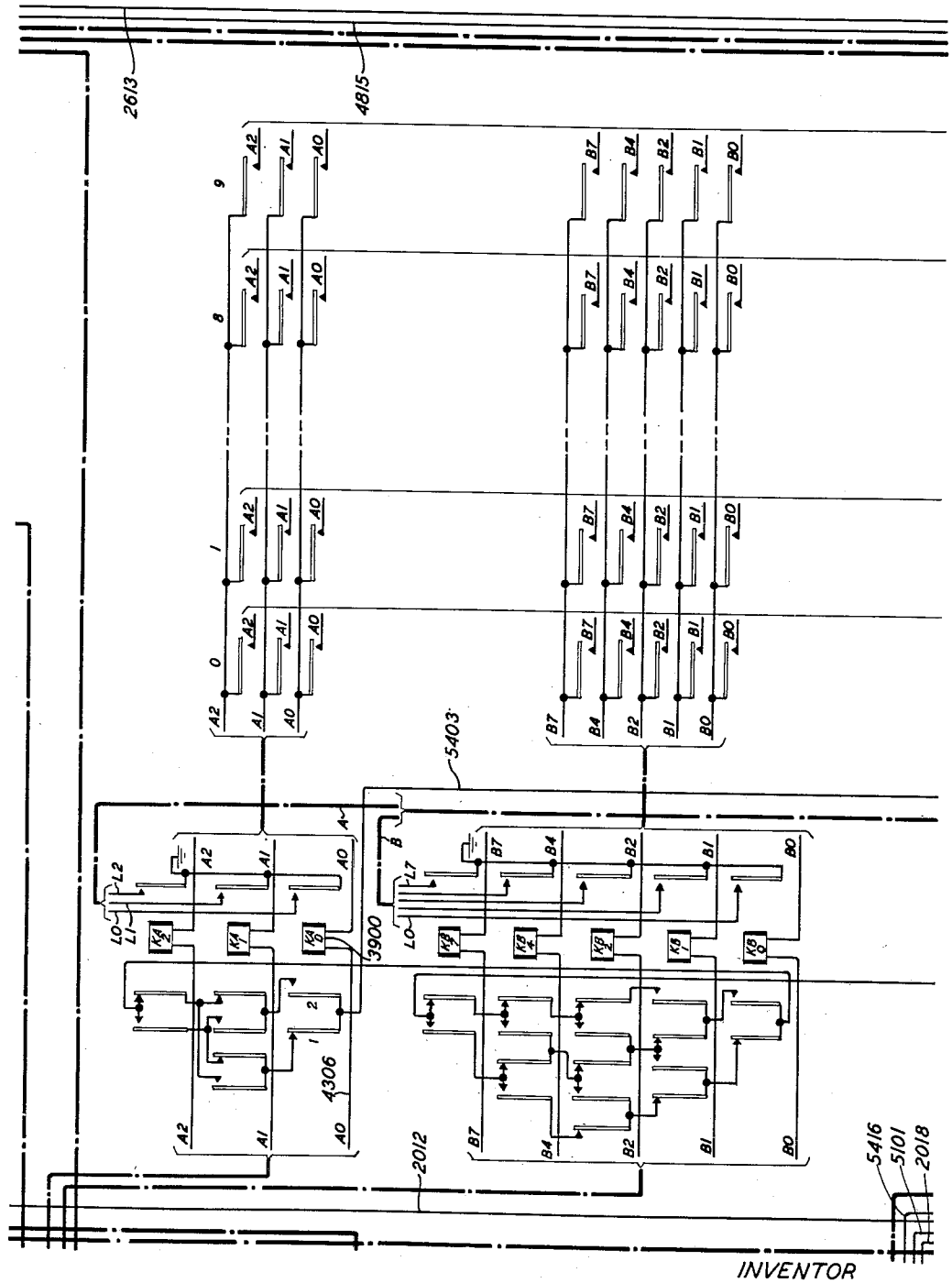

FIG. 39

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 37

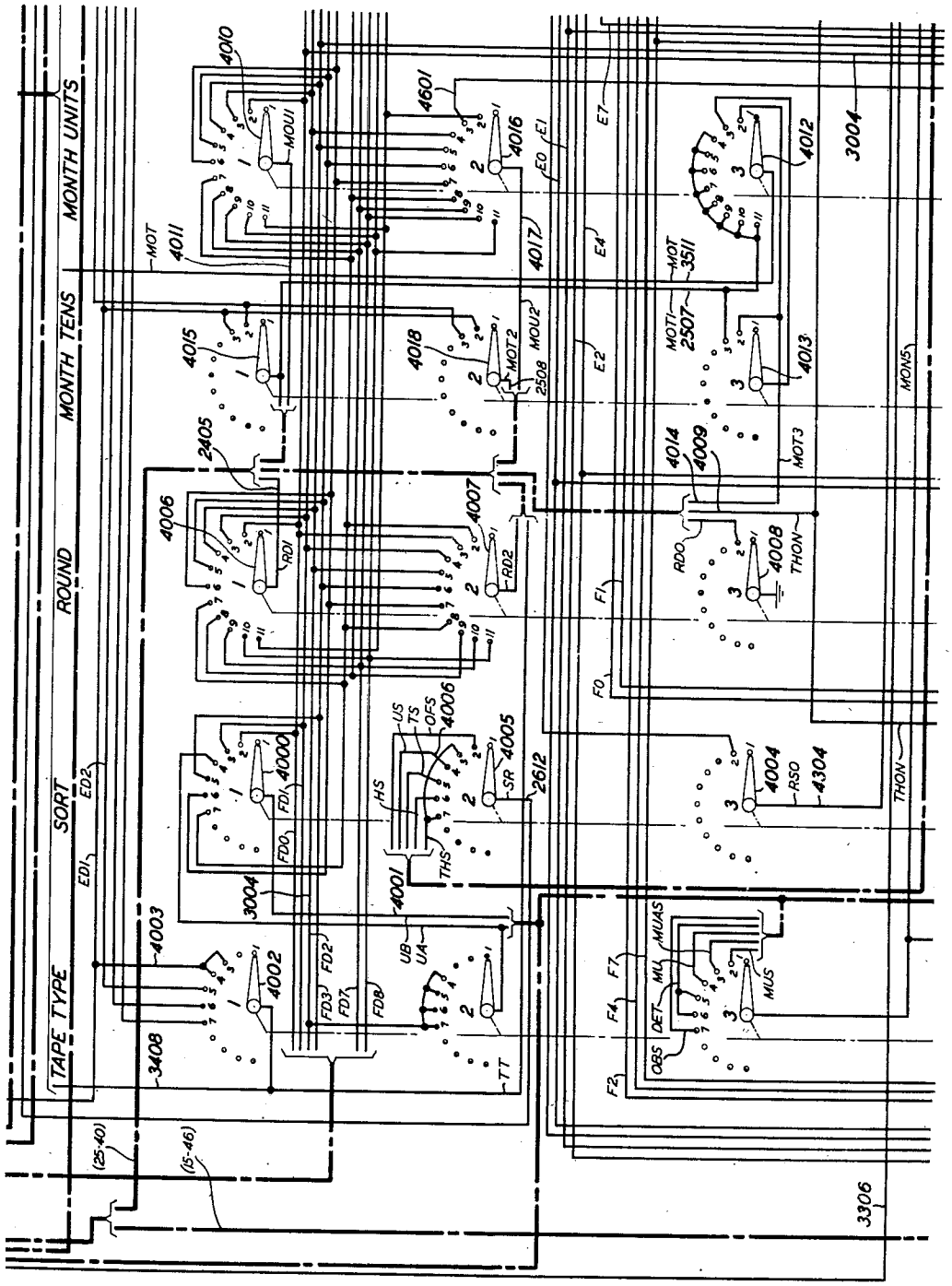

FIG. 40

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 38

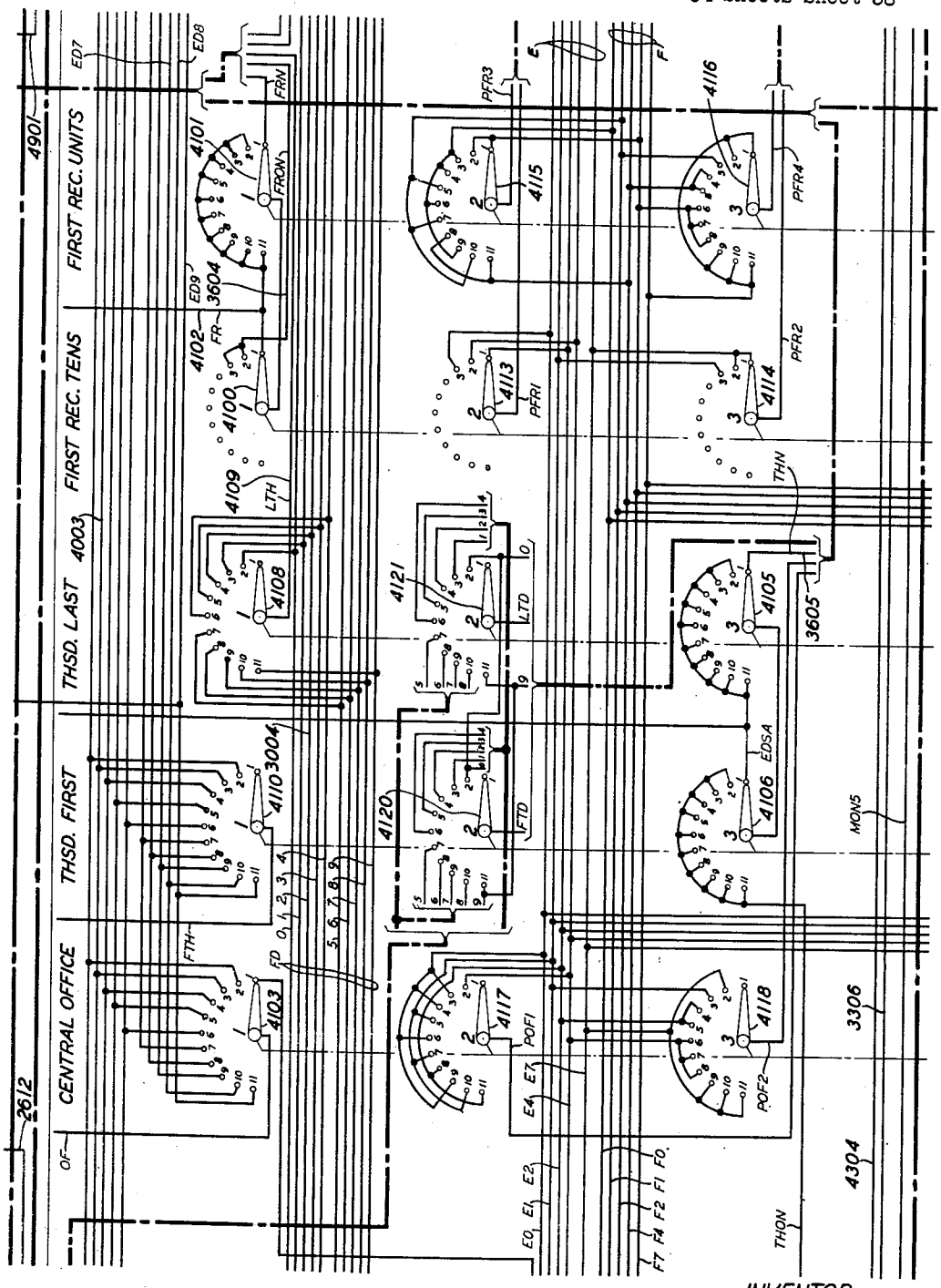

FIG. 41

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 39

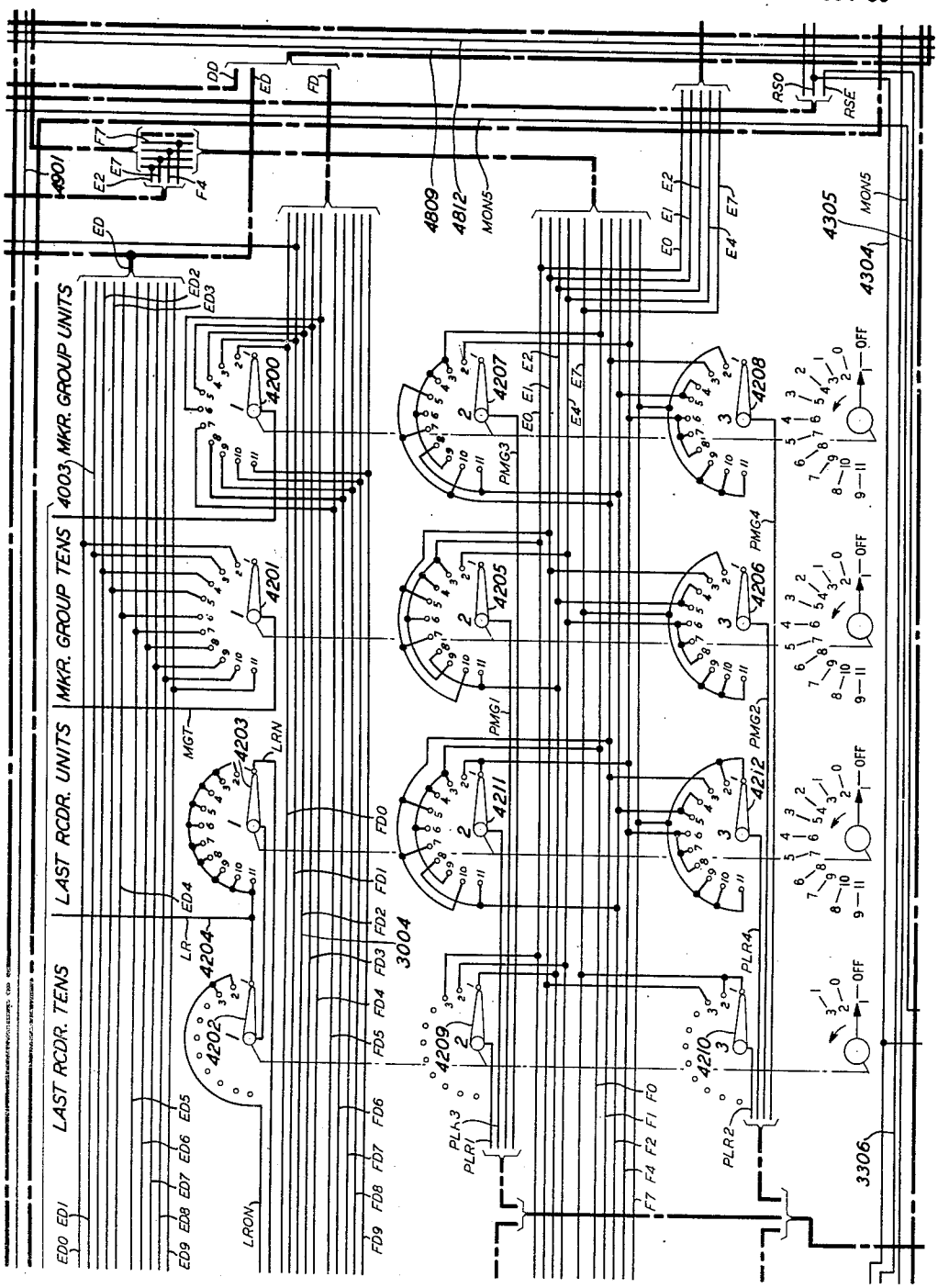

FIG. 42

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 40

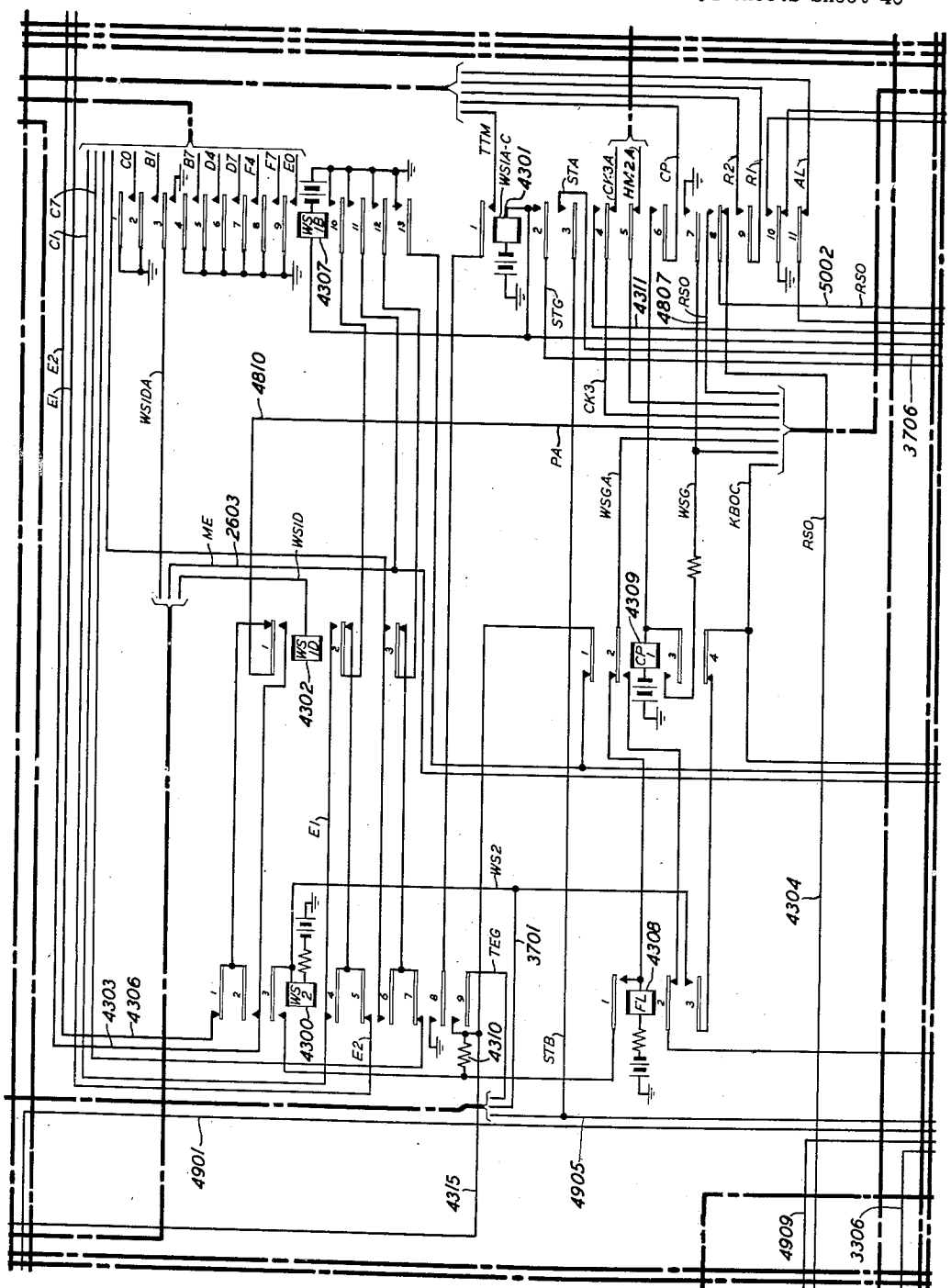

FIG. 43

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 41

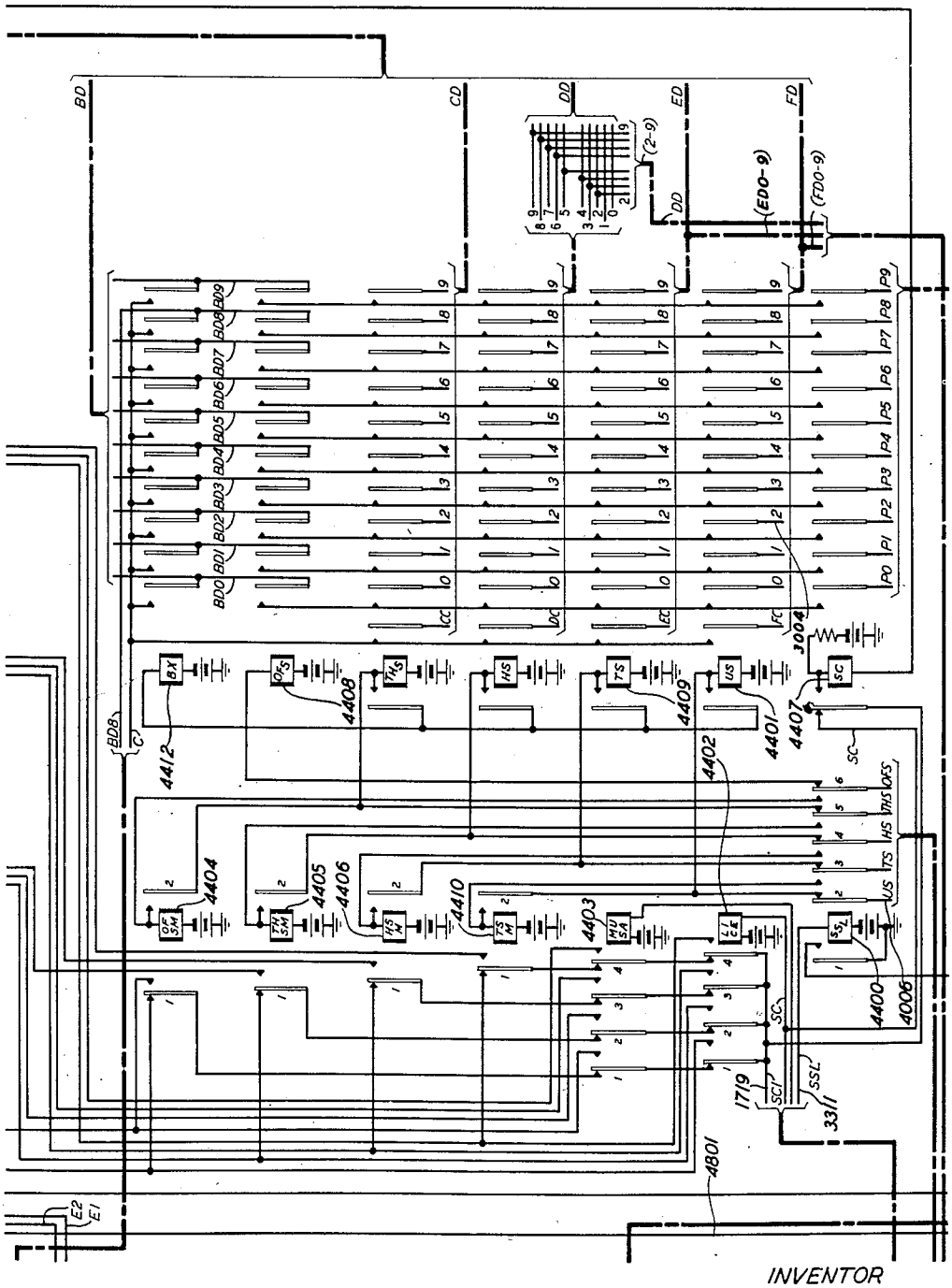

FIG. 44

INVENTOR
A. E. JOEL, JR.
BY
ATTORNEY

March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 42

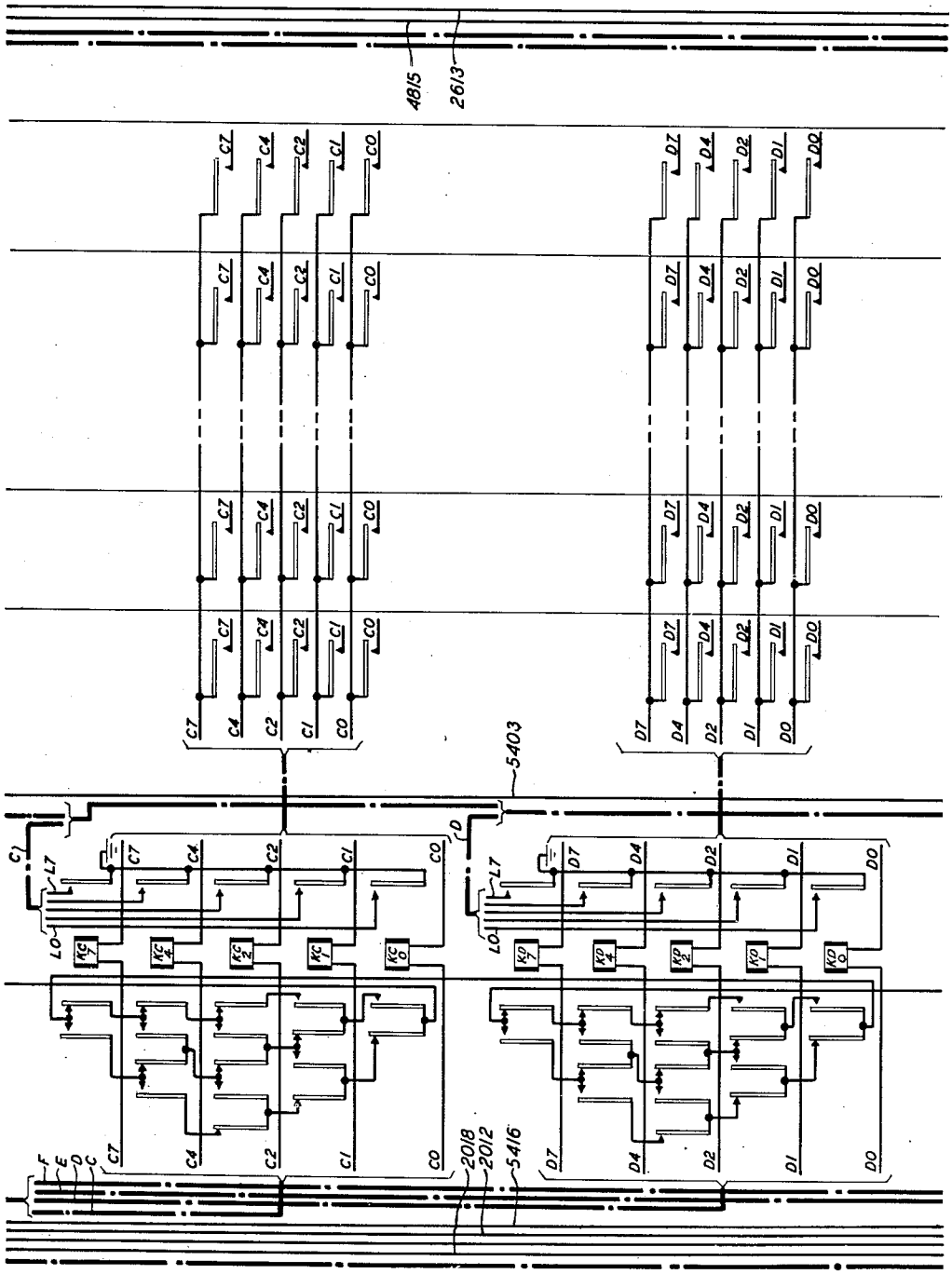

FIG. 45

INVENTOR
A. E. JOEL, JR.
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March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 43

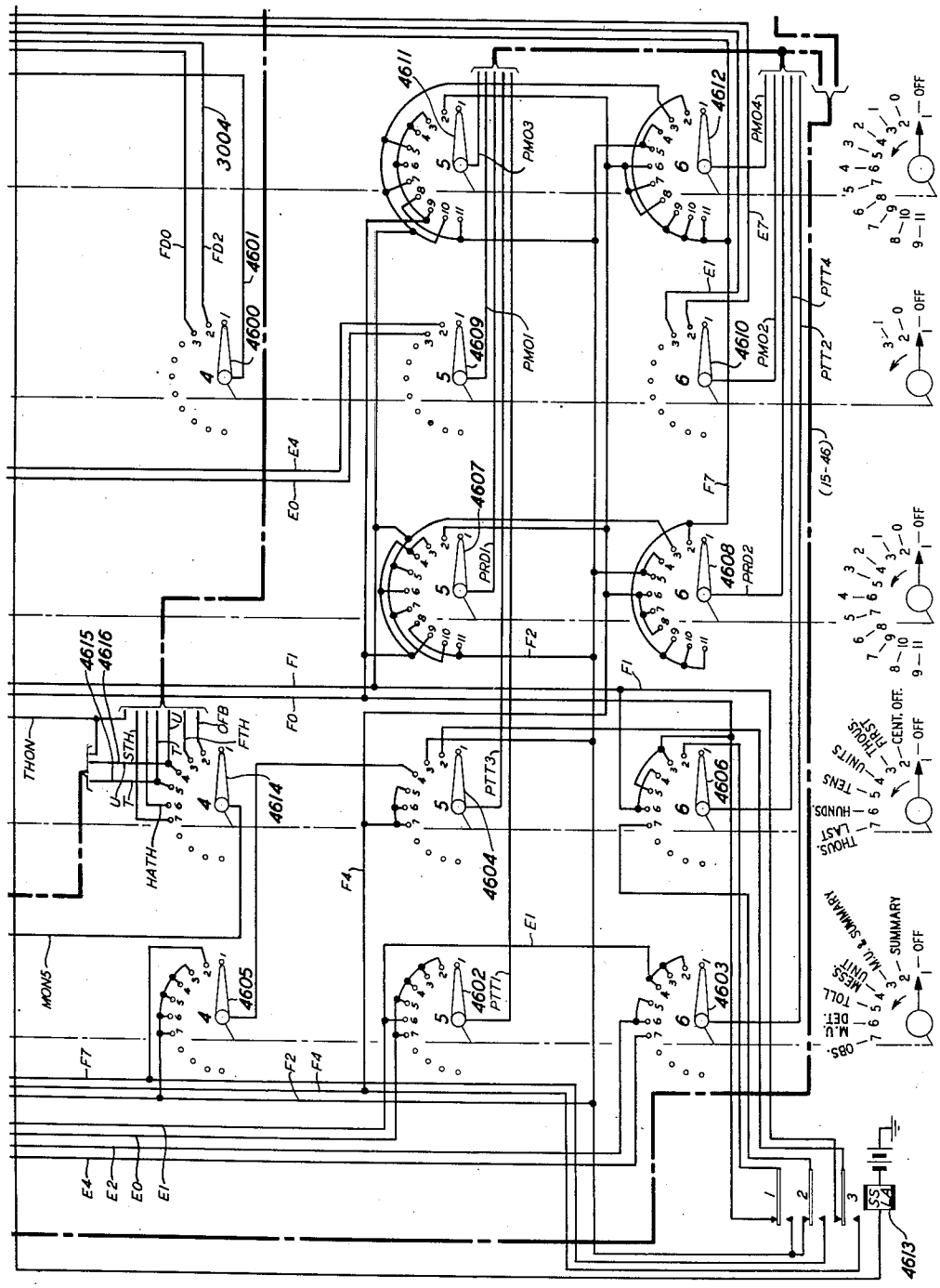

FIG. 46

INVENTOR
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SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 44

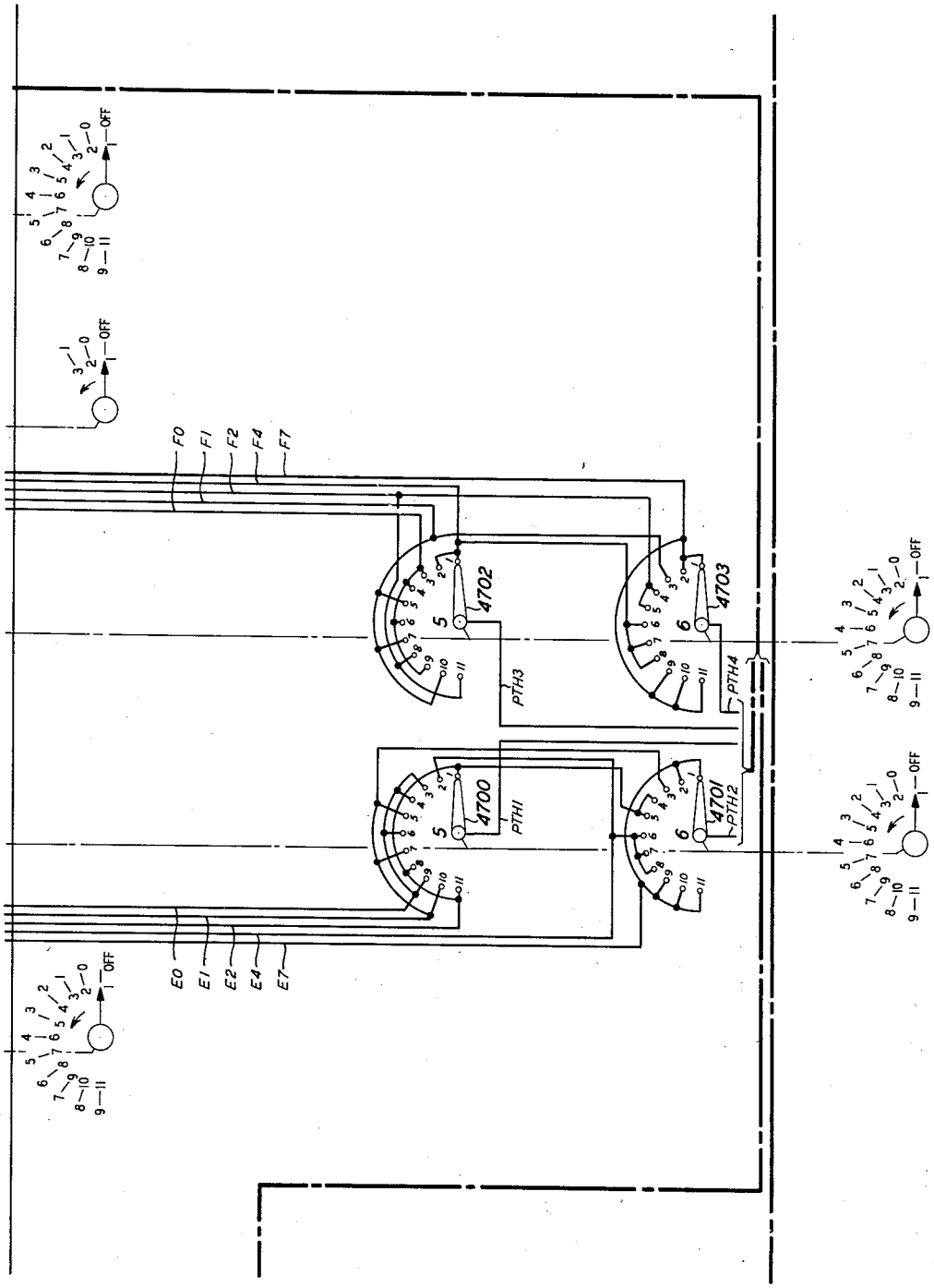

FIG. 47

INVENTOR
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March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 45

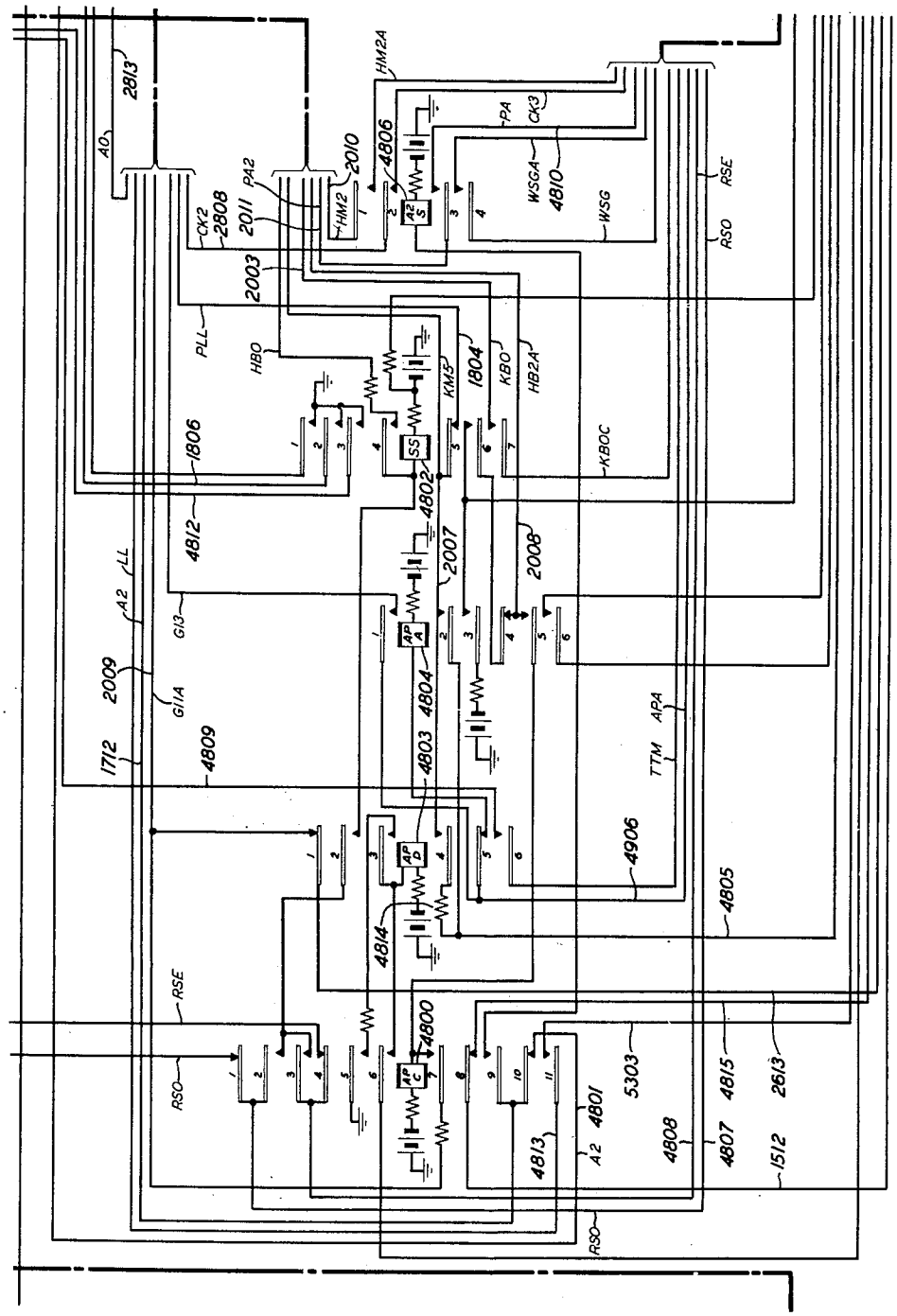

FIG. 48

INVENTOR
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SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 46

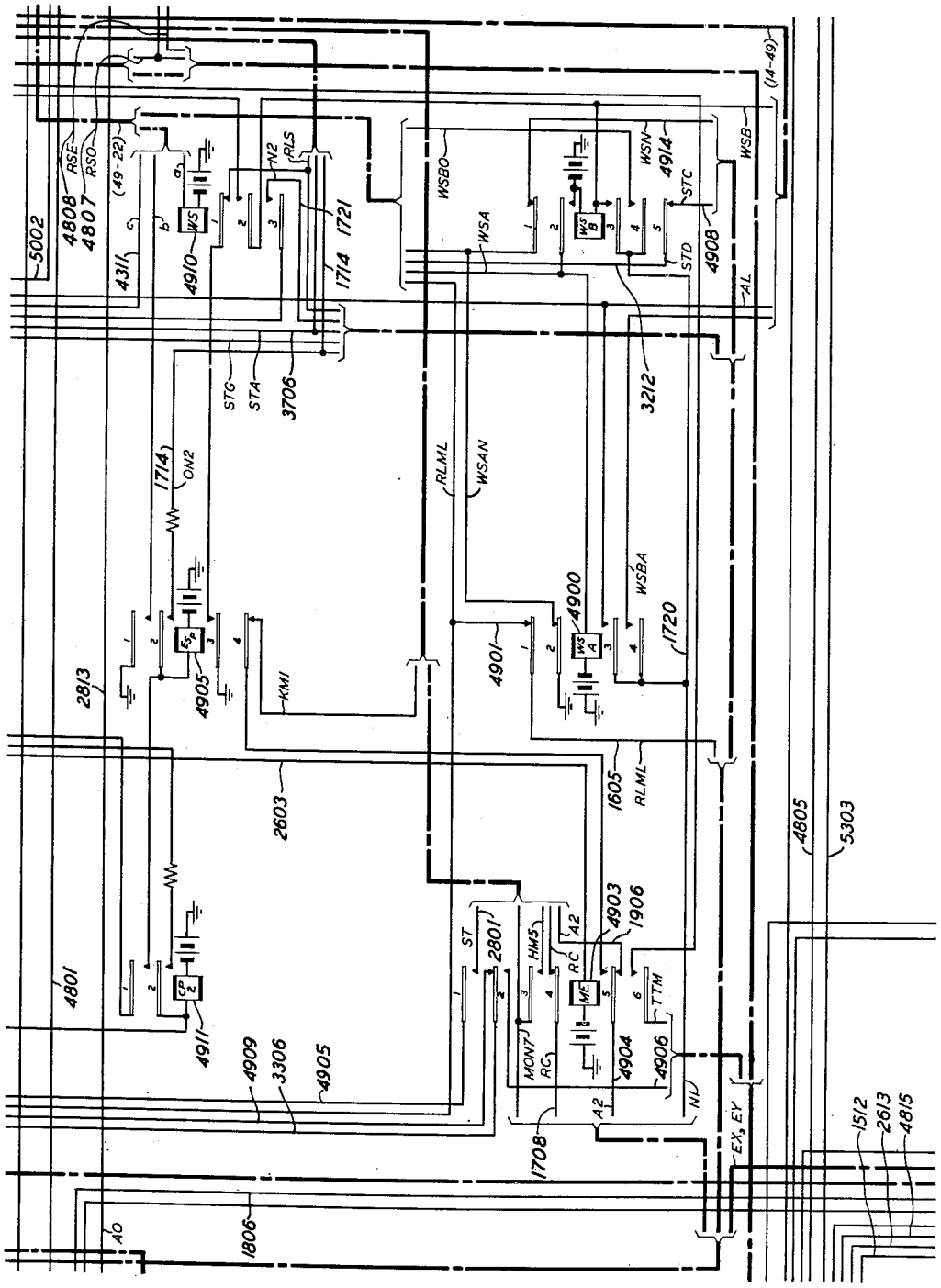

FIG. 49

INVENTOR
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March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 47

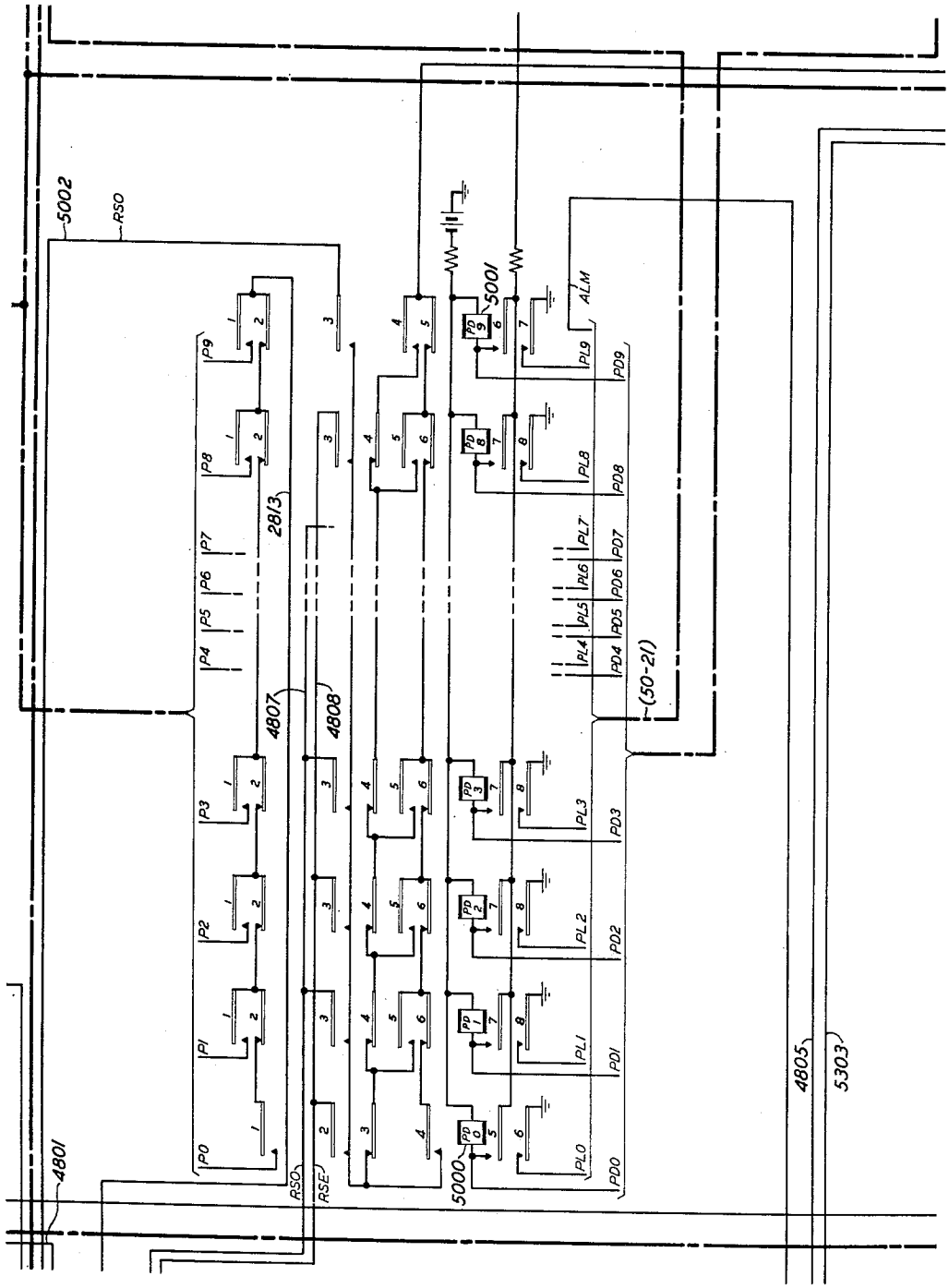

FIG. 50

INVENTOR
A. E. JOEL, JR.
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March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 48

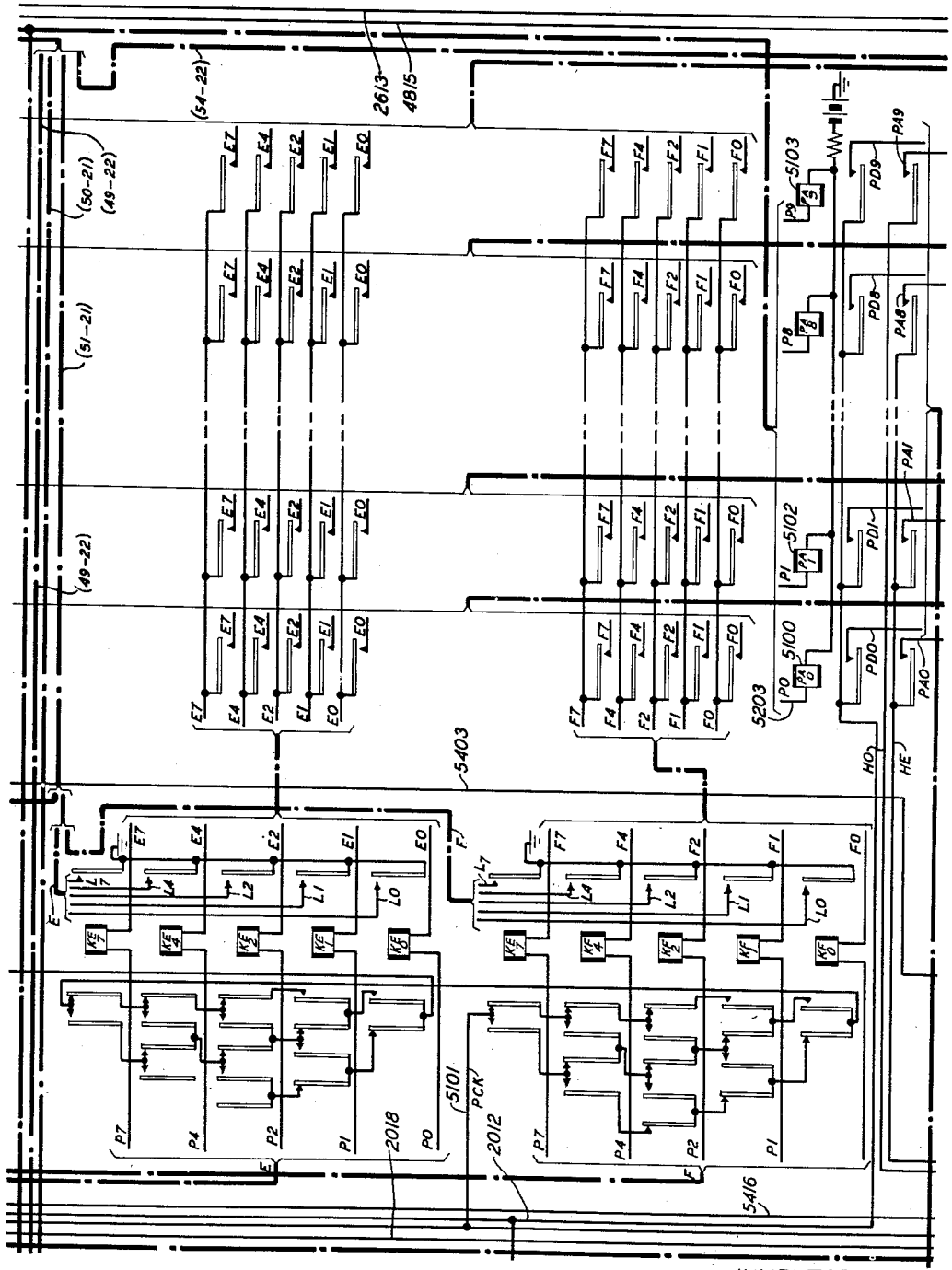

FIG. 51

INVENTOR
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March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 49

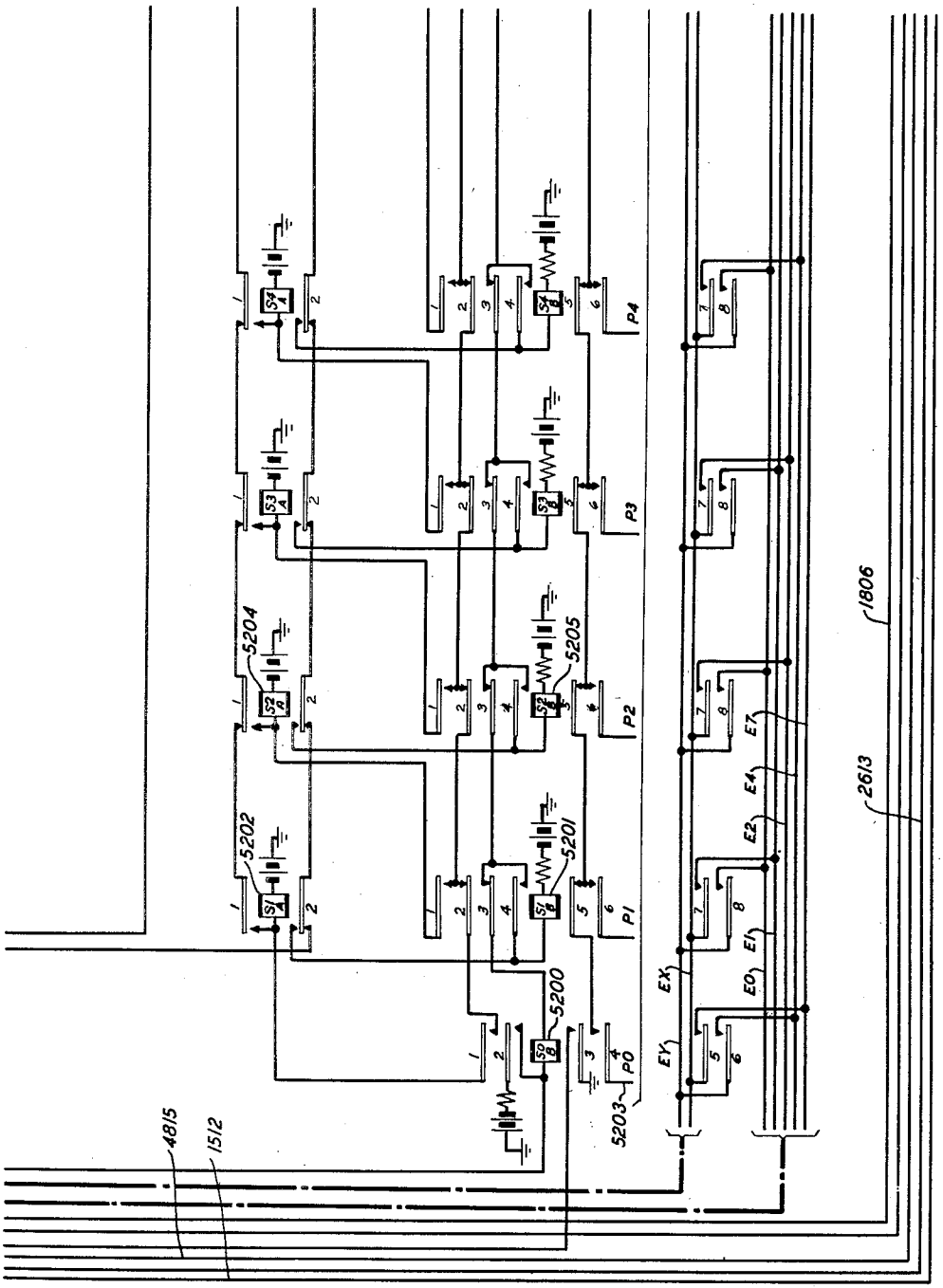

FIG. 52

INVENTOR
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March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 50

