July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 1

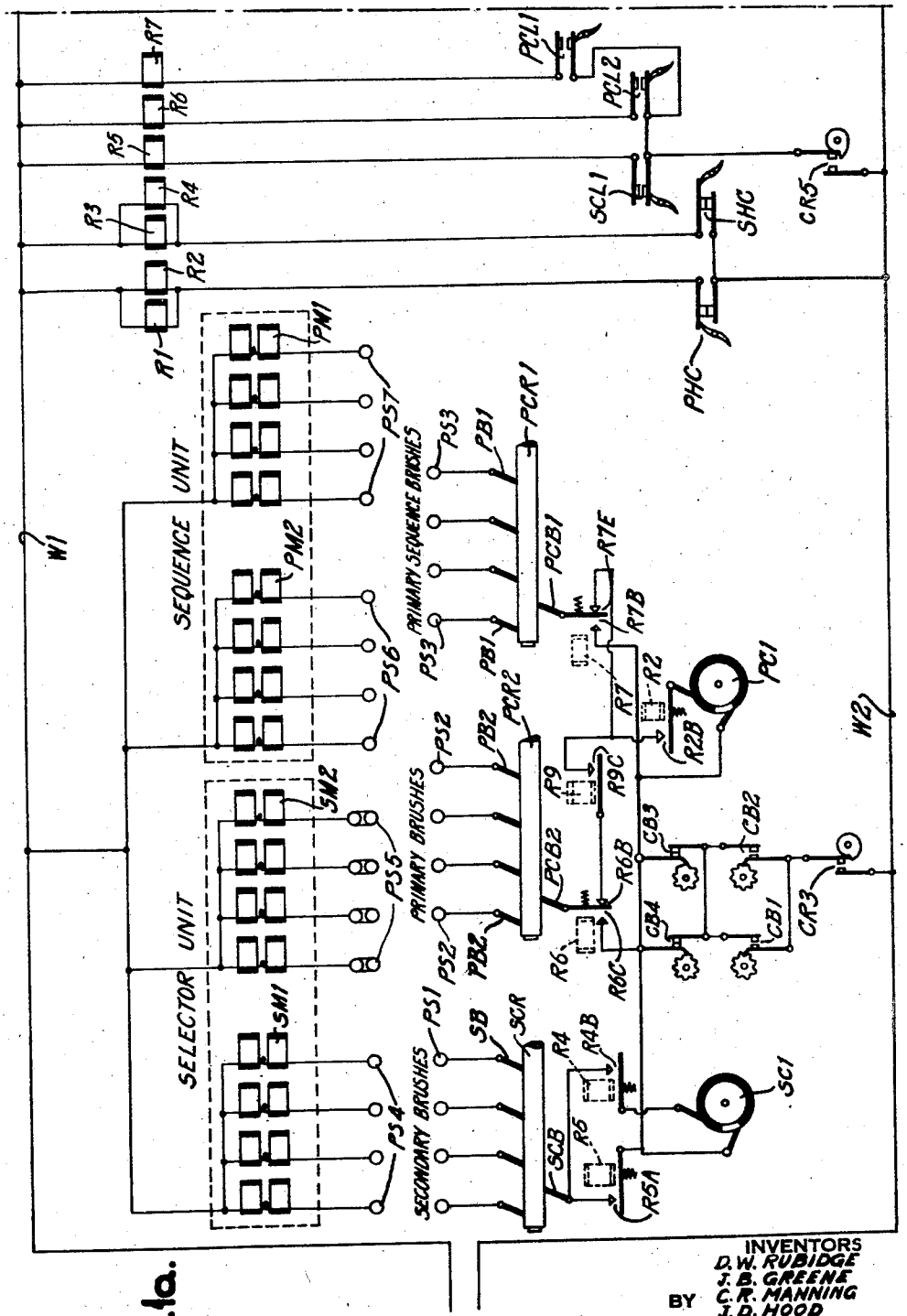

FIG. 1a.

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J. D. HOOD

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July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 2

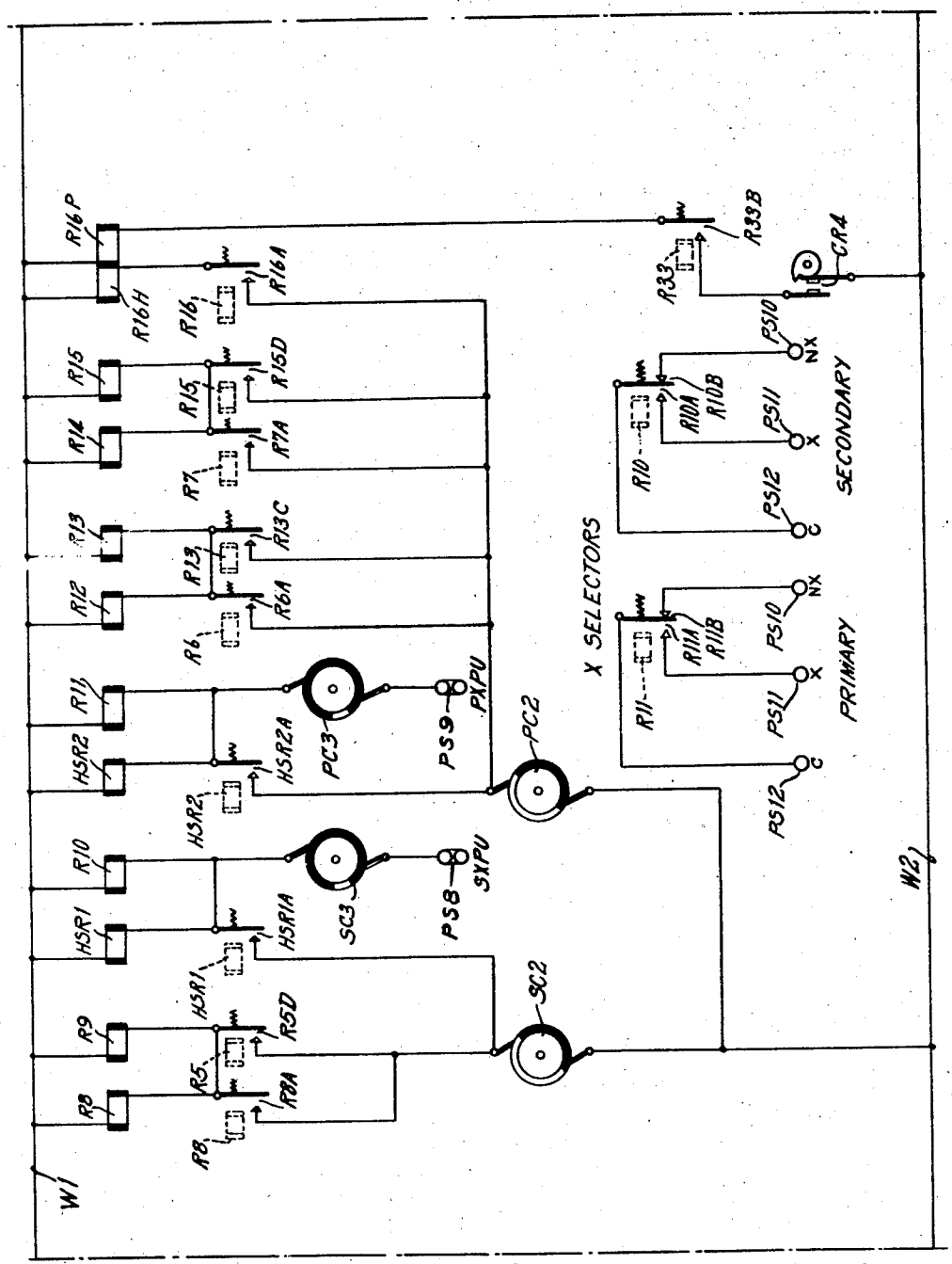

FIG. 1b.

INVENTORS
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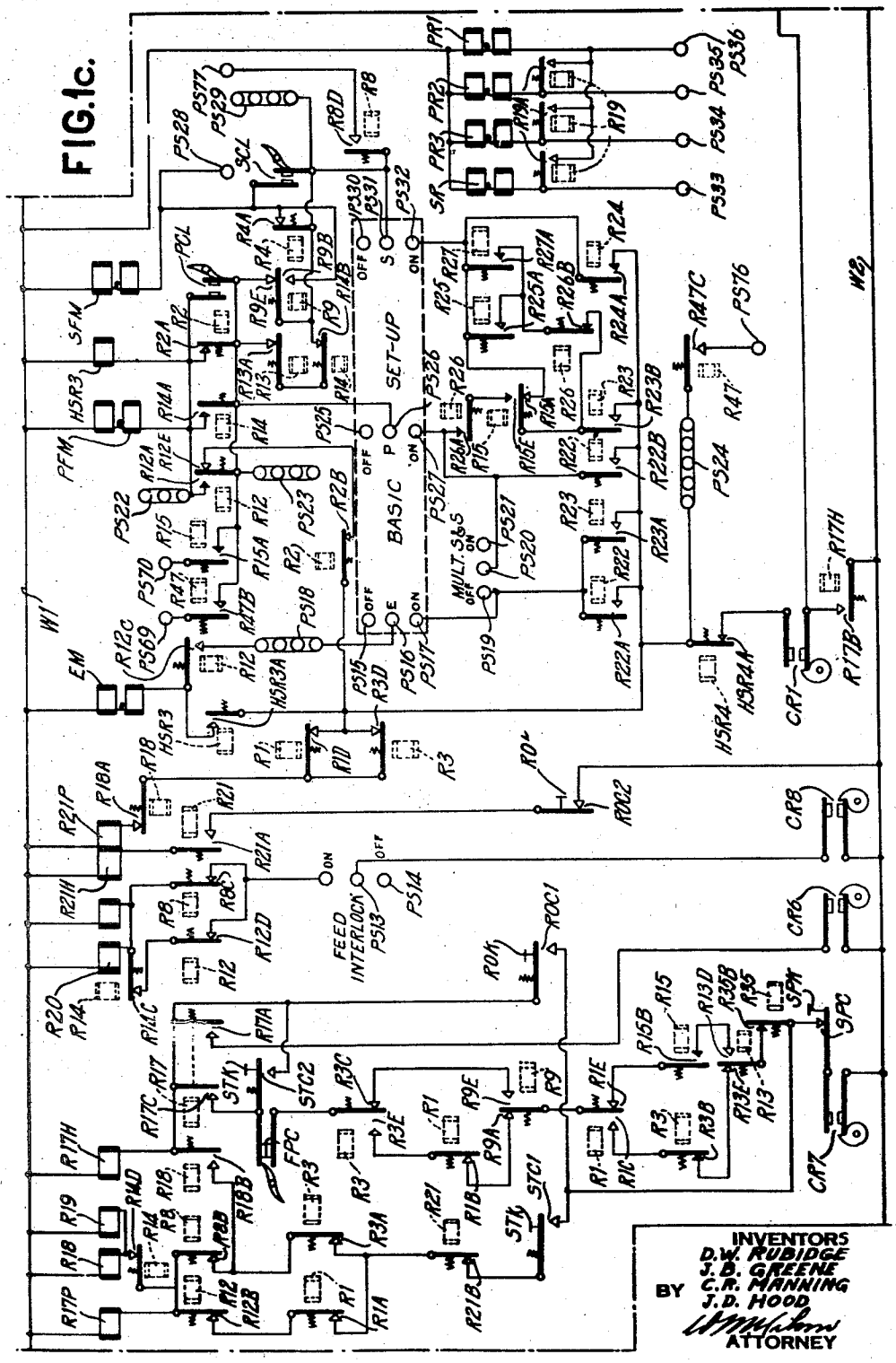
July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 3

FIG. 1c.



July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 4

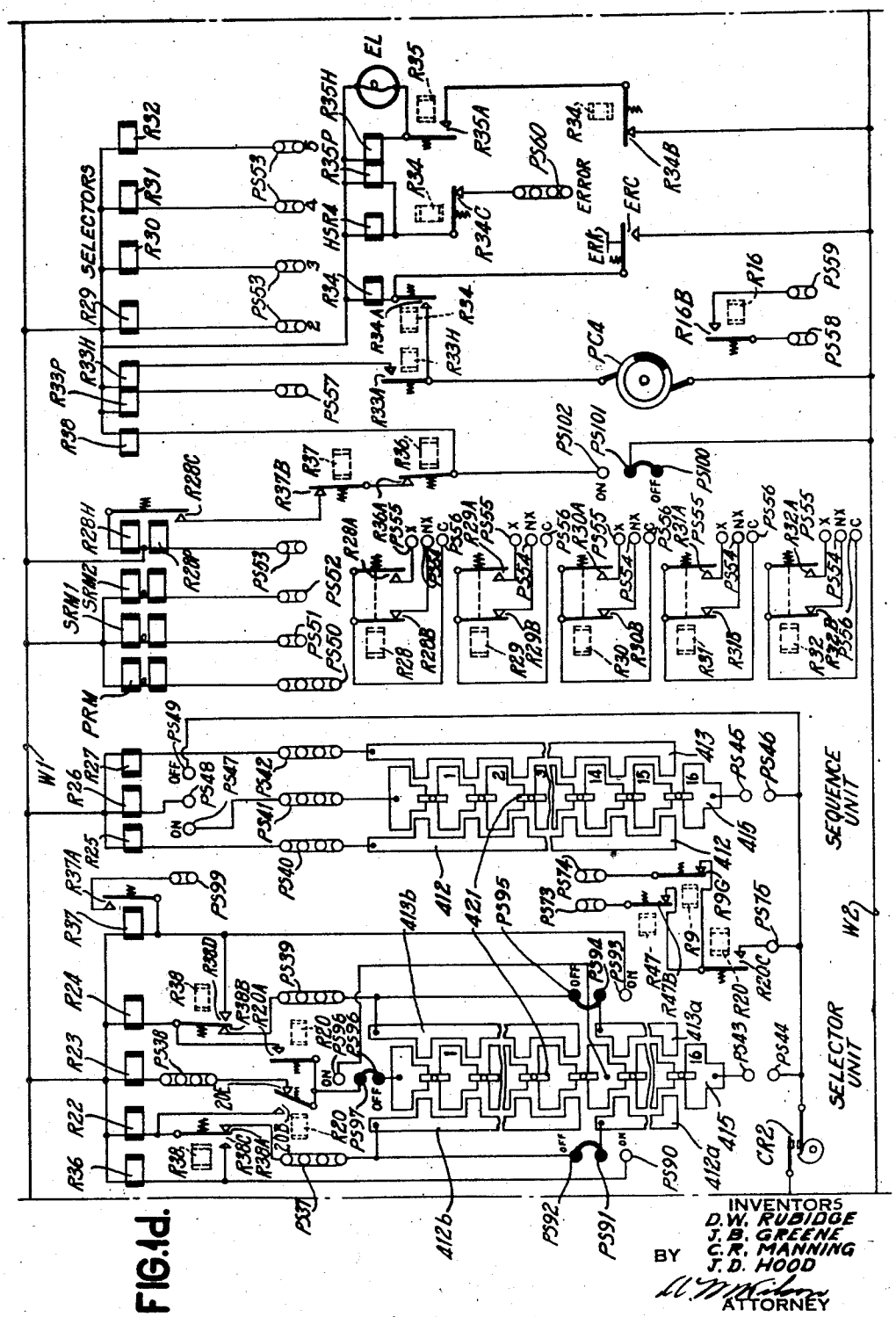


FIG. 1d.

July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 5

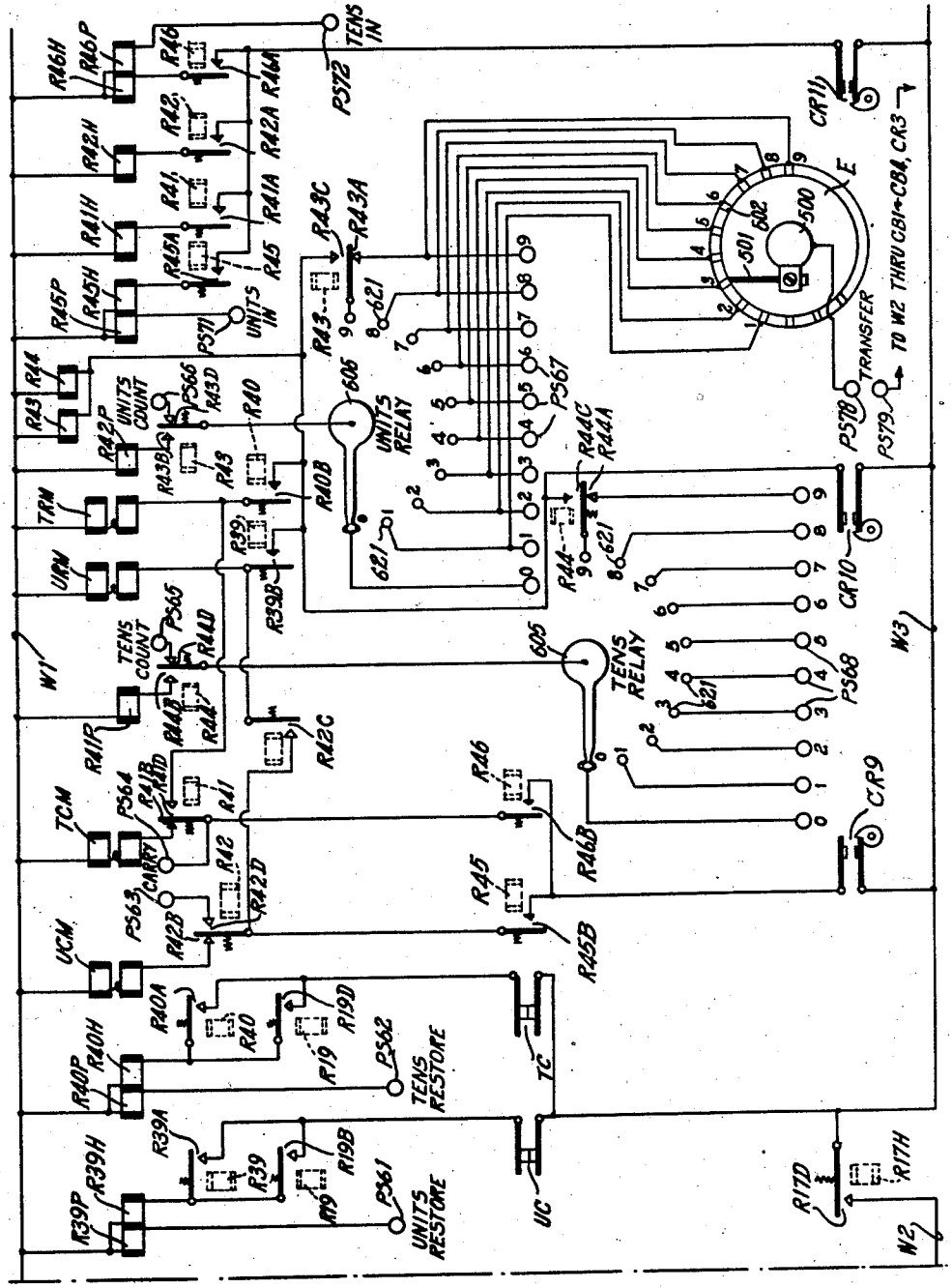


FIG. 1c.

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July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 6

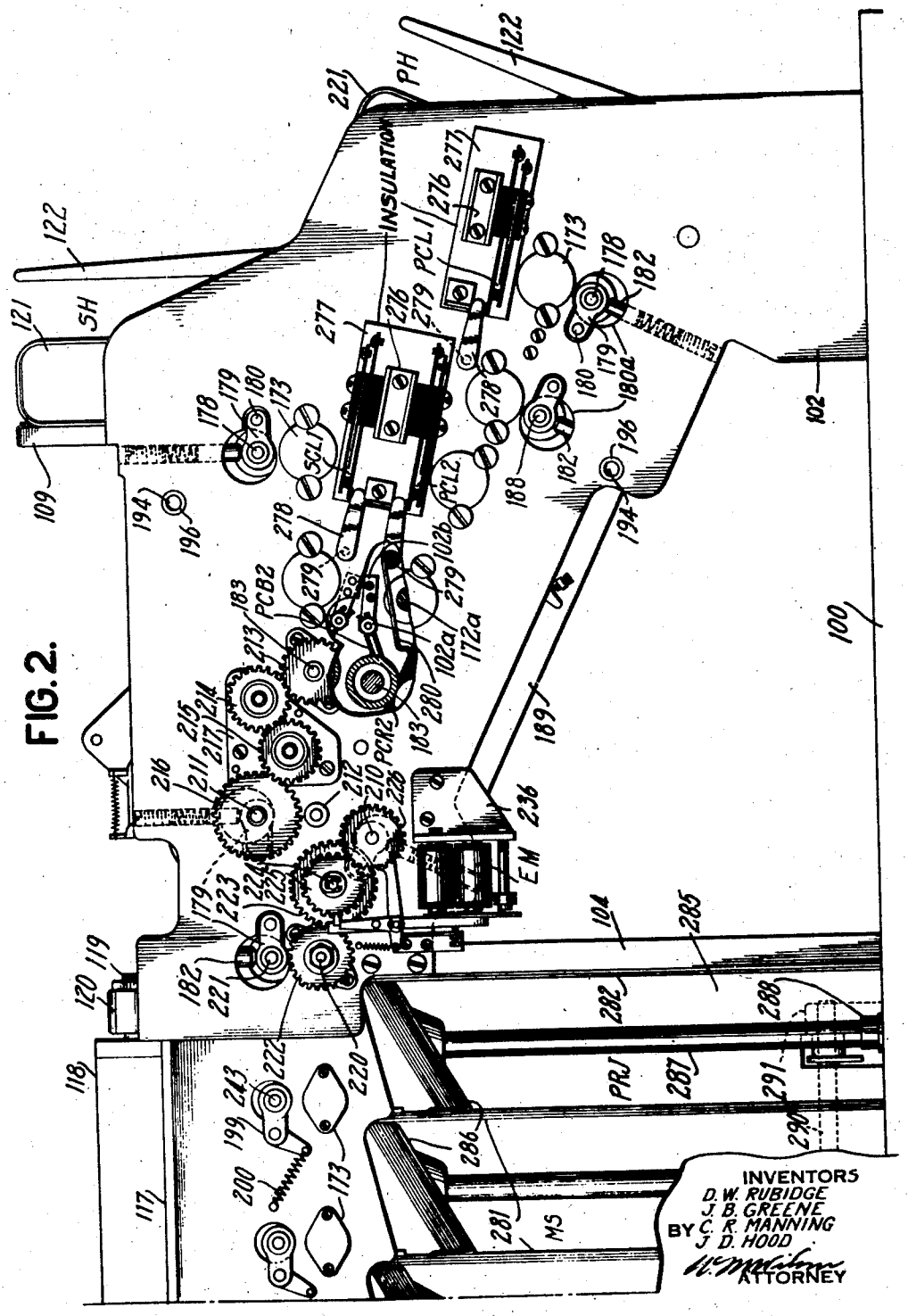

FIG. 2.

INVENTORS
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July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 7

FIG.3a.

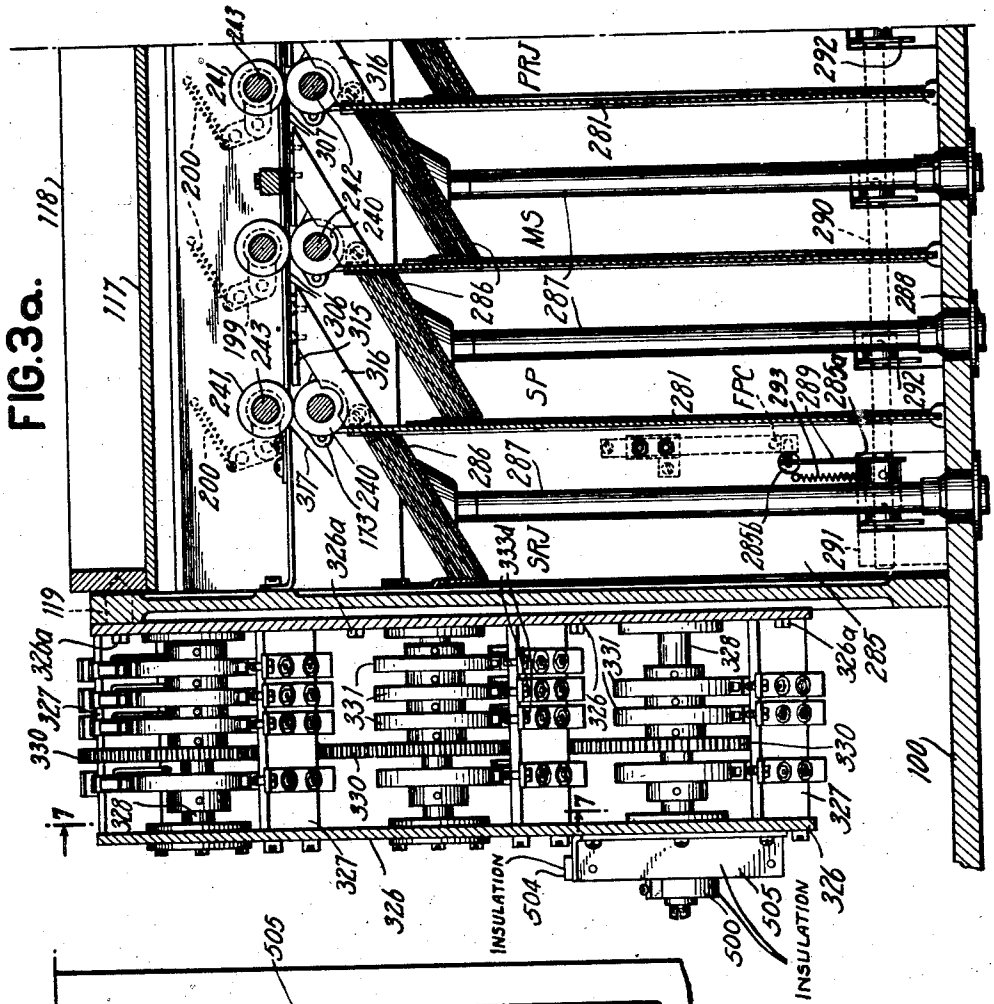
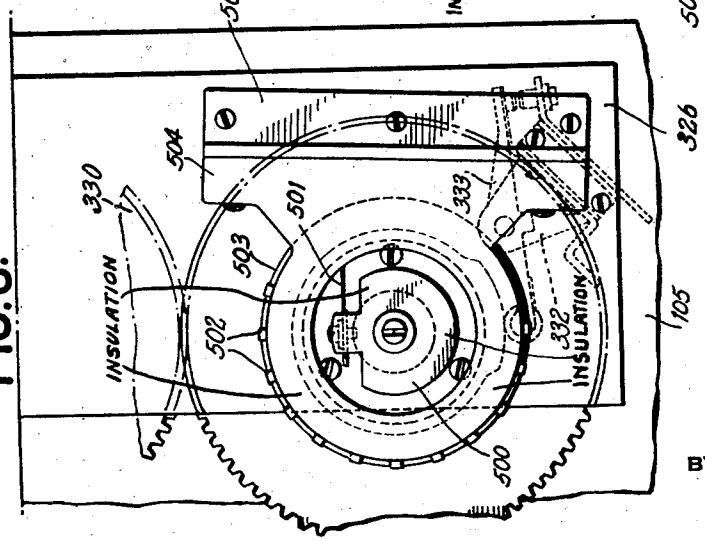


FIG.8.



INVENTORS
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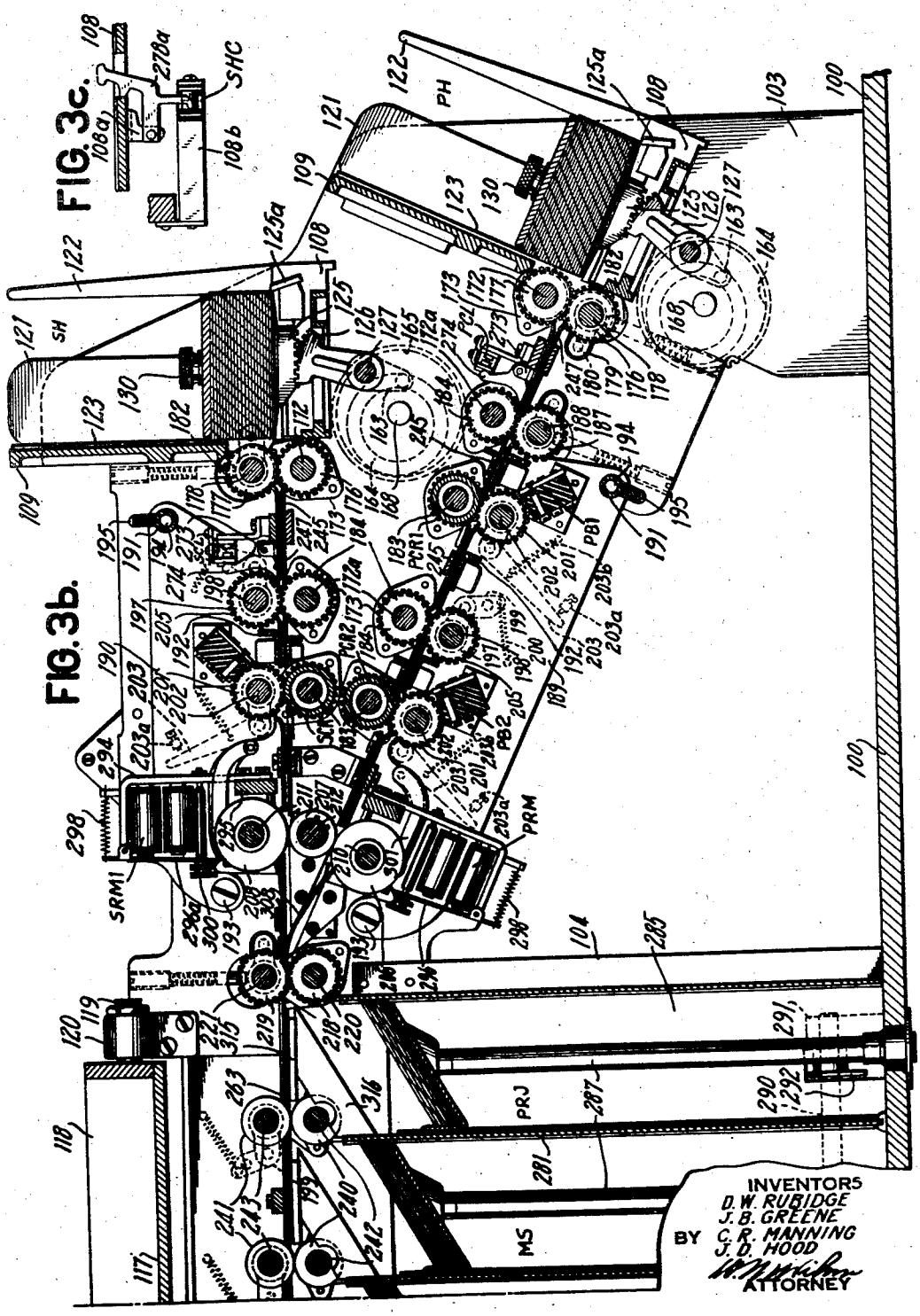
July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 8



July 20, 1948. D. W. RUBIDGE ET AL. 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 9

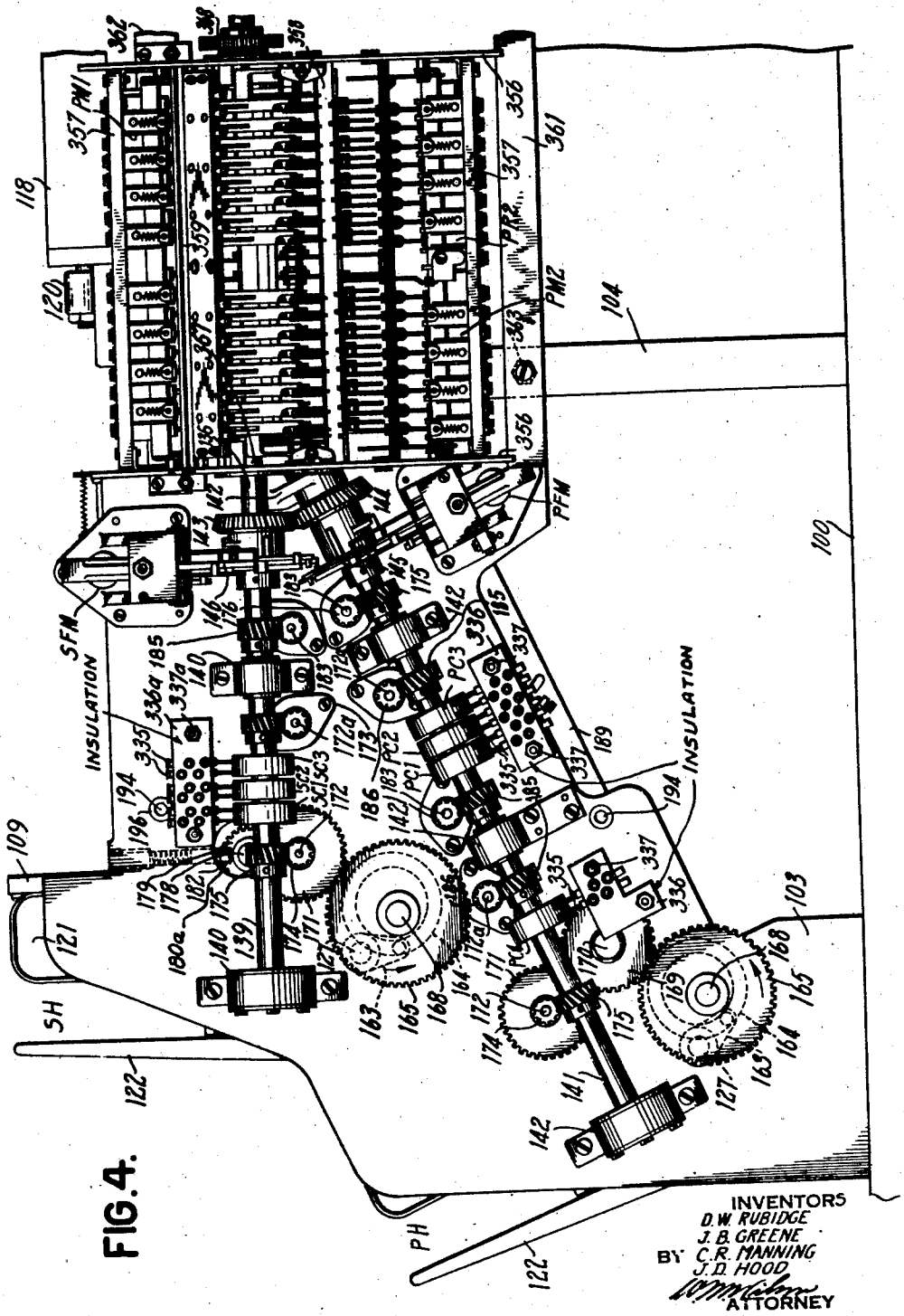


FIG. 4.

July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 10

FIG.5.

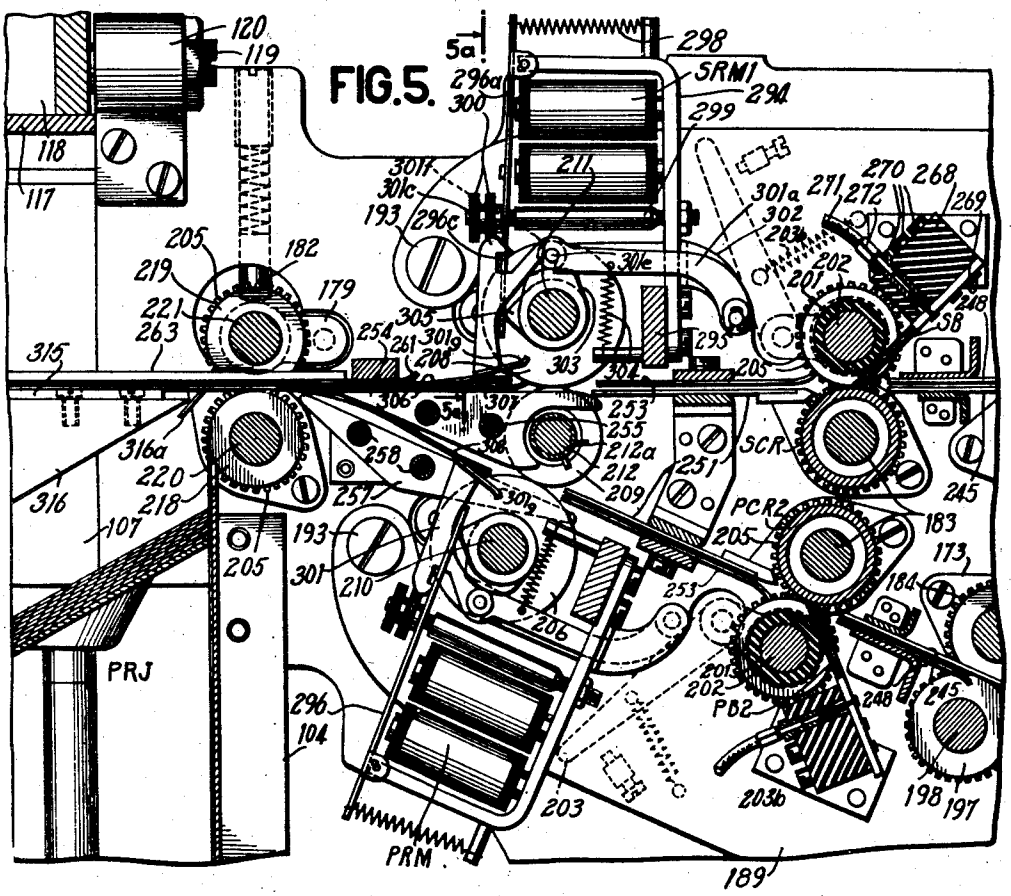


FIG.6c.