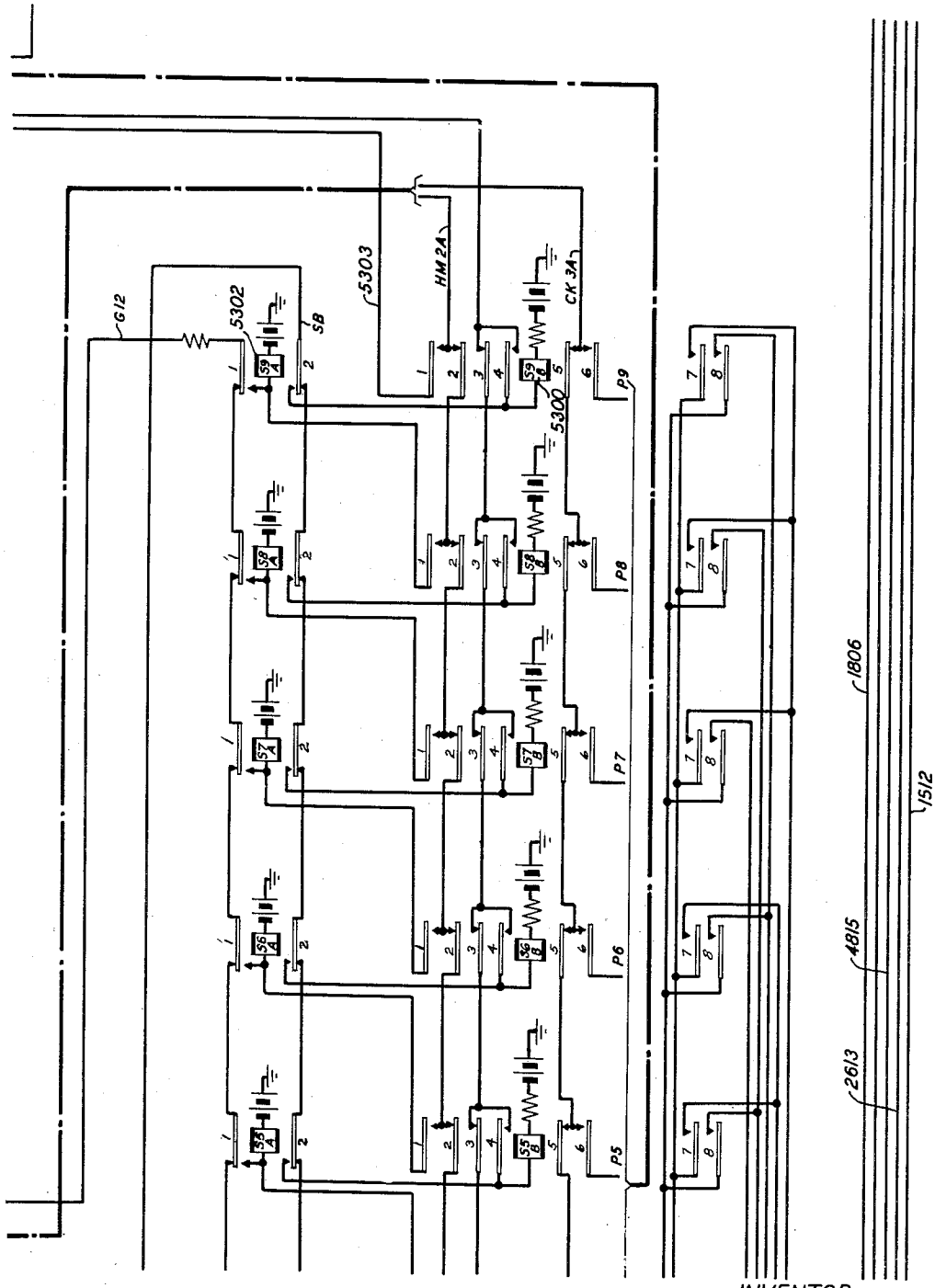

FIG. 53

INVENTOR
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SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 51

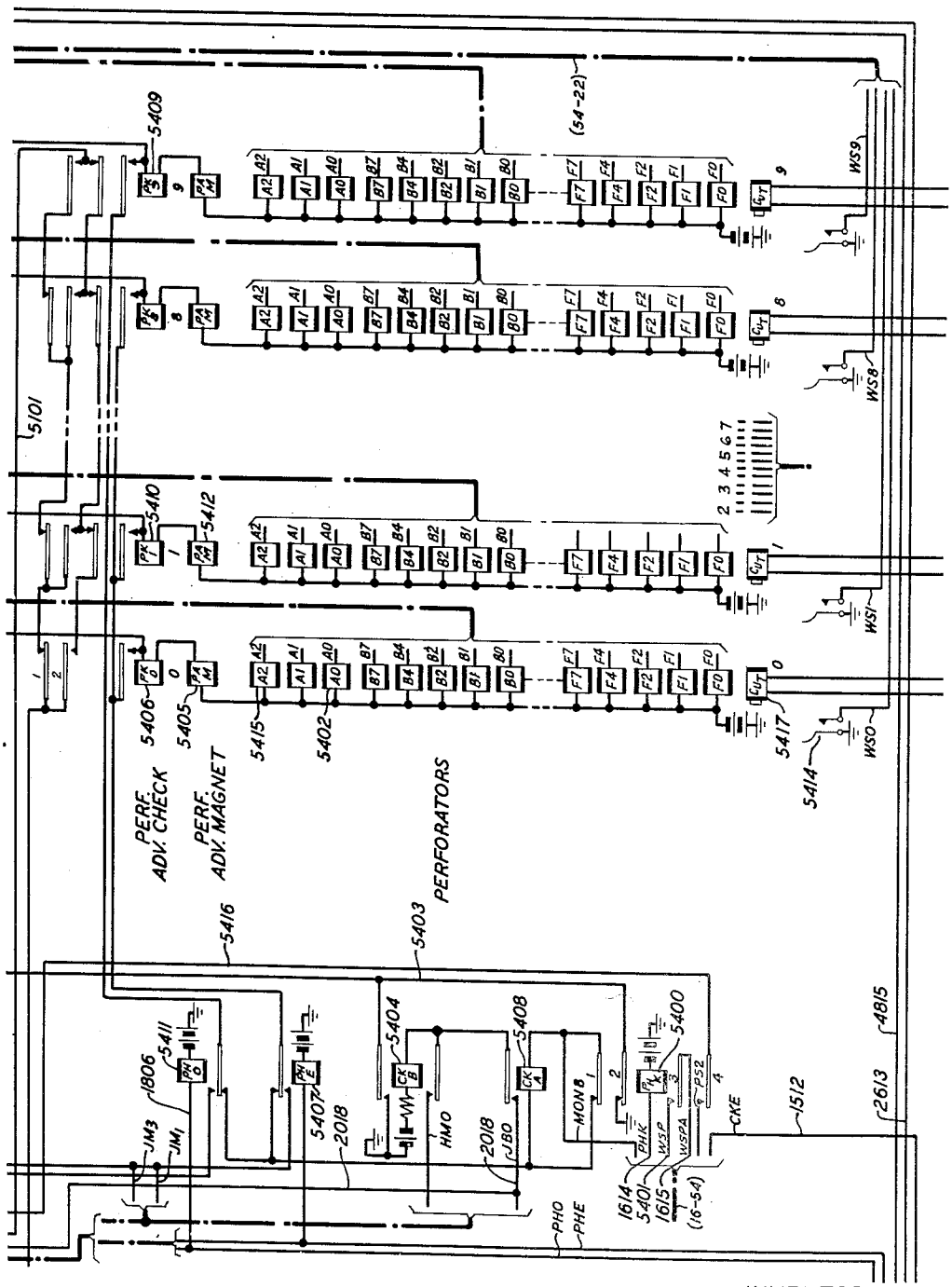

FIG. 54

INVENTOR
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March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 52

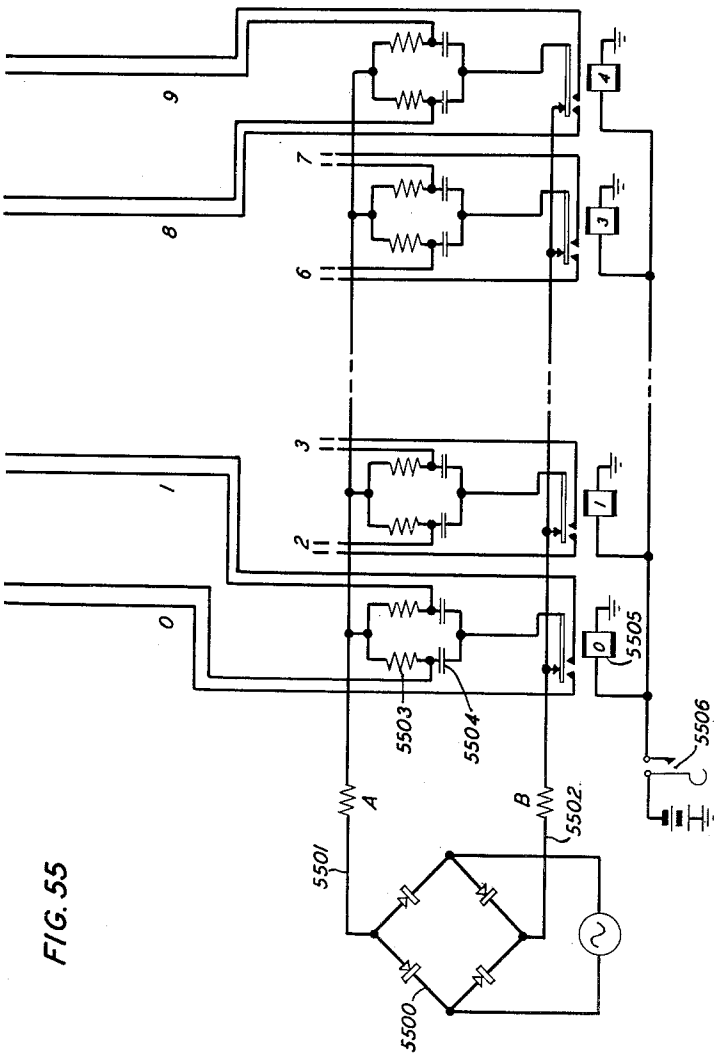

FIG. 55

INVENTOR
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March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 53

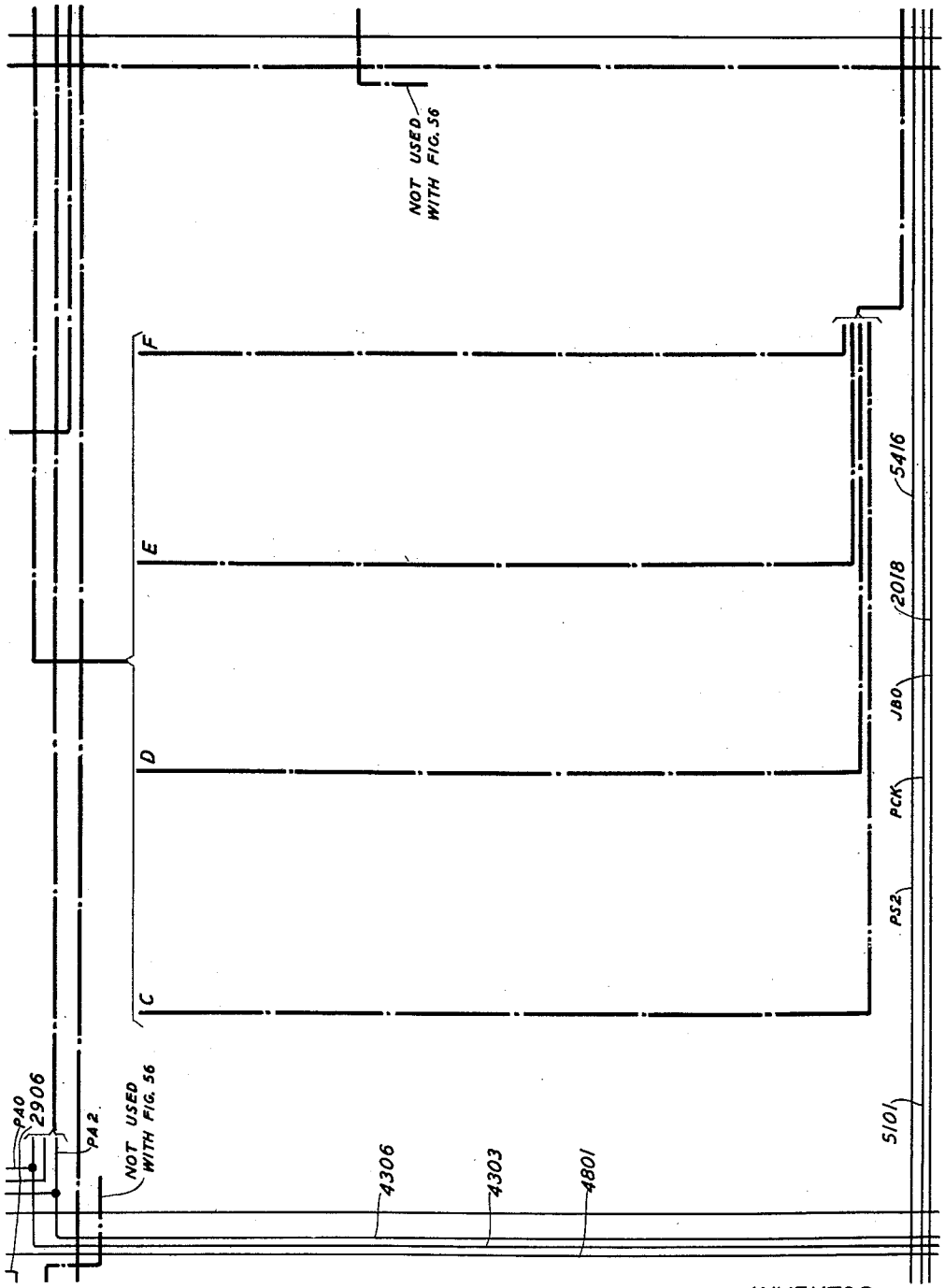

FIG. 56

INVENTOR
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March 25, 1952 A. E. JOEL, JR 2,590,625

SORTING DEVICE

Filed May 16, 1950 54 Sheets-Sheet 54

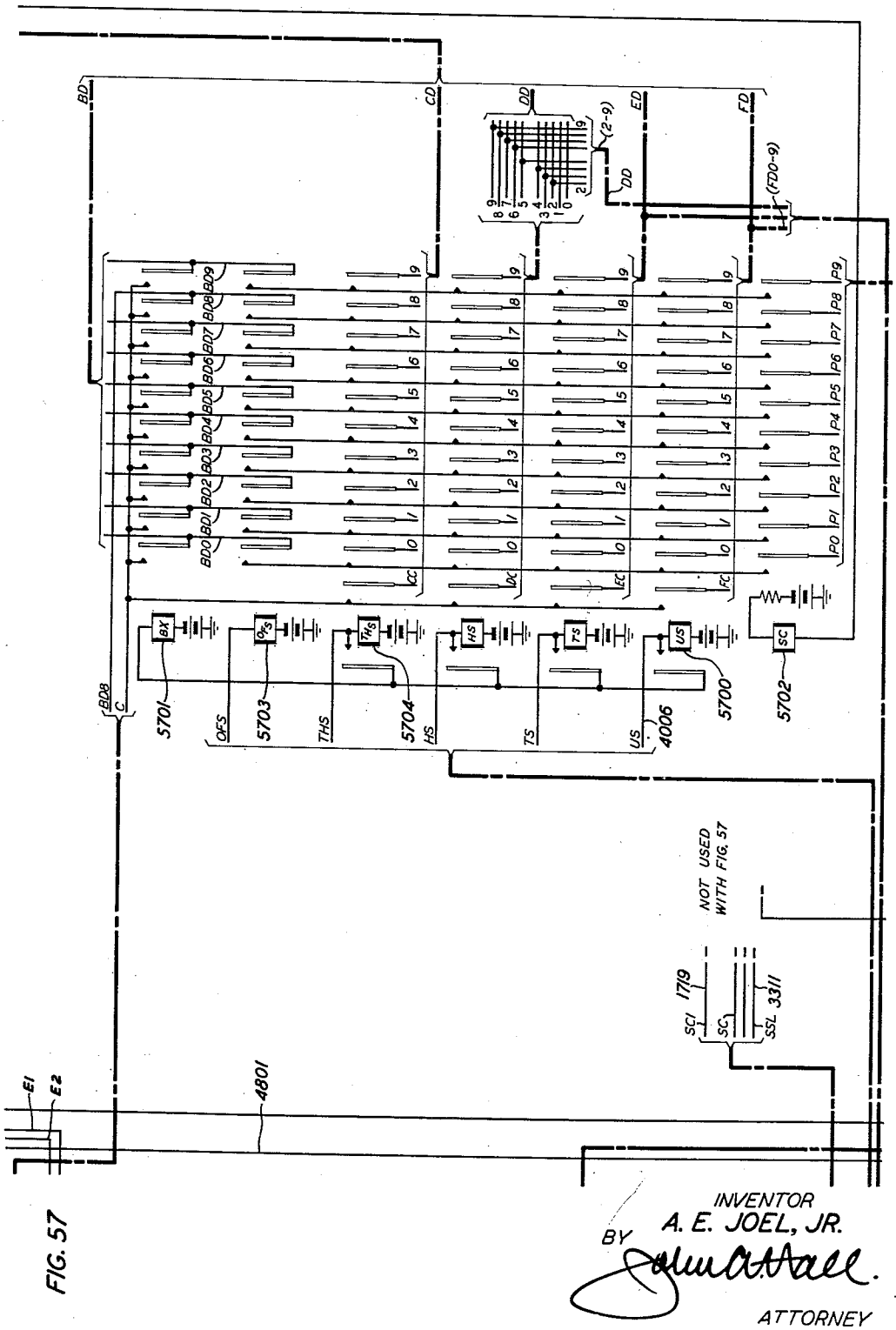

FIG. 57

INVENTOR
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BY
ATTORNEY

Patented Mar. 25, 1952 2,590,625

UNITED STATES PATENT OFFICE

2,590,625

SORTING DEVICE

Amos E. Joel, Jr., New York, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application May 16, 1950, Serial No. 162,222

6 Claims. (Cl. 164—115)

1

This invention relates to sorting devices, particularly to means for sorting large numbers of items recorded on tapes as employed in automatic accounting systems.

An object of the invention is to reduce the tape handling time and to thus promote economy in labor and material in an accounting system.

The invention consists in a novel method of and the means for sorting items in a plurality of stages greater in number than the number of digits used to express the one item of information by the digits of which sorting is accomplished. In the normal method in use in a typical automatic accounting system adapted particularly for the accounting of telephone messages, items of information pertaining to telephone calls recorded through the use of telephone facilities are assembled by one device on an output tape, the customer charges for each call are computed by another device from the tape aforementioned and recorded on a second output tape, the computed charges are then sorted by still another device from the last-mentioned tape and recorded on a third output tape and the records on said third tape are further processed to a final printing of customer charges in billable form by still other devices.

The item of information used in sorting is the four-digit telephone number of the customer who made the call and by which he may be identified. However, this is not complete information since the office in which the line of the customer terminates must also be identified. Now the office may be identified by a single digit used in combination with what is termed the "marker group" number, which is a number that identifies a building in which are located a plurality of offices, and which, if there is but one office in the building, identifies the office. But even this one extra digit cannot be expressed where there is room on the tape for only the four digits of the telephone number, and hence it is the present practice to identify the office in what are called the "tape indentity information entries," which are a series of entries placed at each end of a tape to denote its identity in respect to matters of particular interest to the business office, so that the first sorting of the computed calls is by offices and is accomplished by the computer. Thereafter, the computed calls for each office are run through the sorter four times to sort by the units, tens, hundreds and thousands digits of the calling line numbers in the digital order given. Hence, it will be understood that if the calls for an original central office tape

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came from five offices the present practice would call for five times four or twenty sorting operations to be performed.

The present invention provides means for and a method of reducing this labor to a uniform five sorting operations regardless of the number of offices involved.

The novel conception is to sort by one of the expressed digits, to store that digit in the tape identity information on the output tape and to substiute in its place the index in the tape identity information found on the input tape. In this manner, five sorting operations will complete a sorting by office, thousands, hundreds, tens and units and on the last of these operations will leave each item of information in the form of the four digits of the telephone number with the office index expressed in the tape identity information in a form ready for printing.

It will be realized that large amounts of paper tape are employed, and the tape handling labor, including splicing of tape ends, is great so that a method by which the material and labor may be materially reduced is a matter of substantial economy. The extra amount of apparatus needed for this purpose is very small in comparison to the cost of the material and labor saved. The reduction in time effected is also a matter of considerable importance.

The invention consists of sorting a large plurality of items by one of four expressed digits, and which plurality of items is accompanied by or associated with a set of items of general information, among which there is a single digit expressing a fifth sorting index. Upon each sorting operation, the digit used to control the sorting is removed from the specific item and the index of the general item is inserted therefor. It will be understood that in sorting, the items of information are read from an incoming tape and reproduced on an outgoing tape. The pattern may, therefore, be expressed by the following table:

	Incoming Specific	Common	Outgoing Specific	Sorted By Common
1st Sort	5 1 2 3	4	5 1 2 3	4
2nd Sort	5 1 2 3	4	5 1 2 4	3
3rd Sort	5 1 2 4	3	5 1 3 4	2
4th Sort	5 1 3 4	2	5 2 3 4	1
5th Sort	5 2 3 4	1	1 2 3 4	5

It will be noted in the above tabe that the incoming specific item of information contains all five elements. In actual practice, the calling sub-

scriber's telephone number, including the office designation, is in what is termed the initial entry, but when the data for a call comes to the computer it (under present practice) issues in the form

1 2 3 4 5

the 5, in combination with the marker group number, acting to identify the calling office.

Thus, a call made by the subscriber at telephone CHelsea 3 1234 might appear on the central office tape for marker group 15, and be assembled by the assembler, as shown in Fig. 1, as the following group of codes:

1 4 1 5 6 7
1 3 7 2 6 7
2 1 3 0 6 7
0 5 1 2 3 4

The last of the above codes is the supplementary line of the initial entry and the 5, the second digit thereof, is known as the office index, while the last four are the four digits of the calling line number.

Now, under present practice, the computer will process this information and on one section of the output tape, identified by the marker group number 15 and devoted to all calls having the office index 5, will produce this line:

1 1 1 2 3 4

the first digit identifying the line as a one-line message unit charge, the second digit making a charge of one message unit and the last four digits identifying the calling line number as 1 2 3 4.

When this call has been fully processed, it will eventually be printed on a list of calls, for a given date and made from the office CHelsea 3, as:

1 2 3 4 -1

A feature of the invention may, therefore, be stated as a method of sorting items in a plurality of stages greater in number than the number of digits used to express the item of information, consisting of sorting by one of said digits, removing said digit and substituting therefor, and in a rearranged order among said digits, a digit common to said items (which is in the practice of the invention and as subsequently set forth the digit which identifies the number of the perforator which produces the output tape in which the sorted items are recorded), repeating said operations a number of times equal to the number of digits used to express an item of information plus the said commonly expressed digits.

Another feature of the invention may be stated as the combination in an automatic accounting system wherein a plurality of specific items of information is recorded in succession but not in serial order and in which each said plurality of specific items is accompanied by a group of common group identity items of information, of means for sorting said specific items of information by one digit of a multidigit index, that is, the calling subscriber's number, said sorting means consisting of means for successively reading said items from an incoming group and for reproducing said items in sorted outgoing groups, means for transferring the said one digit to a place in said common group of identity items of information produced to accompany each said sorted outgoing group, means for rearranging the order of said remaining digits of said multidigit index in each said outgoing item of information, and means for inserting in place of said transferred digit, an index taken from among said group of common group identity items of information accompanying said incoming group.

The process consists, in a specific example, of sorting in accordance with one of five digits expressed in the original information, specifically the units digit of the calling subscriber's telephone number, and recording in each specific item of information the office index, the thousands, hundreds and tens units of the said telephone number, the units digit then being expressed by the section of the output tape on which it appears (after the ten separately produced output tapes have been spliced together). The units digit is thus effectively carried in the tape identity information, for this includes the tape section. On the next sort, the units digit is put back in its original place, now being derived from the tape section counting means, and the items are sorted by their tens digits, each item as it is recorded in an output tape containing the office index, and the thousands, hundreds and units digits of the telephone number, the tens digit being expressed by the section of the output tape on which it is recorded. This process is repeated until, at the end, there is a tape section for each office, and each item of specific information contains the thousands, hundreds, tens and units digits of the calling telephone number.

Other features will appear hereinafter.

The drawings consist of fifty-four sheets having fifty-seven figures as follows:

Fig. 1 is a sketch or chart showing the plan of shifting the digits of a designation during a series of successive sorting operations, and showing how the digit by which the sorting at any stage is being controlled is taken out of the designation and another value represented by the tape section is substituted therefor, the value taken out then being represented by the tape section being produced;

Fig. 2 is a similar sketch or chart showing a similar plan used in connection with a tape of slightly different nature, that is, one bearing information previously sorted but which must now be added to information derived and sorted from a tape previously not so processed;

Fig. 3 is a block diagram showing how Figs. 4 and 5 may be placed to form a skeletonized schematic diagram of the circuit arrangements employed for shifting the various digits of a designation during the various sorting steps;

Fig. 4 shows that part of the above said diagram including the reader, the reader connector, the perforate sort connector, the set-up switch, the tape index connector, the tape identity reading progress and a part of the switching relays controlled by the above-named instrumentalities;

Fig. 5 includes the remainder of the switching relays controlled by the instrumentalities of Fig. 5 and, in addition, contains an indication of the perforator magnet check circuit, the perforator connector and a plurality of perforators by which the sorted items of information are recorded;

Fig. 6 placed on the same sheet with Fig. 7 shows the manner in which Figs. 7, 8, 9, 10, 11 and 12 may be arranged to form a somewhat more complete schematic diagram of the circuits employed in the present invention;

Fig. 7 shows an indication of the reader, the reader connector and the reading relays;

Fig. 8 shows the tape identity sort connector, and the tape identity perforator progress circuit;

Fig. 9 shows the perforate sort connector, the entry spread progress circuit and the perforator register circuit used in connection therewith and certain of the set-up switches;

Fig. 10 contains a number of indications of circuits such as the reader line count circuit, the tape section register, the tape identity reading progress circuit and mainly shows the arrangement of the sorting translator, that is, the relays employed for shifting the digital designations during a sorting process;

Fig. 11 shows the tape section E digit register and part of the tape index connector;

Fig. 12 contains the perforator magnet check, the perforator connector and an indication of a plurality of connectors;

Fig. 13 is a block diagram showing how Figs. 14 to 57, inclusive, may be placed to form a complete circuit diagram of the circuits used in the present invention, it being noted that Figs. 14 to 55, inclusive, used as shown in this diagram show the complete circuits whereas with Figs. 56 and 57 used as an appliqué circuit and placed over and substituting for Figs. 38 and 44, respectively, form a complete circuit diagram of a sorting device used as a basis of the present invention and over which the present invention constitutes an improvement;

Fig. 14 shows the alarm and alarm timing circuits;

Fig. 15 shows the tape identity perforate progress circuit;

Fig. 16 shows part of the tape identity perforate progress circuit and the motor control circuit;

Fig. 17 shows the off-normal and start circuits;

Fig. 18 shows the reader step check circuit and the reader step control circuit;

Figs. 19 and 20 show the reader, Fig. 19 showing the motor and tape perforation feelers and Fig. 20 showing the camming contacts cyclically operated by the reader;

Figs. 21 and 22 show the signal lamps by means of which the proper or improper operation of the device may be visualized, Fig. 21 showing the reader or perforator lamps, the perforator entry spread progress lamps and the tape section lamps and Fig. 22 shows a number of individual lamps as labelled to indicate its use such, for instance, as the skip splice lamp and the master off-normal lamp;

Fig. 23 shows the tape section register by means of which the numerical identity of the sections of the incoming tape being read by the reader are properly identified;

Figs. 24 and 25 show the tape index register;

Fig. 26 shows the tape identity perforate control;

Fig. 27 shows the skip splice control;

Fig. 28 shows the reader line count circuit;

Fig. 29 shows the reading relays for the A and B digits;

Fig. 30 shows the reading relays for the C to F, inclusive, digits;

Fig. 31 shows the reading relays translator;

Fig. 32 shows a number of various keys used for switching purposes in locating trouble or unstandard conditions upon an alarm and the keys used for the normal operation of starting and stopping the device;

Fig. 33 shows the tape index connector;

Figs. 34 and 35 show the tape identity reading progress circuit;

Fig. 36 shows the tape identity sort connector;

Fig. 37 shows the splice pattern timing circuit, the tape and perforator control circuit and the mutilated line control;

Fig. 38 shows the sorting translator;

Fig. 39 shows the perforating magnet check for the A and B digits and part of the contacts of the perforator connector relays;

Figs. 40, 41 and 42 show the set-up switches, Fig. 40 showing the switches for the tape type, the sort, the round, the months tens and the months units, Fig. 41 showing the switches for the central office designation, the thousands first, the thousands last, the first recorder tens and the first recorder units, and Fig. 42 showing the switches for the last recorder tens, the last recorder units, the marker group tens and the marker group units;

Fig. 43 shows the window splice perforator control;

Fig. 44 shows part of the sorting translator not shown in full in Fig. 38 and in addition the sorting connector;

Fig. 45 shows the perforating magnet check circuit for digits C and D and some of the contacts of the perforator connector relays;

Figs. 46 and 47 show other contacts of the set-up switches shown in Figs. 40 and 41, respectively;

Fig. 48 shows the entry spread control circuit;

Fig. 49 shows the window splice perforator control;

Fig. 50 shows the perforator register;

Fig. 51 shows the perforating magnet check for the E and F digits and corresponding contacts of the perforator connector relays;

Figs. 52 and 53 show the entry spread progress circuit, Fig. 52 showing the relays for perforators 0 to 4 inclusive, and Fig. 53 showing the relays for perforators 5 to 9 inclusive;

Fig. 54 shows the perforate hold check circuit, the perforator advance check circuit, the perforator tape cutting magnets and the perforators as indicated by the perforator magnets;

Fig. 55 shows the tape cutter circuit; and

Figs. 56 and 57 show the alternate circuit which may be substituted for Figs. 38 and 44 respectively, to show the C and F connecting paths and the perforator sort connector heretofore used before the device had been improved by the present invention.

In the following description the various relays are designated by both letters and numerals, the letters having come to have certain significance to persons familiar with the technical details of the disclosed arrangements. By way of example, the reading relays are known as the A0, A1 and A2 relays for the first group thereof used to register the A digit of the six-digit line used in the automatic accounting system tapes. In the present case there are three relays in the first or A set and five relays such as the B0, B1, B2, B4 and B7 relays in each of the remaining five sets. In a great many cases a relay will have only such an alphabetic designation, but in other cases it will have in addition a numerical designation which always consists of the figure number plus two other digits whereby its location in the drawing may be found by turning to the corresponding figure number thereof. Where conductors are designated by numerals in addition to the usual alphabetic designation thereof the number used will be a combination including the figure

number of the drawing wherein the conductor is first picked up in the tracing of a circuit and this number will be retained even though the conductors extend through another large number of circuits. By way of example, the A0 and A1 conductors 1900 and 1901, respectively, leading from the A0 and A1 armatures of the reader connector relay 1902 extend to armatures of the ST3 start relay 1702 where they make connection to the A0 and A1 conductors 1700 and 1701 respectively, which may then be traced to Fig. 29 where these conductors lead to the windings of the A0 and A1 relays 2900 and 2901 respectively. Another convention used herein for the sake of clarity is a numbering scheme for the cables or bundles of conductors which must be carried across different figures of the drawing. This is the use of a hyphenated number such as 33–29 indicating that this cable or bundle of conductors extends between Figs. 33 and 29. By way of example, the AD1 conductor 3300 may be traced into the cable 33–29 in Fig. 33 and again picked up in Fig. 29 where the AD1 conductor 3300 is seen connected to one of the armatures of the A0 relay 2900.

For obvious purposes, in certain cases, conductors will bear the same alphabetic designation as other apparatus. This is not to be taken as a duplication of the designation but will be readily understood that such a conductor bears an intimate relation to the other piece of apparatus. Again by way of example, the A0 conductor 1700 bears the same alphabetic designation as the A0 relay 2900, but must not be confused therewith, both bearing the same alphabetic designation because they bear such intimate relation one to the other as shown, the A0 conductor being the path leading to and over which the A0 relay is operated.

Similar logical means for designating various elements of the circuits will be found in the drawings and are used as an aid to the clear understanding of the present arrangement.

The apparatus used in constructing the device of the present invention is mostly standard communication apparatus, details of which may be found in the following references:

The relays are of types shown in patents:

1,156,671, E. B. Craft, October 12, 1915
1,633,576, C. H. Franks, June 28, 1927
1,652,489, E. D. Mead, December 13, 1927
1,652,490, D. D. Miller, December 13, 1927
1,652,491, D. D. Miller, December 13, 1927
2,169,551, C. I. Baker, August 15, 1939
2,178,656, P. W. Swenson, November 7, 1939
2,323,961, F. A. Zupa, July 13, 1943

The reader is disclosed in application Serial No. 666,280, May 1, 1946, W. W. Carpenter.

Other apparatus is of conventional design.

This application is one of a group showing apparatus used in an automatic accounting system and bears an intimate relation to other applications heretofore filed as follows:

Serial No.	Filing Date	Inventor
101,088	June 24, 1949	Joel-Rippere.
101,084	do	Flint-Hague-Joel-Rippere.
101,089	do	A. E. Hague.
101,083	do	E. W. Flint.
101,081	do	S. L. Eppel.

Pat. No.	Issued	Inventor
2,496,150	Jan. 31, 1950	W. W. Carpenter.
2,558,746	June 26, 1951	Carpenter-Gooderham.
2,546,835	Mar. 27, 1951	R. O. Rippere.
2,531,622	Nov. 28, 1950	Hague-Joel.
2,522,946	Sept. 19, 1950	J. W. Gooderham.
2,572,804	Oct. 23, 1951	Flint-Joel.

Other applications having some relation to the present disclosure, in that such applications show details of the complete development of which the present is but a part are as follows:

Serial No.	Filing Date	Inventor
759,402	July 7, 1947	Carpenter-Collis.

SORTING SCHEME

Fig. 1 is a chart made up to illustrate the scheme used in sorting by means of the device of the present invention. There are a number of blocks herein representing various of the message accounting system devices such as the block 100 representing the assembler, the block 101 representing the computer, and the block 102, repeated four times, representing the sorter which is the device of the present invention. Between these blocks and connecting the same there is represented a tape in which there are six digital places known as the A, B, C, D, E and F digits. On the left of these tapes an arrow is shown indicating the movement of the tape. Thus, the tape extending from the assembler 100 to the computer 101 will move into the reader of the computer in the manner shown so that the first code to be read thereby will be the code 141567. The series of four codes shown in this part of the tape represents the four items of specific information all relating to one telephone call. The first or bottom one, namely, 141567 is the disconnect time, the next 137267 is the answer time and the next two 213067 and 051234 constitute the initial entry, the first of these 213067 being the first line of the initial entry and the last 051234 being the supplementary line of the initial entry.

It may be noted that both the disconnect time, the answer time and the initial entry are characterized by the call identity index number 67 in the E and F digits. This call identity index number appears in the first line of the initial entry but not in any supplementary entry line thereof.

As these items of specific information are read into the computer circuit they are registered therein and certain computations and transformations of the information contained therein are made. The item with which we are particularly interested (since it is the item according to the digits of which sorting is to be performed) is contained in the supplementary line of the initial entry, that is, the five digits in the B, C, D, E and F digits here for convenience shown as 51234 and representing, by way of example, the office digit and the directory number of the calling subscriber.

In accordance with the scheme of sorting carried out by the device of the present invention the calls of the nature herein illustrated will be sorted in accordance with the units digit of the calling line number (including the office digit), that is, the digit 4 in the code 51234 of this supplementary line of the initial entry. Therefore, as the information is transformed in the computer, this five-digit number will be issued in the form of

four digits in the C, D, E and F places, and a fifth digit implicit in a tape section. It will be understood that on the basis of the decimal system this last or units place (fifth) digit may be any one of ten different values 0 to 9, inclusive. Therefore, during the transformation of this information in the computer each such call will be subjected to a first sorting operation, and all the calls will be distributed each to one of ten recorders in accordance with the value of the units digit in the supplementary line of the initial entry so that the final record of the whole tape is made on ten different recorders numbered 0 to 9, respectively. Thereafter, these ten tapes are spliced together, care being taken to have the tape on the number 0 recorder first, the tape from the number 1 recorder next and so on and each of these tapes now becomes a correspondingly numbered section of the composite or spliced tape, the output of the computer.

Now value 4 of the units digit taken from the F digit place of the supplementary line of the initial entry and shown in Fig. 1 just below the assembler **100**, is an integral part of the calling line number. Yet when this calling line number issues on the tape of the computer it has but four parts as shown 5123 in the first code 115123 just below the computer **101**. The first four digits beginning with the digit 5 will be the office index, the thousands, hundreds and tens digit of the calling telephone number but the units digit thereof does not appear. The units digit, however, is not lost; it is preserved as the number of the tape section on which this code is recorded. Just below the broken line after the code 115123 there is shown the code 28984X and then, after a break in the tape, the code 289113, both bracketed to the left and denoted as common. These two codes are two of the tape indentity codes of a tape section. The lower one is the first code (after the usual splice pattern codes) which will be encountered or read by the next device here noted as the sorter **102** into which this composite tape from the computer is introduced. This 289113 code carries in its E and F digits the tens and units digits of the tape index, in this case shown as 13, and in the system denotes particularly a tape carrying message unit charges which have been sorted in accordance with the units digit of the calling line numbers.

The next code 28984X is known as the code for the round, the number of which appears in the F digit as an X because no specific number would have any meaning in the description of the present invention. The E digit, however, is shown as 4, signifies that the tape following these identity codes has been produced by the number 4 perforator of the computer and is, therefore, the number 4 section of the output tape from the computer. This digit 4 is automatically inserted at this point by the involved recorder of the computer, each of which automatically punches its own identifying digit in the E digit position when producing its own tape section.

Now this tape having been sorted once and resolved into ten output tapes, each of said output tapes is then fed into the reader of the sorter **102**, which may then be set to perform a sorting operation on the basis of the tens digit. Thus the code 115123 as it issues from the computer, will be transformed, after the next sorting operation by the sorter **102**, into the code 115124. It will be noted that in this case the value 4 of the units digit of the calling line number has been placed

in the F digit position in the tape and that the value 3 as the tens digit of the calling line which heretofore occupied this position has now been eliminated. It will also be noted by the guiding broken lines that the calling line number now is represented by the office index, the thousands, hundreds and units digits thereof, and that the tens digit does not appear in the record but does appear in the E digit position in the next code 28983X below, said latter code being the "round" code in the tape identity information entries produced by the number 3 recorder of the sorter.

On the next or third sorting operation, also carried out by the sorter **102**, the calls will be sorted by the hundreds digit of the calling telephone line numbers. Therefore, the calling telephone line number now appears (beginning with the digit 5) as 115134, the hundreds digit 2 having been eliminated and the tens digit 3, being the tape section from the previous tens sort, is substituted therefor. The hundreds digit 2 now becomes the E digit of the tape identity code 28982X on the tape produced by the number 2 recorder of the sorter.

In a similar manner during the fourth sort by the thousands digit said digit is taken out of the code for the calling telephone line number and the previous hundreds digit known by the tape section in which this digit is recorded is substituted in the place of the eliminated thousands digit. In the fifth and last sorting operation by the office index 5, said index is eliminated but its identity is preserved in the number of the tape section in which this item is recorded. The thousands digit found in the tape identity information of the incoming tape is substituted for this eliminated office index 5 so that in the individual item 111234 the true calling line number 1234 is shown and the office index is contained in the common information among the tape identity common items of information. This last tape is then ready for the summarizer or the printer.

The manner is which this information is transformed into a billable charge is fully explained in Patent No. 2,510,061 to Branson et al., issued June 6, 1950.

The individual item of information shown at the bottom of Fig. 1 issuing last from the sorter and comprising the code 111234 is known as a "single line" message unit entry, and shows in its second or B digit the amount of the charge (one message unit abbreviated "MU" on the tape) to be made against the particular calling line number (line number 1234) in the office identified partly by the office index 5 implicit in the tape section. It should be noted that when the number of message units to be charged to such a line number exceeds 9, then the form of the entry is changed from a 1 to a "2-line" entry such as that shown in the first two lines of the tape issuing from the summarizer **200** in Fig. 2 and leading to the sorter **201**. In this case the lower of these entries 201234 shows that the line number 1234 is to be charged for a number of message units expressed by two digits "XX" in the line above 0400XX. If this tape issuing from the summarizer is one produced near the end of a billing period, then it means that a plurality of charges such as that contained in the individual item of information 111234 at the bottom of Fig. 1 have been added together by the summarizer **200** until the number of charges for this billing period has gone into two figures.

We will then suppose that the tape produced on the last sorting operation in Fig. 1 is to be added to a previous record produced by the sum-

marizer. In this case the last tape produced by the summarizer is processed by the sorter to produce a units sorted tape exactly similar to the output of the computer and which may, therefore, be added to and made part of the tape introduced into the sorter for the next or tens sort.

In Fig. 2 in the code 289117 shown just above the sorter 201, the tape index 17 denotes a message unit tape which has been processed and issued from the summarizer. The tape produced by the sorter from this tape is one shown in the lowest code of Fig. 2, namely, 289118 and this tape type index 18 denotes a message unit tape in which the calls have been sorted in accordance with the units digit of the calling line numbers.

It will, therefore, be clear that the five-digit number consisting of the office index and the thousands, hundreds, tens and units digits of the calling line number may be used through a series of sorting operations in each one of which one of these digits is taken out of the record in the output, but its value is preserved in the common tape information, particularly the record of the tape section.

SCHEMATIC

Figs. 4 and 5, when arranged as indicated in the block diagram Fig. 3, form a schematic showing the bare essentials for sorting in accordance with the plan herein provided for.

In accordance with the operation of the automatic accounting system, each unit of the system is operated by an incoming tape and it, in turn, produces one or more outgoing tapes. In a sorter, the items of an incoming tape are sorted onto ten outgoing tapes representing the ten decimal digits any one of which may fill any one of the decimal denominational orders. As explained hereinabove the ten output tapes are produced by ten recorders numbered 0 to 9, respectively. In this schematic the incoming tape is scanned by a reader 400 and transmits the codes found thereon for the six denominational orders A to F, inclusive, to another six denominational orders denoted in like manner, the A to F digits which are indicated at the bottom of Fig. 5 where, by a bracket, the paths are grouped into the cable 500 leading through the perforator magnet check circuit 501 and thence through the perforator connectors 502 to any one of the perforators 503 to 504. It will be understood that in accordance with the usual practice the particular perforator connector which is operated in order to connect this transmission line 500 to a given perforator is operated in accordance with the value of the digit being scanned and by the item of information being sorted.

It will be noted that the A and B digits are transmitted from the reader 400 into the output without change. The C digit, however, coming from the C digit contacts in the reader, may be transmitted to the output either through the C digit wires or through the D digit wires. If the CAR relay 505 is operated it will be transmitted through the C digit wires. On the other hand, if the CAR relay is not operated and the DFC relay 506 is operated, it will be transmitted through the D digit wires. In the latter case, it will be observed that the C digit is transferred from its given place to the next lower denominational order. Likewise, the D digit will be transmitted to the D digit place if the DAR relay is operated or to the E digit place if the EFD relay 515 is operated, the E digit to the E digit place if the EAR relay 508 is operated or to the F digit place if the FFE relay 516 is operated. The F digit goes to the F digit place.

The sorter has within its circuit arrangement a number of circuits each of which may be separately named. Thus the sorter contains what is known as the off-normal and start circuit here shown in the broken line rectangle 401 of this circuit. Only the MON relay 402 is shown in part, this relay being known as the master off-normal relay. Generally speaking, this relay becomes operated as soon as the device is placed in operation and remains operated until the device is shut down. This supplies ground to a number of leads, only two of which are shown in the present schematic drawings.

There is also a circuit known as the tape identity reading progress circuit here shown in the broken line rectangle 403. There are in general nine relays in this circuit each corresponding to one of the nine lines in the tape identity information. Of these nine relays, only three are shown in any detail, namely, the L1 to L5 and the L9 relays. It will be understood that these relays are operated during the time that lines 1, 5 and 9 of the tape identity information are being read by the reader 400.

There is, in addition, the tape index connector shown as the rectangle 404. This circuit is partly under control of the set-up switches which are manually adjusted before the incoming tape is placed in the device and then partly checked by the information contained in the tape itself. Thus, if a number 13 type tape such as that indicated in the common item of information 289113 (the seventh code counting downward in Fig. 1) is to be used in the sorter, then the manual adjustment of certain of the set-up switches will be rendered effective upon the reading of the first line of the tape identity information wherein the tape index 13 is effective to operate the MU relay 405. The 13 type tape as hereinabove explained is a message unit tape which has been sorted in accordance with the units digit during its processing and issuance from the computer. The MU relay 405 corresponds to a simple message unit tape. The MUS relay 406 corresponds to a message unit summary tape, that is, the summary of several MU tapes. The MUAS relay 407 indicates a tape made up of a message unit tape and a summary tape and which, therefore, will produce an output tape containing items of charge for each line heretofore summarized together with the charges for these lines which will now have to be added into the previous summary.

Another portion of the sorter is the arrangement of set-up switches here indicated by the broken line rectangle 408 and showing only a single set-up switch, that is, the one which is manually set to indicate the digit by which the sorting of the incoming tape will be performed. If the switch is set on its first contact then the items of information will be sorted by offices, on the second and the last the items of information will be sorted in accordance with the thousands digits of the calling telephone lines and so on.

Let it be assumed, by way of example, that a tape has been placed in the reader which has issued from the computer and which has already been sorted in accordance with the units digit of the calling telephone numbers. On this next sorting operation, therefore, it is desired to sort these numbers again in accordance with the tens units of the telephone numbers and, therefore,

the set-up switch is sent around to make connection to the lead marked TS, meaning tens sort. We will further assume that this is a simple message unit tape and that, therefore, the MU relay **405** is operated. This will cause the operation of the SS relay **409** so that, through the set-up switch, a circuit is extended over the TS lead through the corresponding armature of the SS relay **409** to cause the operation of the TSM relay **410**.

Due to the fact that one of the three relays in the tape index connector **404** is operated, the circuit for the LICE relay **411** is opened and this relay cannot become operated. Therefore, a ground from the MON master off-normal relay **402** is extended through the armatures and back contacts of the LICE relay, to the armatures of the MUAS relay **412** which will not be operated under the given conditions, and thence to the armatures of the OFSM relay **413**, the THSM relay **414**, the HSM relay **415** and the TSM relay **410** and of which only the latter is operated. The ground extended to the armatures of the LICE relay may, therefore, be traced to cause the operation of the CAR relay **505**, the DAR relay **507**, the EAR relay **508** and the FFR relay **509**. Hence, the A, B, C, D and E digits will be transmitted without change to the A, B, C, D and E leads to the output. The value for the F digit will be derived from the operation of the 0, 1, 2, 4 and 7 relays shown in the right-hand portion of Fig. 5 and which are under the control of the RE relay **510**. This RE relay will have been operated during the reading of the eighth line of the tape identity information, that is, by way of example, during the reading of the code 28984X (the sixth code from the top in Fig. 1). At such a time the value 4 in the E digit will have been transmitted as indicated over the armatures of the RE relay **510** and recorded through the operation and locking of the 0 relay **511** and the 4 relay **512**. Thus upon the reading of the tape identity information this value 4, that is, the value of the tape section, is transmitted into this register and maintained there as long as there are items being read from that given section. As soon as another section is encountered then the LI relay **416** is operated during the reading of the first line and that, by opening up the locking circuit of the register, will release the 0 relay **511** and the 4 relay **512**. Therefore, upon the reading of any one specific item of information under the conditions above described the first five digits will be transmitted to the recorders unchanged in position and the last or F digit will be derived from the register in which the number of the tape section is noted.

As another example, let it be assumed that a summary tape is being sorted in accordance with the units digit of the calling line numbers. In this case the message summary relay **406** will be operated and the set-up switch will be manually adjusted to make connection with the US lead whereby a ground will be extended through the US armature of the SS relay **409** and cause the operation of the US relay **417** in the perforator sort connector. In this case, upon the operation of the L5 relay **418** during the reading of the fifth line code 289550 (third code from the top, Fig. 2) wherein the 5 in the E digit is the office index, then through the operation of the MUS relay **406**, the RE relay is operated at this time to take the record of this E digit and record it in the register by the operation of the 1 relay **513** and the 4 relay **512**.

Through the operation of the MUS relay **406** the MUSA relay **412** will be operated so that through the armatures of the LICE relay **411** and the MUAS relay **412**, the CFR relay **514**, the DFC relay **506**, the EFD relay **515** and the FFE relay **516** will be operated. Hence, the A and B digits of the item being read will be transmitted without change to the perforator, a value for the C digit will be derived from the tape section register (relays **512** and **513**) and the C, D and E digits as read in the reader will be transmitted over the D, E and F circuits, respectively, to the connector. The F digit as read is not transmitted to be recorded in the output, but its value is nevertheless preserved through the sorting operation by having this particular item of information recorded on that number perforator corresponding to the number of this F digit. Thus, the input tape having the identity of the office contained in its tape identity information and the calling line number recorded in each individual item of information is now changed into ten sections of tape each numbered in accordance with a units digit of all of the various specific items of information, with the specific value having been taken out and being replaced by the office index. Therefore, each new specific item of information contains the office index, the thousands, hundreds and tens digits but not the units digit, the latter being implicit in the tape section.

At this point the arrangements in the sorter will "accept" certain kinds of tape in its reader and in response thereto will produce other specific kinds of tapes in its recorders.

It should be noted that each tape used as an incoming source of information and each tape produced by one of these automatic accounting devices is in a given form following a distinctive pattern. First, on the leading end of each tape, there will be a plurality of splice pattern codes used for facilitating the mechanical handling of the tape and particularly, as the name implies, used where two tapes are to be spliced together. The first codes to be read and which are transmitted into the circuits of the device and which affect control therein are the nine lines of tape identity information.

Where a tape from one marker group containing records from a plurality of offices has been processed by the computer, the MU (message units) records will be issued therefrom in ten sections serially numbered from 0 to 9, with the calling line numbers sorted in accordance with their units digits. Each of these ten sections will then contain items of information pertaining to customer charges sorted in accordance with the units digits of the calling line numbers, with the office, the thousands, hundreds and tens digits expressed within the information but the units digits expressed only by the number of the tape section in which they appear.

Thus, by way of example, two items of information such as:

115123 and
137456

appearing on the number 0 tape section would be charges computed for lines in a given marker group from offices 5 and 7 therein and from calling line numbers

1230 and
4560 respectively

Had these items of information appeared on

the number 7 tape section then the line numbers would have been

1237 and
4567 respectively

By way of example, nine lines of tape identity may be as follows with certain digits underlined for explanation:

TAPE IDENTITY CODES

First line 289113 tape type 13 (sorted by units)

Second line 289200 marker group 00

Third line 289310 first recorder, number 10

Fourth line 289415 last recorder, number 15

Fifth line 289550 office index, office 5 in marker group 00 may be MEDIA 6

Sixth line 289690 thousands—first and last

Seventh line 289715 day of round—first and last

Eighth line 289805 tape digit (section) and round

Ninth line 289909 month

The above tape identity information would be exactly the same at the beginning and end of each tape section excepting the 2898 code which is shown above as 289805 for the 0 section and would be 289875 for section 7.

The first line of this tape identity information 289113 contains in its last two places the tape type index. The machine is prepared to process a given type of tape by the adjustment of the set-up switches and then on the first line of the tape identity information being read this tape type is checked and only if it is correct and acceptable will the device continue to operate. In the above example the tape type index is 13. A 13 type tape is one issued from the computer bearing a list of message unit charges assessed against line numbers which have been sorted in accordance with their units digits only, and which are now due for sorting in accordance with their tens digits. Therefore, if the tape type switch is set to "Message Unit" and the sort switch is set to "Tens" this tape will be acceptable as the index 13 will be properly checked on the reading of this first line.

Now when the complete nine lines of tape identity information have been read and properly checked in, the device will proceed to prepare the tape ends of the ten output tapes by "spreading" the nine lines of tape identity information which must appear thereon. By "spreading" is meant the operation of recording a given line of information sequentially on each of the ten output tapes. The first line so spread will be the 2891 line carrying the tape type index of the output tapes, in this case 14.

The different tape type index numbers concerned in operation of the sorter may be understood from the following dissertation.

The computer will accept only an 02 type but will produce various types of output tapes in accordance with the sorting routine and the adjustment of the set-up switches as follows:

Sort Switch Set At	Output Tape	Tape Type of Output Tape
Central office	MU	11
Thousands	MU	12
Units	MU	13
Any setting	Straddle	60
Do	Detail (multioffice MG)	20
Do	Detail (single office MG)	21
Do	MU detail (multioffice MG)	30
Do	MU detail (single office MG)	31
Do	Line obs. (multioffice MG)	40
Do	Line obs. (single office MG)	41

Any one of these tapes with the exception of the straddle tape (type 60) will be accepted by the sorter when the set-up switches have been properly adjusted. In addition, the sorter will accept other type tapes (output tapes of the sorter and the summarizer). In accordance with arrangements in use prior to the present invention the input and corresponding output tapes of the sorter may be tabulated as follows. It may be noted that the summarizer will accept either a 15 or a 16 type tape and will produce therefrom a 17 type tape.

Tape Type Switch	Input Tape Type	Sort Switch	Output Tape Type
MU	11	First thousands	12
MU	11	Units	13
MU	12	do	13
MU	13	Tens	14
MU	14	Hundreds	15
MU	15	Last thousands	16
MUS	17	Units	18
MUAS	11 and 17	do	13
MUAS	12 and 17	do	13
MUAS	13 and 18	Tens	14
TOLL	20	Office	21
TOLL	21	First thousands	22
TOLL	21	Units	23
TOLL	22	do	23
TOLL	23	Tens	24
TOLL	24	Hundreds	25
TOLL	25	Last thousands	26
MUD	30	Office	31
MUD	31	First thousands	32
MUD	31	Units	33
MUD	32	do	33
MUD	33	Tens	34
MUD	34	Hundreds	35
MUD	35	Last thousands	36
OBS	40	Office	41
OBS	41	First thousands	42
OBS	41	Units	43
OBS	42	do	43
OBS	43	Tens	44
OBS	44	Hundreds	45
OBS	45	Last thousands	46

In accordance with the present invention the arrangements for sorting message unit tapes have been changed so that one new type tape will be accepted by the sorter and the progression of the sorting steps becomes invariable. Heretofore where sorting by office had to be carried out, this was always the first operation and never the last and was carried out in the computer. Consequently, there was no provision in the sorter for sorting by office. However, in accordance with the present arrangement when the end of the sorting must show the four digits of the calling line number expressed in the specific items of information and the office index digit expressed in the common items of information, that is, in the form of the tape section digit, the last operation is invariably a sorting by office. Therefore, the setting of the tape type and sort switch for the four sorting steps carried out in the sorter on message unit tapes will be as follows:

Tape Type Switch	Input Tape Type	Sort Switch	Output Tape Type
MU	13	Tens	14
MU	14	Hundreds	15
MU	15	Last thousands	10
MU	10	Office	16

It will be noted that this leaves the arrangements for the summarizer undisturbed. Therefore, the summarizer will process a number 16 type tape and produce therefrom a number 17 type tape. When a tape bearing the summary of a previous day's or several days' business is to be

when the S9B relay 903 is operated, the EX and EY leads will be connected to the E2 and E7 digit reading relays to cause these relays to express the value digit 9. Thus, if the S—B relays are sequentially operated so as to connect the number 0 to the number 9 perforators to the value leads, the E digit value will be changed in strict accordance with the number of the perforator so that when the number 0 perforator 1200 is being operated it will record this eighth line as 289805, and when the number 9 perforator 1201 is being operated it will perforate this eighth line as 289895.

The last digital value to be synthesized for this line is controlled by the PL8 relay in placing grounds on the conductors PRD1 and PRD2 leading, respectively, to the contacts of the Round switches 905 and 906. If the round is number 5 then these switches will be set on their No. 7 terminals so that the F1 and F4 leads will be effected to cause the operation of the F1 and F4 relays 717 and 718, respectively.

In Figs. 4 and 5 the circuits of the CAR relay 1003, the DAR relay 1004, the EAR relay 1005 and the FAR relay 1006 have been shown in some detail. The CAR relay 1003, by way of example, is one which, by its designation, indicates that the C digit will be transmitted as read. These relays are normally operated and hence in the above-noted operations during the operation of the PL8 relay the C, D, E and F digits will be transmitted as read so that the complete set of digits in code will be extended through the perforator magnet check relays A0 to F7 shown in the broken line rectangle 1202 to the armatures of the perforator connector relays such as the connector relay 1203 operated through the operation of the S0B relay 902.

One other arrangement in the sorting means is shown schematically in Figures 9 to 12, inclusive. In Figs. 4 and 5 it is shown how the digits of the calling line number are shifted in transmission from the reader to the perforator. It should be remembered that the sorter in which the present invention is incorporated is essentially a copying device, and that it copies without change each specific item of information that it encounters in the incoming tape and only distributes these items to different outgoing tapes in accordance with the sorting controlled by a particular digit found in such items. In Figs. 4 and 5 it is shown how a rearrangement of the digits constituting the identity of the calling line is shifted for the purpose of sorting. In the schematics now under consideration (that is, Figs. 9 to 12, inclusive) the arrangement whereby the particular digit used in the sorting control is found. In accordance with the arrangements used prior to the present invention the four digits of the calling line number were invariably to be found in the C, D, E and F digits of the first line of an entry, and the office index was invariably found in the calling information. In accordance with the present invention the five digits constituting the office index and the four digits of the calling line number are constantly being rearranged as pictorially shown in Fig. 1. Thus, in the 13 type tape that issued from the computer the tens digit of the calling line is found in the place ordinarily occupied by the units digit and thus if the tape type switch 900 is set to its MU contact and the sort switch is set on its tens sort contact, then, due to the operation of the SSL relay 909, the units sort relay 910 will be operated so that when a specific item of information is being read by the reader the actual tens digit of the calling line number will be picked up over the F digit leads. If, by way of example, a calling line number is found in which the tens digit is 3 then the F1 and F2 reading relays will be operated and the number 3 decimal lead from these relays will be grounded so that through the operation of the US relay the number 3 lead in the group controlled by the armatures of the US relay 910 will be extended through an armature of this relay, thence through a corresponding armature of the SC relay 911 to cause the operation of the perforator connector for the number 3 perforator.

In like manner and at a later sorting stage when the sort switch 907 is set on its last thousands contact so that the sorting will be done in accordance with the thousands digit, the connection will be extended over an armature and front contact of the SSL relay 909 to operate the hundreds sort relay 912 and hence one of the decimal leads from the D digit reading relays will cause the operation of the perforator connector relay corresponding in value to the value of the D digit at that time being read.

COMPLETE CIRCUIT DESCRIPTION (FIGS. 14 TO 55 ARRANGED AS SHOWN IN FIG. 13)

The following description is put in the form of a completely indexed collection of specific descriptions of the functional operations of the components of the device, as follows:

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sorted in with a new day's business, then this number 17 type tape is run through the sorter on a units sort so that it will produce an 18 type tape which may thereafter be combined with an incoming 13 type tape in the following sequence:

Tape Type Switch	Input Tape Type	Sort Switch	Output Tape Type
MUS	17	Units	14
MUAS	13 and 18	Tens	13
MU	14	Hundreds	15
MU	15	Last thousands	10
MU	10	Office	16

It will be shown in detail hereinafter that when, for instance, the tape type switch is set at MUS and the sort switch is set at units that only a number 17 type tape will be accepted as an incoming tape and that the output tape type index perforated on each of the ten output tapes will be number 18.

The arrangements whereby the tape type index is synthesized and spread on the tape ends of the output tapes is explained in detail hereinafter.

Another and similar operation is of more immediate concern at present and will be explained with the help of the schematic of Figs. 7 to 12, inclusive. This is the movement of the tape section digit in line 8 of the tape identity information. It will now be remembered that on each sorting operation in accordance with the present invention, as the tape identity information at the beginning of each section of incoming tape is read, the tap section number must be taken in and registered for the purpose of filling in this digit in each line number copied and for replacing another digit taken out. Arrangements must also be provided for recording the tape section digit in each output tape.

The reader is indicated in the broken line rectangle **709** by the reader contacts which are connected through the reader connector **701** to the reading relays. The three conductors for the A digit reading relays pass through the off-normal and start circuit **702** before entering the reading relay group **703**. The B, C, D, E and F reading relays are indicated in the broken line rectangles **704** to **708**, respectively.

Each set of reading relays has two sets of outgoing leads over one of which the value registered by the relays is transmitted in code and over the other of which it is transmitted decimally.

For the present purposes, it is to be noted that when an incoming tape is passed through the reader the first set of lines to be read will be the nine lines of tape identity. For the present we are concerned only with the eighth line of tape identity of an incoming MU tape and the fifth line of tape identity of an incoming summary tape. From the above table of tape identity codes it will appear that the tape section digit is in the E digit of the eighth line of the MU tape and consequently as this eighth line is being read and the L8 relay **1000** in the tape identity reading progress circuit **1001** is being operated, a ground will be extended through the front contact of either the MU relay **1100** or the MUAS relay **1101** to operate the RE register E digit connector relay **1102**. Either the MU relay **1100** or the MUAS relay **1101** will be operated in accordance with the setting of the tape type switch **900**. If this is a simple message unit tape, then the tape type switch will be set to the MU contact, but if the tape is a combination of a message unit and a summary tape, then the switch **900** will be set to the MUAS contact. Therefore, as the eighth line of the incoming tape identity is being read, the register E connector relay RE **1102** will be operated and connect its five leads 0, 1, 2, 4 and 7 to the corresponding leads of the E reading relays in the rectangle **707** so that the E digit of this line will be registered on the RE–0 to RE–7 relays. These relays will lock and preserve the identity of this tape section digit until the device is entirely released at the end of this particular tape section.

If the SORT switch **900** had been set on the MUS contact, as it will be when a summary tape is being processed in a units sort so that it may be combined with an incoming message unit tape, then the office index is actually registered in the F digit of the fifth line and must be taken off and registered in the register in Fig. 11. Therefore, during the reading of the fifth line of tape identity entries of an incoming summary tape the L5 relay **1002** will be operated and will, therefore, extend a ground to the front contact of the MUS relay **1103** which will then be forwarded to cause the operation of the RE relay **1102**.

After the tape identity has been read from the leading end of the incoming tape or another section of the incoming tape and the checking means have completely accepted this tape the means for spreading the lines of the tape identity on the outgoing tapes is set in motion. The first operation of this nature will be the operation of the TIS tape identity start relay **800** whose circuit in complete detail will be described hereinafter. The TIS relay operates the ME relay (manufactured entry) **801** and this relay places a ground on conductor **802** leading to the A2 relay **709**. At the same time the TIS relay grounds the B1 and B7 leads leading to the B1 and B7 relays **710** and **711**, respectively, so that the digits 2 and 8 for the lines of tape identity are synthesized by the TIS tape identity start relay **800**.

It will be noted that a connection is extended from the reader ground through its K3 contact, thence through a contact closed by the RCD relay **712**, a contact closed by the TIS relay **800** to the tape identity perforate progress circuit. This progress circuit is of a conventional design so that, upon the first closure of this circuit, the PL1 relay will operate and upon each subsequent closure of this circuit through the operation of the K3 contact another one of these PL-relays will operate. In time, therefore, the PL8 relay **803** will operate in order to synthesize the remaining digits of the eighth line, which will be spread on the outgoing tapes. It has been seen how the values 2 and 8 are set up for the A and B digits through contacts of the PL8 relay **803**. The C2 and C7 relays **713** and **714**, respectively, will be operated and the D1 and D7 relays **715** and **716** will be operated to synthesize the values 9 and 8 and the C and D digits. For the E digit, the PL8 relay **803** places ground on two conductors EX and EY extending through the network of the entry spread progress circuit **901** wherein the relays S0B **902** through S9B relay **903** will be sequentially operated. When the S0B relay **902** is operated, the EX and EY leads will be connected to the E4 and E7 leads to the E digit reading relays to cause these relays to express the digit 0. When the S1B relay **904** is operated the EX and EY leads will be connected to the E0 and E1 reading relays to cause these relays to express the digit 1 and, in like manner

12. Reading and checking tape identity on input tape
    - 12.01 Start
    - 12.02 Skipping splice
    - 12.03 End of splice
    - 12.04 Checking tape index
    - 12.05 Checking marker group
    - 12.06 Checking First Recorder switches
    - 12.07 Checking Last Recorder switches
    - 12.08 Checking office
    - 12.09 Checking thousands range
    - 12.10 Stepping tape section selector to initial position
    - 12.11 Skipping days of round
    - 12.12 Checking tape section and round
    - 12.13 Checking month
        - 12.131 General
        - 12.132 Current month
        - 12.133 Previous month
        - 12.134 Completion of month check
13. Perforating tape identity on leading end of output tapes
    - 13.01 Arranging to perforate tape index
    - 13.02 Spreading tape index
    - 13.03 Spreading marker group
    - 13.04 Spreading first recorder
    - 13.05 Spreading last recorder
    - 13.06 Spreading office
    - 13.07 Spreading thousands range
    - 13.08 Spreading days of round
    - 13.09 Spreading tape section and round
    - 13.10 Spreading month
14. Processing call entries
    - 14.1 Preparing for call entries
    - 14.2 Five-line entry
        - 14.21 First line
        - 14.22 Second line
        - 14.23 Third line
        - 14.24 Fourth line
        - 14.25 Fifth line
    - 14.4 Two-line entry
    - 14.5 One-line entry
15. End of one input tape and start of next input tape
    - 15.01 Checking tape identity at trailing end of tape
    - 15.02 Skipping skip splice entry and splice pattern
    - 15.03 End of input tape
    - 15.04 Starting new tape
    - 15.05 Checking tape index
        - 15.051 General
        - 15.052 New tape index same as previous tape index
        - 15.053 Tape index 17 follows tape index 11
        - 15.054 Tape index 17 follows tape index 12
        - 15.055 Tape index 18 follows tape index 13
        - 15.056 Tape index 13 follows tape index 18
    - 15.06 Checking marker group first and last recorder, office and thousands range
    - 15.07 Resetting tape section selector
        - 15.071 General
        - 15.072 Tape index 17 follows tape index 11
        - 15.073 Tape index 17 follows tape index 12
    - 15.08 Skipping days of round

15. End of one input tape and start of next input tape—Continued
    - 15.09 Checking tape section and round
        - 15.091 General
        - 15.092 Tape section agrees with selector
        - 15.093 Tape section is one greater than selector
        - 15.094 Last tape section
    - 15.10 Checking month
16. End of last input tape
    - 16.1 Checking tape identity
    - 16.2 Tape runs out
    - 16.3 Perforating tape identity at trailing end of output tapes
    - 16.4 Perforating skip splice entry and splice pattern at trailing end of output tapes
    - 16.5 Restoring circuit
    - 16.6 Stopping motor
17. Window splice in input tape
    - 17.1 Skipping skip window entry
    - 17.2 Skipping splice pattern
    - 17.3 Skipping second skip window entry
18. Window splice in output tape
    - 18.1 General
    - 18.2 Skip window entries
    - 18.3 Stopping the circuit for window splice
    - 18.4 Starting the circuit
    - 18.5 Perforating first line of window
    - 18.6 Perforating subsequent lines of window
    - 18.7 Perforating last line window
    - 18.8 Release of circuit after window splice
19. Regular release
    - 19.1 Registering release signal
    - 19.2 Awaiting stopping point
    - 19.3 Stopping the circuit and releasing
20. Starting after regular release
    - 20.1 Starting motor
    - 20.2 Starting circuit
    - 20.3 Stopping motor when circuit is not running
21. Timing circuits
    - 21.1 Short timer
    - 21.2 Long timer
22. Alarm
    - 22.1 Operation of alarm relays
    - 22.2 Functions of alarm relays
    - 22.3 Alarm cut-off
    - 22.4 Releasing after alarm
    - 22.5 AL relay fuse blows
23. Master release
24. Tape section reset and release
25. Reader step check
    - 25.1 Alternate line contacts
    - 25.2 G1 contact is closed initially
    - 25.3 G2 contact is closed initially
    - 25.4 Reader step failure
    - 25.5 Prevention of RSF alarm when end of tape key is operated
26. RS— relay release check
27. Manual reader step
28. Perforating mutilated line
29. Mutilated tape identity
    - 29.1 Mutilated tape identity at start of first tape
    - 29.2 Mutilated tape identity during run
30. Emergency reset
31. Lamps
    - 31.1 Lamps under control of reader lamps key
    - 31.2 Lamps under control of maintenance key
    - 31.3 Lamps not under key control

Relay index

1. PURPOSE OF CIRCUIT

1.1 This circuit is for use in the sorting operations of the AMA system in the accounting center.

1.2 The circuit is used to process message unit, toll, message unit detail and observing tapes from the computer, and to sort the calls into numerical order by the directory numbers of the calling subscribers. Message unit summary tapes from the summarizer may be introduced into the sorting of message unit tapes from the computer to include all message unit calls from the beginning of the billing month in the output.

3. CIRCUIT FUNCTIONS

3.1 TAPE PROCESSING

3.101 To sort message unit tapes for one round from the computer, which may have sorted them by office, thousands, or units, to produce a tape containing message unit calls for the round, in numerical order of the directory numbers of the calling subscribers.

3.102 To sort message unit tapes, as described in 3.101, combining them with the summary tape for the previous round from the summarizer, to produce a record of calls in numerical order of the directory numbers of the calling subscribers, the list for each subscriber to contain the total message units for the previous round in the billing month, plus the individual calls for the round being processed.

3.103 To sort toll, message unit detail and observing tapes from the computer to produce for each type of tape a record of calls in numerical order of the directory numbers of the calling subscribers.

3.104 To read one-line entries on the message unit tape, representing calls of from 1 to 9 local message units and to reperforate each entry unchanged on one of ten output tapes, sorting by the TH, H, T or U digit of the directory number, as required.

3.105 To read and reperforate two-line entries on the message unit tape, representing from 10 to 99 local message units or from 1 to 99 extended area message units, in the same manner as in 3.104.

3.106 To read two-line entries on the message unit tape, representing summaries of local area message unit calls and to reperforate each entry unchanged on one of ten output tapes, sorting by the TH, H or T digit of the directory number, as required.

3.107 To read two-line entries on the summary tape, representing summaries of local area message unit calls and to reperforate each entry unchanged on one of ten output tapes, sorting to the T or U digit of the directory number, as required.

3.110 To read five-line entries on the toll, message unit detail and observing tapes and to reperforate each entry unchanged on one of ten output tapes, sorting by the calling office digit or the TH, H, T or U digit of the directory number, as required.

3.111 To read and reperforate five-line entries on the observing tape, representing unanswered observing calls, in the same manner as in 3.110.

3.2 CALL ENTRY SORTING

3.201 To select one of the ten perforators, depending upon information in the set-up switches and in the first line of the entry.

3.202 To perforate the supplementary lines of each entry on the same output tape as the initial line.

3.203 To determine the number of lines in the entry from the first line.

3.204 To count the lines in an entry and block if too few or too many are received.

3.205 To block if the A digit on the input tape is anything other than 0, 1, 2, or all three.

3.206 To block if the B, C, D, E or F digit on the input tape has more or less than two holes perforated.

3.207 To block if the A digit perforating magnets are operated in any combination other than 0, 1, 2 or all three.

3.208 To block if the B, C, D, E or F digit perforating magnets are operated in any other combination than two per digit.

3.209 To block if the perforator advance magnet is not energized when required.

3.210 To hold the perforator advance magnet from releasing if the perforator magnets are operated in an improper combination.

3.211 To check the path for holding the magnet, as described in 3.210, at the start and end of each run.

3.212 To block if the reader fails to step when it is required to.

3.213 To block if the reader steps falsely.

3.214 To prevent processing call entries unless splice pattern was applied to the output tapes and tape identity was checked and perforated initially.

3.215 To prevent processing call entries after receipt of tape identity at the trailing end of an input tape section until tape identity at the leading end of the next input tape section has been checked.

3.216 To check that each entry is perforated on only one perforator.

3.217 To check that only one perforator advances at a time.

3.3 SPLICE SKIPPING

3.301 To skip splice at the start of the first input tape when the Machine Start key is operated if splice pattern has been applied to the output tapes and the A digit being read is 0.

3.302 To skip splice at the start of subsequent input tapes (where input tapes are not spliced together) when the Machine Start key is operated provided the A digit being read is 0.

3.303 To skip splice at the end of input tapes provided a skip splice entry has been received.

3.304 To skip splice at the start of input tapes (where input tapes are spliced together) provided a skip splice entry has been received at the end of the preceding tape.

3.305 To skip window splice following receipt of a skip window entry.

3.306 To pass by a skip splice entry and prepare to skip splice.

3.307 To pass by a skip window entry not preceded by splice pattern and prepare to skip splice.

3.308 To stop skipping whenever an A digit other than 0, a B digit other than 8, an E digit other than 1 or an F digit other than 0 is received.

3.309 To pass by a skip window entry following a window splice and resume regular operation.

3.310 To block if splice pattern is not followed by tape identity or a skip window entry.

3.4 TAPE IDENTITY CHECKING

3.41 To read tape identity entries at each end

of each input tape and check them against the set-up switches, as follows:

3.4101 TAPE INDEX

Input Tape Index	Switches	
	Tape Type	Sort
10	Mess. Unit	Office.
11	Mess. Unit	Thous. First.
11	Mess. Unit	Units.
11	MU and Summ	Do.
12	Mess. Unit	Do.
12	MU and Summ	Units.
13	Mess. Unit	Tens.
13	MU and Summ	Do.
14	Mess. Unit	Hunds.
15	Mess. Unit	Thous. Last.
17	Summary	Units.
17 [1]	MU and Summ	Do.
18 [2]	MU and Summ	Tens.
20	Toll	Cent. Office.
21	do	Thous. First.
21	do	Units.
22	do	Do.
23	do	Tens.
24	do	Hunds.
25	do	Thous. Last.
30	MU Det	Cent. Office.
31	MU Det	Thous. First.
31	MU Det	Units.
32	MU Det	Do.
33	MU Det	Tens.
34	MU Det	Hunds.
35	MU Det	Thous. Last.
40	Observ	Cent. Office.
41	Observ	Thous. First.
41	Observ	Units.
42	Observ	Do.
43	Observ	Tens.
44	Observ	Hunds.
45	Observ	Thous. Last.

[1] Tape index 17 must follow a tape index 11 or 12.
[2] Tape index 18 must follow a tape index 13.

3.4102 MARKER GROUP

To check the marker group entry of all input tapes against the Marker Group switches.

3.4103 FIRST RECORDER

To check the First Recorder switches off-normal on office and first thousands sorts, and off on units, tens, hundreds and second thousands sorts.

3.4104 LAST RECORDER

To check the Last Recorder switches off-normal on office and first thousands sorts, and off on units, tens, hundreds and second thousands sorts.

3.4105 OFFICE

(*a*) To check the Cent Office switch off on office sort.

(*b*) To check the office entry of all input tapes against the Cent Office switch on all sorts except office.

3.4106 FIRST THOUSANDS

(*a*) To check the Thousand First switch off on office and first thousands sorts.

(*b*) To check the Thousand First switch off-normal on units sort.

(*c*) To check the first thousands digit of the thousands range entry against the Thousand First switch on units sort of all tapes, on a message unit tape combined with a summary tape in tens sort, and on a tens sort of a message unit tape from the computer.

(*d*) To check the first thousands digit of the thousands range entry of all input tapes against the Thousand First switch on tens, hundreds and second thousands sorts, except tens sort of a message unit tape from the sorter.

3.4107 LAST THOUSANDS

(*a*) To check the Thousand Last switch off on office and first thousands sorts.

(*b*) To check the Thousands Last switch off-normal on units sort.

(*c*) To check the last thousands digit of the thousands range entry against the Thousand Last switch on units sort of all tapes, on a message unit tape combined with a summary tape in tens sort, and on a tens sort of a message unit tape from the computer.

(*d*) To check the last thousands digit of the thousands range entry of all input tapes against the Thousand Last switch on tens, hundreds and second thousands sorts, except tens sort of a message unit tape from the sorter.

3.4108 To skip the input tape entry indicating the first and last days of round.

3.4109 TAPE SECTION

(*a*) To omit a tape section check on office and first thousands sorts.

(*b*) To omit a tape section check on units sort of message unit tapes which have not been sorted by thousands.

(*c*) To omit a tape section check on units sort of all toll, message unit detail and observing tapes which have not been sorted by thousands.

(*d*) To make a tape section check on units sort of all message unit, toll, message unit detail and observing tapes which have been sorted by thousands.

(*e*) To make a tape section check on units sort of all summary tapes.

(*f*) To make a tape section check on tens, hundreds and second thousands sorts of all tapes.

(*g*) To check, as covered in (*d*) and (*e*) above, that the tape section of the first tape agrees with the setting of the Thousand First switch, that each succeeding tape has a tape section equal to or one greater than the preceding tape, and that the tape section of the last tape agrees with the setting of the Thousand Last switch.

(*h*) To check, as covered in (*f*) above, that the tape section of the first tape is 0, that each succeeding tape has a tape section equal to or one greater than the preceding tape, and that the tape section digit of the last tape is 9. In the case of a combined tens sort of message unit and summary tapes the further check is made that tapes are processed in the order: MU tape 0, S tape 0, MU tape 1, S tape 1, . . . MU tape 9, S tape 9.

3.4110 ROUND

(*a*) To check the round of all input tapes against the Round switch on all sorts except when making a combined units or tens sort of message unit and summary tapes.

(*b*) To check the round of all message unit tapes against the Round switch on combined units or tens sorts of message unit and summary tapes.

(*c*) To check that the round of all summary tapes is the round immediately preceding that set up on the Round switch on combined units or tens sorts of message unit and summary tapes.

3.4111 MONTH

(*a*) To check the month entry of all input tapes against the Month switches on all sorts except when making a combined units or tens sort of message unit and summary tapes.

(*b*) To check the month entry of all message unit tapes against the Month switches on combined units or tens sorts of message unit and summary tapes.

(*c*) To check the month entry of all summary tapes against the Month switches on combined units or tens sorts of message unit and summary

tapes except when the message unit tape is for round 0.

(d) To check that the month of all summary tapes is the month immediately preceding that set up on the Month switches on combined units or tens sorts of message unit and summary tapes when the message unit tape is for round 0.

3.42 To block if any of the nine lines of tape identity is missing, repeated, or in the wrong order, except that missing or repeated third, fourth or seventh lines will not cause the circuit to block.

3.43 To block if any item of the tape identity group does not check.

3.44 To block if the tape identity group is missing from the beginning of any input tape.

3.5 TAPE IDENTITY AND SPLICE PERFORATING

3.501 To perforate splice pattern at the start of all output tapes under control of the End of Tape key.

3.502 To block if perforation of one line of splice pattern on all perforators is not completed within 2.1 seconds (nominal).

3.503 To stop perforating splice when the End of Tape key is released.

3.504 To perforate nine tape identity entries on all output tapes following splice pattern provided the tape identity entires at the start of the input tape have been checked. These entries are perforated as follows:

3.50401 TAPE INDEX

Tape Type Switch	SORT Switch					
	Off.	1-TH	U	T	H	2-TH
Summ			18			
MU and Summ			13	14		
Mess. Unit	16	12	13	14	15	10 or 16
Toll	21	22	23	24	25	26
Mess. Unit Det	31	32	33	34	35	36
Observing	41	42	43	44	45	46

3.50402 MARKER GROUP

Marker group is perforated as set up on the Marker Group switches.

3.50403 FIRST RECORDER

(a) First recorder is perforated as set up on the First Recorder switches on office and first thousands sorts.

(b) 90 is perforated for first recorder on units, tens, hundreds and second thousands sorts.

3.50404 LAST RECORDER

(a) Last recorder is perforated as set up on the Last Recorder switches on office and first thousands sorts.

(b) 90 is perforated for last recorder on units, tens, hundreds and second thousands sorts.

3.50405 OFFICE

(a) Office is perforated on office sort to indicate the office of each output tape.

(b) Office is perforated on all output tapes as set up on the Cent Office switch for all sorts except office.

3.50406 FIRST THOUSAND

(a) 9 is perforated for first thousands on office, first thousands and second thousands sorts.

(b) First thousands is perforated as set up on the Thousand First switch on units, tens and hundreds sorts.

3.50407 LAST THOUSAND

(a) 0 is perforated for last thousands on office, first thousands and second thousands sorts.

(b) Last thousands is perforated as set up on the Thousand Last switch on units, tens and hundreds sorts.

3.50408 DAYS OF ROUND

00 is perforated for days of round entry.

3.50409 TAPE SECTION

The tape section perforated on each output tape agrees with the digit by which the tape was sorted.

3.50410 ROUND

Round is perforated as set up on the Round switch.

3.50411 MONTH

Month is perforated as set up on the Month switches.

3.505 To stop the reader on the last of the nine lines of the tape identity group at the start of the input tape while perforating tape identity.

3.506 To block if perforation of nine lines of tape identity is not completed within 9.2 seconds (nominal).

3.507 To perforate nine tape identity entries, as described in 3.503, a skip splice entry and splice pattern at the end of all output tapes, under control of the End of Tape key. The key is effective only under the following conditions:

(a) Office and First Thousand Sorts

Tape identity checked and perforated initially, tape identity checked at trailing end of tape, no skip window splice entry received, circuit not operating.

(b) Units Sort

Message unit, toll, message unit detail or observing tapes not sorted by thousands: tape identity checked and perforated initially, tape identity checked at trailing end of tape, no skip window splice entry received, circuit not operating.

Combined message unit and summary: tape identity checked and perforated initially, tape identity checked at trailing end of tape, no skip window splice entry received, circuit not operating, all message unit and summary tapes received. Message unit, toll, message unit detail or observing tapes sorted by thousands: tape identity checked and perforated initially, tape identity checked at trailing end of tape, no skip window splice entry received, circuit not operating, all tapes received. Summary tape alone: tape identity checked and perforated initially, tape identity checked at trailing end of tape, no skip window splice entry received, circuit not operating, all tapes received.

(c) Tens, Hundreds and Second Thousands Sorts

Tape identity checked and perforated initially, tape identity checked at trailing end of tape, no skip window splice entry received, circuit not operating, all tapes received.

3.508 To perforate all nine tape identity entries and skip splice signal before stopping if the End of Tape key is released before the circuit begins to perforate splice pattern.

3.509 To block if perforation of nine tape identity entries and skip splice signal is not completed within 9.2 seconds (nominal).

3.510 To stop perforating splice when the End of Tape is released during perforation of splice pattern.

3.511 To block when any perforator encounters a window or end of tape. Circuit will complete a call entry or a set of tape identity entries before stopping.

3.512 To perforate a skip window entry, approximately 40 lines of splice pattern and a sec-

ond skip window entry on any output tape under control of a Window Splice 0–9 key, provided the perforator window signal was received when the End of Tape key was normal.

3.513 To perforate approximately 40 lines of splice pattern, not preceded by or followed by skip window entries, on any output tape under control of a Window Splice 0–9 key, provided the perforator window signal was received when the End of Tape key was operated.

3.6 CIRCUIT CONTROL AND KEYS

3.601 To start the motor by means of a Motor Start key, if the alarm is not in.

3.602 To stop the motor at any time by means of the Emerg Motor Stop key.

3.603 To stop the motor when the circuit blocks.

3.604 To stop the motor after tape identity and splice have been perforated at the completion of a run.

3.605 To start the motor when the Perforate Line key is operated.

3.607 To rotate the reader drum continuously under control of the Tape Feed key on the reader when the motor is running and the circuit is not operating.

3.608 To permit the Tape Feed key to be used to feed tape into the reader while the circuit is perforating splice pattern at the start of the output tapes.

3.609 To permit the Tape Feed key to be used to run tape out of the reader while the circuit is perforating tape identity, skip splice entry and splice pattern at the end of the output tapes.

3.610 To start the sorting process by means of the Machine Start key provided splice pattern has been applied to the output tapes, the motor is running, there is no alarm, there is no perforator window contact closed and the reader is not on a supplementary line of an entry.

3.611 To synchronize the relay circuit with the reader when starting.

3.612 To stop under control of the Machine Release key upon completion of an entry, window splice skipping or the tape identity functions.

3.613 To stop immediately and release the circuit completely, except for the tape section (TD) selector, upon simultaneously operating the Machine Release and the Master Release keys.

3.614 To restore the tape section (TD) selector when the End-of-Tape key is operated at the start or end of a run.

3.616 To block if the input tape runs out of the reader.

3.617 To block if a fuse blows.

3.618 To time out and block if the circuit is unsuccessful in several attempts to read a line of the input tape.

3.619 To time out and block if the circuit is unsuccessful in several attempts to perforate a line on an output tape.

3.620 To cancel the short time-out feature and start the long timer while reading the thousands range entry to allow time for stepping the tape section (TD) selector.

3.621 To block if the RS— relays remain operated more than approximately 0.25 second, except when skipping.

3.622 To light the ALM lamp on the face of the sorter whenever the circuit blocks.

3.623 To light a Machine Pilot lamp whenever the circuit blocks.

3.624 To signal the alarm circuit to sound an audible alarm whenever the circuit blocks.

3.625 To silence the audible alarm and extinguish the Machine Pilot lamp by means of the Alarm Cut-Off key.

3.626 To release the circuit after an alarm by means of the Machine Release key.

3.627 To stop the tape section (TD) selector by means of the Tape Section Reset key provided the circuit is not operating or has blocked and the Reader Lamps key is operated.

3.628 To restore the tape section (TD) selector by means of the Tape Section Release key provided the circuit is not operating or has blocked and the Reader Lamps key is operated.

3.629 To step the reader one line at a time by means of the Reader Step key, provided the motor is running, the Reader Lamps key is operated and the circuit is not operating.

3.630 To perforate, by means of the Perforate Line key, any supplementary line of an entry exactly as it appears on the input tape when the circuit has blocked because the line on the input tape has too few or too many holes.

3.631 To simulate a check of tape identity by stepping the reader with the Reader Step key to the first line following the tape identity group, operating the Tape Identity button and the Machine Start key.

3.632 To restore the circuit to operating condition after a power failure by operating the Emerg Reset button.

3.7 LAMPS

3.701 To read a line on the input tape by means of twenty-eight lamps, under control of the Reader Lamps key.

3.702 To indicate the position of the reader cam shaft by means of the Reading Position lamp under control of the Reader Lamps key.

3.703 To indicate the position of the tape section (TD) selector by means of the Tape Section 0 to 9 lamps under control of the Reader Lamps key.

3.704 To indicate the number of lines in a call entry by means of the Type of Entry (2-line), (3-line), (5-line) lamps under control of the Reader Lamps key.

3.705 To indicate on which line of an entry the circuit blocked by means of the Line of Entry 1 to 5 lamps under control of the Reader Lamps key.

3.706 To indicate when the circuit is checking tape identity by means of the Tape Ident lamp under control of the Reader Lamps key, if the circuit has blocked.

3.707 To indicate when the circuit is perforating tape identity by means of the Perf Tape Ident lamp, if the circuit has blocked.

3.708 To indicate on which perforator an entry is being perforated by means of the Perforator in Use 0 to 9 lamps under control of the Maint key when the circuit is blocked.

3.709 To indicate which perforating magnets are energized by means of twenty-eight lamps under control of the Maint key when the circuit has blocked.

3.710 To indicate when the last tape section of a run is being processed by means of the Last Section lamp.

3.711 To indicate when the circuit is off-normal (but not necessarily operating) by means of the Master Off-Normal lamp.

3.712 To indicate when the circuit is operating by means of the Off-Normal lamp.

3.713 To indicate which perforator has encountered a window or end of tape by means of the Window Splice 0 to 9 lamps.

3.714 To indicate the completion of window

splice perforation by means of the Perf Compl lamp.

3.715 To indicate a blown fuse by means of the Fuse Alarm lamp.

3.716 To indicate that the reader overstepped or failed to step by means of the RDR STP Fail lamp.

3.717 To indicate that the circuit blocked for some reason other than a blown fuse or a reader step failure by means of the Gen Alarm lamp.

3.718 To indicate that the circuit was skipping splice when it blocked by means of the Skip Splice lamp, under control of the Reader Lamps key.

3.719 To indicate that the RS— relays have been operated for more than 0.25 second (nominal) by means of the RDR STP Hold lamp.

Description of operation

5. GENERAL METHOD OF OPERATION

5.1 DESCRIPTION OF SORTING OPERATION

After the set-up switches have been set for the particular sort to be made, the reader motor is started by operating the Motor Start key **3200**. The End-of-Tape key **3208** is then operated to perforate splice pattern at the beginning of the ten output tapes. At the same time the input tape is fed into the reader. When sufficient splice has been perforated the End-of-Tape key **3208** is released and the Machine Start key **3207** is operated. The sorter skips the splice pattern at the start of the input tape, reads and checks the tape identity information on the input tape against the set-up switches, and then perforates tape identity information on all ten output tapes. It then proceeds to read each call entry and to reperforate it on one of the output tapes. The output tape selected depends upon the value of the digit of calling subscriber's directory number by which the tape is being sorted. At the end of the first section of input tape the circuit again encounters tape identity which it checks. It then skips the splice which follows and proceeds to the next section of input tape (if the tapes are spliced together). It again checks tape identity, sorts call entries, and checks tape identity, and proceeds to the next section. The circuit stops at the end of the last section of input tape and sounds an alarm to call the operator. The operator releases the circuit with the Machine Release key **3208**, starts the motor, and operates the End-of-Tape key. This causes the circuit to perforate tape identity information on all output tapes, followed by a skip splice signal and splice pattern. When sufficient splice pattern has been perforated the End-of-Tape key **3208** is released and the entire circuit releases. The input tape is run out of the reader while the circuit is perforating tape identity and splice. The operator presses the Tape Cutter button to cut the output tapes. If the sections of input tape are not spliced together the circuit sounds the alarm at the end of each section. The operator operates the Machine Release key, starts the motor, runs out the old section of tape, feeds in the next section, and operates the Machine Start key **3207**.

5.2 ORDER OF SORTING

5.21 MESSAGE UNIT CALLS

5.211 OFFICE BEING PROCESSED IS NOT ONLY ONE IN MARKER GROUP, AND BUSINESS OF OFFICE IS TOO MUCH FOR ONE SORTER

(*a*) When the computer processes calls of a marker group containing more than one office, message unit calls are sorted by office in the computer, which makes as many message unit tapes as there are offices. The tape for a particular office is then processed in the sorter to arrange the calls in directory number order. If desired the sorting may be expedited by using more than one sorter simultaneously. To do this the tape from the computer is first sorted by the thousands digit of the directory number in one sorter, producing ten output tapes. These output tapes may be divided into several groups and fed into several sorters for the remainder of the sorting process. For example, tapes 0 to 4 may be processed in one sorter, and tapes 5 to 9 in another. Any other grouping may be used as long as each group consists of consecutive thousands arranged in numerical order. In the example above, the group of tapes consisting of 0 to 4 would be sorted next by units, then by tens, hundreds, and finally by thousands again. The output from the last sort would then be five tapes, the first containing calls from directory numbers 0000 to 0999; the second, 1000 to 1999, etc. The 5 to 9 group of tapes would be similarly sorted in another sorter.

(*b*) If the tapes from the first thousands sort are divided into individual thousands, the second thousands sort is omitted in each sorter which is processing calls for only one thousand.

(*c*) The process described above applies only to the end of the first round of billing month. At the end of each subsequent round in the billing month the summary of all calls for previous rounds in the same billing month is introduced into the sorter so that the output tapes contain for each directory number both the total for previous rounds and the individual calls for the latest round.

(*d*) To accomplish this the summary tape from the summarizer for the particular office being processed is fed into the sorter immediately following the message unit tapes during units sort. The summary tape must first be divided into separate thousands or groups of thousands in the same manner as the message unit tapes.

5.212 OFFICE BEING PROCESSED IS NOT ONLY ONE IN MARKER GROUP, AND BUSINESS OF OFFICE CAN BE HANDLED BY ONE SORTER

(*a*) This case is similar to 5.211 except that since it is not necessary to separate the tape from the computer to process it in more than one sorter, the first sort by thousands can be omitted. The tape from the computer is fed into one sorter where it is sorted by units, tens, hundreds and thousands. In the event that all the directory numbers in the office are in the same thousand, the thousands sort is omitted.

(*b*) At the end of each round except the first in the billing month the summary tape is introduced as described in 5.211*d*. The complete summary tape is fed into the sorter without being split.

5.213 OFFICE BEING PROCESSED IS ONLY ONE IN MARKER GROUP, AND BUSINESS OF OFFICE IS TOO MUCH FOR ONE SORTER

(*a*) When the computer is processing calls of a marker group containing only one office, message unit calls are sorted by either thousands or units. In case it is desired to use more than one sorter, the computer makes first thousands sort, producing ten output tapes, one for each thousand. These tapes are divided into groups as described in 5.211*a* and fed into several sorters. Each sorter makes units, tens, hundreds and thousands sorts. If the tapes from the computer are divided into individual thousands, the second thousands sort is omitted in each sorter which is processing calls for only one thousand.

(b) At the end of each round except the first in the billing month the summary tape is introduced as described in 5.211d.

5.214 OFFICE BEING PROCESSED IS ONLY ONE IN MARKER GROUP, AND BUSINESS OF OFFICE CAN BE HANDLED BY ONE SORTER

(a) In this case the computer sorts the message unit calls by units. The ten output tapes from a sorter which sorts them by tens, hundreds and thousands. The thousands sort is omitted in the event that all the directory numbers in the office are in the same thousand.

(b) Since the sorter does not make a units sort of the message unit tapes in this case, the summary tape must be introduced at the tens sort. Before this is done the summary tape for the previous round is sorted by units in the sorter producing ten sections of summary tape. These sections are introduced into the tens sort in such a way that each of the ten sections of message unit tape from the computer is followed by the corresponding section of summary tape. Thus, message unit tape 0 is fed in first, then summary tape 0, then message unit tape 1, then summary tape 1, etc.

5.22 TOLL, MESSAGE UNIT DETAIL AND OBSERVING CALLS

5.221 OFFICE BEING PROCESSED IS NOT ONLY ONE IN MARKER GROUP, AND BUSINESS OF OFFICE IS TOO MUCH FOR ONE SORTER

The computer does not sort toll, message unit detail and observing calls. It produces one tape for each of these classes. Each of these tapes is then processed separately in the sorter. If the marker group contains more than one office, therefore, the sorter must sort the tape by office, producing one output tape for each office. The output tape for the particular office whose calls are being processed is then sorted further in the sorter to arrange the calls in directory number order. If it is desired to expedite the sorting process the sorter is arranged to sort the tape by thousands. The output tapes from this sort may then be divided into several groups and fed into several sorters for the remainder of the sorting process. For example, tapes 0 and 4 may be processed in one sorter and tapes 5 to 9 in another. Any other grouping may be used as long as each group consists of consecutive thousands arranged in numerical order. In the example above, the group of tapes consisting of 0 to 4 are sorted next by units, then by tens, then by hundreds, and finally by thousands. The output from this last sort is then five tapes, the first containing calls for directory numbers 0000 to 0999; the second, 1000 to 1999, etc. If the tapes from the first thousands sort are divided into individual thousands, the second thousands sort is omitted in each sorter which is processing calls for only one thousand.

5.222 OFFICE BEING PROCESSED IS NOT ONLY ONE IN MARKER GROUP, AND BUSINESS OF OFFICE CAN BE HANDLED BY ONE SORTER

This case is similar to 5.221 except that the first thousands sort is omitted. The tape from the computer is sorted by office first, and the output tape for a particular office is next sorted by units, then by tens, hundreds and thousands. The thousands sort is omitted in the event that all the directory numbers in the office are in one thousand.

5.223 OFFICE BEING PROCESSED IS ONLY ONE IN MARKER GROUP, AND BUSINESS OF OFFICE IS TOO MUCH FOR ONE SORTER

In this case the tape from the computer requires no office sort. It is, therefore, sorted by thousands in the sorter, after which it may be divided into groups for simultaneous sorting by more than one sorter. Each such group is sorted next by units, tens, hundreds and thousands, except that the second sort by thousands is omitted in any sorter which is processing calls for only one thousand.

5.224 OFFICE BEING PROCESSED IS ONLY ONE IN MARKER GROUP, AND BUSINESS OF OFFICE CAN BE HANDLED BY ONE SORTER

In this case neither office nor first thousands sort is required. The tape is sorted in the sorter by units, tens, hundreds and thousands. In the event that all the directory numbers in the office are in the same thousand, the thousands sort is omitted.

6. PRINCIPAL PARTS OF SORTER AND RELAY FUNCTIONS

6.03 FIGS 19 AND 20—READER

Figs. 19 and 20 contain the reader which is described in 9.1.

6.04 FIG. 18—READER STEP CHECK

Relays RW, RZ1, RZ2 and RZ3 form an alternate line counting circuit under control of the G1 and G2 contacts of the reader. They control relays RKA and RKB which keep the reading check lead closed and the reader step failure alarm lead open unless the reader steps falsely or fails to step. Relay CRK is used to cancel this check.

6.05 FIG. 19—READER CONNECTOR

The RCA, RCB and RCC relays connect the reading contacts of the reader to the rest of the circuit when the input tape is being read, and open these leads during perforation of splice and tape identity. Relay RCD closes through certain of the leads to the reader control contacts.

6.06 FIG. 17—OFF-NORMAL AND START

Relay MON is the master off-normal relay for the sorter. ST1, ST2, ST3 and ST3A are the start relays which synchronize the circuit with the reader when starting and serve as off-normal relays. RLS is the release relay, used in stopping the circuit. Relay SPA, when operated, indicates that splice pattern has been applied to the output tapes. Relays ER and ERA are used in connection with the Emerg Reset key 322 1 to start the circuit after a power failure.

6.07 FIG. 29—READING RELAYS "A" DIGIT

The A0, A1 and A2 relays are connected to the correspondingly designated reading contacts of the reader for reading the A digit on the input tape.

6.08 FIG. 29—READING RELAYS "B" TO "F" DIGITS

The B1, B1, B2, B4, B7, . . . F7 relays are connected to the reading contacts of the reader to read the B, C, D, E and F digits on the input tape.

6.09 FIG. 31—READING RELAY TRANSLATOR

The 28A, 28B and 28C relays are used when reading lines on the input tape where the A digit is 2 and the B digit 8. Relays B1M and B4M are auxiliary to the B1 and B4 reading relays, to provide additional contacts when the circuit is equipped to process summary tapes containing both 2-line and 3-line entries. PCA and PCB are provided to delay the circuit by one reader cycle after perforating tape identity and before processing call entries, to insure adequate time for certain relay operations.

6.10 FIG. 28—READER LINE COUNT

Relays LN2, LN3 and LN5 indicate the number of lines in call entries. LK1 is a locking relay which operates on the first line of all but one-

line entries. Relay LK2 is a similar relay which operates between the first and second lines of multiline entries. L2A, L2B, L3A, L3B, L4A, L4B, LLA and LLB are relays used to count lines of entries. L2A and L2B count the next to the last line, L3A and L3B count the third from the last line, and L4A and L4B count the fourth from the last line. LLA and LLB count the last line.

6.11 FIG. 18—READER STEP CONTROL

RS1, RS2, RS3 and RS4 are operated when the reader is to be stepped. Relays RS1 and RS3 (odd) operate together for approximately half the reader step operations, and relays RS2 and RS4 (even) operate for the other operations. This is done to decrease wear on the relays. Relay SR is used for stepping the reader manually.

6.12 FIGS. 44 AND 57—PERFORATE SORT CONNECTOR

SC is the main sort connector relay which connects contacts on the reading relays to the perforator during the processing of call entries, and disconnects them at other times to prevent backups. The individual OFS, THS, HS, TS and US relays are used on office, thousands, hundreds, tens and units sort, respectively. Relay BX is used when sorting by any digit other than the B digit (all sorts except office).

6.13 FIG. 39—PERFORATING MAGNET CHECK "A" AND "B" DIGITS

The KA0, KA1 and KA2 relays are used as series checking relays for the corresponding perforating magnets.

6.14 FIGS. 45 AND 51—PERFORATING MAGNET CHECK "C" TO "F" DIGITS

The KC0, KC1, KC2, KC4, KC7, . . . KF7 relays are used as series checking relays for the corresponding perforating magnets.

6.15 FIGS. 39, 45 AND 51—PERFORATOR CONNECTOR

Ten sets of PA, PB and PC relays are provided to connect the perforators one at a time to the relay circuit.

6.16 FIG. 54—PERFORATORS

Fig. 54 contains the perforator, which is described in 9.3.

6.17 FIG. 50—PERFORATOR REGISTER

One of the PD0 to PD9 relays is operated on the first line of a multiline entry to serve as a register relay, causing the remainder of the entry to be perforated on the same output tape as the initial line.

6.18 FIG. 54—PERFORATOR ADVANCE CHECK

The ten PK0 to PK9 relays are used as series checking relays for the perforator advance magnets.

6.19 FIG. 54—PERFORATOR HOLD CHECK

Relay PHK is operated while the first line of splice is being spread at the beginning of a run and while the skip splice entry is being perforated at the end of a run. It serves to initiate the perforator hold check. CKA, CKB, PHE and PHO relays make the perforator hold check.

6.20 FIG. 49—WINDOW SPLICE PERFORATE CONTROL

Relays WSA and WSB are associated with the perforator window detecting contacts and lamps. Relay WS is associated with the Window Splice keys. Relays WS1A, WS1B, WS1C, WS1D and WS2 prepare the circuit for perforating window splice. Relay ME (manufactured entry) is operated for any lines to be perforated which are not copies from the input tape. Relay FL operates during the first line of window splice, and relays CP1 and CP2 (change pattern) operate during the last line. Relay ESP (end splice pattern) operates when the window splice perforation is complete.

6.21 FIG. 37—SPLICE PATTERN TIMING

Relay TTM activates the cold-cathode tube timer for timing window splice perforating, tape section selector stepping, tape identity perforating and splice pattern perforating. When the tube fires it operates relay CTT.

6.22 FIG. 37—TAPE END PERFORATE CONTROL

Relay PSP (perforate splice) is operated by the End-of-Tape key at the start of a run, and relay PTI (perforate tape identity) at the end. Relay TE (tape end) operates both times.

6.23 FIG. 27—SKIP SPLICE CONTROL

Relays SK1, SK2, SKP and SKW control the splice skipping functions. Relay ESK (end skip) operates to stop skipping. Relay STT (start tape) is used to initiate skipping at the beginning of a tape.

6.24 FIGS. 34 AND 35—TAPE IDENTITY READING PROGRESS

L1, L1T, L1UA, L1UB, L2, L5, L6, L8 and L9 are the relays which make connections to the set-up switches and the reading relays for checking the lines of tape identity. Relay L1 is used for checking the first line, relay L2 for the second, etc. Relays L1UA, L1UB and L1T are used for the first line when message unit and summary tapes are being processed together. Relays CL1, CL2, CL5, CL6 and CL8 indicate that the corresponding lines of tape identity have been checked. Relay TIC (tape identity checked) is operated when tape identity has been checked at the leading end of a tape section, to permit the circuit to process call entries. It is released when the initial line of tape identity has been checked at the trailing end of a tape section. Relay TICA operates when tape identity is being read at the trailing end of a tape section. It is released when the circuit stops skipping.

6.25 FIGS. 40, 41, 42, 46 AND 47—SET-UP SWITCHES

The fourteen switches in these figures are used in preparing the sorter for a particular run. They are discussed in section 8.

6.26 FIG. 23—TAPE SECTION REGISTER

The TD selector is used for counting input tapes during a run. It is brought into play by the FT1 and FT2 (first tape) relays initially, advanced by means of relay STD (step tape digit), and restored by relay RTD (restore tape digit). Relay EC is used to connect the E digit reading relays to the selector. Relay LTD is used to indicate that the last tape has been received. Relay TDA furnishes ground for the tape section lamps during the alarm condition. Relay TDS (tape digit step) prepares for stepping the selector. Relay TK indicates an OK check of the tape digit after the switch is reset.

6.27 FIG. 26—TAPE IDENTITY PERFORATE CONTROL

Relays MTI and MTIA (mutilated tape identity) are associated with the Tape Ident key for simulating a tape identity check. Relays TIE and TIEA are operated after tape identity has been checked, and perforated at the start of a run. Relay TIS is the start and off-normal relay for tape identity and splice perforation.

6.28 FIG. 15—TAPE IDENTITY PERFORATE PROGRESS

Relay PX allows a reader cycle to pass before perforating splice or tape identity to provide time for certain relay functions. Relay W1 to W9,

with auxiliary relay W2A, form a walking circuit used in perforating tape identity, to walk from one line of identity to the next. Relay WSP is part of the same chain, and operates prior to splice perforation. Relays PL1 to PL9 are used to control the perforating of the nine lines of tape identity. Relay EP (end perforation) operates upon completion of these nine lines. Relay PS1 is used for perforating the skip splice entry, relay PS2 for perforating splice pattern, and relay PS3 for perforating splice pattern and making the perforator hold check.

6.29 FIG. 48—ENTRY SPREAD CONTROL

Relay A2S is a substitute for the A2 reading relay when splice and tape identity are being perforated. Relays APA, APB, APC and APD (all perforators) recycle the perforator walking circuit after each line of splice or tape identity has been spread. SS (skip step) takes the place of the RS— relays during splice and tape identity spreading, and advances the circuit without stepping the reader.

6.30 FIGS. 52 AND 53—ENTRY SPREAD PROGRESS

Relays S1A to S9A and S0B to S9B form the walking circuit which progresses from one perforator to the next when spreading splice and tape identity.

6.31 FIG. 14—ALARM

AL and ALA are the alarm relays which stop the circuit and signal the external alarm circuit. Relay ALCO (alarm cut-off) restores these relays when the circuit is released. Relay EAC (external alarm cut-off) silences the alarm under control of the Alarm Cut-Off key. FAL is the fuse alarm relay. Relay RSF operates if the reader fails to step or steps falsely. Relay RSR times the RS— relays and operates relay RSH if they remain operated too long. Relay RSH brings in the alarm under this condition.

6.32 FIG. 14—ALARM TIMING

The TM relay is a condenser-timed polarized relay used as the short timer.

6.33 FIG. 21—LAMP CONNECTOR

Relays PLA, PLB, PLC and PLD connect those lamps which are under control of the MAINT key. Relays RLA, RLB, RLC and TDD connect lamps under control of the Reader Lamps key. Relay TI controls Tape Ident lamp. Relay DS connects miscellaneous progress lamps.

6.35 FIG. 16—MOTOR CONTROL

The MST and RLM relays control the starting and stopping of the reader motor. MRL is the master release relay. Relay MST also provides battery to the reader STEP magnet.

6.36 FIG. 37—PERFORATE MUTILATED LINE CONTROL

The PM1 and PM2 relays are under control of the Perforate Line key and are used to perforate a mutilated supplementary line of a call entry.

6.37 FIG. 36—TAPE IDENTITY SORT CONNECTOR

Relay OFB is operated on office sort, relay FTH on first thousands sort, relay STH on second thousands sort, relay HATH (hundreds and thousands) on hundreds and thousands sorts, relay T on tens sort and relay U on units sort. They make the necessary interconnections in the tape identity checking circuit.

6.38 FIG. 33—TAPE INDEX CONNECTOR

These relays serve as additional contacts on the Tape Type switch. Relay MU is used for message unit tapes, relay MUS for summary tapes, relay MUAS for message unit and summary tapes together, relay DET for toll and message unit detail tapes, and relay OBS for observing tapes.

6.39 FIGS. 24 AND 25—TAPE INDEX REGISTER

The MOC (month check) relay is used to check the tape identity month entry during a sort of message unit and message unit summary tapes combined. The remaining relays 11A, 11BA, 11BB, 12A, 12B, 13A, 13BA, 13BB, 17A, 17BA, 17BB, 18A, 18BA, 18BB and 18C are used in checking tape indices 11, 12, 13, 17 and 18 as indicated by the numerals in the relay designations. X1A and X1B are for tapes 11, 21, 31 and 41.

7. KEY FUNCTIONS

7.01 MOTOR START

The Motor Start key is a non-locking key used to start the reader motor. It is operated before starting the sorter, either with the End-of-Tape key or the Machine Start key. If the Perforate Line key is to be used the Motor Start key is not used, as the motor starts automatically.

7.02 EMERG MOTOR STOP

The Emerg Motor Stop key is a non-locking key used to stop the motor if the sorter must be stopped immediately because of a tape not feeding properly, or some serious mechanical difficulty. Normally the Machine Release key is used for stopping.

7.03 END OF TAPE

The End-of-Tape key is a locking key which is used at the start and end of each run. At the start it is operated after the motor has been started, to perforate splice on the output tapes. It is released when sufficient splice pattern has been applied. After the completion of the last tape of a run the circuit is released, the motor started and the End of Tape again operated. This time it causes the perforation of tape identity, a skip splice entry and splice pattern. When sufficient splice pattern has been supplied the key is restored.

7.04 MACHINE START

The Machine Start key is a non-locking key. It is used to start the sorter after splice pattern has been applied to the output tapes and an input tape put into the reader. It is used to start the circuit whenever it has been stopped by the operation of the Machine Release key. It is also used to start after the circuit has blocked and the Machine Release and Motor Start keys have been operated. It is used to start following the application of window splice.

7.05 MACHINE RELEASE

The Machine Release key is a non-locking key which is used to stop the circuit during sorting. The circuit does not stop immediately, but waits until a proper stopping point is reached. The Machine Release key is also used after the circuit has blocked to release the circuit before it is started again.

7.06 ALARM CUT OFF

The Alarm Cut-Off key is a non-locking key used following an alarm to silence the bell and extinguish the machine pilot.

7.07 WINDOW SPLICE 0 TO 9

The ten Window Splice keys are locking keys used to perforate splice pattern on the output tapes. After the circuit has blocked with one of the Window Splice lamps lit the Machine Release and Motor Start keys are operated and then the Window Splice key corresponding to the lamp is turned. When the perforation is complete the key is restored and the Motor Start and Machine Start keys are operated.

7.08 READER STEP

The Reader Step key is a non-locking key which is effective when the circuit is not operating and the Reader Lamps key is operated. Each time it is operated the reader advances the tape one line.

7.09 TAPE FEED

The Tape Feed key is a push-button type key located on the reader. Its operation causes the reader drum to rotate continuously. It is used for feeding tape into the reader and running tape out of the reader.

7.10 MASTER RELEASE

The Master Release key, a non-locking key, is ineffective when operated alone. When operated with the Machine Release key it releases all relays in the circuit, leaving only the TD selector off normal. This operation is used only if a run is stopped before completion, or if the circuit is inadvertently advanced off normal.

7.11 PERFORATE LINE

The Perforate Line key, a non-locking key, is used when the sorter has stopped on a supplementary line of a call entry because of a mutilation in the input tape. Operation of this key will automatically start the motor, release the alarm, perforate the mutilated line as read and permit the circuit to proceed.

7.12 TAPE SECTION RESET

The Tape Section Reset key, non-locking, advances the TD selector one step for each operation provided the alarm is in or the circuit is not operating. It is used only if a tape in a series is missing. If the tape was accidentally omitted it cannot be fed into the reader out of turn without upsetting the sorting process.

7.13 TAPE SECTION RELEASE

The Tape Section Release key, non-locking, restores the TD selector when an alarm is in or the circuit is not operating. It can be used if for some reason the selector was not automatically restored to normal.

7.14 TAPE IDENT

The Tape Ident key is a push-button mounted beneath a cover. If the tape identity portion of an input tape is mutilated the tape is stepped to the first line following tape identity. The Tape Ident key is then operated, after which the circuit is started by means of the Machine Start key.

7.15 EMERG RESET

The Emerg Reset key is a push-button mounted beneath a cover. It is used following a power failure which occurred during processing to restore the necessary relays to permit the sorting to proceed. After its operation the circuit is started with the Machine Start key.