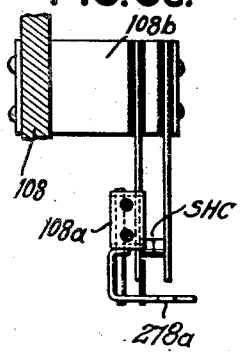
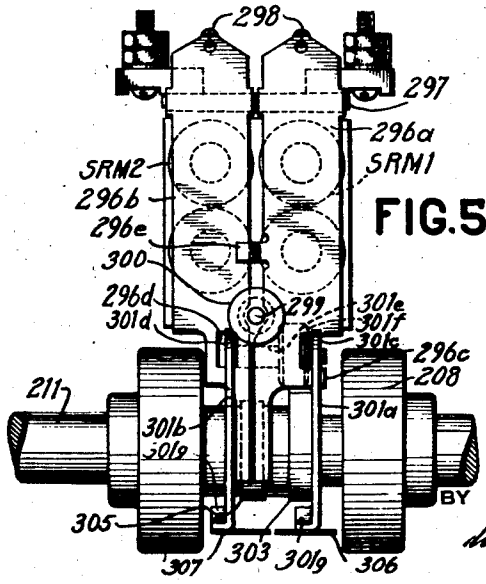


FIG.5a.



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RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 11

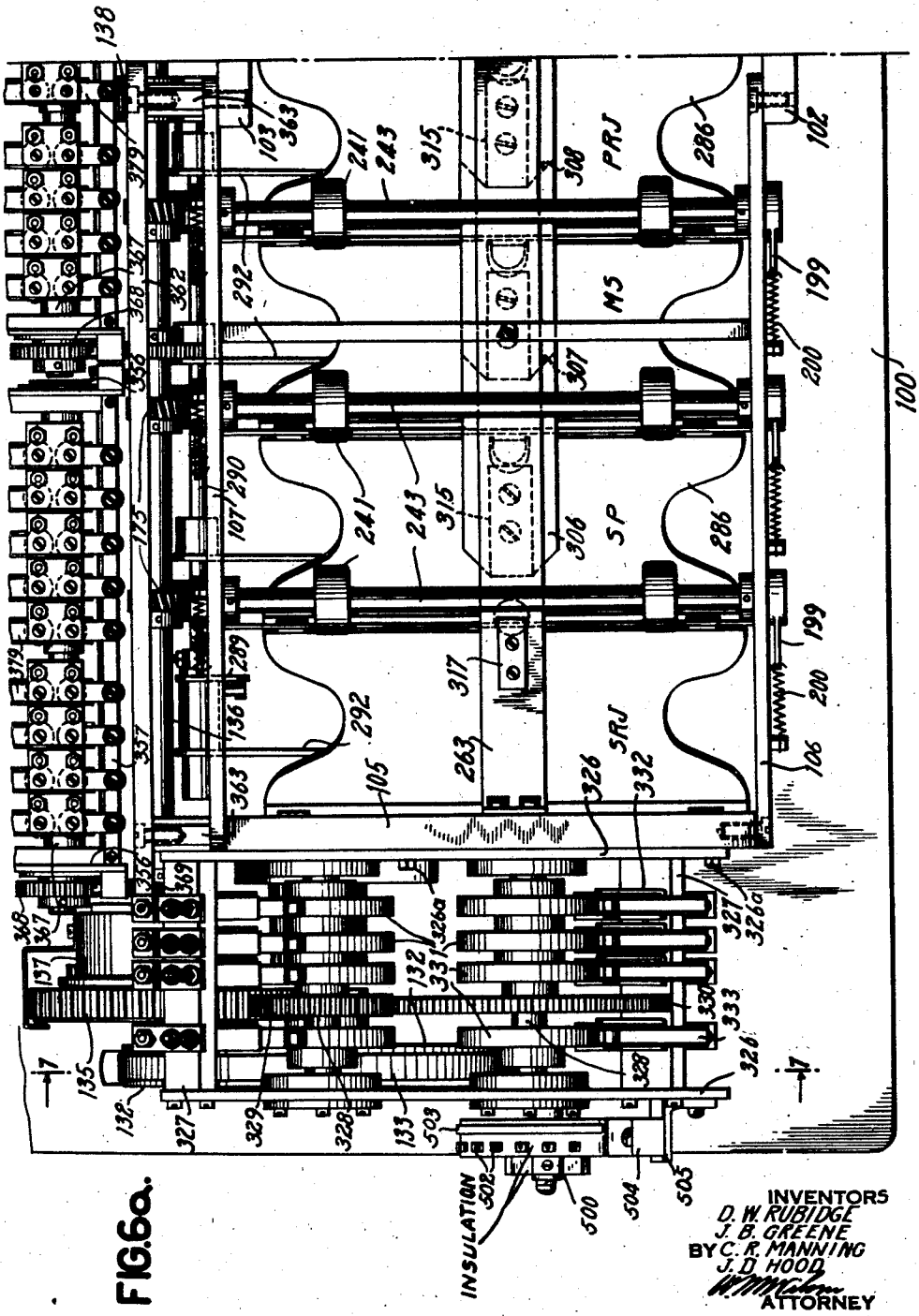

FIG.6a.

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RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 12

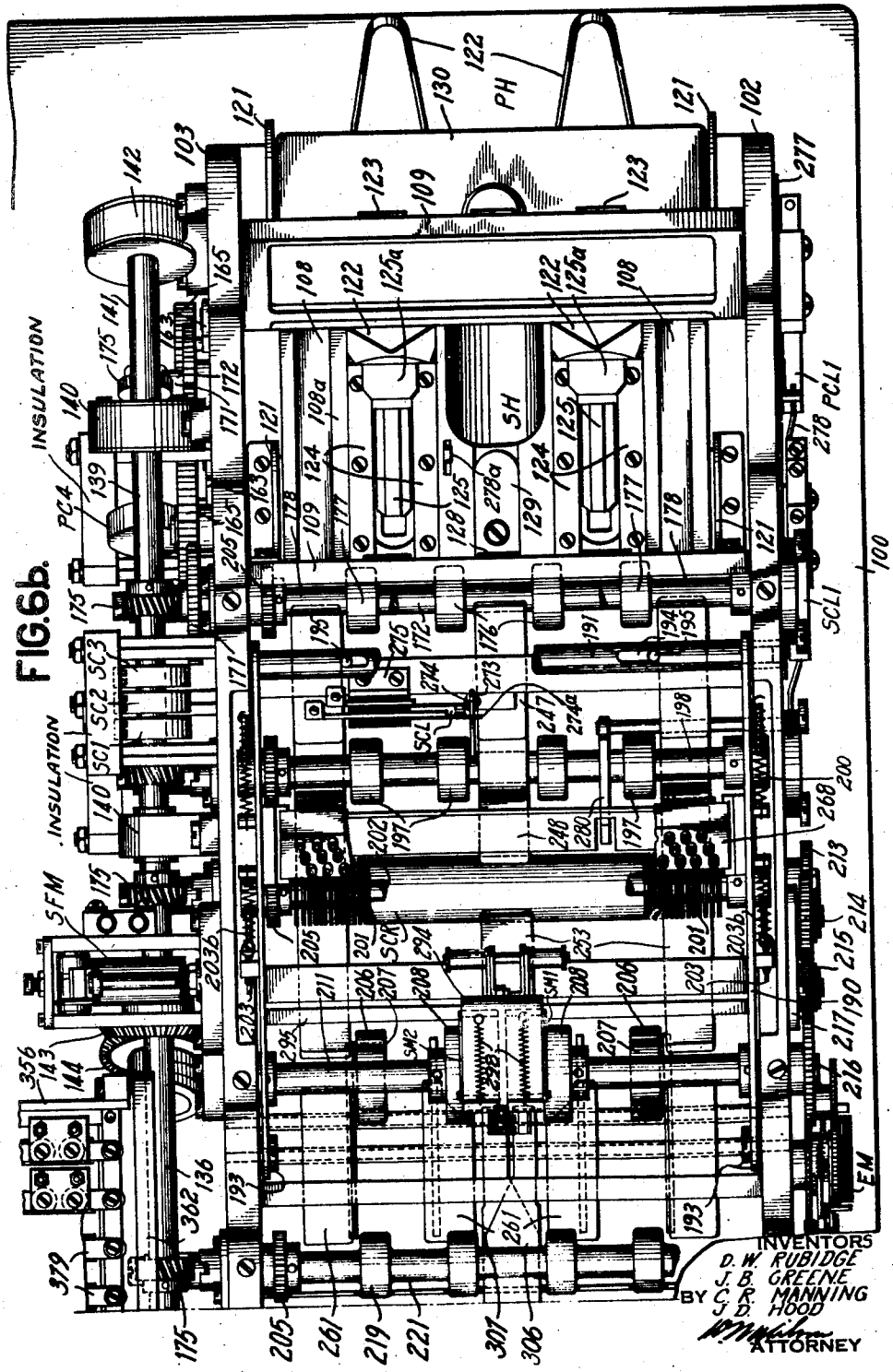

FIG. 6b.

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RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 13

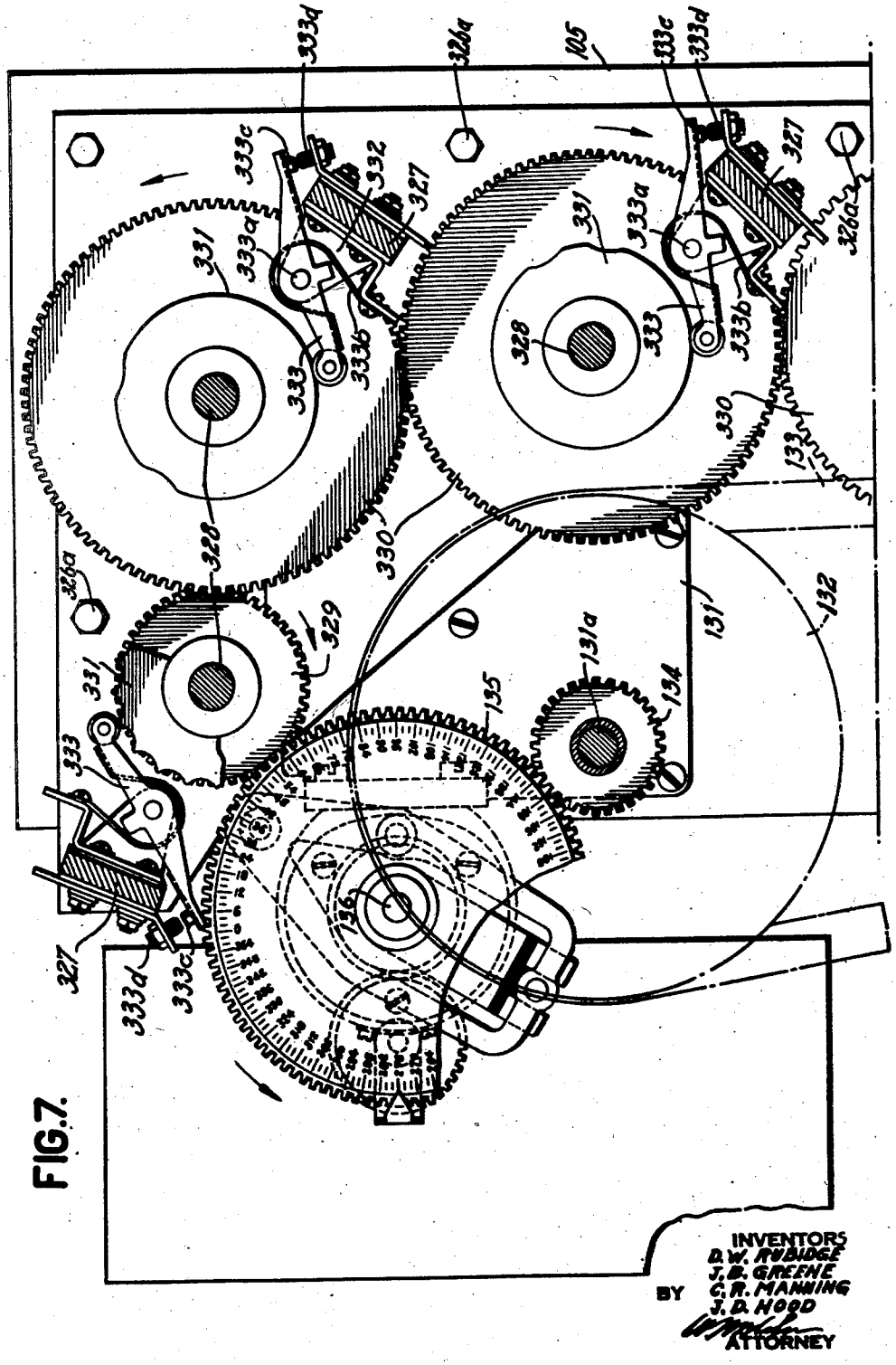

FIG. 7.

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July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 14

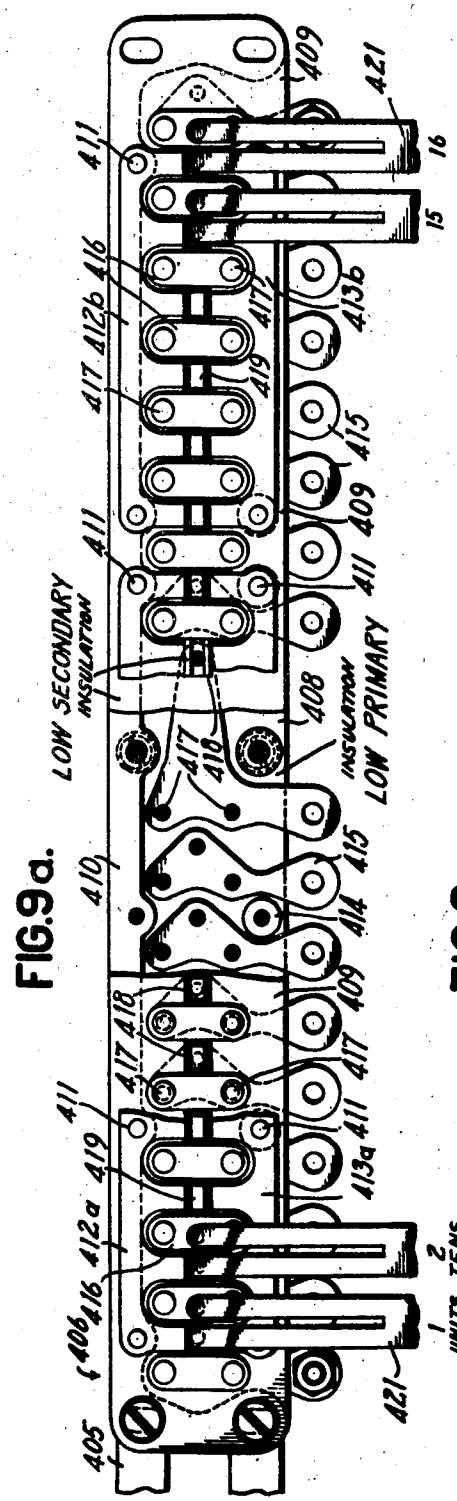

FIG.9a.

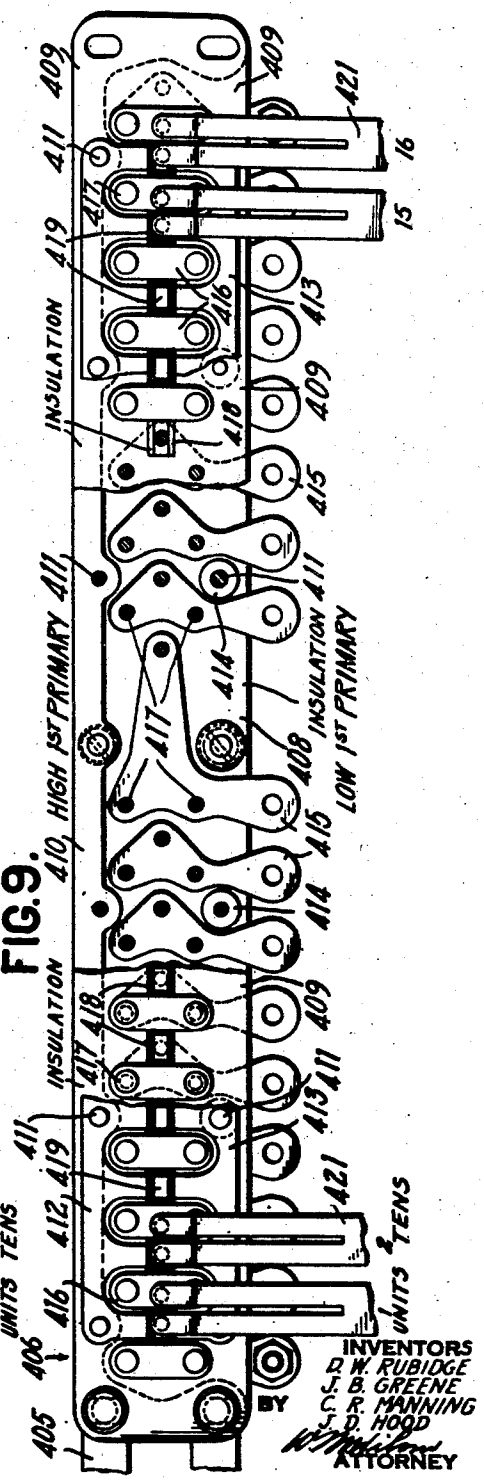

FIG.9.

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RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 15

FIG.10a.

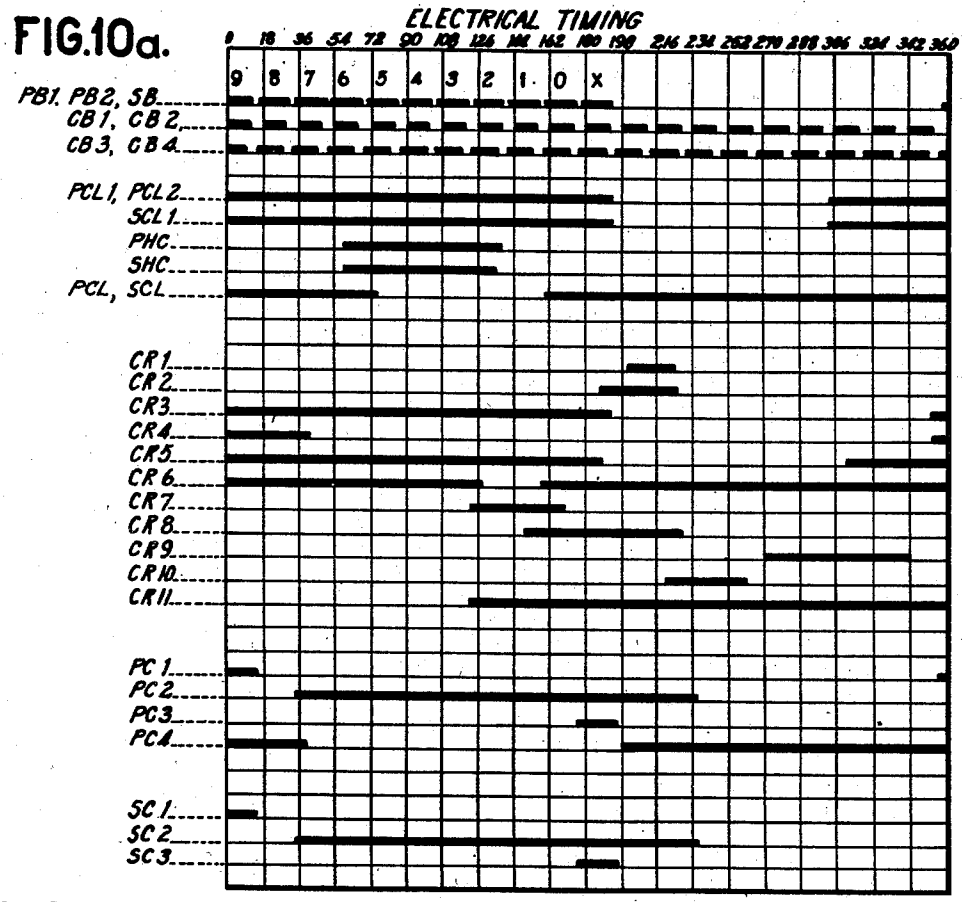
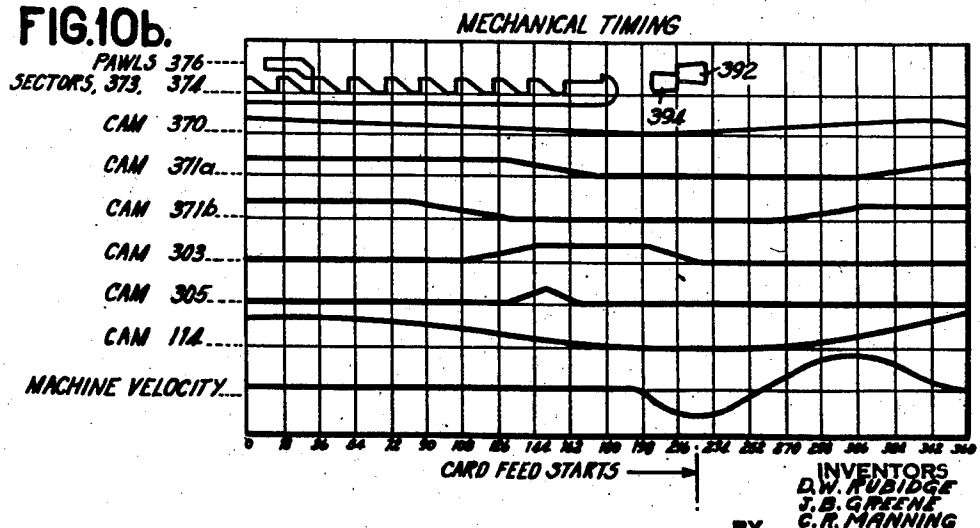


FIG.10b.



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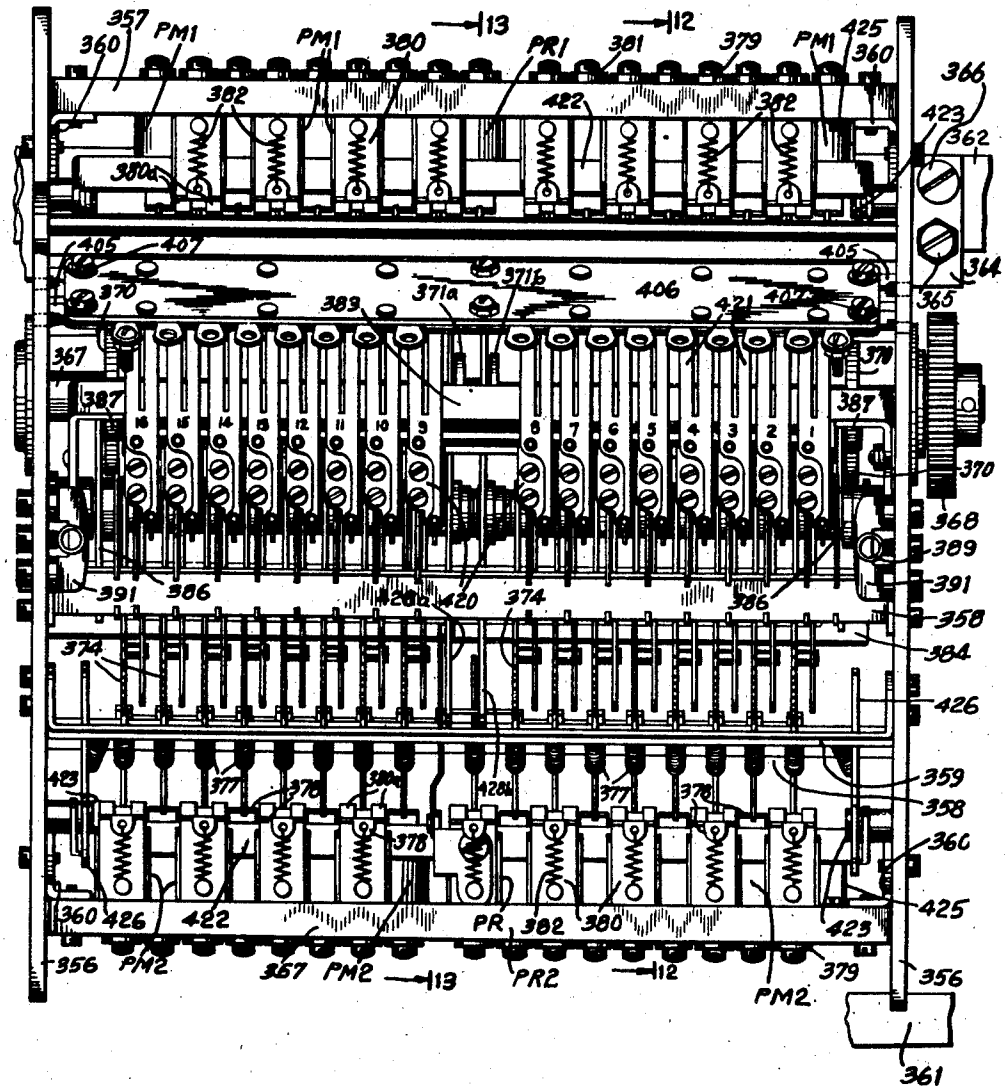
Original Filed July 24, 1940 28 Sheets-Sheet 16

FIG. 11.



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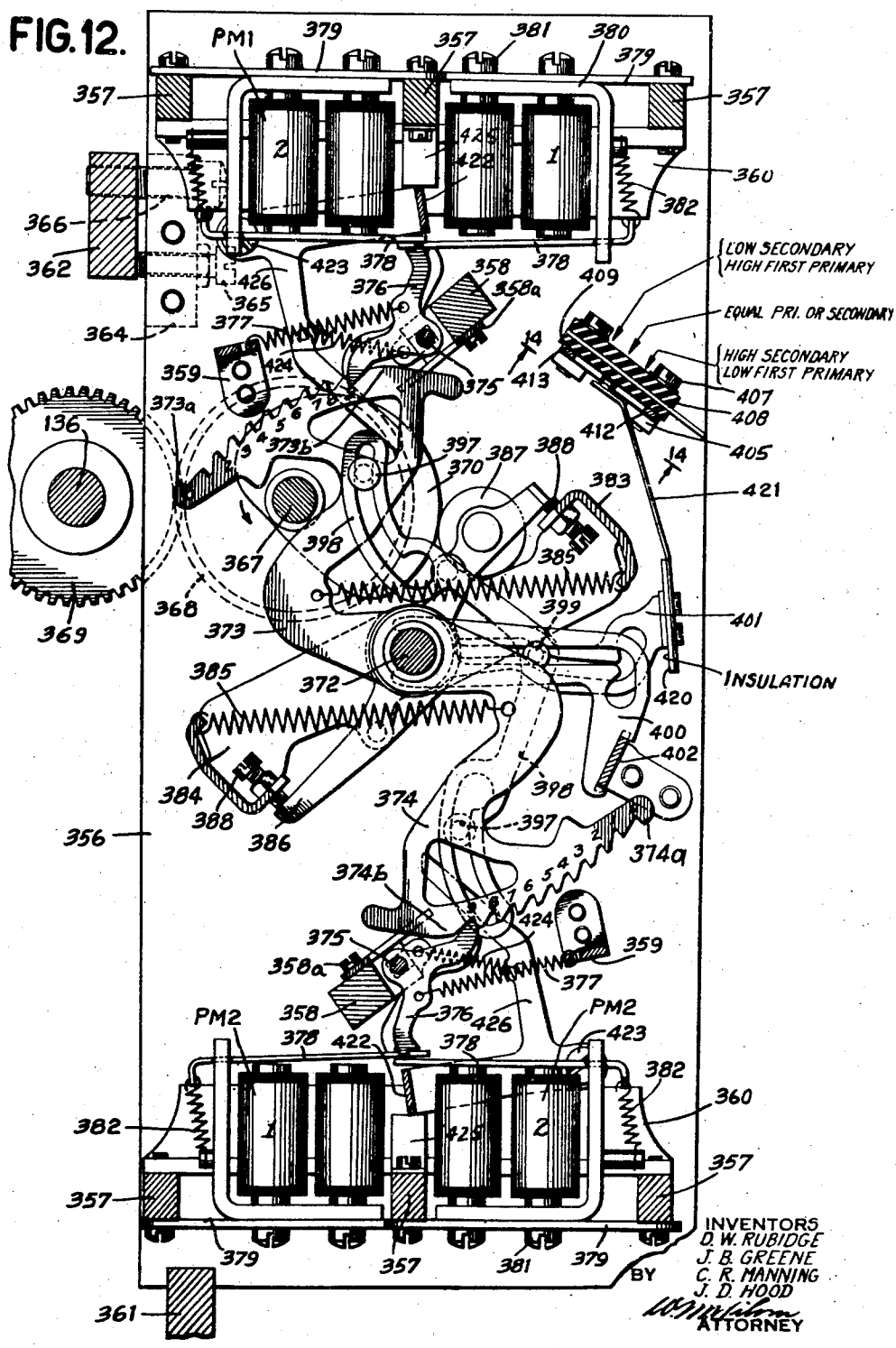
RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 17

FIG. 12.



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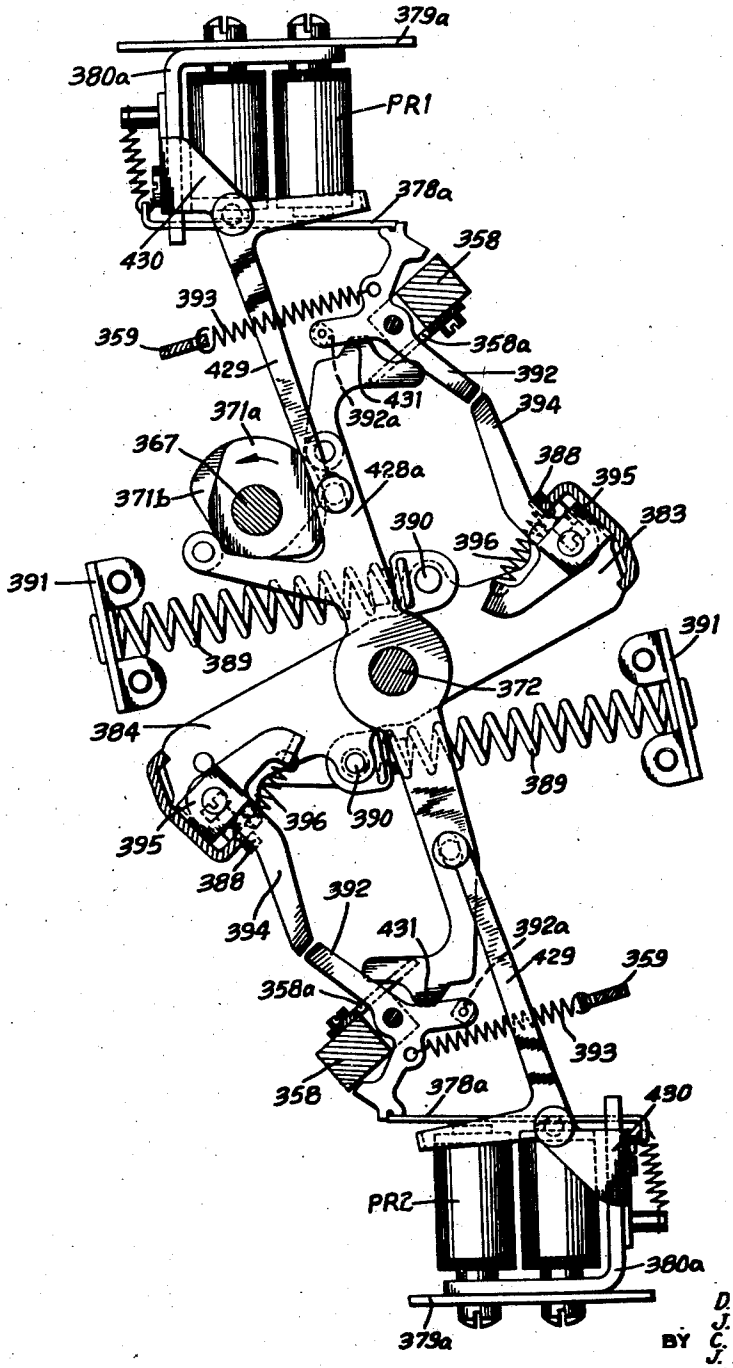
RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 18

FIG.13.



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July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 19

FIG.14.

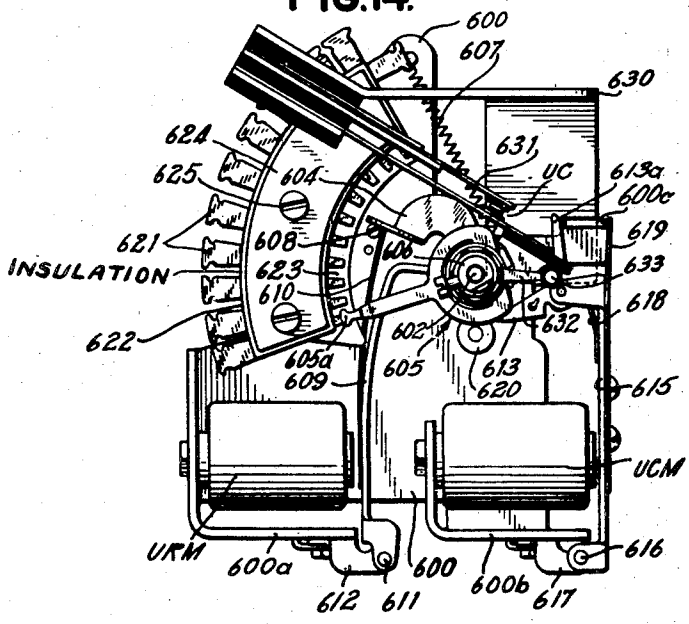
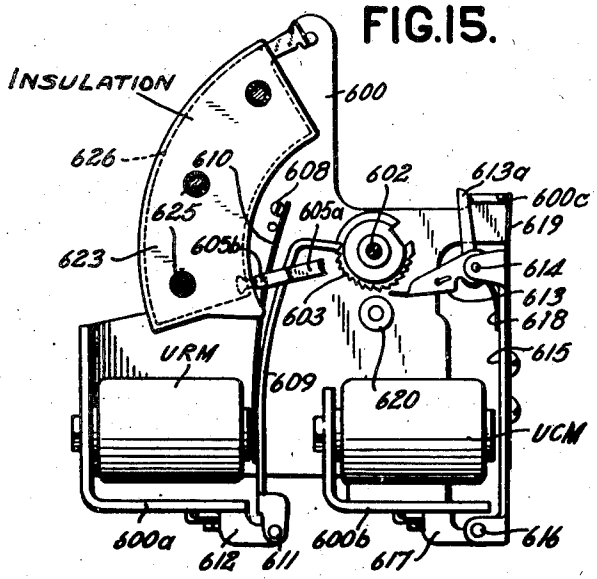


FIG.15.



INVENTORS
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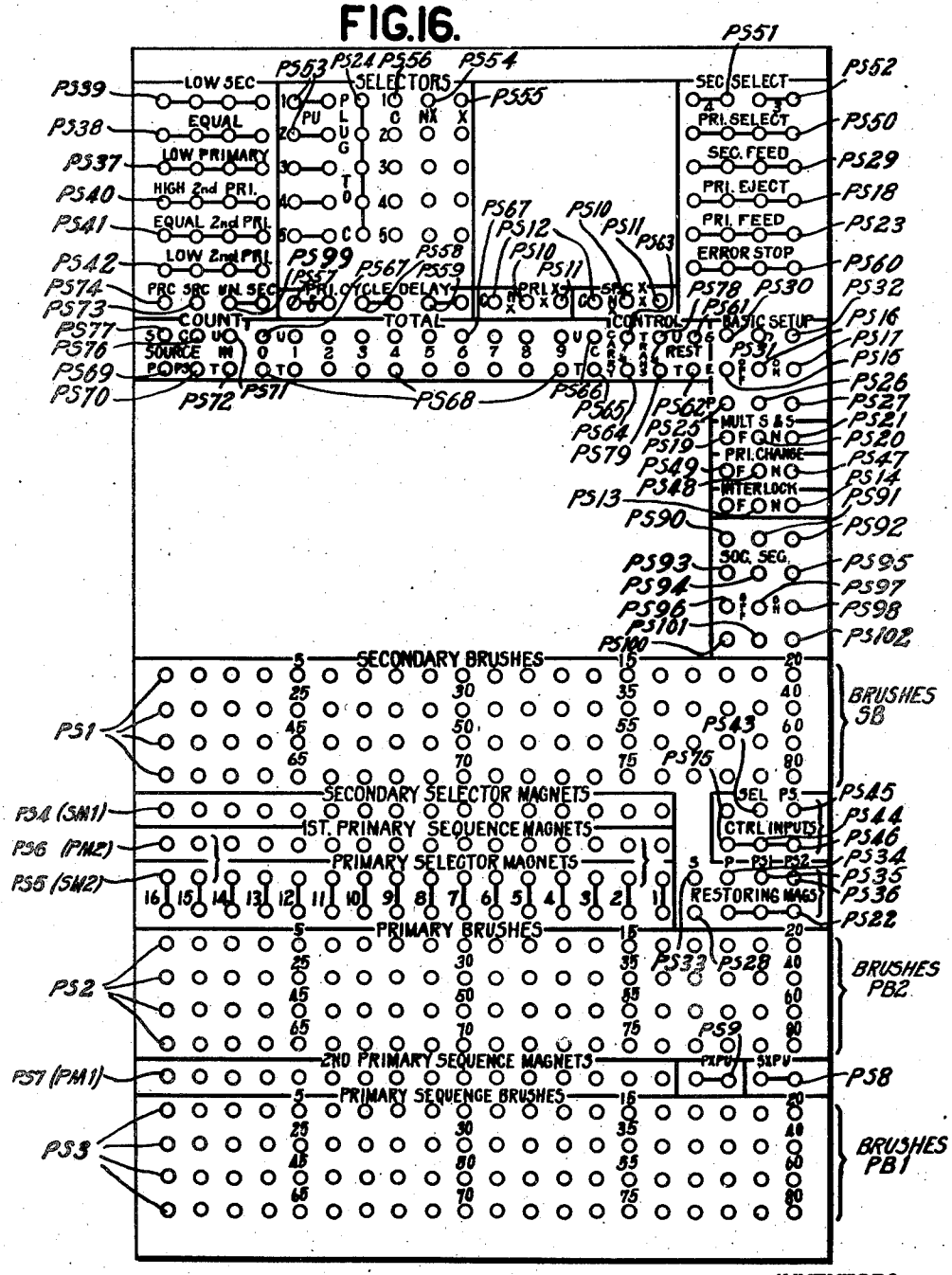
July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 20

FIG.16.