7.16 READER LAMPS

The Reader Lamps key is a locking key which may be operated at any time to read the input tape by means of reading lamps. In case the circuit blocks the key is operated to light lamps indicating the number of lines in the call entry in process, the line of the entry on which the circuit blocked, the position of the TD selector and whether the circuit is checking tape identity or skipping.

7.17 MAINT

The Maint key is a non-locking key which is used in case of trouble to light lamps indicating the perforator in use and the perforating magnets operated.

8. SET-UP SWITCHES

8.01 GENERAL

Before a sorting process is started, the fourteen set-up switches on the panel of the machine must be set for the operation to be perforated.

8.02 TAPE TYPE

This switch has seven positions, as follows:

Off
Summary
MU and Summ
Mess Unit
Toll
MU Det
Observ

The Off position is used only for maintenance purposes. The switch is set to one of the other positions depending upon the type of tape to be processed. Since the switch setting is not changed during a run, it must be set to MU and Summ whenever both message unit and summary tapes are to be sorted together on units or tens sort. The output tapes resulting from such a combined sort are treated as message unit tapes on subsequent sorts. The switch position designated Summary is used only on units sort for the summary tape which is to be combined with the message unit tape in tens sort.

8.03 SORT

The Sort switch has seven positions, as follows:

Off
Cent Office
Thous First
Units
Tens
Hunds
Thous Last

The Off position is used only for maintenance purposes. The other positions are used to control the directory number digit by which calls are to be sorted. The switch is set to Thous Last for the thousands sort following hundreds sort, whether or not a first thousands sort was made.

8.04 MARKER GROUP TENS AND MARKER GROUP UNITS

Each of these two switches has an Off position, used only for maintenance purposes, and ten positions designated 0 to 9. The switches are set for the marker group to which the office whose tapes are being processed belongs.

8.05 FIRST RECORDER TENS AND FIRST RECORDER UNITS

Each of these two switches has an Off position. The First Recorder Tens switch has two other positions designated 0 and 1, and the First Recorder Units switch has ten other positions designated 0 to 9. On office and first thousands sorts these switches are set to indicate the lowest numbered recorder in the group of tapes being processed. On other sorts the switches are set to the Off position.

8.06 LAST RECORDER TENS AND LAST RECORDER UNITS

Each of these two switches has an Off position. The Last Recorder Tens switch has two other positions designated 0 and 1, and the Last Recorder Units switch has ten other positions designated 0 to 9. On office and first thousands sorts these switches are set to indicate the highest numbered recorder in the group of tapes being processed. On other sorts the switches are set to the Off position.

8.07 CENT OFFICE

The Cent Office switch has an Off position and ten positions designated 0 to 9. On office sort the switch is set to the Off position, and on all other sorts it is set to indicate the office whose tapes are being processed. Where the office is the only one in a marker group it is arbitrarily called 0, and the switch is set to position 0.

8.08 THOUSAND FIRST

This switch has an Off position and ten positions designated 0 to 9. On office and first thousands sorts the switch is set to the Off position. On all other sorts it is set to the lowest numbered thousands digit of directory number of the tapes being processed.

8.09 THOUSAND LAST

This switch has an Off position and ten positions designated 0 to 9. On office and first thousands sorts the switch is set to the Off position. On all other sorts it is set to the highest numbered thousands digit of directory number of the tapes being processed.

8.10 ROUND

This switch has an Off position, used only for maintenance purposes, and ten positions designated 0 to 9. The switch is set to indicate the round of the tapes being processed. In the case of a combined sort of message unit and summary tapes the Round switch is set for the round of the message unit tape.

8.11 MONTH TENS AND MONTH UNITS

Each of these two switches has an Off position, used only for maintenance purposes. The Month Tens switch has two other positions designated 0 and 1, and the Month Units switch has ten other positions designated 0 to 9. These two switches are set to indicate the month of the tapes being processed. In the case of a combined sort of message unit and summary tapes the Month switches are set for the month of the message unit tape.

9. DESCRIPTION OF APPARATUS

9.1 READER

9.11 GENERAL

The reader provides means for reading the input tape, and in addition serves as a mechanism for timing and synchronizing the sorter circuit operation. The input tape enters a chute and passes around a perforated drum, emerging by another chute. The perforations in the tape fit into the holes in the drum to provide traction. A motor drives a cam shaft, causing twenty-eight reading pins to attempt to enter the drum through the tape. Those pins which coincide with perforations in the tape move far enough to close one make contact for each pin. The cam controlling the reading pins is cut so that the contacts are closed for approximately two-thirds of the cam shaft revolution.

9.13 READER

9.131 STEPPING MECHANISM

The drum is rotated by the square motion action of a step rack in association with the step gear attached to the drum. The drum advance is controlled by a Step magnet which permits advance when operated and prevents advance when released. A centrifugal throw-out ratchet in the flywheel is operative at low speeds to prevent the reader shaft from being turned back.

9.132 ALTERNATE LINE CONTACTS

Contacts G1 and G2 are similar to the reading contacts. Each is equipped with a reading pin, but these pins strike the drum outside the tape. This part of the drum has holes arranged so that contact G1 closes in one position of the drum G2 in the next, etc. These contacts are used as part of the circuit which checks that the reader steps properly.

9.134 TAPE FEED KEY

A push-button type Tape Feed key is provided on the reader to cause the drum to step continuously for feeding tape into and out of the reader. It is ineffective unless the circuit is normal or is perforating splice pattern at the start of a run or tape identity and splice pattern at the end of a run.

9.135 CONTROL CONTACTS

Three sets of ten contacts each, designated H, J and K are provided. They are driven by cams on the main cam shaft. Contacts H3, H4, H8, H9, J3, J4, J8, J9, K3, K4, K8, and K9 are break contacts; the others are makes. The H and K contacts are in phase with the reading contacts so that the make contacts are closed for the same two-thirds cycle as the reading contacts. The J contacts close 0.008 second later. The H, J and K contacts are not equipped with reading pins, and therefore operate each cycle.

9.136 PERFORATING CONTACTS

There are thirty additional contacts used to operate the perforator magnets. These contacts, designated P1, P2, PA0, PA1, PA2, PB0, . . PF1, are all make contacts and operate in phase with the reading contacts. They are not equipped with reading pins.

9.137 FEEDING TAPE INTO THE READER

Tape is always fed into the reader of the sorter in the same direction in which it emerged from the previous machine. It is pushed into the upper tape chute of the reader with the perforations down and the A digit on the left. The tape is engaged on the exposed surface of the drum and the tape feed key is operated to rotate the drum.

9.2 PERFORATOR

9.21 GENERAL

The perforators convert unperforated tape into perforated output tapes. Ten perforators are provided in the sorter, designated 0 to 9. All call entries whose sorting digit is 0 are perforated on perforator 0, those whose sorting digit is 1 are perforated on perforator 1, etc. The ten tapes from the perforators, taken in order, constitute the output of a sorting process.

9.22 PERFORATING MECHANISM

The perforator is equipped with a perforated drum, similar to that in the reader. Unperforated tape is inserted so that it passes over the top of the drum. Above the drum are twenty-eight punches, each operated by a perforating magnet. When a magnet is energized its punch strikes the paper, driving it into a tapered hole in the drum, producing a perforation. The perforations engaging in the drum, provide traction for advancing the paper when the drum rotates.

9.23 STEPPING MECHANISM

The drum is rotated by a ratchet operated by the perforator advance magnet (PAM). Operation of the magnet cocks the ratchet arm, and release of the magnet steps the drum, advancing the tape one line.

9.24 WINDOW DETECTING CONTACT

A switch, operated by a pivoted arm, is provided to detect a window in the unperforated tape feeding into the perforator, or the end of the

tape. The arm rides on the tape as it approaches the drum, and when the tape ends, or a window is encountered, the arm moves, closing the contact. Normally, before the supply of tape to a perforator is exhausted, a new supply is spliced to the end of the old. A window, a rectangular opening in the center of the tape, is cut at the point of splicing to stop the sorter before the splice gets into the perforator. A length of splice pattern is then perforated on this output tape to cover the spliced portion, preventing the sorter from attempting to perforate call entries through the splice, where the added thickness of paper prevents proper perforations from being made.

10. ENTRIES

10.1 MESSAGE UNIT ENTRIES

10.11 1 TO 9 LOCAL MESSAGE UNITS

This entry appears on message unit tapes:

A	B	C	D	E	F
1	MU	TH	H	T	U
		Calling Line number			

10.12 10 TO 99 LOCAL MESSAGE UNITS OR 1 TO 99 EXTENDED AREA MESSAGE UNITS

This entry appears on message unit tapes:

A	B	C	D	E	F
2	0	TH	H	T	U
		Calling Line number			
0	MU index	0	0	x	x
				MU	

10.13 MESSAGE UNIT ENTRIES ON TYPE 13 TAPES

Where the computer has sorted the MU entries by units the C, D, E and F digits contain the Office, Thousands, Hundreds and Tens digits and the Units digits of the calling line numbers are represented by the tape section digits.

10.2 SUMMARY ENTRIES

10.21 LOCAL MESSAGE UNITS

This entry appears on summary tapes, and on message unit tapes after a combined sort has been made of message unit and summary tapes:

A	B	C	D	E	F
2	0	TH	H	T	U
		Calling Line number			
0	3,4	x	x	x	x
		Message Units			

3=less than 1000 message units
4=exactly 1000 message units

10.22 LOCAL AND EXTENDED AREA MESSAGE UNITS

This entry appears on summary tapes, and on message unit tapes after a combined sort has been made of message unit and summary tapes:

A	B	C	D	E	F
2	1	TH	H	T	U
		Calling Line number			
0	3,4	x	x	x	x
		Local Message Units			
0	5,6	x	x	x	x
		Extended Area			

3 and 5=less than 1000 message units
4 and 6=exactly 1000 message units

10.3 DETAIL ENTRIES

10.31 COMPLETED CALL

This entry appears on toll, message unit detail and observing tapes:

A	B	C	D	E	F
1	Office index	TH	H	T	U
	Calling line number				
0	Start Time				
0	Area index	Called No. index	Called office code		
0	TTH	TH	H	T	U
	Called line number				
0	MU index	Chargeable time		Message units	

10.32 UNANSWERED CALL

This entry appears on observing tapes:

A	B	C	D	E	F
3	Office index	TH	H	T	U
	Calling line number				
0	Start time				
0	Area index	Called No. index	Called office code		
0	TTH	TH	H	T	U
	Called line number				
0	0	0	0	0	0

10.4 TAPE IDENTITY ENTRIES

A	B	C	D	E	F	
2	8	9	1	x	x	Tape index.
2	8	9	2	x	x	Marker group.
2	8	9	3	x	x	First recorder number.
2	8	9	4	x	x	Last recorder number.
2	8	9	5	x	0	Office.
2	8	9	6	x	x	Thousands range.
2	8	9	7	x	x	Days of round.
2	8	9	8	x	x	Tape section and round.
2	8	9	9	x	x	Month.

10.5 MISCELLANEOUS ENTRIES

A	B	C	D	E	F	
2	8	6	0	x	x	Skip splice (xx=machine number).
2	8	7	0	2	0	Skip window.
2	8	1	0	1	0	Splice.

10.6 CODE OF PUNCHED HOLES

10.61 A DIGIT

0	1	2	
x	----	----	0
----	x	----	1
----	----	x	2
x	x	x	3

10.62 B, C, D, E AND F DIGITS

0	1	2	4	7	
--	--	--	x	x	0
x	x	--	--	--	1
x	--	x	--	--	2
--	x	x	--	--	3
x	--	--	x	--	4
--	x	--	x	--	5
--	--	x	x	--	6
x	--	--	--	x	7
--	x	--	--	x	8
--	--	x	--	x	9

11. PERFORATING SPLICE AT START OF OUTPUT TAPES

11.1 STARTING MOTOR

At the start of a run all keys and relays in the circuit and the TD selector should be normal. The selector is automatically restored at the start and end of each run.

READER

The device is put into operation by the operation of the motor start key **3200**. This key, through its left contacts, extends a circuit over the MSTA lead **3201**, armature **1** and back contact of the MRL relay **1600**, the EM lead **1601**, the emergency motor key **3202**, the MSTA lead **3203**, armature **1** and back contact of the AL alarm relay **1400**, the MST lead **1401**, leading into the winding of the MST relay **1602**. The consequent operation of the MST relay **1602** extends a ground from the left-hand contacts in normal position of the machine stop key **3205**, over the RL1 lead **1606** to armature **3** and front contact of the MST relay **1602** and thence to the winding of the MON master off-normal relay **1703**. The master off-normal relay is thus operated and it locks to the ground on the RL1 con-

ductor 1608 through the armature 2 and back contact of the MRL relay 1600 and its own armature 5 and front contact so that this master off-normal relay 1703 will remain operated thereafter until the motor stop key 2305 or the MRL relay 1600 is operated. The operation of the motor start key 3200 also extends a ground through its right contacts over the RLM lead 3204 to the RLM relay 1603 which thereupon locks through its front contact and armature 1, conductor 1605, armature 1 and back contact of the WSA relay 4900, the RLML lead 4901, the right contacts of the machine stop key 3205 to the MON9 conductor 3206 leading through armature 3 and front contact of the MON relay 1703 to ground.

The MST relay 1602 connects battery through its armature 1 and front contact and conductor 1607 to the reader step magnet 1902 so that this magnet is now under the direct control of the reader step relays, the RS1—3 relay 1800 and the RS2—4 relay 1801. Through its armature 2 and front contact the MST relay also extends ground to the alternating current power control circuit 1608, part of which circuit is shown on Fig. 19 as a simple closing switch 1904 in series with the source of alternating current 1905 and the motor 1903 so that upon this operation of the motor start key the motor will be started. The operation of the MON relay 1703 applying ground over its front contact and armature 7 causes the operation of the RSR relay 1402 which is a slow release relay, and serves to normally hold the circuit of the RSH relay 1405 open. Through its front contact and armature 12, the master off-normal relay 1703 applies ground to the LP conductor 1704 leading to the master off-normal lamp in Fig. 22 so that this lamp signals the fact that the circuit is in operation. The master off-normal relay 1703 also operates any one of the MUS, MUAS, MU, DET or OBS relays in Fig. 33 in accordance with the setting of the third switch arm of the tape type switch shown in Fig. 40. Ground for this purpose is extended from armature 14 and front contact of the MON relay to the MON5 conductor leading to the third switch arm of the tape type switch (Fig. 40) and in parallel therewith the fourth switch arm of the sort switch shown in Fig. 46. Through this latter connection the MON relay thereby also causes the operation of some one of the relays in the tape identity sort connector in Fig. 36.

11.2 INSERTING INPUT TAPE

The first input tape to be sorted is fed into the reader as described in 9.137 by using the Tape Feed key on the reader. The Tape Feed key is effective only if the ST3A relay is normal or the CRK relay is operated. Under these conditions, ground is extended from armature 1 and back contact of the ST3A relay 1705 so that upon the operation of the Tape Feed key the step magnet 1902 will operate. The reader drum thus steps continuously. The key can be used if the motor is running and the circuit is normal, and it can also be used while the circuit is perforating splice pattern at the start of the output tapes and while it is perforating tape identity, skip splice entry and splice pattern at the end of the output tapes. Thus, the input tape may be fed into the reader during the splice perforating operation described below.

11.3 OPERATING THE START RELAYS

The end-of-tape key 3208 is operated to prepare the end of the output tapes for, in accordance with the invention set forth in the above-noted Eppel application (Serial No. 101,981, filed June 24, 1949), the start key cannot become effective (see section 12.01) until a minimum number of splice pattern codes has been spread over all the output tape ends. Upon the operation of the end-of-tape key 3206, a circuit is established from armature 2 and back contact of the WSA relay 4900, the armature 1 and back contact of the WSB relay 4902, WSN conductor 4904, armature 10 and back contact of the ST3A relay 1705, the WN conductor 1706, armature 5 and back contact of the TIEA relay 2600, the PSP conductor 2601, the inner left-hand contacts of the end-of-tape key 3208, the A conductor 3209 and thence through the winding of the PSP relay 3700. The PSP relay operates and then locks from ground on the MON9 conductor 3206, through the right-hand contacts of the machine stop key 3205, conductor 4901, back contacts and armature 4 of the WSP relay 1609, the PTIL conductor 1610, armature 3 and front contact of the PSP relay 3700. Also ground on the armature 2 and back contact of the WSA relay 4900 is extended over armature 1 and back contact of the WSB relay 4902, the WSN conductor 4914, the outer right contacts of the end-of-tape key 3208 to the PTIL conductor 1610. The PSP relay operates the WS2 relay over a circuit extending from ground on the front contact and armature 6 of the PSP relay 3700, the WS2 conductor 3701, to the winding of the WS2 relay 4300. The PSP relay also operates the TE relay 3702 over an obvious circuit from the front contact and armature 4 of the PSP relay 3700. The TE relay operates the CRK and the TIS relays, the circuit of the first of which may be traced from ground at armature 9 and front contact of the TE relay 3702 over the CRK conductor 3703 to the CRK relay 1802, and the circuit of the last of which may be traced from the armature 2 and front contact of the TE relay 3702, the TIS conductor 3704, to the winding of the TIS relay 2602. If the tape section register in Fig. 23 is off-normal, then ground on the SON conductor 2300 is extended over armature 1 and front contact of the TE relay 3702, the TDR conductor 3705 to the RLS magnet 2301 of the tape section register, whereby this causes the switch arms 2302 and 2303 to return to the normal position as shown in Fig. 23.

The operation of the TIS relay is also followed by the operation of the ME relay 4903 in a circuit from ground, armature 11 and front contact of the TIS relay, the ME conductor 2603 to the winding of the ME relay 4903. In the first open period of the reader following the operation of the ME relay the ST1 relay operates from ground, contact H8 over the conductor 2000, armature 7 and back contact of the RS2—4 relay 1801, the armature 10 and back contact of the RS1—3 relay 1800, the ST conductor to the back contact and armature 1 of the LK1 relay 2800, the ST conductor 2801, the armature 1 and front contact of the ME relay 4903, conductor 4905, the front contact and armature 7 of the TE relay 3702, the STA conductor 3706, armature 2 and back contact of the ST2 relay 1709, armature 2 and back contact of the RLS relay 1710, armature 2 and front contact of the RLM relay 1603 to the winding of the ST1 relay 1707. The ST1 relay locks in a circuit from ground, armature 2 and front contact of the MON relay 1703, armature 7 and front contact of the ST1 relay 1707, the winding of the ST2 relay 1709 and thence over the

circuit just traced to the winding of the ST1 relay 1707. The ST1 relay thus grounds the winding of the ST2 relay, but this latter relay is short-circuited by the original operating ground for the ST1 relay and therefore does not become operated until this original ground is released upon the next opening of the H8 contact whereby ground is removed from the conductor 2000. The ST1 relay, in operating, closes a circuit from its front contact and armature 4 over the RC conductor 1708 to cause the operation of the RCD relay 2001. At the same time the ST1 relay rends the reader step key 3210 ineffective. It may be noted that a circuit may be traced from the contact H8 over conductor 2000, the back contact and armature 3 of the ST1 relay, a front contact and armature 1 of the RS1 relay, the SR1 conductor to the right-hand contact of the reader step key 3210, the SR0 conductor to the SR relay 1803. Due to the operation of the ST1 relay, however, this circuit is rendered ineffective at this time. When the ST2 relay operates upon the opening of the H8 contact, it prepares an operating path for the ST3 relay which becomes effective in the next reader open period, that is, upon the next closure of the H8 contact. This circuit may be traced from the H8 contact over the conductor 2000, the back contact and armature 7 of the RS2 relay 1801, the back contact and armature 10 of the RS1 relay 1800, the armature 1 and back contact of the LK1 relay 2800, the ST conductor 2601, the armature 6 and front contact of the ST1 relay 1707, the armature 2 and front contact of the ST2 relay 1709, and thence through the winding of the ST3 relay 1702. The operation of the ST3 relay closes the circuits for the A0, A1 and A2 relays, which become effective upon the later operation of the RCA—B—C relay 1902. The path for the A0 relay may be traced from armature 2 of the RCA relay 1902, over conductor 1900, armature 1 and front contact of the ST3 relay 1702 to the winding of the A0 relay 2900. A parallel path for the A1 relay may be traced over conductor 1901, armature 2 and front contact of the ST3 relay 1702, the A1 conductor 1701, to the A1 relay 2901. The path for the A2 relay is more complex, but may be traced from the armature of the RCA relay 1902, over conductor 1906, back contact and armature 5 of the ME relay 4903, the A2 conductor 4904, the armature 10 and front contact of the ST3 relay 1702, the conductor 1712, the armature 10 and back contact of the APC relay 4800, conductor 4801 to the winding of the A2 relay 2902. The ST3 relay 1702 operates the ST3A relay 1705 in an obvious circuit from its armature 9 and front contact. The ST3 relay locks over its front contact and armature 6 through the armature 1 and back contact of the RLS relay 1710, the armature 2 and front contact of the ST2 relay 1709, the MON1 conductor leading to the armature 2 and front contact of the MON relay 1703. The ST3A relay 1705, through its armature 5 and front contact, connects battery to the TMB connector, thus connecting battery to the TM relay 1404. The TE relay 3702 locks through its front contact and armature 5 to the ON2 conductor 1714, being supplied with ground from the front contact and armature 9 of the ST3A relay 1705.

11.4 STARTING THE TAPE IDENTITY PERFORATOR CIRCUITS

When the TIS relay 2602 operates, it operates the ME relay 4903 as above described. The TIS relay also shunts the battery at the TI relay 2200 to prevent it from operating. The shunting circuit may be traced from ground, the armature 9 and front contact of the ST3A relay 1705, conductor 1714, armature 5 and back contact of the TE relay 3702, the TEN conductor, the front contact and armature 7 of the TIS relay 2602, the PTI conductor 2604 to the left-hand terminal of the TI relay 2200 whereby this last relay will be prevented from operating under these circuit conditions when ground is applied to its right-hand terminal.

The TIS relay 2602 locks from ground, front contact and armature 7 of the RCD relay 2001, the TISL conductor 2002, the armature 1 and back contact of the TIE relay 2605, the front contact and armature 6 of the TIS relay 2602, to the winding thereof. In operating, the TIS relay, through its armatures 9 and 10, respectively, ground the B1 and B7 leads leading directly to the windings of the B1 relay 2903 and the B7 relay 2904 to cause the operation of these reading relays. The fundamental connection for the step magnet 1902 may be traced from ground over either the front contact and armature 5 of the RS1—3 relay 1800 or the front contact and armature 3 of the RS2—4 relay 1801, over the RS(*b*) lead, the back contact and armature 8 of the TIS relay 2602, the armature 3 and back contact of the MT1A relay 2607, conductor 2608, the back contact and armature 4 of the RSF relay 1406, the RS(*d*) conductor 1407, to the winding of the stepping magnet 1902. Therefore, upon the operation of the TIS relay this lead is opened so that the reader cannot step during the perforating of the splice pattern on the output tapes.

The operation of the TIS relay closes a circuit for the PX relay 1500, which may be traced from the K3 contact controlled by the reader, over the front contact and armature 8 of the RCD relay 2001, conductor 2003, the front contact and armature 5 of the TIS relay 2602, conductor 2606, the armature 1 and back contact of the W2A relay 1501, armature 2 and back contact of the WSP relay 1609 and thence in a chain circuit through armatures and back contacts of the EP relay 1611, the W9 relay, the W8 relay, the W7 relay, the W6 relay, the W5 relay, the W4 relay, the W3 relay and the W1 relay, to conductor 1502 leading directly to the winding of the PX relay 1500. This circuit is, therefore, closed during an open period of the reader when the K3 contact is closed. The function of the PX relay is to use an extra reader cycle to provide time for the ME relay 4903 to operate fully when splice pattern is automatically perforated at the end of a tape. In the case under discussion this extra time is not required. The PX relay 1500 locks in a circuit from ground, front contact and armature 2 of the ST3A relay 1705, back contact and armature 6 of the RS1—3 relay 1800, the PLL conductor 1804, the front contact and armature 2 of the TIS relay 2602 and thence in a long chain circuit including an armature and back contact of each of the PS2, PS3, PS1, PL9, PL8, PL7, PL6, PL5, PL4, PL3, PL2, and PL1 relays, to the armature 2 and front contact of the PX relay 1500. The PX relay 1500, in operating, prepares a path for the W1 relay 1503 leading from the K5 reader contact over the KM3 conductor 2004 and thence through a long chain circuit including an armature and a back contact of each of the PS2 to PL1 relays, the

armature 1 and back contact of the PX relay 1500, to the winding of the W1 relay 1503. The W1 relay, therefore, operates in the following reader closed period. During the same reader closed period the A2 reading relay is operated in a circuit extending from ground, the reader contact K1, the front contact and armature 5 of the RCD relay 2001, the KM1 conductor, the back contact and armature 4 of the ESP relay 4905, the front contact and armature 5 of the ME relay 4903, and thence over the circuit through the conductor 4904 hereinabove described. Upon the operation of the A2 relay a connection is established from the H6 contact, through the armature 3 and front contact of the RCD relay 2001, the HN4 conductor, thence over the armature 3 and back contact of the A0 relay 2900, the front contact and armature 4 of the A2 relay 2902, the back contact and armature 3 of the A1 relay 2901, the LK1 lead 2905, the front contact and armature 7 of the 28C relay 3100, the LK1 lead 3101 to the winding of the LK1 relay 2800 so that the latter relay operates and locks in a circuit extending from the front contact and armature 3 of the ST3A relay, over the back contact and armature 6 of the LLA relay 2803 and the armature 4 and front contact of the LK1 relay 2800. The LK1 relay 2800, through its armature 6 and front contact, places a ground on the circuit leading through armature 5 and back contact of the LK2 relay 2804, the LNG conductor 2805, the back contact and armature 6 of the 28B relay 3102, the LN conductor 3103, the front contact and armature 8 of the A2 relay 2902, conductor 2906, the back contact and armature 10 of the TE relay 3702, conductor 3707, back contact and armature 9 of the OBS relay 3300, the LN conductor 3301, and thence through either armature 6 and back contact of the B7 relay 2904 or armature 8 and back contact of the B1 relay 2903, the LN2 conductor 2907 to the winding of the LN2 relay 2807. In the present case, since both the B1 and B7 reading relays are operated, this circuit is held open and the LN2 relay does not operate at the present time.

In the reader open period following the operation of the W1 relay 1503, the PS3 relay is operated over a path extending from contact K3 hereinbefore described for the operation of the PX relay up to armature 1 of the W1 relay 1503, which relay now being operated switches this circuit over the P0 conductor 1504, thence through armature 1 and front contact of the PSP relay 3700, the PS3 conductor to the winding of the PS3 relay 1612. Since the original energizing circuit for the PX relay has been broken by the operation of the W1 relay 1503, the holding circuit, therefore, is now broken by the PS3 relay and the PX relay releases. The PS3 relay locks in a circuit from ground, armature 2 and front contact of the ST3A relay 1705, the back contact and armature 6 of the RS1—3 relay 1800, the PLL conductor 1804, the front contact and armature 2 of the TIS relay 2602, the armature 8 and back contact of the PS2 relay 1613, armature 7 and front contact of the PS3 relay 1612, to the winding thereof. An alternate locking circuit for the PS3 relay may be traced from the K7 reader contact over the KM5 conductor, thence through armature 5 and back contact of the SS relay 4802 to the PLL conductor 1804. The operation of the PS3 relay 1612 establishes a circuit from ground, front contact and armature 5 thereof, over the PHK conductor 1614 leading to the winding of the PHK relay 5400 which thereupon becomes operated.

The PS3 relay 1602 operates the C0 and C1 reading relays through its armatures 3 and 4, respectively, the D4 and D7 reading relays over its armatures 2 and 1, respectively, the E0 and E1 reading relays over its armatures 9 and 10, respectively, and the F4 and F7 reading relays over its armatures 11 and 12, respectively. Thus, the reading relays are operated to express the code 281010. It will be found that the A2 relay will shortly release and the A2S relay will operate in its stead so that the code which will be perforated will be 081010, known as the splice pattern code.

11.5 PERFORATING FIRST LINE OF SPLICE PATTERN

The A2 reading relay 2902 releases at the end of the reader closed period which it operated through the opening of the K1 contact. It reoperates on the next closed period. There are now two reading relays operated for each digit B through F and the reading check path is closed, operating the APA relay. This path may be traced as follows: Ground is transmitted from either the G1 or the G2 alternate line reader contacts, one of which is operated at this time and which is tied to the other by armature 2 and front contact of the CRK relay 1802 which is operated at this time so that ground is extended to the CK conductor 1805 which may be traced to the front contact and armature 11 of the RCD relay 2001, conductor 2005, armature 3 and back contact of the AL relay 1400, the CK conductor 1408 through the two-out-of-five check circuits of the F, the E and the D digit reading relays which are identical in configuration with the two-out-of-five check circuits network of the C digit relays shown by the left-hand armatures thereof, to conductor 30000 and thence in detail through the armature 1 and front contact of the B7 reading relay 2904, the back contact and armature 2 of the B4 reading relay, the back contact and armature 3 of the B2 reading relay, the front contact and armature 2 of the B1 reading relay 2903 and the back contact and armature 1 of the B0 reading relay, to the CKB conductor 2908, the back contact and armature 4 of the LK2 relay 2804, conductor 2808, front contact and armature 6 of the A2 relay 2902, back contact and armature 5 of the A1 reading relay 2901, back contact and armature 5 of the A0 reading relay 2900, the AD2 conductor 2907, and thence through a front contact and armature of either the MU relay 3302, the MUAS relay 3303, or the MUS relay 3304 to the BC conductor 3305, thence through armature 4 and front contact of the B7 reading relay 2904, the front contact and armature 7 of the B1 reading relay 2903, the armature 8 and back contact of the B4 reading relay 2908, the BD conductor 2909 and again through a front contact and armature of either the MU, MUAS or MUS relay to the 28X conductor 3306, the armature 2 and front contact of the ME relay 4903, the APA conductor 4906, the armature 4 and back contact of the APD relay 4803, to the winding of the APA relay 4804. A1 alternate link in this chain may be traced from the AD2 conductor 2907, through an armature and front contact of either the OBS relay 3300 or the DET relay 3307, directly to the 28X conductor 3306. It will be noted that this check circuit is carried through the five relays of each of the B, C, D, E and F digits in such a way that it is closed only when two relays of the

set are operated. If fewer than two or more than two relays are operated, then the lead is opened. It will further be noted that this check circuit will be closed when any one of the relays of the tape index connector are operated, and that it is necessary that at least one be so operated.

The WSP relay is operated at the same time as the A2 relay in a circuit which may be traced from the K5 contact, conductor 2004, armature 6 and back contact of the PS relay 1613, conductor 1615, armature 3 and front contact of the PHK relay 5400, the WSP conductor 5401 to the winding of the WSP relay 1609 which now locks over its armature 3 and front contact to the ground supplied over the front contact and armature 3 of the TIS relay 2602. The operation of the WSP relay 1609 opens the holding circuit for the W1 relay 1503 so that this relay releases at the same time the circuit for the W2A relay 1501 is closed through armature 1 and front contact of the WSP relay 1609 to the ground supplied at the front contact and armature 8 of the ST3A relay 1705 so that W2A becomes operated. The W2A relay 1501, at its armature 1 and back contact, opens the lead from the K3 contact of the reader which previously operated the PX and PS3 relays so that this lead is now connected to said contact only when the RS1 relay 1800 operates. This circuit shunting the armature 1 and back contact of the W2A relay may be traced from conductor 2606 through the front contact and armature 1 of the RS1—3 relay 1800 to the P0 conductor leading to armature 2 of the WSP relay 1609. The APA relay 4804 closes a circuit from the K7 reader contact over the KM5 conductor 2007, the front contact and armature 2 of the APA relay 4804, conductor 4805, thence through a chain circuit starting at the back contact and armature 3 of the S9B relay 5300 and continuing to the armature 3 of the S1B relay 5201, the winding of the S0B relay 5200, the armature 6 and front contact of the APA relay 4804, and again through a chain circuit starting at the back contact and armature 2 of the S1A relay 5202 and ending on the armature 2 of the S9A relay 5302 to the front contact and armature 3 of the APA relay 4804. The S0B relay operates in this circuit and locks to a battery supply independent of the chain circuit through the S1A to S9A relays, inclusive. The operation of the APA relay 4804 closes a circuit from the H8 reader contact, through the front contact and armature 6 of the RCD relay 2001, over the HB2A conductor 2008, the front contact and armature 5 of the APA relay 4804 to the winding of the APC relay 4800. The latter relay locks in a circuit from the H1 reader contact, the front contact and armature 2 of the RCD relay 2001, the GHA conductor 2009, the armature 7 and front contact and the winding of the APC relay 4800. Ground is also supplied from the front contact and armature 7 of the LK1 relay 2800, the armature 1 and back contact of the LLA relay 2803, to GHA conductor 2009 so that the locking circuit of the APC relay does not at this time depend on the reader contact H1. Through the operation of the APC relay, conductor 1712 which extended through armature 10 and back contact of the APC relay 4800 to the winding of the A2 relay 2902 is now opened and, instead, a connection is established from armature 9 and front contact of the APC relay 4800 to the winding of the A2S relay 4806 whereby the A2S relay instead of the A2 relay operates in the next closed period. The lead used for the operation of the RS1—3 relay 1800, known as the RSO lead, is connected to the front contact and armature 4 of the APC relay 4800 so that by the operation of the APC relay at this time, this particular path to the RS1 relay is opened for purposes which will be explained more fully hereinafter. The operation of the APC relay operates the APD relay in a circuit from ground, armature 3 and front contact of the S0B relay 5200, and armature 6 and front contact of the APC relay. When the APD relay operates, it releases the APA relay 4804 and it locks it turn to the armature 5 and front contact of the APC relay 4800. Upon the operation of the APC relay, the RSO (reader step odd) lead 4807 and the RSE (reader step even) lead 4808 are both connected through armatures 2 and 3, respectively, of the APC relay 4800 to armature 2 of the APD relay 4803 and thence to the winding of the SS relay 4802. The purpose and utility of this connection will be described shortly. A circuit is now established from armature 10 and back contact of the WS1A—C relay 4301, the front contact and armature 6 of the ME relay 4903, the TTM conductor to armature 6 and front contact of the APD relay 4803, over conductor 4809 to the winding of the TTM relay 3709, and this relay locks through its front contact and armature 2 to the TTML conductor, back contact and armature 3 of the WSP relay 1609, over the WL conductor deriving ground at armature 3 and front contact of the TIS relay 2602. Operation of the TTM relay starts the long timer.

At the beginning of the next closed period of the reader the A2S relay 4806 operates over the path previously used to operate the A2 relay 2902. Thereupon a circuit is closed from the H2 reader contact over the HM2 conductor 2010, armature 1 and front contact of the A2S relay 4806, the HM2A conductor to the armature 5 and back contact of the WS1A relay 4301 and thence over a chain circuit including the armature 2 and back contact of the S—B relays, such as the S9B relay 5300, to the armature 1 and back contact of the S0B relay 5200 and thence through the winding of the S1A relay 5202. The S1A relay operates and locks in a circuit from ground, armature 5 and front contact of the LK1 relay 2800, armature 1 and back contact of the S9A relay 5302, and thence through a chain circuit of similar contacts to the armature 1 and front contact of the S1A relay 5202. The A2S relay 4806 also connects the reading check path described earlier in this section from the conductor 2908 through the back contact and armature 4 of the LK2 relay 2804, the CK2 conductor 2808, the armature 2 and front contact of the A2S relay 4806, the CK3 conductor through the armature 4 and back contact of the WS1A—C relay 4301, the CK3A conductor to the back contact of armature 5 of the S9B relay, and thence in a chain of similar contacts to the front contact and armature 4 of the S0B relay 5200, the P0 conductor 5203, to the winding of the PA0 perforator connector relay 5100, and thence to battery whereby the number 0 perforator is connected to the incoming leads. The twenty-eight magnets of the perforator 0 are now connected to their corresponding relays through the windings of the K— series checking relays shown in Figs. 39, 45 and 51. Those magnets, corresponding to the operated reading relays, are connected to perforating contacts on the reader, which are closed during the closed period of the reader. The A0 perforating magnet 5402 of the perforator is connected through the con-

nector relay and its KA0 series relay 3900 to the PA2 contact of the reader over the PA2 conductor 2011, armature 3 and front contact of the A2S relay 4806, the PA conductor 4810, the armature 1 and back contact of the WS1D relay 4302, the armature 2 and front contact of the WS2 relay 4300, the PA0 conductor 4303 to the winding of the KA0 relay 3900. Eleven perforating magnets operate to cause the perforation of the code 081010 on the output tape of the 0 perforator. The corresponding series relays KA0, KB1, KB7, etc. operate and the perforator register relay PDO also operates. A circuit for this last relay may be traced from ground, the H5 reader contact, the HM3 conductor 2012, the number 1 lower armature and front contact of the PA0 connector relay 5100, the PD0 conductor leading to the winding of the PD0 relay 5009 and thence to battery. This relay is not required when spreading lines on all output tapes and its locking circuit is open since no LN2 or LN5 relay is operated at this time. When the J make contacts on the reader close approximately 8 milliseconds after the start of the reader closed period, the PAM perforator advance magnet 5405 is operated through the PK0 series relay 5406 over the front contact and lower armature 2 of the PA0 relay 5100, the JM3 conductor, armature 18 and front contact of the RCD relay 2001 to ground supplied over the J5 contact of the reader. Operation of the PAM perforator advance magnet 5405 cocks the ratchet pawl but does not step the perforator drum.

11.6 PERFORATOR HOLD CHECK

In normal operation the perforating magnets are operated as described above, followed by the operation of the PAM magnet. If the perforating check lead is closed through, as it is when the proper perforating magnets operate as will be described hereinafter, the RS relays are operated to step the reader and advance the input record to the next line. At the end of the reader closed period, the perforating magnets release and shortly after that the PAM magnet 5405 releases, stepping the perforator. In the event that the perforating check lead is not closed because of failure of the proper magnets to be energized, a path is provided to hold the PAM magnet 5405 operated. If this were not done the perforator would step, and since the reader did not step, the same line would be perforated again on the output tape. This holding path is checked at the beginning of each run during the perforation of the first line of splice pattern. At the end of each run during the perforation of the code 2860XX, the check is brought into play by the PHK relay 5400 which operates from the PS3 relay 1612 at the beginning of the run and from the PS1 relay 1616 at the end of the run.

At the end of the reader closed period during which the first splice pattern code 081010 is perforated, the A2S relay 4806, the PA0 relay 5100, the perforating magnets and their series relays all release. Eight milliseconds later the reader J contact opens, but the PAM magnet 5405 and the PK0 relay 5406 do not release remaining locked through the back contact of the PHE relay 5407 through the winding of the CKA relay 5408 to the ground on the MON3 conductor, derived from the front contact and armature 6 of the MON relay 1703. The CKA relay 5408 operates and connects the CKB relay 5404 to the JB0 conductor, which derives ground through the J3 reader contact when said contact closes. The A2S relay 4806 and the connector relays operate again in the next reader closed period, reoperating the same perforator magnets and series relays and the PD0 relay 5000. The perforating check lead is now closed from ground at a front contact of the CKB relay over conductor 5403 through the armature 2 and front contact of the KA0 relay 3900, and thence through the one-out-of-three network provided by the left-hand armatures of the KA relays and thence in series through the two-out-of-five networks of the KB, KC, KD, KE and KF relays, conductor 5101, and thence in a chain circuit through back contacts and armatures of the PK9 relay 5409 to the PK1 relay 5410, and thence to the front contact and armature 2 of the PK0 relay 5406 through another chain circuit beginning at armature 5 and back contact of the PD9 relay 5001, through similar circuits controlled by the PD8 to PD1 relays, inclusive, thence through armature 4 and front contact and armature 2 and front contact of the PD0 relay 5000, the RS2 lead 4803, armature 3 and front contact of the APC relay 4300, armature 2 and front contact of the APD relay 4303 to the winding of the SS relay 4802. The SS relay, in operating through its armatures 1 and 2, places ground on the conductors leading to the windings of the PHE relay 5407 and the PH0 relay 5411. The PHE relay 5407 opens the locking circuit for the PAM magnet 5405 so that when the J make contact operates, the magnet will release. The SS relay 4802 locks over its armature 4 and front contact and the HB0 lead to the reader contact H3, and by applying ground through its front contact and armature 4 to conductor 4812, shunts the timing condenser 1410 connected to the upper winding of the timing relay 1404. At the end of the closed period the A2S relay 4806, the S0B relay 5200, the perforator connector relays, the PD0 relay 5000, the perforator magnets and their series relays all release. Shortly thereafter the PAM perforator advance magnet 5405, the PK0 relay 5406, the CKA relay 5408 and the CKB relay 5404 release. The SS relay 4802 remains locked until the end of the open period of the reader. The release of the PAM magnet 5405 steps the perforator.

11.7 SPREADING FIRST LINE OF SPLICE PATTERN ON ALL TAPES

During the open period of the reader, ground from a reader back contact H8, through the front contact and armature 6 of the RCD relay 2001, the HB2A conductor 2003, the back contact and armature 4 of the APA relay 4804, the armature 6 and front contact of the SS relay 4802, and thence through the chain circuit starting at armature 2 and back contact of the S9A relay 5302, is extended through the armature 2 and front contact of the S1A relay 5202 to cause the operation of the S1B relay 5201. The S1B relay locks to a reader make contact reached over its armature 4 and front contact and armature 2 and front contact of the APA relay 4804, or through armature 5 and back contact of the SS relay 4802, conductor 1804, armature 6 and back contact of the RS1—3 relay 1800, to the ground supplied by armature 2 and front contact of the ST3A relay 1705. The S1B relay 5201 prepares the operating path for the S2A relay 5204 and the operating path for the connector relays for perforator 1. At the start of the next reader closed period the SS relay 4802 releases and the A2S relay 4806 and the S2A relay 5204 operate. The A2S relay 4806 now operates the PA1 relay 5102 in the same manner as hereinabove described in connection with the PA0 relay 5100. The per-

forator hold check again operates so that two reader cycles are used to perforate 081010 on output tape 1. The operation is the same as for perforator 0 except that the PAM magnet 5412 of the perforator operates in series with the PK1 relay 5410, and locks through the PH0 relay 5411 instead of the PHE relay 5407. The SS relay 4802 is operated at the end of the second cycle over the RSO lead instead of the RSE lead. The same K— series checking relays are used for all perforators. At the end of the second closed period the SS relay 4802 is again operated and the S2B relay 5205 operates. The circuit continues in this manner, perforating the code 081010 on each of the ten output tapes, taking two reader cycles for each perforator.

11.8 PERFORATING REMAINING SPLICE LINES.

When the A2S relay 4806 operates at the start of the first reader closed period for perforating the first 081010 on tape 9, ground from the reader contact H2 is extended through conductor 2010, armature 1 and back contact of the A2S relay 4806, back contact and armature 5 of the WS1A relay 4301, armature 1 and back contact of the S9B relay 5300, conductor 5303, the front contact and armature 10 of the APC relay 4800, the LL conductor 4813 to the winding of the LLA relay 2803. This relay locks to ground provided at armature 7 and front contact of the LK1 relay 2800. During the second reader closed period for perforator 9, the closure of the perforating check lead, instead of being extended over the armature 3 and back contact of the PD9 relay 5001 to operate the SS relay 4802, is extended instead over the armature 3 and front contact of the PD9 relay 5001, conductor 5002, the armature 8 and back contact of the WS1A relay 4309 to the RS0 conductor 4304 leading directly to the winding of the RS1—3 relay 1800. The RS1 relay operates and grounds a lead to the step magnet of the reader and, through its armature 5 and front contact, grounds a lead which would ordinarily extend to the step magnet, but this lead is held open at the back contact and armature 8 of the TIS relay 2602 so that the reader does not step. The RS1 relay locks itself to the reader back contact H3, the RS1—3 relay 1800 shunts down the timing condensers connected to the TM relay, attempts to shunt down the RSR relay by closing its armature 3 and front contact, and causes the operation of the PH0 relay 5411 over a circuit extending from ground, armature 16 and front contact of the RS1—3 relay 1800, over the PH0 lead 1806 to the winding of relay PH0. With the LLA relay 2803 and the RS1—3 relay 1800 operated, the APC relay 4800, the LK1 relay 2800 and the S9B relay 5300 are locked only to the reader make contacts, their other locking paths having been opened. At the end of the second closed period for perforator 9 the following relays release: the A2S relay 4806, the PA9 relay 5103, the perforating magnets for the perforator 9, the LLA relay 2803, the LK1 relay 2800, the PS3 relay 1612 and the S9B relay 5300. The release of the APC relay 4800 opens the circuit for the APD relay 4803 and the release of the LK1 relay 2800 drops the S9A relay 5302. The release of the APD relay 4803 drops the TTM relay 3709, the release of the PS3 relay 1612 opens the circuit for the PHK relay 5400 and the C, D, E and F reading relays which it had operated. The PAM magnet for the perforator 9, the PK9 relay 5409 and the CKA relay 5408 release shortly after the end of the closed period when reader contact J1 opens. The CKA relay releases the CKB relay 5404. At the start of the open period of the reader, ground from reader contact K3 is extended over the front contact and armature 8 of the RCD relay 2001, the conductor 2003, the front contact and armature 4 of the TIS relay 2602, the conductor 2606, armature 1 and front contact of the RS1—3 relay 1800, the P0 conductor leading to armature 2 and front contact of the WSP relay 1609, the front contact and armature 2 of the W2A relay 1501 to the winding of the PS2 relay 1613, which relay operates and locks to a circuit from ground, armature 8 and front contact of the TE relay 3702, armature 9 and front contact of the WS2 relay 4300, conductor 4305, thence through the armature 7 and front contact of the PS2 relay 1613. The RS1—3 relay 1800 remains locked up until the end of the open period. The PS2 relay 1613 reopens the reading relays C0, C1, D4, D7, E0, E1, F4 and F7. When the reader closed period starts, the A2 relay 2002 operates since the APC relay 4800 has released. The reading check path is closed through the A2 relay and the other reading relays and operates the APA relay 4804 as described in section 11.5. The A2 relay also operates the LK1 relay 2800, and the APA relay 4804 operates the S0B relay 5200 as described in section 11.5. During the open period of the reader the APC and APD relays operate and the APD relay 4803 operates the TTM relay 3709. On the following closed period the A2S relay 4806 operates instead of the A2 relay 2002 as hereinbefore described. This operates the connector relay for perforator 0 and the code 081010 is perforated again on the output tape but with the PHK relay 5400 released, only one cycle is required for each perforator. Ground from a back contact of the PHK relay 5400 replaces ground from a front contact of the CKB relay which was previously applied to the conductor 5403 the beginning of the perforating check lead. This lead is, therefore, grounded as soon as the perforating magnet series relays operate, operating the SS relay 4802. The SS relay operates the PHE relay 5407, and the PH0 relay 5411 opening the holding path for the PAM magnet so that the latter releases, stepping the perforator after one closed period. The circuit walks from one perforator to the next in the same manner as when perforating the first line of the code 081010 except that it now takes only one cycle per perforator instead of two. When the circuit reaches perforator 9, the RS1—3 relay 1800 operates instead of the SS relay 4802, and the LLA relay 2803 operates releasing the LK1 relay 2800 and the APC relay 4800. The circuit then repeats walking across all ten perforators, again perforating a third line of the code 081010 on each one. This operation continues until the operator releases the end-of-tape key 3208.

11.9 COMPLETION OF SPLICE ON OUTPUT TAPES

When sufficient splice pattern has been perforated on the output tapes and the operator releases the end-of-tape key, the PSP relay 3700 is thereby released. Release of this relay opens the operating circuit for the TE relay 3702, leaving it temporarily locked to the ST3A relay 1705. At this time a circuit is established from ground, armature 6 and front contact of the TE relay 3702, the armature 5 and back contact of the PSP relay 3700, to the winding of the SPA relay 1715 which thereupon locks through its armature 2 and front contact to the MON3 conductor, deriving ground over the front contact and armature 9 of the MON relay 1703. Perforation of

splice pattern continues until a line has been spread across all perforators. The RS1—3 relay 1800 operates at the end of this line as previously described. In the open period of the reader following the operation of the RS1—3 relay, the RLS relay 1710 is operated from ground supplied over the H8 reader contact, the front contact and armature 6 of the RCD relay, conductor 2008, armature 12 and front contact of the RS1—3 relay, conductor 1807, the armature 5 and front contact of the PS2 relay 1613, the RL conductor leading to the front contact and armature 3 of TE relay 3702 through the armature 2 and back contact of the PSP relay 3700, the armature 3 and back contact of the PT1 relay 3710, the front contact and armature 4 of the TE relay 3702, the RLS conductor leading directly to the winding of the RLS relay 1710. RLS relay locks to ground supplied over the front contact and armature 1 of the RCD relay 2001 connected to the RLSL conductor 2014. The operation of the RLS relay 1710 releases the ST1 relay 1707, the ST2 relay 1709, the ST3 relay 1702 and the ST3A relay 1705. The ST3A relay removes battery from the TM relay 1404 and the release of the ST1 and ST3 relays releases the RCD relay 2001 and the TE relay 3702. When the RCD relay releases, it opens the holding circuit for the RLS relay 1710 and releases the TIS relay 2602. With the release of the starting relays and the TIS relay, all the relays in the circuit are now released except those associated with the motor starting function and the master off-normal relay 1703, the SPA relay 1715 and the RSR relay 1402.

12. READING AND CHECKING TAPE IDENTITY ON INPUT TAPE

12.01 START

After the splice pattern codes have been perforated at the beginning of all output tapes, the machine start key 2307 is operated momentarily. This key is effective only if the motor is running, the RS relays 1800 and 1801 are released, the LK1 relay 2800 is released and no perforator has its window detecting contact (such as the contact 4514) closed. Ground from the reader contact H8 over conductor 2000, armature 7 and back contact of the RS2—4 relay 1801, armature 10 and back contact of the RS1—3 relay 1800, the ST conductor to the back contact and armature 1 of the LK relay 2800, thence over the conductor 2801, through the contacts of the machine start key 3207, conductor 3212, armature 5 and back contact of the WSB relay 4902, conductor 4908, front contact and armature 1 of the SPA relay 1712, armature 2 and back contact of the ST2 relay 1709 and thence over the circuit hereinbefore traced to the winding of the ST1 relay 1707, will result in the operation of the latter relay. This makes the reader step key 3210 ineffective, operates the RCA—B—C relay 1902 through the back contact and armature 4 of the ME relay 4903, operates the RCD relay 2001 directly, shunts the contact on the machine start key 2307 which operated ST1 by extending a connection from conductor 2801 through its front contact and armature 6 directly to the armature 2 of the ST2 relay 1709, and applies ground through its armature 7 and front contact to the winding of the ST2 relay in the manner hereinbefore disclosed. The ST2 relay 1709 remains shunted until the end of the reader open period when the H8 contact opens the circuit of the ST2 relay 1709, then prepares operating and locking paths for the ST3 relay.

The operation of the reader connector relay 1902 connects the B, C, D, E and F digit reading relays to the reading contacts of the reader. and certain of these relays operate during each reader closed period and release during each open period. The A digit reading relays do not operate in the first closed period since the ST3 relay 1702 has not as yet been operated. The ST3 relay responds to the next closure of the H8 contact in the circuit hereinbefore described and causes the operation of the ST3A relay 1705. The ST3 relay locks from ground through armature 2 and front contact of the MON relay 1703, the armature 1 and front contact of the ST2 relay 1709, the armature 1 and back contact of the RLS relay 1710. The operation of the ST3 relay connects the A digit reading relays to the reader. In the next closed period, the reading relays for all digits operate in accordance with the values thereof on the input tape. The first portion of the input tape consists of splice pattern codes 081010 operating reading relays A0, B1, B7, C0, C1, D4, D7, E0, E1, F4 and F7. Ground over the reading check path is extended from conductor 2908, over the back contact and armature 7 of the A2 reading relay 2902, the back contact and armature 7 of the A1 reading relay 2901 and the front contact and armature 7 of the A0 reading relay 2900, thence over the AD0 conductor to the armature 5 and back contact of the 28B relay 3102, thence over the STT conductor 3104, the armature 8 and back contact of the TIC relay 3400, the STT conductor 3401 to the winding of the STT relay 2700, whereby this relay operated. The back contact of the 28B relay 3102 is open during tape identity checking and, therefore, prevents the STT relay from operating during such tape identity checking and perforating and during normal splice skipping, the back contact of the TIC relay 3400 preventing it from operating during call entries. The STT relay 2700 locks from ground, armature 6 and front contact of the ST3A relay 1705, conductor 1716, armature 3 and back contact of the 28C relay 3100, the STTL conductor 3105, the armature 3 and front contact of the STT relay 2700 and thence through the winding thereof to battery. The operation of the STT relay operates the SK2 relay 2701 in an obvious path from its armature 1 and front contact. The STT relay also closes a connection through its front contact and armature 2 over the 28X conductor through the back contact and armature 2 of the 28C relay 3100 to the winding of the 28A relay 3106 to cause the operation of this latter relay. The operation of the 28A relay 3106 operates the 28B relay 3102 directly and connects the winding of the 28C relay 3100 through its front contact and armature 2 over the KB2 lead to the K8 reader contact which is open at this time. The 28A relay 3106 locks through its front contact and armature 1 to the HB9 lead controlled by the H3 reader contact. The 28B relay 3102 performs no functions at this time. The RS2—4 relay 1801 is operated by ground from the J7 reader contact over the JM5 conductor 2015, the normal contacts of armature 4 of the ESK relay 2702, the SK conductor 2703, the back contact and armature 7 of the AL relay 1400, the back contact and armature 1 of the LIT relay 3402, the back contact and armature 1 of the LIUA relay 3403, the back contact and armature 2 of the LI relay 3404, the SK conductor 3405, the armature 4 and back contact of the SKW relay 2704, and now through the armature 5 and front contact of the SK2 relay 2701 to the RSE conductor 4305 leading to the winding of the RS2—4 reader step relay 1801. A circuit for shunting the RSR relay 1402 extends

from ground, the armature 9 and front contact of the ST3A relay 1705, the armature 4 and back contact of the PM1 relay 3711, the armature 1 and front contact of the RS2—4 relay 1801, the armature 3 and back contact of the SK2 relay 2701 to the battery terminal of the slow-releasing RSR relay 1402. The operation of the SK2 relay 2701 at this time prevents the operation of the RS2—4 relay 1801 from shunting down the RSR relay 1402, cancelling a checking feature which is intended to block the circuit if the reader step relays fail to release, that is, if this shunting circuit is maintained over a longer period than the time it takes for the slow-releasing relay RSR to release. The SK2 relay 2701 locks in a circuit from ground, armature 9 and front contact of the ST3A relay 1705, the armature 1 and back contact of the ESK relay 1702 to the front contact and armature 4 of the SK2 relay 2701. Another locking circuit for the SK2 relay may be traced from ground, armature 9 and front contact of the ST3A relay 1705, the ON2 conductor 1714 through the back contact and armature 8 of the L1 relay 3404, the armature 7 and back contact of the L1UA relay 3403, the armature 7 and back contact of the L1T relay 3402, over the SK2L conductor 3406, and thence either over the back contact and armature 4 of the T1C relay 3400 to the SKWS conductor, or the armature 1 and back contact of the SKWS relay 2704 to the SKWS conductor leading to the front contact and armature 4 of the SK2 relay 2701.