INVENTORS
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July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 21

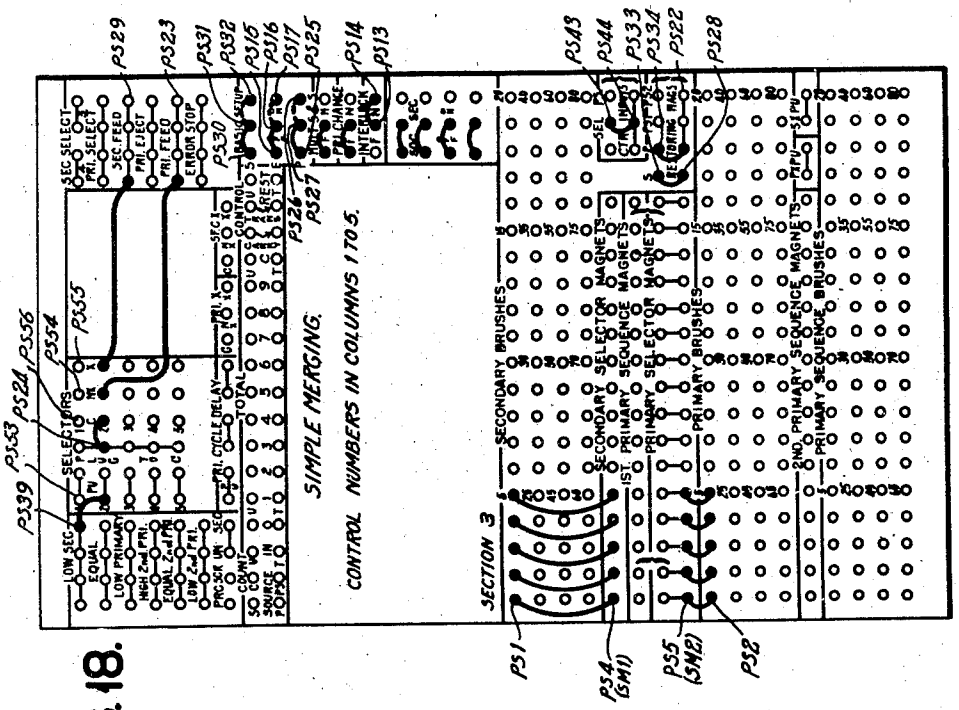

FIG. 18.

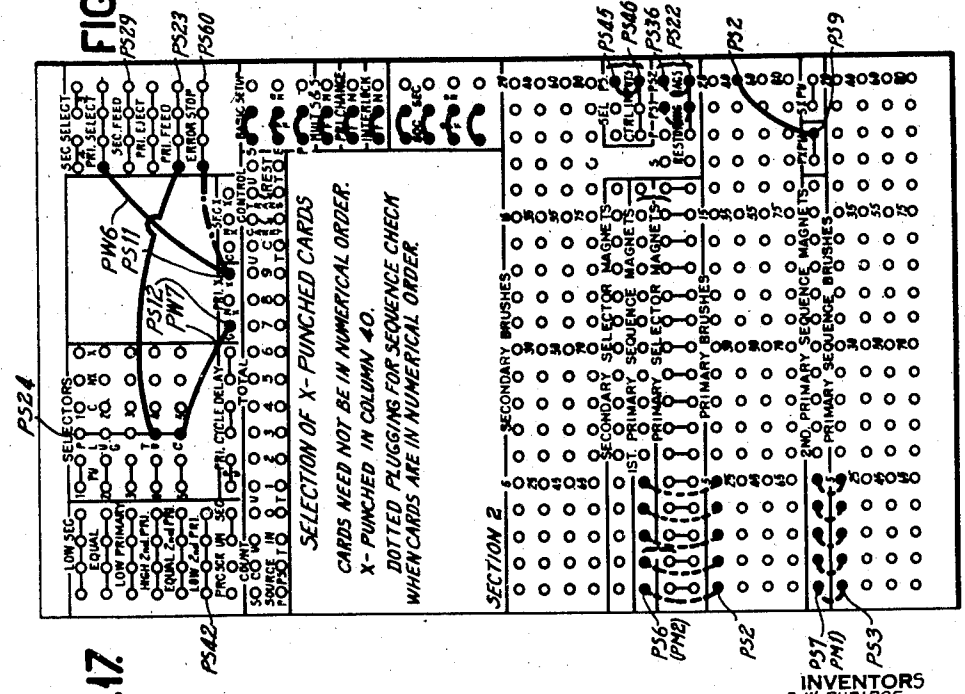

FIG. 17.

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July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 22

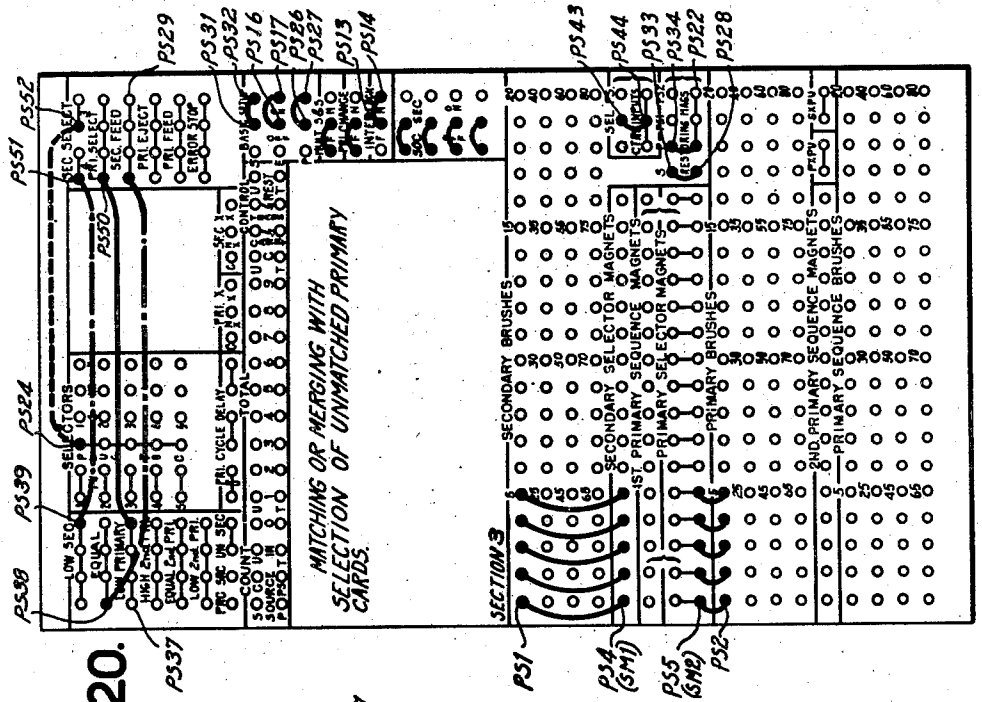

FIG. 20.

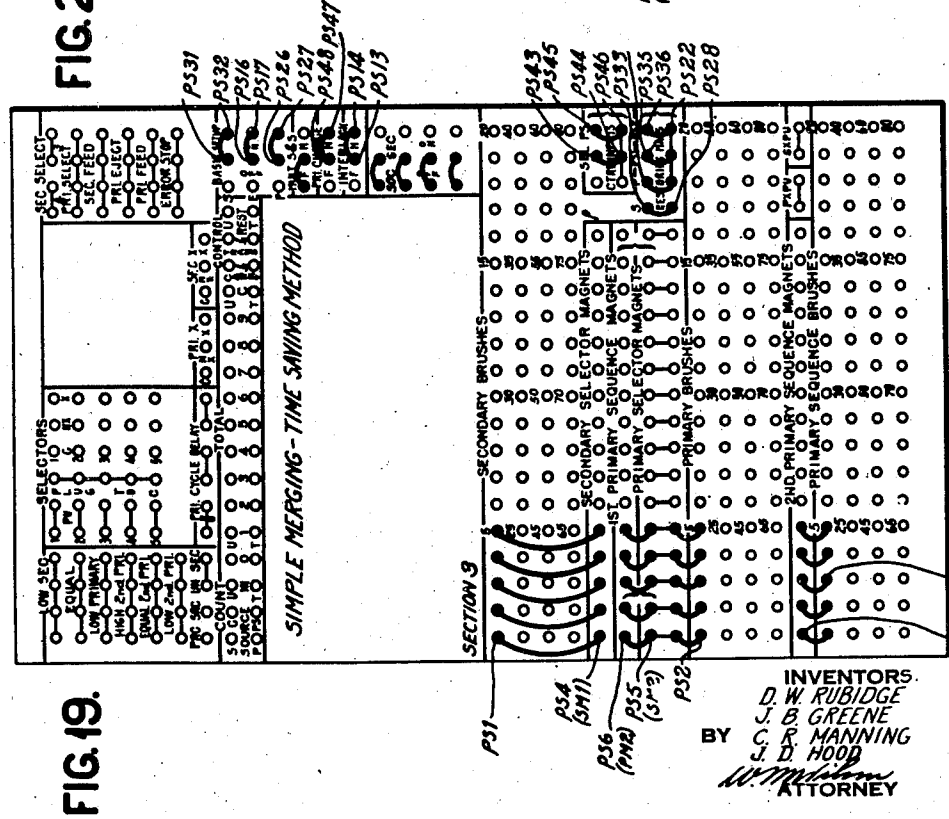

FIG. 19.

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July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 23

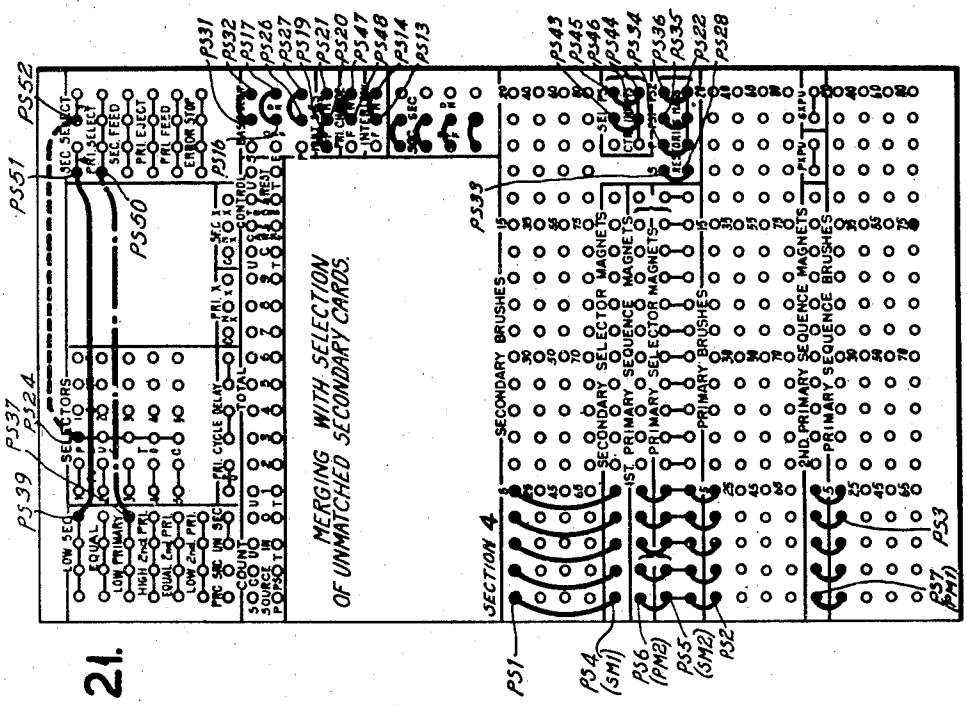

FIG. 21.

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July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 24

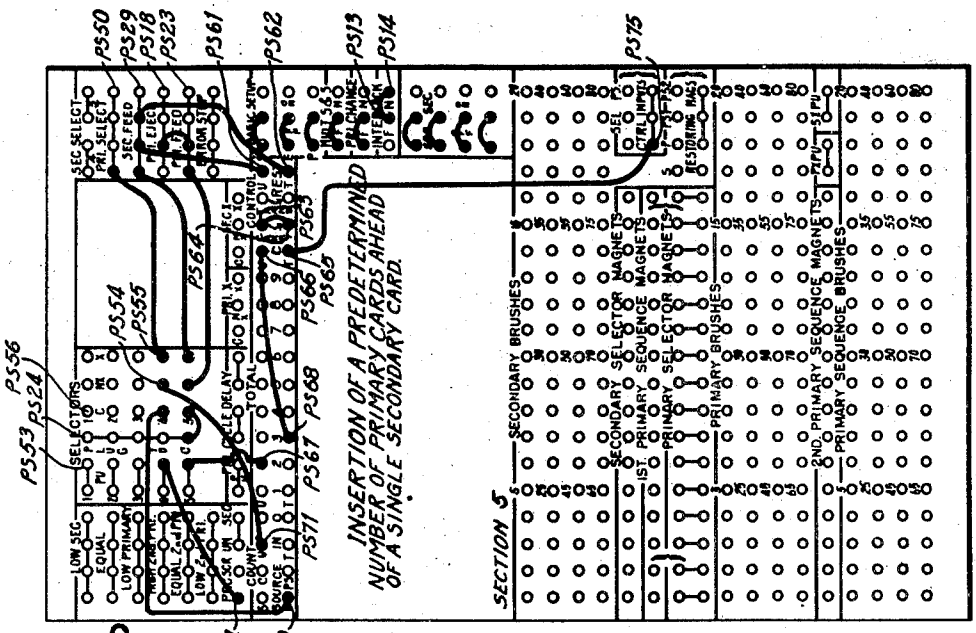

FIG. 22b

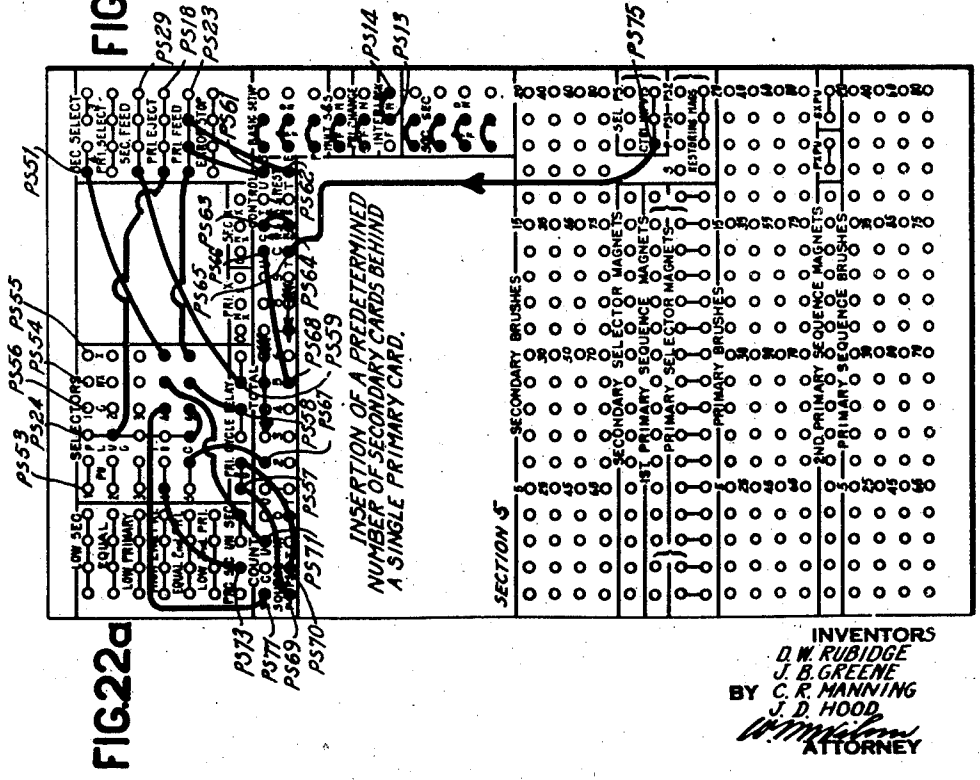

FIG. 22a

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July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 25

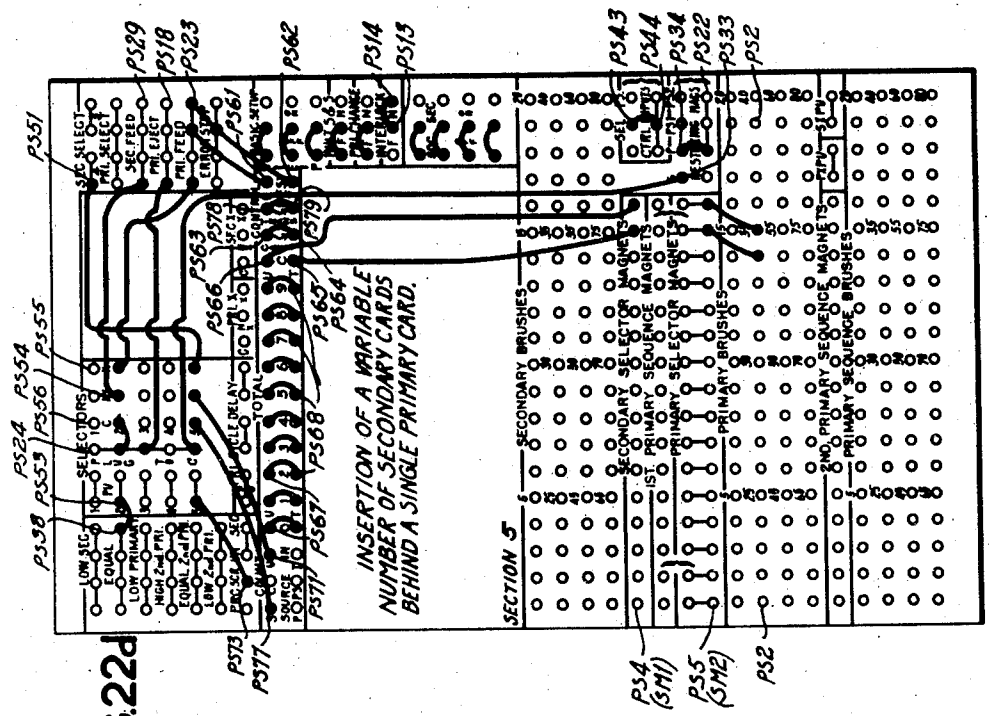

FIG.22d

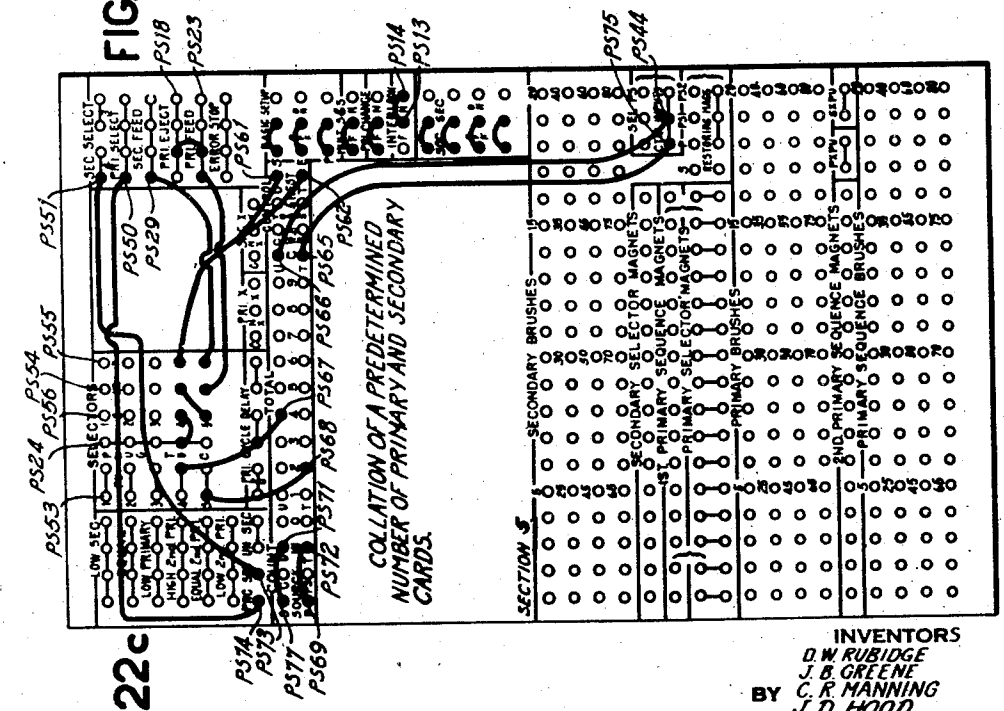

FIG.22c

INVENTORS
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July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 26

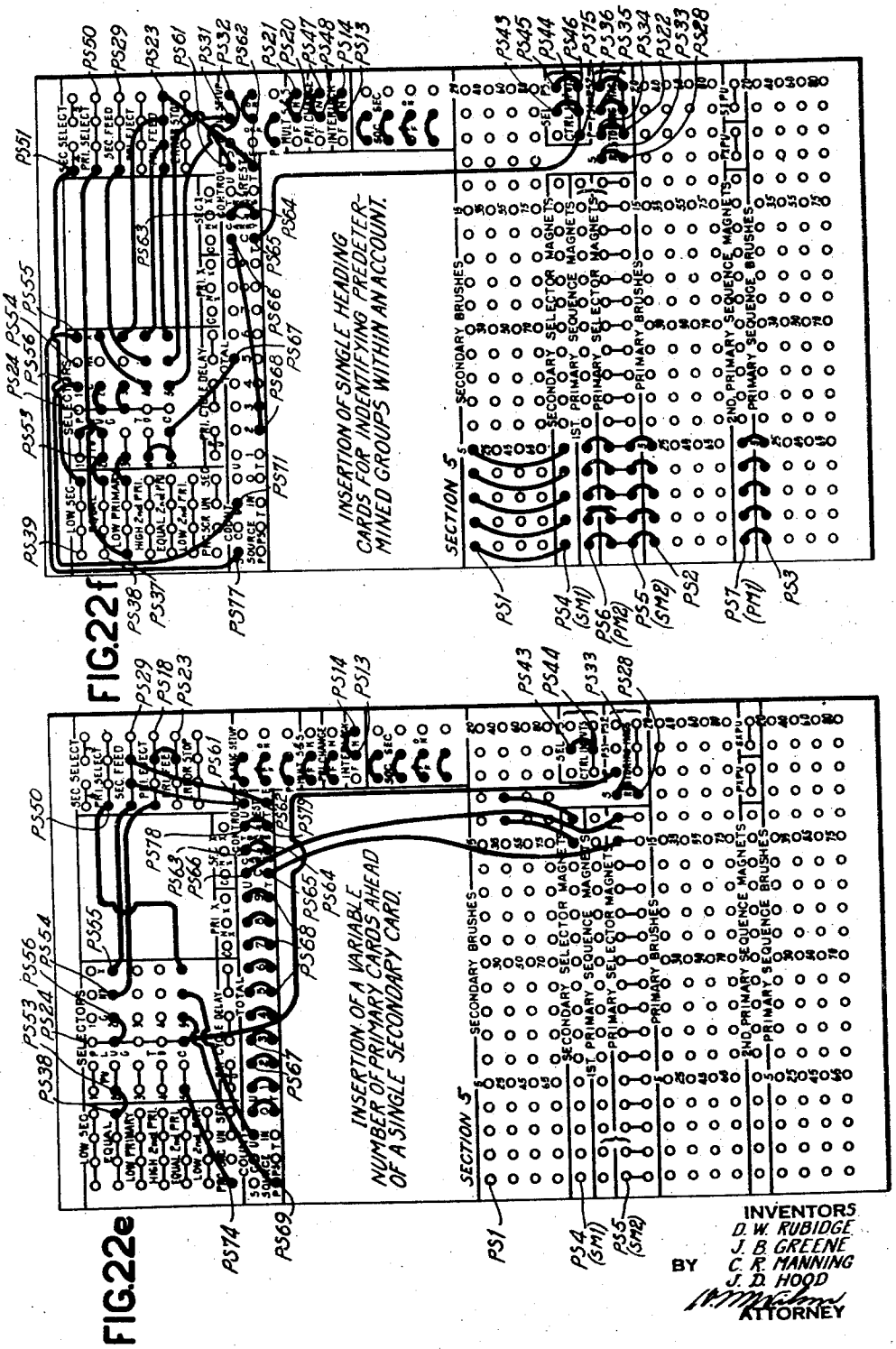

FIG.22f

FIG.22e

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July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 27

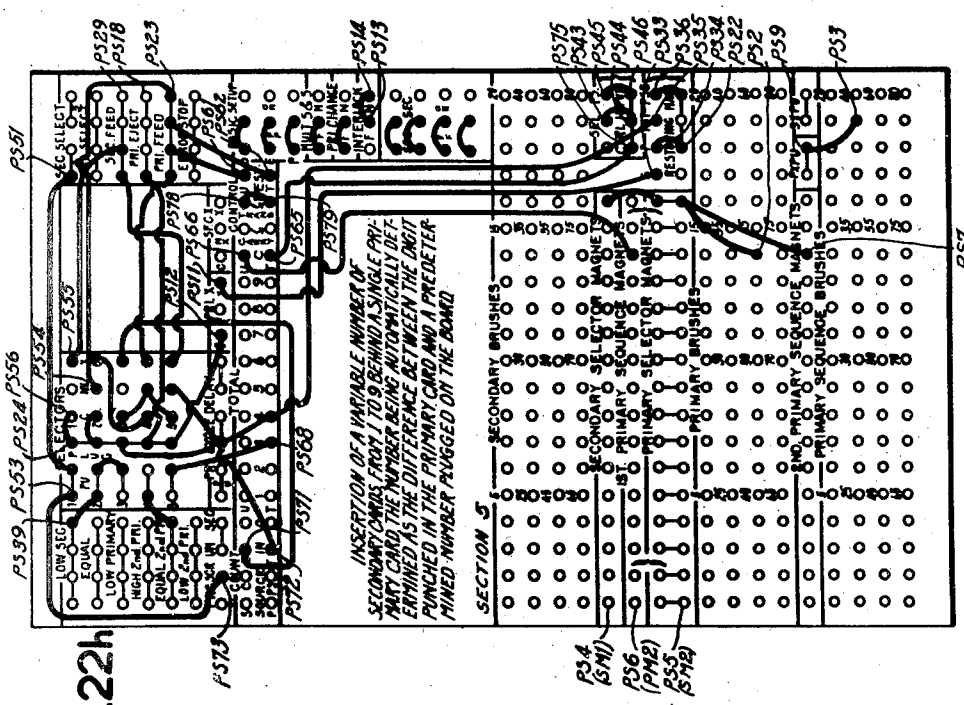

FIG. 22h

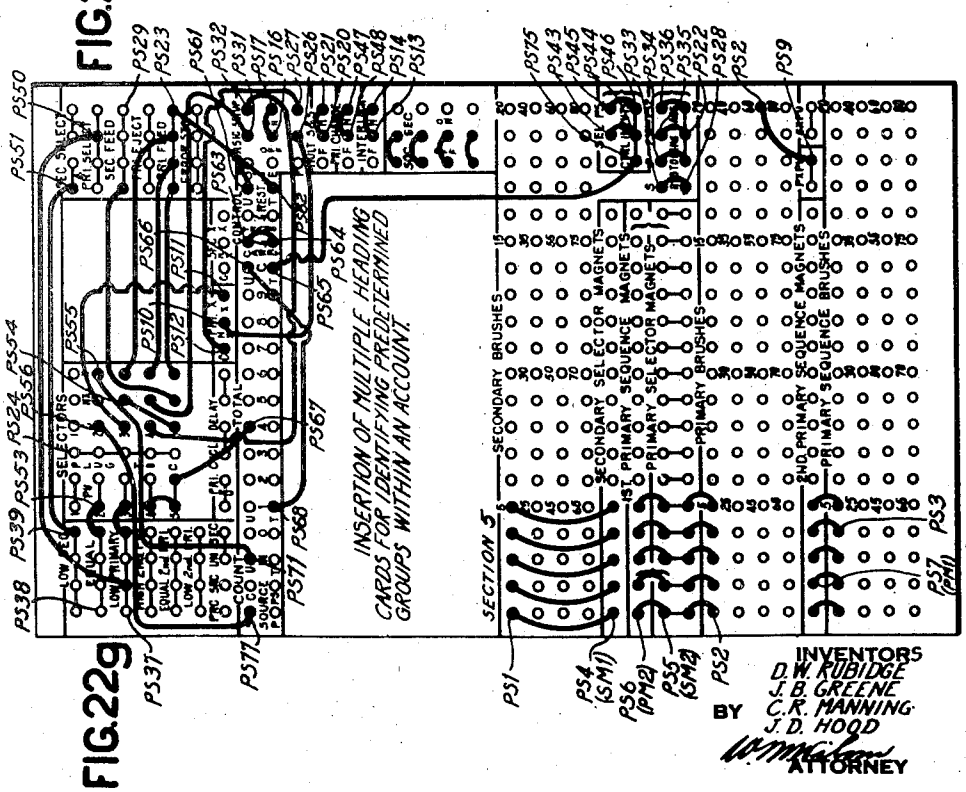

FIG. 22g

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July 20, 1948. D. W. RUBIDGE ET AL 2,445,636

RECORD CONTROLLED MACHINE

Original Filed July 24, 1940 28 Sheets-Sheet 28

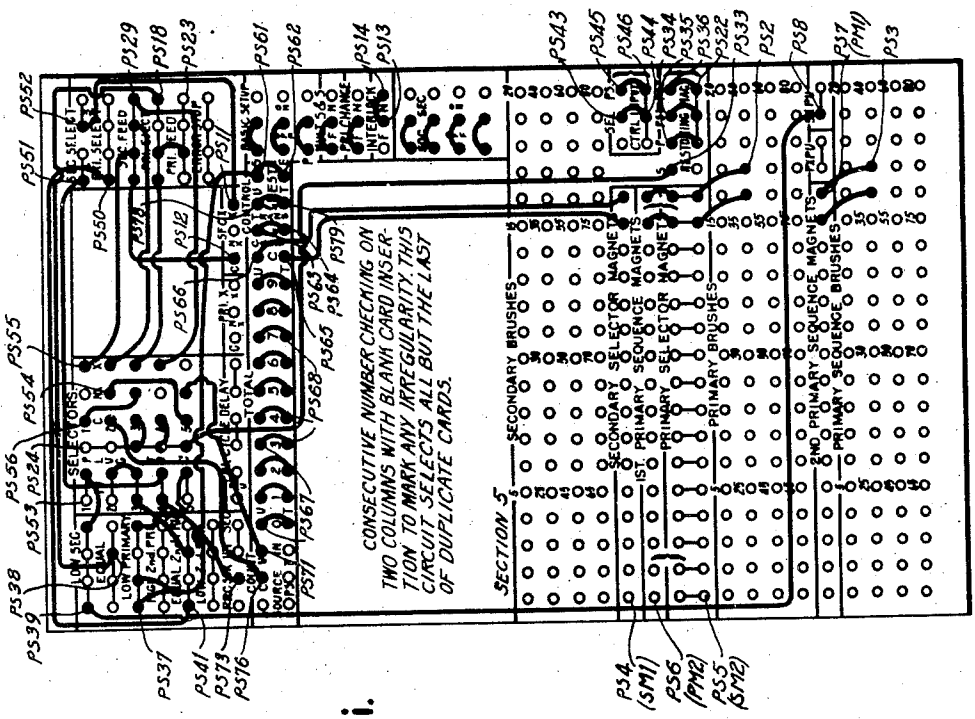

FIG.22i.

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BY W. M. Adams
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Patented July 20, 1948 2,445,636

UNITED STATES PATENT OFFICE

2,445,636

RECORD CONTROLLED MACHINE

David W. Rubidge, Chatham, N. J., Clarence E. Manning, Vestal, N. Y., James B. Greene, New Brunswick, N. J., and James DeK. Hood, Endwell, N. Y., assignors to International Business Machines Corporation, New York, N. Y., a corporation of New York

Original application July 24, 1940, Serial No. 347,226. Divided and this application September 1, 1942, Serial No. 456,890

27 Claims. (Cl. 270—58)

1

This invention relates to record controlled machines and particularly to that class of machine which has become known in the art as a collator.

The present application is a division of application Serial No. 347,226, filed July 24, 1940, now Patent No. 2,379,828, issued July 3, 1945, by D. W. Rubidge, C. R. Manning, J. B. Greene, and J. D. Hood. The present application claims the counting device whereas the parent application contains the claims to general machine combinations and sub-combinations involving the comparing units, feed mechanisms, card distributing mechanisms, run-out controls, and X selectors.

The broad object of the present invention is to improve record controlled machines of the type mentioned to the end that a greater number of operations may be obtained to thereby make the machine more flexible in its adaptability to perforated record accounting systems, such as those which employ the well known Hollerith perforated record cards.

An object is to provide a machine which is capable of carrying out an unlimited number of different kinds of record filing, matching, merging and selecting operations.

An object is to provide a flexible record counting device for use in conjunction with sorting machines, collators, or similar machines for controlling the selection, feeding and sorting of records on a quantitative basis.

An object is to provide a device which may be settable to control the insertion of any predetermined number of records between groups of file records.

An object is to provide a device capable of verifying the numerical sequence of records.

An object is to provide a counting device which is very flexible in its application to record filing and selecting operations.

A specific object is to improve the machine disclosed in application Serial No. 117,493, filed December 24, 1936 by Ralph E. Page, now Patent 2,359,670.

In the Page application there is disclosed a record controlled machine designed to perform a limited number of record matching, merging, and selecting operations. This machine is provided with a plurality of record comparing mechanisms and two feeding mechanisms for feeding two separate batches of cards for effecting various types of selecting, merging, and matching mechanisms utilizing one or both of the feed mechanisms. In this machine, the relays which control the operation of the machine, such as the magnets which control the feeding of records, the restoring of

2

the comparing mechanisms, the selection of records, and the comparing mechanisms, are more or less permanently connected, whereby the flexibility of the machine is more or less limited. The machine described herein may be plugged to perform an unlimited number of operations.

Other objects of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of example, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

In the drawings:

Figs. 1*a* to 1*e*, inclusive, comprise a wiring diagram of the machine.

Fig. 2 is a front elevation of the card feeding and sensing section of the machine with the front cover removed.

Figs. 3*a* and 3*b* together comprise a vertical longitudinal section.

Fig. 3*c* is a vertical section showing the hopper contacts.

Fig. 4 is a rear elevation of the card feeding and sensing section of the machine with the rear cover removed.

Fig. 5 is a large scale vertical section showing parts of the card sensing and distributing mechanism.

Fig. 5*a* is a vertical section on the line 5*a*—5*a* in Fig. 5.

Figs. 6*a* and 6*b* together comprise a plan view of the machine with the machine covers removed.

Fig. 6*c* is a plan view of the hopper contacts.

Fig. 7 is a vertical section on the line 7—7 in Fig. 6*a*.

Fig. 8 is a view in elevation of the emitter as viewed from the left in Fig. 6*a*.

Fig. 9 is a detail view of the switch mechanism for the sequence comparing unit.

Fig. 9*a* is a view of the switch mechanism for the selector comparing unit.

Fig. 10*a* is an electrical timing chart.

Fig. 10*b* is a mechanical timing chart.

Fig. 11 is a large scale elevation of the sequence comparing unit as viewed from a point behind the machine.

Fig. 12 is a vertical section on the line 12—12 of Fig. 11.

Fig. 13 is a vertical section on the line 13—13 in Fig. 11.

Fig. 14 is an elevation of the units count relay.

Fig. 15 is a vertical section showing the mechanism for rotating the wiper assembly of the units count relay.

Fig. 16 is a view of the face of the plugboard.

Figs. 17 to 22*i* are charts showing how the machine is plugged for the various operations it can perform.

I. System of Designating Electrical Parts of Machine

In describing the invention it will be found convenient, and will make the drawings more nearly self-explanatory, to designate the various controlling magnets, contacts, relays, and other electrical elements by means of capital letters derived as far as possible by taking the initial letters of the name of the magnet or other element; and where more than one of a kind is present, to distinguish them by means of numerical suffixes. Thus, the relays are designated R1, R2, etc. Other illustrations of this system of designations are the letters EM (eject magnet), PFM (primary card feed magnet), and SFM (secondary card feed magnet).

Due to the complexity of the wiring of the machine, the wiring diagram would become a maze of crossing wires difficult to follow if it were attempted to show each relay magnet opposite the contacts it controls. Accordingly, the circuits in Figs. 1*a* to 1*e* have been laid out so as to extend as directly as possible from one line wire to the other with the relay magnets separated from their contacts. In order to avoid confusion, the contacts associated with each magnet will be designated with the same letters and numbers as the magnets plus the letters *a*, *b*, *c*, etc. Thus the contacts of relay R1 are designated R1*a*. In addition the relay magnets will be shown in dotted lines adjacent the contacts wherever the latter appear in solid lines.

II. Framework

The main framework comprises a heavy oblong base casting **100** (Figs. 2, 3*a*, 3*b*, 4, 6*a*, and 6*b*) supported by four legs (not shown) secured to the base. Two frame castings **102**, **103** are secured to the top surface of the base **100** along the front and rear edges nearest the right hand end of the base (see Figs. 2, 3*b*, 4, and 6*b*). The frame castings **102**, **103**, which are more or less alike but irregular in outline, extend upwardly and to the left. The left hand ends of both frame castings **102**, **103** are secured to the upper ends of a pair of vertical bars **104** (Figs. 2, 3*b*, 4, and 5) which are secured to base **100**. An end plate **105** (Figs. 3*a* and 6*a*) is secured to base **100** near the left hand end thereof and extends at right angles to the planes of frame castings **102**, **103**. Front and rear plates **106**, **107** (Figs. 2, 3*a*, 3*b* and 6*a*) are secured to the front and rear vertical edges of plate **105**, respectively, and to the frame castings **102**, **103**. Two pairs of frame castings **108**, **109** (Figs. 3*b* and 6*b*) join the frame castings **102**, **103** and form part of the two card hoppers which will be described hereinafter.

The framework mounted on base **100** just described supports the card feeding, sensing, comparing, distributing and analyzing mechanisms, and the card pockets and hoppers.

The legs attached to the base support a framework (not shown) on which are mounted the driving motor and, where direct current is not available, a suitable motor generator. The relays, fuse box, a terminal board and other usual appurtenances of an electrically controlled machine are also wholly or partly supported by this framework or partly by the base.

The usual hinged glass shelf **117**, with which sorting machines and other record controlled machines are commonly equipped, is provided above the card pockets. This consists of a sheet of plate glass secured in a frame **118** (Figs. 2, 3*a*, and 3*b*) pivoted on conical studs **119**, one of which is threaded into a hole in plate **105** (Fig. 3*a*) while the other is similarly mounted on a bracket **120** secured to rear frame casting **103** (Figs. 3*b* and 5). The shelf **117** thus can be swung upwardly and rearwardly to remove cards which may become jammed above the pockets.

III. Card Hoppers

The machine is provided with two separate card sensing and feeding mechanisms for control by two separate batches of perforated record cards, consequently two card hoppers are provided. The record cards used in this machine may be of the well known type now used in the Hollerith system of perforated card accounting. The size of the card and the number of columns available for recording data is unimportant but the machine will be described herein as designed for control by eighty column cards like the one described and claimed in Patent No. 1,772,492. The machine is easily adapted for control by either 34 or 45 column cards, this requiring merely a change in the spacing of the card sensing brushes in the case of 45 column cards, and in addition, a change in the dimensions of the card hoppers in the case of 34 column cards.

As a means of distinguishing them, the hoppers will be termed the primary and secondary hoppers, and the adjectives "primary" and "secondary" will also be used in naming the cards placed in these hoppers, and in designating the card feeding, sensing, and comparing mechanisms, and other parts associated with the hoppers or controlled by the respective cards. It will be understood that the words "primary" and "secondary" as used herein are employed purely as a convenience in description for the purpose of identifying the parts of the machine and the records and have no special significance. Thus, the cards which in one case may be placed in the primary hopper and become primary cards for a specified type of operation, may at another time be placed in the secondary hopper and thereby become for the moment secondary cards for a different type of operation.

The primary hopper is generally designated PH while the secondary hopper is designated SH in Figs. 2, 3*b*, 4, and 6*b*. These hoppers and the card picker mechanisms associated therewith are constructed in a well known way, having been used for a number of years in "International" record controlled machines, such as sorting machines, reproducers, and multiplying punches. Consequently, only a very brief description of the hoppers will be given herein. Both hoppers are alike in details of construction and differ only in that the primary hopper PH is inclined owing to the fact that the cards from the two hoppers are fed to a common point for distribution to the card pockets.

Each pair of frame plates **108**, **109** forms the bottom and one side of one of the hoppers. Two sheet metal card guides **121** (Figs. 2, 3*b*, and 6*b*) are secured to the top of each frame casting **108** adjacent frame castings **102**, **103** and serve to guide the ends of the cards. Two posts **122**, etc. are also secured to the edges of each frame casting **108** opposite the frame castings **109** and guide the right hand or trailing edges of the cards, while two metal strips **123** (Figs. 3*b* and 6*b*) secured to the right hand face of each frame casting **109**

guide the leading edges of the cards. When the cards are placed in the hoppers the lowest card lies partly on top of ribs 108a (Fig. 6b) formed in the frame castings 108 and also on picker guides 124 secured to said castings.

Card pickers 125 (Figs. 3b and 6b) of well known construction are provided having the usual picker knife 125a and are guided for reciprocatory movement by the guides 124. Each picker 125 is provided with rack teeth meshing with gear segments 126 secured to shafts 127 journaled in frame castings 102, 103, there being two pickers 125, two segments 126, and one shaft 127 associated with each hopper. The usual adjustable throat knife 128 (Fig. 6b) and throat block 129 are provided to prevent feeding more than one card at a time from each hopper. In order to keep the cards flat in the hoppers, the latter are provided with the usual follower weights 130 (Figs. 3b and 6b). In Fig. 6b the secondary cards and the secondary hopper follower weight have not been shown in order to illustrate the construction of the secondary hopper more clearly.

One or both shafts 127 are oscillated at regular intervals to push one card from the associated hopper to the left in Fig. 3b into position to be gripped by feed rollers to be described later. The means for oscillating the shafts 127 will be described in part IV dealing with the driving mechanism.

IV. Driving Mechanism

The driving mechanism is shown in Figs. 4, 6a, 6b, and 7. A bracket in the form of a casting 131 is secured to the left hand face of frame plate 105 (Figs. 6a and 7) and mounted on this casting is a stud 131a on which is journaled a driven pulley 132 connected to the main driving motor (not shown) by a belt 133. When the machine is in use, the pulley 132 is continually driven by the motor. Secured to pulley 132 (Fig. 7) is a pinion 134 meshing with a gear 135 which is loose on the main drive shaft 136. The latter is journaled in bearings 137, 138 (Fig. 6a) secured to the casting 131 and plate 107, respectively. Gear 135 and shaft 136 are coupled by mechanism disclosed in Patent No. 2,174,705, which causes the speed of the drive shaft 136 to vary between maximum and minimum limits.

Coaxial with shaft 136 (Figs. 4 and 6b) is the secondary feed shaft 139 journaled in two bearings 140 secured to the rear face of frame casting 103. The primary feed shaft 141 is journaled in three bearings 142, also secured to frame casting 103, and makes an angle of approximately 24° with shafts 136, 139, the extreme right hand bearings 142 (Fig. 4) being located so that the right hand end of shaft 141 extends quite close to the left hand end of shaft 136. Secured to the left hand end of shaft 136 (Fig. 4) is a bevel gear 143 meshing with a bevel gear 144 loosely mounted on shaft 141. Obviously bevel gear 144 rotates continually at a varying speed while the machine is in operation.

V. Card Feed Clutch Mechanism

The feed shafts 139, 141 may be selectively clutched to shaft 136 by means of two one-revolution clutches generally designated 145 and 146, termed the primary and secondary feed clutches respectively. The clutches 145 and 146 are controlled by two magnets designated PFM and SFM in Fig. 4, and called the primary and secondary feed magnets, respectively. Both of these clutches are shown in Fig. 4 and appear directly to the left of the bevel gears 143, 144. The lower of these clutches in Fig. 4 is the primary feed clutch while the secondary feed clutch is located directly above the primary feed clutch and are of a form now well known in the art. The mechanism of the two clutches and the clutches are identical except that the parts of the primary clutch are reversed in location and direction of movement relative to the secondary clutch due to the fact that gears 143, 144 rotate in opposite directions and due to limitations of space which preclude mounting the magnets and other parts in the same relative positions with respect to the associated feed shafts. Thus the corresponding parts of the clutch mechanisms are symmetrically located with respect to the bisector of the angle between shafts 139, 141. Since the specific construction of the clutches is not material to the present disclosure, they will not be described in detail. The clutches are described in detail in the Page application. It will suffice to state that each time the magnet SFM or PFM is energized, shaft 139 or 141 is clutched to the main drive shaft 136 and will continue to rotate as long as the magnet is kept energized or repeatedly energized.

VI. Card Feed Rollers

Two independent feed mechanisms are provided for feeding the cards from the hoppers to the point where the distribution of the cards to the pockets is determined and, in addition to these feed mechanisms, a common feed mechanism for conveying the cards to the pockets is provided. The first two feed mechanisms are driven by shafts 139, 141 and will be termed the secondary feed mechanism and primary feed mechanism, respectively, while the third feed mechanism is driven by shaft 136 and will be called the pocket feed mechanism. These feed mechanisms are conventional in details of structure.

The primary and secondary feed mechanisms are essentially the same in direction of feed, details of construction and general arrangement, but there are more feed rollers in the primary card feed mechanism than in the secondary feed mechanism since the primary cards sometimes must be sensed twice whereas the secondary cards are only sensed once prior to their distribution to the pockets. The primary and secondary feed mechanisms will be described first and are shown in Figs. 2, 3b, 4, 5, and 6b. The description will begin with the hoppers and follow the paths of the cards to the point of distribution to the pockets.

Secured to each shaft 127, which it will be recalled are rockable to actuate the card pickers 125, is an arm 163 (Figs. 3b and 4) having a roller in a cam groove 164 formed in a gear 165. Gears 165 may be journaled on frame casting 103 in any suitable way as by means of studs 168 or long shafts supported by both frames 102, 103. The gear lowest or primary 165 meshes with an idler gear 169 (Fig. 4) journaled on a stud 170 carried by frame casting 103. Gear 169 meshes with a gear 171 secured to a feed roller shaft 172 journaled in anti-friction bearings 173 carried by the frame castings 102, 103 adjacent the primary hopper PH (see Figs. 2 and 3b). The secondary gear 165 meshes directly with a gear 171 secured to a similar feed roller shaft 172 journaled in bearings 173 adjacent the secondary hopper SH. Secured to the respective shafts 172 are spiral gear pinions 174 meshing with spiral gears 175 fixed to the

shafts 139, 141, respectively. Thus the feed roll shafts 172 may be driven in unison but in opposite directions while pickers 125 are driven in unison but in the same direction by shafts 139, 141 through the two trains of gearing just described.

Each feed roll shaft 172 is provided with card feeding rollers 176 cooperating with similar rollers 177 secured to a shaft 178 (Figs. 3b and 6b). The shafts 178 are journaled in arms 179 (see Fig. 2 also) pivoted at 180 in suitable recesses formed in the front faces of the castings 102, 103. Shafts 178 project through large openings 180a in the frames 102, 103.

Housed in holes in the frame castings 102, 103, at an angle to the bore of openings 181, are spring pressed plungers 182 (Figs. 2 and 3b) which, by engagement with the ends of arms 179, press rollers 177 into firm contact with rollers 176. This general scheme of mounting one feed roll shaft in fixed bearings and the other on spring actuated arms has been used for all the feed rollers. Due to limitations of space and other reasons, the means whereby the spring pressure is applied will vary in details of construction. The two sets of feed rollers 176, 177 rotate whenever the respective feed shafts 139, 141 turn and grip the cards advanced from the hoppers PH and SH and convey said cards toward the left (Fig. 3b) to a position to be gripped by the next set of feed rollers associated with the respective hoppers.

Certain of the remaining feed rollers of the primary and secondary feed mechanisms are journaled in fixed bearings carried by the frame castings 102, 103 in the same general fashion as the rollers 176 but the coacting rollers of each feed mechanism are mounted on a pivoted frame to permit removal of cards which fail to feed properly or jam in the feed mechanism. There is one of these pivoted frames for each feed mechanism, the one for the secondary feed mechanism being arranged to swing upwardly while the other swings downwardy. The two frames are substantially alike in details but the one for the primary feed mechanism is longer due to the greater number of feed rollers required for feeding the primary cards PC.

Journaled in fixed anti-friction bearings 173 (Figs. 2, 3b, and 4) in the frame castings 102, 103 are two pairs of feed roller shafts 172a, 183, for the primary feed mechanism and one pair similarly designated for the secondary feed mechanism. Feed rollers 184, like the feed rollers 176' are secured to shafts 172a, while to the feed roller shafts 183 are secured metallic contact rollers which are insulated from the shafts 183 (see Fig. 5 also). The contact rollers for the primary feed mechanism are designated PCR1, PCR2 while the one for the secondary feed mechanism is designated SCR. The contact rollers PCR1, PCR2, SCR, and feed rollers 184 are driven from the respective feed shafts 139, 141 by spiral gears 185 (Fig. 4) secured to said shafts and meshing with spiral gear pinions 186 secured to the shafts 182, 183.

Cooperating with the feed rollers 184 on the shaft 172a nearest the primary hopper PH (Fig. 3b) are feed rollers 187 on a shaft 188 which is mounted on frame castings 102, 103 in the same fashion as the feed roller shafts 178 by means of arms 179 actuated by spring pressed plungers 182. The feed rollers cooperating with the contact rolls PCR1, PCR2, SCR and with the remaining feed rollers 184 are all mounted on the pivoted frames mentioned above.

These frames are shown in Figs. 3b, 5, and 6b. They include a pair of side plates 189, in the case of the primary feed mechanism, and a pair of side plates 190 in the case of the secondary feed mechanism. These pairs of plates are rigidly joined together, in each case, at the ends nearest the hoppers, by means of tubes 191, and along the edges of the plates by a number of angle strips 192. At the ends opposite the hoppers, the plates 189, 190 are pivoted to the confronting faces of frame castings 102, 103 by means of screw studs 193. The ends of tubes 191 are provided with spring pressed bolts 194 (Figs. 3b and 6b) having knurled finger pieces 195 working in slots in the tubes 191 which bolts enter the bore of hardened steel bushings 196 pressed into holes (Figs. 2 and 4) in the frame castings 102, 103. The right hand end of the frame of which plates 189 are part can be lowered by pressing the finger pieces 195 of the bolts 194 associated with these plates toward each other to release the bolts. Similarly the right hand end of the frame including plates 190 may be raised.

Cooperating with the feed rollers 184 immediately to the right of the contact rollers PCR2, SCR are feed rollers 197 (Figs. 3b and 6b) secured to shafts 198. The ends of shafts 198 extend through large holes in the respective plates 189, 190 and are journaled in bearings carried by the arms of bell cranks 199 pivoted on plates 189, 190. Springs 200, attached to the other arms of bell cranks 199 and to pins carried by plates 189, 190, respectively, urge the feed rollers 197 into contact with feed rollers 184. The holes in plates 189, 190 through which shafts 198 project, permit a small amount of movement of feed rollers 197 away from rollers 184 to allow for the thickness of the cards and the walls of said holes act as stops to prevent the rollers 197 from becoming displaced from their proper positions more than a small amount when the frame units of which plates 189, 190 form part are lowered or raised, respectively. Cooperating with the contact rollers PCR1, PCR2, SCR are feed rollers 201, most clearly shown in Figs. 5 and 6b, which are made of some form of insulating material, such as "Bakelite," mounted on shafts 202. These shafts are mounted in bearings on the short arms of bell cranks 203 pivoted in the plates 189, 190 and operated by springs 203b which urge rollers 201 into engagement with the contact rollers PCR1, PCR2, SCR. The shafts 202 for the feed rollers 201 work in open slots in the plates 189, 190 to permit removal of the feed rollers when desired. In order to prevent the feed rollers 201 from moving far enough to damage the card sensing brushes or unhook the springs 203b when the frames including plates 189, 190 are lowered or raised, respectively, adjustable stops 203a are provided to limit movement of the arms 203 supporting the feed rollers to an amount a little more than is sufficient to compensate for the thickness of the cards and allow for reasonable wear.

Cooperating with each contact roller PCR1, PCR2, SCR is a pair of contact roll brushes, these pairs of brushes being designated PCB1, PCB2, SCB (Fig. 1a) for the respective contact rollers. As shown in Fig. 2, each pair of brushes is mounted in the end of a metallic terminal post 102a the latter having two parallel slots in which the brushes are clamped. The posts 102a extend through large holes in the frame casting 102 and are secured in the ends of short bars 102b of insulating material mounted on the frame casting 102.

The various feed rollers described above, including the contact rollers, all have the same diameter whereby the primary and secondary cards will be fed at a uniform speed and in exact synchronism. Shafts 139, 141 drive these feed rollers by means of spiral gears 175 and spiral pinions 174 as in the case of the feed rollers 176, 177 (Figs. 4 and 6b). Dependence is not placed on friction between the cards and the feed rollers to feed the cards accurately but each coacting pair of feed rollers is geared together for driving purposes by a pair of spur gears 205 (Figs. 3b, 5, and 6b) secured to the feed roller shafts.

The distribution of the cards to the pockets is determined at the point where the primary and secondary lines of feed meet. The space between this point and brushes SB, PB2 may be termed the eject station. Here the primary and secondary cards are gripped by the eject feed rollers, designated 206, 207 in the case of the primary feed mechanism, and 208, 209 in the case of the secondary feed mechanism. These feed rollers are most clearly shown in Figs. 5 and 6b while their driving connections are best shown in Figs. 2 and 4. The feed rollers 206 and 208 are mounted in the frame castings 102, 103 on shaft 210 which are mounted like the feed rollers 177 in arms 179 actuated by spring pressed plungers 182. The feed rollers 207, 209 are mounted on anti-friction bearings supported by a shaft or rod 212 carried by frame castings 102, 103 intermediate shafts 210, 211, the anti-friction bearings being prevented from moving axially of shaft 212 by some simple means such as wire snap rings or spring clips 212a (Fig. 5) sprung into grooves in the shaft 212, there being a pair of spring clips for each roller 107, 109. Rollers 206, 207 and 208, 209 are not geared together as at this point in the feed of the primary and secondary cards it is not necessary that they be fed exactly in synchronism hence frictional contact of the eject feed rollers with the cards is sufficient properly to feed the cards.

The secondary eject feed rollers 208, 209 are driven by the secondary feed shaft 139 through a train of gears designated 213, 214, 215, 216 in Figs. 2 and 6b. In this train, gear 213 is secured to the secondary contact roller shaft 183 driven by shaft 139; gears 214, 215 are idler gears mounted on studs carried by a plate 217 secured to frame casting 102; while gear 216 is secured to the shaft 211. Thus eject feed rollers 208, 209 rotate when the secondary feed shaft 139 turns.

The primary eject feed rollers 206, 207 are driven by the main shaft 136 through a one revolution clutch controlled by a magnet designated EM in the drawings and hereinafter to be called the eject magnet. The first pair of pocket feed rollers is designated 218, 219 in Figs. 3b, 5, and 6b and are mounted on shafts 220, 221, respectively, which shafts are rotatably mounted in frame castings 102, 103 in the same general fashion as shafts 172, 172a, 178, 188 with correspondingly designated parts. Shaft 220 is driven by a spiral gear pinion like the pinions 172 in Fig. 4 secured to shaft 220 and meshing with a spiral gear like 175 fixed to shaft 136 (Fig. 6b).

Secured to shaft 220 is a gear 222 (Fig. 2) meshing with a gear 223 rotatably mounted on a stud 224 carried by frame casting 102. A gear 225 is loosely mounted on stud 224 and meshes with a gear 226 fixed to shaft 210. The eject clutch is located between gears 223, 225 and is quite similar to the primary and secondary feed clutches. The magnet EM is mounted on a bracket 236 secured to the front face of the frame casting 102. The eject clutch is engaged when magnet EM is energized and operates like the primary and secondary feed clutches. It is believed a description of the operation of the eject clutch is unnecessary, particularly as this type of one revolution clutch is now well known in the art of constructing perforated record card controlled machines. All of these clutches are fully described in the Page application.

Three pairs of pocket feed rollers are provided to the left of the pocket feed rollers 218, 219 and are designated 240, 241 in Figs. 3a, 3b, 6a, and 6b. Feed rollers 240 are secured to shafts 242 mounted in fixed bearings 173 carried by the plates 106, 107 which shafts are provided with spiral gear pinions like 172 in Fig. 4 meshing with spiral gears 175 (Fig. 6a) on shaft 136. The feed rollers 241 may be made of rubber and are secured to shafts 243 journaled in the arms of bell cranks 199 actuated by springs 200 as in the case of the feed rollers 197. The pocket feed rollers 240, 241 are not geared together as extreme accuracy of feed is not necessary after the cards have passed the eject station. However feed rollers 218, 219 are coupled together by gears 205 (Fig. 5).

VII. Card Guides

The cards are supported and guided from one pair of feed rollers to the next by means of card guides which are shown in Figs. 3a, 3b, 5, 6a, and 6b. These guides consist of substantially flat bars or strips extending in the line of travel of the cards but may be bent slightly at one or both of their ends to prevent catching the cards. The guides are designated 245, 247, 248, 251, 253, 261, 263, and are mounted in various ways. The guides 245, 247, 251, 253, 261 are secured to suitable cross-bars mounted between the frames 102, 103 while the guides 248 are secured to cross-bars mounted in plates 189, 190. The guide 263 consists of a long bar extending lengthwise of plates 106, 107 above the card pockets. The bar 263 is secured to the plates 106, 107 by suitable cross bars and is located half way between the plates. At its left hand end, bar 263 is secured to plate 105 (Figs. 3a and 6a).

At the point where the cards from the primary and secondary cards meet there is provided a set of card gu es consisting of four plates 254 (Fig. 5) mounted on two rods 255 carried by plates 102, 103. The plates 254 are shaped like an arrowhead to accommodate shaft 212 and their edges guide the cards over and under said shaft. The edges of a set of triangular plates 257 similarly mounted on cross rods 258 support the primary cards between the pairs of feed rollers 206, 207 and 218, 219.

VIII. Card Sensing Brushes

The holes in the cards are sensed by three groups of card sensing brushes as the cards pass the contact rollers. The primary cards are first sensed by the group of primary brushes designated PB1 and then by the group of primary brushes PB2, while the secondary brushes are sensed only by the group of secondary brushes SB. The brushes SB, PB1, and PB2 cooperate with the contact rollers SCR, PCR1, PCR2, respectively, and are so spaced that the corresponding index-point positions on one secondary card and two successive primary cards are all sensed together as the respective cards are fed in unison past the respective brushes, assuming that both card feed shafts 139 and 141 are rotating. There are eighty

brushes in each group since the machine as shown in the drawings is designed for control by cards having eighty columns of index-point positions.

Fig. 5 shows the brushes SB and PB2 on a larger scale than Fig. 3b. The brushes SB, for example, are secured in transverse slots in a bar 268 made of insulating material, such as "Bakelite," secured in the frames 189, 190. Eye-bolts 269, through the "eyes" of which the shanks of the brushes SB project, are threaded into holes in headed sleeves or thimbles 270 located in holes in the bar 268 at right angles to the slots in which the brushes are laid. The heads of the sleeves may be slotted, as shown, or provided with square or hexagonal heads for turning the sleeves to draw up the eye-bolts tight and thereby clamp the brushes in their slots. The electrical connections are made by attaching the circuit wires 271 to plugs 272 which are pushed into the bores of thimbles 270. Due to the closeness of the spacing of the brushes, the holes for thimbles 270 and eye-bolts 269 are staggered as shown in Fig. 6b to ensure that neither the thimbles 270 nor plugs 272 can make electrical contact with each other. The feed rollers 201 are provided with eighty deep circumferential slots through which the brushes extend into contact with the contact rollers. The brushes PB1 and PB2 are similarly mounted.

In conjunction with the comparing units, the brushes may compare data on two successive primary cards and, if desired, the data on the first of the two primary cards can at the same time be compared with the data on a secondary card. Thus a dual comparison of data on three different cards can be made simultaneously in a single card feeding cycle.

IX. Card Levers

The primary and secondary cards actuate card levers in the course of their feeding movement from the hoppers to the eject rollers 206, 207 and 208, 209. These card levers in turn actuate certain card lever contacts for controlling the operation of the machine and are shown in Figs. 2, 3b and 6b.

The central card guide strip 247 (Figs. 3b and 6b) located between the pairs of secondary feed rollers 176, 177 and 184, 197 and between the central guide strip 245 extending between the primary contact rollers PCR1 and rollers 176, 177 (Fig. 3b only) each have mounted thereon brackets 273. Pivoted on brackets 273 are card levers 274 which are made of stiff insulating material such as "Bakelite." One arm of each card lever extend downwardly and to the left (Fig. 3b) close to the line of contact of feed rollers 184, 197, and into the paths of cards fed by feed rollers 176, 177. The other arm of each card lever 274 engages the longer of two spring contact members 274a (Fig. 6b) carrying contacts designated SCL in the case of the secondary feed mechanism. The spring contact members 274a are insulated from each other and brackets 275 by means of which the contact members are mounted on the bars 246. The contacts SCL, PCL are engaged by and rocked clockwise (Fig. 3b) to force the contacts closed.

When the leading edges of the cards are about to pass between the brushes PB1, PB2, SB and the coacting contact rollers PCR1, PCR2, SCR, further card levers are actuated. The contacts controlled by these card levers are shown in Figs. 2 and 6b and are designated PCL1, PCL2, SCL1. The spring contact members carrying these contacts are insulated from each other and brackets 276 by means of which these members are mounted on the front face of frame casting 102. Since these contacts are mounted quite close to the frame casting 102, thin sheets of fibre insulation or "Bakelite" 277 are interposed between blocks 276 and frame casting 102 and are large enough to prevent possible accidental grounds between the contact members and the frame casting 102.

Each pair of contact members is actuated by an arm 278 (Fig. 2) secured to a stub shaft 279 journaled in a tube secured in a hole in the frame casting 102. Behind the frame casting 102 card lever arms 280 are secured to stub shafts 279 and project into the paths of the cards quite close to the respective contact rollers. The arm 280 for operating contacts SCL1 is shown in Fig. 6b in plan view and is arranged to be depressed by a passing card thereby rocking the stub shaft 279 and the arm 278 operating contacts SCL1 in a counterclockwise direction (Fig. 2) to close contacts SCL1. Similarly contacts PCL1, PCL2 are closed when a card is about to pass between brushes PB1, PB2 and contact rollers PCR1, PCR2, respectively, but in this case the arms 278 are rocked clockwise, since their associated arms 280 are located above the line of feed of the primary cards instead of below and consequently are lifted by the primary cards. The card levers associated with contacts PCL1, PCL2, SCL1 thus operate to close these contacts only when a card is very close to the position where sensing of the holes is about to commence.

The primary and secondary hoppers are provided with contacts designated SHC, PHC in Fig. 1a which are opened whenever cards are placed in the hoppers and are closed whenever the hoppers become exhausted of cards. The construction of these contacts is shown in Figs. 3c and 6c. The underside of each casting 108 is provided with a bracket 108a on which is pivotally mounted a lever 278a. One arm of each lever 278a extends upwardly through a slot in the casting 108 as shown in Fig. 6b, whereby the lever will be rocked clockwise (Fig. 3c) whenever cards are placed in the secondary hopper, for example. One arm of the lever 278a engages one of the members supporting the contacts SHC and presses such contacts apart whenever the lever is rocked clockwise. The members carrying the contacts SHC are supported on a bracket 108b which is secured to casting 108.

These contacts are used for two purposes; one to automatically condition the machine for operation under control of cards from either one or both feeds and second to stop the machine when cards become exhausted before the last card which leaves the exhausting hopper can enter the brushes SB1, PB1 in order to enable the operator to replenish the card. The temporary exhaustion of cards from either hopper does not, as was formerly the case, cause a hiatus in the operation of the machine, since the operator can now place more cards in the hoppers and the machine will resume feeding cards without leaving a gap other than the normal short gap which exists between cards. Were it not for the provision of the contacts SHC, PHC and circuits controlled thereby, the machine would continue to run until the card levers SCL1, PCL1 open and, when more cards are placed in the hopper, the new cards would be unable to close the one cycle gap which would exist between the first of the new cards in the hopper and the last card which left the hopper.

X. Card Pockets

Four card pockets are provided to which the cards are selectively distirbuted by the card distributing mechanism in accordance with the comparison of data on the cards. The pockets are shown in Figs. 2, 3*a*, 3*b*, 5, 6*a*, and 6*b* and are designated as follows: SRJ the secondary reject pocket; SP, split pair pocket; MS, merged sets pocket; and PRJ, primary card reject pocket. The pockets PRJ and SRJ receive the rejected primary and secondary cards. The split pair pocket SP receives the secondary cards which are paired or matched with primary cards having the same data but which are to be kept separate from the associated primary cards, hence the convenient short name. Pocket MS receives the matched or paired primary and secondary cards when they are to be kept together and not split between the pockets SP and MS. Pocket MS also receives the primary cards which are to keep the secondary cards separate from the corresponding primary cards. Pocket MS will also receive all cards when one set of cards is to be filed with another set in numerical sequence.

It is desired to point out that the names given the pockets is purely for convenience in description because as will be shown later, the cards which fall in primary reject pocket PR, in certain types of operation of the machine, may be the ones it is desired to select for use in preparing a statement on a tabulating machine and the ones that fall in pockets MS or SP may or may not be used after the operations are finished. In other words, the term "reject pocket" for pockets SR and PR does not necessarily mean that the cards falling in these pockets are not used for any purpose.

The construction of the pockets is old and well known, having been used in "International" record controlled machines for some time, for this reason the pockets will not be described in minute detail.

The side walls of the pockets consist of the end plate **105** (Figs. 2, 3*a*, 3*b*, and 6*a*) three partition plates **281**, and an end plate **282**.

The back walls of the pockets are formed of a plate **285** secured to the back of the machine. Associated with each card pocket is a card platform **286** secured to a tube **287** which slides in a tube **288** secured in a hole in base **100**. A long coil spring in each tube **288** exerts an upward force on tube **287** sufficient to balance the weight of tube **287** and card platform **286**. As the cards accumulate on the tops of the card platforms their weight causes the platforms and tubes to descend until the pocket eventually becomes full.

When any pocket becomes full, it operates the usual full pocket stop contacts designated FPC in Fig. 3*a*. These contacts are carried by spring contact members insulated from each other and the plate **285** on the rear face of which they are mounted just behind the secondary reject pocket SRJ (Figs. 3*a* and 6*a*). The contacts are closed when no pocket is full but are opened by means of an arm **289** secured to a shaft **290** journaled in bearings **291** mounted on base **100** behind plate **285**. Arm **289** is curved forwardly through an opening **285***a* in plate **285**, upwardly, and thence rearwardly through a hold **285***b* in plate **285** and is provided with an insulating pin engaging the rear side of the rear contact member of contacts FPC. Secured to the shaft **290** behind each pocket are arms **292** which extend forwardly into the path of the associated card platforms **286**. A spring **293** (Fig. 3*a*), attached to a pin on arm **289** in front of plate **285** and to a pin secured to said plate, holds said arm against plate **285** so as to keep contacts FPC open, the rear spring contact member being biased so as to tend to move forwardly to close the contacts.

When a pocket becomes nearly full, its platform engages the associated arm **292** and, with the addition of a few more cards, the platform moves arm **292** downwardly. This causes arm **289** to move forwardly permitting contacts FPC to open.

XI. Card Distributing Mechanism

The disposition of the cards to the pockets SRJ, SP, MS, PRJ is effected by card distributing mechanism. This mechanism is shown in detail in Figs. 3*a*, 3*b*, 5, 5*a*, 6*a*, and 6*b*, and is controlled by three magnets designated PRM and SRM1, SRM2, hereinafter termed the primary and secondary reject magnets, respectively. The mechanism directly associated with these magnets is most clearly shown in Figs. 5 and 6*b*. The construction of the magnets and the mechanism individual to each are practically identical but the location and direction of movement of the corresponding parts is reversed as these magnets are located on opposite sides of the lines of feed of the cards in the respective feed mechanisms. The parts of the two magnets SRM1, SRM2 and magnet PRM, as well as the mechanism individual to them, are symmetrically located with respect to the bisector of the angle between the lines of feed of the primary and secondary cards as is clearly shown in Fig. 5. Consequently a description of the secondary reject magnets SRM1, SRM2 and the mechanism individual to them will suffice for the primary reject magnet PRM and the mechanism individual to the primary reject magnet, the corresponding parts being identically designated except for one or two exceptions.

The magnets SRM1, SRM2 are mounted on a bracket **294** (Figs. 3*b*, 5, 5*a*, and 6*b*) which is secured to a bar **295** mounted on the frame castings **102**, **103**. The armatures **296***a*, **296***b* of magnets SRM1, SM2 are pivoted at **297** to bracket **294** and are normally held away from the poles of the magnets by means of springs **298**. Movement of the armatures toward the poles of the magnet is limited by a shoulder formed in a long stud **299** screwed into member **294**. The left hand end of stud **299** adjacent the shoulder is threaded and reduced in diameter and extends loosely through confronting notches (Fig. 5*a*) in the armatures, the radius of the notches being smaller in diameter than the smooth part of stud **299** but larger than the threaded end. Thumb screws **300** screwed on the threaded portion just mentioned limit movement of both armatures **296** away from the poles of the magnet in response to the tension of springs **298**.

The armatures **296***a*, **296***b* are shaped to provide a lug **296***c* and an opening **296***d* (Fig. 5) which are engaged by hook-shaped portions **301***c*, **301***d* of curved blade operating arms **301***a*, **301***b* pivoted on a bracket **302** secured to the bracket **294**. Thus armature **296***a* of magnet SRM1 holds the arm **301***a* in raised position and armature **295***b* holds arm **301***b* in raised position. The blade operating arm **301***b* has a pin **301***e* carrying a roller **301***f* cooperating with a cam **303** secured to shaft **211** and a spring like **304** (Fig. 5) normally tends to draw the arm **301***b* downwardly to cause roller **301***f* to follow the periphery of cam **303**. This cam

is so proportioned that the arm **301b** is raised a slight amount during each revolution of shaft **211** so as to free the hook-shaped portion **301a** from the edge of opening **296d** and relieve magnet SRM2 from the frictional load caused by the contact of such edge with the hook-shaped portion **301a**. This enables the armature **296b** to move faster and the impulses of current through magnet SRM2 are timed to occur only when arm **301b** is being held up by cam **303**.

The pin **301e** on which roller **301f** is mounted is provided with a reduced portion (Fig. 5a) cooperating with a notch in arm **301a** to hold said arm up against the tension of its spring **304** as shown in Fig. 5. Thus both arms **301a**, **301b** are controlled by a common cam. Armature **296a** is provided with a lug **296b** whereby the latter is always operated when magnet SM1 is energized.

The arms **301a**, **301b** are roughly L-shaped in general outline with the portion below hook portions **301a**, **301b** extending downwardly to a point just above the line of feed of the secondary cards and slightly to the left of shaft **211** (Fig. 5). At this point these members are formed with lugs **301g** (see Fig. 5a also) which are at right angles to the plane of the bulk of members **301a**, **301b**. Lugs **301g** slope upwardly from left to right and at their extreme right hand ends are also bent upwardly. Armatures **296a**, **296b**, extend downwardly into a position to be engaged by a common cam **305** fixed to shaft **211**, but the thumb screws **300** are so adjusted that springs **298** normally hold the armatures **296a** **296b** clear of the cam.

The magnet PRM controls similar mechanism which differs only in that the threaded end of pin **299** projects through a hole in the armature **296** of this magnet and the cams **303**, **305** are secured to shaft **210**.

The distribution of the cards to the respective pockets is effected by means of three guide blades designated **306**, **307**, **308** in Figs. 5 and 6b. These blades vary in length and are located in superposed relation beneath the bar **263**. The two top blades **306**, **307** (Figs. 3a and 6a) lead to the pockets SP and MS respectively, while the blade **308** leads to the pocket PRJ.

The blades **306**, **307** extend horizontally under the lugs **301g** of the arms **301a**, **301b** associated with magnets SRM1, SRM2 while the blade **308** is curved downwardly toward the right into cooperation with the lug **301g** of the arm **301** associated with the magnet PRM. All of the blades are of greater width than bar **263** throughout substantially the entire length of the latter (Fig. 6a) but the extreme right hand ends (Figs. 5 and 6a) of blades **306**, **307** are narrowed and cut away to form two tongues which clear each other and press side-by-side upwardly against the underside of lugs **301g** of arms **301a**, **301b** whereby the free end of blade **307** may be depressed by member **301b**, independently of blade **306**, below the line of feed of the secondary cards without affecting the blade **306**. However, since both arms **301a**, **301b** are released when magnet SRM1 is energized, in consequence of lug **296e**, both blades **306**, **307** will be depressed together whenever magnet SRM1 is energized.

With magnets SRM1, SRM2 in deenergized condition, the blades **306**, **307** are held above the line of feed of the secondary cards which permits the secondary cards to pass underneath both these blades and over the blade **308** to the pocket MS. The energization of magnet SRM1 causes armature **296a** of this magnet and the armature **296b** of magnet SM2 to move to the right (Fig. 5) disengaging lug **296c** and opening **296d** from the hook-shaped portions **301c** of arms **301a**, **301b**. This allows springs **304** to draw the arms **301a**, **301b** downwardly as the cam **303** rotates thereby depressing both blades **306**, **307** below the line of feed of the secondary cards. In this case the secondary cards will pass over both blades **306**, **307**, under bar **263**, and be guided to the secondary reject pocket SRJ. The energization of magnet SRM2, however, causes only the blade **307** to be depressed and secondary cards will be guided between blades **306**, **307** to the pocket SP.

The blade **308** normally occupies a position below the line of feed of the primary cards as shown in Fig. 5 whereby the primary cards may pass over said blade and underneath blade **307** into the pocket MS. When magnet PRM is energized the blade **308** is pushed upwardly above the line of feed of the primary cards and the primary cards will then pass beneath all the blades into the primary reject pocket PRJ. When any magnet SRM1, SRM2, PRM is operative to cause the associated blades to move inwardly, that is, between the card guides **254**, the cards affected travel between the lugs **301g** and the operative blade. The lugs **301g** are inclined away from the lines of feed of the cards and bent at their right hand ends as shown in Fig. 5 in order to prevent the cards from being caught by the arms **301**, **301a**, **301b**.