12.02 SKIPPING SPLICE

In each reader closed period the J1 reader contact operates the RS2—4 relay 1801 over a circuit hereinabove described. This operates the step magnet of the reader. As long as the RS2—4 relay completes operating, the step magnet advances the reader drum one line each cycle. In this way all the splice lines are skipped at the start of the input tape. At the start of the open period following the operation of the 28A and 28B relays, the 28C relay 3100 operates. The 28C relay locks over the armature 9 and front contact of the SK2 relay and also extends this locking ground over its front contact and armature 6, the armature 1 and back contact of the MT1 relay 2610 to the winding of the 28B relay 3102. The operation of the 28C relay 3100 also opens the locking circuit for the STT relay 2700. This relay also closes a circuit from ground, armature 6 and front contact of the ST3A relay 1705, conductor 1716, the armature 4 and front contact of the PCA relay 3107, and opens the operating path of the 28A relay 3106 which thereupon releases at the end of the open period. The PCA relay 3107 locks through the normally closed contacts of armature 1 of the PCA relay 3108.

12.03 END OF SPLICE

The splice pattern is followed by the first tape identity line 2891XX at the start of a tape. Under some conditions when a window has been encountered, the splice pattern is followed by the window splice code 287020. Therefore, the appearance of a 2 in the A digit is the signal to stop skipping. The operation of the A2 reading relay operates the end of skip ESK relay 2702 from ground, front contact and armature 9 of the A2 relay over the ESK conductor leading through the front contact and armature 10 of the SK2 relay 2701 to the winding of the ESK relay 2702. Relay ESK, when operated, locks to ground at the front contact and armature 11 of the SK2 relay and through its own armature 3 and front contact. The ESK relay opens the operating path for the RS2—4 reader step relay 1801 and the circuit stops skipping. It may be noted that the ESK relay is also operated by the E2, E4, E7, F0, F1 or F2 relay, no one of which is operated by a splice pattern code. Thus, in the event that the appearance of an A2 perforation fails to operate the ESK relay, the appearance of an E digit other than 1 or an F digit other than 0 will also operate the ESK relay. If, because of an irregular tape condition, a 1 in the A digit or any B digit other than 8 appears, the AL alarm relay 1400 will be operated to sound the alarm (see section 22). This also opens the operating path for the RS2—4 relay 1801 so that the circuit stops skipping. As a further safeguard against skipping too far the short-timer relay TM1404 (see section 21.1) is recycled each time a 0 is read in the A digit. If the timer is not recycled the AL alarm relay will be operated in approximately 0.25 second. This covers the time required to skip a splice between tapes when the reading pins may not penetrate the tape. The circuit for recycling the timer is from ground, front contact and armature 9 of the A0 relay 2900, over the A0G conductor, armature 5 and back contact of the SK1 relay 2704, armature 7 and front contact of the SK2 relay 2701, armature 4 and front contact of the RS2—4 relay 1801 to the TM conductor 4812 so that the condenser 1410 may be discharged sufficiently often to prevent the TM relay 1404 from operating. The operation of the TM4 relay upon the completion of the charge of the condenser 1410 will be described in detail hereinafter.

12.04 CHECKING TAPE INDEX

The first line of tape identity is 2891XX in which the E and F digits indicate the tape index of the input tape. These digits are checked against the Tape Type and Sort switches. There are three methods used to check tape index depending upon the tape index and the sort. The following table lists all the possible combinations and shows in which of the three following sections each combination is described.

Input Tape	Sort	Tape Index	Section
MU tape alone	1 TH	11	12.041
Do	U	11	12.043
Do	U	12	12.041
Do	T	13	12.041
Do	H	14	12.041
Do	2 TH	15	12.041
Do	Office	10	12.041
Summary tape alone	U	17	12.041
MU and summary tapes	U	11 and 17	12.042
Do	U	12 and 17	12.042
Do	T	13 and 18	12.042
Toll tape	Office	20	12.041
Do	1 TH	21	12.041
Do	U	21	12.043
Do	U	22	12.041
Do	T	23	12.041
Do	H	24	12.041
Do	2 TH	25	12.041
MU detail tape	Office	30	12.041
Do	1 TH	31	12.041
Do	U	31	12.043
Do	U	32	12.041
Do	T	33	12.041
Do	H	34	12.041
Do	2 TH	35	12.041
Observing tape	Office	40	12.041
Do	1 TH	41	12.041
Do	U	41	12.043
Do	U	42	12.041
Do	T	43	12.041
Do	H	44	12.041
Do	2 TH	45	12.041

12.041

When the A2 relay operates on the 2891XX line it operates the ESK relay 2702 as described

above, and operates the LK1 relay 2800, over the following path: ground provided by the H6 reader contact, the front contact and armature 3 of the RCD relay 2901, the HN4 conductor through armature 3 and back contact of the A0 relay 2900, the front contact and armature 4 of the A2 relay 2902, the armature 3 and back contact of the A1 relay 2901, the LK1 conductor 2905, front contact and armature 7 of the 28C relay 3100, conductor 3101 to the winding of the LK1 relay 2800. This relay operates and locks through the armature 6 and back contact of the LLA relay 2803 as before described. As soon as the reading relays operate, the L1 relay is operated through the reading relay check path hereinbefore described. The ground originates either at reader contact G1 through the RKA relay 1810 or at the reader contact G2 through the RKB relay 1809 (the operation of these relays will be described in section 25) and is extended through the circuit described to the CKB conductor 2908, through the back contact and armature 4 of the LK2 relay 2804, thence through a front contact and armature 6 of the A2 relay, a back contact and armature 5 of the A1 relay, a back contact and armature 5 of the A0 relay to the conductor 2907 where the path divides, the branch used depending upon the tape index of the tape being handled. For message unit, summary or combinations of the two, the path continues through the MUS, MUAS or the MU relay to the conductor 3305, through closed armatures of the B7 and B1 relays and a back contact of the B4 relay to the conductor 2909, thence through one of the armatures of the MU, MUAS or MUS relays to the conductor 3306 leading to armature 2 of the ME relay 4903. For toll, message unit detail and observing tapes where no call entries start with 2 in the A digit, it is not necessary to read the B digit. Hence the path continues from the A0 relay, over conductor 2907, through an armature and front contact of either the CBS or DET relays, directly to the conductor 3306. From the armature 2 of the ME relay the path may be traced over the back contact thereof, conductor 4909, front contact and armature 1 of the 28C relay 3100, front contact and armature 1 of the 28B relay 3102, the CC conductor, armature 4 and front contact of the C7 relay 3001, armature 9 and front contact of the C2 relay 3002, the CD9 conductor 3003, the back contact and armature 4 of the PX relay 1500, the CD8 conductor 1505, the front contact and armature 9 of the 28B relay 3102, the DC conductor which will enter the network of armatures and contacts controlled by the D reading relays. Since the D digit must be 1, the path will come out on the DD1 conductor, thence over the front contact and armature 4 of the 28B relay 3102, the DD1 conductor, armature 4 and back contact of the CL8 relay 3500 and in a series circuit through the armatures and back contacts of the CL6, CL5, CL2 and CL1 relays, through an armature and contact of some one of the tape index connector relays in Fig. 33 to the the L1 conductor leading directly to the winding of the L1 relay 3404. The L1 relay, in operating, locks to the DD1 conductor and releases the SK2 relay 2701 by the movement of its armature 8, thus breaking the circuit from the off-normal to ground on conductor 1714. The release of the SK2 relay releases the ESK relay by removing ground from the armature 11 of the SK2 relay 2701. The RS1—3 relay 1800 is operated if the tape index perforated on the input tape agrees with the setting of the tape type and the sort switches, the path being as follows: Ground at armature 5 and front contact of the L1 relay 3404, the FC conductor 3407, armature 8 and front contact of the 28B relay 3102, the FC conductor 3110, thence out on one of the decimal leads (assuming the tape type switch to be set for MU and the sort switch to be set for hundreds, then the incoming tape must be a number 14 so that this F digit will be 4), the FD4 lead through the sort switch arm 4000 set on its number 6 contact (sort by hundreds), the UB conductor 4001, armature 1 and back contact of the MUS relay 3304, armature 3 and front contact of the L1 relay 3404, the TT conductor 3408, the tape type switch arm 4002 (set on its number 4 contact MU), the ED1 conductor 4003 through the network controlled by the E digit reading relays (set to represent the value 1), out on the EC conductor, through armature 7 and front contact of the 28B relay 3102, the EC conductor 3111, the front contact and armature 4 of the L1 relay 3404, the RSO conductor 4304 to the winding of the RS1—3 reader step relay 1800. The connection between the tape type switch and the E reading relays is such that the tens digit of the tape type index E must be 1 for message unit or summary, 2 for toll, 3 for message unit detail and 4 for observing. The connection between the sort switch and the F digit reading relays is such that the units digit of tape index F must be 0 for office sort, 1 for first thousands sort, 3 for tens sort, 4 for hundreds sort, 5 for second thousands sort, while for units sort it must be 2 for message unit, toll, message unit detail and observing tapes and 7 for summary tapes (for message unit and summary tapes combined see section 12.042). When checking a 17 type tape alone in units sort, the RS1—3 relay 1800 will be operated in a circuit through contacts controlled by the L1 and 28B relays both operated, the F digit reading relays, the MUS relay operated, the Sort switch again through the MUS relay and the L1 relay operated, the E digit reading relays, the 28B relay and the L1 relay operated in a path similar to that just described. The RS1—3 relay 1800 locks over the reader open period causing the reader to step. The RS1—3 relay 1800, through its armature 15 and front contact, places a ground on the RSG lead which may be traced to armature 6 and front contact of L1 relay 3404 and thence through the winding of the CL1 relay 3409 causing the operation of this latter relay. Upon operation, the CL1 relay 3409 extends ground through its armature 7 and front contact to the TI conductor 3410 leading to the winding of the TI relay 2200 which operates and locks over its armature 2 and front contact and through armature 9 and front contact of the 28C relay 3100. The CL1 relay 3409 locks itself in a chain circuit starting with its armature 2 and front contact and leading through the back contact and armatures of the CL2, CL5, CL6 and CL8 relays to the CLL conductor 3501, through the back contact and armature 2 of the PX relay 1500, and over the CLL conductor which derives ground from armature 3 and front contact of the 28C relay 3100. The CL1 relay also opens the operating path for the L1 relay at its armature 3 and prepares a path for the operation of the L2 relay 3411 at its armature 1. The L1 relay 3404 releases at the end of the closed period of the reader, at which time the reading relays also release. If the SK2 relay 2701 fails to release when the L1 relay 3404 operates, the operation of the CL1 relay 3409 will complete a circuit for

the AL alarm relay from ground, front contact and armature 6 of the CLI relay 3409, over the SKAL conductor to armature 1 and front contact of the SK2 relay, the AL conductor leading to the winding of the AL relay 1400. Thus the alarm relay AL will operate and bring in an alarm.

12.042

This section describes the tape index check for message unit tapes combined with summary tapes in units or tens sort. When the reading relays operate, the ESK relay 2702 and the LKI relay 2800 are operated as previously described. Instead of the LI relay 3404, either the LIUA relay 3403 or the LIT relay 3402 operates as follows: The same path is followed as described in 12.041 until a connection common to all the relays of the tape index connector is reached. When, instead of being extended as hereinbefore described through armature 3 and front contact of the MU relay 3302 to the LI conductor leading to the LI relay 3405, it is now extended through the armature 4 and front contact of the MUAS relay 3303 to the LIB conductor 3306 leading to the armatures 1 of both the U relay 3600 and the T relay 3601 so that if this is a "sort by units" the circuit is extended to the winding of the LIUA relay 3403, and if this is a "sort by tens" then the circuit is extended to the winding of the LIT relay 3402. The LIUA or the LIT relay releases the SK2 relay 2701 in the same manner as before (note the series circuit through armatures 7 of the LIT and LIUA relays and armature 8 of the LI relay). The release of the SK2 relay 2701 is followed by the release of the ESK relay as heretofore. Either the LIUA relay 3403 or the LIT relay 3402 locks through its armature 6 and front contact to the operating conductor. Two cycles of the reader are required for checking tape index under the conditions of this section. The first input tape on units sort is either tape index 11 or 12. The first tape on tens sort is 13. Therefore, one of the three relays, the 11A relay 2500, the 12A relay 2400 or the 13A relay 2501 is operated during the first cycle. Assuming, by way of example, that this is to be a units sort and that the tape is index 12, a circuit may be traced from ground, the armature 4 and front contact of the LIUA relay 3403, the FC conductor 3407, the front contact and armature 8 of the 28B relay 3102, the FC relay 3110, through the network controlled by the F relays which now must express the digit 2 through the operation of the F0 and F2 relays, over the FD2 conductor 3004, armature 9 and front contact of the LIUA relay 3403, the FD2A conductor, the armature 8 and back contact of the 17B relay 2402, the armature 6 and back contact of the 11B relay 2502, the armature 6 and back contact of the 12B relay 2401 and thence through the winding of the 12A relay 2400, thus responding to the registration of the digit 2 in the F reading relays. The circuits for the 11A and 13A relays may be traced in a similar manner. The 12A relay, in operating, locks in a circuit from ground, armature 6 and front contact of the ST3A relay 1705, over the ONI conductor 1716, the back contact and armature 5 of the CLI relay 3409, the ONIA conductor leading to the armature 2 of the 12A relay 2400 whereby this relay becomes locked. Upon its operation, the 12A relay 2400 establishes a circuit from the K8 reader contact over the KB2 conductor 2016, the armature 1 and front contact of the 12A relay 2400 to the winding of the 12B relay 2401 so that this latter relay operates during the reader closed period locking to off-normal ground from the MON relay (armature 4 and front contact of the MON relay 1703, the MON6 conductor leading to armature 2 of the 12B relay 2401).

When the second reader closed period begins, the reading relays again operate, and a path is now closed to operate the RSI—3 relay 1800. The operating circuit traces from ground on the armature 4 and front contact of the LIUA relay 3403, conductor 3407, the armature 8 and front contact of the 28B relay 3102, the FC conductor 3110 through the network provided by the F digit reading relays to the FD2 conductor 3004 (we are assuming that the tape index is 12), the armature 9 and front contact of the LIUA relay 3403, the FD2A conductor to armature 4 of the 12B relay 2401, thence through its front contact over the TTU conductor to the front contact and armature 2 of the LIUA relay 3403, the TT conductor 3405 to the first switch arm 4002 of the tape type switch (which we will assume is set on its MUAS contact), the number 3 contact thereof, over the EDI conductor 4003, through the network provided by the E digit reading relays (expressing the digit 1) to the EC conductor leading through the front contact and armature 7 of the 28B relay 3102, thence over conductor 3111, the front contact and armature 3 of the LIUA relay 3403 to the RSO conductor 4304 leading to the winding of the RSI—3 relay 1800. Similar circuits will be closed when either the 11B or 13B relay is operated to cause the reader to step during this second closed period. The RSI—3 relay causes the operation of the CLI relay 3409 (as hereinbefore described) which then operates the TI relay 2200. The TI relay locks to the 28C relay 3100 and the CLI relay locks through the CL2 to CL8 relays and the PX relay to the 28C relay 3100. The CLI relay opens the operating path for the LIUA relay 3403 and prepares the operating path for the LU relay 3411. The LIUA relay 3403 or the LIT relay 3402 releases at the end of the closed period at which time the reading relays also release. If the SK2 relay 2701 fails to release when the LIUA or the LIT relay operates, the operation of the CKI relay 3409 operates the AL alarm relay 1400 through the SK2 relay 2701 and brings in the alarm.

12.043

This section describes the tape index check on units sort for tapes 11, 21, 31 and 41. Two cycles are required in these cases in order to operate the XIB relay 2403 to cancel thousands check on these tapes. During the first reader closed period the LI relay 3404 is operated and the SK2 relay 2701 and the ESK relay 2702 are released as described in section 12.041. Ground is extended through the armatures of the LI relay 3404 and the 28B relay 3102, thence through the F digit reading relays (the F digit expresses the value 1), through the armatures of the U relay 3600 and the LI relay 3404, the armature 6 and back contact of the XIB relay 2403 to the winding of the XIA relay 2404 which operates and locks in the manner hereinbefore described in connection with the 12A relay 2400. The XIB relay 2403 then operates during the following open period of the reader. On the second closed period the RSI—3 relay operates in a circuit similar to that hereinbefore traced from a ground starting at the armature 5 and front contact of the LI relay 3404 and finally ending on conductor 4304 to the winding of the RSI—3

relay 1800. The E digit relays are connected to the Tape Type switch so that the E digit must be 1 for message unit, 2 for toll, 3 for message unit detail and 4 for observing. The reader steps and the CL1 relay 3409 is operated and locked as described before. The CL1 relay releases the X1A relay 2404. If the SK2 relay 2701 fails to release when the L1 relay operates, the operation of the CL1 relay 3409 operates the AL relay 1400 and brings in an alarm.

12.05 CHECKING MARKER GROUP

The second line of tape identity is 2892XX in which the E and F digits indicate the marker group. These digits are checked against the Marker Group Tens and Marker Group Units switches for all tapes on all sorts. Ground over the reading check lead through the armatures of the A, B, C and D digit reading relays and the CL1 relay 3409 operates the L2 relay 3411 during the reader closed period. This is a circuit similar to that heretofore traced for the operation of the L1 relay 3404 but differs from it in that the checking path issues from the DD2 lead (this is the second line of tape identity and the D digit must express the value 2) which will be seen is connected to the front contact of armature 1 of the CL1 relay 3409 leading directly to the winding of the L2 relay 3411 which thereupon locks directly to the DD2 conductor. The ground for operating the reader step RS1—3 relay 1800 may be traced in this instance from ground, armature 3 and front contact of the L2 relay 3411, conductor 3407, armature 8 and front contact of the 28C relay 3102, the FC conductor 3110 through the F digit reading relays (and assuming the marker group to be 45), then out over the FD5 lead, the number 7 contact associated with the Marker Group Units switch 4200, the MGU lead over the front contact and armature 1 of the L2 relay 3411, the MGT lead to the switch arm 4201 (now assumed to be placed on its number 6 terminal), over the ED4 lead, out over the EC lead, the front contact and armature 7 of the 28B relay 3102, conductor 3111, front contact and armature 2 of the L2 relay to the RSO conductor 4304 leading to the winding of the RS1—3 relay 1800 to cause the operation of this relay and the consequent stepping of the reader. The Marker Group Tens and Marker Group Units switches must be set on the proper terminals to correspond with the expected reading of the E and F digit reading relays, and when so connected will check the digits expressed thereby and cause the proper operation of the reader step relay. The reader step relay 1800 steps the reader in the open period thereof and operates the CL2 relay 3412, thereby releasing the CL1 relay 3409. The CL2 relay 3412 locks to the ground formerly used for holding the CL1 relay 3409.

12.06 CHECKING FIRST RECORDER SWITCHES

The third line of tape identity is 2893XX in which the E and F digits indicate the number of the first recorder. This item is not checked on input tapes, but a check is made that the First Recorder switches (tens and units) are off-normal on office and first thousands sorts and in the Off position on all other sorts. Ground over the reading check lead may be traced from conductor 2908, through the back contact and armature 4 of the LK2 relay 2804, the CK2 lead 2808 through the front contact and armature 6 of the A2 relay 2902, the back contact and armature 5 of the A1 relay 2901, the back contact and the armature 5 of the A0 relay 2900, the AD2 conductor 2907, thence through an armature and front contact of either the MU relay 3302, the MUAS relay 3303 or the MUS relay 3304 to the BC conductor 3305, thence through the armature 4 and front contact of the B7 relay 2904, the front contact and armature 7 of the B1 relay 2903, the armature 8 and back contact of the B4 relay 2908, the BD conductor 2909 and again through one of the armatures and contacts controlled by the MU, the MUAS or the MUS relay to the 28X conductor 3306 or alternatively from the AD2 conductor 2907 through an armature and front contact of the OBS relay 3300 or the DET relay 3307 directly to the 28X conductor 3306 through the armature 2 and back contact of the ME relay 4903, conductor 4909, the front contact and armature 1 of the 28C relay 3100, the front contact and armature 1 of the 28B relay 3102, the CC conductor, armature 4 and front contact of the C7 relay 3001, armature 9 and front contact of the C2 relay 3002 (the C digit reading relays must express the value 9), conductor 3003, back contact and armature 3 of the PX relay 1500, conductor 1505, front contact and armature 9 of the 28B relay 3102, the DC conductor through the network controlled by the D reading relays (these relays must express the value 3) to the DD3 conductor, thence through either armature 5 and front contact of the FB relay 3602 or the FTH relay 3603 to the FRON conductor 3604 to the First Recorder Tens switch arm 4100 set on either its number 2 or number 3 terminals (positions 0 or 1, respectively), thence to the First Recorder Units switch arm 4101 set in any one of its terminals 0 to 9, over the FR conductor 4102, the front contact and armature 6 of the CL2 relay 3412 to the RSO lead 4304 to cause the operation of the RS1—3 relay 1800. The operation of the reader step relay 1800 steps the reader.

12.07 CHECKING LAST RECORDER SWITCHES

The fourth line of tape identity is 2894XX in which the E and F digits indicate the number of the last recorder. This item is not checked on input tapes but a check is made that the Last Recorder switches are off-normal on office and first thousands sorts and normal on all other sorts. Ground is now extended over a circuit similar to that traced under section 12.06 and which will be further extended over the LRON lead to the Last Recorder Tens switch arm 4202 set to express the digit 0 or 1, thence to the Last Recorder Units switch arm 4203 set to express any one of the digits 0 to 9, over the LR conductor 4204, thence through the front contact and armature 5 of the CL2 relay 3412 to the RSO lead 4304, to cause the operation of the reader step RS1—3 relay 1800. This steps the reader.

12.08 CHECKING OFFICE

The fifth line of tape identity is 2895X0 in which the E digit indicates the office. This item is checked on all sorts except office sort where a check is made that the Central Office switch is in the Off position. Ground over the reading check lead through the A, B, C and D digit reading relays, the DD5 lead (the D digit reading relays must express the value 5), armature 1 and front contact of the CL2 relay 3412, the winding of the L5 relay 3502 to cause the opera-

tion of this reader relay. Upon the operation of the L5 relay a circuit is established from ground, armature 1 and front contact thereof, over the OF lead to the Central Office switch arm 4103 set on any one of its contacts to express an office digit index 0 to 9 (let us assume that it is on its terminal 6 corresponding to the digit 4), thence over the ED4 lead through the network of the E digit reading relays which should now express the digit 4 to the EC conductor, over the front contact and armature 7 of the 28B relay 3102, conductor 3111, thence over the front contact and armature 2 of the L5 relay 3502 to the RS0 lead 4304 to operate the RS1—3 relay 1800 to step the reader. Alternately, the Central Office switch arm may be in its Off position, whereupon the circuit is traced from the switch arm 4103 to the central office sort position of the Sort switch where the switch arm 4004 extends the circuit directly over the RS0 lead 4304 to step the reader. Upon the operation of the RS1—3 relay 1800, ground is applied through armature 15 and front contact thereof to the RSG lead, thence over armature 3 and front contact of the L5 relay 3502 to the winding of the CL5 relay 3503 which thereupon operates. The CL5 relay causes the release of the CL2 relay 3412.

If the Tape Type switch is set on its number 2 terminal, that is, the first beyond the Off position and marked Summary, and the Sort switch is on its number 4 terminal, that is, the third beyond the Off position and which is marked Units, then arrangements are made for registering the office index, that is, the E digit of the line being read by the reader. Therefore, the ground for operating the L5 relay is extended over the L5 conductor 3415, armature 3 and front contact of the MUS relay 3304 (operated because the Tape Type switch is set in its summary position), over the RE conductor 3310 to the winding of the RE relay 3800. The RE relay extends the code conductors from the E reading relays to the windings of the RE–0, RE–1, RE–2, RE–4 and RE–7 relays so that when the PE reader contacts operate, the RE register relays will operate in exactly the same pattern in which the E reading relays are operated. Assuming the office digit to be 5, then the RE–1 relay 3801 and the RE–4 relay 3802 will become operated. A circuit is now established from ground, armature 1 and front contact of the MON relay 1703, conductor 1718, back contact and armature 1 of the L1 relay 3404, the L1 conductor 3416 to the armatures of each of the RE code relays used in their locking circuits. These code relays, therefore, lock under control of the L1 relay 3404 so that this register, now set during the reading of the fifth line of tape identity in the particular incoming tape type 17, will remain so locked until the tape identification codes are read another time, that is, when the next section of the incoming tape is encountered. At that time the operation of the L1 relay during the reading of the first line of tape identity will open the locking circuit of these register relays and, therefore, erase the record made thereon so that during the reading of the fifth line a new record may be established.

12.09 CHECKING THOUSANDS RANGE

The sixth line of tape identity is 2896XX in which the E and F digits indicate first and last thousands where required, or appear as 90 where first and last thousands information is not needed. The following table indicates on which tapes 90 or actually thousands are received:

F and L Thous.	90
10	
13 (from sorter)	11.
14	12.
15	1s (from computer).
18	17.
23, 33, 43	20, 30, 40.
24, 34, 44	2., 31, 41.
25, 35, 45	22, 32, 42.

Ground over the reading check lead through the A, B, C and D digit reading relays will be extended over the DD6 lead (the D digits must express the value 6), the armature 1 and front contact of the CL5 relay 3503 to the winding of the L6 relay 3504, whereby this relay now becomes operated. On office and first thousands sorts, all input tapes will have 90 for the first and last thousands digits, that is, in the E and F digit places, and the thousands first and thousands last switches will be in the Off position. The L6 relay, through its armature 4 and front contact, places a ground on conductor 3407 which is extended through armature 8 and front contact of the 28B relay 3102, the FC conductor 3110, through the armatures and contacts of the F relays (F digit=0), the FDO conductor, armature 7 and front contact of the L6 relay 3504, the FDA conductor, thence over the front contact and armature 7 of either the OFB relay 3602 or the FTH relay 3603, the THN conductor 3605, the Off position of the Thousands Last switch and the switch arm 4105, thence through the switch arm 4106 of the Thousands First switch in its Off position, thence over the ED9A conductor 4107, armature 1 and front contact of the L6 relay 3504, the ED9 conductor, through the armature and contact network of the E reading relays (the E digit must be the value 9), over the EC conductor, through the front contact and armature 7 of the 28B relay 3102, the EC conductor 3111, the front contact and armature 3 of the L6 relay 3504 to the RS0 lead 4304 leading to and causing the operation of the RS1—3 relay 1800. All units sort on input tapes will have 90 perforated on them, but the switches will be set to control the tape section count. In this case, the FDOA conductor leading from the front contact of armature 7 of the L6 relay 3504 will be extended by the armature 9 of the U relay 3600, or the armature 2 and front contact of the 13B relay 2503 to the THON conductor leading to all positions other than Off of the Thousands First switch controlled by the switch arm 4106, or through the front contact and armature 10 of the T relay 3601, over the FDOB conductor, the front contact and armature 1 of the MU relay 3302 to the THON conductor, thence over the switch arm 4106 set in any one of its positions other than Off, the switch arm 4105 of the Thousands Last switch set in any one of its positions other than Off, and thence over the ED9A conductor and the remainder of the circuit as previously traced to cause the operation of the reader step RS1—3 relay 1800. The actual switch settings are not checked at this time during tape section check. However, if the switches are not properly set, the circuit will block on failure of the tape section checking circuit. On tens sort of all tapes except tape 13 from the computer the tape will indicate first and last thousands and the switches will be off normal. In this case (and assuming first

thousands to be 5 and last thousands to be 9), the circuit is extended from the FD9 lead over the corresponding position of the Thousands Last switch, through the switch arm 4108, the LTH lead 4109, through armature 2 and front contact of the T relay 3601 to the front contact of armature 2 of the L5 relay 3504, or alternatively through armature 1 and front contact of the HATH relay 3606 to the front contact of armature 2 of the L6 relay, thence over the FTH lead to the switch arm 4110, now assumed to be set to express the digit 5, thence over the ED5 conductor, through the armatures of the E digit reading relays to the EC conductor, front contact and armature 6 of the 28B relay 3102, conductor 3111, thence over the front contact and armature 3 of the L6 relay 3504 to the RS0 conductor 4304 to cause the operation of the RS1—3 reader step relay 1800. In this case the E and F digits on the tape must agree with the setting of the Thousands First and Thousands Last switches, respectively. On tens sort of tape 13 from the computer the RS1—3 relay is operated over the circuit above traced through the T and MU relays with the Thousands First and Thousands Last set-up switches in any one of their positions other than Off. On hundreds and second thousands sorts, the L5 relay operates the RS1—3 reader step relay 1800 through the circuit described under control of the HATH (hundreds and thousands) relay 3606. Under any of the above conditions, the operation of the RS1—3 relay 1800 steps the reader and operates the CL6 relay over the armature 5 and front contact of the L6 relay. The CL6 relay 3506 now locks to the circuit hereinbefore used for the locking of the CL5 relay 3503. The operation of the CL6 relay 3506 releases the CL5 relay 3503.

12.10 STEPPING TAPE SECTION SELECTOR TO INITIAL POSITION

During the reader open period following the check of the 2896XX line, the tape section selector TD as shown in Fig. 23 is stepped off normal in those cases where its use is required. The selector, however, is never used on office and first thousands sort but is always used on tens, hundreds and second thousands sort. On units sort, it is not used for tape 11 alone or tapes 21, 31 and 41. It is used for tapes 12 alone, 17 alone and tapes 22, 32 and 42. When tapes 11 and 17 are processed together, the selector is used only for tape 17. When tapes 12 and 17 are processed together, the selector is used twice, once for tape 12 and then again, after resetting, for tape 17. If the selector is to be used, the FT1 relay 2304 is operated to step the selector from its normal position to its initial position. The circuit for the FT1 relay may be traced from ground on the reader contact K3, over the KB0 conductor 2016, thence through the armature 7 and front contact of the CL6 relay 3506, the FT1E conductor, over the armature 4 and back contact of the TIEA relay, to the FT1D conductor. The latter conductor is extended in a variety of ways to the FT1 conductor and may be traced, by way of example, through armature 2 and front contact of the U relay 3600, the FT1C conductor to the front contact and armature 8 of the MUS relay 3304 to the FT1 conductor (as when a tape 17 from the summarizer is being sorted in accordance with a units setting of the sort switch), to armature 3 and back contact of the FT2 relay 2305, thence through the winding of the FT1 relay 2304 to battery. The FT1 relay operates and locks in a circuit from ground, front contact and armature 6 of the CL6 relay, the FT1L conductor, armature 2 and back contact of the FT2 relay 2305, the armature 1 and front contact of the FT1 relay 2304 to the winding thereof. The FT1 relay 2304 is, therefore, operated during the reader open period since the K8 contact is closed at that time. On tens, hundreds and second thousands sorts, it is operated by ground from a reader back contact, through the CL6 relay operated, the TIEA relay 2600 normal, the T relay 3601 or the HATH relay 3606 operated, and the FT2 relay 2305 normal. On units sort of message tapes alone, toll, message unit detail or observing tapes, the path is from a reader contact K3, through the CL6 relay operated, the TIEA relay 2600 normal, the U relay 3600 operated, the MU relay 3302, the DET relay 3307 or the OBS relay 3300 operated, the X1B relay 2403 and the FT2 relay 2305 normal. The operation of the X1B relay 2403 for tapes 11, 21, 31 and 41 prevents the operation of the FT1 relay 2304 for these tapes. On units sort of the summary tape alone, the path is that just described in detail hereinabove. On units sort of tapes 12 and 17, the path is from the reader contact K3 through the CL6 relay 3506 operated, the TIEA relay 2600 normal, the U relay 3600 and the MUAS relay 3303 both operated, the 11B relay 2502 and the FT2 relay 2305 normal. The FT1 relay, therefore, operates for tapes 12 and 17 but not for tape 11 when it is to be followed by tape 17. If the FT1 relay operates, it locks through the FT2 relay 2305 in its normal position to the ground supplied by the armature 6 of the CL5 relay 3506. In the following reader closed period the ROT magnet 2306 of the selector TD is operated from ground supplied by the K5 reader contact, over the KM3 conductor 2004, armature 5 and front contact of the FT1 relay 2304, the back contact and armature 5 of the FT2 relay 2305, the back contact and armature 5 of the LTD relay 2307, conductor 2308, back contact and armature 3 of the ALA relay 1411, conductor 1412 to the winding of the ROT magnet 2306. The selector steps from normal position to its first terminal which corresponds to tape section 0, that is, both the arms 2302 and 2303 step from their Off or normal terminals in which they are shown onto their terminals marked 1. At the end of the closed period the rotary magnet 2306 releases. During the next closed period the selector takes another step unless the FT2 relay 2305 has operated. It continues to take one step for each reader cycle until stopped by the operation of the FT2 relay 2305. On tens, hundreds and second thousands sorts where the selector is always used to check tape sections 0 through 9, the FT2 relay 2305 operates when the selector reaches the position corresponding to tape digit 0 as follows: Ground is extended through the reader break contact K3 over the KB9 conductor 2017, the front contact and armature 3 of the FT1 relay, the back contact and armature 4 of the STD relay 2307, switch arm 2303, terminal 1 reached thereby, the 0 conductor and thence through either the front contact and armature 7 of the HATH relay 3606 or the front contact and armature 8 of the T relay 3601 to the FTD conductor leading through armature 2 and front contact of the FT1 relay 2304 to the winding of the FT2 relay 2305. On units sort the selector TD is used to check a

series of tape sections whose value and lower limits are determined by the setting of the Thousands First and Thousands Last switches. In this case, ground from reader contact K3 over the circuit just traced operates the FT2 relay. Thus, the selector TD is stopped in a position corresponding to the setting of the Thousands Frst switch. The FT2 relay 2305 releases the FT1 relay 2304 and locks itself through the back contact and armature 3 of the RTD relay 2308 to the MON3 conductor deriving ground from the front contact and armature 9 of the MON master off-normal relay 1703. The operation of the FT2 relay 2305 extends the EC lead connected to the winding of the LH relay 3507 through the back contact and armature 1 of the TDA relay 2309, the armature 6 and front contact of the FT2 relay 2305 to the winding of the EC relay 2310 which now operates to connect the decimal leads from the E digit reading relays to arcs of the selector switch. Thereafter during the reading of line 8 when the L8 relay 3507 is operated, the EC relay 2310 will respond. The release of the FT1 relay 2304 prevents further stepping of the selector at this time, leaving it now under control of the circuit just described.

12.11 SKIPPING DAYS OF ROUND

The seventh line of tape identity is 2897XX in which the E and F digits indicate the first and last days of the round. These items are not checked by the sorter. Ground over the reading check lead through the A, B, C and D digit reading relays, thence over the DD7 lead (the D reading relays must express the value 7), through the front contact and armature 1 of the CL8 relay 3506 grounds the RSO conductor 4304 to cause the operation of the reader step RS1—3 relay 1800. This steps the reader.

12.12 CHECKING TAPE SECTION AND ROUND

The eighth line of tape identity is 2898XX in which the E digit is the tape section and the F digit is the round. The round is checked on all tapes in all sorts. The tape section is the digit by which the tapes were previously sorted. In a sorter, for example, during a hundreds sort, the output tape perforated by perforator 0 in which all hundreds digits are 0 carries tape section 0. The conditions under which the tape section is checked are given in section 12.10. They are those cases where the TD selector (Fig. 23) is stepped off normal. Ground over the reading check lead and through the A, B, C and D digit reading relays must come out on conductor DD8 since this is the eighth line and the digit expressed in the D reading relays must be 8, thence through armature 2 and front contact of the CL6 relay 3506 to cause the operation of the L8 relay 3507. In those cases where no check is made on tape section, the selector TD will not have been stepped off normal. In such a case a circuit may be traced from ground, the upper spring 2311 of the selector off-normal switch, conductor 2312, and thence through the armature 6 and front contact of either the OFB relay 3602, the FTH relay 3603 to the TDG conductor 3607, or alternatively from the conductor 2312, through the armature 1 and front contact of the X1B relay 2403 or armature 1 and front contact of the 11B relay 2502, armature 4 and back contact of the STD relay 2307, armature 4 and back contact of the FT1 relay 2304, the TD conductor 2313, the front contact and armature 6 of the L8 relay 3507, the RD conductor 3508, armature 4 and back contact of the 18B relay 2504, armature 4 and back contact of the 17B relay 2402, the RD1 conductor 2405, the switch arm 4006 of the Round switch (and assuming round 5) on its number 7 terminal, the FD5 conductor into the F digit reading relays, the FC conductor 3110, the front contact and armature 8 of the 28B relay 3102, conductor 3407, through the front contact and armature 1 of the L8 relay 3507 to the RSO conductor 4304 leading to the winding of and causing the operation of the RS1—3 reader step relay 1800. This checks that the round digit on the tape agrees with the setting of the Round switch. The contacts of the OFB, FTH, 11B and X1B relays are provided so that if the selector fails to step off normal in a case where it should, the path from its off-normal contacts just described will not be closed. If a summary tape is being sorted alone, the Round switch is set to correspond with the round of the tape. Whenever a summary tape is being sorted with a message unit tape, the Round switch is set to correspond to the round of the message unit tape, and the circuit checks that the summary tape is for the previous round. On such a combined sort the 17B relay 2402 or the 18B relay 2504 is operated whenever the summary tape is being processed, and the round check is made through arc 2 of the Round switch, that is, under control of the switch arm 4007, checking that the round digit of the summary tape is for the round preceding that set up on the Round switch. It will be noted that whereas the number 7 contact for the switch arm 4006 is connected to the FD5 conductor, the connection for the switch arm 4007 on its seventh contact is to the FD4 conductor. Where the TD selector has been stepped off normal, ground may be traced from armature 2 and front contact of the L8 relay 3507, the EC conductor 3111, the armature 7 and front contact of the 28B relay 3102, the EC conductor going into the E digit relays (now set to express the tape section digit, let us assume tape section 3), out over the ED3 conductor, through armature 4 and front contact of the EC relay 2310, the fourth contact of the TD selector switch arm 2303 on which this switch arm must be resting at this time, onto conductor 3607 and thence over the circuit previously traced to the RS1—3 relay 1800 to step the reader. If the selector TD was stepped off normal it stepped to the position corresponding to the tape section at that time in the reader while the circuit was skipping the 2897XX line. Thus, it is already off normal when the 2898XX code is being read and in those cases where the switch is used, the circuit waits until the selector has stepped all the way to its initial position before the path is closed for checking tape digit and round. This prevents a satisfaction check of the wrong tape section while the selector is still stepping. The check path is not closed until the EC relay 2310 operates following the operation of the FT2 relay 2305 by which time the selector has reached its position. While the selector is stepping and the tape section and round are being checked, the TM relay 1404 is prevented from operating by ground placed on its condensers by the front contact and armature 9 of the CL6 relay to the conductor 4812. The CL6 relay 3506, through its front contact and armature 7, also places a ground on conductor 4809 to operate the TTM relay 3709 and start the long timer. The RS1—3 relay 1800 steps the reader and operates the CL8 relay 3507 which locks and releases the CL6 relay 3506.

Again in this case the ground extended to the winding of the L8 relay 3507 is also transmitted over the EC conductor 3509 where, through the

armature 2 and front contact of the MU relay 3302 or the armature 3 and front contact of the MUAS relay 3303, it is connected to the RE conductor 3310 to cause the operation of the RE connector relay 3800 so that the tape section code as now expressed by the E digit reading relays is transmitted into the register of Fig. 33 to operate the RE code relays in the manner hereinbefore described. Again, it may be noted that the locking circuit for the RE relays is controlled over the L1 conductor 3416, deriving ground from the armature 1 and front contact of the master off-normal relay 1703 so that the record established in this E digit tape section register will be maintained as long as this particular section of tape is being processed by the sorter. When this section runs out and the next section comes on for processing, the L1 relay will first be operated to check the first line of tape indentity of this next section, and this will result in releasing the tape section register and making it ready for operation shortly thereafter when the 2898XX line is again encountered.

12.13 CHECKING MONTH

12.131 GENERAL

The ninth and last line of tape identity is 2899XX in which the E and F digits indicate the month. This is checked against the Month Tens and Month Units switches on all tapes in all sorts. In most cases the month shown on the tape agrees with the switches. This is true for message unit tapes alone, summary tapes alone, toll, message unit detail and observing tapes. It is also true on combined sorts of message unit and summary tapes whenever the message unit tape is being processed and when the summary tape is being processed provided the message unit tape is not for round 0. In this one case, when the summary tape is being processed in a combined sort with a message unit tape for round 0, the circuit checks that a summary tape is for the preceding month. Since on a combined sort the summary tape is always for the round preceding the message unit tape when the reader is for a round 0 of any month, the summary tape must be for round 5 or 9 of the preceding month. The MOC relay 2505 is operated from ground on the Round switch arm 4008, the RD0 conductor 4009, and thence through either the front contact and armature 1 of the 17B relay 2402 or the front contact and armature 1 of the 18B relay 2504, to the winding of the MOC relay 2505. Otherwise, it remains normal. Ground over the reading check lead through the A, B, C and D digit reading relays must now come out on the DD9 conductor since the code 2899XX is being read and, therefore, will extend ground through armature 1 and front contact of the CL8 relay 3500 to the winding of the L9 relay 3510. The L9 relay responds.

12.132 CURRENT MONTH

When the MOC relay 2505 is normal the path for checking month is as follows:

MONTH 01

Ground, armature 4 and front contact of the L9 relay 3510, the FC conductor 3407, the armature 8 and front contact of the 28B relay 3102, the FC conductor 3110 through the F reading relays now set to express the digit 1, the FD1 conductor, the terminal number 3 of the Month Units switch arm 4010, the MOU1 conductor 4011, back contact and armature 2 of the MOC relay 2505, the MOU conductor 2506, front contact and armature 1 of the L9 relay 3510, the MOT conductor 3511, the Month Units switch arm 4012 also on its terminal number 3, the Month Tens switch arm 4013 set on its number 2 terminal (corresponding to month tens =0), the MOT3 conductor 4014, the armature 1 and back contact of the MOC relay 2505, the MOT1 conductor 2507, the month tens switch arm 4015 set on its number 2 terminal, the ED0 conductor, thence through the circuits of the E digit reading relays to the EC conductor, through the front contact and armature 7 of the 28B relay 3102, the EC conductor 3111, armature 3 and front contact of the L9 relay 3510, the ECA conductor 3512, the armature 1 and back contact of the TIEA relay 2600 to the winding of the TIS relay 2602. The TIS tape identity start (perforate) relay operates in this circuit.

MONTH 02—09

Ground from armature 4 of the L9 relay will cause one of the FD2 to FD9 leads to be grounded in accordance with the units digit of the month, thence to the Month Units switch arm 4010, the MOU1 conductor 4011, the back contact and armature 2 of the MOC relay 2505, the MOU conductor 2506, the front contact and armature 1 of the L9 relay 3510, the MOT conductor 3511, the Month Units switch arm 4012 set on any one of its contacts terminals 4 to 11, inclusive, the MOT1 conductor 2507, the Month Tens switch arm 4015 set on its number 2 position (expressing the digit 0), the ED0 conductor through the circuits of the E digit reading relays to the EC conductor, front contact and armature 7 of the 28B relay 3102, the EC conductor 3111, the armature 3 and front contact of the L9 relay 3510, the ECA conductor 3512, the armature 1 and back contact of the TIEA relay 2600 to the winding of the TIS relay 2602, causing the operation of this tape identity start relay.

MONTH 10

Ground from armature 4 on the L9 relay will cause the FD0 lead to be grounded in accordance with the units digit of the month, thence to the Month Units switch 4010 set on its terminal 2, over the MOU1 conductor 4011, the back contact and armature 2 of the MOC relay 2505, conductor 2506, front contact and armature 1 of the L9 relay 3510, conductor 3511, the Month Units switch 4012 set on its terminal 2, conductor 4014, armature 1 and back contact of the MOC relay 2505, conductor 2507, the Month Tens switch 4015 set on its number 3 terminal to express the digit 1, the ED1 conductor through the E digit network to the EC conductor, thence over front contact and armature 6 of the 28B relay 3102, conductor 3111, armature 3 and front contact of the L9 relay 3510, conductor 3512, armature 1 and front contact of the TIEA relay 2600 to the winding of the TIS relay 2602.

MONTH 11

Ground from armature 4 of the L9 relay will cause the FD1 lead to be grounded in accordance with the units digit of the month, thence to the Month Units switch 4010 set on its number 3 terminal to express the digit 1, over the conductor 4011, the back contact and armature 2 of the MOC relay 2505, conductor 2506, front contact and armature 1 of the L9 relay 3510, conductor 3511, the Month Units switch 4012 set on its number 3 terminal, the Month Tens switch 4013 set on its number 3 terminal, conductor 2507, the Month Tens switch 4015 set on its number 3 terminal, the ED1 conductor, and thence over the circuit previously traced to the TIS relay 2602.

MONTH 12

Ground from armature 4 of the L9 relay will

cause the FD2 lead to be grounded in accordance with the units digit of the month, thence to the Month Units switch arm 4010 set on its number 4 terminal to express the digit 2, conductor 4011, back contact and armature 2 of the MOC relay 2505, conductor 2506, front contact and armature 1 of the L9 relay 3510, conductor 3511, the Month Units switch arm 4012 set on its number 4 terminal, conductor 2507, Month Tens switch arm 4015 set on its number 3 terminal to express the digit 1, the ED1 conductor, and thence over the circuit previously traced to the winding of the TIS relay 2602.

12.133 PREVIOUS MONTH

When the MOC relay 2505 is operated the path for checking the month is as follows:

MONTH EXPRESSED ON TAPE —12 ON SWITCHES 01

Ground from armature 4 of the L9 relay will cause the FD2 lead (the reading relays following the tape expressed, the digits 1 and 2 in the E and F relays, respectively) to be grounded, and this ground will be extended to the Month Tens switch arm 4600 set on its number 2 terminal to express the digit 0, conductor 4601, the number 3 terminal and the Month Units switch arm 4016, the MOU2 conductor 4017, the front contact and armature 2 of the MOC relay 2505, conductor 2506, front contact and armature 1 of the L9 relay 3510, conductor 3511, the Month Units switch arm 4012 set on its number 3 terminal to express the digit 1, the Month Tens switch arm 4013 set on its number 2 terminal to express the digit 0, conductor 4014, armature 1 and front contact of the MOC relay 2505, the MOT2 conductor 2508, the Month Tens switch arm 4018 set on its number 2 terminal, the ED1 conductor, and thence over the circuit described to the winding of the TIS relay 2602.

MONTH EXPRESSED ON TAPES 01 TO 08 ON SWITCHES 02 TO 09

Ground from armature 4 of the L9 relay will cause one of the FD1 to FD8 leads (the E and F digits will express the values 01 to 08) to be grounded and this ground will be extended over such FD lead to the Month Units switch arm 4016 set to express a units digit one higher than the value expressed by the F digit leading relays, thence over the conductor 4017, the front contact and armature 2 of the MOC relay 2505, conductor 2506, the front contact and armature 1 of the L9 relay 3510, conductor 3511, the Month Units switch arm 4012 set on the same terminal as its companion switch arm 4016, conductor 2507, the Month Tens switch arm 4015 set on its number 2 terminal to express the digit 0, the ED0 conductor, and thence over the circuit hereinbefore traced to the winding of the TIS relay 2602.

MONTH EXPRESSED ON TAPE —09 EXPRESSED ON SWITCHES —10

Ground from armature 4 of the L9 relay will cause the FD9 conductor (the E and F digit reading relays will express the values 0 and 9, respectively) to be grounded, and this ground will be extended over terminal 2 of the Month Units switch arm 4016 now set on this terminal to express the digit 0, thence over the conductor 4017, the front contact and armature 2 of the MOC relay 2505, conductor 2506, front contact and armature 1 of the L9 relay 3510, conductor 3511, the Month Units switch arm 4012 also set on its terminal number 2, conductor 4014, armature 1 and front contact of the MOC relay 2505, the MOT2 conductor 2508, the Month Tens switch arm 4018 set on its number 3 terminal to express the digit 1, the EDO conductor, and thence over the circuit hereinbefore described to the winding of the TIS relay 2602.

MONTH EXPRESSED ON TAPE —10 EXPRESSED ON SWITCHES —11

Ground from the armature 4 of the L9 relay will cause the FD0 lead (the E and F digit reading relays will express the values 1 and 0, respectively) to be grounded, and this ground will be extended to the Month Tens switch arm 4600 set on its number 3 terminal to express the digit 1, conductor 4601, the Month Units switch arm 4016 set on its number 3 terminal to express the digit 1, the MOU2 conductor 4017, the front contact and armature 2 of the MOC relay 2505, conductor 2506, front contact and armature 1 of the L9 relay 3510, conductor 3511, the Month Units switch arm 4012 set on its terminal number 3, the Month Tens switch arm 4013 set on its number 3 terminal, conductor 2507, the Month Tens switch arm 4015 set on its number 3 terminal, the ED1 conductor, and thence over the circuit hereinbefore described to the winding of the TIS relay 2602.

MONTH EXPRESSED ON TAPE —11 EXPRESSED ON SWITCHES —12

Ground from armature 4 of the L9 relay will cause the FD1 lead (the E and F digit reading relays will express the values 11 and 12, respectively) to be grounded, and this ground will be extended over the Month Units switch arm 4016 set on its number 4 terminal to express the value 2, the MOU2 conductor 4017, the front contact and armature 2 of the MOC relay 2505, conductor 2506, front contact and armature 1 of the L9 relay 3510, conductor 3511, the Month Units switch arm 4012 set on its number 4 terminal, the conductor 2507, the Month Tens switch arm 4015 set on its number 3 terminal to express the digit 1, thence over the ED1 conductor and the circuit hereinbefore traced to the winding of the TIS relay 2602.

12.134 COMPLETION OF MONTH CHECK

The TIS relay operates as described under these various conditions instead of the reader step RS1—3 relay 1800 at the completion of the month check. The reader is not stepped at this time and hence remains on the 2899XX line during the tape identity perforating operations which follow.

13. PERFORATING TAPE IDENTITY ON LEADING END OF OUTPUT TAPES

13.01 ARRANGING TO PERFORATE TAPE INDEX

The TIS relay is locked in a circuit from ground, front contact and armature 7 of the RCD relay 2001, the TISL conductor 2002, the back contact and armature 2 of the TIE relay 2605, the front contact and armature 6 of the TIS relay 2602 to the winding thereof. The circuit from ground, armature 5 and front contact of the RS1—3 relay 1800, over the RS(*b*) conductor which is normally closed through the back contact and armature 8 of the TIS relay to the RS(*a*) conductor and which has been traced hereinbefore to the lower terminal of the step magnet 1902 of the reader, is now open by the operation of the TIS relay 2602 to prevent the reader advance during the tape identity perforating through its armature 11 and front contact. The TIS relay grounds conductor 2603 leading to the winding of the ME relay 4903 so that this relay becomes operated at this time. The TIS relay shunts down the winding of the TI relay 2200 by applying ground to conductor 2664, and it operates the reading relays B1 and B7 independently of the tape. The ME relay 4903 opens the circuit of RCA—B—C

relay 1902 thus disconnecting the reading relays from the reader and releasing all of them except the B1 and B7 relays operated as above described. The ME relay 4903 connects the A2 reading relay 2902 to the reader contact K1 through the RCD relay 2001 as hereinbefore described. The A2 relay thus operates during the reader closed periods providing, however, that the APC relay 4800 is normal. In the reader open period, ground from reader contact K3 may be traced through the front contact and armature 8 or RCD relay 2001, conductor 2003, the front contact and armature 4 of the TIS relay 2602, conductor 2606, back contact and armature 1 of the W2A relay 1501, armature 2 and back contact of the WSP relay 1609, and thence in a chain circuit through armature 2 and back contact of the EP relay 1611 and similar contacts of the W9 to W1 relays in Fig. 15 to the winding of the PX relay 1500 which now operates and locks to ground supplied by the front contact and armature 2 of the ST3A relay through the back contact and armature 6 of the RS1—3 relay 1800, conductor 1804, the front contact and armature 2 of the TIS relay 2602, and a chain circuit involving armatures and back contacts of the PS2 relay 1613, the PS3 relay 1612, the PS1 relay 1611, and each of the PL relays of Fig. 15. Alternatively, a ground from the reader contact K7 transmitted over the KM5 lead 2007 and thence through the armature 5 and back contact of the SS relay 4802 to the conductor 1804 may also be used in the holding circuit of the PX relay 1500. The operation of the PX relay releases the CL8 relay 3500.

In the next reader closed period the W1 relay 1503 operates in a circuit hereinbefore described through the front contact and armature 1 of the PX relay. This extra reader cycle is provided before tape identity perforating to allow the ME relay 4903 to operate fully. In the open period following, the PL1 relay operates from ground supplied over the reader, contact K3, the front contact and armature 8 of the RCD relay 2001, the conductor 2003, the front contact and armature 4 of the TIS relay 2602, the PX conductor 2606, the back contact and armature 1 of the W2A relay 1501, the armature 2 and back contact of the WSP relay 1609, and thence in a chain circuit involving armatures and back contacts of the EP relay 1611, the W9 to W2 relays, inclusive, the armature 1 and front contact of the W1 relay 1503, the P0 conductor, the armature 1 and back contact of the PSP relay 3700, the PL1 conductor to the winding of the PL1 relay 1506. The PL1 relay 1505 which controls the perforation of line 1 of the tape identity on all the output tapes operates and locks through the chain circuit hereinbefore described for the locking of the PX relay 1500.

13.02 SPREADING TAPE INDEX

The operation of the PL1 relay 1506 releases the PX relay 1500 and appropriates the locking circuit heretofore used by the PX relay in the manner just above described. The PL1 relay is used to synthesize the first line of tape identity to be spread on the outgoing tapes. Through its armatures 1, 2, 3 and 4 the PL1 relay places ground on the D1, the D0, the C2, and the C7 leads directly to operate the corresponding relays in the C and D digit relays. This relay also operates two of the E and F reading relays through the tape type and sort switches in such a way that the following tape index numbers will be perforated:

Tape	Sort					
	Off	1TH	U	T	H	2TH
Summary			18			
MU and Summary			13	14		
MU		12	13	14	15	[1] 16
Toll	21	22	23	24	25	26
MU Detail	31	32	33	34	35	36
Observing	41	42	43	44	45	46

[1] When the circuit of Figs. 56 and 57 is used then the tape index 16 will be perforated but when the circuit of Figs. 38 and 44 is used then the tape index 10 will be perforated.