The blades **306**, **307**, **308** are secured, as by welding, at their left hand ends to blocks **315** (Figs. 3a, 3b, 5, and 6a). The latter are secured by suitable screws to the beveled surface of card deflector blocks **316** which are secured to the partition plates **281** directly beneath bar **263**. The deflector blocks **316** extend upwardly and to the right at an angle to the partition plates **281**, being beveled for that purpose, and the planes of the bevels are at right angles to each other so that blocks **315** are horizontal. The heads of the screws securing blocks **315** are countersunk to avoid catching the edges of the cards as they pass over the left hand ends of the blades. Tongues **316a** (best shown in Figs. 5 and 6a) pierced out of the blades **306**, **307**, **308** extend downwardly and to the left to deflect cards away from the space between blocks **315** and deflectors **316**. Over pocket SR (Figs. 3a and 6a) a deflector **317** is secured to the top of bar **236** and extends downwardly and to the left, being bent around the edges of a large hole in bar **263**.

XII. Circuit Timing Device

A number of devices such as commutators and impulse distributors are provided for the purpose of controlling the times of closure and duration of various circuits and to prevent arcing between the sensing brushes and contact rolls. These devices will be described in this section.

There are two main groups of these timing devices designated CB1 to CB4, CR1 to CR11 in Figs. 1a to 1e and of which CB1 to CB4 rotate twice per card cycle, while CR1 to CR11 rotate once per card cycle. The variable speed driving mechanism disclosed in Patent No. 2,174,705, causes all of the shafts to be driven at a variable speed which at one point in the cycle is approximately 40% below, and at another point in the cycle is a similar amount above the average speed. As shown in Fig. 10, the speed is constant during substantially the first half of the cycle but is reduced by the variable speed driving mechanism at the point where the card feed clutches controlled by magnets PFM, SFM are engaged in order to

reduce the shock of engagement. It is desirable that the timing devices designated CB1 to CB4 and CR1 to CR11 be always driven at a constant speed and for this reason they are driven directly by pulley 132, instead of by shaft 136 as was the case in the machine disclosed in the Page application.

Figs. 3a, 6a, 7 and 8 show the timing devices CB1 to CB4 and CR1 to CR11. These devices are mounted in a supplemental frame comprising two plates 326, and short cross-bar 327 one of which plates is secured to the left side of plate 105 by means of bolts 326a (Fig. 7). Rotatably mounted in suitable anti-friction bearings, on the plates 326 are four shafts 328 to which are secured gears 329, 330. The gear 329 meshes with the gear 135 which, it will be recalled, is driven by the pulley 132 through the pinion 134. The gear 329 is one half the diameter of the gear 135 whereby the upper left hand shaft 328 (Fig. 8) is driven at twice the speed of gear 135. Gears 330 are of the same diameter as gear 135 whereby the other three shafts 328, of which only two are shown at the right in Fig. 8, are driven at the rate of one revolution per card cycle.

Secured to the shafts 328, are eleven cams 331 made of non-metallic composition such as "Bakelite" or material of similar characteristics in order to make the operation of the timing devices as quiet as possible. Secured to the bars 327, are eleven brackets 332, each of which supports a cam follower lever 333, pivoted on a stud 333a. Each cam follower lever is actuated into contact with the adjacent cam 331 by means of a spring 333b and the cam follower lever is provided with a suitable roller cooperating with the cam. Each lever 333 is provided with a contact element 333c cooperating with a contact element 333d. The brackets 332 and the contact elements 333d are separated from the bars 327 by means of strips of insulating material and the electrical connections are made to the brackets and to the contact elements 330d. It is evident from Fig. 7 that rotation of the cams 331 causes the contact elements 333c, 333d, to make and break according to the location of the high and low points on the cams. The cams 331 located on the shaft 328 carrying gear 329 have scalloped edges and the contacts which they actuate are designated CB1 to CB4 in Fig. 1a. These contacts are termed circuit breakers, and their principal function is to prevent arcing at the brushes SB, PB1, PB2 when the card is sensed. The remaining contacts 333c, 333d are designated CR1 to CR11 in Figs. 1a to 1d and their function is to control the points of closure, opening, and duration of circuits through the various relays, switch mechanisms, and control magnets of the machine.

A group of primary commutators designated PC1, PC2, PC3, PC4 (Figs. 1a, 1b, 1c, 4b and 6b) is mounted on the primary shaft 141. The brushes 335 for this group (Fig. 4) are mounted in slots in two support blocks 336 in the same general fashion as the brushes PB1, PB2, SB. Blocks 336 are mounted on the frame casting 103 by means of hexagonal posts screwed into said casting.

A pair of secondary commutators SC1, SC2, SC3 is mounted on the shaft 139 and its brushes 335a are mounted on block 336a in the same fashion as the brushes 335 on a block 336a supported by posts 337a.

XIII. Plugboard

A plugboard, the details of which are not shown, is provided to secure flexibility of operation and is so constructed that the machine may be preset for operation by multi-prong plugs or plug wires. The plugboard is removably mounted in the machine whereby it may be removed and another one like it, but plugged according to a different plan, substituted for the one removed. The plugboard and the mechanism for locating it in the machine and locking it in place is well known in the art and substantially identical in details of construction with the one disclosed in the Page application.

The face plate of the plugboard in the present machine is different from the one in the Page application because of the provision of a greater number of control relays, magnets, and plug sockets. Fig. 16 shows the face plate of the improved machine.

It is contemplated that the machine disclosed herein be provided with a number of plugboards, each one being plugged differently from the others whereby no time need be lost in re-plugging the machine each time it is desired to change the type of operation or operate the machine under control of cards which have the data disposed according to a different card form.

XIV. Analyzing Mechanism

The analyzing mechanism comprises two sections or comparing units each having two groups of sixteen controlling magnets. Both the primary and secondary comparing units are nearly identical in construction except in a few details. In the present section, the construction of the primary comparing, or sequence unit will be described first, and the respects in which the construction of the secondary comparing or selector unit differs from the secondary unit will be explained at the proper points.

The primary comparing unit will be termed the sequence unit because it compares two successive primary cards to determine the sequence of the control numbers. The secondary comparing unit will be termed the selector unit because it selectively controls the feeding of primary and secondary cards to determine their order of merging and also because it may be used as a multiple-column selector.

Fig. 4 shows a rear elevation of the sequence unit, while Fig. 11, is a similar view, on a larger scale, of the same unit. Portions of both units appear in Figs. 6a and 6b to illustrate their location, manner of mounting in the machine, and the driving connections which are identical for both units. The mechanism for each unit is mounted in a pair of side plates 356 (Figs. 4, 6a, 6b, 11 and 12) secured together by six magnet support bars 357, two stop pawl support bars 358 (Figs. 4, 11, 12, and 13), and two spring anchoring bars 359. The magnet support bars 357 are secured to plates 356 by means of angle strips 360 screwed to said plates.

The two rigid frames thus formed by plates 356 and the bars 357, 358, 359 are mounted on two rectangular bars 361, 362 (Figs. 4, 6a, 11 and 12) secured to the main framework of the machine by means of two pairs of hexagonal screw studs 363. The pair of studs for bar 361 are screwed into the support bar 104 (Fig. 4) and the end plate 105 (Fig. 6a), while the pair for bar 362 are screwed into plate 105 and the rear frame casting 103, respectively. The lower, horizontal edges of plates 356 have open rectangular slots (see Fig. 12) embracing the bar 361 while the upper front corners of the plates are adjustably secured to bar 362 by means best shown in Figs. 11

and 12. This means consists of blocks **364**, secured to plates **356**; a stop screw **365**, screwed into a threaded hole in block **364** and abutting the side of bar **362**; and a clamping screw **366** passing loosely through a hole in block **364** and into a threaded hole in bar **362**. By loosening the screws **366** for each comparing unit and turning screws **365** in the proper direction, the unit may be adjusted relative to bar **362** by a pivoted movement on bar **361**. This adjusting means is provided for the purpose of bringing the drive gears for the comparing units into proper meshing relation.

There is provided a separate drive shaft **367** (Figs. 4, 6*a*, 11 and 12) for each comparing unit which shafts are journaled in the frame plates **356**. Secured to the shafts **367** are gears **368** which mesh with gears **369** secured to the main drive shaft **136**. Each shaft **367** has secured thereto a pair of bail operating cams **370** (Figs. 11 and 12) each of which is located adjacent one of the side plates **356**, and also a pair of restoring cams **371***a*, **371***b* (see Fig. 13 also) located close together on a common hub near the center of the shaft. Thus shaft **367** and cams **370**, **371***a*, **371***b* are rotated continually by the main drive shaft **136**.

Each of the comparing units is provided with a main support rod **372** (Figs. 12 and 13) which is secured to the centers of the side plates **356** and the bulk of the moving parts of the comparing units are supported by these rods. Rotatably mounted on rod **372** in interspersed relation are two series of sectors designated **373**, **374** in Figs. 11 and 12. There may be sixteen sectors in each series to correspond with the number of comparing magnets in the comparing units. In the case of the primary comparing unit, each sector **373** is associated with one of the comparing magnets PM1 and is paired with one of the sectors **374** which sector, in turn, is associated with one of the magnets PM2. There is a pair of magnets like PM1, PM2, and a pair of sectors **373**, **374** for each denominational order of both comparing units. The sectors **373**, **374** for each denominational order are located side by side but are separated by certain parts which are mounted on rod **372** between the sectors. The pairs of sectors may be separated from each other by suitable spacing washers or by the hubs to which the sectors are secured.

The bars **358** (Figs. 11, 12, and 13) are transversely slotted and are also longitudinally grooved to support pivot wires **375**. The wires **375** act as pivots for stop pawls **376** located in and spaced by the transverse slots in the bars **358**. There is a stop pawl **376** for each sector **373**, **374** and each pawl is located in the plane of its cooperating sector so as to be capable of engaging ratchet teeth formed in the sector. Springs **377**, anchored to the pawls and to the spring anchoring bars **359**, tend to rock the pawls **376** into engagement with the ratchet teeth on the sectors **373**, **374**. Combs **358***a* secured to bars **358** hold the pawls **376** and sectors **373**, **374** in alignment.

Normally the pawls are held out of engagement with the sectors by means of the armatures **378** of the comparing magnets. The comparing magnets SM1, SM2, PM1, PM2, are mounted on narrow plates **379** (Figs. 6*a*, 6*b*, 11 and 12) each secured to the central bar **357** and to one of the outer bars. Since the coils of the magnets are larger in diameter than the width of the space allotted to each pair of sectors **373**, **374** with their pawls and other parts comprising one denominational order, the magnets of each group of sixteen are arranged in two parallel rows of eight each, with the magnets in staggered relation. Thus the two pawls **376** associated with the two sectors **373**, **374** shown in Fig. 12 are controlled by the left hand magnet PM1 and the right hand magnet PM2, while the right hand magnet PM1 and the left hand magnet PM2 control the pawls associated with the pair of sectors **373**, **374** immediately behind those shown in Fig. 12. The numerals 1 and 2 on the coils of the magnets indicate the denominational orders. The small numbers 1 to 16 in Fig. 11 just below shaft **367** also indicate the denominational orders, with 1 designating the units order, 2 the tens, and so on.

Normally the magnets PM1 and PM2 will be plugged to the primary brushes PB1 and PB2, respectively, to place magnets PM1 under control of the holes in the second of two successive primary cards and magnets PM2 under control of the first of the two cards. Similarly, magnets SM1 and SM2 will ordinarily be connected to brushes SB and PB2, respectively. It is evident that the numeral suffixes in the designations indicate which of the two sets of primary card sensing brushes the magnets correspond.

The comparing magnets have L-shaped yokes **380** (Fig. 12) secured to the plates **379** by the same screws **381** as are used to secure the cores of the coils to the yokes. The vertical portions of the yokes are provided at their ends with rectangular slots (see Fig. 11) to form a pair of posts **380***a* which project through aligned slots located on opposite edges of the armatures **378**. The horizontal portions of the slots in the yokes **380** and the sides of the slots in the armatures **378** are slightly beveled and these beveled portions coact to form pivots for the armatures. Springs **382** (Figs. 11 and 12), attached to the armatures **378** and to pins carried by yokes **380**, tend to hold the armatures in engagement with the stop pawls **376**.

The free ends of armatures **378** associated with the left hand row of magnets PM1 (Fig. 12) and the right hand magnets PM2 rest on shoulders formed in the tails of the associated pawls **376** and abut the vertical walls of the shoulders. The armatures **378** for the right hand magnets PM1 and the left hand magnets PM2 have openings adapted to hook over the tooth formed by the shoulders in the pawls and rest on the shoulders. Thus the armatures **378** normally hold pawls **376** out of engagement with the sectors **373**, **374**.

Rotatably mounted on the rod **372** are two bails **383**, **384** associated with the two series of sectors **373**, **374**, respectively. The bail **383** projects through the planes of all the sectors **373** and is connected to the sectors by means of springs **385** which tend to draw the sectors **373** into engagement with the bails so that oscillation of the bails will cause the sectors to follow the movements of the bails provided none of the pawls **376** have been released. Bail **384** is similarly associated with sectors **374**.

Oscillation of the bails is controlled by the cams **370**. Rotatably mounted on rod **372** adjacent the side plates **356** are cam follower levers **386** (Fig. 12) having rollers **387** engaging the respective cams **370**. The ends of the levers **386** engage the ends of screw studs **388** located at the ends of bails. Heavy coil springs **389** (Fig. 13), anchored to pins **390** carried by the arms of the bails and to brackets **391** secured to plates **356**, have a tendency to rock the bails in a counterclockwise direction (Figs. 12 and 13) and thereby, through

the screw studs 388, press the rollers 387 into contact with cams 370.

There are nine ratchet teeth in each sector 373, 374 and also abutments 373a, 374a comprising zero stops projecting a greater distance radially of rod 372 than the ratchet teeth so as to arrest the sectors in a zero position by engaging the ends of stop pawls 376 in every case where a stop pawl is not released by energization of a magnet. In other words, the sectors 373, 374 will always move to zero positions unless stopped in other position by release of the stop pawls 376. The ratchet teeth have the numerical values shown in Fig. 12 by the small numerals adjacent the teeth and the cams 370 are so shaped that, as the bails move in a clockwise direction, the ratchet teeth will pass the ends of pawls 376 in synchronism with the sensing of the corresponding index-point positions on the record cards. In other words, all of the "9" teeth will be approaching and close to the ends of pawls 376 when the brushes reach the "9" index point position and so on for the other index-point positions.

Fig. 12 shows the positions the sectors 373, 374 for the tens order of the sequence unit assume when both of two successive primary cards have a "9" hole in the tens column of the card field in which the numbers compared are recorded. In this figure the bails 383, 384 have moved to their limit of travel in a clockwise direction, reached after about 198° of movement of shaft 136 from the point where the sensing of the card commences, and the cam roller 387 is on the dwell shown in Fig. 10 between the 198° and 216° positions of the cycle.

Normally, movement of the bails 383, 384 is prevented by mechanisms controlled by certain restoring magnets designated PR1, PR2, PR3 and SR. The mechanism controlled by magnets PR1, PR2 is shown in Fig. 13 which illustrates the bail control mechanism for the sequence unit. Restoring magnets PR1 and PR2 are constructed like the comparing magnets PM1, PM2, SM1, SM2, etc., and are similarly mounted on the bars 357 by means of plates 379a like the plates 379. The armatures 378a of magnets PR1, PR2 engage shoulders in stop pawls 392 actuated by springs 393 anchored to bar 359. The stop pawls project into the paths of stop arms 394 pivoted on slotted blocks 395 secured to the centers of bails 383, 384. Springs 396, anchored to bails 383, 384 and to ears formed in the stop arms 394 normally hold the stop arms against the bails which act as stops to limit clockwise movement of the stop arms.

Each pair of sectors 373, 374, in moving to various positions under control of the card sensing brushes, will also move relative to each other different extents angularly about rod 372 according to whether the hole in one of the columns compared is higher or lower in value than the other but will not move relative to each other when the holes are of the same value. Each pair of sectors 373, 374 is connected together mechanically to control a switching device for manifesting which of the holes in two cards compared is higher or lower in respect to the column compared and also to indicate when the holes are equal in value. This mechanical connection is most clearly shown in Fig. 12.

Both sectors 373, 374 are provided with pins 397 located equal distances from rod 372 and having circumferential slots riding in curved slots formed in a differential link 398 which in outline has some resemblance to an ox bow as viewed from the right hand margin in Fig. 12. Each differential link has a pin 399 which extends through, and projects from both sides of the differential link. The front end or head of the pin 399 is provided with a circumferential groove embracing a straight slot formed in a guide plate 400, while the shank of the pin acts as a rivet to secure a grooved collar to the rear side of the differential link. The grooved collar is of substantially the same dimensions as the head of the pin and the groove in the collar embraces a cam slot formed in a contact control arm 401.

The guide plates 400 are forked at one end to partly surround rod 372 and also have a shallow rectangular slot at the other end embracing a support bar 402 secured to plates 356. The upper and lower edges of bar 402 are provided with slots to prevent the guide plates from being displaced along said bar. The rod 372 is provided with circumferential grooves into which the forked portions of guide plates 400 are located. Thus the guide plates are maintained in accurately spaced relation on rod 372 and bar 402, respectively.

The guide slots in the plates 400 are straight and extend radially of rod 372. It is evident that links 398 may rotate about pins 399 as an axis and that pins may also slide radially of rod 372 but can not be displaced angularly of rod 372. The curved slots in links 398 are so designed that, when both sectors of a pair move equal distances, as would be the case when both holes in a given column of two successive primary cards have the same numerical value, both ends of the link will receive equal angular displacements and consequently pin 399 (Fig. 12) will remain stationary so far as movement radially of rod 372 is concerned. On the other hand, if a hole in a given column of the first of the two primary cards, for example, is lower in value than the hole in the same column of the second primary card, the sector 374 will move clockwise a greater extent than the sector 373. As a result, the lower end of link 398 will be moved farther to the left than the upper end is moved to the left, causing pin 399 to move to the left.

The contact control arms 401 are rotatably mounted on rod 372 and the slots therein have two long straight portions, angularly displaced with reference to rod 372 and substantially radial of rod 372, and also a relatively short straight portion connecting the longer portions but making a rather sharp angle to a line passing through the center of rod 372. When both sectors 373, 374 of a pair are at either of their limits of travel or in positions having the same value, the pin 399 will be located at the center of the short connecting portion of the slot in arm 401 thus holding said arm in a neutral position. When any pin 399 is caused to move to the left, as is the case where a hole in a given column of the first of two primary cards is lower than the hole in the second primary card, pin 399 enters the left hand straight portion of the slot in the associated contact control arm 401 causing said arm to rock clockwise. On the other hand, when the numerical relation of the holes is reversed and pin 399 moves to the right from the neutral position, pin 399 enters the right hand straight portion of the slot in contact control arm 401, camming said arm in a counterclockwise direction.

Summarizing the foregoing, the switch control arms 401 move in a clockwise direction (Fig. 12) when the first of two successive primary cards is lower than the second card, and move counterclockwise when the second primary card is lower in value.

The selector unit, controlled by the magnets SM1, SM2, is identical in construction with the sequence unit so far as such unit has been described up to the present point. The magnets SM1, SM2 are located at the same relative positions as the magnets PM1, PM2 (Fig. 12), and it will be understood that the arms 401 move clockwise when the secondary card is higher than the primary card with which it is compared and counterclockwise when the primary card is higher. The restoring magnets designated SR and PR3 are provided for this unit and are located in the same relative positions as the magnets PR1, PR2 (Fig. 13). The magnet PR1 causes a reading taken from the brushes PB1 to be erased from the sequence unit while magnet PR2 causes a reading from the reading PB2 to be erased. Similarly, the magnets SR and PR3 cause the readings taken from brushes SB and PB2 respectively, to be erased. For those operations of the machine in which both comparing units are in use, the magnets PM2, SM2 will be controlled by the brushes PB2 while the magnets PM1, SM1 will be controlled by the brushes PB1 and SB, respectively.

The switching mechanism for the sequence unit shown in Figs. 9, 11 and 12 is substantially identical with the switch unit disclosed in the Page application, and will be briefly described hereinafter. But the switching mechanism associated with the selector unit has certain features of construction which enable a supplemental comparison to be effected by the selector unit. These features of the selector unit will be explained later after the description of the switching mechanism for the sequence unit has been completed.

The enlarged portions of the slots in the parts designated 398, 400, 401 have no useful purpose so far as the operation of the comparing units are concerned, but are provided to facilitate assembly, and for this purpose are made large enough to insert the heads of the pins 397, 399 to engage the grooves in said pins with the edges of the slots.

The contact control arms 401 operate switching mechanisms which selectively control the various card feed magnets, reject magnets, and eject magnet, either directly or through relays. The switching mechanism also controls the restoring magnets PR1, PR2, PR3, SR to cause the numbers entered in the comparing units to be erased by restoring the sectors 373, 374. The switching mechanism for the sequence unit is shown to best advantage in Figs. 9, 11, 12 and 14.

Mounted on posts 405 (Figs. 9, 11 and 12), which are rectangular in cross section and pressed into holes in the side plates 356, is a switch contact assembly generally designated 406 in the drawings, screws 407, threaded into transverse holes in posts 405, being used to secure the switch contact assembly to the posts. The base of the switch contact assembly consists of a base plate 408 (Fig. 9) and a face plate 409 both of stiff insulating material like "Bakelite" separated by a thin and narrow spacing strip 410, also of insulating material. The rivets 411, which secure the plates 408, 409 and the spacing strip 410 together also secure two common contact strips 412, 413 to the face of the strip 409. Washers 414, through which the rivets 411 along the lower edges of strips 408, 409 pass, space said plates apart a distance equal to the thickness of strip 410.

Located between the two strips 408, 409 is a series of seventeen terminal plates 415 the shanks of which project downwardly in Fig. 9 beyond the edges of strips 408, 409 and have holes for terminal screws. The upper portions of plates 415 to some extent resemble 45° right triangles in shape with the apexes of the 90° angle pointing to the right. On the face of the strip 409 are seventeen contact plates 416. Each terminal plate 415 is riveted to the strip 409 and to one of the contact plates 416 by means of a common pair of metallic rivets 417 so that each terminal plate 415 is electrically connected to a contact strip 416.

The contact strips 412, 413 are serrated and so arranged that the serrations confront each other and extend into the spaces between the contact plates 416, but the serrations on one contact strip do not touch either the plates 416 or the serrations on the other contact strip. Fitting between the abutting ends of the serrations in strips 412, 413 and the opposing edges of the contact plates 416 are rectangular blocks 418 of insulating material secured to terminal plates 415 by means of rivets 419 the round shanks of which pass through holes in the strip 409 and the rectangular heads of which are set in rectangular grooves formed in blocks 418. After the switch assembly has been riveted together, the faces of the strips 412, 413, plates 416, blocks 418, and rivets 419 are ground flat to obtain a uniform height above the strip 409. The extreme left hand contact plate 416 (Fig. 9) associated with the extreme left hand contact rivet 419, has no other purpose than to provide a metallic backing for the rivets 417 which secure said plate to the left hand terminal plate 415.

Secured to each of the contact control arms 401 (Figs. 11 and 12) is a narrow plate of insulating material 420 on which is mounted a contact wiper blade 421 having two contact fingers each carrying contact points. Normally the fingers of each blade 421 bridge the gap between the contact rivets 419 of one terminal plate 415 (Fig. 9) and the contact plate 416 of the next terminal plate 415 at the right. When the holes in the columns of two cards have the same value, that is, the numbers recorded are equal, the contact control arms 401 remain in the central or equal position, as has already been explained, whereby the terminal plates 415, contact plates 416, and contact rivets 419 will be connected in series by the fingers of contact blades 421 as shown diagrammatically in Fig. 1*d*. This condition prevails in respect to unused orders of the comparing units, as for example, if only the lower four orders were used for comparing numbers having four digits, the sectors 373, 374 for the fifth to sixteenth orders would always move to the "0" position causing their associated arms 401 to remain in the central or "equal" position.

The small numbers in Figs. 9 and 9*a* below the blades 421 and in Fig. 1*d* adjacent the diagrammatic representation of said blades indicate the denominational orders of the comparing units. Assume that certain columns of a secondary card are punched to represent the number 6896 while the same columns of the primary card are punched 6977. Since the two numbers are equal in the highest order the control arm 401 for this order will remain in equal position. The arm 401 for the third or hundreds order, will move counterclockwise (Fig. 12) causing its contact blade 421 to move upwardly (Fig. 9) or to the right (Fig. 1*d*). The contact blade 421 for the units order will move in the same direction as the primary card is higher than the secondary

card in both the units and hundreds orders. The arm 401 and blade 421 for the tens order will move in a clockwise direction (Fig. 12) or to the left in Fig. 1d since the primary card is lower than the secondary card in the tens columns. The blade 421 for the hundreds order, in moving upwardly in Figs. 9 and 12 slides over the fourth contact plate 416 from the left (Fig. 9), or the fourth from the top in Fig. 1d, to a position to bridge the gap between said plate and one of the serrations in strip 412 thereby electrically connecting said strip with the fourth contact plate from the left in Fig. 9. In Fig. 1d, in order to simplify the wiring diagram, the contact plates and terminal plates are shown in a simplified form as if the contact plates were T-shaped with the vertical part of the T extending between the serrations in strips 412, 413. It is apparent that this movement of the hundreds arm 401 and its blade 421 has the effect of breaking the circuit to the units and tens blades 421 and no current can flow through them notwithstanding the fact that the units order blade 421 contacts with strip 412 and the tens order blade 421 with the strip 413. As the tens order blade also breaks the circuit to the units order blade, there is no danger of a back circuit to contact strip 413 through the units and tens order blades 421.

In order to adapt the selector unit for effecting a special operation which has been devised for use in machines designed for the Social Security Board, the construction of the selector unit is slightly different from the sequence unit. Instead of having two continuous contact strips 412, 413 the selector unit is provided with two separate contact strips 412a, 412b on the low secondary side of the switch assembly and similarly two separate contact strips 413a and 413b on the low primary side. This makes it possible, by means of the four special switches shown in Fig. 16 in the box with the heading "Soc. Sec.," meaning "Social Security," to split the selector unit into two sections to enable the lowest ten denominational orders of the selector unit to be used for purposes of comparison of employees' names and the remaining six for purposes of comparison of the most significant part of the Social Security account number. For this special operation, it is not necessary that the equal circuit be broken, and in fact it is not desirable, since the name comparison must always depend upon the account number comparison. For this reason only the strips 412, 413 have been divided into two parts to enable the two sections of the selector unit to operate in parallel insofar as the unequal selections are concerned. Since the Social Security is described and claimed in the hereinbefore mentioned application Serial No. 347,226, and will not be described herein, the Social Security switches will always be plugged "off" as shown by the solid lines in Figs. 1d and 17 to 22i. This connects the two strips 412a, 412b together and similarly connects together strips 413a, 413b. This causes the selector unit to function like the sequence unit to emit only one of three impulses signifying high, equal, or low values of two numbers entered in the selector unit.

Knock-off mechanism is provided for the armatures of the comparing magnets SM1, SM2, PM1, PM2 and the restoring magnets PR1, PR2, PR3, SR. The knock-off mechanism for the comparing magnets PM1, PM2 of the sequence unit is shown in Figs. 11 and 12. A separate knock-off bail 422 is provided for the armatures of each group of comparing magnets SM1, SM2, PM1, PM2. Each bail is pivoted on a pair of screw studs 423 carried by side plates 356 and extends transversely of the tips of armatures 378 on the same side thereof as the coils of the comparing magnets. Springs 424 anchored to bars 358, hold the knock-off bails against the edges of angle strips 425 secured to bars 357, which angle strips act as stops for the knock-off bails. Secured to each bail is a pair of side arms 426 which extend into the paths of bails 383, 384. When the latter push the sectors 373, 374 back to their starting position by rotation in a counterclockwise direction, the noses of pawls 376 wipe over the teeth in sectors 373, 374 and eventually ride up on the smooth portions 373b, 374b of the sectors which are made sightly higher than the teeth for the purpose of camming the pawls 376 slightly beyond the latching position. At this point the bails 383, 384 strike the arms 426 and rock bails 422 clockwise thereby forcing the armatures 378 into latching relation with the pawls 376 in the event the armatures should stick to the poles of the magnets.

The knock-off mechanism for magnets PR1, PR2, is illustrated in Figs. 11 and 13. Rockably mounted on rod 372 is a pair of cam follower levers 428a, 428b each having two rollers cooperating with one of the cams 371a, 371b whereby both levers 428a, 428b are oscillated periodically when shaft 367 rotates. Cam 371b is timed approximately 50° in advance of cam 371a (Fig. 16), so that lever 428b always rocks to the left (Fig. 13) ahead of lever 428a. As a convenience of manufacture, levers 428a, 428b are alike and may be made with the same die but they have separate functions.

Lever 428a has pin and slot connections to arms of two armature knock-off levers 429, each associated with one of the magnets PR1, PR2. The levers 429 are pivoted on brackets 430 secured to the L-shaped yokes 380a of the restoring magnets PR1, PR2 and the other arms of levers 429 have bent-over lugs cooperating with the armatures 378a of the restoring magnets. It is apparent that once in each cycle of shaft 367 the lever 428a will be rocked counterclockwise, thereby operating the levers 429 to force the armatures 378a away from the poles of the magnets. Before this takes place lever 428b is similarly rocked and, by engagement of cam lugs 431 formed in said lever with square studs 392a secured to pawls 392, said pawls are rocked clockwise slightly beyond their latching positions with armatures 378a. Thus both the pawls 392 and armatures 378a are positively restored whenever sticking thereof occurs. The selector unit is similarly constructed. The levers 428a, 428b, as well as the pawls 392 are guided by the combs 358a in both comparing units.

Since the construction and operation of the comparing units has been described in detail in the present section, in subsequent sections dealing with the various types of operation of which the machine is capable, only general reference will be made to the operation of the comparing units.

XV. Machine Control Keys

The machine is provided with a group of four manual controlling keys which consists of the start key STK, the stop key SPK, the runout key ROK, and the error reset key ERK. These keys are mounted at a convenient place at the front of the machine on the top surface of the casting 100. Since these keys are of conventional form,

their mechanical structure is not shown but they, with their contacts, are shown in the wiring diagram in Figs. 1c and 1d. The start key and the runout key, each when depressed, closes contacts designated STC1, STC2 in the case of the start key and ROC1, ROC2 in the case of the runout key. The stop key SPK opens contacts SPC when depressed. The error stop reset key closes contacts ERC when depressed.

XVI. Impulse Emitter

The mechanism which controls the counting and feeding of cards quantitatively includes an impulse emitter generally designated E in Fig. 1e. This emitter is conventional in principle of operation, consequently only a very brief description will be given of its mechanical construction with reference to Figs. 3a, 6a, and 8. Secured to the lowest shaft **328** is a brush carrying member **500** which may be made of insulating material, such as "Bakelite." This brush carrier carries two brushes **501**, one of which cooperates with a row of 12 segments **502** of which only nine are actually used. The other brush **502** cooperates with a continuous contact segment **503** which provides a means of connecting the brush **501** which cooperates with segments **502** to the circuits of the machine. The segments **502**, **503** are part of a molded member **504** of insulating material which is secured to a bracket **505** mounted on the left hand plate **326**. The molding **504** has a large central opening to accommodate the brush carrier **500** and the inner ends of the segments **502** and the inner surface of the segment **503** are molded flush with the cylindrical surface of the opening in the molding **504**. The brush carrier **500** rotates continuously while the machine is in operation.

With reference to Fig. 1e, the common segment **503** is connected to a plug socket PS78 and a cooperating plug socket PS79 is connected to the line wire W2 through the contacts of circuit breakers CB1 to CB4 and the cam actuated contact CR3. The emitter E is timed so that impulses are passed therethrough to make the plug sockets PS57 live in the same order as the brushes, SB, PB1, PB2 sense the holes in the cards and in synchronism therewith. In other words, the brush **501** which cooperates with the segments **502** will touch the "9" segment **502** at the time when a card brush arrives at the "9" index point position on a card. This emitter E is used in a variety of ways in conjunction with the units and tens counting relays to be described in the next part of the specification to emit impulses which have numerical values.

XVII. Count Relays

The machine is provided with two relays, termed the units count relay and the tens count relay, shown diagrammatically in Fig. 1e. These relays are more or less conventional in principle and in their general details of mechanical construction, consequently only a very brief description will be given herein in reference to Figs. 14 and 15 which show the units count relay. These relays are alike, consequently a description of one will suffice for both.

The units count relay has a main frame **600** formed with offset lugs **600a**, **600b** on which are mounted the units count magnet UCM and the units restoring magnet URM. The frame **600** also is provided with a fixed post **602** on which is rotatably mounted a contact wiper assembly which includes a ratchet **603**, a stop arm **604** and a wiper arm **605**. The latter is insulated from the ratchet **603** and stop arm **604**. A collar **606** on post **602** retains the wiper assembly on the post **602**. A spring **607** anchored to a pin on the frame **600** and to a lug forming part of the stop arm **604**, normally holds the latter against a stop pin **608** carried by the frame **600**. A retaining pawl **609** forming a part of the armature of magnet URM is held by a leaf spring **610** against the teeth of the ratchet **603** as shown in Fig. 15. The spring **610** is secured to pawl **609** and bears against the pin **608**. The armature or pawl **609** is pivoted at **611** to a bracket **612**, secured to the lug **600a** on which the magnet URM is secured. When the magnet URM is energized, the armature or retaining pawl **609** is attracted sufficiently to release the ratchet **603** and permit the spring **607** to restore the wiper assembly to the position of Fig. 14 by a counterclockwise movement.

The wiper assembly is actuated in a clockwise direction step by step by means of a pawl **613** which is pivotally mounted at **614** on the end of the armature **615** of magnet UCM. This armature is pivoted at **616** to a bracket **617** mounted on the lug **600b** of frame **600**. The feed pawl **613** is provided with an arm **613a** which cooperates with a lug **600a** formed in the frame **600** to normally hold the pawl **613** out of engagement with the teeth of ratchet **603**. A spring **618** coiled around the pivot **614** urges the pawl **613** in a clockwise direction. A leaf spring **619** secured to the armature **615** has its upper end bearing against the right hand side of lug **600c** and holds the pawl **613** in the retracted position of Figs. 14 and 15. When the magnet UCM is energized, the armature **615** rotates in a counterclockwise direction (Fig. 15) which initially allows the spring **618** to rotate the pawl **613** in a clockwise direction into engagement with the teeth of ratchet **603** so that with further movement of the armature **615** the ratchet **603** is rotated in a clockwise direction one tooth space. A collar **620** carried by a pin secured to the frame **600** cooperates with the end of the pawl **613** in its leftward movement and limits the rotation of the ratchet **603** to one tooth space and at the same time, in a well known way, prevents overthrow of the ratchet **603** and the wiper assembly of which it is part.

The wiper **605** is composed of two cooperating resilient fingers **605a**, **605b**, of which the front finger **605a** in Fig. 14 wipes over the front sides of the inner ends of ten contact segments **621** which are clamped between two plates **622**, **623** of insulating material by means of a plate **624** secured to the frame **600** by means of screw **625**. The rear finger **605b** of the wiper, which is not shown, traverses the rear side of a metallic plate which is designed to act as a common contact strip for the relay. This plate **626** is insulated from the frame **600** by means of a plate of insulating material of the same general shape as the plate **624**. When the wiper **605** is stepped in a clockwise direction by the magnet UCM, the fingers of the wiper **605** electrically connect together segments **621** and the plate **626**.

Secured to the frame **600** is a bracket **630** on which is mounted a pair of spring contact members **631** carrying contacts designated UC in the case of the units relay. Also forming part of the wiper assembly is a contact operating arm **632** having a pin **633** cooperating with a plate of insulating material secured to the lower of the two contact members **631**. When the wiper assembly is in the restored positon of Fig. 14, the pin on the arm **632** engages the plate and holds the contacts

UC closed. When the magnet UCM receives its first impulse of current advancing the wiper 685 to the next succeeding segment 621 in a clockwise direction, the arm 632 moves far enough to cause the contacts UC to open and remain open until the wiper assembly is restored to normal position. The arm 632 is made adjustable in relation to the wiper 685 and arm 684.

The tens count relay is identical in construction and is provided with magnets TCM, TRM (Fig. 1e) similar to the magnets UCM, URM, respectively and with contacts TC, similar to the contacts UC.

XVIII. Operation of the Machine

Section 1.—General conditions applicable to all operations

In the present section will be described various conditions which prevail in all, or nearly all, cases, such as starting conditions and the stopping conditions, as when one or both of the hoppers become exhausted of cards or the card lever contacts open. In the present section, the operation of the comparing units in selectively controlling feeding of the cards and the distribution of the cards to the various pockets will not be treated but will be explained in subsequent sections dealing with specific kinds of operation that the machine can perform. The present section also will describe generally the plugging of the brushes to the comparing units and other things which are more or less basic to all operations.

In the sections dealing with the operation of the machine, a detailed explanation of the plugging necessary for each operation will not be given in order to reduce the size of the specification as much as possible. Instead, the plugging will be indicated by means of plugboard charts which are shown in Figs. 17, 18, 19, 20, 21 and 22*a* to 22*i*. The plugboard charts are associated with the pertinent sections of the specification by giving the section numbers on the charts for the different operations described in each section. Thus Fig. 17 relates to section 2; Figs. 18, 19 and 20 to section 3; etc. This will facilitate the reference to the pertinent sections of the specification.

In order to reduce as much as possible repetitious tracing of circuits, the following should be borne in mind in reading the descriptions of operations.

It will be noted by reference to Fig. 1c that once the machine is started in operation and the start relay contacts R17B have closed, the plug socket PS24 will be pulsed or made "hot" once per cycle and therefore any circuit, magnet, or relay which happens to be plugged to the plug socket PS24 will likewise receive an impulse of current. In the majority of cases, when a plug wire is inserted in plug socket PS24, a magnet such as the primary feed magnet will be energized every cycle of the machine. For example, with reference to Fig. 17 which shows the plugging for a very simple selecting operation, the plug socket PS24 is plugged directly to plug socket PS23 whereby the primary feed magnet PFM will be energized every cycle of the machine provided, of course, the machine is feeding cards and the relay R17B is maintained energized.

With reference to Fig. 1*d*, it will be noted that whenever plug wires or double plugs are inserted between one or both of the plug sockets PS43, PS45 and the plug sockets PS44, PS46, pulses of current will be delivered to one or both of the comparing units and must travel through one of the relays R22 to R27, depending upon the condition of the compared unit which in turn will be dependent upon the numerical relationships between the records compared or the numbers which may be retained in the comparing units. When the numbers are equal, one or the other of relays R23, R26 will be energized. If the relationship of the numbers is such that a secondary card number or the second of two compared primary cards is the lower in value, relays R24 or R27 will be energized. Similarly, relays R22 and R25 will be energized when the conditions are the reverse. When a pulse of current is delivered to any of the relays R22 to R27 under one of the three conditions of numerical relationship, the corresponding one of the plug sockets PS37 to PS42 will be pulsed. By inserting plug wires in any of the plug sockets, PS37 to PS42 and in any of the plug sockets PS18, PS22, PS23, PS28, PS29; PS33 to PS36, inclusive; PS50, PS51 to PS53, PS57 to PS60, the various feed magnets, restoring magnets, the eject magnet, the reject magnets, the cycle delay device, selector relays, and the error stop circuit may be energized as desired. This will greatly facilitate an understanding of the operation of the machine with reference to the plug board diagrams and will save much description and repetitious tracing of circuits. For example, with reference to Fig. 17*a*, bearing in mind that plug socket PS42 is made live each time the sequence unit moves to the low second primary condition, the error stop relays HSR4 and R35P will be energized and it is unnecessary to retrace these circuits in detail. However, certain circuits which are conditional that is, depending upon the operation of relays, such as R10, R11, will be traced in detail at least once in the following sections but the retracing will not be repeated for each operation where either of these relays may happen to be plugged to a brush for control by an "X" punched card.

It will be convenient to remember that when the secondary card is lower than the primary and when the second of two compared primary cards is lower than the first, the switch assemblies of the comparing units are operative, in the order corresponding to the highest significant digit, to switch the circuit to the right in Fig. 1*d* and when the reverse condition exists, the circuit is switched to the left. When the numbers are equal, the circuit runs straight through the center to select relays R23 or R26. In Fig. 16 and upward, the captions over the plug sockets indicate the numerical condition which renders the corresponding plug socket live during the operation of the machine or indicates the effect of a pulse delivered to the plug socket.

The group of plug sockets designated PS15, PS16, PS17, PS25, PS26, PS27 and PS30, PS31, PS32 enclosed by the dotted rectangle in Fig. 1c and in a box entitled "Basic setup" in Figs. 16 and up, are known as the basic setup switches and are provided as a convenience to simplify plugging when certain basic card feeding operations are performed which are very common and will be frequently used. In order to plug these switches, double pronged plugs will be used which make it possible to interconnect PS16 and PS17, PS26 and PS27, PS31 and PS32 by the simple insertion of the two pronged plugs. The plug board is laid out so that frequent use of these double pronged plugs may be made to avoid obscuring the plugboard by dangling wires. Thus, in Fig. 17*a*, for example, two pronged plugs are utilized between PS3 and PS7 to connect the

brushes PB1 to the magnets PM1. These two pronged plugs are used wherever it is necessary to plug between two adjacent plug sockets as shown at the right in Fig. 17*a* to connect the three hole plug socket PS22 to plug sockets PS35, PS36 to render both comparing units operative.

The first case treated will be the starting of the machine and its stoppage when only the primary side of the machine is to be used for a relatively simple operation which does not require the use of the comparing units. As a basis for commencing the description, it will be assumed that current has been turned on the line wires W1, W2, and the motor has been started in operation, causing contacts CB1 to CB4 and CR1 to CR11 to close in the timed sequence shown in Fig. 10*a*.

As soon as the current is turned on the line wires W1, W2, the relays R1 to R4 become energized, since the primary and secondary hopper contacts PHC and SHC remain closed when the hoppers are empty. However, as soon as the primary cards are placed in the primary hopper PH, the contacts PHC are thereby opened and deenergize the relays R1, R2 and their contacts remain as in Fig. 1*c*. On the other hand, the contacts SHC remain closed, since the secondary side of the machine is not being used; consequently, the contacts associated with the relays R3, R4 will take positions the reverse of those shown in Fig. 1*c*.

The start key STK is now depressed thereby closing the start key contacts STC1, STC2 (Fig. 1*c*). This initially establishes a circuit as follows: line wire W1, the coil R17P of the start relay, and contacts R12B, R1A, R21B, STC1, SPC, CR7, to line wire W2. At this point it is desired to mention that the start relay, besides its coil R17P, has a second coil designated R17H and both of these coils operate the contacts designated R17A, R17B, R17C. The contacts R17A establish a holding circuit for the coil R17H through contacts CR6 which maintain the circuit for the start relay into the next card cycle. Contacts R17B close and cause the energization of the primary feed magnet PFM by a circuit as follows: line wire W1, magnet PFM, and contacts R2A, R12E, R2B, HSR4A, CR1, R17B, to line wire W2.

The energization of magnet PFM causes the primary feed mechanism to start its operation thereby advancing the first card from the primary hopper PH. The first primary card is advanced to a position between the feed rollers 184, 187 during this first card feeding cycle of the machine. However, the card will not advance far enough to close the card lever contacts PCL1, but must continue for another cycle to obtain this effect. Contacts PCL close but have no effect since contact R2A remains closed. Unless the start key ST is held down for another cycle, the feeding of primary cards will stop as the starting relay R17H is held at this time only through contacts CR6 which open near the end of the feed cycle before contacts CR1 can close to impart another impulse to the primary feed magnet PFM.

With the start key still held depressed, the primary feed magnet PFM will receive a second impulse during the following cycle in exactly the same way as before, causing the second primary card to be advanced from the primary hopper and the first primary card to be advanced past brushes PB1 thereby closing the primary card lever contacts PCL1. The contacts PCL2, however, still remain open as the first card stops just under the second pair of feed rollers 184, 187 from the right in Fig. 3*d*. The closure of the contacts PCL1 during the second cycle causes the relay R7 (Fig. 1*a*) to be energized over a circuit extending from line wire W1 to the coil of relay R7 and contacts PCL1 and CR5, to line wire W2. The contacts R7A (Fig. 1*b*) close a circuit through the coils of relays R14, R15 as follows: line wire W1, the coils of said relays in parallel, contacts R7A, and commutator PC2, to line wire W2. Contacts R7B close and connect the contact roller PCR1 to the circuit breakers CB1 to CB4 and contacts CR3 to condition the primary brushes PB1 for operation. The second primary card is also advanced during the second cycle to a position between the first pair of feed rollers 184, 187.

Closure of both card lever contacts PCL1, PCL2, is necessary to maintain the feeding of cards, since contacts R17B must be kept closed, even when very simple operations, not requiring the use of the comparing units, are being performed. Start relay coil R17H must be kept energized by means of contacts R17A, R17C alternately, that is, when the circuit through contacts R17A is open, contacts R17C must hold a relay R17H. Since relay R13 is still deenergized and contacts R3B are being held open due to lack of secondary cards in hopper SH, a holding circuit for relay R17H cannot be established through contacts R17C. Consequently the start key STK must be held down long enough to initiate a third feeding cycle. During the early part of the card feeding third cycle, the card lever contacts PCL2 (Fig. 1*a*) are closed, thereby energizing relay R6 by a circuit similar to the one for relay R7. Relay R6 closes its contacts R6A and connects the relays R12, R13 in parallel with relays R14, R15. Contacts R6B close and condition the primary brushes PB2 for sensing cards during the third cycle, the card lever contacts PCL2 closing just before the first primary card starts beneath the brushes PB2. Thus, during this third cycle, card brush circuits, may be established through any of the controls, such as the comparing units or X selectors, which may be plugged to any of the brushes as required by operations subsequently to be described. Since no secondary cards have been fed and the secondary card levers remain inactive, the contacts R5A prevent any circuits from being established through the brushes SB. Although contacts R4B are now closed, commutator SC1 is at rest and no circuits can be established therethrough.

The continuance of feeding of primary cards after the third cycle will depend largely upon the type of operation which the machine is to perform. The energization of relay R12 causes its contacts R12E (Fig. 1*c*) to open and R12A to close, thereby interrupting the circuit which extends through these contacts to energize the primary feed magnet PFM during the initial cycles of the machine. It is necessary to have some additional means for energizing the primary feed magnet PFM repeatedly or selectively as required if the feeding of primary cards is to continue. In a very simple case where the operation to be performed merely requires continuous feeding of primary cards, it is possible to connect the plug socket PS23 to the plug socket PS24 by means of a plug wire as in Fig. 17*a*, whereby the magnet PFM is energized every cycle, provided relay R17H remains energized. In such a simple case it would be also necessary to cause the energization of the eject magnet EM, as the feeding of cards between the contact roller PCR2 and the first

set of pocket feed rollers 218, 219 is effected by the eject feed rollers 206, 207 which rotate only when the eject clutch magnet EM is energized. For this purpose the magnet EM could be rendered operative by a double plug between plug sockets PS18 and PS23. As will be explained hereinafter, relay HSR3 also performs this function. The energization of relay R12 when the card lever contacts PCL2 close causes contacts R12C to close, whereby both magnets EM and PFM may receive impulses over parallel circuits through the contacts R17B, CR1, HSR4A, the double plug and plug wire, contacts R12C, the coil of magnet EM; also through contacts R14A and magnet PFM. As will be seen later herein, the control of the magnets EM, PFM, and others may also be vested in the comparing units in different ways; in the X selectors R10, R11; or in the selectors R28 to R32.

After the primary lever contacts PCL2 have closed, the feeding of cards is maintained by a test circuit closed once per cycle which causes the feeding of cards to stop in the event that the primary hopper becomes exhausted, when for some reason a primary card fails to feed causing the card lever contacts to remain open, when the full pocket contacts FPC open, or stop key SPK is depressed. The card lever contacts open for a short period of time during each cycle in consequence of the gap between the cards, no means being provided to maintain the card lever relays R6, R7 in energized condition while the gaps in the cards are passing the brushes. This is true of the secondary card lever contacts and the relay R5 which has the same function as the relays R6, R7.

The test circuit extends through the second coil of the start relay designated R17H and the contacts R17C of this relay. As soon as the cards begin to pass the primary brushes PB2, the contacts R13D close. Since contacts R15B are now closed in consequence of the second primary card passing the brushes PB1, a holding circuit will be established as follows: from line wire W1, coil R17B, and contacts R17C, FPC, R3E, R1B, R9A, R1E, R15B, R13D, R35B, SPC, CR7, to line wire W2. This circuit is opened momentarily once each cycle by the contacts CR7, and also by the contacts R13D, R15B which open when the gap between primary cards passes the levers for contacts PCL1, PCL2; however, during this period, contacts CR6 are closed and maintain the circuit for relay coil R17H through the contacts R17A. As long as the primary hopper contains cards and the cards continue to feed, the relay coil R17H will remain continuously energized. Consequently the closed contacts R17B enable the contacts CR1 to repeatedly energize the primary feed magnet PFM and the eject magnet EM.

It is desirable that the comparing units be clear of all numbers when the machine is started in order that errors may not occur due to the accidental retention of a number from a previous run of the machine for some operation involving the use of the comparing units. For this purpose means is provided to always cause the comparing units to be automatically cleared or reset during the first cycle necessary to feed the first primary card and/or the first secondary card to a position in readiness to pass the first set of primary brushes PB1 and/or brushes SB. The restoring magnets SR, PR1, PR2, PR3 are provided with plug sockets designated PS33 to PS36 which enable one or more of these magnets to be plugged to various functional controls which will be explained more clearly hereinafter. Ordinarily these magnets will be selectively controlled by the comparing units and will be energized only under certain conditions of equality or inequality of numbers compared, according to the function or operation to be performed. As a general rule, the secondary restoring magnet SR will be connected in parallel with the secondary feed magnet SFM by inserting a double plug between the plug sockets PS28 and PS33. The remaining three restoring magnets PR1, PR2, PR3 will similarly be connected in parallel with primary feed magnet PFM by plugs inserted between the triple plug socket PS22 and the plug sockets PS34, PS35, PS36. Under these conditions the secondary restoring magnet SR will always be energized when the secondary feed magnet is energized, and likewise the three primary restoring magnets PR1, PR2, PR3 will always be energized when the primary feed magnet is energized.

When the starting key STK is depressed, the relays R18, R19 are energized in parallel with the starting relay coil R17P through contacts R14D, and relay R18 closes its contacts R18B to place the coil R17H in parallel with relays R17P, R18, R19. The contacts R19A are arranged to place all of the restoring magnets SR, PR1, PR2, PR3 in parallel, whereby all of these magnets will be energized with the first energization of magnet PFM. It is clear that both of the comparing units will be automatically restored before cards can pass any of the brushes. This will take place notwithstanding how the magnets just mentioned may be plugged to any of the functional controls. For instance, if only the sequence unit is to be used, the selector unit will also be automatically cleared and placed in equal condition immediately to avoid the risk of back circuits which might occur due to this unit being left with a number on one or both sides, resulting in such units standing in either of the conditions of inequality or equality which by selective control of various relays might accidentally cause back circuits or incorrect operation. As soon as cards pass the brushes PB1 or SB, the relays R14, and/or R8 will be energized and contacts R14D and/or R8B open to deenergize the relays R18, R19. This permits the contacts R19A to open and restores magnets SR, PR1, PR2, PR3 to selective control by the comparing units or other controls. Contacts R18B also open and prevent the relays R18, R19 from receiving current in parallel with coil R17H.

As soon as the last card leaves the primary hopper PH, the contacts PHC will close, thereby energizing the relays R1, R2. Contacts R1C close and contacts R1E open but contacts R1C are ineffective since contacts R3B are kept open when the secondary hopper SH is empty. Consequently, when contacts CR6 open and contacts CR7 close, the latter will be unable to maintain the holding circuit for coil R17H through contacts R17C and the start relay R17P—R17H will be deenergized, opening contacts R17B to prevent an impulse from being given to the magnet PFM. As a result, the feeding of primary cards will stop at 226° (Fig. 10*b*) with the leading edge of the last primary card a short distance to the right of the brushes PB1. However, the primary card lever circuits controlled by relays R6, R7 will not be disturbed since, at the time the card feed stops, the commutator PC2 will maintain the relays R12 to R15 in energized condition.

The energization of relays R1, R2 causes contacts R1A to open and has the effect of prevent-

ing restarting of the machine by means of the start key STK. This is partly due to the fact that there are no cards in the secondary hopper whereby relay R3 as well as relay R1 is energized interrupting the circuit including the start key contacts STC1 which were initially used to start the machine in operation. The test circuit is also opened at contacts R1B and R3C. It is still possible however, to start the machine by means of the runout key ROK, since the contacts ROC1 controlled by this key enable relay R17H to be energized directly instead of through contacts R18B. This enables the operator to cause the last cards to be run into the pockets.

If it is desired to continue the operation of the machine as would be the case where the hopper became exhausted due to inattentiveness of the operator or his enforced absence from the machine, more cards may be placed in the primary hopper thereby reclosing the primary hopper contacts PHC and reenergizing the relays R1, R2. This causes contacts R1A to reclose and enables restarting of the machine by means of the start key ST by closing contacts STC2 to close the test circuits through contacts R1E. However, it is merely necessary to operate the start key STK once in this case since the machine stopped with primary cards in position to pass the brushes PB1, PB2 and contacts R3E, R1B, R9A, R15B, R13D remained closed when the machine stopped.

On the other hand, if it is not desired to continue the operation, the runout key is depressed and held depressed until the last primary card has reached the feed rollers 218, 219, after which the last card will be conveyed to the pocket for which it is destined. It is necessary to hold the runout key depressed as otherwise the opening of the contacts R15B in consequence of the passage of the last primary card pass the brushes PB1 would stop the machine with the last primary card between brushes PB1, PB2.

The circuits controlled by the hopper contacts PHC, SHC and the card lever contacts are so arranged that the machine cannot be started with both hoppers empty but may be operated with one or the other of the hoppers PH, SH empty or with cards in both. Consequently the start circuits are so arranged that either of the primary or secondary feed mechanisms or both may be used and when both are used, the feeding of cards will be selectively controlled in various ways, depending upon the type of operation to be performed. It will now be assumed that it is desired to use only the secondary side of the machine and that the primary feed mechanism is not to be used. There are definite advantages in using the secondary side of the machine alone. One reason is that the secondary cards may be distributed to any one of the three pockets designated SRJ, SP, MS, respectively, whereas the primary cards can only be distributed to pockets PRJ and MS.

When cards are placed in the secondary hopper SH, relays R3, R4 become deenergized while the relays R1, R2 remain energized. This causes the primary hopper relays R1, R2 to reverse the condition of the contacts shown in Fig. 1c. When the start key is depressed, the relay R17P is energized in much the same way as before, except that the circuit extends through the contacts R3A, R8B instead of through contacts R1A, R12B, otherwise the machine starts in the same fashion. A single secondary card will be fed from the hopper SH and will stop with its leading edge a short distance to the right of the contact rollers SCR (Fig. 3b) and to continue the feeding of secondary cards, it is necessary to hold the start key down initially long enough to start a second feeding cycle. The circuit for the secondary feed magnet SFM during the first feeding cycle is established by the closure of contacts CR1. For the purpose of conditioning the machine to feed secondary cards only, in the case of a very simple operation involving continuous feeding, a plug wire may be inserted between plug sockets PS24 and PS29, whereby the secondary feed magnet will be energized by a circuit as follows: line wire W1, magnet SFM, contacts R4A, the plug wire, contacts HSR4A, CR1 and R17B, to line wire W2. This circuit must be established twice before the first secondary card feeds far enough to close the secondary card lever contacts SCL1. During the first feeding cycle, the card lever contacts SCL close but have no special effect since they are in parallel with contacts R4A which are closed at this time. The closure of contacts SCL1 during the second cycle enables the machine to continue to feed secondary cards until the hopper SH becomes exhausted. In this case, the test circuit for maintaining the relay R17H in energized condition extends through contacts R3C, R9E, R1C, R3B and R13D, all of which remain closed as long as there are cards in the secondary hopper and in the course of feed pass the brushes SB. It will be noted that one less cycle is required to make the test circuit effective to hold the start relay R17H.

When the secondary hopper becomes empty, the secondary hopper contacts SHC close and energize relays R3, R4. The opening of contacts R3A prevents restarting the machine by means of the start key ST, contacts STC1, until cards are placed in the hopper. The opening of contacts R3B prevents the establishment of the test circuit which maintains relay R17H in energized condition and is the cause of the stoppage of the feed. As soon as new cards are placed in the secondary hopper, the relays R3, R4 are again deenergized and the machine is conditioned for restarting by means of the start key STK and contacts STC2. Since the card lever relays R8, R9 are still energized, the relays R18, R19 cannot be reenergized when the start key is depressed. Consequently the comparing units will not be automatically cleared and the machine will resume its operation as if no interruption in the feeding of cards had occurred. The contacts R14D associated with primary card lever relay R14 have a similar effect when only primary cards are being fed.

In the event that it is desired to discontinue the particular operation requiring the use of either the primary or the secondary feed mechanism alone or both, the runout key must be depressed to cause the last secondary card to travel far enough to be gripped by the first pocket feed rollers 218, 219 exactly as in the first case described above where only the primary feed mechanism is used.

The circuits of the machine are arranged so that cards must be placed in the one or both hoppers at the start before the machine can be started with the key STK. In other words, if one or both feed mechanisms are to be used, cards must be placed in one of the hoppers before the machine will start. Once the machine has been started in operation, either with one feed or both feeds in use, regardless of which feed is in use, it must be continued in operation in the same man-

ner and if the hopper becomes exhausted while the machine is running, it cannot be started again by means of the start key until cards are placed in the hopper which becomes empty. On the other hand, when it is desired to terminate the operation and the hopper becomes exhausted simply because there are no more cards to be treated, it is desirable that the operator be compelled to press the runout key to clear the machine of the last cards which remain in the machine between the hoppers and the eject station at the time the machine stopped. For this purpose, relay R21 is provided and has the following effect.

When the start key is depressed, the closure of contacts STC1 causes the energization of relay R18, and R19 and effects the restoring of the comparing units. Relay R18 is energized and opens its contacts 18A before the contact CR1 can close a circuit through magnets PFM, SFM. Consequently the pickup coil R21P cannot be energized during the first cycle of the machine. During the second cycle of the machine, the relay R14 is energized due to the closure of card lever contacts PCL1, thereby deenergizing relay R18. As a result relay R21P is energized at the beginning of the third cycle and closes its contacts R21A to establish a holding circuit through the holding coil R21H of the same relay. This causes contacts R21B to open and remain open throughout the remainder of the run of the machine. Consequently, no circuits can be established through the coil R17P or the relays R18, R19, even in the event that it might happen that the card lever contacts opened through the creation of one or two card gaps for some reason or other.

When the machine stops through the exhaustion of the hopper, the operator has his choice of doing two things. If operation of the machine is to be continued with more cards, the operator must replenish the hopper which becomes exhausted and then depress the key STK to start the machine through contacts STC2. If the machine is not to be continued in operation, the operator cannot restart the machine by means of the start key STK but must press the runout key. The holding circuit for relay R21H is maintained through the contacts ROC2 of the runout key. When the runout key is depressed, the relay R17H is energized directly and the machine will again feed cards but the key must be held depressed, at least, until the last card has reached the feed rollers 218, 219. The operation of the runout key opens the contacts ROC2 and causes relay R21H to become deenergized. However, this deenergization of relay R21P has no harmful effect during the last cycles necessary to run the remaining cards out of the machine, because the relays R1 to R4 will now be energized due to exhaustion of the hoppers, and, even if the operator depressed the start key at the same time as the runout key, it would be impossible to reset the comparing units independently of the selective reset control by the comparing units. Usually, the resetting of the comparing units will be taken care of properly when running out the last cards, due to the selective action of the comparing units. It will be seen that the machine is interlocked in respect to the start key and runout key so that the operator is compelled to do the right thing.

The arrangement of the circuits is such that when the machine stops for any reason, the operator must ascertain the reason for the stoppage. For instance, if the machine runs out of cards in either hopper, the machine cannot be started until the cards are replenished. If the machine should stop in consequence of an error which caused relay R35 to open the contacts R35B, it cannot be restarted through contacts STC1 or STC2, because the contacts R35B are in series with STC2 and the contacts STC1 are in series with contacts R21B. If contacts FPC open when a pocket becomes too full, the pocket must be emptied since contacts FPC are likewise in series with contacts STC2. Therefore, the operator only has left the runout key to enable him to run the last cards out of the machine in the event of an interruption in the feeding of the cards. Sometimes cards jam in the course of feeding, leaving several which must be removed after the jam has been cleared. In such a case the runout key is available for clearing the machine of the last few cards before restarting the run with the condition corrected by putting new cards in the hopper to take the place of the ones which may have been damaged by jamming in course of feed.

It will now be assumed that both feeding mechanisms are to be used and that cards have been placed in both the primary and secondary hoppers. In this case, all of the relays R1 to R4 will be deenergized and the contacts which they control will remain in the condition shown in Figs. 1b and 1c. When the start key is depressed, a circuit will be established as follows: line wire W1, relay R17P, contacts R12B and R1A, or R8B and R3A, all of which are closed, contacts R21B, STC1, SPC, and CR7 to line wire W2. The relays R18, R19 will also be energized in parallel with relay R17P through contacts R14D. Contacts R18B close and connect the coil R17H in parallel with relays R17P, R18, R19. The feeding of both primary and secondary cards commences by a circuit as follows: line wire W1, magnet PFM and contacts R2A; also magnet SFM and contacts R4A, R9E; contacts R12E, R1D, R2B, HSR4A, CR1, and R17B, to line wire W2. During this initial cycle, the first primary card and the first secondary card will be advanced to positions to the right of the contact rollers PCR1 and SCR, respectively and the card lever contacts SCL, PCL will close. These card lever contacts, however, have no effect at the start because they are in parallel with the contacts R4A, and R2A, respectively, which remain closed as long as cards remain in the hoppers.

Because of the fact that none of the card lever contacts PCL1, PCL2, SCL have closed and the relays R8, R9, R12 to R15 are still deenergized, the test circuit for relay R17H cannot be made and the start key must be held down to continue the feeding of cards for a second cycle. During this second cycle, the first secondary card is fed past the brushes SB and closes the secondary card lever contacts SCL1, thereby energizing relay R5. This causes the relays R8, R9 to be energized, the contacts R9E closing part of the test circuit. Also the first primary card will pass the brushes PB1 and close card lever contacts PCL1 to energize relay R7. Relay R7 in turn causes the energization of relays R14, R15 as described before and relay R15 closes its contacts R15B as a further step in establishing the test circuit. The energization of relays R8, R14 opens the circuit for relays R18, R19.

During the first cycle, relay R19 causes the automatic resetting of the comparing units in the manner previously described, it being understood that one or more of the SR, PR1, PR2, PR3 magnets has been plugged for selective control in such a fashion as to be energized. The

contacts R9E associated with the secondary card lever relay R9 also open during the second cycle and prevent a third impulse from being given the magnet SFM in consequence of which the secondary feed stops and will remain stopped until one of the selective controls which are to be effective during the subsequent operation of the machine establishes a circuit to such feed magnet.

Since cards have not yet passed the brushes PB2, the card lever contacts PCL2 remain open and relay contacts R13D likewise remain open to prevent the test circuit from being established to hold relay R17H. Consequently, as was the case in dealing with feeding of primary cards alone, it is necessary to hold the start key down until a third card feeding cycle has commenced during which the contacts PCL2 will close and cause the energization of relays R12, R13. During this cycle, the test circuit for relay R17H will be established as follows: line wire W1, relay R17H, contacts R17C, FPC, R3C, R9E, R1E, R15B, R13D, R35B, SPC and CR7, to line wire W2. Energization of relay R12 will cause contacts R12E to open and stop the feeding of primary cards unless one of the selective controls has been conditioned for some particular operation to continue the feeding of the primary or secondary cards. As will be seen later, the further feeding operations of the machine will depend not upon the start circuits but upon the selective effect of the comparing units or any of the selectors which may have been plugged for some special operation.

In subsequent sections dealing with specific operations, the start circuits will not be described in detail but it will be understood that the starting conditions will be the same as described above and will differ only as to the means by which the impulses of current are given to the magnets PFM and SFM. In some cases, these impulses of current will be given invariably by means of plug wires inserted between plug socket PS24 and plug sockets PS23, PS329; in other cases, the impulses of current will be controlled by the relays R22 to R27 which are associated with the comparing units or by selector relays R28 to R32 which may be plugged to control the selection of the feed magnets, restoring magnets, and reject magnet in various ways.

Section 2.—Control by "X" holes

By means of the primary and secondary "X" selector relays R10, R11, it is possible to perform a number of special operations, such as the removal of all cards designated with an "X" hole. A very simple operation consists in the selection of "X" punched cards using only the primary or secondary side of the machine. A suggested use of such an operation is the removal of balance cards from a batch of detail balance and heading cards after an invoicing operation has been completed. It will be assumed that the balance cards have an "X" hole in column 40. The machine is plugged as shown in Fig. 17 by solid lines for the "X" selection feature alone. The cards need not be in numerical order and are placed in the primary hopper.

With the arrangement shown in Fig. 17, the primary feed mechanism operates continuously as long as the primary hopper is kept supplied with cards. As soon as an "X" punched card is detected by the brush PB2 for column 40, the relays HSR2, R11 are both energized. The circuit for these relays is traced in Fig. 1*b* as follows: line wire W1, the coils of said relays, commutator PC3, the plug wire PW4 (Fig. 17) between plug sockets PS9 and PS2, brush PB2 for column 40 (Fig. 1*a*), contact roller PCR2, brush PCB2, contacts R6C, CB1 to CB4, and contacts CR3, to line wire W2. Relay HSR2 closes its contacts HSR2A (Fig. 1*b*) and establishes a holding circuit through commutator PC2 which circuit is maintained until the beginning of the next card feeding cycle. The contacts R11A close a circuit through the primary reject magnet PRM as follows: line wire W1, magnet PRM (Fig. 1*d*) the plug wire PW6 (Fig. 17) between plug sockets PS50, PS11, contacts R11A, plug wire PW7 between the plug sockets PS12, PS24, contacts HSR4A, CR1, and R17B to line wire W2. The energization of magnet PRM causes the "X" punched card to be deposited in the pocket PRJ. Thus all cards which are "X" punched will accumulate in the pocket PRJ while the remaining cards will accumulate in pockets MS.

Section 3.—Simple merging

a. A simple merging or filing operation involving the bringing together of two parts of a file will now be described. There may be groups of identically numbered cards as well as single cards in both the primary and secondary hoppers. The machine may be plugged as shown in Fig. 18 to utilize the selector unit to compare control numbers represented by perforations in columns 1 to 5 on the primary and secondary cards. Any one of the selector relays R28 to R32 inclusive may be utilized to selectively control the operation of the primary and secondary feed mechanisms, conveniently relay R29, with which is associated the row of four plug sockets PS53, PS56, PS54, PS55 from the top in Fig. 18. The coil of the relay R29 is plugged to be responsive to a low secondary card condition in the selector unit whereby this relay is energized each time the secondary card has a lower control number than the primary card which it is compared with. For this purpose, the plug wire is inserted between plug socket PS39 and the one below the top-most plug socket PS53.

It will be assumed that the primary cards are numbered as follows, 1, 1, 2, 3, 4, 6, and 7 and that the secondary cards are numbered 1, 2, 4, 5, and 6. It will also be assumed that the initial cycles have been performed and that the first secondary card has passed the brushes SB and has stopped at the eject station and that the first two primary cards have passed the brushes PB1, PB2, respectively and that the first primary card is at the eject station. The third primary card will be in a position to pass the brushes PB1 during the fourth cycle of the machine provided the primary feed mechanism is operative. During the third cycle of the machine, the first primary card will have passed the brushes PB2 and the control number 1 will be entered on the primary side of the selector unit.

During the second cycle of the machine, the first secondary card, which is numbered 1 will pass the brushes SB and its control number will have been entered in the secondary side of the selector unit. This causes the equal condition to be created in the selector unit during the third cycle and the primary feed magnet PFM will be energized over a circuit which is partially traced from the plug socket PS24 (Figs. 1*c* and 18), the plug wire to plug socket PS56 associated with relay R29 (Fig. 1*d*), the normally closed contacts R29B and plug socket 54, the plug wire to plug socket PS23 (Fig. 1*c*), contacts R12A, and primary feed magnet PFM, to line wire W1. The

energization of the primary feed magnet causes the primary cards to feed for another cycle. However, since relay R29 was not energized and its contacts R29A remain open, the secondary feed magnet SFM cannot be energized and the secondary feed mechanism will remain dormant. As a result, the first primary card numbered 1 will be advanced toward the pocket MS during the fourth cycle of the machine.

During the fourth cycle of the machine, the second primary card which is also numbered 1 will be sensed by the brushes PB1 and since the equal condition is again created in the selector unit, the primary feed mechanism will continue to feed for another cycle and the secondary feed mechanism will remain stopped.

During the fifth cycle, the third primary card numbered 2 will be compared with the first secondary card numbered 1 and the low secondary condition will be created in the selector unit. This causes the energization of relay R29 over a circuit partially traced from plug socket PS39 in Figs. 1d and 18 the plug wire between plug sockets PS39 and PS53 for relay R29, and the coil of said relay, to line wire W1. Relay R29 will close its contacts R29A and thereby energize the secondary feed magnet SFM by a circuit traced from plug socket PS24 (Figs. 1c and 18), the plug wire to plug socket 56, contacts R29A, the plug wire between plug sockets PS55 and PS29, and the magnet SFM, to line wire W1, contacts R29B open and prevent energization of the primary feed magnet PFM. Consequently, the feeding of primary cards stops and the feeding of secondary cards starts.

During the sixth cycle, the first secondary card numbered 1 is fed and follows the last primary card similarly numbered into the pocket MS. The second secondary card, which is numbered 2, also is sensed and, since its control number 2 agrees with the control number of the third primary card, the selector unit again takes the equal setting, to restart, the feeding of primary cards for the seventh cycle.

During the seventh cycle, the primary card numbered 3 is compared with the secondary card numbered 2 and the feeding of the primary cards is again stopped and the feeding of the secondary cards started.

During the eighth cycle, the secondary card numbered 4 is compared with primary card numbered 3, creating a low primary condition, and the secondary feed mechanism is stopped and the primary feed mechanism started. During the ninth cycle, the secondary card numbered 4 will be compared with primary card numbered 4 and the latter will be fed while the secondary card numbered 4 will not be fed.

During the tenth cycle, the secondary card numbered 4 will be compared with the primary card numbered 6 and the secondary card will again feed. This action keeps up, alternating the feed where necessary, to cause each secondary card to follow behind the next lowest numbered primary card.

Whenever the feeding of cards on one side of the machine is stopped, the number from the card which last passed the brushes SB1 or PB2 will be retained in the machine since, for the plugging shown in Fig. 18 the restoring magnets for the selector unit are connected in parallel with their associated feed magnets whereby the selector units are only reset automatically on the side which is about to feed. For this reason, it is possible to retain the reading of the first secondary card numbered 1 in the secondary side of the selector unit and compare it with the second primary card numbered 1 notwithstanding the fact that the first secondary card has passed the brushes SB and is in the eject position. Since it is not possible for both a primary and a secondary card to feed together from the eject station, there is no possibility that a secondary card will be inserted in the wrong place. In the event that the file contained only odd cards and the cards to be filed were of even number, the feeds would merely alternate, assuming that there are no duplicated or missing numbers on either side of the machine. Where there are duplicate primary cards, the feeding of the primary cards continues without interruption until the low secondary card condition is created. The secondary feed mechanism operates continuously when the secondary cards continuously remain lower in control number than the primary card which is held in the eject position.

b. In Fig. 18 the plugging shown in solid lines at the top is more complex than necessary. This form of plugging has been chosen because it is relatively simple to understand with reference to the wiring diagram since it requires the tracing of only a few very simple circuits which are not confused with other circuits. There are certain matching, merging, and selecting operations which are more or less basic in respect to feeding of the cards and which are frequently encountered in the field. These operations are often combined with other operations and the plugging necessary to carry out the combined operations will become very complicated and the plug wires become a maze which is very difficult to check in the event that the operations are not performed by the machine as they should be after the plugging is completed.

It will be noted by reference to Figs. 1c, 16, and other figures which contain reproductions of the plugboard face plate, that the plug sockets PS15, PS16, PS17, PS25, PS26, PS27, PS30, PS31, PS32 are shown collected in a group under the boxed heading "Basic setup." It is possible to greatly simplify the plugging for the basic operations by merely inserting double plugs in the plug sockets of the basic setup group. For example, the four plug wires shown in solid lines at the top of Fig. 18 need not be used but in their place three double plugs may be inserted as shown by the dotted lines in Fig. 18. Normally, for operations which do not require the same feeding of cards as matching and merging, these double plugs are turned as shown in solid lines in Fig. 18, so as to be equivalent to a single pole switch in the off position.

The three groups of plug sockets under the heading "Basic setup" are known as the basic setup switches and when plugged on the position indicated by the dotted lines in Fig. 18, they condition the machine for the more complicated matching and merging operations which would otherwise require a very complicated plugging of the selector relays R28 to R32, inclusive, of which an example has been given by the solid line plugging at the top of Fig. 18. Under normal conditions the three basic setup plugs are left in the plugboard so that the operator may readily switch the machine to a matching, merging operation without resorting to complicated plugging.

It should be emphasized at this point that many operations which the machine is capable of performing with the use of the basic setup switches alone, can also be accomplished by special plug-

ging of the relays R28 to R32. The main purpose in providing this group of selector relays is to enable plugging of the machine to accomplish operations which cannot be accomplished by the use of the basic setup plugging alone and the use of these relays gives the machine a very high degree of flexibility in conjunction with the feed magnets, restoring magnets, and the magnets which determine the distribution of the primary and secondary cards to the pockets. When the basic setup switches are used, the top of the plugboard is left clear for special plugging connections, making it much easier to check the wiring in the event that the machine does not operate properly after it is plugged, and to facilitate changes in the plugging to take care of other operations when the time comes for a change in the function of the machine.

It will be assumed that the cards are numbered the same as outlined above. During the third cycle of the machine, the first primary card numbered 1 will be compared with the first secondary card numbered 1 and fed to the eject position, the secondary card having reached this position during the second cycle of the machine. The equal condition will be created in the selector unit and a circuit will be traced as follows to energize the primary feed magnet. Line wire W1, magnet PFM, contacts R14A, the plug between plug sockets PS26, PS27, the plug between plug sockets PS19, PS20, contacts R23A to equal relay R23 which is energized when the equal condition is created in the selector unit, and contacts HSR4A, CR1, R17B to line wire W2. The relay HSR3 is likewise energized in parallel with magnet PFM and, by closure of its contacts HSR3A, will cause the eject magnet EM to be energized. As a result, primary cards will feed another cycle.

The closure of contacts R23B has no effect because contacts R15A are open in consequence of the fact that there are primary cards in course of feed. Since the contacts R25A, R27A, R26B, R15A, R24A, are all open, no circuits can be established to the secondary feed magnet SFM.