In the next reader closed period the A2 relay 2902 is again operated and the W2 relay 1507 operates from the reader contact K5 over the conductor 2004 and through a chain circuit ending in armature 5 and front contact of the PL1 relay 1506 directly to the winding of the W2 relay 1507. The W2 relay, in turn, locks through its front contact and armature 2 in the locking circuit heretofore used for the W1 relay 1503 and thereby releases the latter relay. The operation of the W2 relay extends ground from the armature 8 and front contact of the ST3A relay 1705, the armature 1 and front contact of the W2 relay 1507 to the winding of the W2A relay 1501 which thereupon locks through its front contact and armature 4 to the ground supplied at the front contact and armature 3 of the TIS relay 1602. The circuit from the K3 reader contact of conductor 2003, through the front contact and armature 4 of the TIS relay 2602, thence over conductor 2606, is now broken at the back contact and armature 2 of the W2A relay, so that the walking circuit controlling the items to be perforated will step only when the reader step relays operate after each line has been spread across the tapes of all ten perforators. With the A2 relay 2902 operated and the other reading relays operated, the reading check lead is closed. It has been shown how the A2, the B1, the B7, the C2, the C7, the D0 and the D1 relays have been operated. By way of example, if the tape type switch has been set to summary and the sort switch has been set to units, then the E and F digit reading relays will be operated as follows: Through its armatures 9, 10, 11 and 12, the PL1 relay 1506 will ground the four PTT conductors. If the circuit of Figs. 56 and 57 is being used, then the PTT1 conductor will extend ground through the Tape Type switch arm 4602 to its number 2 terminal expressing the tape type MUS (summary tape) to ground the E0 conductor. The PTT2 conductor will extend ground over the Tape Type switch arm 4603 set on its number 2 terminal to ground the E1 conductor, so that the E0 and E1 digit reading relays are operated to express the digit 1. The PTT3 conductor will extend ground through the sort switch arm 4604 to its number 4 terminal expressing the sort by units and this ground will now be extended over the tape type switch arm 4605 to ground the F7 conductor. The PTT4 conductor will ground the sort switch arm 4606 on its number 4 terminal to ground the F1 conductor so that the F1 and F2 digit reading relays are operated to express the digit 3. Therefore, in this case the first line will be synthesized as the code 289113.

The closing of the reading check lead extends ground over conductor 2008, through the back contact and armature 4 of the LK2 relay 2804, the front contact and armature 6 of the A2 relay 2902, the back contact and armature 5 of the A1 relay 2901, the back contact and armature 5

of the A0 relay 2900, the AD2 conductor 2907, then by way of example, through the armature 6 and front contact of the MUS relay 3304, conductor 3305, armature 4 and front contact of the B7 relay 2904, front contact and armature 7 of the B1 relay 2903, armature 8 and back contact of the B4 relay 2908, the BD conductor 2909, thence through armature 5 and front contact of the MUS relay 3304, the 28X conductor 3306, the armature 2 and front contact of the ME relay 4903, the APA conductor 4906, the armaure 5 and back contact of the APD relay 4803 to the winding of the APA relay 4804. The APA relay operates the S0B relay 5200, at the same time checking the chain circuits through the S—A and the S—B relays of Figs. 52 and 53. The S0B relay 5200 operates from battery connected to armature 3 and front contact of the APA relay 4804, through a chain circuit consisting of the armature 2 and back contact of the S9A relay 5302 to and including a similar contact controlled by the S1A relay 5202, the armature 6 and front contact of the APA relay 4804, the winding of the S0B relay 5200, and thence over a chain circuit consisting of the armature 3 and back contact of the S1B relay 5201 and similar contacts of the remaining S—B relays, conductor 4805, armature 2 and front contact of the APA relay 4804 to the ground on the KM5 conductor 2007 derived from the reader contact K7. The S0B relay 5200 locks to battery connected to its armature 2 and front contact, and when the APA relay 4804 is released after the operation of the APD relay 4803, a holding resistance 4814 is inserted in the ground path. The APA relay 4804 also connects the APC relay through its front contact and armature 5 to the ground on the HB2A conductor 2008 so that the APC relay operates in the next open period of the reader. The APC relay 4800 locks itself through the back contact and armature 1 of the LLA relay 2803 to the ground supplied at the front contact and armature 7 of the LK1 relay 2900. The APC relay 4800 switches the lead which operated the A2 relay 2902 so that in the next closed period of the reader it operates the A2S relay 4806 instead of the A2 relay. The APC relay 4800 disconnects the reader step relays from the RSE and the RSO leads, at its armatures 1 and 4, from the perforator connector relays. The operation of the APC relay operates the APD relay 4803 from a ground supplied at armature 3 and front contact of the S0B relay 5200. When the APD relay 4803 operates, it releases the APA relay 4804 and locks itself to the ground supplied by armature 5 and front contact of the APC relay 4800. The RSE and RSO leads from the contacts of the PD0 to PD9 relays (Fig. 50) are now connected together at armatures 2 and 3 and their front contacts of the APC relay 4800 and connected through the armature 2 and front contact of the APD relay to the winding of the SS relay 4802. Ground extended from the armature 10 and back contact of the WS1A—C relay 4301 is now extended through the front contact and armature 6 of the ME relay over the TTM conductor through armature 6 and front contact of the APD relay 4803, conductor 4809 to the winding of the TTM relay 3709 which now becomes operated.

At the beginning of the next closed period of the reader, the A2S relay 4806 operates over the path previously used to operate the A2 relay 2902. Ground supplied by the H2 reader contact over conductor 2010 is now extended over armature 1 and front contact of the A2S relay 4806, the HM2A conductor, armature 5 and back contact of the WS1A—C relay 4301, the HM2A conductor leading to the back contact and armature 2 of the S9B relay 5300, and thence through a chain circuit to the front contact and armature 1 of the S0B relay 5200, and thence to the winding of the S1A relay 5202. This causes the operation of the S1A relay which thereupon locks to the ground supplied by armature 6 and front contact of the LK1 relay 2900. The A2S relay 4806 also connects the reading check path extended over the CK2 conductor 2908, through armature 2 and front contact of the A2S relay 4806, the CK3 conductor, over armature 4 and back contact of the WS1A—C relay 4301, the CK3A conductor to the back contact and armature 5 of the S9B relay 5300, thence in a chain circuit over similar armatures and contacts of the other S—B relays, to the front contact and armature 4 of the S0B relay 5200, conductor 5202 to the winding of the PA0 perforator 0 connector relay 5100 so that the perforator magnets of the perforator 0 are now connected to the leads over which they will be operated to perforate this first line of tape identity. The twenty-eight perforating magnets of perforator 0 are now carried to their corresponding reading relays through the K series checking relays shown in the left-hand portions of Figs. 39, 45 and 51. Those magnets whose reading relays are operated are connected to the perforating contacts on the reader. The A2 perforating magnet, by way of example, is connected from the PA2 reader contact, over the PA2 lead 2011 through the armature 3 and front contact of the A2S relay 4806, the PA conductor 4810, the armature 1 and back contact of the WS1D relay 4302, the armature 1 and back contact of the WS2 relay 4300, the PA2 conductor 4306 through the winding of the KA0 relay 3900, the corresponding contact of the perforator connector relay 5100 to the A2 perforating magnet 5415. The B1 and B7 perforating magnets are operated by the PB1 and PB7 reader contacts through the front contact and armature 5 of the B1 relay 2903 and the front contact and armature 3 of the B7 reading relay 2904, respectively.

If the circuits of Figs. 56 and 57 are used, then the C, D, E and F perforating magnets are operated directly from the C, D, E and F reading relays in the same manner as that just explained in connection with the B reading relays. If, on the other hand, the circuits of Figs. 38 and 44 are used, then the paths between the reading relays and the perforating magnets have to pass through the armatures of certain relays such as the CAR relay 3803, the DAR relay 3804, the EAR relay 3805 and FAR relay 3806. These relays are normally operated at this time so that the path for the C digit code conductors is, by way of example, from the PC reader contacts, thence through the front contact and armature 3 of the C7 relay 3001 and the front contact and armature 6 of the C2 relay 3002 (the C digit must express the value 9 at this time), thence through the armatures 5 and 3, respectively, of the CAR relay 3802 and their front contacts to the windings of the KC7 and KC2 relays, respectively.

The manner in which the CAR, DAR, EAR and FAR relays are operated at this time may be traced as follows: Ground is extended over armature B and front contact of the MON relay 1703, the SC1 conductor 1719, armature 1 and back contact of the LICE relay 4402, the armature 1 and back contact of the MUSA relay 4403, the armature 1 and back contact of the OFSM

relay 4404 to the winding of the CAR relay 3803. The other similar relays are operated in the same manner so that the paths from the reading relay contacts through Fig. 38 are in effect exactly the same as the paths through Fig. 56. Eleven perforating magnets, therefore, operate perforating the code 2891XX on output tape 0. The corresponding series relays KA2, KB1, KB7, etc. operate, and the PD9 perforator register relay 5406 also operates. This relay is not required when spreading entries on all output tapes, and its locking circuit is open since the LN2 relay 2807 and LN5 relay 2809 are all normal. When the J make contact on the reader closes approximately .008-second after the start of the reader closed period, the PAM perforator advance magnet 5405 is operated through the series relay PK9 5406 and a contact of the PA9 connector relay 5100. When the perforator series checking relays have operated, the perforating check lead is closed, operating the SS relay 4802 as hereinbefore described. At the end of the closed period of the reader the S9B relay 5200 releases. During the open period of the reader, ground from a reader back contact H8 through the front contact and armature 6 of the RCD relay 2001 places ground on conductor 2008, which is extended over the back contact and armature 4 of the APA relay 4804, the armature 6 and front contact of the SS relay 4802, thence to the armature 2 and back contact of the S9A relay 5302 and in a chain circuit of similar armatures and contacts to and including the S2A relay 5204, thence over armature 2 and front contact of the S1A relay 5202 to the winding of the S1B relay 5201. The S1B relay operates and locks to a reader make contact or through the SS and the RS1—3 relay to a ground supplied by the ST3A relay as hereinbefore described. The S1B relay prepares the operating path for the A2S relay 4806 and for the connector relays for perforator number 1. At the start of the next reader closed period the SS relay 4802 releases and the A2S relay 4806 and the S2A relay 5204 operate. The A2S relay now operates the PA1 connector relay 5102, thus cutting in perforator number 1. At the end of the closed period, the SS relay is again operated and the S1B relay 5201 releases. At the start of the next reader open period the S2B relay 5205 operates. The circuit continues in this manner perforating the code 2891XX on each of the ten output tapes. When the A2S relay 4806 operates at the start of the reader closed period for perforating the 2891XX on tape number 9, ground from reader contact H2 over conductor 2010, through armature 1 and front contact of the A2S relay 4806, armature 5 and back contact of the WS1A—C relay 4301, the front contact and armature 1 of the S9B relay 5300, conductor 5303, front contact and armature 11 of the APC relay 4800, conductor 4813 is extended to the armature of the LLA relay 2803 to cause its operation. This relay locks over its armature 3 and front contact to ground supplied by the front contact and armature 7 of the LK1 relay 2800. The perforating check lead operates the RS1—3 relay in a circuit from the front contact and armature 3 of the PD9 relay, the RSO lead 5002, the armature 7 and back contact of the WS1A—C relay 4301, conductor 4304 to the winding of the RS1—3 relay 1800. The SS relay 4802 does not operate for perforator 9. The RS1—3 relay, however, is prevented from stepping the reader since the connection between the RS(a) lead and the RS(b) lead, normally closed by the armature 8 and back contact of the TIS relay 2602, is held open at this time. The RS1—3 relay locks to the HB9 conductor which derives ground from the H3 reader contact so that the RS1—3 relay will remain locked through this open period. The RS1—3 relay shunts the timing condensers 1410 through its front contact and armature 7, and atempts to shunt down the RSR relay 1402 by applying ground to the RSB conductor, but this is prevented by the opened back contact and armature 8 of the TIS relay 2602. With the LLA relay 2803 and the RS1—3 relay 1800 operated, the APC relay 4800 and the LK1 relay 2800 are now only locked to the reader make contacts, their other locking paths having been opened. At the end of the closed period for perforator 9, the following relays release: The AS2 relay 4806, the PA9 relay 5103, the S9B relay 5300, all of the perforating magnets, the LLA relay 2803, the LK1 relay 2800 and the PL1 relay 1506. The release of the APC relay 4800 releases the APD relay 4803, and the release of the LK1 relay 2800 opens the circuit of the S9A relay 5302. The PAM magnet associated with the number 9 perforator releases shortly after the end of the closed period when the reader contact J1 opens. At the start of the open period, ground from the reader contact K3 through front contact and armature 8 of the RCD relay 2001, conductor 2003, the front contact and armature 4 of the TIS relay 2602, conductor 2606, armature 1 and front contact of the RS1—3 relay 1800, the P0 conductor 1808, the armature 2 and back contact of the WSP relay 1609 and thence in a chain circuit to armature 2 of the W2 relay 1507, thence through the front contact thereof, armature 3 and front contact of the W2A relay 1501 is now extended to the winding of the PL2 relay 1508, thereby causing the operation of this line 2 relay which has the duty of synthesizing the second line of tape identity to be perforated on the outgoing tapes. The PL2 relay operates and locks over the same path which previously held the PL1 relay.

The arrangement provided herein to meet the difference between the circuits of Fig. 57 and Fig. 44 should be noted. Under the previous arrangement as shown in Fig. 57, no provision is made for operating the SSLA relay 4613 in Fig. 46 with the circuits of Fig. 44 provided, however, the operation of the SSL relay 4400 will result in the operation of the SSLA relay 4613.

Let it be assumed that a message unit tape is placed in the reader and the sort switch is adjusted on its second thousands position. Under the old arrangement the tape index will be automatically perforated as 16 while under the new arrangement the tape index will be produced as 10. It will be noted that upon the operation of the PL1 relay 1506 the four PTT conductors are grounded. In each case the PTT1 conductor through the Tape Type switch arm 4602 will ground the E0 conductor and the PTT2 conductor connected to the Tape Type switch arm 4603 will ground the E1 conductor to express the digit 1 in the E relays. With the SSLA relay 4613 in its normal position the PTT3 conductor through the Sort switch arm 4604 on its number 7 terminal will ground the F4 conductor, but the PTT4 conductor through the Sort switch arm 4606 will extend the ground through the armature 2 and back contact to the F2 conductor so that the F digit reading relays will express the digit 6. In this instance, a number 16 type tape

is produced, which will be accepted and processed by the summarizer.

In accordance with the present invention, however, the SSLA relay 4613 will be energized so that the PTT4 conductor will extend ground through the Sort switch arm 4604, the armature 2 and front contact of the SSLA relay 4613 to the F7 conductor whereby the digit 0 is produced in the F digit reading relays and a type 10 output tape results. This tape is one which will be accepted by the sorter when the Sort switch has been adjusted to its central office position. In this case, through the operation of the SSLA relay 4613, the PTT3 conductor through the Sort switch arm 4604 in its central office position will extend a ground through the armature 3 and front contact of the SSLA relay 4613 to the F4 conductor, while the PTT4 conductor through the sort switch arm 4606 will extend a ground through armature 1 and front contact to the F2 conductor whereby the digit 6 will be expressed so that the output will be a type 16 tape acceptable by the summarizer.

13.03 SPREADING MARKER GROUP

With the PL2 relay 1508 operated, a new set of reading relays is energized to synthesize the second line of tape identity to be perforated in the outgoing tapes, namely, 2892XX. The A, B and C digit relays will be operated as before. In this case, however, armatures 1 and 2 of the PL2 relay 1508 will ground the D0 and D2 leads to express the value 2 in the D digit reading relays. The E and F digits which represent the marker group are under control of the Marker Group Tens and Marker Group Units switches, respectively, armatures 9, 10, 11 and 12 of the PL2 relay 1508 ground the four PMG conductors of which the PMG1 and PMG2 conductors lead to Marker Group Tens switch arms 4205 and 4206, respectively, and the PMG3 and PMG4 conductors lead to the Marker Group Units switch arms 4207 and 4208, respectively. Simple inspection of the connections to the terminals traversed by these switch arms will indicate the manner in which the E and F digit relays are operated in accordance with the setting of these switches. This second line 2892XX is then spread on the outgoing tapes in the manner hereinbefore described. During the first closed period of the reader, the A2 relay 2902 operates and causes the operation of the APA relay 4804 and the LK1 relay 2800. The APA relay 4804 operates the S0B relay 5200 and the APC relay 4800 and the APD relay 4803 operate during the open period. The next ten closed periods are used to spread the line on the ten perforators. At the end of this process, the PL2 relay 1508 releases and the PL3 relay 1509 operates.

13.04 SPREADING FIRST RECORDER

With the PL3 relay 1509 operated, the reading relays are now energized in a new combination. Armatures 1 and 2 of the PL3 relay cause the operation of the D1 and D2 reading relays so that the 2893 code is expressed in this instance. The armatures 9 to 12, inclusive, of the PL3 relay 1509 place grounds on the PFR conductors extending to the First Recorder Tens and First Recorder Units switch arms. The PFR1 and PFR2 conductors lead to the First Record Tens switch arms 4113 and 4114, respectively, while the PFR3 and PFR4 conductors lead to the First Recorder Units switch arms 4115 and 4116, respectively. Again a simple inspection of the connections to the terminals for these switch arms will show the manner in which the E and F digit reading relays are operated in accordance with the setting thereof. The E and F digits which represent the first recorder are controlled by the First Recorder Tens and First Recorder Units switches, respectively. With these switches off normal, as they are for office and first thousands sorts, the E and F digit reading relays corresponding to the settings are operated. On other sorts where the switches are in Off position, the E2, E7, F4 and F7 relays are operated to prepare the code 90. This line is spread as described above. At the end of the process, the PL3 relay 1509 releases the PL4 relay 1510 becomes operated.

13.05 SPREADING LAST RECORDER

With the PL4 relay 1510 operated, the fourth line of tape identity for the last recorder will be synthesized through armatures 1 and 2 of this relay. The D0 and D4 conductors will be grounded to operate the corresponding D digit reading relays so that the line 2894 is prepared in a manner similar to that hereinbefore described. The armatures 9 to 12 of this relay ground the four PLR conductors leading to the switch arms of the Last Recorder Tens and the Last Recorder Units set-up switches. The PLR1 and PLR2 conductors lead to the Last Recorder Tens switch arm 4209 and 4210 while the PLR3 and PLR4 conductors lead to the Last Recorder Units switch arms 4211 and 4212, respectively. In the manner similar to that heretofore described, the contacts reached by these switch arms are connected to the E and F digit reading relays so that the E and F relays corresponding to the switch settings are operated. With these switches off normal, as they are for office and first thousands sorts, the E and F digit reading relays will be operated in accordance with the particular setting of these switches. On other sorts where the switches are in Off position, the E2, E7, F4 and F7 relays are operated to prepare the code 90. This line is spread as described above. At the end of the process the PL4 relay 1510 is released and the PL5 relay 1511 is operated in its stead.

13.06 SPREADING OFFICE

With the PL5 relay 1511 operated, the digit reading relays will be energized in another combination. Armatures 1 and 2 of the PL5 relay will cause the operation of the D1 and D4 relays to express the code 5 so that the first four digits of this code 2895 will be expressed as hereinbefore. Armatures 9 and 10 of this relay will ground the F4 and F7 leads whereby the F digit will be invariably expressed as 0. The armatures 11 and 12, however, ground the POF conductors so that through the POF1 conductor the Central Office switch arm 4117 is grounded and through the POF2 conductor, the Central Office switch arm 4118 is grounded. Through these two switch arms the E digit reading relays will be operated to record the digital value expressed by the setting of the Central Office set-up switch. On Office sort, each tape is given an office digit corresponding to the number of its perforator. In this case the central office set-up switch is set to Off position but the POF1 and POF2 conductors are extended through the armatures 2 and 3 of the OFB relay 3602 to the EX and EY conductors, respectively, leading to the spread control relays, such as the armatures 6 and 5, respectively, of the S0B relay 5200. Hence, when the S0B relay is operated, the EX and EY conductors

grounded cause the operation of the E4 and E7 relays to express the digit 8 corresponding to the perforator 0 on which this line will be perforated. In like manner, when the S9B relay 5300 is operated, grounds will be extended over the EX and EY conductors, thence through armatures 7 and 8 of the S9B relay 5300 to ground the E7 and E2 conductors, respectively, to express the value 9. The reading check path normally through the armature and contact network of the E digit reading relays is shunted in a circuit from conductor 3005, the front contact and armature 5 of the W2A relay 1501, conductor 1512, armature 3 and back contact of the APC relay 4800, conductor 4815 which is connected to the CKE conductor leading out of the E digit reading relay check path. This connection is provided to allow the operation of the APA relay 4804. This is necessary because the E digit reading relays do not operate until after the S0B relay 5200 operates. This line is spread as described above. At the end of the process, the PL5 relay 1511 is released and the PL6 relay 1513 is operated in its stead.

13.07 SPREADING THOUSANDS RANGE

With the PL6 relay 1513 operated, the 2896 line is synthesized, the armatures 1 and 2 of this relay causing the operation of the D2 and D4 relays. The armatures 9 to 12, inclusive, of this relay ground the PTH conductors. The PTH1 conductor is connected to the Thousands First switch arm 4700 and the PTH2 conductor is connected to the Thousands First switch arm 4701. In like manner, the PTH3 and PTH4 conductors are connected to the Thousands Last switch arms 4702 and 4703, respectively, and the contacts accessible to these switch arms are connected to the E and F digit reading relay conductors so that these reading relays may be operated in accordance with the setting of these two set-up switches. The E and F digits which represent the first and last thousands are under control of the Thousands First and Thousands Last switches, respectively, on all sorts except second thousands when they are under control of the STH relay 3608. With these switches off normal as they are for units, tens and hundreds sorts, the E and F digit relays corresponding to the switch settings are operated. With the switches in the Off position as they are for office and first thousands sorts, the E2 and E7, F4 and F7 relays are operated to perforate the code 90. These same relays are also operated through the armatures 1 to 4, inclusive, of the STH relay 3608 on the second thousands sort regardless of the positions of the switches which are off normal in this case. This line is spread as described above. At the end of the process the PL6 relay 1513 releases and the PL7 relay 1514 operates in its stead.

13.08 SPREADING DAYS OF ROUND

With the PL7 relay 1514 operated the reading relays are now energized in another combination. Armatures 1 and 2 of this relay place grounds on the D0 and D7 conductors to express the digit 7. Armatures 11 and 12 cause the operation of the E4 and E7 relays to express the digit 0, and armatures 9 and 10 ground the F7 and F4 relays to express the digit 0, so that this line is invariably perforated as 289700. This line is spread as described above. At the end of the process the PL7 relay 1514 releases and the PL8 relay 1515 operates in its stead.

13.09 SPREADING TAPE SECTION AND ROUND

With the PL8 relay 1515 operated, the reading relays will be energized in another combination. Armatures 1 and 2 of this relay will cause the operation of the D1 and D7 relays to express the digit 8. The armatures 9 and 10 will ground the EY and EX conductors, respectively, so that the E digit will be recorded to correspond with the perforator on which the line is at the time being perforated. The EX and EY conductors, as before pointed out, are extended by the S0B to S9B relays and thence to the windings of the E digit reading relays. Each tape thus receives a tape section digit corresponding to the number of its perforator. The armatures 11 and 12 of the PL8 relay 1515 place grounds on the PRD conductors leading to the Round switch. The PRD1 and PRD2 conductors are connected to the Round switch arm 4607 and the Round switch arm 4608, respectively, and the contacts accessible thereto are connected to the F digit reading relays. The F digit which represents the Round is, therefore, controlled by the Round switch. The reading check lead again is carried around the E reading relays through the back contact and armature 8 of the APC relay 4800 and the armature 5 and front contact of the W2A relay 1501 in the manner hereinbefore described to permit the APA relay 4804 to operate. This is necessary again because the E relays do not operate until after the S0B relay 5200 has operated. This line is spread as described above. At the end of the process, the PL8 relay 1515 releases and the PL9 relay 1516 operates in its stead.

13.10 SPREADING MONTH

With the PL9 relay 1516 operated, the reading relays will be energized in another combination. The armatures 1 and 2 of this relay will ground the D2 and D7 leads to cause the D2 and D7 readings relays to operate to express the value 9. The armatures 9 to 12, inclusive, will place grounds on the PMO conductors. Of these, the PMO1 and PMO2 conductors are connected to the Month Tens switch arm 4609 and 4610, respectively, and the PMO3 and PMO4 conductors are connected to the Month Units switch arms 4611 and 4612, respectively. The contacts reached by these switch arms are connected to the E and F reading relay conductors so that the E and F reading relays may be operated. The E and F digits which represent the month are thus controlled by the Month Tens and Month Units switches. This line is spread as described above.

During the closed period of the reader following the operation of the PL9 relay 1516, the EP relay 1611 is operated from the KM3 conductor 2004, over the front contact and armature 5 of the PL9 relay 1516. The EP relay operates and locks over its armature 3 and front contact to the WL conductor which derives ground from the front contact and armature 4 of the TIS relay 2602. The operation of the EP relay 1612 also releases the W9 relay 1517.

After the operation of the EP relay 1611, the 28B relay 3102 and the 28C relay 3100 will be locked from reader contact H1, front contact and armature 2 of the RCD relay 2001, conductor 2009, front contact and armature 4 of EP relay 1611, armature 5 and front contact of TIS relay 2602, the 28CL conductor 2513, the front contact and armature 5 of the 28C relay 3100 to the winding thereof and the front contact and armature 6 of the 28C relay 3100, the 28BL conductor through armature 1 and back contact of the MTI relay 2610 to the winding of the 28B relay 3102. Another path for locking the 28B and 28C relays may be traced from the front contact and arma-

ture 7 of the LK1 relay 2800, the back contact and armature 11 of the RS1—3 relay 1800, the back contact and armature 8 of the RS2—4 relay 1801, the G11A conductor 2009 which may be traced to the back contact and armature 1 of the APD relay 4803, thence over the 28CL conductor 2613 for locking the 28B and 28C relays. A third path may be traced from ground, the front contact and armature 7 of the LK1 relay 2800, through armature 1 and back contact of the LLA relay 2803 to conductor 2009 and thence over the path just traced through the back contact and armature 1 of the APD relay 4803. The EP relay closes the circuit of the step magnet of the reader by effectively closing the circuit opened at armature 8 and back contact of the TIS relay 2602. The armature 1 and front contact of the EP relay 1611 establishes a connection between the RS(b) conductor through the RS(c) conductor, the back contact and armature 4 of the CRK relay 1802 to the RS(a) conductor. Therefore, when after the operation of the EP relay even though the TIS relay is operated the operation of the reader step RS1—3 relay 1800 will result in the stepping of the reader. Thus, when the RS1 relay is operated at the end of the spreading of this ninth line of tape identity information, the reader will be stepped off the last line of tape identity on the input tape. During the open period of the reader a circuit will be established from the K3 contact, front contact and armature 8 of the RCD relay 2001, the conductor 2003, the front contact and armature 4 of the TIS relay 2602, the PX conductor 2606, the back contact and armature 1 of the W2A relay 1501 to the P0 conductor 1808, or alternatively from the PX conductor 2606 through the armature 1 and front contact of the RS1—3 relay 1800 to the P0 conductor 1808, thence through the armature 2 and back contact of the WSP relay 1609, the armature 2 and front contact of the EP relay 1611, the TIE conductor 1617, the back contact and armature 2 of the PTI relay 3710, the TIE conductor 3712 to the winding of the TIE relay 2605. The TIEA relay 2600 operates directly from the armature 4 and front contact of the TIE relay 2605.

After the last line of tape identity 2899XX has been spread, the APC relay 4800, the APD relay 4803, the LK1 relay 2800 and the PL9 relay 1516 are released. The operation of the EP relay 1611 also results in the extension of a connection from ground, armature 6 and front contact of the EP relay 1611, the TIC conductor 1618, through the armature 1 and back contact of the TICA relay 3417 to the winding of the TIC relay 3400. The TIC relay locks in a circuit from ground, armature 11 and front contact of the MON relay 1703, the back contact and armature 1 of the SKP relay 2706, thence over the TICL conductor 2707, the back contact and armature 4 of the CL1 relay 3409, the front contact and armature 1 of the TIC relay 3400. The operation of the TIC relay is, as its name implies, an indication that the tape identity has been checked. The TIE and TIEA relays indicate that the tape identity has been checked and perforated. The TIE relay releases the TIS relay 2602, and locks to ground supplied by the armature 11 and front contact of the MON relay 1703. The TIE relay 2605 also operates one of the relays of Fig. 57, such as the US relay 5700 or alternatively if the Fig. 44 is being used, one of the corresponding relays such as the US relay 4401. The circuit for the US relay may be traced from ground, the front contact and armature 5 of the TIC relay 3400, over the SR conductor 3414, the armature 6 and front contact of the TIE relay 2605, the conductor 2612, thence over the Sort switch arm 4005 set on its number 4 terminal corresponding to units sort conductor 4006 to the winding of the US relay 5700. In case the circuit of Fig. 44 is being used, then the conductor 4006 may be traced through the armature 2 and back contact of the SSL relay 4400 to the winding of the US relay 4401. The TIEA relay 2600 opens the operating path for the FT1 relay 2304. The TIS relay 2602 releases the ME relay 4903, the W2A relay 1501, the TTM relay 3709, the EP relay 1611, the B1 and B7 relays and remove the shunt from the TI relay 2200. The release of the PL9 relay 1516 releases the C, D, E and F digit reading relays. The release of the ME relay operates the RCA—B—C connecting relay 1902 thus connecting all of the reading relays to their corresponding reader contacts.

14. PROCESSING CALL ENTRIES

14.1 PREPARING FOR CALL ENTRIES

With the TIC, TIE and TIEA relays operated the circuit is ready to handle call entries. Some one of the Sort switches in Fig. 57 or Fig. 54 is operated as described to prepare the circuit for sorting. An extra reader cycle is passed following the perforating of tape identity to permit the release of the relays involved in this process, and to allow the reader connector relay 1902 to operate. A circuit may now be traced from ground, reader contact K5, the KM3 conductor 2004, the armature 10 and back contact of the 28C relay 3109, through the armature 4 and front contact of the PCA relay 3107 operated as hereinbefore described to the winding of the PCB relay 3108 to cause the operation of this relay, which now locks through its armature 2 to the front contact and armature 2 of the PCA relay 3107. The holding circuit for the PCA relay is now transferred from the grounded conductor 1716 to the KM4 conductor depending upon the K6 reader contact. At the end of the closed period of the reader, the PCA relay releases and in turn releases the PCB relay. While the PCA relay 3107 is operated, the SC relay 5702 or SC relay 4407 is prevented from operating. As soon as the RCA—B—C reader connector relay 1902 operates, the reading relays operate. The SC relay operates when the PCA relay 3107 releases, in a circuit from ground, armature 1 and front contact of the RCA—B—C relay 1902, the SCA conductor, over armature 1 and back contact of the LK2 relay 2804, the SC conductor, the armature 5 and back contact of the PCA relay 3107, to the winding of the SC relay 5702, or alternatively to the winding of the SC relay 4407. The release of the PCA relay 3107 also causes the operation of the LK1 relay 2800 in a circuit from the H6 reader contact, the front contact and armature 3 of the RCD relay 2001, the HM4 conductor, the armature 3 and back contact of the AO relay 2900, the front contact and armature 4 of the A2 relay 2902, the back contact and armature 3 of the A1 relay 2901, the LK1 conductor 2905, the armature 3 and back contact of the PCA relay 3107, the LK1 conductor 3101 to the winding of the LK1 relay 2800 which thereupon locks in a circuit from ground, the front contact and armature 3 of the ST3A relay 1705, the back contact and armature 6 of the LLA relay 2803, the armature 4 and front contact of the LK1 relay 2800.

14.2 FIVE-LINE ENTRY

14.21 FIRST LINE

There are two types of five-line entries. The detail entry which is identified by a 1 for the A digit of the first line is found on toll, message unit detail and observing tapes. It is the only type of call entry on toll and message unit detail tapes. The unanswered call entry, which is identified by a 3 for the A digit of the first line, is found only on observing tapes. Except as described above where on the first call entry following tape identity an extra cycle is allowed, one reader cycle is used per line of entry. During the first closed period of the reader the reading relays operate. If the A digit is 1, the LK1 relay **2800** is operated from ground through reader contact H6, front contact and armature **3** of the RCD relay **2001**, the HM4 conductor, the armature **3** and back contact of the A0 relay **2900**, the back contact and armature **3** of the A2 relay **2902**, the front contact and armature **2** of the A1 relay **2901**, the LK1A conductor and thence through either armature **2** and front contact of the OBS relay **3300**, or armature **1** and front contact of the DET relay **3307**, the LK1 conductor **2905**, the armature **3**, and back contact of the PCA relay **3107**, the LK1 conductor **3101** to the winding of the LK1 relay **2800**. If the A digit is 3 the path is from the reader contact and over the HM4 conductor as before, thence through the armature **3** and front contact of the A0 relay **2900**, armature **2** and front contact of the A2 relay **2902**, the LK1B conductor, through the armature **1** and front contact of the OBS relay **3300**, the LK1C conductor, the front contact and armature **2** of the A1 relay **2901** and thence over the path previously traced from this point to the winding of the LK1 relay **2800**. LK1 locks in the path heretofore described and operates the LN5 relay **2809** in a path from ground, armature **6** and front contact of the LK1 relay **2800**, armature **5** and back contact of the LK2 relay **2804**, the LNG ground **2805**, the back contact and armature **6** of the 28B relay **3102**, the LN conductor **3103**, the front contact and armature **8** of the A1 relay **2901**, the LN5 conductor to the winding of the LN5 relay **2809**. The LN5 relay operates and locks to the ground supplied by the armature **6** and front contact of the LK1 relay **2800**.

In order to select the proper perforator on which to perforate the entry, one set of perforator connector relays is operated corresponding to the sorting digit. In accordance with the arrangements shown in Figs. 56 and 57 the sorting digit is B for office sort, C for first or second thousands sort, D for hundreds sort, E for tens sort and F for units sort. In accordance with the modified arrangement involving the features of the present invention as shown in Figs. 38 and 44, the sorting digit is C for office sort, D for thousands sort, E for hundreds sort and F for units sort, these digits being reached through a shifted arrangement whereby the sorter attempts to reach the points originally designated for this purpose. One of the relays of Fig. 57 or one of the corresponding relays of Fig. 44, is already operated depending upon the position of the Sort switch. The perforator connector relays are operated through the reading check lead for which ground originates either at the reader contact G1 through the armature of the RKA relay **1810** in normal position, or reader contact G2 through the armatures of the RKB relay **1809** in operated position. The check lead **1805** is extended through the front contact and armature **11** of the RCD relay **2001**, conductor **2005**, armature **3** and back contact of the AL relay **1400**, the CK leads **1408**, thence through the two-out-of-five check circuits of the F, E, D, C and B digit reading relays, conductor **2908** through the back contact and armature **4** of the LK relay **2804** to conductor **2808**. If at this time the A digit is 1, the check lead may be traced through the back contact and armature **5** of the A2 relay **2902**, the front contact and armature **4** of the A1 relay **2901**, the back contact and armature **4** of the A0 relay **2900**, the AD1 conductor **3314**, thence through either an armature and front contact of the OBS relay **3300** or an armature and front contact of the DET relay **3307**, the conductor **3305**, over the BC conductor to the B reading relays. If the A digit is 3, the path is through the front contact and armature **6** of the A2 relay **2902**, the front contact and armature **6** of the A1 relay **2901**, the front contact and armature **6** of the A0 relay **2902**, the AD3 conductor and thence through the front contact and armature **7** of the OBS relay **3300** and then the armature **6** and front contact of the OBS relay **3300**, again to the BC conductor **3305** to the B relays. If the entries are to be sorted by office, the perforator connector relays are operated directly by the leads from the B relays through the contacts of the OFS relay **5703**, or the OFS relay **4408** and the companion SC relay **5702** in one instance and the SC relay **4407** in the other. Under this arrangement the number of the perforator selected corresponds to the number recorded for the B digit on the input tape. The BD lead **2909**, in effect the BD8 lead, is closed through a contact of one of the relays of Fig. 33. If the entries are to be sorted by thousands, hundreds, tens or units, the BX relay **5701** or **4402** will be operated through an armature **1** and front contact of the thousands, hundreds, tens or units relay by the ground extended for the operation of such relay and, therefore, all ten leads from the B digit reading relays will be tied together by the front contacts of the BX relay **5701**. This lead is then connected through the front contact and armature **2** of the THS relay **5704** to the CC conductor leading to the C digit reading relays, and through corresponding contacts of the HS, TS and US relays, to corresponding conductors leading to the D, E and F digit relays, respectively. The perforator selector thousands corresponds to the thousands, hundreds, tens or units digit recorded on the input tape.

The perforator connector relays such as the PA0 relay **5100** connect the twenty-eight perforating magnets in series with checking relays through their corresponding reading relays to a group of reader make contacts so that those magnets corresponding to operated reading relays operate, perforating the line read on the input tape on one of the output tapes.

The arrangement shown on Figs. 38 and 44 should be noted. If the Sort switch has been set to sort by tens then the TS lead to armature **3** of the SSL relay **4400** will be grounded. If a message unit tape is being used as the input tape either by itself or in combination with the summary tape so that the MU relay **3302** or the MUAS relay **3303** is operated, then a ground will be extended over the SSL conductor **3311** to the winding of the SSL relay **4400** so that this relay will be operated. Under this condition, the ground on armature **3** of this relay will be disconnected from the tens TS relay **4409** and con-

nected instead to the winding of the TSM relay 4410. This relay, in turn, extends the ground which caused its operation to the winding of the US relay 4401 so that the code for sorting will be derived from the F digit reading relays rather than from the E digit reading relays. At the same time the ground on the SC1 conductor 1719 will be extended through the armature 4 and back contact of the L1CE relay 4402, the armature 4 and back contact of the MUSA relay 4403, the armature 1 and front contact of the TSM relay 4410 to the winding of the FFR relay 3807 so that the record established in the RE relays will be transmitted over the F digit leads so that this digit will be perforated in the F digit place in the perforator instead of the digit which has now been taken off through the armatures of the US relay 4401 and used for the selection of the perforator. At the same time ground from the SC1 conductor 1719 will be transmitted through the back contacts and armatures 1, 2 and 3 of the L1CE relay 4402, the corresponding armatures and back contacts of the MUSA relay 4403, the armatures 1 and back contacts of the OFSM relay 4404, the THSM relay 4405, and the HSM relay 4406 to the windings of the CAR relay 3803, the DAR relay 3804 and the EAR relay 3805 so that the C, D and E digits are transmitted from the C, D and E reading relays to the perforator magnets as read.

If this is any other kind of tape such as observing tape, a detail tape or a summary tape which is being sorted, then the SSL relay 4400 will not be operated and the sorting procedure will be carried out as heretofore, that is, if the TS lead is grounded then the TS relay will be operated. One point of difference may be noted in the case of a summary tape. When the MUS relay 3304 is operated, it will transmit a ground from its armature 7 and front contact to operate the MUSA relay 4403. The operation of this relay will have the same effect as the simultaneous operation of the TSM relay 4410, the HSM relay 4406, the THSM relay 4405 and the OFSM relay 4404, that is, instead of operating the CAR relay 3803 over its armature 1 and back contact, it causes the operation of the CFR relay 3808 over its armature 1 and front contact. Likewise, it substitutes the DFC relay 3809 for the DAR relay 3804, the EFD relay 3810 for the EAR relay 3805 and the FFE relay 3811 for the FAR relay 3806. Thus, each line read from such a summary tape will have its C digit derived from the tape section number registered in the relays of Fig. 38, its D digit derived from the C digit reading relays, its E digit derived from the D digit reading relays and the F digit derived from the E digit reading relays.

On the observing and detail tape no shift is made so that all digits are perforated as read.

The perforator register relays shown in Fig. 50 are operated from the H2 reader contact over conductor 2010 and thence through the number 1 lower armature and front contact of the operated perforator connector relay such as the PA0 relay 5100. A locking circuit for the PD relays of Fig. 50 may be traced from ground, armature 4 and back contact of the LLA relay 2803, the front contact and armature 4 of the LN5 relay 2809 to the conductor 2012 normally grounded periodically by the H5 contact, but grounded steadily under the condition just described so long as the LN5 relay is operated and the LLA relay 2803 is normal, or alternatively both the RS1—3 relay 1800 and the RS2—4 relay 1801 are both unoperated. The PD relay thus selectively operated remains operated throughout the entry to cause the supplementary lines of the entry which do not contain sorting digits to be perforated on the same tape as the initial line. The perforator advance magnet such as the PAM magnet 5405 operates in series with its checking relay such as the PK0 relay 5406 from the reader J5 contact over the JM3 lead, the front contact and armature 10 of the RCD relay, the JM3 conductor, and thence through the lower armature 2 and front contact of the PA0 perforator connector relay 5100. If the line perforated checks, i. e., if either one or all three A magnets are energized and two and only two magnets in each other digit are energized, one of the reader step relays will operate to step the reader. The perforating check lead starts its ground on the back contact and armature 2 of the PHK relay 5400, thence over the conductor 5403 and through the KA0, KA1 and KA2 relay contacts in such a way that only one or all three of these relays must be operated through the KB, KC, KD, KE and KF relays in such a way that two and only two of each of these groups must be operated through a chain circuit hereinbefore described, which checks that one and only one of the PK— relays is operated through a similar checking path for checking the operation of one and one only of the PD relays of Fig. 50, then through a front contact of the operated one of these relays such as the armature 2 and front contact of the P0 relay 5000 to the RSE lead 4806 for operating the RS2—4 relay 1801. The RS1—3 relay is used for odd-numbered perforators and the RS2—4 relay 1801 is used for even-numbered perforators. Perforator 9 operates the RS1—3 relay 1800 over armature 3 and front contact of the PD9 relay 5001, the RSO conductor through the armature 8 and back contact of the WS1A—C relay 4301 and thence over the RSE conductor 4305. The operated reader step relay locks to the reader back contact H3 so that it will remain locked up until the end of the reader open period. Either one of the reader step relays 1809 or 1801 will step the reader under the present conditions.

At the end of the closed period, the reading relays, perforator connector relays, perforating magnets and series relays all release. Shortly after the start of the open period, when the reader J contacts open, the perforator advance magnet such as the PAM magnet 5405 and its companion relay, the PK0 relay 5406, release, since the operation of the reader step relay operates either the PH0 relay 5411 or the PHE relay 5407 to open the perforator advance magnet locking circuit. Whenever the reader step relays fail to operate, the PAM magnet is prevented from releasing and stepping the perforator so that the line just perforated is not repeated on the output tape. The LK2 relay 2804 is operated during the open period following the first line, over a circuit from ground at a reader back contact H8, over the front contact and armature 6 of the RCD relay 2001, conductor 2008, thence through either armature 9 and front contact of the RS2—4 relay 1801 or armature 13 and front contact of the RS1—3 relay 1800, thence in a chain circuit through armatures and back contacts of the L2A relay 2810, L3A relay 2811 and L4A relay 2812 to the LK2B conductor, the armature 10 and back contact of the 28B relay 3102, the LK2A conductor, the back contact and armature 5 of the LLA relay 2803, armature 3 and front contact of the LK1 relay 2809 to the winding of the LK2

relay 2804. The LK2 relay operates and locks through the back contact and armature 1 of the LLA relay 2803 to the ground on the front contact and armature 7 of the LK1 relay 2800. The LK2 relay opens the connection between the reading check lead and the reading relays through which the perforator connector relays were operated on the first line of the entry and releases the SC relay 5702 or 4407 to separate the perforator connector relays from the reading relays.

14.22 SECOND LINE

At the start of the reader closed period for the second line the reading relays again operate. Before the circuit can proceed it must check that the A digit is 0 and that all the other digits meet the two-out-of-five test. The reading check lead passes through the B to F digit check path to the conductor 2908, thence through the back contact and armature 7 of the A2 relay 2902, the back contact and armature 7 of the A1 relay 2901 and the front contact and armature 7 of the A0 relay 2900, over the AD0 conductor leading to armature 2 and front contact of the LK2 relay 2804, the A0 conductor 2813 to armatures 1 and 2 of the PD9 relay 5001, from whence it is extended by that one of the PD relays which is operated to one of the P0 to P9 conductors leading to the corresponding perforator connector relay such as the PA1 relay 5102. This will be the same connector relay that was used for the first line of the entry. Ground from the reader contact H2 over conductor 2010 may be traced through the front contact and armature 8 of the A0 relay 2900, the LCA conductor, armature 6 and front contact of the LK2 relay 2804, armature 2 and back contact of the L2B relay 2814 and similar contacts of the L3B relay 2815, and L4B relay 2816, the back contact and armature 1 of the LN2 relay 2807, armature 2 and front contact of the LN5 relay 2809 to the winding of the L4A relay 2812 which now becomes operated, indicating that this is the fourth from the last line of the entry. When the perforator connector relays operate, the perforating magnets perforate the second line. The PAM magnet operates and the perforating check lead operates the reader step relays as before, stepping the reader to the third line. During the open period following the second line the L4B relay 2816 operates from ground, reader contact H3, front contact and armature 6 of the RCD reader 2001, HB2A conductor 2008 and thence through either armature 9 and front contact of the RS2—4 relay 1801 or armature 13 and front contact of the RS1—3 relay 1809 to armature 2 and back contact of the L2A relay 2810, armature 2 and back contact of the L3A relay 2811, armature 2 and front contact of the L4A relay 2812 to the winding of the L4B relay 2816. The L4B relay will lock to the ground supplied by the front contact and armature 7 of the LK1 relay 2800.

14.23 THIRD LINE

The third line is perforated in the manner just above described. The L3A relay 2811 operates during the closed period of the reader; during the following open period which follows, the L3B relay 2815 operates. The L3A relay 2811 releases the L4A relay 2812 and the L3B relay 2815 releases the L4B relay 2816.

14.24 FOURTH LINE

The fourth line is perforated in the same manner. The L2A relay 2810 operates during the closed period, releasing the L3A relay 2811. The L2B relay 2814 operates in the open period which follows, in turn releasing the L3B relay 2815.

14.25 FIFTH LINE

The fifth line is perforated in a similar manner. The LLA relay 2803 will operate during the closed period of the reader over the path heretofore established for successively operating the L4A, L3A and L2A relays, but now over armature 1 and front contact of the L2B relay 2814. The operation of the LLA relay 2803 unlocks the PD relay of Fig. 50 which has been operated, as well as the L2A relay 2810, the LK1 relay 2800 and the LK2 relay 2804. The PD relay releases at the end of the line if the reader step relay operates properly. The L2A relay releases immediately. The LK1 relay 2800, however, is locked to a reader make contact and through the reader step relays RS so that it releases at the end of the closed period provided the RS reader step relay operates. The LK2 relay is similarly locked and it releases at the same time as the LK1 relay. The release of the LK1 relay 2800 releases the LN5 relay 2809, the LLA relay 2803 and the L2B relay 2814. The release of the LK2 relay 2804 reopens the SC relay 4407. The operation of the reader step relays steps the reader to the first line of the next entry, thus preparing the circuit for said next entry.

14.4 TWO-LINE ENTRY

All two-line entries have twenty as their A and B digits on the first line. They occur on both message unit and summary tapes. The LK1 relay 2800 is operated on the first line from ground, the H6 reader contact, front contact and armature 3 of the RCD relay 2001, the HM4 conductor, the armature 3 and back contact of the A0 relay 2900, the front contact and armature 4 of the A2 relay 2902, the back contact and armature 3 of the A1 relay 2901, the LK1 conductor 2905, the armature 3 and back contact of the FCA relay 3107, the LK1 conductor 3101 to the winding of the LK1 relay 2800. For operating the perforator connector relays, ground from the reading check lead goes through the back contact and armature 4 of the LK2 relay 2804, the CK2 lead 2808, the front contact and armature 6 of the A2 relay 2902, the back contact and armature 5 of the A1 relay 2901, the back contact and armature 5 of the A0 relay 2900, the AD2 conductor 2907, through an armature and front contact of either the MU relay 3302, the MUAS relay 3303 or the MUS relay 3304 to the BC conductor 3305, and thence through the B reading relays to one of the BD leads. Through the operation of the BX relay 4402, these leads are all tied together so that in accordance with the operated relay, such as the TS relay 4409, this ground is extended to conductors such as the EC conductor leading to the network of the reading relays involved in the sorting operation, then through the operated relay such as the TS relay 4409, again and now through the front contact of one of the armatures of the SC relay 4407 to the selected perforator connector relay. This entry is processed in the same manner as the five-line entry except that the LN2 relay 2807 is operated instead of the LN5 relay 2809. The LLA relay 2803, therefore, operates on the second line. The LN2 relay is operated in a circuit from ground, armature 6 and front contact of the LK1 relay 2800, the armature 5 and back contact of the LK2 relay 2804, conductor 2805, the back contact and armature 6 of the 2SB relay 3102, the LN conductor 3103, the front contact and armature 8 of the

A2 relay 2902, conductor 2906, back contact and armature 10 of the TE relay 3702, conductor 3707, back contact and armature 9 of the OBS relay 3300, the LN conductor 3301 and thence either over the armature 8 and back contact of the B1 relay 2903 or the armature 6 and back contact of the B7 relay 2904, conductor 2907 to the winding of the LN2 relay 2807.

14.5 ONE-LINE ENTRY

All one-line entries have 1 as their A digit and are found only on message unit tapes. The LK1 and LK2 relays do not operate on one-line entries. No LN2 or LN5 relay is operated and, therefore, the line counting relays such as the L1A and L1B relays and the LLA relay are not operated. For operating the perforator connector relays, ground from the reading check lead goes through the back contact and armature 4 of the LK2 relay 2804, conductor 2808, back contact and armature 5 of the A2 relay 2902, front contact and armature 4 of the A1 relays 2901, back contact and armature 4 of the A0 relay 2900, the AD1 conductor 3314 and thence through either the armature 6 and front contact of the MU relay 3302 or the armature 7 and front contact of the MUAS relay 3303 to the C conductor leading to the front contacts of the BX relay and the front contacts of other relays such as the TS relay 4409, and thence through to the armature thereof to the EC conductor, through the network of the E digit reading relays, thence through other contacts closed by the TS relay 4409, the front contacts of the SC relay 4407 to the perforator connector relays. Since no LN relay is operated, the perforator register relay such as the PD0 relay 5000 does not lock up on one-line entries. Perforation, perforator advance and reader stepping are accomplished in the same manner as for other entries.

15. END OF ONE INPUT TAPE AND START OF NEXT INPUT TAPE

15.01 CHECKING TAPE IDENTITY AT TRAILING END OF TAPE

Tape identity at the trailing end of an input tape follows immediately after the last call entry. The circuit reads 2891XX, and the 28A relay 3106 operates as before. The TICA relay 3417 now operates from a ground over the front contact and armature 4 of the 28A relay 3106, over the TICA conductor, the armature 2 and front contact of the TIC relay 3400 to the winding of the TICA relay. The TICA relay locks to the armature 9 and front contact of the ST3A relay, over conductor 1714, armature 1 and back contact of the ESK relay 2702, the SKWS conductor, the armature 2 and front contact of the TICA relay 3417. The 28A relay causes the operation of the 28B relay 3102 in an obvious circuit, and of the 28C relay during the next reader open period, the latter relay over a circuit extending through the reader contact KH, the KB2 conductor 2016, and the armature 2 and front contact of the 28A relay 3106. The 28C relay, operating during this next reader open period, operates the PCA relay 3107 as before described. The circuit then checks the nine tape identity entries as described in sections 12.04 to 12.09 and 12.11 to 12.13. The operation of the CL1 relay 3409 during the checking of the tape index releases the TIC relay 3400 which releases the OFS, THS, HS, TS or US relay of either Fig. 57 or Fig. 44, which has been operated, preventing the circuit from handling any call entries until tape identity has been fully checked at the reading end of the next tape section. This is to prevent the operator from skipping manually past tape identity in the event that it fails to check. Only one cycle is required for checking tape index, since the tape index register relays of Figs. 24 and 25, if required, are already operated from the tape index entry at the beginning of the tape. With the TIEA relay 2600 operated, the FT1 relay 2304 does not operate and the TD selector is not stepped. During the check of month, the LLA relay 2803 is operated through the conjoint operation of the TIEA relay 2600 and the L9 relay 3510. This releases the LK1 relay at the end of the line in which month is checked, and also releases the 28B and 28C relays in Fig. 31. Satisfactory checking of month is used to operate the RS1—3 relay 1800, now that the TIEA relay 2600 is operated, instead of to operate the TIS relay 2602, as was done at the corresponding part of the first tape.

15.02 SKIPPING SKIP SPLICE ENTRY AND SPLICE PATTERN

When the reader steps off the month tape identity line, it reads the skip splice entry 2860XX (the E and F digits represent the number of the machine which produced the tape). During the reader closed period the PCB relay 3108 and the reading relays operate. Ground from the reading check path operates the 28A relay 3106 which operates the 28B relay 3102. In the open period of the reader the PCA and PCB relays release as hereinbefore described and the 28C relay 3100 operates. The 28A relay locks until the end of the open period and then releases. When the reading relays operate in the next closed period, the LK1 relay 2800 operates over a circuit hereinbefore described. Under this condition where the A2 relay is operated and the A0 and A1 reading relays are normal, the SKP relay 2706 operates from the check path which may be traced through the CC lead, the armature 7 and front contact of the C2 relay 3002, the armature 7 and front contact of the C4 relay 3006, the CD6 lead through the armature 2 and front contact of the 28B relay, the 286 lead to the winding of the SQP relay 2706. The LK1 relay 2800 and the LKP relay 2706 operate the SK1 relay 2704 which, in turn, operates the PS2—4 reader step relay 1801 to step the reader. The SKP relay 2706 remains operated until the end of the reader closed period. The SK1 relay 2704 locks to the front contact and armature 8 of the LK1 relay and opens the ground by which the reader step relay recycles the short timer each time it operates. The next line read is the splice code 081010 which operates the A0 reading relay 2900. The A0 relay operates the SK2 relay 2701, through the front contact and armature 6 of the SK1 relay 2701. The SK2 relay 2702 locks to the ST3A relay through the back contact and armature 1 of the ESK relay 2702. Another circuit for locking the SK2 relay in parallel with the armature 1 and back contact of the ESK relay 2702 may be traced both through the back contact and armature 1 of the SKW relay 2705 to conductor 3406 and over the SKWS conductor, armature 4 and back contact of the TIC relay 3400 to conductor 3406, thence through back contacts and armatures of the L1T relay 3402, the L1UA relay 3403 and L1 relay 3404 to the ON2 conductor 1714. The operation of the SK2 relay prevents the RS2—4 relay from shunting down the RSR relay 1402, operates the LLA relay 2803 through the SK1 relay 2704 when the J7 reader contact closes and provides another locking

ground for the 28C relay 3100. The SK2 relay connects the RS2—4 reader step relay in a circuit from the J7 contact over the conductor 2015, the normal contacts of armature 4 of the ESK relay 2702, the conductor 2703, the back contact and armature 8 of the AL relay 1400, thence in a circuit including a back contact and armature of the L1T relay 3402, the L1UA relay 3403, the L1 relay 3404, conductor 3405, the armature 4 and back contact of the SKW relay 2705, the armature 5 and front contact of the SK2 relay 2701, conductor 4315 to the winding of the RS2—4 relay 1801. Thus, the reader step relay is placed in a circuit where it will automatically operate until the alarm relay 1400 or the ESK relay 2702 operates. It will be noted that the ESK relay is known as the "end of the skip relay" and will be operated under a number of conditions which indicate that the end of this operation has arrived. The AL relay is the alarm relay and will operate under certain unstandard conditions which will be described hereinafter.

15.03 END OF INPUT TAPE

The circuit continues to skip splice until the end of the tape permits the additional reading relays to operate, provided the sections of tape are not spliced together or until the A2 reading relay operates on the first tape identity line at the start of the next section of the tape, if the sections are spliced together. If the tapes are not spliced and the tape runs out of the reader the circuit brings in an alarm as described in section 22.

15.04 STARTING NEW TAPE

If the tapes are not spliced together and the circuit has blocked, it is released by the operation of the machine release key 3205, as will be hereinafter described in section 22. The motor is then started and the new tape is fed in. The circuit proceeds as described in sections 12.01, 12.02 and 12.03 to skip the splice at the beginning of the new input tape, stopping when it reaches the code 2891XX. If the tapes are spliced together, the circuit skips without stopping from the skip splice entry near the end of the previous tape to the code 2891XX on the new tape.

15.05 CHECKING TAPE INDEX

15.051 GENERAL

If the machine is processing message unit tapes alone, summary tapes alone, toll tapes, message unit detail tapes or observing tapes, the tape index of the new tape will be the same as the tape index of the previous tape. Under the conditions described in section 12.041 the circuit will operate exactly as described there. Under the conditions described in section 12.043 where the X1A relay 2404 and the X1B relay 2403 have been previously operated, the X1B relay 2403 will be locked in its operated position and the check will be completed in one cycle of the reader instead of the two originally required. Under the conditions described in section 12.042 where message unit and summary tapes are being processed together, there are several possible conditions.

15.052 NEW TAPE INDEX SAME AS PREVIOUS TAPE INDEX

If the new tape has the same index as the previous tape, tape index is checked in one reader cycle because the tape index register relays, the 11, 12, 17 or 18 relays of Figs. 24 and 25 will still be operated.

15.053 TAPE INDEX 17 FOLLOWS TAPE INDEX 11

If the previous tape index was 11, then the 11B relay 2502 will be operated. On the first reader cycle, the 17A relay 2406 operates from ground, armature 4 and front contact of the L1UA relay 3403, conductor 3407, armature 8 and front contact of the 28B relay 3102, the FC conductor 3110, the FD7 conductor (the F digit reading relays will be set to express the value 7), armature 10 and front contact of the L1UA relay 3403, the FD7A conductor, front contact and armature 8 of the 11B relay 2502, armature 10 and back contact of the 17B relay 2402, to the winding of the 17A relay 2406 which thereupon operates. The 17A relay 2406, through its armature 4 and front contact, grounds the TDS conductor leading directly to the winding of the TDS relay 2314. Ground from armature 11 and front contact of the MON master off-normal relay 1703 is extended through the armature 5 and back contact of the CL8 relay 3500, thence over the TDSL conductor to lock the TDS relay 2314 through its front contact and armature 1. In the reader open period the 17B relay 2402 will operate, thus releasing the 17A relay 2406 and the 11B relay 2502. In the second closed period of the reader, the tape index check is completed through the 17B relay 2402.

15.054 TAPE INDEX 17 FOLLOWS TAPE INDEX 12

If the previous tape index was 12, then the 12B relay 2401 will have been locked through the back contact and armature 6 of the 17B relay 2402. If the LTD relay 2307 is also operated, indicating that all the twelve tapes have been received, the 17A relay 2406 operates on the first reader cycle from ground and thence over the circuit just above described. The 17A relay 2406 again operates the TDS relay 2314 which locks as previously described. The RTD relay 2308 operates in a circuit from ground, armature 7 and front contact of the 12B relay 2401, armature 1 and front contact of the 17A relay 2406 to the winding of the RTD relay 2308. In the reader open period the 17B relay 2402 operates, thus releasing both the 17A relay 2406 and the 12B relay 2401. The momentary operation of the RTD relay just prior to the release of the 12B and 17A relays, serves to release the tape section selector TD (Fig. 23) by operating the release magnet 2301 if the off-normal switch has been operated so that the conductor 2300 is grounded. In the second closed period of the reader the tape index check is completed through the 17B relay 2402.

15.055 TAPE INDEX 18 FOLLOWS TAPE INDEX 13

If the previous tape index had been 13, then the 13B relay 2503 will have been operated and locked under control of armature 7 and back contact of the 18B relay 2504. On the first reader cycle, the 18A relay 2509 will operate in a circuit similar to that hereinbefore described, but this time coming out over the FD8 lead from the F reading relays which must now express the value 8, over the front contact and armature 8 of the L1T relay 3402, the FD3A conductor, the front contact and armature 7 of the 13B relay 2503, the armature 10 and back contact of the 18B relay 2504 to the winding of the 18A relay 2509. In the reader open period the 18B relay 2504 operates and releases the 18A relay 2509 and the 13B relay 2503. The operation of the 18B relay 2504, through its front contact and armature 8, also extends the MON6 lead to the winding of the 18C relay 2510 which now becomes operated and locked through its armature 1 and front contact of the 18CL conductor, the back

contact and armature 2 of the TK relay 2315 to the ground on the MON6 conductor, supplied by the armature 4 and front contact of the master off-normal relay 1703. In the second closed period of the reader the tape index check is completed through the 18B relay 2504.

15.056 TAPE INDEX 13 FOLLOWS TAPE INDEX 18

If the previous tape had been an 18 type tape, then the 18B relay 2504 and 18C relay 2510 would have been locked in their operated positions. In the first reader cycle, the 13A relay 2501 will operate over a circuit similar to that hereinbefore described, but coming out at this time on the FD3 lead since the F digit reading relays must express the value 3 at this time, over the front contact and armature 9 of the LIT relay 3402, the 13A conductor through the front contact and armature 11 of the 18B relay 2504, the armature 8 and back contact of the 13B relay 2503 to the winding of the 13A relay 2501. The 13A relay operates in this circuit. In the following reader open period the 13B relay 2503 operates and releases the 18B relay 2504 and the 13A relay 2501. In the second closed period of the reader the tape index check is completed through the 13B relay 2503.

15.06 CHECKING MARKER GROUP, FIRST AND LAST RECORDER, OFFICE AND THOUSANDS RANGE

The circuit reads and checks tape identity lines 2892XX, 2893XX, 2894XX, 2895XX and 2896XX as described in sections 12.05 to 12.08, inclusive.

15.07 RESETTING TAPE SECTION SELECTOR

15.071 GENERAL

On units sort of message unit and summary tapes combined, it is necessary to move the tape section selector TD following the check of first and last thousands. If tapes 11 and 17 are being processed together, the selector TD remains normal during the processing of tape 11 and must be set to an initial position corresponding to the Thousands First switch following thousands check of the first tape 17. If tapes 12 and 17 are being processed together, the selector TD is used to count the twelve tapes, then following thousands check on the first 17 tape it must first be restored to normal and then advanced to an initial position corresponding to the thousands first switch.

15.072 TAPE INDEX 17 FOLLOWS TAPE INDEX 11

During the tape index check of the first 17 type tape, the TDS relay 2314 also operated as described in section 15.053. When the CL6 relay 3506 operates following the check of first and last thousands, the FT1 relay 2304 is operated in the open period of the reader to advance the selector to its initial position. This path is from ground, the reader contact K8, over the front contact and armature 7 of the CL6 relay 3506, the FT1E conductor 3513, the front contact and armature 2 of the TDS relay 2314, the FT1D conductor, the armature 2 and front contact of the U relay 3600, the FT1C conductor, the armature 8 and front contact of the MUAS relay 3303, the FT1A conductor, the back contact and armature 3 of the 11B relay 2502, the FT1 conductor, back contact and armature 3 of the FT2 relay 2305 to the winding of the FT1 relay 2307. The FT1 relay locks in the circuit hereinbefore described. In the following reader closed period the rotary magnet 2306 of the selector TD is operated from ground on the KM3 conductor 2004 through the armature 5 and front contact of the FT1 relay 2304, the back contact and armature 4 of the FT2 relay 2305, the back contact and armature 5 of the LTD relay 2307, conductor 2308, back contact and armature 3 of the ALA relay 1411, conductor 1412 to the winding of the rotary magnet 2306. The selector steps from its normal position to the position corresponding to tape digit 0. At the end of the closed period of the reader the rotary magnet 2306 releases. During the next closed period, the selector takes another step unless the FT2 relay 2305 has operated. It continues to take one step for each reader cycle until stopped by the operation of the FT2 relay. The FT2 relay is operated by ground from the reader contact K3 over the KB0 conductor 2017, the front contact and armature 2 of the FT1 relay 2304, the back contact and armature 4 of the STD relay 2307, the selector switch arm 2303 in the position to which it has been driven, thence through the Thousands First switch arm 4120, the FTD lead through the armature 7 and front contact of the U relay 3600, over the FTD lead 3609, the armature 2 and front contact of the FT1 relay 2304 to the winding of the FT2 relay 2305. The operation of the FT2 relay releases the FT1 relay, the former relay locking through its front contact and armature 4 to the MON3 lead grounded by the master off-normal relay 1703. The FT2 relay connects the winding of the E digit EC connector relay 2310 in parallel with the winding of the L8 relay 3507. The release of the FT1 relay 2304 prevents further stepping of the selector TD at this time.

15.073 TAPE INDEX 17 FOLLOWS TAPE INDEX 12

During the tape index check of the first type 17 tape, the TTD and RTD relays were operated as described in section 15.054. The RTD relay 2308 locks through the front contact and armature 1 of the 17A relay 2406 to ground on the front contact and armature 7 of the 12B relay 2401, and causes the release of the FT2 relay 2305 and the LTD relay 2307. The RTD relay 2308 also closes a circuit for the operation of the release magnet 2301, thus restoring the selector to normal. The release circuit is opened by the off-normal springs when the selector reaches its normal position. When the CL6 relay 3506 operates, the completion of the first and last thousands check, the selector is normal and the FT1 relay 2304 operates. The selector is stepped as described in section 15.072.

15.08 SKIPPING DAYS OF ROUND

The 2897XX line is skipped in the same manner as described in section 12.11.

15.09 CHECKING TAPE SECTION IN ROUND

15.091 GENERAL

At the start of the first input tape of a run, the tape section must check with the selector TD, which has stepped either to 0 or to a position corresponding to the Thousands First switch. On subsequent tapes, the tape section may agree with the selector setting, or it may be one greater than the selector setting. In the latter case, the selector is advanced one step, and on the following reader cycle, the tape section check is completed.

15.092 TAPE SECTION AGREES WITH SELECTOR

The tape section check, where the tape section and the selector agree, is described in section 12.12. For those tapes where the tape section is not checked, the selector is normal and the check is omitted. Round is checked in all cases.

15.093 TAPE SECTION IS ONE GREATER THAN SELECTOR

If the tape section of the input tape does not agree with the setting of the TD selector, the path for operating the RS1—3 relay 1800 is open.

If it exceeds the setting of the selector by 1, a path is closed to operate the STD relay **2307** as follows: Ground, armature **2** and front contact of the L8 relay **3507**, the EC conductor **3111**, armature **7** and front contact of the 28C relay **3102**, the EC conductor, thence out on one of the ED leads (let us assume ED5), through the corresponding armature of the EC relay **2310**, the number **5** terminal of the selector switch arm **2302**, back contact and armature **3** of the TDS relay **2314**, the SA conductor, front contact and armature **9** of the TIE relay **2605**, the SA conductor **2617**, front contact and armature **5** of the L8 relay **3507**, the STD conductor **3515**, the armature **6** and back contact of the 18B relay **2504**, and thence either over the back contact and armature **4** of the 18B relay **2503** or the front contact and armature **2** of the 18C relay **2510**, the STD conductor **2512** to the winding of the STD relay **2307**. This relay operates and locks in a circuit from ground, front contact and armature **8** of the 28C relay **3100**, the CLL conductor **3112**, the armature **3** and back contact of the PX relay **1500**, the CLL conductor **3501**, armature **3** and back contact of the CL8 relay **3500**, the STDL conductor through the armature **2** and front contact of the STD relay **2307**. The front contact of the TIE relay **2605** in this path prevents stepping the selector TD when reading the first input tape, which must agree with the initial setting of the selector. The back contact of the TDS relay **2314** prevents stepping the selector TD when the first tape 17 is being read. This tape must always agree with the initial setting of the selector. The contacts of the 18B relay **2504**, the 18C relay **2510** and the 13B relay **2503**, are provided so that the selector will not step on tape 18 during a combined sort of tapes 13 and 18 but will step on tape 13 only if a tape 18 has already been processed. This is necessitated by the method in which tapes 13 and 18 are processed on tens sort. The lowest numbered tape 13 is sorted first, followed by the correspondingly numbered tape 18. Then the next section of tape 13 is processed followed by the corresponding tape 18, etc. When the STD relay operates as described it will lock in the circuit just above described, and will connect the TK relay **2315** to the reader back contact K8 over the KB2 conductor **2016**. The operation of the STD relay **2307** completes a circuit from ground, its front contact and armature **5**, over the back contact and armature **5** of the LTD relay **2307**, the conductor **2308**, the back contact and armature **3** of the ALA relay **1411**, conductor **1412** to the winding of the rotary magnet **2306** so that the rotary magnet of the selector operates, stepping the selector forward one position. During the reader open period the TK relay **2315** operates and locks through the back contact and armature **2** of the PX relay **1500**. The operation of the TK relay **2315** releases the 18C relay **2510**, and closes the circuit opened at the back contact and armature **4** of the STD relay **2307**, now through the front contact and armature **3** thereof and the front contact and armature **3** of the TK relay **2513** for the operation of the RS1—3 relay **1800**. If the tape section and the selector setting now agree, and if the number of the round agrees with the setting of the Round switch, the reader step relay operates, followed by the operation of the CL8 relay which, at its armature **2** and back contact, opens the holding circuit for the STD relay so that this relay now becomes released. The operation of the RS1—3 relay **1800** steps the reader to the next line.

15.094 LAST TAPE SECTION

During the check of month, the LTD relay **2307** is connected to the selector TD, and if the selector is in the position corresponding to the last tape section expected on the run, the LTD relay operates. The path is from ground, back contact and armature **10** of the CL6 relay **3506**, the TDG conductor **3607**, the selector arm **2303**, and thence either through one of the ten conductors leading from the EC relay to the Thousands Last switch arm **4121** and over the LTD conductor through the front contact and armature **8** of the U relay **3600**, or alternatively over the conductor **9** reached by the selector switch arm **2303**, thence through either the front contact and armature **8** of the HATH relay **3606** or the front contact and armature **9** of the T relay **3601** to the front contact and armature **7** of the L9 relay **3510**, thence over the LTD conductor to the front contact and armature **1** of the FT2 relay **2305** to the winding of the LTD relay **2307**. On tens, hundreds and second thousand sorts, the LTD relay **2307** operates when the selector TD is in the position corresponding to tape section 9. On units sort the LTD relay operates when the position of the selector corresponds to the setting of the Thousands Last switch. The LTD relay locks from ground, armature **10** and front contact of the MON master off-normal relay **1703**, over the MON2 conductor through the armature **2** and back contact of the RTD relay **2308** through the armature **2** and front contact of the LTD relay. The LTD relay opens the circuit to the rotary magnet **2306** and opens one of the paths for operating the 17A relay **2406**. The operation of the LTD relay also makes the end-of-tape key effective under certain conditions.

The LTD relay lights the last section lamp over a circuit from ground, armature **9** and back contact of the MUAS relay **3303**, the LP conductor, the front contact and armature **3** of the LTD relay **2307** and the LS conductor to the next section lamp in Fig. 22. This lamp will light under these conditions for all sorts except those involving combined message unit and summary tapes during which times MUAS relay **3303** is operated. In these cases, the lamp is lighted over a circuit from the front contact and armature **2** of the 17B relay **2402**, or the armature **2** and front contact of the 18B relay **2504**. Instead of lighting as soon as the LTD relay **2307** operates while a message unit tape is in process therefor, the lamp waits until the summary tape is being handled. If tapes 12 and 17 are being processed together on units sort, the LTD relay must be operated before a tape 17 can be accepted (see section 15.054). When tape 17 is read, it operates the RTD relay **2308** which releases the LTD relay (see section 15.073).

15.10 CHECKING MONTH

Month is checked as described in 12.13 except that with the TIE relay **2605** operated, the RS1—3 relay **1800** operates upon satisfactory completion of the check. The operation of the reader step relay with the L9 and TIE relays operated reoperates the TIC relay **3400** through the back contact and armature **1** of the TICA relay **3417**, indicating that the tape identity has been checked and calls may now be processed.

16. END OF LAST INPUT TAPE

16.1 CHECKING TAPE IDENTITY

Tape identity appearing at the trailing end of the last input tape is checked in the usual manner as described in sections 12.04 to 12.09, 12.11, 12.12 and 12.13. At the start of the last

tape the tape, section selector TD steps to the position corresponding to the tape section of the last tape accepted, and the LTD relay operates as described in section 15.094. The TIC relay 3400 releases at the start of the tape identity. After the month check, the circuit advances to the skip splice entry 2860XX.

16.2 TAPE RUNS OUT

The reader skips the skip splice entry and all the splice pattern which follows until the input tape runs out of the reader, the circuit blocks and the alarm is brought in. The lighted last section lamp indicates that the last tape has been received (see section 15.02).

16.3 PERFORATING TAPE IDENTITY AT TRAILING END OF OUTPUT TAPES

After all the input tapes for a run have been processed and the circuit has been released, the end-of-tape key 3208 is operated to perforate tape identity skip splice entry and splice pattern on the end of all output tapes. This key is effective only after the proper tapes have been processed.

a. Office and first thousands sorts

The end-of-tape key now closes a circuit from ground, armature 2 and back contact of the WSA relay 4900, the armature 1 and back contact of the WSB relay 4902, the WSN conductor 4914, the armature 10 and back contact of the ST3A relay 1705, the WN conductor 1706, thence through either the armature 1 and front contact of the OFB relay 3602, or armature 1 and front contact of the FTH relay 3603, the PT1A conductor, armature 8 and front contact of the TIE relay 2605, the PT1 conductor through the armature 6 and back contact of the TIE relay 3400, the PT1 conductor 3418, the inner right-hand contacts of the end-of-tape key 3208, the B conductor to the winding of the PTI relay 3710.

b. Units sort—Tape 11, 21, 31 or 41 alone

The end-of-tape key operates the PTI relay 3710 through the same circuit just above traced, except that the circuit from the WN conductor 1706 now finds a path through the front contact and armature 2 of the X1B relay 2403.

c. Units sort—Tapes 11 and 17 together

The end-of-tape key is not effective until the LTD relay 2307 has operated and the 11B relay 2502 has released. This insures that tape 11 and all tapes have been processed. The PTI relay 3710 is then operated from the ground on the WN conductor 1706, through the back contact and armature 1 of the 12B relay 2401, the back contact and armature 2 of the 11B relay 2502, the back contact and armature 1 of the 13B relay 2503, PT1B conductor through the front contact and armature 1 of the LTD relay 2307 and thence over the PT1A conductor through the contacts of the end-of-tape key as previously described to operate the PTI relay 3710.

d. Units sort—Tapes 12 and 17 together

The end-of-tape key is not effective until the LTD relay has operated and the 12B relay has released. This insures that all tapes 12 and 17 have been processed. The PTI relay operates over the path just described.

e. Units sort—Other tapes

The end-of-tape key is effective as soon as the LTD relay operates. The PTI relay operates over the path just above described.

f. Tens sort—Tapes 13 and 18 together

The end-of-tape key is not effective until the LTD relay has operated and the 13B relay 2503 has released. This insures that all tapes 13 and 18 have been processed. The PTI relay operates over the path described in paragraph *c* above.

g. Tens, hundreds and second thousands sorts

The end-of-tape key is effective as soon as the LTD relay 2307 operates. The PTI relay operates over the path described in paragraph *c* above.

The PTI relay is locked to ground on the MON9 conductor 3206 through the right-hand contacts of the machine stop key 3205, the RLML conductor 4901, the back contact and armature 4 of the WSP relay 1609, the PTIL conductor 1610, and thence through the armature 4 and front contact of the PTI relay 3710 and the winding thereof. Another path for locking this relay may also be traced from ground through the armature 2 and back contact of the WSA relay 4900, the WSAN conductor through the outer right-hand contacts of the end-of-tape key 3208 to the PTIL conductor 1610. The PTIL relay operates the TE relay in an obvious circuit from its armature 5 and front contact which, in turn, operates the TIS relay from the armature 2 and front contact of the TE relay over the TIS conductor 3704. The TE relay also closes a circuit through its armature 1 and front contact to operate the release magnet 2301 of the selector switch TD providing the off-normal contacts 2311 are operated, thus restoring the selector to normal. When the selector is restored, the movement of these off-normal contacts to the position shown opens the circuit of the release magnet 2301.

The TIS relay 2602 operates the ME relay 4903 from its armature 11 and front contact and this, as before described, opens the circuit for operating the RCA—B—C connector relay 1902. In the first open period of the reader following the operation of the ME relay, the ST1 relay 1707 operates over a circuit heretofore traced from the H8 reader contact, back contacts of the RS2—4 relay 1801, RS1—3 relay 1800, the LK1 relay 2800, the armature 1 and front contact of the ME relay 4903, the front contact and armature 7 of the TE relay 3702, the armature 2 and back contact of the ST2 relay 1709, the armature 2 and back contact of the RLS relay 1710 and the front contact and armature 2 of the RLM relay 1603 to the winding of the ST1 relay 1701. The ST1 relay operates the RCD relay 2001. The ST2 relay 1709 operates at the end of the open period when the original operating circuit of the ST1 relay is broken by the H8 reader contact and the ST3 and ST3A relays operate in the following open period. When the TIS relay 2602 operates, it shunts down the battery at the TI relay 2200 and operates the B1 and B7 reading relays. The TIS relay also operates the PX relay 1500 during the reader open period from ground at the contact K3 of the reader through the front contact and armature 8 of the RCD relay 2001, the conductor 2003, the front contact and armature 4 of the TIS relay 2602, the PX conductor 2606, the armature 1 and back contact of the W2A relay 1501, conductor 1808, armature 2 and back contact of the WSP relay 1609, thence through a chain circuit to the armature 1 and back contact of the W1 relay 1501, conductor 1502 to the winding of the PX relay 1500. The PX relay locks in a circuit from the front contact and armature 2 of the ST3A relay 1705, the back contact and armature 6 of the RS1—3 relay

1800, the PLL conductor 1804, the front contact and armature 2 of the TIS relay 2602 and thence through a chain circuit including an armature and back contact of the PS2, PS3, PS1 and each of the PL relays to the armature 2 and front contact of the PX relay 1500. The PX relay prepares a path for the W1 relay 1503 so that this relay operates on the following reader closed period from ground applied by the reader contact K5 to the KM3 conductor 2004 leading through a chain circuit including an armature and back contact of the PS2, PS3, PS1 and all of the PL relays to the armature 1 and front contact of the PX relay 1500. During this same reader closed period, the A2 reading relay is also operated from ground at reader contact K1, front contact and armature 5 of the RCD relay 2001, the KM1 lead, back contact and armature 4 of the ESP relay 4905, the front contact and armature 5 of the ME relay 4903, the A2 conductor 4904, the front contact and armature 10 of the ST3 relay, conductor 1712, the armature 10 and back contact of the APC relay 4800, the A2 conductor 4801 to the winding of the A2 reading relay 2902. The A2 reading relay operates the LK1 relay 2800, from ground at the reader contact H6 through the front contact and armature 3 of the RCD relay 2001, the HM4 conductor, the armature 3 and back contact of the A0 reading relay 2900, the front contact and armature 4 of the A2 reading relay 2902, the back contact and armature 3 of the A1 reading relay 2902, the LK1 conductor 2905, the armature 3 and back contact of the PCA relay 3107, the LK1 conductor 3101 to the winding of the LK1 relay 2800. The LK1 relay locks to the front contact and armature 3 of the ST3A relay 1705, through the back contact and armature 6 of the LLA relay 2803, and thence through the armature 4 and front contact of the LK1 relay 2800 and the winding thereof. During the reader open period following the operation of the W1 relay 1503, the PL1 relay 1506 is operated over the following path: Ground at the reader contact K3, front contact and armature 8 of the RCD relay 2001, conductor 2003, the front contact and armature 4 of the TIS relay 2602, conductor 2606, the back contact and armature 1 of the W2A relay 1501, conductor 1809, the armature 2 and back contact of the WSP relay 1609 and thence in a chain circuit through an armature and back contact of the EP relay and the W9 to W2 relays 1507, the armature 1 and front contact of the W1 relay 1503, the P0 conductor 1504, the armature 1 and back contact of the PSP relay 3700, the PL1 conductor to the winding of the PL1 relay 1506. The PL1 relay now locks in a circuit heretofore employed for locking the PX relay 1500, and by opening this circuit, releases the PX relay 1500. The PL1 relay operates the C, D, E and F digit reading relays as described in section 13.02. The circuit now perforates nine lines of tape identity on each of the ten output tapes as described in sections 13.02 to 13.10. The EP relay 1611 operates when the last line (month) has been perforated as described in section 13.10.

16.4 PERFORATING SKIP SPLICE ENTRY AND SPLICE PATTERN AT TRAILING END OF OUTPUT TAPES

During the reader open period the PS1 relay 1616 is operated from ground at reader contact K3 through the front contact and armature 8 of the RCD relay 2001, conductor 2003, the front contact and armature 4 of the TIS relay 2602, the PX conductor 2606, the armature 1 and front contact of the RS1—3 relay 1800, the P0 conductor 1808, the armature 2 and back contact of the WSP relay 1609, the armature 2 and front contact of the EP relay 1611, conductor 1617, armature 2 and front contact of the PTI relay 3710, the PS1 conductor to the winding of the PS1 relay 1616. The PS1 relay locks through its front contact and armature 7 to the locking ground heretofore provided for by the PL relay. The PS1 relay, in operating, operates the PHK relay over the conductor 1614. The PS1 relay operates the C2, C4, D4 and D7 reading relays and two E and two F reading relays. Each sorter is wired to operate a particular set of E and F relays representing the machine number assigned to it. With the PS1 relay operated the code 2860XX is perforated on all output tapes (XX is the machine number just mentioned). The perforator hold check described in section 11.6 is made while this line is being perforated. After the code 2860XX is perforated, a series 081010 splice pattern lines is perforated on all tapes as described in sections 11.7 and 11.8. In order to perforate 2860XX, the A2 perforator magnet is connected through the connector relay and series check relay and through the WS2 and WS1A—C relay 4301 and the A2S relay by means of the reader contact PA2. During the break period after the operation of the WSP relay 1609, the WS2 relay 4300 is operated by ground from the reader break contact K3 through the front contact and armature 8 of the RCD relay 2001, conductor 2003, front contact and armature 4 of the TIS relay 2602, the PX conductor 2606, the armature 1 and front contact of the RS1—3 relay 1800, the P0 conductor 1808, the armature 2 and front contact of the WSP relay 1609, the front contact and armature 2 of the W2A relay 1501, the PS2 conductor, the front contact and armature 4 of the PHK relay 5400, the PS2 conductor 5416, the back contact and armature 6 of the PSP relay 3700, the WS2 conductor 3701 to the winding of the WS2 relay 4300. This opens the circuit to the A2 perforator magnet 5415, and connects the A0 perforator magnet 5402 to the reader contact PA2 over the PA2 conductor 2011, the armature 3 and front contact of the A2S relay 4806, the PA conductor 4810, the armature 1 and back contact of the WS1D relay 4302, the armature 2 and front contact of the WS2 relay 4300, the PA0 conductor 4303 through the corresponding armature of the perforator connector relay such as the PA0 relay 5100 to the A0 perforator magnet 5402.

16.5 RESTORING CIRCUIT

When sufficient splice pattern has been perforated on the output tapes, the operator releases the end-of-tape key 3208. Release of the key opens the operating path for the PTI relay 3710, but this relay remains locked until the WSP relay 1609 operates so that the circuit will perforate nine lines of tape identity and perforate the skip splice entry. At the start of spreading the 2860XX code, the WSP relay is operated, releasing the PTI relay 3710 if the end-of-tape key has been restored. The PTI relay opens the operating circuit for the TE relay 3702, leaving it locked to the ST3A relay 1705. Perforation continues until the code has been spread across all perforators. The RS1—3 relay 1800 operates at the end of this process. The ground from the H3 reader contact may be traced over conductor 2008 from the H8 reader contact, the front contact and armature 6 of the RCD relay 2001, the HB2A conductor 2008, the armature 12 and front contact of the RS1—3 relay 1800, conductor 1807, armature 5 and front contact of the PS2 relay

1613, the RL conductor, the front contact and armature 3 of the TE relay 3702, the armature 2 and back contact of the PSP relay 3700, the armature 3 and back contact of the PTI relay 3710, the MRL conductor, armature 2 and front contact of the TIE relay 2605 to the winding of the MRL relay 1600. This relay locks to the ground on armature 8 and front contact of the MON master off-normal relay 1703 through its front contact and armature 3. The ground on the MRL conductor at the front contact of armature 3 of the PTI relay is also extended through the front contact and armature 4 of the TE relay 3702, the RLS conductor leading to the winding of the RLS relay 1710 so that the RLS relay operates and locks to the ground supplied by the front contact and armature 1 of the RCD relay 2001. The RLS relay, in operating, releases the ST1, the ST2, the ST3 and the ST3A relays. With the release of these relays, all the relays in the circuit are released except those associated with the MON master off-normal relay 1703, the RSR relay 1402 and the motor 1903.

16.6 STOPPING MOTOR

When the MRL relay 1600 operates, it locks to the MON master off-normal relay 1703 as described and opens the locking circuit of this master off-normal relay, leaving it held only by the MST relay 1602. The release of the MST relay releases the motor relay in the alternating-current power and distributing circuit 1608, removes battery from the step magnet 1902 and releases the MON master off-normal relay 1703. The release of the MON relay releases all other relays.

17. WINDOW SPLICE IN INPUT TAPE

17.1 SKIPPING SKIP WINDOW ENTRY

The input tape may have a window splice in it at any point except in portions that contain call entries or a series of tape identity entries. The window splice is perforated by the preceding machine to cover the splice in the tape. It consists of a series of 081010 codes covering the actual splice and is both preceded and followed by a 287020 code line. An exception is made in that if the splice occurred while splice pattern was being perforated at the end or beginning of a tape, the 287020 lines are omitted. In this case, the window splice is merely a prolongation of the regular splice pattern and is passed by unnoticed. When the sorter reads the skip window entry 287020 the A2 reading relay operates the LK1 relay 2800 which locks through the LLA relay 2803. It may be noted that the back contact and armature 6 of the LLA relay 2803 is in parallel with a connection through the back contact and armature 8 of the RS1—3 relay 1800 and the back contact and armature 5 of the RS2—4 relay 1801. The reading check lead through the A digit reading relays and through or around the B digit reading relays (depending upon the type of tape being processed) operates the 28A relay 3106. The 28A relay in turn operates the 28B relay 3102 and connects the 28C relay 3100 to a reader back contact so that the 28C relay operates in the reader open period. The 28C relay locks itself to the 28CL conductor 2613 to which ground is extended from ground, front contact and armature 7 of the LK1 relay 2800, the armature 1 and back contact of the LLA relay 2803, the conductor 2009, back contact and armature 1 of the APD relay 4303 to the 28CL conductor 2613. The PCA relay 3107 is operated from the ground on armature 6 and front contact of the STA relay 1705, conductor 1716, armature 4 and front contact of the 28C relay 3100 to the winding of the PCA relay 3107. In the next reader closed period when the reading relays operate, the reading check path 2908 is extended through the back contact and armature 4 of the LK2 relay 2804, over the CK2 conductor 2808, thence through the front contact and armature 6 of the A2 relay 2902, the back contact and armature 5 of the A1 relay 2901, the back contact and armature 5 of the A0 relay 2900, the AD2 conductor 2907 and thence to the 28X conductor 3306, over a number of possible paths: (1) through the armature 5 and front contact of the OBS relay 3300, (2) the armature 4 and front contact of the DET relay 3307, (3) the armature 5 and front contact of the MU relay 3302, thence over conductor 3305, the armature 4 and front contact of the B7 reading relay 2904, the front contact and armature 7 of the B1 reading relay 2903, the armature 8 and back contact of the B4 reading relay 2908, the BD conductor 2909, the armature 4 and front contact of the MU relay 3302 to the 28X conductor 3306, (4) over a similar path including the armature 6 and front contact of the MUAS relay 3303 and the armature 5 and front contact of this same relay, (5) over a similar path including the armature 6 and front contact of the MUS relay 3304 and the armature 5 and front contact of this same relay, thence from the 28X conductor 3306, over the armature 2 and back contact of the ME relay 4903, conductor 4909, the armature 1 and front contact of the 28C relay 3100, the armature 1 and front contact of the 28B relay 3102, the CC conductor, thence out over the CD7 lead (the C digit is 7 in this instance), the armature 3 and front contact of the 28B relay 3102, the 287 conductor to the front contact and armature 9 of the TIC relay 3400, over the SKW lead to the winding of the SKW relay 2705. The SKW relay operates, in turn causing the operation of the SK1 relay 2704 from the armature 8 and front contact of the LK1 relay 2800. The SK1 relay 2704 locks to this same ground and, in turn, operates the RS2—4 relay 1801 from a ground at the back contact and armature 5 of the SK2 relay 2701, the front contact and armature 3 of the SK1 relay 2704, the front contact the armature 3 of the SKW relay 2705, to the RSE conductor 4305 leading to the winding of the RS2—4 relay 1801. At the end of the closed period, the SKW relay 2705 releases when the reading relays release and the reader steps to the next line.

17.2 SKIPPING SPLICE PATTERN

The next line on the input tape is 081010 which operates the A0 reading relay. This operates the SK2 relay 2701 directly from the front contact and armature 9 of the A0 relay 2900, the A0G lead through the armature 6 and front contact of the SK1 relay 2704. The SK2 relay locks to the ground supplied from armature 9 and front contact of the ST3A relay 1705 through the armature 1 and back contact of the ESK relay 2702. Another locking circuit for the SK2 relay is provided from the ground on armature 9 and front contact of the ST3A relay 1705, over the conductor 1714, thence through the armature 3 and front contact of the TIC relay 3400, over the SK2L conductor 3406, the armature 1 and back contact of the SKW relay 2705 to the front contact and armature 4 of the SK2 relay 2701. The operation of the SK2 relay 2701 prevents the RS2—4 relay 1801 from shunting down the RSR relay 1402. The operation of

the SK2 relay also places a ground through its armature 9 and front contact on the 28CL conductor 2613 to hold the 28C and 28B relays. In addition, the SK2 relay completes a circuit from the J7 reader contact over the JM5 conductor 2015, the front contact and armature 6 of the SK2 relay 2701, the front contact and armature 4 of the SKI relay 2704, thence over the LL lead to the winding of the LLA relay 2803, which is then locked to the ground on the front contact and armature 7 of the LKI relay 2809. The SK2 relay opens the path over which the RS2—4 relay 1801 was previously operated and connects the RSE conductor 4305 to the J7 reader contact in a circuit from the JM5 conductor 2015, the normal contacts of armature 4 of the ESK relay 2702, conductor 2703, the back contact and armature 8 of the AL relay 1400, conductor 1413, the back contact and armature 1 of the L1T relay 3402, the back contact and armature 1 of the L1UA relay 3004, the back contact and armature 2 of the L1 relay 3404, the SK conductor 3405, the armature 4 and back contact of the SKW relay 2705, the armature 5 and front contact of the SK2 relay 2701 to the RSE conductor 4305 leading to the winding of the RS2—4 relay 1801. With the RS2—4 relay and the LLA relay 2803 both operated, the LKI relay 2809 is released at the end of the reader closed period allowing the SKI relay 2704 to release. The RS2—4 relay now operates periodically under control of the J7 reader contact until either the ESK relay 2807 or the AL relay 1400 is operated so that the reader will pass through this part of the tape automatically.

17.3 SKIPPING SECOND SKIP WINDOW ENTRY

Window splice pattern is followed by a second skip window entry 287020. Therefore, the appearance of a 2 in the A digit is a signal to stop skipping. The A2 reading relay operates the ESK relay 2702 directly from the front contact and armature 9 of the A2 reading relay 2903. The ESK relay locks to the ground on the front contact and armature 11 of the SK2 relay 2701, through its own armature 3 and front contact. Again, as previously described, the reading of the code 287020 causes the operation of the SKW relay 2705. The ESK and SKW relays both open the operating path for the RS2—4 relay 1801 and the circuit stops skipping. The ESK relay is also operated by the E2 reading relay, which places a ground on the ESK conductor (as shown in Fig. 29) at armature 9 of the A2 reading relay 2902. This provides two normal paths for operating the ESK relay 2702. In the event of a tape irregularity which prevents the A2 or the E2 relay from operating, the ESK relay is operated by the E4, the E7, the FO, the F1 or the F2 relay so that the appearance of an E digit other than 1, or an F digit other than 0, operates the ESK relay. The appearance of an A1 or any B digit other than 8 operates the AL relay 1400 to bring in an alarm (see section 22). This also opens the operating path for the RS2—4 relay so that the circuit stops skipping. As a further safeguard against skipping too far, the short timer relay TM (see section 21.1) is recycled each time a 0 is read in the A digit. If the timer is not recycled, the AL alarm relay will be operated in approximately 0.25 second. This covers the time required to skip a splice between tapes where the reading pins may not penetrate the tape. The circuit for recycling the timer is from ground at the front contact and armature 9 of the A0 relay 2900, over the A0G lead through armature 5 and back contact of the SKI relay 2704, the armature 7 and front contact of the SK2 relay 2701, the armature 4 and front contact of the RS2—4 relay 1801, the TM conductor 4812 to the terminal of the timing condenser 1400. The LKI relay 2800 operates when the code 287020 is read, and this operates the SKI relay 2704 through the armature 3 and front contact of the SKW relay 2805. The SKW relay releases the SK2 relay and operates the LLA relay 2803 from the J7 reader contact, the JM5 conductor 2015, the operated contact of the armature 4 of the ESK relay 2702, the front contact and armature 5 of the SKW relay 2705 to the winding of the LLA relay 2803. The SKI relay locks as before described to the LKI relay 2800 and reoperates the RS2—4 relay 1801 from the back contact and armature 5 of the SK2 relay, the front contact and armature 3 of the SKI relay 2704, the front contact and armature 3 of the SKW relay 2705 to the RSE conductor 4305 leading to the winding of the RS2—4 relay 1801. At the end of this closed period, the reading relays, the SKW relay 2705 and the LKI relay 2800 release and the reader steps to the first line of the next entry.

18. WINDOW SPLICE IN OUTPUT TAPE

18.1 GENERAL

When the supply of paper to a perforator is nearly exhausted, a new length of paper is spliced on to the end of the old section. A window, consisting of a rectangular hole straddling the splice, is cut in the tape to provide an indication to the sorter that a splice is approaching. The sorter stops its regular processing and prepares a series of splice pattern lines on the spliced tape and then proceeds. This is done because the perforator cannot perforate through the extra thickness of a splice and the plastic material used for making this splice so that call entries might be lost. A finger in the paper chute leading into the perforator detects the window and closes a contact to stop the sorter and light an indicating lamp pointing to the perforator which caused the stoppage. The operator releases the circuit, starts the motor and operates a window splice key associated with this perforator. This causes the sorter to perforate a skip window entry 287020 followed by approximately forty lines of splice pattern 081010, followed by a second skip window entry 287020. The machine stops again and the operator restores the window splice key, starts the motor and operates the machine start key. The circuit does not stop upon receipt of a window signal from a perforator until it has finished a call entry or finished perforating tape identity. If the sorter is perforating splice pattern when the window signal comes in, the two skip window 287020 entries will not be perforated, the affected tape merely having its splice pattern extended by about forty lines to cover the splice. If the machine stops for a window while it is perforating splice at the beginning of the output tapes, the operator may find, after the window has been perforated, that the other tapes do not have sufficient splice pattern on them. She may then reoperate the end-of-tape key to perforate more splice. At the end of the output tapes, if the window signal occurs during the perforation of tape identity or skip splice entry, the machine waits until these have been perforated before stopping for the window. When the operator operates the machine release key to release the circuit before operating the

window splice key the circuit releases in the same way as when the end-of-tape key is released at this time. If, after the window splice has been perforated, the operator finds no splice pattern or insufficient splice pattern on the output tapes, she operates the motor start and end-of-tape key. Since the circuit has already released as though the run were completed, this causes the circuit to perforate splice pattern without tape identity, and the output tapes can be provided with sufficient splice pattern.

18.2 SKIP WINDOW ENTRIES

The WS1D relay determines whether the skip window and end window signals, 287020, are to be perforated. If the sorter is perforating splice at the beginning of the output tapes when the window signal is received, the TIE relay is normal. When relay WS1C operates, it operates relay WS1D through relay TIE normal. Relay WS1D prevents the perforation of 287020. If the sorter is perforating tape identity, the skip splice entry, or splice pattern at the end of the output tapes when the window signal is received, the circuit is completely released when the machine release key is operated. In this case, relay WS1D is also operated when relay WS1C operates and the 287020 lines are omitted. At the other times, relay WS1D will not be operated by relay WS1C and 287020 will be perforated before and after the forty lines of splice pattern.

18.3 STOPPING THE CIRCUIT FOR WINDOW SPLICE

Closure of the window contact in a perforator connects ground through one of the window splice lamps to the WSA relay, operating it. The lamp does not light in series with relay WSA. A resistor placed around each lamp prevents overlooking a window signal if a lamp is burned out. The operation of relay WSA releases relay RLM. Relay RLM opens part of the locking circuit of relay MST, leaving it locked to relay MON through relay ST3A, and releases relay ST1 and ST2. Relay ST2 opens the operating path and one of the locking paths for relay ST3, leaving it locked to a reader make contact and a make contact of relay LK1. The circuit continues until it has completed an entry, at which time the release of relay LK1 releases relay ST3, which releases relay ST3A. Relay ST3A releases relay MST and stops the motor. Ground from the back contact and armature 8 of the ST3 relay is extended over the NI conductor 1720 through the armature 3 and front contact of the WSA relay 4900 to the AL conductor leading to the AL relay 1400. The AL relay operates the ALA relay 1411 from the front contact and armature 2 of the AL relay 1400. The alarm is sounded and the WSB relay 4902 operates from the ground on the NI conductor 1720 through the armature 4 and front contact of the WSA relay 4900, the WSBA conductor, the armature 9 and front contact of the AL relay 1400, the WSB conductor to the winding of the WSB relay 4902. The WSB relay, by applying battery through its front contact and armature 2, shunts the WSA relay 4900 through its front contact and armature 3. The WSB relay locks to the ground on the NI conductor 1720. The placing of a direct battery connection on the winding of the WSA relay 4900 now supplies sufficient current to that one of the window splice lamps in Fig. 22 through which the connection to operate relay WSA was made to cause this lamp to glow at the present time (for a description of the action of the alarm AL and ALA relays see the following section 22). The operator now releases the circuit by operating the machine release key (see section 22). The operation of the WSB relay 4902 renders the machine start key ineffective.

18.4 STARTING THE CIRCUIT

After the motor has been started, the locking window splice key corresponding to the perforator which encountered the window is operated. This operates the WS relay 4910 and this, in turn, operates the WS1A—C relay 4301 and the WS1B relay 4307 from ground, armature 12 and back contact of the ST3A relay 1705, over the N2 conductor 1721, the front contact and armature 3 of the WS relay 4910 to the winding of relays WS1A—C and WS1B. The WS1B relay 4307 operates the ME relay from ground, its front contact and armature 11. The WS1B relay also operates the following reading relays directly: the B1, the B7, the C0, the D4, the D7, the E0, the F4 and the F7 relays. If the WS1D relay 4302 is normal, the C7 and E2 relays are operated by the WS1B relay through the armatures 2 and 3 of the WS1D relay 4302. If the WS1D relay is operated, then the C1 and E1 relays are operated in place of the C7 and E2 relays. When the ME relay, the WS1A—C relays have all operated, ground through the reader contact H8 is connected over conductor 2000, armature 7, the back contact and armature 7 of the RS2—4 relay 1801, the armature 10 and back contact of the RS1—3 relay 1800, the ST conductor through the back contact and armature 1 of the LK1 relay 2800, the ST conductor 2801, the armature 1 and front contact of the ME relay 4903, armature 3 and front contact of the WS1A—C relay 4301, the STA conductor 3706, the armature 2 and back contact of the ST2 relay and thence over a circuit previously traced to the winding of the ST1 relay, which will cause this latter relay to operate during an open period of the reader. In the next closed period, the ST2 relay 1709 operates followed by the operation of the ST3 and ST3A relays in the following open period. The ST3 relay, in operating, unlocks the WSB relay 4902, but this relay remains operated for the time being in a circuit from ground, the armature 10 and front contact of the WS1A—C relay 4309, the front contact and armature 2 of the WS relay 4910. In the reader closed period following the operation of the ST3 and ST3A relays the A2 reading relay operates from ground at the reader contact K1, the front contact and armature 5 of the RCD relay 2001, the KM1 conductor, the back contact and armature 4 of the ESP relay 4905, the front contact and armature 5 of the ME relay 4903, the A2 conductor 4904, the armature 10 and front contact of the ST3 relay 1702, conductor 1712, the armature 10 and back contact of the APC relay 4800, conductor 4801 to the winding of the A2 reading relay 2902. The reading check path is now closed through the A digit reading relay through or around the B digit reading relays (depending upon the type of tape), through the contacts of the ME relay 4903, the armature 5 and back contact of the APD relay 4803 to operate the APA relay 4804. The APA relay operates the SOB relay 5200, whose lead for operating the perforator connector relays is opened at the WS1A—C relay 4301. The APA relay also connects the APC relay 4800 to

a reader back contact so that the latter relay operates in the next open period of the reader. The APC relay locks through a back contact of the LLA relay to the ground supplied by the front contact and armature 7 of the LK1 relay 2800. The APC relay switches the lead which operated the A2 relay so that, in the next closed period, it operates the A2S relay 4806 in its stead. The APC relay, at its armatures 1 and 4, disconnects the RSO and RSE leads from the perforator connector relays so that the reader step relay circuits are opened at the present time. The operation of the APC relay operates the APD relay 4803 from a ground at the armature 3 and front contact of the S0B relay 5200. When the APD relay operates it releases the APA relay 4804 and locks to the ground supplied at the armature 5 and front contact of the APC relay 4800. The APC relay also extends the RSO and RSE leads from the perforator connector circuit to the winding of the SS relay 4802.

18.5 PERFORATING FIRST LINE OF WINDOW SPLICE PATTERN

At the beginning of the next closed period of the reader the A2S relay 4806 operates over the path previously used to operate the A2 relay. The A2S relay connects the A2 perforator magnet to a reader make contact through the WS2 relay 4300 if the WS1D relay 4302 is not operated, and connects the A0 perforator magnet to a reader make contact if the WS1B relay 4302 is operated. The A2S relay 4806 operates the FL relay 4308 from ground, front contact and armature 7 of the WS1A—C relay 4301, the WSG conductor through the armature 4 and front contact of the A2S relay 4806, the WSGA conductor, the armature 2 and back contact of the CP1 relay 4309 to the winding of the FL relay 4308. The FL relay locks through its armature 1 and front contact to the ground supplied at the front contact and armature 13 of the WS1B relay 4308, the back contact and armature 1 of the CP1 relay 4309, the resistor 4310, and thence through the armature 1 and front contact of the FL relay 4308, ground from the reading check lead extended over conductor 2903, the back contact and armature 4 of the LK2 relay 2804, conductor 2803, armature 2 and front contact of the A2S relay 4806, the CK3 lead, the armature 4 and front contact of the WS1A—C relay 4301, the C conductor 4311, and thence through a series circuit consisting of the normal right-hand contacts of the window splice keys to that one which is operated, and thence over a P conductor to operate the corresponding perforator connector relay such as the PA0 relay 5100. When the perforator connector relay operates, eleven magnets on the perforator operate to perforate the 287020 code if the WS1D relay 4302 is normal or the 081010 code if the WS1D relay is operated. The corresponding series K relays operate and the perforator register PD-relay of Fig. 50 also operates. When the contact on the reader closes, the PAM magnet, such as the PAM magnet 5405, is operated through its series PK relay such as the PK0 relay 5406. The perforating check lead is closed from ground at a back contact of the PHK relay 5400 connected to the conductor 5403, and is extended through the network of armatures and contacts controlled by the KA0 to KF7 relays, checking the proper operation of each group thereof, then through a chain circuit of the PK relays coming out on either the armature 1 or 2 of the PK0 relay 5406, thence through a chain circuit controlled by the PD-relays of Fig. 50, coming out on either the RSE conductor 4808 or the RSO conductor 4807, now connected through the armatures 2 and 3 of the APC relay 4800 to the winding of the SS relay 4802 to cause the operation of this relay. The SS relay locks to a reader back contact and operates the PHE relay 5407 and the PH0 relay 5411. At the end of the reader closed period the A2S relay 4806, the perforator connector relays, the perforating magnets and their series relays all release. Since the PHE and PH0 relays of Fig. 54 are operated, the PAM magnet and the PK relays release shortly thereafter when the reader contacts open and the perforator steps

18.6 PERFORATING SUBSEQUENT LINES OF WINDOW

In the open period, ground from the reader contact K3 through the front contact and armature 8 of the RCD relay 2001, over the KB0 conductor 2003, passes through the front contact and armature 7 of the SS relay 4802, the KB0C conductor, the armature 4 and back contact of the CP1 relay 4309, the armature 3 and front contact of the FL relay 4308 to the winding of the WS2 relay 4300. This relay operates and locks to the ground supplied by armature 13 and front contact of the WS1B relay 4307, the armature 1 and back contact of the CP1 relay 4309, thence over the KM0 conductor 4315 through the resistor 4310, the armature 3 and front contact of the WS2 relay 4300 to the winding thereof. The KM0 conductor 4315 is intermittently grounded by the K0 reader contact, but at the present time it is grounded steadily in the circuit just traced. If the WS1D relay 4302 is in normal position, the WS2 relay 4300 connects the perforator magnet A0 in place of the perforator magnet A2, causes the operation of the reading relays C1 and E1 and releases the reading relays C7 and E2 whereby the code 081010 rather than the code 287020 is perforated. If the WS1D relay 4302 is operated, the WS2 relay 4300 has no effect. In any case, the WS2 relay operates the TTM relay 3709 to start the long timer. The circuit now perforates a series of splice entries for a long enough time to extend them over the spliced portion of the tape. The operation of the TTM relay 3709 connects ground to the CTT cold cathode tube 3714 through the winding of the CTT relay 3713. At the same time it removes the shunt from the condenser 3715. This condenser, connected to the control anode of the tube 3714, starts to charge through the resistance 3716. The circuit for charging the condenser normally is from the +130-volt battery supply in series through the CTC resistance 3716, the CTD resistance 3717, and the CTE resistance 3718 to the R2 conductor leading to the charging condenser 3715. However, the CTE resistance is short-circuited at this time through the armature 9 and front contact of the WS1A—C relay 4301, and both the resistances CTD and CTE are short-circuited through the front contact and armature 5 of the WSP relay 1609. (By way of example, these resistances may have the following values: CTC 300,000 ohms, CTD 100,000 ohms and CTE 910,000 ohms.) In approximately 2.75 seconds the tube fires, thus providing a circuit from ground through the winding of the CTT relay 3713, the front contact and armature 1 of the TTM relay 3709, the cathode of the tube 3714 to the anode thereof and the source of +130-volt battery supply, whereupon the CTT relay 3713 responds. This closes a circuit from the K2 reader contact, over

the KM2 conductor 2006, the front contact and armature 1 of the CTT relay 3713, armature 6 and front contact of the WS1A—C relay 4301 to the winding of the CP1 relay 4309, and this relay operates and locks to the ground supplied by the front contact and armature 7 of the WS1A—C relay 4301. The CP1 relay, in operating, unlocks the WS2 and FL relays leaving them held by a reader make contact. At the completion of the line of splice pattern code 081010 the WS2 relay 4300 and the FL relay 4308 release. The release of the WS2 relay causes the release of the TTM relay 3709, thus extinguishing the tube 3714. If the WS1D relay 4302 is in its normal position then the WS2 relay 4300 switches back from perforator magnet A0 to perforator magnet A2 and from reading relays C1 and E1 to reading relays C7 and E2, preparing the circuit to perforate the window splice code 287020. If the WS1D relay 4302 is operated, the circuit is still arranged to perforate the splice pattern code 081010.

18.7 PERFORATING LAST LINE OF WINDOW

In the next reader closed period the CP2 relay is operated from ground on the front contact and armature 7 of the WS1A—C relay 4301, the WSG conductor to the front contact and armature 4 of the A2S relay 4806, the WSGA conductor, the front contact and armature 2 of the CP1 relay 4309, the armature 2 and back contact of the FL relay 4308 to the winding of the CP2 relay 4911 which now operates and locks through its front contact and armature 2 to the ground supplied at the front contact and armature 13 of the WS1B relay 4307. The circuit perforates either a second line of the code 287020 or another line of the splice pattern code 081010 depending upon whether the WS1D relay is normal or operated. When the SS relay 4802 responds, it operates the ESP relay 4905 through the front contact and armature 1 of the CP2 relay 4911. The ESP relay opens the operating path for the A2S relay 4806, lights the perforation completed lamp and locks to the ST3A relay over the ON2 conductor 1714. With the A2S relay 4806 thus disabled, the circuit cannot continue, times out, and brings in the alarm.

18.8 RELEASE OF CIRCUIT AFTER WINDOW SPLICE

The operator now releases the window splice key, thus releasing the WS relay 4910. This establishes a circuit from ground, armature 3 and front contact of the ESP relay 4905, armature 1 and back contact of the WS relay 4910, over the RLS conductor leading to the winding of the RLS relay 1710 so that this release relay RLS now operates and locks through its front contact and armature 3 to the ground on the RLSL conductor 2014 supplied at the front contact and armature 1 of the RCD relay 2001. The operation of relay RLS releases the ST1, the ST2, the ST3 and ST3A relays, all in Fig. 17. The release of the ST1 and the ST3 relays releases the RCD relay 2001, the WS1A—C relay 4301, the WS1B relay 4307 and the WSB relay 4902. The WS1B relay 4307 releases the ME relay 4903, and the ST3A relay releases the ESP relay 4905 and the LK1 relay 2800. The CP1 relay 4309 is released by the WS1A—C relay 4301 and the CP2 relay 4911 is released by the WS1B relay 4307. The release relay 1710 releases when the RCD relay 2001 opens the locking circuit at its armature 1 and front contact. The circuit is now ready to continue with its regular processing as soon as the motor start and machine start keys are operated.

19. REGULAR RELEASE

19.1 REGISTERING RELEASE SIGNAL

The machine release key 3205 (non-locking) may be operated at any time if it is desired to stop the circuit during a run. The key releases the RLM relay 1303 which, in turn, releases the ST1 relay 1707 and the ST2 relay 1709. The release of the ST2 relay removes one of the locking paths for the ST3 relay, leaving it locked to a reader make contact, a front contact of the LK1 relay and a front contact of the ME relay if either of these relays is operated.

19.2 AWAITING STOPPING POINT

The circuit continues until a proper stopping point is reached.

a. If skipping regular splice on input tape the ST3 relay 1702 releases at the end of the first reader closed period following the release of the ST2 relay 1709.

b. If checking tape identity at the start of the first input tape in a run, the ST3 relay will not release until all of the tape identity entries have been checked and all the tape identity entries have been perforated on the output tapes. The ST3 relay is held first by the LK1 relay 2800 (armature 2 and front contact of the LK1 relay) and then by the ME relay over its front contact and armature 3 in this case.

c. If checking any other tape identity, the ST3 relay will not release until all these entries have been checked, after which the LK1 relay 2800 releases.

d. If perforating splice, either at the beginning or end of output tapes, or perforating window splice, the ST3 relay will not release until this perforating has finished and the ME relay 4903 has released.

e. If perforating tape identity, the ST3 relay will not release until all such entries have been perforated on the output tapes, at which time the ME relay 4903 releases.

f. If processing regular entries, the ST3 relay will not release until the end of an entry, when the LK1 relay 2800 releases.

g. If skipping window splice, the ST3 relay is held through the armature 7 and front contact of the TIC relay 3400, over the TICG conductor through armature 2 and front contact of the SK2 relay 2701 and, therefore, does not release until the complete splice pattern and the window entry following it have been skipped, at which time the release of the SK2 relay 2701 allows the ST3 relay to release.