During the fourth cycle, the first primary card is ejected from the eject station and the second primary card numbered 1 is compared with the first secondary card numbered 1, the reading of the latter being retained in the secondary half of the selector unit. The same events will take place and the primary feed magnet will again be energized to eject the second primary card and feed the primary card numbered 2 past brushes PB2 during the fifth cycle.

During the fifth cycle, the low secondary card condition is created, causing low secondary relay R24 instead of relay R23 to become energized. The contacts of relay R24A close and the secondary feed magnet is energized by a circuit traced from line wire W1, magnet SFM, contacts R9B, the plug between plug sockets PS31, PS32, contacts R24A, HSR4A, CR1, R17B, to line wire W2. Since the contacts R22A, R23A and R22B remain open, no circuits can be established through the primary feed magnet PFM, consequently the primary feed will stop.

During the sixth cycle, the secondary card numbered 1 will be ejected and the secondary card numbered 2 will be fed past the brushes SB and compared with the primary card numbered 2 now in the eject position. This causes the feeding of secondary cards to stop and the feeding of primary cards to start over circuits as traced above owing to the equal condition which causes relay R23 to be energized. It is thus clear that whenever an equal condition or a low primary condition exists in the selector unit, the primary cards are fed and that the secondary cards are only fed when the low secondary card condition prevails which signifies that the card which caused such condition must be fed ahead of the card which is held at the primary side of the eject station.

c. It will be noted in the discussion of the operation of the machine with respect to Fig. 18 that the feeding of the cards either alternates or remains continuous on one side or the other of the machine and both feeds never operate together except during the first two cycles of the machine required to bring the secondary card to the eject position and enter the control number thereon in the secondary side of the selector unit. In other words, when the last primary card of a group is compared with a corresponding secondary card, the secondary card must be held for one more cycle to make sure that it will fall on top of the last primary card in the pocket MS. The reason for this is that the single comparing unit in use for this operation is incapable of detecting a change in the numbering of the primary cards until the card which the change occurs in has actually passed the brushes PB2.

Where there are no duplicate cards on the secondary side of the machine, that is, there is only one card per control number, it is possible, by the use of the sequence unit to effect a saving of time in merging the cards by anticipating that the group numbers of the primary cards are about to change and that the secondary card may be safely fed simultaneously with the last primary card with which it agrees. In order to obtain this result, the machine is plugged as shown in Fig. 19 using the basic setup switches instead of the more complicated plugging shown in solid line at the top of Fig. 18, and the sequence unit is brought into play by the additional plugging shown which places this unit under control of the brushes PB1, PB2.

With this scheme of plugging each active brush PB2 controls the energization of corresponding magnets PM2, SM2 whereby each brush impulse is delivered to both magnets. The effect of this is to read into the primary side of the selector unit and the first primary side of the sequence unit the control number of the first of two successive primary cards. It is for this purpose that the magnets SM2 are provided with double plug sockets PS5 to enable the brushes PB2 and magnets SM2, PM2 to be connected in common by means of only two plug wires.

It will be assumed that, as before, the primary cards are numbered 1, 1, 2, 3, 4, 6, 7 and that the secondary cards are numbered 1, 2, 4, 5, 6, as above.

When the first two primary cards pass the brushes PB1, PB2 during the third cycle of the machine, the equal condition is created in the sequence unit and the selector unit because the first and second primary cards are identically numbered with the first secondary card. Relays R23 and R26 will both be energized during the third cycle and circuits will be set up to energize the magnet PFM as follows: line wire W1, magnet PFM, also relay HSR3, contacts R14A, the primary basis setup switch marked P in Fig. 1c, contacts R26A, R15E, R23B, HSR4A, CR1, and R17B to line wire W2. The eject magnet EM will also be energized by a circuit extending from line wire W1, magnet EM, contacts R12C, the eject basic setup switch E, contacts R23A,

HSR4A, CR1, R17B, to line wire W2. The secondary feed magnet SFM is not energized, because contacts R15A, R25A, R27A are open, consequently the operation of the machine will be the same as described above in reference to Fig. 20 during the fourth cycle in which the first primary card is fed from the eject station and the second and third primary cards are compared with each other and with the first secondary card. It is at this point that the machine operates differently and causes one cycle of the machine time to be saved.

The third primary card is numbered 2, whereas the second primary card is numbered 1. While the equal condition will again be created in the selector unit, a high second primary condition will be created in the sequence unit, causing relay R25 to be energized as well as relay R23. The latter has the same effect as described above of energizing the primary feed magnet and the eject magnet EM, causing the primary feed to continue in operation.

Additionally, the closure of contacts R25A causes the secondary feed magnet to be energized over a circuit as follows: line wire W1, magnet SFM, contacts R9B, the secondary basic setup switch S, contacts R25A, R26B, R23B, HSR4A, CR1, and R17B, to line wire W2. Thus, the primary and secondary feed mechanisms operate together and the second secondary card numbered 2 and the third primary card numbered 2 are fed to the eject cycle during the next cycle. The first secondary card, numbered 1, and the last primary card, numbered 1, are fed together, one over the other, and ultimately will drop into the pocket MS in this relation.

The same condition prevails again since the fourth primary card is numbered 3 with the result that the primary and secondary cards numbered 2 will be fed together. During the cycle in which the two cards numbered 2 are fed from the eject station, secondary card numbered 4 will be compared with primary card numbered 3 which causes the low primary card condition to be created in the selector unit and the high second primary condition be again created in the sequence unit because of the fact that the primary card numbered 3 is followed by the primary card numbered 4. This time the relays R22 and R25 are energized together. Contacts R22B close and cause the energization of magnet PFM by a circuit as follows: line wire W1, magnet PFM, contacts R14A, the primary basic setup switch, contacts R22B, HSR4A, CR1, and R17B, to line wire W2. No circuits can be established through the secondary feed magnet, notwithstanding the closure of contacts R25A, because of the fact that the contacts R23B remain open. Thus, the secondary feed stops and the primary feed continues. As a result the primary card numbered 3 will be fed from the eject position during the next cycle and the primary cards numbered 4 and 6 will be compared with each other and with the secondary card numbered 4. This again causes the secondary card to resume feeding because of the equal condition in the selector unit and the change in the primary card numbers.

It will be seen from the foregoing that the sequence unit enables the machine to anticipate the fact that the equal secondary card can be fed during the next cycle and causes the secondary card to be fed one cycle earlier. It is thus possible to effect a considerable saving in time where there are a large number of matching primary and secondary cards with or without multiple primary cards because feeding of the primary cards is only stopped when it is necessary to feed a secondary card which does not match with any primary card where, as in the cases discussed with reference to Fig. 18, the secondary feeding mechanism remains inactive until the card following the last primary card which agrees with the secondary card has passed brushes PB2. Such card must then be held in the eject position until the secondary card which belongs with the preceding group of primary cards has been ejected. In a theoretical case where there are no odd cards on the secondary side, that is, cards which do not match with any primary card and no multiple secondary cards, considerable saving in time is effective because both feeds remain in continuous operation except during the period in which primary cards are passing the brushes which do not match with the secondary card.

d. If it should happen that there are multiple secondary cards, that is, there may be groups of more than one secondary card with the same control number, this saving in time is offset by the fact that the primary feed mechanism must stop long enough to permit the last of a group of multiple secondary cards to be ejected. This will be illustrated by an example.

When, as will be seen later, there are likely to be multiple secondary cards and secondary cards are to be selected, the multiple secondaries and select switch designated "Mult. S & S" (Figs. 1*c* and 16) may be plugged to the "on" position, thereby breaking the connection which ties the contacts R23A, R22A with the contacts R22B. This makes it possible to energize the eject magnet without energizing the primary feed magnet PFM. It will be assumed that at the start there are two primary cards and two secondary all numbered 1 instead of one secondary card so numbered.

During the third cycle of the machine, the equal condition will prevail in both comparing units and the operation of the machine will be the same as described above, causing the first primary card to be ejected and the second and third primary cards to be compared with the first secondary card during the fourth cycle of the machine. During this cycle, the high secondary primary condition is set up in the sequence unit and the equal condition in the selector unit as before, causing the first secondary card numbered 1 and the second primary card numbered 1 to be fed together and ejected during the fifth cycle. At this point, it is necessary that the mode of operation of the machine change because of the fact that there is still a secondary card numbered 1 to be fed which will pass the brushes SB during the fifth cycle. It is desirable, but not absolutely necessary to retain the reading of the last primary card numbered 1 for one or more cycles, in the present case one, because there is only one additional secondary card to be merged with the first secondary card and the two primary cards numbered 1. It is desirable to stop the feed on the primary side of the cards numbered 2 and 3 before such cards can pass the brushes PB1, PB2 but at the same time, it is desirable to feed the last primary card numbered 1. This result is obtained by energizing the magnet EM but not the magnet PFM during the fourth cycle when the first secondary card and the last primary card feed together. During the fourth cycle, the equal condition in the selector unit causes relay R23 to be energized and, since relay R25 is also energized, the closure of contacts R25A causes the

secondary feed magnet to be energized. The closure of contacts R23A causes the eject magnet to be energized by a circuit traced from line wire W1, magnet EM, contacts R12C, the eject basic setup switch E, contacts R23A, HSR4A, CR1, and R17b to line wire W2. The plugging of the "Mult. S & S" switch to the "on" position prevents the closure of contacts R23A from establishing a circuit to the primary feed magnet and thereby stops feeding of cards with the passage of the second primary cards numbered 1 past the brushes PB2 insofar as the cards numbered 2 and 3 are concerned. However, the energization of the eject magnet EM allows the ejection of the second primary card numbered 1 and, of course, the first secondary card numbered 1 is ejected. Since the magnet PFM was not energized, the magnets PR1, PR2 will not be energized and the reading of the second primary card numbered 1 will be retained in the selector unit and will not be erased, nor will the feeding of primary cards be resumed until such time as a higher numbered secondary card is sensed. Thus, whether there should happen to be only two secondary cards numbered 1 or more than two, the secondary cards will continue to feed and be compared with the retained reading of the second or last primary card numbered 1.

It will be seen that a gap has been created in the feeding of primary cards in consequence of the fact that it has been necessary to stop the feeding of primary cards until all of the secondary cards of the same number have been ejected. Thus the saving effected by feeding of a primary and a secondary card together is offset by the lost time resulting from stopping the feeding of primary cards to permit the disposition of the multiple secondary cards.

Operations in which the feeding of cards is the same as in a merging operation but which do not require the selection of secondary cards, do not require the use of the "Mult. S & S" switch. In other words, in a simple merging operation, such as has been described in connection with Figs. 18 and 19, it is not necessary to use the "Mult. S & S" switch even though there may be several secondary cards which have the same control number as a group of primary cards. In a case like this, the use of the sequence unit effects the saving of time because when the first secondary card is fed simultaneously with the last primary card, the primary feed magnet will be energized along with the eject magnet by a circuit which extends through the contacts R23A, the "Mult. S & S" switch and the basic setup switch P to the magnet PFM. For example, in dealing with the four cards numbered 1 in the last illustrative example, the last primary card numbered 1, the first primary card similarly numbered, and the primary cards numbered 2 and 3 will all be fed together and during the following cycle, primary card numbered 2 will be compared with the second secondary card numbered 1. The feeding of secondary cards will be continued in consequence of the low secondary card condition created in the selector unit. Regardless of the condition which exists in the sequence unit, the primary feed will then stop and the secondary cards will continue to feed. The reason for this is that relays R22 and R23 are not energized on a high second primary condition and the energization of one of them is required to cause the feeding of primary cards. Thus, the cards are fed to the maximum extent possible and no time is lost in the operation of the machine. When the selection of secondary cards other than a single secondary card is required, the necessity for retention of the reading of the primary card which controls a selection causes a gap to be created to the extent of at least one cycle which offsets the one cycle saving in time which results from feeding the primary and secondary together. In other words, when the resumption of feeding of primary cards takes place, the eject station will be empty whereas under other conditions, the eject station will always be filled by a primary card.

e. Fig. 20 shows in solid lines the plugging necessary to merge secondary cards with primary cards and at the same time select, that is, reject all primary cards which do not have a corresponding secondary card. In order to simplify the description and more clearly show the change necessary to produce this result, the basic setup switches are plugged to the "on" position and, with the exception of the plug wires shown at the top in Fig. 20, the plugging is identical with Fig. 18, consisting the dotted basic setup plugging there shown as replacing the equivalent solid line plugging at the top. Insofar as the feeding of cards and the disposition of the secondary cards and the matching primary and secondary cards are concerned, the operation of the machine will be the same as explained with reference to Fig. 18 with either form of plugging there shown.

It will be assumed that the cards are numbered the same as described above in reference to Fig. 18, that is, as follows: primary cards numbered 1,1, 2, 3,4, 6,7 and secondary cards numbered 1, 2, 4, 5, 6. It will be noticed that in this illustrative arrangement of cards, the primary card numbered 3 has no corresponding secondary card and it is desired that this card be set aside. In order to effect this result, a plug wire is inserted so as to render the magnet PRM responsive to a low primary condition in the selector unit. During the eighth cycle of the machine, the primary card numbered 3 passes the brushes PB2 and will be compared with secondary card numbered 4 which passes the brushes during the seventh cycle. As a result, a low primary condition will be created in the selector unit and a circuit will be established from the plug socket PS37 (Figs. 1*d* and 20), the plug wire and plug socket PS50, magnet PRM to line wire W1.

During the ninth cycle of the machine, the blade 308 will be in the raised position (Fig. 3*b*) in consequence of the energization of magnet PRM and the primary card numbered 3 will ultimately become deposited in the pocket PRJ. Since it is evident that the secondary card numbered 4 cannot be fed until a primary card which is equal to or higher than secondary card numbered 3 is sensed by brushes PB2, it is evident that the low primary card condition will always prevail when a primary card is fed which does not have a corresponding secondary card. The primary is always the first to feed of a pair of equal primary and secondary cards. The same result could be obtained with the plugging shown in solid lines in Fig. 18c by inserting an additional plug wire between the plug sockets PS37 and PS50.

Considering the arrangement of the cards just mentioned, it will be noted that the secondary card numbered 5 has no corresponding primary card and for a merging operation it is desirable that this card be deposited in the pocket MS along with the other secondary cards. In some cases, it is desired to match cards but keep them separate in the pockets SP and MS, respectively, and

there will always be a corresponding primary card for each secondary card in the primary side of the machine. In other words, it may be desired to select all the primary cards which match secondary cards but keep the matched primary cards separate from the secondary cards and unmatched primary cards. This result may be obtained by causing the magnet SRM2 to be energized each cycle of the machine whereby all secondary cards become deposited in the pocket SP. This is accomplished by inserting a plug wire as shown by a dotted line at the top of Fig. 20. Insofar as the feeding of the cards is concerned, the operation of the machine will be unchanged but the secondary cards, owing to energization of magnet SRM2 will always be deposited in the pocket SP by passing between the blades 306, 307 after leaving the eject station. The corresponding primary cards will be deposited in the pocket MS and the unmatched primary cards will be deposited in the pocket PRJ.

f. The same general scheme of plugging used in Fig. 20 may be used to select unmatched single secondary cards, that is, if there is no more than one unmatched secondary card per control number. In the illustrative arrangement of cards considered in conjunction with Fig. 18, it will be noticed that the secondary card numbered 5 does not have a corresponding primary card, that is, it is unmatched. During the eleventh cycle of the machine, this card would ordinarily be compared with the primary card numbered 6 and a low secondary condition will be created which will cause the secondary to feed and ultimately eject the card numbered 5 to the pocket MS. In other words, a low secondary condition may indicate, in the illustrative group of cards, that a secondary card is unmatched, as all primary cards which could possibly have been matched have already been ejected without, however, an equal condition having been created. By inserting a plug wire between the plug socket PS39 and PS51 instead of between plug sockets PS37 and PS50, as shown by the dot-dash line in Fig. 20, a low secondary card will always be rejected and become deposited in the pocket SRJ. If desired, both the dot-dash plugging and the solid plugging at the top in Fig. 20 may be used together to cause both unmatched secondary and unmatched primary cards to be rejected. With the addition of the dotted plugging, the matched secondary cards will become deposited in the pocket SP. Without the dotted plugging, the matched secondary cards will be deposited in the pocket MS with matched primary cards. Thus, with the plugging shown in Fig. 20, considering both the dotted and the dot-dash plugging, a two-pocket distribution for the secondary cards and a two-pocket distribution for the primary cards is possible as follows: Unmatched primaries—pocket PRJ; matched primaries—pocket MS; matched secondaries—pocket SP; unmatched secondaries—pocket SRJ.

In order to select the unmatched secondaries on a low secondary condition, using only the selector unit, it is necessary to modify the operation of the machine when equal secondary cards are encountered. This is because a secondary card which matches one of a group of primary cards is ejected in consequence of the low secondary condition created when the next highest primary card is fed past brushes PB2 while the matching secondary card is to be held at the eject station. Obviously, such a card must not be rejected on a low secondary condition. In order to correct this difficulty, it is necessary to plug the secondary feed magnet SFM to operate upon the equal condition as shown by the lower dot-dash line in Fig. 20. This has the effect, when the first equal condition is created as, for example, when the first primary card numbered 1 and the secondary card numbered 1 are compared, of causing the secondary card to feed along with the first primary card with the result that the secondary card will become deposited in the pocket MS between the first and second primary cards.

In cases where it is not necessary that the secondary cards follow the corresponding primary card or cards, this mode of operation may be used. But where selection of unmatched secondary cards is desired and it is also desired that the matched secondary cards follow the corresponding primary cards, it is necessary to use the sequence unit as will be made clear in the following section dealing with operations in which both units are used.

Section 4.—Operations involving the use of both comparing units

a. In section 3 a number of operations were described which can be accomplished by means of the selector unit alone. In some cases, those where the primary cards are arranged in numerical order, the sequence unit can be used as a means of checking the sequence of the primary cards. The operation of merging cards both with and without selection of primary and secondary cards were discussed and in only one case was the sequence unit required. This case involved the use of the sequence unit as a means of reducing the number of machine cycles necessary to merge cards; however, the sequence unit is not essential to a merging operation. In the simple merging operations mentioned, it is possible to also select any number of unmatched primary cards by making use of a low primary condition in selector unit as a means of energizing the magnet PRJ. In this simple merging operation, the primary cards are fed when the equal or low primary condition is created in the selector unit and the secondary cards are only fed when the low secondary condition is created. Since reliance is made on the low secondary condition to feed secondary cards, even when they are equal to primary cards which have preceded them into pocket MS, it is not possible to use the low secondary condition alone as a means of differentiating matched from unmatched secondary cards, that is, those which do not have corresponding primary cards.

When a low secondary card is fed past the brushes SB, and reaches the eject station, its control number will be entered on the secondary side of the selector unit. When this occurs, either of two conditions may prevail. The primary card with which it is compared and which is fed during the same cycle to the eject station may have a lower number than the secondary card, in which case the primary feed will continue until all primary cards which are lower in value than the secondary card have been ejected. Ultimately a primary card must be sensed by the brushes PB2 and fed to the eject station which has a control number higher than the low secondary card. There can not possibly be a primary card which is equal to the low secondary card because of the initial assumption that the low secondary card has no corresponding primary card. Under this condition, it would be safe to utilize a low secondary condition as a means of selecting the secondary card and caus-

ing it to be deposited in the pocket SRJ. This merely requires the insertion of the solid line plug wire at the top in Fig. 21*a*. But there is one condition under which the above plugging would prove useless because it would cause a card to be selected which matched a primary card.

Let it be assumed that a matching secondary card is fed to the eject station and compared with the primary card which is the last of a group of primary cards having the same control number as the secondary card. Bearing in mind that only the selector unit is in use, the feeding of primary cards continues for another cycle until the next higher primary card is compared with the matching secondary card which belongs with the preceding primary card. Naturally, this would create a low secondary condition, yet this card actually should not be selected because it belongs with one or a group of primary cards. It is necessary, therefore, if a merging operation is to be performed which requires the selection of unmatched secondary cards and the matching secondaries must follow the primaries, that the sequence unit be used to further control the feeding of secondary cards.

When the sequence unit is utilized as was explained in the preceding section, the last primary card of a group and the corresponding secondary card which may be the first of a group, are fed together by energizing the eject magnet EM and the secondary feed magnet SFM together. However, provided the "Mult. S & S" switch is on, the primary feed mechanism is caused to stop owing to failure to energize the magnet PFM, with the result that the next highest numbered primary card will be held between the two rows of brushes PB1, PB2 and the reading of the last primary card will be retained in the selector unit. Thus it is impossible to have the low secondary card condition occur in respect to the secondary card which belongs with a group of primary cards.

As long as secondary cards continue to agree with the retained reading of the ejected primary card, the equal condition created in the selector unit causes the secondary cards to continue to feed until the next highest secondary card changes the conditions in the selector unit from equal to high secondary card. This causes the resumption of the feeding of primary cards, and, if the primary card which was previously held between the two rows of brushes PB1, PB2 is found to be higher in number than the secondary card which caused the change, the low secondary condition will be a true indication that the secondary card has no corresponding primary card. The effect of the sequence unit is to prevent the primary card which, in comparison with the low secondary card, sets up the low secondary condition from feeding past brushes PB2 until all equal secondary cards have been started toward the pocket MS. Thus, when both units are in use, a low secondary condition always indicates that the secondary card involved has no corresponding primary card.

When it is desired to merge the cards and select the unmatched secondary cards, the solid line plugging of Fig. 21 is utilized. This scheme of plugging is substantially the same as in Fig. 19 but differs in that the addition of the solid line plugging at the top of Fig. 21, causes the magnet SM1 to be energized each time a low secondary condition occurs with the result that the secondary card is not only fed but passes over the blades into the pocket SRJ. It may be desired to select the unmatched primary cards at the same time in which case the dot-dash line plug wire shown in Fig. 21 may be inserted. Under these conditions, the creation of a low primary condition in the selector unit indicates that the primary card has a lower number than the secondary card and such card will be deposited in the pocket PRJ. Insofar as the feeding of the cards is concerned, and the selective control of the comparing units, it will be the same as described in reference to Fig. 19.

b. Under some conditions, it is desirable to remove all of the unmatched cards and match the primary and secondary cards which have identical control numbers but keep such matched cards separate in the pockets MS and SP. In order to do this, a plug wire is inserted as shown by the dotted line at the top of Fig. 21. This causes magnet SM2 to be energized every cycle and, unless magnet SM1 operates, all secondary cards will go to the pocket SP. It will be understood that magnet SM1 is dominant and will cause cards to go to the pocket SRJ notwithstanding the energization of magnet SM2 because of the effect of the lug on the armature for magnet SM1. In other words, the invariable impulse to magnet SM2 will be superfluous when the magnet SM1 is also energized.

Section 5.—Card counting device

a. In the preparation of cards for gang punching operations, it is desirable that each punched card which is to control the punching of subsequent cards be followed by the cards which are to be punched. Usually, an operation of this kind requires a definite number of punched cards to be prepared from each master card. With the plugging arrangement shown in Fig. 22*a*, it is possible to accomplish the collation of punched cards with cards to be punched. This operation may be used for other purposes where it is necessary to place a predetermined number of cards behind each card of a file. In the present case, the comparing units are not being used as the operation of the machine is to be controlled solely by the card levers and the counting device, the holes having no significance.

In Fig. 22*a* the units and tens count relays have been plugged to cause the insertion of 52 secondary cards after each primary or master card. In this figure, the lines with the arrow heads leading from plug sockets 65, 66 to the 5 and 2 plug sockets 68, 67, respectively indicate the path of the current through the wipers and segments of the units and ten relays when the count of 52 is reached. It is thus possible to trace in Fig. 22*a* the circuit which is closed when the 52d secondary card has been inserted after a primary card. The cards to be inserted are placed in the secondary hopper and the punched master cards in the primary hopper.

When the start key is depressed and held depressed, the cards feed for two cycles until the secondary card reaches the eject position and the first primary card or master card arrives between the two rows of brushes PB1, PB2. At this point, it is necessary to stop feeding of the secondary cards and keep the secondary feed from operating until the first primary card reaches the eject station in order to insure that the first primary card will enter the pocket MS ahead of the first secondary card. This condition must be met only in the start of the machine, owing to the fact that it takes three cycles to get a card from the primary

hopper to the eject station and only two to get a secondary card to the eject station.

During the second cycle of the machine when the first primary card passes the brushes PB1, the card lever contacts PCL1 close and the card lever relays controlled by PCL1 will be energized as in the normal operation of the machine in merging. This causes the energization of relay R15, closing its contacts R15A and enabling a circuit to be established from the plug socket PS70 to the coil of the primary cycle delay relay R33P. The initial feeding of the secondary cards takes place in consequence of a circuit established through contacts R12E and R4A. The energization of the coil R33P of the primary cycle delay relay sets up provisionally the primary cycle delay circuit but the secondary feed magnet SFM cannot be energized through the normally closed contacts R32B of selector relay R32 because these contacts are in series with the contacts R16B of the primary cycle delay relay. Owing to this fact, the secondary feed magnet is not energized during the second cycle and the secondary feed will stop.

During the third cycle, the first primary card passes the brushes PB2 and a circuit is closed through the contacts R16B of primary cycle delay relay from plug socket PS24, the contacts R32B of relay R32, contacts R16B and the secondary feed magnet SFM. Thus, the secondary feed mechanism is started in operation but the primary feed magnet will not be energized because the opening of the contacts R12E will stop the feeding of primary cards, contacts R32B being still open. However, eject magnet EM, as shown in Fig. 22*a*, is plugged for invariable energization with the result that the first primary card and the first secondary card will be ejected together during the fourth cycle. From this point on the cycle delay relay is maintained in energized condition, because of the fact that the coil R16H of this relay is maintained in energized condition by commutator PC2 operated by the primary feed mechanism. This commutator stops in closed circuit condition, whereby, as soon as the primary feed stops, the cycle delay relay will remain energized and, by keeping its contacts R16B closed, keep the secondary feed operating continuously until relay R32 is energized to stop the feeding of secondary cards.

The energization of relay R32 is controlled by the units and tens count relays and will be energized only when a count of 52 is reached. The units count relay R45P is energized once per secondary feed cycle and for this purpose, an impulse is emitted from plug socket PS77 each time a secondary card is fed from the eject station which impulse goes to the contacts R31B of relay R31 and thence to plug socket PS71 and the coil of relay R45P. The effect of the plugging arrangement shown in Fig. 22*a* is to place the relay R45 in parallel with the secondary feed magnet whereby relays R45P and magnet SFM are energized together beginning with the second cycle of the machine.

When cards pass the brushes SB, the card lever relay R8 is energized, closing its contacts R8B to place the relay R45P in parallel with magnet SFM. When magnet SFM receives the impulse during the third cycle which restarts the feeding of secondary cards, relay R45P will also be energized and close its contacts R45B (Fig. 1*e*). This enables a circuit to be closed to the units count magnet UCM when contacts CR9 close during the fourth cycle and is traced as follows: line wire W1, magnet UCM, contacts R42B, R45B, CR9, line wire W3, and contacts R17D to line wire W2. Assuming that the count relays are in restored condition, this causes the units count relay to advance one tooth space from the 0 segment to the 1 segment. At the same time, this causes the contacts UC to open. The first primary card and the first secondary card are ejected together during the fourth cycle and the count starting with this cycle continues for 51 cycles until 52 secondary cards have been counted.

The relays R43, R44 are energized once per cycle over a circuit which extends from line wire W1, the coils of such relays, contacts CR10, line wire W3, and contacts R17D, to line wire W2. Consequently, the contacts R43A, R44A are opened and contacts R43C, R44C closed once per cycle. Initially these contacts have no effect but control the transfer from the units relay to the tens relay when 0 is reached during the course of the count. The contacts R43D, R44D also open and R43B, R44B close once per cycle but likewise have no effect. When the count of nine is reached, the wiper 605A moves onto the 9 segment of the units count relay. Subsequently, the closure of contacts R43B, R43C has the effect of energizing relay R42P in parallel with relays R43, R44. The coil R42H is energized by closure of contacts R42A. Relay R42P closes its contacts R42D and opens contacts R42B, thereby switching the circuit through contacts R45B to the tens count magnet TCM through the double plug between plug socket PS63, PS64 and the contacts R41B. As a result, the next time contacts R45B close, that is, with the counting of the tenth card, the tens count magnet TCM will be energized. Contacts R42C also will be closed at this time and the units restoring magnet URM will be energized in parallel with the tens count magnet, thereby causing the units relay to restore to the 0 position in readiness for the next count of one. As a result of these operations, the tens count relay will be advanced to the 1 position and its contacts TC will open.

This action continues until the count of 52 is reached. The count of 2 on the units relay has no effect because, until the wiper assembly of the tens relay reaches the 5 segment, no control circuit can be established by the count relays by way of the contacts R43D, R44D; although these contacts are opened and closed each time a unit is counted. On the count of 52, however, the reclosure of the contacts last mentioned permits a circuit to be established to the coil of relay R32 which traces from plug socket PS75 to plug socket PS65, contacts R44D, the wiper assembly of a tens relay, the 5 segment, plug sockets PS68 to PS66, contacts R43D, the wiper assembly of the units relay and its 2 segment, the plug wire between plug sockets PS67 and PS53, and the coil of relay R32, to line wire W1.

The energization of the relay R32 causes the contacts R32B to open and stop the feeding of secondary cards and its contacts R32A to close and start the feeding of primary cards. At the same time, both restoring relays R39P, R40P will be energized because these relays as shown in Fig. 22*a* are plugged in parallel with the primary feed magnet with the result that the primary feeds a cycle and both count relays are restored automatically to the starting position. This happens because relays R39P, R40P close contacts R39B, R40B to energize magnets URM, TRM in parallel with relays R43, R44.

The restoring of the count relays breaks the

circuit to the coil of the relay R32. This causes the primary feed mechanism to stop and the secondary feed mechanism to restart and also restarts the counting sequence beginning with 1. The foregoing sequence of operations keeps up continuously, feeding one primary card and inserting 52 secondary cards, until the last primary card leaves the hopper PH. When this last primary card passes the brushes PB1, the card lever contacts PCL1 open but have no effect on the primary cycle delay relay because the coil of this relay can still receive an impulse from plug socket PS69. Thus, the last primary card will start under the brushes PB2 and the cycle delay relay will be kept energized to this point.

During the cycle when the last primary card is passing brushes PB2, the card lever contacts PCL2 open, thereby cutting off further impulses from the plug socket PS69 to the coil of the primary cycle delay relay R33P. However, the deenergization of the card lever relays comes too late to cause the deenergization of relay R16 during that cycle and, when the primary feed mechanism stops in consequence of the operation of relay R32, the cycle delay relay R16 remains energized. It will be remembered that commutator PC2 stops in closed circuit condition at 226° (Fig. 10*a*), thereby maintaining the relay coil R16H energized through the contacts R16A. This is necessary in order to insure that 52 secondary cards will be inserted behind the last primary card.

As long as cards continue to feed on the primary side of the machine, relay R47 remains energized, holding contacts R47B open, thereby preventing the energization of relay R31. The contacts R31B enable the count to continue to 52 but, as soon as the last card leaves the primary brushes, the card lever contacts PCL2 open but do not have any immediate effect because the primary feed stops with relay R16H and the card lever relays R12 to R15 inclusive remain energized due to the timing of commutator PC2. When the last count of 52 is reached and relay R32 is again energized, another impulse will be given to the primary feed magnet PFM through the contacts R32A, causing the primary feed mechanism to operate one idle cycle without feeding cards since there are none to be fed on the primary side of the machine. This has the effect of causing the card lever relays R12 and the primary cycle delay relay R16H to become deenergized during this cycle; thereby enabling the relay R47 which is in parallel with relays R12, R13 to close its contacts 47B. This enables an impulse to be given to the relay R31 with the result that the closure of contacts R31A energizes the magnet SM1 and the opening of contacts R31B interrupts the count circuit. This stops counting and at the same time diverts the surplus secondary cards remaining in the hopper into the pocket SRJ. Thus, when the primary runs out of cards, the proper number of secondary cards will be inserted after the last primary card and more than the required number cannot be inserted in consequence of the energization of the magnet SM1 at the proper time.

b. In Fig. 22*b* there is shown the plugging of the machine to accomplish very nearly the same general result of inserting a predetermined number of primary cards ahead of a single secondary card. In this case, the plugging of the device, insofar as the count relays are concerned, is the same as in Fig. 22*a*, relay R32 being energized each time the count reaches 32, for example. In this case, the primary cycle delay mechanism is not needed because the primary cards are to go first as in the normal operations of the machine in merging and matching cards. The run-in cycles, that is, the start cycles, will be the same as described in section 1. In this case, however, the run-out of primary cards must be controlled and for that reason, the coil of relay R31 is plugged to plug socket PS74 and, since the primary cards will be counted, the contacts of this relay are plugged to plug socket PS69 instead of PS77. The restoring magnets are plugged in parallel with the secondary feed magnet and the eject and primary feed magnets likewise operate in parallel.

During the second cycle of the machine, the first secondary card will arrive at the eject station while the first primary card will reach this point during the third cycle. The energization of the card lever relays R12, R13 by the passage of cards past brushes PB2 causes contacts R47A to close and condition the machine for counting the primary cards, the counting circuit in this case extending through contacts R47A and R31B to the coil of relay R45P. The secondary feed cannot operate because the contacts R32A are open but the primary feed can operate because contacts R32B are closed. The eject magnet will also be energized with result that after the third cycle, primary cards continue to feed and the numbering begins with the first one which leaves the eject station during the fourth cycle.

When the count of 32 is reached, relay R32 will be energized as described in conjunction with Fig. 22*a* but in this case, the closure of its contacts R32A will start the secondary feed and the opening of its contacts R32B will stop the feeding and ejecting of primary cards. The energization of the secondary feed magnet will also cause the energization of the magnets URM, TRM to restore the counting relays in readiness for another count of 32. This, of course, causes the deenergization of the relay R32 and confines the operation of the secondary feed to one cycle. When the last secondary card passes brushes SB, the opening of the card lever contacts does not have any immediate effect as the secondary feed mechanism stops with relays R8, R9 in energizing condition. Thus, contacts R9G remain open and for the time being prevent energization of the relay R31.

The primary now continues to feed for another count of 32 and at the end of this count of 32, the secondary feed mechanism will be restarted in the normal way and will cause the deenergization of the card lever relays R8, R9. The closure of contacts R9G causes relay R31 to be energized, thereby interrupting the count circuit through the contacts R31B and energizing the magnet SM1 through contacts R31A. It will thus be seen that under the run-out conditions, the operation of the machine when counting primary cards is substantially the same as when operating to count secondary cards.

At this point with reference to both Figs. 22*a* and 22*b*, it is desired to mention that when the machine nears the end of the primary or secondary cards respectively, the operator should take care to make sure that there are slightly more secondary or primary cards respectively, than the last inserting operation requires in order to make sure that the full complement of cards will be inserted on the run-out. As explained above, the surplus secondary or primary cards will be deposited in the pockets PRJ, or SRJ, respectively.

c. In Fig. 22*c* there is shown an arrangement

for feeding a predetermined number of primary cards ahead of a predetermined number of secondary cards. Illustratively, two primary cards are to be fed ahead of four secondary cards. When the machine plugged as in Fig. 22c, the primary feed mechanism will operate two times and stop; then the secondary feed mechanism will operate four times and stop. The coil of relay R45 is connected in parallel with the secondary feed magnet SFM through the contacts R8D of the secondary card lever relay R8, while the tens count relay R46P is similarly connected in parallel with the primary feed magnet through the contacts of contacts R47B of relay R47 which, it will be remembered, are energized every time the relays R12, R13 controlled by card lever contacts PCL2 are energized.

In this case, the run-in cycles are the same as in a merging operation, that is, two secondary cards feed the secondary feed stops then three primary cards feed and the primary feed stops, provided, of course, there are no special controls plugged to continue feeding. When the secondary card arrives at the eject station, the closure of contacts R8D will place the secondary feed magnet in parallel with relay R45P. Similarly, when the first primary cards arrive at the eject station, the closure of contacts R47B will place the relay R46P in parallel with magnet PFM.

It will be noticed in Fig. 22c that the primary feed magnet is plugged in series with the contacts R31B, R32B, whereby the tendency is to continue the feeding of primary cards; therefore, the feeding of primary cards will be continuous after the card lever contacts PCL2 have closed. With the feeding of the first primary card from the eject station during the fourth cycle of the machine, the relay R46P will be energized (Fig. 1e) and the closure of contacts R46B will cause the tens count magnet TCM to be energized when contacts CR9 close. Thus, the tens relay will be stepped one unit for each primary card fed. When the tens relay has counted two, a circuit will be established from line wire W1, the coil of relay R32, the 2 segment of the tens relay, contacts R44D, CR2 and R17B to line wire W2. The energization of relay R32 causes the deenergization of the primary feed magnet and the energization of the secondary feed magnet by the opening of contacts R32B and closing of contacts R32A, respectively. The secondary feed mechanism now starts to operate and causes the pulsing of the relay R45P with each impulse to the magnet SFM as was explained in reference to Fig. 22a, paragraph a, and following. The tens relay is not restored for the time being.