19.3 STOPPING THE CIRCUIT AND RELEASING

The release of the ST3 relay opens the circuit of the A digit reading relays, preventing further reading of the input tape. The ST3 and ST3A relays release all relays in the circuit except those held by the master off-normal relay 1703. The ST3A relay releases the MST relay 1602 which releases the motor relay in the alternating-current power control circuit 1608. The release of this relay stops the reader motor. The release of the MST relay removes battery from the step magnet 1902 and opens the operating circuit for the master off-normal relay. The following relays remain operated:

MON
RSR
MUS, MUAS, MU, DET or OBS
OFB, FTH, U, T, HATH or STH (HATH remains up in STH is up)

Some of the following relays may also remain operated:

TIE and TIEA, if tape identity has been perforated at start
TIC, if prepared to handle entries
SPA, if splice was perforated initially
11BA and 11BB
12B
13BA and 13BB
17BA and 17BB
18BA, 18BB and 18C
X1B
FT2
LTD

20. STARTING AFTER REGULAR RELEASE

20.1 STARTING MOTOR

In order to start the circuit after a regular release, the motor start key **3200** must be operated. This operates the RLM relay **1603** which locks from the armature 3 and front contact of the MON relay **1703**, over the MON9 conductor, the normally closed contacts of the machine release key **3205**, conductor **4901**, the back contact and armature 1 of the WSA relay **4900**, conductor **1605**, through the armature 1 and front contact of the RLM relay **1603** to the winding thereof. The operation of the motor start key extends ground over the conductor **1705**, the armature 1 and back contact of the MRL relay **1600**, conductor **1601**, the emergency motor stop key **3202**, the MSTA conductor **3203**, the armature 1 and back contact of the AL alarm relay **1400**, the MST conductor **1401** to the winding of the MST relay **1603** and this relay, in operating, locks in a circuit from the MON9 conductor **3206** and thence through the armature 3 and front contact of the RLM relay **1603**, the front contact and armature 4 of the MST relay **1602** to conductor **3201**, and thence over that portion of the operating circuit for the MST relay just above described, to hold this relay in locked position. The MST relay connects battery to the step magnet and operates a relay in the alternating-current power and distributing circuit **1608** which starts the motor.

20.2 STARTING CIRCUIT

The machine start key **3207** is next operated, and ground from the H8 reader contact over the conductor **2000**, armature 7 and back contact of the RS2—4 relay **1801**, armature 10 and back contact of the RS1—3 relay **1800**, the ST conductor, armature 1 and back contact of the LK1 relay **2800**, the ST conductor **2801**, the machine start key **3207**, conductor **3212**, the armature 5 and back contact of the WSB relay **4902**, the conductor **4908**, the armature 1 and front contact of the SPA relay **1712**, the STA conductor **3706**, the armature 2 and back contact of the ST2 relay **1709**, the armature 2 and back contact of the RLS relay **1710**, the armature 2 and front contact of the RLM relay **1603** to the winding of the ST1 relay **1701**. The ST1 relay operates and locks in a circuit from ground, armature 2 and front contact of the MON relay **1703**, the armature 7 and front contact of the ST1 relay to the other terminal of the ST2 relay **1709**. When the reader back contact H8 opens, this locking circuit for the ST1 relay becomes effective and the ST2 relay operates in series therewith. The machine start key is effective only under the following conditions:

a. When the reader step relays are normal.
b. When the LK1 relay **2800** is normal.
c. When the WSB relay **4902** is normal.
d. When the SPA relay **1712** is operated indicating that splice pattern has been perforated at the start of all output tapes.
e. When the RLS relay **1710** is normal (this contact is used for releasing the ST1 and ST2 relays and not to indicate a circuit condition where the key should be ineffective).
f. When the RLM relay **1603** is operated indicating that the motor has been started.

During the first reader open period after the operation of the ST2 relay, the ST3 relay operates and, in turn, causes the operation of the ST3A relay. The circuit then proceeds as described elsewhere. If the circuit stopped while skipping splice, the STT relay **2700** would have become operated and the circuit would then start as it does at the beginning of a run.

20.3 STOPPING MOTOR WHEN CIRCUIT IS NOT IN OPERATION

If the motor has been started but the machine start key has not been operated, the operation of the machine release key **3205** stops the motor. This key releases the RLM relay **1603** which, in turn, releases the MST relay **1602**. The release of the MST relay releases the motor relay in the alternating-current power and distributing circuit. The circuit is released as described in section 16.6 except for the master off-normal relay and those relays under its control.

21. TIMING CIRCUITS

21.1 SHORT TIMER

The short timer consists of a polarized relay TM here numbered **1404** and which has two windings. The primary winding tends to operate the relay, and is energized when either the ST3A relay **1705** extends battery through its armature 5 and front contact to the conductor **1713**, or when the ALCO relay **1414** is operated to extend battery through its front contact and armature 3 to this same conductor **1713**. The secondary winding, when energized, overpowers the primary winding and keeps the relay from operating. Its battery is supplied from conductor **1713** from either the ST3A relay or the ALCO relay, and its ground is supplied from a number of points in the circuit. When this ground is removed, current flows in the secondary winding to charge the condensers **1410** connected thereto. After approximately 0.25 second, this current decreases to such a point that the primary winding is stronger than the secondary winding and the TM relay **1404** operates, in turn operating the AL relay **1400**. As long as the circuit is operating properly, the TM relay timing circuit is recycled sufficiently often by grounding the condensers **1410**, over the conductor **4812** to prevent the TM relay **1404** from operating. Recycling occurs under the following conditions:

a. Whenever the perforate line key **3213** is operated to perforate a mutilated line. This releases the alarm, and ground from the ALCO relay **1414** recycles the timer.
b. When the circuit is released after it has stopped at the completion of perforating a window splice. Ground from the ALCO relay recycles the timer.
c. When the circuit releases after perforating splice on the output tapes at the beginning of a run. Ground through the ALCO relay recycles the timer.
d. When the circuit releases after perforating tape identity and splice at the end of a run. Ground through the ALCO relay recycles the timer.
e. After perforating each line except on perforator 9 (see *f* below) when spreading splice or tape identity on the output tapes. Ground from the SS relay **4802** recycles the timer.

f. After perforating each line on perforator 9 when spreading splice or tape identity on output tape 9. Ground from the RS1—3 relay 1800 recycles the timer.

g. After perforating each line of window splice. Ground from the SS relay recycles the timer.

h. Each time the reader steps. Ground through armature 7 and front contact of the RS1—3 relay 1800 or armature 4 and front contact of the RS2—4 relay 1801 recycles the timer.

i. Following the check of first and last thousands. At this time the TD selector in Fig. 23 may be stepped and several extra reader cycles may be required. Ground from the CL6 relay 3506 through the front contact and armature 9 of this relay prevents the timer from operating.

j. When the circuit releases. The release of the ST3 relay 1702 grounds conductor 4812 at the armature 7 and back contact thereof to ground the condenser 1410, and the release of both the ST3A relay 1705 and the ALCO relay 1414 disconnects battery from the windings of the TM relay 1404.

The battery supplied through the ALCO relay is used to release the TM relay whenever the ALCO relay 1414 operates since the TM relay is not equipped with a biasing spring.

21.2 LONG TIMER

The long timer consists of a cold cathode tube CTT numbered 3714 and an associated resistance-condenser network. It is started by the operation of the TTM relay 3709 which connects ground to the cathode through the winding of the CTT relay 3713, at the same time removing the shunt about the condenser 3715. With the control anode connected to the positive voltage supply and the shunt removed, the condenser starts to charge through the resistance 3716. When the potential of the control anode reaches the firing voltage, the tube fires, operating the CTT relay 3713. The long timer is used under the following conditions:

a. While perforating window splice. Ground from the front contact and armature 8 of the WS2 relay 4300 through the armature 1 and front contact of the WS1A—C relay 4301 operates the TTM relay 3709. The armature 9 and front contact of the WS1A—C relay 4301 short-circuits the CTE resistance 3718. The condenser charges through the CTC and CTD resistances and the tube fires after 2.8 seconds.

b. Following the check of the first and last thousands. Ground from the CL5 relay, over conductor 4809 operates the TTM relay 3709. The condenser under this condition charges through all three resistances in series and the tube fires after 9.2 seconds. The short timer is prevented from operating at this time (see section 21.1 *i*).

c. While spreading nine lines of tape identity at beginning or end of a run. Ground from the WS1A—C relay through its armature 10 and back contact extended through the front contact and armature 6 of the ME relay 4903, the armature 6 and front contact of the APD relay 4803 to conductor 4809, operates the TTM relay 3709. The TTM relay locks from ground, front contact and armature 3 of the TIS relay 2602, the WL conductor through armature 3 and back contact of the WSP relay 1609 to the TTML conductor leading to armature 2 and front contact of the TTM relay 3709. The condenser charges through all three resistances 1716 to 1718, inclusive, and the tube fires after 9.2 seconds.

d. While spreading the splice code 081010 under control of the end-of-tape key 3208, or while spreading the code 2860XX at the end of a run. Ground from armature 10 and back contact of the WS1A—C relay 4301, through the front contact and armature 7 of the ME relay 4903 and the armature 6 and front contact of the APD relay 4803 applied to conductor 4809, operates the TTM relay 3709. An armature 5 and front contact of the WSP relay 1609 shorts the CTD and CTE resistances so that the CTE resistance 3716 alone is effective and the condenser charges through this last resistance. The tube fires after 2.1 seconds.

When the CTT relay 3713 operates, ground from the J3 reader contact over the JBO conductor 2018, is extended through the front contact and armature 2 of the CTT relay 3713 to the AL conductor leading directly to the winding of the AL relay 1400, whereby the alarm relay is operated. When the CTT relay 3713 operates during the preparation of window splice, this path is opened, and the CPI relay 4309 is operated instead, as described in section 18.6.

22. ALARM

22.1 OPERATION OF ALARM RELAYS

The alarm relay 1400 which operates the ALA auxiliary alarm relay 1411 is operated under the following conditions:

a. When the TM relay 1404 of the short timer circuit operates with the master off-normal relay 1703 operated.

b. When a fuse blows, operating the FAL relay 1415.

c. When the RSH relay 1405 operates. This is the reader step relay release check described in section 26.

d. When the WSA relay 4900 operates and the ST3 relay 1702 releases. This is the condition when the circuit stops because a perforator has received a window signal (see section 18.3).

e. When the RSF relay 1402 operates with the master off-normal relay operated and the ALCO relay 1414 normal. This is the reader step check circuit described in section 25.

f. When the CTT relay 3713 operates with the WS1A—C relay 4301 normal. This is the long timer alarm (see section 21.2).

22.2 FUNCTIONS OF ALARM RELAYS

The alarm relays perform the following functions:

a. Light ALM pilot lamp.

b. Light machine pilot lamp.

c. Light general alarm lamp if the RSF relay 1406 and the FAL relay 1415 are normal, that is, if the alarm is caused by something other than blown fuse or reader step failure.

d. Ground a lead to the external alarm circuit.

e. Provide a ground to hold the EAC relay 1416.

f. Release the MST relay 1602 to stop the motor.

g. Permit the operation of the DS relay 2201 and the PLA relay 2100 under control of the maintenance key 3214 for lighting the maintenance lamps.

h. Permit the operation of the perforate line key 3213 for perforating a mutilated line.

i. Open the reading check lead to prevent further circuit progress. Operation of the PLA relay 2100 when the maintenance lamps are lit recloses this lead at armature 9 and front contact thereof.

j. Operate the WSB relay 4902 if the WSA relay 4900 is operated (see section 18.3).

k. Operate the TDA relay **2303** if the reader lamps key **3215** is operated, to supply ground for the tape section lamps in Fig. 21.

l. Connect the RLS relay **1710** to the machine release key for releasing the circuit after alarm.

m. Release the RS2—4 relay **1801** if the circuit is skipping splice to prevent the reader step failure lamp and the reader step hold lamp from lighting under this condition.

The AL relay **1400** locks through the back contact and armature **2** of the ALCO relay **1414** to ground supplied over the MON4 conductor by the armature **6** and front contact of the MON relay **1703**. When a window signal is received from a perforator while the end-of-tape key is operated, the WSB relay **4902** operates and causes the operation of the ALCO relay **1414**. In order to prevent this from releasing the AL relay **1400**, an auxiliary locking path for the AL relay is provided from ground at the back contact and armature **8** of the ST3 relay **1702**, over the N1 conductor **1720**, the armature **4** and front contact of the WSB relay **4902**, the WSBO conductor to the outer left-hand contacts of the end-of-tape key **3208**, over the ALG conductor, through the resistance **1417** to the front contact and armature **4** of the AL relay **1400**.

22.3 ALARM CUT-OFF

The operator may silence the external alarm **1418** by operating the alarm cut-off key **3216**. This places a ground on the EAC conductor leading directly to the winding of the EAC relay **1416** which, at its armature **2**, opens the connection to the external alarm circuit. At its armature **3**, the EAC relay **1416** opens the connection of the MP lead used for lighting the machine pilot lamp which is now, therefore, extinguished. When the sorter circuit is released the EAC relay releases, reclosing the lead to the alarm for subsequent use.

22.4 RELEASING AFTER ALARM

After the completion of perforating window splice when the alarm comes in, the release of the window splice key restores the circuit and releases the AL alarm relay **1400**. Under these circumstances, it is not necessary to operate the machine release key **3205**. After all other alarms, the circuit must be restored by operating this key, the operation of which is described in section **18**. With the AL relay **1400** operated, however, the RLS release relay **1710** operates, releasing the ST3 relay **1702** and the ST3A relay **1705** immediately regardless of the position of the circuit. The RLS relay also operates the ALCO relay **1414** which, in turn, releases the AL relay **1400** and causes the TM relay **1404** to operate to its released position as shown. The rest of the circuit releases as described in section 18.3 except that in this case the MST relay **1602** has already been released by the alarm relay **1400**.

22.5 ALARM RELAY FUSE BLOWS

If the fuse supplying the alarm relay **1400** (not shown) blows, the FAL relay **1415** operates and supplies ground directly to the alarm circuit and the machine pilot lamp. In the drawing (Fig. 14), a single fuse **1419** is shown, by way of example. This fuse is mechanically affixed to a spring **1420** which is stressed in such a manner that if the fuse blows, the spring **1420** will make contact with the bus bar **1421** and thus connect battery thereto for the operation of the FAL relay **1415**. Upon the operation of the FAL relay **1415**, ground on armature **4** thereof is extended through the front contact and over the armature **3** and back contact of the EAC relay **1416** to the machine pilot lamp.

23. MASTER RELEASE

The master release key **3217** is provided for releasing the entire circuit, including all memory relays. In order to prevent accidental operation of this key from interfering with circuit operation, both the machine release key **3205** and the master release key **3217** must be operated simultaneously. When this is done, the RLM relay **1603** and the master off-normal relay **1703** are both released. The MST relay **1602** releases and stops the motor. All the relays in the circuit now release and only the TD selector of Fig. 23 is left off-normal.

24. TAPE SECTION RESET AND RELEASE

The tape section reset key **3218** is provided to permit advancing the TD selector in case one or more tapes in a series has not been processed. It is effective only with the reader lamps key **3215** operated and with the ALA relay **1411** operated or the master off-normal relay **1703** operated with the ST2 relay **1709** in normal position. The reader lamps key **3215**, through its left-hand contacts, operates the RLA relay **2101** to indicate the position of the selector by means of the tape section lamps, and this in turn connects the ground extended to the ALG1 lead by armature **4** and front contact of the ALA relay **1411**, through the right-hand armature and front contact of the RLA relay **2101** to the TDA conductor leading directly to the winding of the TDA relay **2309** which relay, in turn, supplies ground for operating the lamps over its armature **2** and front contact. The tape section reset key **3218** operates the rotary magnet of the selector, stepping at one position for each operation of the key. The key also operates the FT2 relay **2305** if it is not already operated. Under the same conditions described above, the tape section release key **3219** may be used to restore the selector to normal. This key establishes a connection between the TS and the TDR leads as indicated in Fig. 23, the TDR lead being the one connected directly to the winding of the release magnet **2301** and the TS lead being the one connected to the front contact of armature **4** of the TDA relay **2309**. Therefore, if the selector is off normal, ground over the off-normal switch arm **2311** will be connected over the armature **4** and front contact of the TDA relay **2309** to cause the operation of the release magnet **2301**. This circuit will be opened as soon as the selector assumes its normal position. The ALA relay **1411** opens the path to the rotary magnet **2306** so that it cannot prevent the release of the selector.

25. READER STEP CHECK

25.1 ALTERNATE LINE CONTACTS

The reader is equipped with two contacts G1 and G2 which operate in phase with the reading contacts. Each of these contacts is equipped with a reading pin engaging holes in the reader drum. The holes are arranged so that the G1 contact is closed on every second line of the drum and the G2 contact is closed on the alternate lines. By means of these contacts the circuit checks that the reader steps one line whenever it is supposed to and does not step at any other time.

25.2 G1 CONTACT IS CLOSED INITIALLY

Assume that contact G1 is closed at the start of the circuit operation. Ground is supplied to the reading check lead from contact G1 through the armature and back contact of the RKA relay **1801**. When the first reader step occurs, ground

from the reader back contact K3, through the front contact and armature 8 of the RCD relay 2001 to the KBO conductor 2002, armature 1 and back contact of the MTIA relay 2607, armature 1 and back contact of the TIS relay 2602, the KBOB lead, armature 1 and back contact of the PTI relay 3710, thence through either armature 2 and front contact of the RS2—4 relay 1801, or armature 4 and front contact of the RS1—3 relay 1800, armature and back contact of the RZ2 relay 1813 to the winding of the RW relay 1814, causing the operation of this last relay. The operation of the RW relay operates both the RKA relay 1810 and the RKB relay 1809 from the ground at the front contact and armature 5 of the ST1 relay 1707 or ground at the front contact and armature 5 of the ST3A relay 1702, thence through the armature and back contact of the RZ3 relay 1815, the armature and front contact of the RW relay 1814 to the windings of the RKA and RKB relays in parallel. These relays operate and switch the reading check lead, the CK conductor 1805 from the G1 to the G2 contacts of the reader. At the end of the open period during which the reader steps, the RZ1 relay 1816 operates in series with the RW relay, holding the latter operated and itself becoming operated. The RZ1 relay 1816 immediately operates the RZ2 relay 1813 for the next reader step. The ground from reader contact K3 over the RA conductor to the armature of the RZ2 relay 1813 operates the RZ3 relay 1815. The RZ3 relay releases the RKA relay 1810, the RKB relay 1809, the RW relay 1814 and the RZ1 relay 1816. At the end of the open period, the RZ3 relay 1815 releases as long as the RZ3 relay is operated. Then ground through its armature and front contact maintains the RZ2 relay 1813 operated even though the RZ1 relay 1816 has released. Now, however, upon the release of the RZ3 relay, the RZ2 relay 1813 releases. The reading check lead is now connected to contact G1 again and the circuit is ready for another cycle of operation.

25.3 G2 CONTACT IS CLOSED INITIALLY

If the G2 contact is closed when the circuit is started, ground from this contact, through armature 3 and back contact of the ST3 relay 1702, armature 2 and front contact of the ST1 relay 1707, the armature and back contact of the RZ2 relay 1813 will be extended to the winding of the RW relay 1814, causing this latter relay to operate while the circuit is starting. When the ST3 relay 1702 operates, this lead is broken and the RZ1 relay now operates in series with the RW relay. The RW relay 1814 in turn operates the RKA and RKB relays, and the RZ1 relay 1816 operates the RZ2 relay 1813. The reading check lead is thus connected to the G2 contact and the circuit can proceed as described above.

25.4 READER STEP FAILURE

If the reader steps falsely, or fails to step, the RKA and RKB relays gets out of synchronism with the G1 and G2 contacts, the reading check lead is not closed and the circuit blocks. The ground from the G1 or the G2 contact is connected through the armatures of the RKA and RKB relays to the RSF conductor 1817 and thence completed into a circuit which may be traced through armature 11 and front contact of the ST3A relay 1705, conductor 1722, armature 1 and back contact of the RSH relay 1405 to the winding of the RSF relay 1406. The RSF relay, in operating, grounds the AL conductor and operates the alarm relay 1400. The RSF relay, in turn, locks through the back contact and armature 2 of the ALCO relay 1414 to ground supplied over the MON4 conductor from the front contact and armature 7 of the master off-normal relay 1703. The operation of the RSF relay also lights the reader step failure lamp over the RSF lead from the armature 1 and front contact of the RSF relay 1406. The RSF relay also opens the circuit from ground, armature 1 and back contact of the FAL relay 1415, through a back contact and armature 5 of the RSF relay 1406, the front contact and armature 4 of the ALA relay 1411, over the GA conductor to the general alarm lamp to extinguish this lamp. The RSF relay 1406, at its armature 4 and back contact, opens the circuit to the step magnet 1302 to prevent any further stepping. When the circuit is released, the operation of the ALCO relay 1414 to release the alarm relay 1400 also releases the RSF relay 1406.

25.5 PREVENTION OF RSF ALARM WHEN END-OF-TAPE KEY IS OPERATED

It is often convenient to use the tape feed key on the reader to insert a tape in the reader while the circuit is perforating splice pattern at the start of a run, and to use it to remove a tape from the reader while the circuit is perforating tape identity and splice codes at the end of a run. Since the reader step relays do not operate from the tape feed key, the CRK relay 1302 is provided to prevent the reader step check circuit from opening the reader check path and bringing in an alarm. The CRK relay operates from the front contact and armature 9 of the TE relay 3702 when the circuit is perforating splice at the start of a run and tape identity and splice at the end. It ties the G1 and G2 reader contacts together to keep the reading check path closed, and opens the operating circuit to the RSF relay to prevent bringing in an alarm.

26. READER STEP RELAY RELEASE CHECK

Since the short timer is recycled by the operation of the reader step relays, it cannot be used to detect a circuit blocking condition in which either one of these relays remains operated. If one of these relays should remain operated, then the input tape would have passed through the reader and entries would be lost. A check circuit is, therefore, provided to guard against this condition. The RSR relay 1402 is operated from a master off-normal ground as soon as the circuit as a whole goes off normal. This circuit may be traced from ground, armature 8 and front contact of the MON relay 1703 directly to the winding of the RSR relay 1402. The relay is shunted by the operation of the RS1—3 or the RS2—4 relay, but since the RSR relay 1402 is a slow-to-release relay, it does not release when so shunted unless the reader step relay remains operated longer than the time necessary for one reader step. If the RSR relay 1402 releases, ground from the front contact and armature 7 of the ST3A relay 1705 is transmitted through the back contact and armature of the RSR relay to the winding of the RSH relay 1405, and this relay locks through its armature 2 and front contact, ground from armature 8 and front contact of the ST3A relay 1705, the back contact and armature 4 of the PM1 relay 3711, the PM1N conductor to the armature 2 of the RSH relay 1405. The RSH relay operates the alarm relay 1400, bringing in an alarm and blocking the circuit. A back contact of the RSH relay opens the operating

circuit for the RSF relay 1406 and thereby prevents the operation of this latter relay, and a ground is extended from armature 3 and front contact of the RSH relay 1405, over the RSH lead to the reader step hold lamp. The ground placed on the RSR(a) lead by one of the reader step relays is opened at the back contact and armature 3 of the SK2 relay to prevent the RSR relay 1402 from being shunted down while the circuit is skipping splice on the input tape. The ground from RS2—4 relay 1801 is opened by the PM1 relay 3711 to prevent the RSR relay from being shunted down when the perforate line key 3213 is operated. Since the motor is starting at this time the reader step relays may be operated longer than normal because of the slow speed of the reader.

27. MANUAL READER STEP

The reader step key 3210 is provided for stepping the reader one line at a time. It is effective only if the ST1 relay 1707 is normal to prevent interference with circuit operation. The reader lamps key 3215 must also be operated. When the reader step key is operated, ground from reader make contact K2 over conductor 2006, through the armature 1 and back contact of the ST1 relay 1707, is transmitted over the SR conductor through the inner right armature and front contact of the RLA relay 2101, the left-hand contacts of the reader step key 3210, the SR2 conductor, the back contact and armature 2 of the SR relay 1803 to the winding of the RS1—3 relay 1800 to operate this reader step relay and step reader. In the reader open period the RS1—3 relay 1800 remains locked over the HB0 conductor and the reader back contact H3. Ground from the reader contact H8, over conductor 2000, through the back contact and armature 3 of the ST1 relay 1707, the front contact and armature 2 of the RS1—3 relay 1800, over the SR1 conductor, through the right-hand contacts of the reader step key 3210, back over the SR0 conductor, leads directly to the winding of the SR relay 1803 and causes its operation. The SR relay locks through its armature 1 by placing a ground directly on the SR1 conductor so that the SR relay will now remain locked under control of the reader step key. Through its armature 2 the RS relay opens the operating path for the RS1—3 relay 1800 which releases at the end of the open period. The SR relay 1803 remains operated until the key is released. Thus, the reader takes only one step for each key operation regardless of the length of time the key is held operated.

28. PERFORATING MUTILATED LINE

If the circuit blocks because of a mutilated line on the input tape which does not pass the two-out-of-five check, the operator determines by the lamps whether it is an initial line of a call entry, or a supplementary line. If it is an initial line, nothing of the entry will be perforated, and the operator discards the entry by operating the machine release key, starting the motor with the motor start key and then stepping the circuit ahead with the reader step key until it is on the initial line of the next entry. If it is a supplementary line, however, part of the entry is already perforated and the operator causes the circuit to perforate the remainder of the entry as read by operating the perforate line key 3213. It is not necessary to operate the machine release or any other key. The proper line key is effective only if the circuit has blocked on a supplementary line with the ALA relay 1411 and the LK2 relay 2804 operated. The operation of the perforate line key 3213 then connects ground from the reader make contact K2, over the conductor 2006, the front contact and armature 1 of the ALA relay 1411, conductor 1422, the armature 8 and front contact of the LK2 relay 2804, the PLM conductor through the right-hand contacts of the perforate line key 3213, the Y conductor, through the armature 1 and back contact of the PM2 relay 3719 to the winding of the PM1 relay 3711. The PM1 relay locks through its front contact and armature 3 directly to the KM2 conductor 2006. The PM1 relay operates the MST relay by placing a ground through its front contact and armature 5 on the MSTA conductor 3201 and which will have the same effect in operating the MST relay 1602 as the operation of the motor start key 3200. The operation of the motor start relay 1602 starts the motor as hereinbefore described, and the operation of the PM1 relay 3711 operates the ALCO relay 1414 by placing ground through its front contact and armature 2 on the ALCO conductor leading directly to the winding of the ALCO relay 1414. The operation of the ALCO relay releases the alarm relay 1400, closes the reading check path around the reading relays so that the failure of the two-out-of-five check no longer prevents progress, opens the ground to the RSR relay 1402 so that it will not be shunted down, opens the locking path for the RSH relay 1405 and operates the PM2 relay 3719. The PM2 relay locks through its front contact and armature 2, over the conductor X to ground applied thereto by the left-hand contacts of the perforate line key 3213. The PM2 relay also opens the original locking circuit for the PM1 relay, leaving this relay under control of the reader contact K2, and applies ground to the perforating check lead 5101 to permit progress despite failure of the two-out-of-five check of the perforator magnets. The PM1 relay 3711 releases at the end of the closed period and opens the reading and perforating check leads. The PM2 relay 3719 remains held to the perforate line key and prevents the PM1 relay 3711 from reoperating. If the next line of the input tape passes the two-out-of-five check, the circuit proceeds.

29. MUTILATED TAPE IDENTITY

29.1 MUTILATED TAPE IDENTITY AT START OF FIRST TAPE

If any of the tape identity information at the start of the first input tape of a run is mutilated, the circuit blocks. The operator releases the circuit, starts the motor and then steps the reader forward one line at a time with the reader step key recording the information on each line as read on the lamps and stopping when the lamps indicate that the reader is on the first line following tape identity. The tape identity key 3220 is then operated to close a circuit from ground, the back contact and armature 8 of the ST3 relay 1702, the front contact and armature 3 of the SPA relay 1715, the MTI conductor through the left-hand contacts of the tape identity key 3220, the TIEA conductor, the armature 3 and back contact of the TIEA relay 2600 directly to the winding of the MTI relay 2610. This same ground used for operating the MTI relay is also transmitted over the MTI(a) conductor through the right-hand contacts of the tape identity key 3220 to cause the operation of the 28C relay 3100 through its front contact and armature 5. The MTI relay 2610 operates the TDS relay 2314 and through its armature 1 and back contact the MTI relay opens the circuit of the 28B relay 3102. The

28C relay 3100 operates the PCA relay 3107. When the TIS relay 2602 operates it operates the ME relay 4903, shunts the battery at the TI relay 2200 to keep it from operating, operates the B1 and B7 reading relays and locks the 28C relay and the MTI relay in parallel. The operator then operates the machine start key, which starts the circuit. When the ST3A relay operates, it closes a circuit for the MT1A relay 2607 from the front contact and armature 6, the STA relay 1705, conductor 1715, armature 2 and front contact of the MTI relay 2610 to the winding of the MTIA relay 2607. This relay operates and locks to ground on the front contact and armature 15 of the RS1—3 relay 1900, the RSG conductor, the front contact and armature 2 of the MTIA relay 2607 and thence through the winding thereof for locking this relay due to the operation of the MTIA relay. The lead to the step magnet 1902 is opened at the armature 3 and back contact thereof. The MTIA relay, at its back contact and armature 1, also opens the lead from the K3 reader contact, which is used to advance the reader step check circuit by operating the RW relay 1814 to prevent this circuit from getting out of synchronism with the reader when the reader step relays operate. The circuit proceeds to prepare the nine tape identity entries on all the output tapes in the usual manner. The TDS relay 2314 releases for the operation of the TD selector (Fig. 23) if required. The tape identity information at the end of this tape will then set up the selector if necessary. The TIE relay 2605, the TIEA relay 2609 and the TIC relay 3400 are operated at the completion of tape identity perforation and the MTI relay 2610 releases when the 28C relay 3100 releases. When the reader step relays operate after the last tape identity entry has been perforated on perforator 3, ground at the front contact and armature 15 of the RS1—3 relay 1900 locks the MTIA relay 2607, holding it after the MTI relay has released. This prevents the stepping of the reader at this time, since the operator has already stepped it to the first line following tape identity. When the reader step relay releases, the MTIA relay 2607 is released, enabling the step magnet and reconnecting the lead to advance the reader step check.

29.2 MUTILATED TAPE IDENTITY DURING RUN

If any of the tape identity information is mutilated at any other than the start of the first tape, the TIE and TIEA relays will be operated. When the circuit blocks, the operator releases it, starts the motor and then steps the reader one line at a time with the reader step key, checking the information by using the lamps until the reader is on the first line following tape identity. The tape identity key 3220 is then operated to close the circuit from ground, back contact and armature 8 of the ST3 relay 1702, the front contact and armature 3 of the SPA relay 1715, the MTI conductor to the left contacts of the tape identity key 3220, over the TIEA conductor, the armature 3 and front contact of the TIEA relay 2600, the TIC conductor 1618, through the armature 1 and back contact of the TICA relay 3417 to the winding of the TIC relay 3400 to cause the operation of this relay. This prepares the circuit for processing call entries and the operator now operates the machine start key and the operation of the circuit proceeds.

30. EMERGENCY RESET

If a power failure occurs during a run, the various memory relays in the circuit will be released. After such an occurrence, the motor is started and the emergency reset key 3221 is then operated. This results in the establishment of a circuit from the back contact and armature 8 of the ST3 relay 1702, over the NI conductor 1720, the right-hand contacts of the emergency reset key 3221, the ER conductor to the winding of the ER relay 1724. The ER relay operates the SPA relay from its front contact and armature 4, operates the TIC relay 3400 by placing ground through its armature 2 and front contact on the TIC conductor 1618, and operates the TIE relay by placing ground through its front contact and armature 1 on the TIE conductor 3712. The TIE relay 2605 operates the TIEA relay 2609. If the TD selector of Fig. 23 is off normal, then the FT2 relay 2305 is operated from ground, the off-normal switch 2311, over the SON (selector off normal) conductor 2300, the front contact and armature 6 of the ER relay 1724, the FT2 conductor leading directly to the winding of the FT2 relay 2305.

If the circuit is sorting message unit and summary tapes together on tens sort, the ER relay 1724 operates the 13B relay 2503 and the 18C relay 2510 from ground at armature 14 and front contact of the MON relay 1703, over the MON5 conductor, the SORT switch arm 4614 set on its number 5 terminal representing the tens sort, over the T conductor 4615, the armature 1 and front contact of the MUAS relay 3303, the 13B conductor 3312 to the front contact and armature 3 of the ER relay 1724, thence over the 13B conductor 1726 to the winding of the 13B relay 2503. This ground is also extended over the front contact and armature 4 of the ER relay 1724, thence over the 18C conductor 1727 to the winding of the 18C relay 2510. This provides paths for operating the 18A relay 2509 (through armature 7 and front contact of the 13B relay 2503), or for checking a tape type 13 when the next tape identity entries are read. On units sort of message unit and summary tapes together the emergency reset key operates the ERA relay 1725 in a circuit from ground, the front contact and armature 14 of the MON relay 1703, the MON5 conductor, the Sort switch arm 4614 resting on its number 4 terminal for units sort, the units conductor 4616, the armature 2 and front contact of the MUAS relay 3303, the ER conductor 3313, the left-hand contacts of the emergency reset key 3221, the ERA conductor leading to the winding of the ERA relay 1725. The ERA relay locks through its armature 1 and front contact to the ERAL conductor, which may be traced through armature 3 and back contact of the 11A relay 2500, armature 3 and back contact of the 12A relay 2400, the back contact and armature 6 of the 17B relay 2402, the resistor 2511 to the MON6 conductor, deriving ground from the front contact and armature 4 of the MON relay 1703. The operation of the ERA relay 1725 provides a path through its armature 2 and front contact to operate the 17A relay when tape 17 is encountered.

31. LAMPS

31.1 LAMPS UNDER CONTROL OF READER LAMPS KEY

31.11 GENERAL

The reader lamps key 3215 is used for operating the RLA relay 2101 for connecting the reader lamps of Fig. 21 to the pins of the reader for reading the line of input tape which is effectively placed in the reader at the time. This reader lamps key 3215 is also used for determining the position of the TD selector by operating the tape section lamps also under control of the RLA re-

lay 2101. The reader lamps key also lights various circuit progress lamps. When the reader lamps key is operated if the alarm relay 1400 is operated, it also operates the DS relay 2201 to light certain lamps which will give an indication of the nature of the alarm.

31.12 READING LAMPS

The RLA relay 2101 connects twenty-eight reader or perforator lamps indicated in Fig. 21, and bearing designations like those of the reading relays to the corresponding reading contacts of the reader. In addition, the reading position lamp marked JM in Fig. 21 is connected to the out-of-phase reader contact J6 to show the position of the reader shaft. If the motor is stopped and the reader lamps do not light when the reader lamps key is operated, the shaft may be turned by hand to the closed position. A lamp lights for each hole in the line of input tape being read.

31.13 TAPE SECTION LAMPS

The RLA relay 2101 also connects the ten tape section lamps 0 to 9, inclusive, to the TD selector. Ground for the lamps is supplied from a back contact and armature 10 of the CL6 relay, over the conductor 3607, or alternatively by the armature 2 and front contact of the TDA relay 2309. The TDA relay will be operated if the AL alarm relay 1400 is operated.

31.14 TYPE OF ENTRY LAMPS

The DS relay 2201 connects the type of entry lamps designated two-line and five-line to the LN2 and LN5 relays, respectively, to indicate the number of lines in the entry being processed.

31.15 LINE OF ENTRY LAMPS

The DS relay 2201 connects the line of entry lamps 1 to 5, inclusive, to the L—A and L—B relays (Fig. 28) to indicate which line of entry is being read. The number 1 lamp is lighted by ground from the front contact and armature 1 of the RCA relay 1902, the SCA conductor, armature 1 and back contact of the LK2 relay 2804, over the SC conductor to the number 1 lamp of the line of entry lamps (Fig. 22). It is thus lit when the circuit has not progressed to the second line of an entry or beyond. The number 2 lamp is lit on the second line by ground from the front contact and armature 7 of the LK1 relay 2800, armature 8 and front contact of the LK2 relay 2804, and thence through a chain circuit including an armature and back contact of the L2B relay 2814, the L3B relay 2815 and the L4B relay 2816 to the L2 conductor leading through the armature 5 and front contact of the DS relay 2201 to the number 2 lamp of the line of entry lamps. The number 3 lamp is lit on the third line of a five-line entry by the ground for operating and locking the L4B relay 2816. The number 4 and number 5 lamps are lit in similar circuits, the number 4 lamp during the operation of the L3B relay 2815 and the number 5 lamp during the operation of the L2B relay 2814.

31.16 TAPE IDENTITY LAMP

The tape identity lamp shown in Fig. 22 is lit as soon as the tape index entry has been checked. The CL1 relay 3409 operates the TI relay 2200, and this in turn places ground on the armature 10 of the DS relay 2201 so that when the reader lamps key is operated and the DS relay 2201 responds, the tape identity lamp will give its indication. The TI relay 2200 releases when the 28C relay 3100 releases, or when it is shunted down by the operation of the TIS relay 2602 when the circuit starts to perforate tape identity.

31.17 SKIP SPLICE LAMP

The skip splice lamp shown in Fig. 22 is lit whenever the circuit is skipping, by ground applied to the SKLP conductor by armature 1 and front contact of the SK1 relay 2704 or by the front contact and armature 11 of the SK2 relay 2701.

31.2 LAMPS UNDER CONTROL OF MAINTENANCE KEY

31.21 GENERAL

The maintenance key 3214 is provided for controlling the perforator lamps. It is effective only if the alarm relay 1400 is operated, in which case it operates the PLA—D relay 2100.

31.22 PERFORATOR LAMPS

The PLA—D relay 2100 connects the twenty-eight reader or perforator lamps described in section 31.12 to make contacts on the correspondingly designated KA0, KA1, etc. relays which are in series with the perforating magnets and thereby indicate which perforating magnets are operated.

31.23 PERFORATOR-IN-USE LAMPS

The PLA—D relay 2100 connects ten perforator-in-use lamps 0 to 9 to the corresponding PD—relays (Fig. 50) to indicate which of the perforators is connected to the circuit.

31.3 LAMPS NOT UNDER KEY CONTROL

31.301 MACHINE PILOT LAMP

The machine pilot lamp lights from the alarm relay 1400 on all alarms. Operation of the alarm cut-off key 3216 operates the EAC relay 1416 and extinguishes this lamp. This machine pilot lamp is also lighted by the FAL relay 1415 if a fuse blows.

31.302 ALARM LAMP

The ALM lamp, a bull's eye on the face of the sorter, lights on all alarms.

31.303 FUSE ALARM LAMP (FA)

The fuse alarm lamp lights when a direct-current fuse such as the fuse 1419 blows. The fuse spring 1420 supplies battery to the alarm bus 1421, operating the FAL relay 1415 and lighting the lamp by the application from armature 1 and front contact of the FAL relay 1415 over ground to the FA1 conductor.

31.304 GENERAL ALARM LAMP

The general alarm lamp (shown in Fig. 22) lights on all alarms other than reader step failure and blown fuse.

31.305 LAST SECTION LAMP

The last section lamp is described in section 15.104.

31.306 MASTER OFF-NORMAL LAMP

The master off-normal lamp shown in Fig. 22 operated over the LP conductor 1704 lights whenever the circuit is started. It remains lit through a run until tape identity and splice have been applied at the end. It remains lit after regular release to indicate that the circuit is not entirely normal. It is extinguished by a master release operation.

31.307 OFF-NORMAL LAMP

The off-normal lamp is lit during any operation

of the sorter. It goes out following a regular release.

31.308 PERFORATE TAPE IDENTITY LAMP

The perforate tape identity lamp lights when the circuit blocks while perforating tape identity automatically at the start of a run. Ground from the armature **9** and front contact of the ST3A relay **1705** is transmitted over the ON2 conductor **1714** to armature **5** and back contact of the TE relay **3702**, thence over the TEN conductors to the front contact and armature **7** of the TIS relay **2602**, the PTL conductor **2604**, the front contact and armature **6** of the ALA relay **1411** to the PTI conductor leading to the perforate tape identity lamp. The back contact of the TE relay prevents lighting the lamp while perforating tape identity or splice under control of the end-of-tape key.

31.309 READER STEP FAILURE LAMP

The reader step failure lamp lights when the circuit blocks because the reader step relays had failure of the reader to step.

31.310 READER STEP HOLD LAMP

The reader step hold lamp lights whenever the circuit blocks because the reader step relays had been operated for more than 0.25 second.

31.311 PERFORATION COMPLETE LAMP

The perforation complete lamp lights at the completion of the window splice perforation as described in section 18.7.

31.312 WINDOW SPLICE LAMPS

The window splice lamps indicate that the circuit blocked because of a window in a perforator. Such a window is detected, by way of example, by a switch such as the switch **5414** which, in closing its contacts, will operate the corresponding window splice lamp. The number of the lamp indicates which perforator encountered the window. The lamp goes out while splice is being applied unless there is no paper in the perforator. In this case a new splice of paper is inserted and the window splice is applied again at which time the window splice lamp goes out.

32. TAPE CUTTERS

Fig. 55 shows the tape cutter circuit. A source of alternating current is connected to a rectifier bridge circuit **5500** to supply on the buses **5501** and **5502** a source of direct current. Under normal conditions, this direct current will charge a plurality of condensers in a circuit such as the circuit from the bus **5501** through the resistance **5503**, the condenser **5504**, the armature of the relay **5505** and its back contact, to the bus **502**. In this manner, a condenser for each of the perforators is maintained at a charge potential. When the operator has completed a run on the sorter and wishes to sever the completed outgoing tapes from the roll of unperforated tape, she will momentarily operate the key **5506**, and this key will simultaneously operate five relays such as the relay **5505**. Each of these relays thereupon connects its corresponding condenser directly to the winding of the corresponding tape cutter magnet, such as the magnet **5417**, and the discharge of the condenser through the windings of such tape cutting magnet serves to operate the tape cutting mechanism.

By way of example, the source of alternating current is the commercial 117-volt supply and each condenser such as the condenser **5504** is of 200-microfarad capacity.

Relay	Fig.	Function
11A, 11BA	25	Register, tape index 11.
12A, 12B	24	Register, tape index 12.
13A, 13BA	25	Register, tape index 13.
17A, 17BA	24	Register, tape index 17.
18A, 18BA, 18C	25	Register, tape index 18.
28A, 28B, 28C	31	Reading translator (line starting "28").
A0, A1, A2	29	A digit reading relays.
A2S	48	A2 reading relay for spreading.
AL, ALA	14	Alarm.
ALCO	14	Alarm cut-off.
APA, APC, APD	48	All perforators (spreading).
B0, B1, B2, B4, B7	29	B digit reading relays.
BX	44 and 57	Except B (sorting by other digits than B).
CAR	38	C digit as read.
CFR	38	C digit from tape section register.
C0, C1, C2, C4, C7	30	C digit reading relays.
CKA, CKB	54	Check (perforator hold check).
CL1	34	Tape identity line 1 checked.
CL2	34	Tape identity line 2 checked.
CL5	35	Tape identity line 5 checked.
CL6	35	Tape identity line 6 checked.
CL8	35	Tape identity line 8 checked.
CP1	43	Change pattern (window perforating).
CP2	49	Change pattern (window perforating).
CRK	18	Cancel reader check.
CTT	37	Cold tube timer.
DAR	38	D digit as read.
D0, D1, D2, D4, D7	30	D digit reading relays.
DET	33	Toll and MU detail tapes.
DFC	38	D digit from C as read.
DFR	38	D digit from tape section register.
DS	22	Display.
E0, E1, E2, E4, E7	30	E digit reading relays.
EAC	14	External alarm cut-off.
EAR	38	E digit as read.
EC	23	E digit connector relay.
EFD	38	E digit from D as read.
EFR	38	E digit from tape section register.
EP	16	End of perforating (tape identity).
ER, ERA	17	Emergency reset.
ESK	27	End of skipping.
ESP	49	End of (window) splice perforating.
F0, F1, F2, F4, F7	30	F digit reading relays.
FAL	14	Fuse alarm.
FAR	38	F digit as read.
FFE	38	F digit from E as read.
FFR	38	F digit from tape section register.
FL	43	First line (window splice perforating).
FT1, FT2	23	First tape digit.
FTH	36	First thousands sort.
HATH	36	Hundreds and thousands sorts.
HS	44 and 57	Hundreds sort connector.
HSM	44	Hundreds sort—MU tapes.
KA0, KA1, KA2	39	Check of A digit perforating.
KB0 to KB7	39	Check of B digit perforating.
KC0 to KC7	45	Check of C digit perforating.
KD0 to KD7	45	Check of D digit perforating.
KE0 to KE7	51	Check of E digit perforating.
KF0 to KF7	51	Check of F digit perforating.
LI	34	Checking TI, line 1.
L1CE	44	Line 1—call entry.
L1T	34	Checking TI, line 1, tens.
L1UA	34	Checking TI, line 1, units.
L2	34	Checking TI, line 2.
L2A, L2B	28	Counting next to last line of entry.
L3A, L3B	28	Counting 3rd from last line of entry.
L4A, L4B	28	Counting 4th from last line of entry.
L5	35	Checking TI, line 5.
L6	35	Checking TI, line 6.
L8	35	Checking TI, line 8.
L9	35	Checking TI, line 9.
LK1	28	Lock (first line of multiline entry).
LK2	28	Lock (after first line of multiline entry).
LLA, LLB	28	Counting last line of entry.
LN2	28	2-line entry.
LN5	28	5-line entry.
LTD	23	Last tape digit.
ME	49	Manufactured entry.
MOC	25	Month check.
MON	17	Master off-normal.
MRL	16	Master release.
MST	16	Motor start.
MTI, MTIA	26	Mutilated tape identity.
MU	33	Message unit tape.
MUAS	33	Message unit and summary tapes.
MUS	33	Summary tape.
MUSA	44	Summary tape—auxiliary.
OBS	33	Observing tape.
OFB	36	Office sort.
OFS	44 and 57	Do.

Relay index—Continued

Relay	Fig.	Function
OFSM	44	Office sort—MU tapes.
PA0 to PA9	51	Perforator connector.
PCA, PCB	31	Pulse count (extra cycle after twenty-eight entries).
PD0 to PD9	50	Perforator registers.
PHE	54	Perforator hold, even.
PHK	54	Perforator hold, check.
PH0	54	Perforator hold, odd.
PK0 to PK9	54	Perforator hold, check (advance magnet).
PL1 to PL9	15	Perforate tape identity lines.
PLA, PLB, PLC, PLD.	21	Perforator lamp connectors.
PM1, PM2	37	Perforate mutilated line.
PS1	16	Perforate skip splice signal (286).
PS2	16	Perforate splice.
PS3	16	Perforate splice (perforator hold check).
PSP	37	Perforate splice (start of tapes).
PTI	37	Perforate TI (end of tapes).
PX	15	Extra cycle before perforate TI.
RCA, RCB, RCC	19	Reader connector.
RCD	20	Do.
RE	38	Register E digit—connector.
RE-0 to RE-7	38	Register E digit—register relays.
RKA, RKB	18	Reader check.
RLA, RLB, RLC	21	Reader lamp connector.
RLM	16	Release motor.
RLS	17	Release.
RS1 to RS4	18	Reader step.
RSF	14	Reader step failure.
RSH, RSR	14	RS relay release check.
RTD	23	Restore TD selector.
RW	18	Reader step check W.
RZ1, RZ2, RZ3	18	Reader step check Z.
SOB	52	Select perforator O.
S1A to S9A	52 and 53	Perforator select advance 1 to 9.
S1B to S9B	52 and 53	Selector perforator 1 to 9.
SC	44 and 57	Sort connector.
SK1, SK2	27	Skip splice.
SKP	27	Do.
SKW	27	Skip window.
SPA	17	Splice pattern applied (at start).
SR	18	Step reader (manually).
SS	48	Skip (reader) step.
SSL	44	Shift sort leads.
SSLA	46	Shift sort leads—auxiliary.
ST1, ST2, ST3	17	Start.
ST3A	17	Do.
STD	23	Step TD selector.
STH	36	Second thousands sort.
STT	27	Start tape.
T	36	Tens sort.
TDA	23	Tape digit alarm.
TDS	23	Tape digit start (during recycle.
TE	37	Tape end.
THS	44 and 57	Thousands sort.
THSM	44	Thousands sort—MU tapes.
TI	22	Tape identity (lamp control).
TIC, TICA	34	Tape identity check.
TIE, TIEA	26	Tape identity end (of perforate).
TIS	26	Tape identity start (perforate).
TK	23	Tape digit check (after selector step).
TM	14	Short timer.
TS	44 and 57	Tens sort.
TSM	44	Tens sort—MU tapes.
TTM	37	Tube timer.
U	36	Units sort.
US	44 and 57	Do.
W1 to W9	15	TI perforators walking, 1 to 9.
W2A	15	Auxiliary to W2.
WS	49	Window splice.
WS1A, WS1B, WS1C	43	Do.
WS1D	43	Do.
WS2	43	Do.
WSA, WSB	49	Do.
WSP	16	Splice perforator walking.
X1A, X1B	24	Tape indices 11, 21, 31 and 41.

What is claimed is:

1. In an automatic accounting system in which customer charges for uses of given facilities are derived from scattered items of specific and general information including a multidigit index identifying each said facility recorded on continuous tapes during and by the said customer uses of the given facilities and wherein the conversion of said data into customer bills is accomplished in a series of steps by a plurality of accounting devices each of which is adapted to read items of information from an incoming tape and to assemble, sort, translate, compute or otherwise rearrange said items and to record the results on a plurality of outgoing tapes, one of said devices consisting of a sorter for rearranging items in serial number in accordance with the said multidigit index identifying the faciilty for the use of which a bill is being prepared, said sorter consisting of a reader for reading items of information from an incoming tape, a plurality of recorders for recording said items on a plurality of outgoing tapes and selective means for selecting one of said recorders for each said item in accordance with an index within each said item, means for rearranging said multidigit index between reading and recording, consisting of means for transferring the digit of said index in each specific item of information used to control said selective means from said specific item to said general items of information and means for transferring an index digit from said general items of information read by said reader to a place in each specific item of information recorded by one of said recorders.

2. In an automatic accounting system in which customer charges for uses of given facilities are derived from scattered items of specific and general information including a multidigit index identifying each said facility recorded on continuous tapes during and by the said customer uses of the given facilities and wherein the conversion of said data into customer bills is accomplished in a series of steps by a plurality of accounting devices each of which is adapted to read items of information from an incoming tape and to assemble, sort, translate, compute or otherwise rearrange said items and to record the results on a plurality of outgoing tapes, one of said devices consisting of a sorter for rearranging items in serial number in accordance with the said multidigit index identifying the facility for the use of which a bill is being prepared, said sorter consisting of a reader for reading items of information from an incoming tape, a plurality of recorders for recording said items on a plurality of outgoing tapes and selective means for selecting one of said recorders for each said item in accordance with an index within each said item, said reader having separate means for reading each digit of a multidigit code and each recorder having a means for separately controlling the recording of each digit of a multidigit code, a plurality of registers, each for registering a digit, said registers being arranged in digital code places, a path from each digital place from said reader, means for extending each said path to a corresponding digital place register or alternatively to a next in order to a corresponding digital place register, a sorting control means, means for selectively extending said paths to said sorting control means, a tape section counting means, including means controlled thereby for synthesizing a digit, and means for extending to a selected recorder said digit synthesizing circuit and said registers whereby an item of information read by said reader will be reproduced by one of said recorders in accordance with one digit of said item in a form in which said controlling digit is deleted and a synthesized digit substituted therefor.

3. The method of sorting items each expressed in a multidigit code in which the said item after the first and all subsequent sorts is expressed in a code having a lesser number of digital places than the said code as originally expressed, which consists of sorting by one (control) digit of said code, deleting said control digit from each sorted item, on the first sort and on the second and all

subsequent sorts substituting for the said deleted digit a synthesized digit derived from the order in which the sorted item had been placed on a previous sort.

4. The method of sorting items each expressed in a multidigit code perforated in an incoming tape, the said code after the first and all subsequent sorts being expressed in a code having a lesser number of digital places than the said code as originally expressed, a sorting operation consisting of reading a code from an incoming tape and then reproducing it on a selected one of a plurality of outgoing tapes, the selection of an outgoing tape being accomplished under control of and responsive to the value of one control digit of the said read code, the said output tapes at the end of a sorting operation being spliced to form a multisection tape for use as an incoming tape for a subsequent sort, deleting said control digit and on the second and each subsequent sort substituting therefor a digit representing the number of the tape section from which the item being sorted is read.

5. In an automatic accounting system in which customer charges for uses of given facilities are derived from scattered items of specific and general information including a multidigit index identifying each said facility recorded on continuous tapes during and by the said customer uses of the given facilities and wherein the conversion of said data into customer bills is accomplished in a series of steps by a plurality of accounting devices each of which is adapted to read items of information from an incoming tape and to assemble, sort, translate, compute or otherwise rearrange said items and to record the results on a plurality of outgoing tapes, one of said devices consisting of a sorter for rearranging items in serial number in accordance with the said multidigit index identifying the facility for the use of which a bill is being prepared, said sorter consisting of a reader for reading items of information from an incoming tape, a plurality of recorders for recording said items on a plurality of outgoing tapes and selective means for selecting one of said recorders for each said item in accordance with one of N digits within each said item, a sort selector for controlling the location of the said digit by which the said sort is made, a register, means responsive to the said items of general information for setting said register at the beginning of the reading of each section of incoming tape, means for rearranging said multidigit index between reading and recording consisting of shifting means for shifting each of said digits of said index to the left of that one used for sorting each one place to the right and for filling in the place of that one used for sorting with the value expressed in said register.

6. In an automatic accounting system in which customer charges for uses of given facilities are derived from scattered items of specific and general information including a multidigit index identifying each said facility recorded on continuous tapes during and by the said customer uses of the given facilities and wherein the conversion of said data into customer bills is accomplished in a series of steps by a plurality of accounting devices each of which is adapted to read items of information from an incoming tape and to assemble, sort, translate, compute or otherwise rearrange said items and to record the results on a plurality of outgoing tapes, one of said devices consisting of a sorter for rearranging items in serial number in accordance with the said multidigit index identifying the facility for the use of which a bill is being prepared, said sorter consisting of a reader for reading items of information from an incoming tape, a plurality of recorders for recording said items on a plurality of outgoing tapes and selective means for selecting one of said recorders for each said item in accordance with the value of the digit in one of four digital places in each of said specific items of information, a sort selector for selecting the said one of said four digital places from which the said controlling value is to be taken for sorting purposes, a register, means responsive to the said items of general information for setting said register at the beginning of the reading of each section of incoming tape, and means for rearranging said multidigit index in transmission between reading by said reader and recording by a selected one of said recorders consisting of shifting means for shifting each of said digits of said index to the left of that one used in accordance with the setting of said sort selector for selecting the said recorder each one place to the right and for filling in the place of that one used for sorting with the value expressed in said register.

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