When the units relay has counted 4, the relay R31 is energized in the same general way as explained in reference of Fig. 22b, paragraph b, and following. This not only stops the feeding of secondary cards by opening the contacts R31B but also energizes both the units and the tens restoring magnets TRM, URM because of the closure of contacts R39B, R40B. Relays R39P, R40P are first energized by the closure of contacts R31A and in turn they close their contacts R39B, R40B, respectively. The energization of both the restoring magnets causes both the units and tens relays to return to the zero position, thereby deenergizing both relays R31, R32. The reclosure of contacts R31B, R32B of these relays restarts the primary feed mechanism and also causes the machine to resume counting of primary cards and also stops the feeding of secondary cards in consequence of the opening of contacts R32A. Thus, the feed mechanisms alternate feeding two primary cards and four secondary cards, until it is desired to terminate the operation of the machine.

d. In Fig. 22d there is shown a plugging arrangement to enable the insertion of variable numbers of secondary cards after single primary cards under control of holes perforated in the primary cards to determine the number of secondary cards to be inserted. In other words, each primary card contains holes representing any value from 1 to 99 to determine the number of secondary cards which are to follow the primary card containing such number. For this purpose the emitter E is used for entering in the secondary side of the selector unit, during each secondary feeding cycle, the amount standing in the units and tens relays. The amount which is punched in the card is entered in the primary side of the selector unit and is retained there until the required number of secondary cards has been fed. The magnet PR3 is energized with each energization of the primary feed magnet PFM, whereby the primary side of the selector unit will only be reset when the primary cards feed. The secondary side of the selector unit is restored by the energization of magnet SR every cycle. The count relays are restored only when the primary feed is operative.

With the plugging of relay R29 as shown at the top of Fig. 22d, this relay will be energized to stop the feeding of secondary cards and start the feeding of primary cards whenever the count reached by the units and tens relays is equal to the amount entered in the primary side of the selector unit under control of the primary card. Thus, the selector unit is plugged to energize relay R29 whenever the equal condition occurs in this unit. Initial cycles of the machine are the same as in a normal merging operation, both the first primary and first secondary cards arriving at the eject station before the counting operations are started. The circuits for starting the counting and controlling the run-out will be the same as described above in reference to Fig. 22a beginning with paragraph a, using relay R32 instead of relay R31.

With reference to Fig. 1e, the impulse emitter turns at the rate of one revolution per cycle continuously and each cycle tends to send impulses of current through the tens and units counting relays by successively making the segments of the counting relays live in parallel synchronously with the sensing of cards. In other words, brush 501 touches the "9" spot of the emitter and thereby renders all of the "9" segments of the units and tens relays alive when the card brushes sense 9 on the cards. After the count of 1, occurring when the first secondary card is ejected, a circuit will be established through units magnet SM1 by the emitter E which is traced as follows, it being remembered that relays R43, R44 close their contacts R43B, R44B once per cycle automatically: line wire W1, the coil of magnet SM1, the wiper assembly of the units relay, the "1" segment 621 of such relay, the "1" segment of emitter E, brush 501 of the emitter, to line wire W2 through the circuit breakers CB1 to CB4 and contact CR3. Magnet SM1 causes the associated sector 373 to stop at "1." The relay R42P cannot be energized because contacts CR10 which cause the energization of relay R43 close too late in the cycle. The tens magnet SM1 is energized at "0" but has no effect as the sector for this magnet stops at zero anyway. The result is that each cycle the selector unit on the secondary side

receives the count up to that point in the cycle. After nine units have been added in the units relay, a transfer occurs to the tens relay and, if more than nine cards are to be inserted after each primary card, the emitter E will also pulse the magnet SM1 for the tens or second order of the selector unit at "1" in the cycle.

The comparing unit will take a low secondary condition each cycle until the count reaches the number recorded in the primary card, at which time the selector unit will take an equal setting, thereby energizing relay R29. The opening of contacts R29B will stop the feeding of secondary cards and start the feeding of primary cards. Since restoring magnets URM, TRM are controlled by relays R39B, R40B which are plugged in parallel to the primary feed magnet, both the relays will be restored automatically with the feeding of the next primary card. This, of course, will cause the selector unit to take another unequal reading during the primary feeding cycle, deenergizing relay R29 and causing the feeding of secondary cards to again take place. Thus, for each primary card the number of secondary feeding cycles is determined by the number punched in the primary card.

When the last primary card is reached, the primary card lever contacts PCL2 will open but the primary feed will stop with the card lever relays in energized condition, so that the relay R32 will be maintained in energized condition until the feeding of primary cards is restored upon the required number of secondary cards being fed behind the last primary card as explained above. The deenergization of the card lever relays causes relay R32 to be energized and interrupts further counting operation and at the same time energizes magnet SM1 as explained above in reference to Fig. 22*a*. Since the capacity of the counting device is limited to two digits, not more than 99 cards can be inserted after each primary card.

e. In Fig. 22*e* there is shown a somewhat similar arrangement for inserting variable numbers of primary cards ahead of single secondary cards. Insofar as the operation of the machine is concerned, there is little difference from the arrangement shown in Fig. 22*d*, the primary feed being plugged to operate normally instead of the secondary until interrupted by necessity for feeding a single secondary card. In view of this it is believed that the operation of the machine with respect to Fig. 22*e* need not be described.

f. Fig. 22*f* shows the plugging of the machine which makes it possible to insert heading cards as a preliminary to the printing of the statements on the tabulating machine. There are certain classes of work where items must be listed upon separate sheets and it frequently happens that the number of items will exceed the capacity of the sheets, making it necessary to print the remaining items on a second or third sheet. An example is the listing of the holdings of stocks and bonds in trust accounting. Such statements often run to three or four sheets, particularly with large trusts where the holdings may be very considerable. It is desirable in the printing of statements that each separate sheet be identified, as with the names of the trust, the name of the trustee, and the trust account number.

The number of heading cards required will be determined by experience. It is necessary to prepunch a special file of heading cards for use in this operation and every account number or at least every active trust account will be represented by a series of heading cards. The number of heading cards for each number may vary according to past experience with that trust to determine the number of sheets which will be likely to be required to list all holdings of stocks and bonds. Thus, one trust might require six heading cards while another trust might only require one. The heading cards are placed in the primary hopper and the file of detail cards representing the holdings of stocks and bonds will be placed in the secondary hopper of the machine.

Basically, this is a merging operation since it is necessary to merge the heading cards with the corresponding detail cards for the same account number but it differs from an ordinary merging operation in that the secondary cards to be inserted are inserted ahead of the primary cards at intervals. In other words, when the equal condition is created, instead of feeding the primary cards upon the equal condition being first established, the primary feed mechanism is stopped but the primary card which creates the equal condition is ejected along with the first secondary or detail card and the feeding of secondary cards then continues until the required number of secondary cards have been fed and another primary card must be fed. Thus the matching primary cards will be placed at regular intervals instead of being all inserted ahead of the secondary cards.

For this purpose, it is necessary to modify the merging operation by removing the control of primary feeding from the primary basic setup switch and placing it under control of one of the selector relays which in turn will be controlled by the counting device, whereby the primary cards will feed only once for each series of secondary cards fed under control of the counting device.

In Fig. 22*f*, except for the primary basic setup switch, the effect of the plugging is to render the machine operative for a normal merging operation, the closed contacts of the relay R32 controlling the normal feeding of secondary cards.

It may happen that certain trusts have been closed since the last time statements were prepared and that there are no detail cards present but there will be heading cards for the trust account which has been closed. Such cards should be rejected as they are no longer of value in the heading card file. On the other hand, it may happen that new trusts have been created and detail cards will be present but there will be no corresponding heading cards and such cards must be rejected as otherwise the statements would be prepared without heading cards which, of course, is undesirable. In this case, the rejection of the detail cards indicates the necessity for preparing heading cards before the statement printing operation begins. Such heading cards will be prepared and inserted by hand at the proper points and the cards restored to their proper place in the file of merged heading cards and detail cards before tabulating operations have begun.

The problem has three phases, the first of which is to merge the matching heading and detail cards. The second phase is to eliminate all detail cards for which there are no heading cards. A third phase involves rejection of the unmatched or unused heading cards, for example, one account may require only one page, that is, there may be fewer items to go on that page than its capacity, which means that only one heading card will be required for that account.

Initially, the operation of the machine is sub-

stantially the same as described in reference to Figs. 20*a* and 21, the machine rejecting any unmatched detail cards or heading cards until a match is reached. This match will be obtained with the feeding of the first primary or heading card which corresponds to the first secondary or detail card of a given account. This causes the selector unit to take an equal setting and energizes the selector relays R28, R29 in parallel. Contacts R28A close and start the counting of secondary cards. Contacts 29*a* close and start the feeding of secondary cards which in the present case are the detail cards. Since there is another heading card of the same account number following the first heading card, the sequence unit will take an equal setting, but will not cause feeding of the primary feed mechanism in the normal way because primary basic setup switch is plugged "off."

With the ejection of the first secondary card and heading card, the machine starts to count the cards by circuits similar to those described in reference to Fig. 22*a*. When the count of 25 is reached, relays R31, R32 will be energized. Since the equal condition still exists in the selector unit and relays R28, R29 are energized, the energization of relays R31, R32 will cause a circuit to be established to the primary feed magnet and also to the restoring relays R39P, R40P, traced from plug socket PS24, through contacts R29A, R31A, and the coils of relays R39P, R40P and magnet PFM in parallel. The opening of contacts R31B interrupts the circuit through the secondary feed magnet SFM, notwithstanding the fact that contacts R29A are still closed. The primary cards feed one cycle only because the restoration of the counting device causes the deenergization during this cycle of relays R31, R32. This causes the starting of the secondary feed again for another group of detail cards of the same account number. This action continues as long as detail cards of the same account number continue to feed.

It is very unlikely that the secondary cards of a given account number will be evenly divisible by the number of heading cards. Consequently, the count will not reach 25 on the last group of secondary cards with the result that a secondary card of higher number will be fed past brushes SB, thereby creating a high secondary condition. At this point, it is necessary to stop the feeding of secondary cards exactly as would be the case had the counting been carried to 25 and reject all the remaining heading cards, if any, belonging to that account since they will be of no further use.

The high secondary condition causes primary reject magnet PRM to be energized and at the same time causes relay R30 to be energized. This closes a circuit to the primary feed magnet PFM and the restoring relays R39P, R40P, thereby restoring the counting device to starting position. However, there is no primary card in position to be ejected and, for the time being, the energization of magnet PRM has no effect. Since the secondary unit is no longer in equal condition, relays R28, R29 become deenergized, thereby stopping the counting of secondary cards and stopping the feeding of secondary cards by the opening of contacts R28A, R29A, respectively. However, the primary cards commence to feed and the reading of the secondary card which caused the high secondary condition is retained in the selector unit.

If the primary card which was held between the two rows of brushes PB1, PB2 is a surplus primary card which is not necessary, the high secondary condition will again be created when this card passes brushes PB2 upon the resumption of primary feeding with the result that this card will be rejected and at the same time another primary card will take its place. If the next primary card has the same control number, it too will be rejected and the rejection of primary cards will continue until all of the surplus cards have been rejected and the primary card which matches the secondary card now being held at the eject station is fed. This restores the operation of counting and feeding of secondary cards.

Thus, it will be seen that as far as the surplus cards are concerned, the operation of the machine is very similar to a merging operation with the rejection of unmatched primary cards. If the cards intervening between the matched surplus primary cards and the next succeeding matching primary card have different control numbers from the surplus cards and the next matched, these cards too will be rejected. For example, if there was a surplus card for account number 12 and the next matching card is numbered 15 to correspond with the secondary card being held in the eject position, the primary cards numbered 13 and 14 will be rejected.

During the operation of the machine, it may happen that there are detail cards present for which there are no primary cards. This condition will always be manifested by a low secondary condition which will cause the energization of relay R28 and will cause the secondary reject magnet to be energized. Insofar as the unmatched detail cards are concerned, the operation of the machine is the same as in any ordinary merging operation with selection of unmatched secondary cards, the feeding being controlled through basic setup switch S. When this condition occurs, relays R31, R32 will be deenergized, permitting the normal basic setup circuit to cause secondary feed to be made through contacts R32*b* functioning as part of secondary basic setup switch S.

g. In Fig. 22*g* there is shown a somewhat similar arrangement for the purpose of inserting a plurality of heading cards at spaced intervals. An illustration of the desirability for such an operation is in the insertion of heading cards for invoicing purposes where it is desirable to head each sheet of an invoice with the name and address, account number and other data. In this case, the heading card file consists of groups of sets of heading cards for each account number which are arranged in order by account numbers and each group will comprise a plurality of sets of heading cards, each set containing a name card and several cards for the street address, city and State, according to circumstances. The last heading card of each group will contain an X hole, for example, in column 60.

Except when a primary or heading card matches a secondary or detail card, the operation of the machine is the same as for a merging operation with selection of unmatched primary and secondary cards, the contacts R11B of the primary X selector relay R11 functioning as the primary basic setup switch and contacts R31B of selector relay R31 functioning as the secondary basic setup switch to control the feeding of primary and secondary cards which do not match. Until a match is obtained between a primary and a secondary card, the open contacts R29A of relay R29 will prevent counting of secondary cards.

Upon the feeding of the first primary and first secondary cards, which match, the equal condition will be created in the selector unit, thereby energizing relay R29. This condition will occur when the primary and secondary cards, respectively, move into the eject station. Continuous feeding of the primary cards and cessation of the feeding of the secondary cards result through the functioning of the basic setup circuits as in an ordinary merging operation until the last card of a set containing the X passes brushes PB2. The energization of the primary X selector relay R11 by opening contacts R11B interrupts the feeding of primary cards and, by closure of the contacts R11A, establishes a circuit from primary basic setup switch plug socket PS27 through the contacts R11A, contacts R30B, R32B to the secondary feed magnet SFM. This starts the feeding of secondary cards and stops the feeding of primary cards but the eject magnet EM will be energized in the normal way through the eject basic set-up switch E. Consequently, the card with the X hole will be fed with the first secondary card.

Since the counting of cards with the plugging shown in Fig. 22*g* is dependent upon the delivery of an impulse of the secondary feed magnet, while primary cards are feeding, no circuits are established from the plug socket PS77 through contacts R29A during the feeding of the first set of heading cards. However, as soon as the impulse is given the magnet SFM to start the feeding of secondary cards, an impulse is given to the relay R45P in parallel with the secondary feed magnet as explained before herein. The result is that counting of secondary cards continues until 14 secondary cards have been fed.

Since the commutator P2 stops in closed circuit condition, the primary X selector relay R11 will be maintained in energized condition at the time of the stoppage of the primary feed, thereby maintaining contacts R11A closed. The selector unit and sequence unit are attempting to control the feeding of primary cards as in a normal merging operation because of the fact that there are still heading cards, corresponding to the same account number, to be fed, and the equal condition created in the sequence unit tends to pulse the primary feed magnet. With the plugging arrangement shown in Fig. 22*g*, the secondary feed magnet is pulsed instead, the effect of the primary basic set-up circuits being temporarily transferred to the secondary feed magnet.

Upon the count of 14 being reached, relays R31, R32 will be energized in the manner hereinbefore explained, resulting in the closure of contacts R31A, R32A. This causes a circuit to be established from plug socket PS27 through the contacts R11A which are still closed, contacts R30B, R32A to the primary feed magnet. This restarts the feeding of primary cards and also, through the energization of relays R39, R40 causes the restoration of the count relays. The feeding of the first primary card of the next set to the eject station causes the deenergization of the X selector relay R11 and the deenergization of relays R31, R32, the latter occurring in consequence of the restoration of the counting relays.

It has been assumed up to this point that there is another set of heading cards of the same number to be inserted behind further secondary cards in which event the operations described in the preceding paragraphs will be repeated until another set of heading cards and the remaining secondary cards have been inserted at the proper place.

It might happen, however, that a heading card with the X hole is the last heading card of a group comprising several sets and it will be immediately followed by a higher numbered first heading card of the next group. This will cause the sequence unit to assume the high second primary condition which, in combination with the equal condition in the selector unit, in an ordinary merging operation would be a signal to restart the feeding of the secondary card to run the remaining secondary cards of a group into the pocket MS. This means that the plug socket PS32 would be made live instead of plug socket PS27, whereby the impulse which is to start secondary feeding operations must come through the secondary basic setup switch S.

Since relay R31 is now energized, the contacts R31B will act as the secondary basic setup switch and cause the secondary feed magnet to be deenergized to restart the feeding of secondary cards. The feeding of secondary cards will continue until the last one of the same account number has passed brushes SB and another secondary card of higher number is sensed. In view of the fact that the account number of the first of the secondary and heading cards is still being retained in the selector unit, the latter will take a low primary condition which will result in the restarting of the primary feed and energization of the magnet PRM. This will have no effect as there is no primary card in the eject station. This same thing would happen if all of the sets of heading cards are not required as might be the case, for instance, if three sets of heading cards were provided and there were only twenty-three secondary cards calling for only two sets of heading cards. Usually, however, with the feeding of the next succeeding primary card, an equal condition will be reestablished in the selector unit with the result that magnet PRM will not be again reenergized. It is possible, however, that there might not be any detail cards corresponding to the next succeeding primary cards and in which case such card would be rejected because then the selector unit would remain in the low primary condition until the next match is reached.

After the counting of secondary cards is started, it will be seen that several conditions must be satisfied when the secondary cards of the same account number become exhausted. There are only two possible conditions when the last X punched heading card of a group comprising several sets passes the brushes PB2. In the event that there should be an insufficient number of heading cards as would be the case if say, only three sets of heading cards were provided and there were fifty-six detail cards, the excess detail cards will be rejected in consequence of a low secondary condition, exactly as if they were unmatched because when the heading cards become exhausted, a new one of higher number will be fed into position to compare with the remaining detail cards.

h. In Fig. 22*h* there is shown a plugging arrangement which is useful for the preparation of cards for a gang punching operation needed in railroad accounting. Loaded railroad freight cars are often routed over several different lines to their destination, making it necessary for reports to be prepared as a basis for demurrage charges for the use of the cars on the different lines and possibly division of the freight rates. A single

card is prepared if not more than a predetermined number of roads must be traveled by the car and used as a master card for gang punching further cards, if necessary, when there are more than the predetermined number of roads to be traveled by the car.

In the present case, it will be assumed that a single card will be prepared when three roads or less are to be involved and that one additional card is to be made for each road in excess of three. Thus if car No. 98081 has to travel over seven railroads to reach its destination, a single card punched 98081 will be made out for the first three roads and used to punch four more cards for the remainder. The number of roads involved in each car routing will be indicated on the master card by a number punched in say, column 54 (Fig. 22*h*). Blank cards will be placed in the secondary hopper and the master cards will be placed in the primary hopper on top of a finder card having the number "3" punched in column 54 and also having an X hole. The X hole as shown by the plugging in Fig. 22*h*, arbitrarily appears in column 39 of the finder card. This finder card functions in the following manner to enter the value 3 into the secondary side of one order of the selector unit.

During the second cycle of the machine, when the "X" punched finder card passes the brush PB1 for column 39, the restoring magnet SR will be energized by a circuit as follows: Line wire W1, magnet SR (Fig. 1c), the plug wire between plug sockets PS33 (Fig. 22*h*) and plug socket PS11, contacts R11A of primary class selector relay R11, the plug wire between plug sockets PS12—PS24; contacts HSR4A, CR1, R17B; to line wire W2.

Insofar as the feeding of cards is concerned initially, a secondary card and a primary card will feed to the eject station. This will bring the finder card and the first blank card to the eject station in readiness for further operation by the machine. During the passage of the finder card past brushes PB1, the magnet SR is energized to reset the secondary side of the selector unit in consequence of closure of contacts R11A as traced above. The magnets PR1, PR3 will be energized to reset the primary side of the selector unit and the secondary primary side of the sequence unit. The first primary side of the sequence unit will be reset in consequence of the plug wire which is inserted in plug sockets PS24 and PS35. This will happen during the second cycle of the machine.

Next the finder card passes the brushes PB2 during the third cycle of the machine and the number "3" which is punched in such card in column 54 will be entered into both sides of the selector unit and also in the second primary side of the sequence unit. Since the secondary side of the selector unit will not be reset during future cycles, the number "3" will be retained therein throughout the remainder of the operation of the machine. This will cause an equal condition to be created in the selector unit and will cause a high second primary condition to prevail in the sequence unit.

During the third cycle the emitter E tries to energize magnet PM2 through the units counting relay but cannot close any circuits because there is no provision to do this, the emitter not being wired to the zero segment of the units count relay. In any event, since this relay now stands at zero, the energization of magnet PM2 at this time would have no effect because the sector 374 would reach zero at the time the magnet was energized. Thus, during the third cycle of the machine neither of the relays R29, R31 which are the only ones plugged for control by numerical relationship, can be energized with the result that the primary feed magnet will be energized through the closed contacts R11B and another cycle will take place to feed another primary card to the eject station past brushes PB2.

For convenience this will be termed the first primary card to simplify explanation and, among other things will have a number punched in column 54 indicating the number of lines involved in the routing of a particular freight car. It will be assumed for the moment that this card has a "3" punched in column 54. The value "3" is entered into the primary side of the selector unit by energizing magnet SM2 and in the second primary side of the sequence unit by energizing magnet PM1. This again sets up an equal condition in the selector unit and the low secondary condition again prevails in the sequence unit because the emitter is still unable to energize magnet PM2 in consequence of the fact that the condition of the units count relay has not been changed. Again, neither of the relays R29, R31 will be energized and the primary will feed for another cycle to bring the second primary card into the eject station.

If this card should be perforated "2" or "1," the same events will occur because, while the selector unit takes a low primary setting, relay R29 can only be energized on a low secondary condition and the sequence unit still will assume a high second primary condition. Thus, whenever the number punched in the card is equal to or lower than the value which has been previously inserted in the selector unit under control of the X punched card, which number is also represented by the plugging of the tens counting relay, passes brushes PB2, the primary feed will continue for another cycle.

Now let it be assumed that a primary card is sensed which has the value "5" perforated in column 54. After this card, there should be inserted two blank cards. When this card passes the brushes PB2, the value 5 will be entered in the primary side of the selector unit and in the second primary side of the sequence unit. This will cause a low secondary condition to occur in the selector unit but the high second primary condition will still prevail in the sequence unit. In this case, relays R29, R30 will be energized because these relays are both rendered responsive to a low secondary condition with the result that contacts R29A close and start counting in the tens relay by a circuit which is traced as follows: plug socket PS24, contacts R11A, R31B, R32B, and relay R46P, to line wire W1. The closure of contacts R30A causes a somewhat similar circuit to units count relay R45P. This starts the counting in the tens and units relays by circuits traced hereinbefore in reference to Fig. 22c. This is possible because the contacts designated CR1, CR2, etc. operate continually and the magnets UCM, TCM can be pulsed notwithstanding the fact that neither feed mechanisms are in operation.

Three "idle" machine cycles take place during which no feeding operations are performed but the units and tens relays are stepped to the value "3." This enables a circuit to be established through the tens relay from plug sockets PS75 to the coil of relay R32, thereby closing contacts R32A. Since no feeding operations have taken place, the comparing units remain in the posi-

tions determined by the numbers read into such units during the primary feeding cycle with the result that relay R29 is still energized and enables a circuit to be established from plug socket PS24, through contacts R29A, R31B, R32A to the secondary feed magnet SFM. This starts the feeding of secondary cards.

During each of the idle cycles, the emitter E reads a value from the units counting relay into the first primary side of the sequence unit. Thus, with a count of 1, the sequence unit becomes set at 1; with the count of 2, at 2, etc. However, the value 5 has been read into the secondary primary side so that this unit, at the time the equal condition is created in the selector unit with the count of 3, still is in the low secondary condition.

With each secondary card fed a unit is counted in the units counting relay but due to the opening of contacts R32B, the counting in the tens relay is stopped. When the count reaches 5, which will occur when two secondary cards have been fed, the sequence unit will attain the equal condition because magnet PM2 will be energized with the count of 5 through the units count relay, thereby causing the sequence unit to take an equal setting, energizing relay R31. This opens contacts R31B and stops counting in the units relay, and the feeding of secondary cards. At the same time, through closure of contacts R31A, the feeding of primary cards restarts.

The restarting of the primary feed not only causes the magnets PR1, PR3 to be automatically energized along with magnet PR2, but also causes the restoration of the counting relays. The value 3, however, is retained on the secondary side of the selector unit. The sequence unit will be restored and take a new reading on the second primary side thereof from the next primary card and this same reading will be entered in the primary side of the selector unit. The subsequent operation of the machine will be dependent on the satisfying of either or one of the three conditions discussed above, that is, whether the number representing the routing of the car is equal to, less than, or greater than 3. When the last primary card is fed, the primary feed mechanism will stop and the necessary number of secondary cards will be inserted in the same general way as explained hereinbefore in describing the run-out conditions, relay R28 being energized to close the contacts 28A to continue secondary feeding and magnet SRM1 is energized at the same time to cause the surplus secondary cards to run into the pocket SRJ.

i. The machine can be used for the purpose of verifying consecutive numbering of cards, inserting one blank card for each duplicate number or missing number and selecting all but the last of a group of identically numbered cards. The plugging for this operation is shown in Fig. 22*i*, using the selector unit for the number checking part of the operation and the sequence unit for detecting duplicates. Blank cards are placed in the secondary hopper and the file cards in the primary hopper. The latter is supposed to have a single card for every control number between the first and last cards and no duplicates. However, numbers may be missing, duplicated, or not in order due to errors in filing the cards.

The run-in cycles are the same as for a merging operation, a primary and a secondary card feeding to the eject station during the third and second cycles respectively. During the third cycle the number on the first primary card is entered into the primary side of the selector unit and in the first primary side of the sequence unit. Also the number in the secondary primary card is entered in the second primary side of the sequence unit. Assuming there are no duplicates of the first primary card, the sequence unit assumes high second primary condition. Emitter E tries to enter a number in the secondary side of the selector unit through the units and tens relays but cannot because they are at zero. Relay R28 is energized and the closure of contacts R28A starts feeding secondary cards by closing a circuit to magnet SFM through the contacts R30B. Relay R10 is also energized during the next secondary feed cycle and, by closing its contacts R10A, causes energization of magnet SRM2. However, the first secondary card is thereby deposited in pocket MS for reasons made clear hereinafter. Counting also starts by the closure of the contacts R47C controlled by card lever contacts PCL2 thus the first secondary card is counted 1, the second 2, etc., and they are deposited in pocket SP.

Nearing the fourth cycle of the machine, the units relay steps to 1 and subsequently the emitter E enters this value in the secondary side of the selector unit for comparison with the number already entered in the primary side from the first primary card which is still at the eject station.

This action is repeated, the number in the selector unit increasing by one with each secondary feed cycle until the numbers agree. Since only two orders of the control number are used for the checking operation, not more than 99 secondary cards will be fed before the units and tens counting relays equal the number on the first primary card. If the first card happened to be numbered 9756, secondary cards will be fed until 56 has been entered in the counting relays and transferred to the secondary side of the selection unit. This means that 56 secondary cards will be fed. The first will be deposited in pocket MS because the circuit for relay R10 must be made through contacts SC3 which will not close until the secondary card has already started under blades 306, 307.

When the selection unit has 56 read into the secondary side thereof, relay R28 is not reenergized to continue feeding of secondary cards, but magnet PFM is energized to restart feeding primary cards. The counting also continues and a unit is added for each primary card to keep the amount in the counting relays. The cards following 9756 should be 9757, 9758, 9759, etc. and if this is true, the equal condition in the selector unit will be present during the primary feed cycles in which these cards feed to the eject station. This magnet PFM is repeatedly impulsed. When card No. 9800 is reached, no numbers will be read on either side of the selector unit thereby continuing the equal condition which maintains the feeding of primary cards.

Four types of error may exist, namely; (1) one or more cards may be missing at one place; (2) a low card may be misplaced behind one of higher number; (3) a high card may appear between two cards which are consecutive in number but lower in number; and (4) there may be two or more cards with the same number.

Condition 1 would be present if card No. 9756 is followed by 9758. When this happens the counting relays will reach 9757 when card 9758 feeds to eject. This causes the low secondary condition in the selector unit which starts feeding of secondary cards. One more unit will be counted with the feeding of the secondary card

to bring the counting relays to 58. This will restart feeding of primary cards to eject a card 9758. Magnet SRM2 will not be energized for the reason explained above and the blank card will follow card 9756 into pocket MS. Card 9758 will fall on top of the blank card.

It may happen, however, that card 9758 is missing also in which case the secondary feed continues but magnet SRM2 will be energized since commutator SC3 will now be turning whereby the second blank card will be deposited in pocket SP. Thus when a whole group of cards is missing only one blank card is inserted to mark the gap.

Condition 2 will be present if card 9756 is followed by card 9754. When the latter feeds to the eject station, 54 will be entered in the primary side and 57 in the secondary side of the selector unit thereby producing the low primary condition. Relay R32 will be energized opening contacts R32B to stop counting. The relays R39, R40 will be energized to cause restoration of the units and tens relays. The starting sequence must now be repeated to bring the counting relays to 54 because no impulses have been delivered to magnets SFM, PFM during the cycle in which card 9754 feeds to the eject station. The emitter E, the cams operating the contacts CR1 and the comparing units are still operative, consequently 54 will remain in the primary side of the selector unit, but nothing will be entered in the secondary side which will be cleared by an impulse to magnet SR from plug socket PS24 caused by contacts CR1. This recreates the low secondary condition, reenergizing relay R28, deenergizing relay R32, restarting feeding of secondary cards, and preparing a circuit from magnet SRM2.

A secondary card will now be fed to pocket MS followed by 53 cards to pocket SP before the counting relays reach 54 to restore feeding of primary cards to bring the next primary card to the eject station.

Theoretically the condition of the file after card 9754 indicates cards 9755, 9756 are missing although they actually precede card 9754. However, the machine has "forgotten" tens and proceeds to operate, as for condition 1 to feed a blank card between cards 9754, and 9757 and count to 57 before feeding the latter.

If card 9756 is followed by cards 9759, 9757, 9758 condition 3 will exist when 9759 is fed to the eject station and 59 is compared with 57. First the machine will function as for condition 1 to insert a blank card, count to 59, and eject card 9759. Next the machine feeds card 9757 and counts 60 thereby again recreating a low primary condition. The operation of the machine will be the same as above for condition 2, that is, the feeding of cards will stop, the counting relays restored, counting will be resumed until 57 is reached, to release the card 9757, and a blank card will be fed ahead of this card.

If card 9756 is duplicated, an equal condition will be recreated in the sequence unit when the first of the two cards reaches the eject station. This energizes relay R29, R30 closing contacts R30A to energize magnet PFM and closing contacts R29A to transfer the counting impulse to magnet SFM. Magnet PRM will also be energized. As a result counting will stop owing to the opening of contacts R29B, a blank card will be fed, and the first of the two duplicate cards will be deposited in pocket PRJ. The second duplicate card 9756 will be fed to the eject station and usually will be followed by card 9757 restoring the high second primary condition in the

sequence unit indicating ascending sequence. Relays R29, R30 will be deenergized to restart counting and interrupt feeding of secondary cards. The selector unit remains in equal condition during both of the cycles in which cards 9756 pass brushes PB2 to continue feeding of primary cards until card 9757 reaches and passes the eject station. The counting relays count to 57 when card 9757 moves into the eject station to enable card 9758 to be fed to the eject station.

Relay R28 and magnet SRM1 are energized when the last primary card leaves brushes PB2 to cause all remaining blank cards to be fed to pocket SRJ. The blank cards deposited in pockets SRJ, SP may be removed from time to time and used to keep hopper SH supplied.

Section 6.—Run-out controls

When operations are performed which involve the use of both feed mechanisms, it is desirable that the last cards on both sides of the machine be properly treated, particularly operations like matching or merging with selection of primary or secondary cards. General conditions of stoppage, insofar as the effect of the hopper contacts and card lever contacts on relay R17P, R17H are concerned, have been discussed in section 1. But the selection and selective feeding of the last cards depends on the condition of the basic setup switches or selector relays R28 to R32 which in turn depend on the conditions in the sequence and selector units. The last few cards can always be removed from the machine after contacts PHC, SHC have stopped the machine by using the run-out key ROK.

In a merging operation the cards should always occur in ascending sequence. When the last card passes brushes PB1, the card lever contacts RCL1 will open and relay R7 will be deenergized at 236°, after the last card has started toward brushes PB2. The opening of contacts R7B would prevent circuits through the brushes PB1 causing zeros to be entered in the second primary side of the sequence unit. Since a number would be read into the first primary side from brushes PB2, the sequence unit would take a low second primary condition whereas in the normal operation of the machine an equal or high second primary condition would prevail. Also when the last primary card has been ejected the primary side would tend to take zero settings creating a low primary condition in the selecting unit. The remaining secondary cards would obviously be unmatched cards which should be selected when the machine is conditioned for selecting unmatched secondary cards. But a low secondary or equal condition is necessary for selecting unmatched or equal secondary cards. The same situation would be true if the last secondary card is ejected and primary cards remain, a low secondary condition being created in the selector unit where an equal or low primary condition should be present.

In order to force the comparing units to take the proper positions provision is made for causing them to operate as if a mythical higher numbered card had been fed. This means consists of relay contacts R4B, R8B, R9C, R2B, R7E and commutators PC1, SC1.

When the last primary card leaves hopper PH the machine will stop feeding cards and the operator must press and hold down run-out key ROK to continue the feeding of cards. Contacts R2B close but have no immediate effect since primary card and secondary card lever relays R7, R8 are

still energized holding contacts R7E, R6B open. The card lever contacts PCL1 open when at 198° of the cycle when the last card passes brushes PB1 allowing contacts R7E to close. Since contacts CR3 are open at this time, magnets PM1 cannot be energized. During the next card cycle the last primary card passes brushes PB2 and the number therein is entered in the two comparing units in the usual way. Since contacts R7E are now closed, the closure of contacts PC1 at "9" (355° to 15°) causes all the plugged magnets PM1 to be energized stopping all sectors 373 of the sequence unit at "9." The effect is the same as if a card numbered 9999---- had been the last primary card and the sequence unit will take the high second primary condition.

Similarly, magnets PM2, SM2 will be energized at "9" when the last primary card is ejected and contacts R6B close due to the opening of contacts PCL2. This produces a low secondary condition which will cause the selection of the remaining secondary cards. The primary feed mechanism stops after contacts PCL2 open and, since resetting of the primary side of the selector unit is dependent on feeding a primary card for another cycle, the nines are retained in the primary side of the selector unit until the end of the run. These nines will be automatically cleared by the action of relay R19 the next time the machine is started by means of the start key.

When the secondary cards run out first, contacts SCL1 open as the last card moves to the eject station, causing contacts R5A to open. Since contacts R4B are now closed because the secondary hopper is empty, commutator SC1 will close circuits to all plugged magnets SM1 at "9" and cause sectors 373 to stop at "9." This creates a low primary condition which is maintained until the end of the run and causes the selection of the remaining primary cards.

When either hopper becomes exhausted and the run is to be terminated, the operator removes the remaining cards if any, from the other hopper and runs out those in course of feed by means of the run-out key ROK. There will always be at least two cards in both feeds and possibly three on the primary side, depending on whether or not a primary card is at the eject station.

The feed interlock switch must be put in the "on" position by inserting a double plug in plug sockets PS13, PS14 when both feeds are to be used for operations like merging with selection of unmatched primary and/or secondary cards. Initially, the insertion of the plug causes relay R20 to be pulsed once per cycle by contacts CR8. As soon as cards fill the feed mechanisms up to the eject station and card lever relays R8, R12, R14 become energized, the relay R20 is deenergized opening contacts R20A, R20B and closing contacts R20E. This conditions the selector unit for selective energization of relays R22, R23, R24 and any relays or magnets plugged to the plug sockets PS37, PS38, PS39.

There is a possibility that the last card on either side of the machine may actually bear the number 9999----. In this case such a card obviously is an unmatched card or it would have been fed with the corresponding cards on the other side of the machine. But such a card will create an equal condition in the selection unit because nines will be entered on both sides of this unit. When either side of the machine runs out of cards either contacts R8C will be closed (secondary feed exhausted first) or contacts R12D, R16C will be closed (primary feed exhausted first). Relay R20 is thereby energized and the equal impulse to relay R23 will be emitted to both relays R22, R24 and plug sockets PS37, PS39. This results in the selection of any unmatched last cards which happen to be numbered 9999----.

The various hopper and card lever relay contacts which control the feed magnets, eject magnet, restoring magnets, and interlock relay are so disposed in the circuits, and the holding circuits for these relays are so designed, that the proper feeding of cards is assured during the final operating cycles of each run. For example, contacts SHC open when the secondary hopper is emptied but contacts SCL, R9B make it possible to energize magnet SFM to continue feeding of secondary cards. Next contacts SCL open at "6" in the cycle while the last secondary card is passing brushes SB but relay R9 holds the contacts R9B closed until the last secondary card is started from the eject station even when a primary card must first be fed. Similarly, contacts PCL, R2A, R14A, R12A ensure feed impulses for magnet PFM and relay HSR3 when the primary runs out of cards. Furthermore, contacts R12E, R13A, R14A ensure impulses for magnet SFM when starting and when running out the last secondary card after the last primary card has been ejected.

In starting the machine, contacts R19B, R19D close and energize restoring relays R39, R40 to cause the energization of the restoring magnets URM, TRM. This resets the counting relays to zero before cards can feed past the brushes. Contacts R20C open after the card lever contacts have closed and prevent run-out circuits for the counting unit from being accidentally established.

While there has been shown and described and pointed out the fundamental novel features of the invention as applied to a single embodiment, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention. It is the intention therefore to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. In a machine of the class described, a plurality of means to feed separate successions of records, a record counting device, means to place the record feeding mechanisms under selective control of the record counting device for automatic selection in rotation, and means to condition the counting device to predetermine the number of records in each succession fed by each of said feeding mechanisms.

2. In a machine of the class described, a record feeding mechanism, means settable to cause a variable number of operations of the feeding mechanism in a continuous succession, a second record feeding mechanism, a record counting device for the second feeding mechanism, means controlled by the counting device for causing a predetermined number of feeding operations of said second feeding mechanism between successions of operations of the first feed mechanism, and for alternately selecting the feeding mechanisms for operation.

3. In a machine of the class described, two record feeding mechanisms, a record counting device, means controlled by said device for selectively causing said mechanisms to operate alternately, and means to at will preset said device to vary the number of records fed by any one or both of the feeding mechanisms.

4. In a machine of the class described, two record feed mechanisms, means to count records settable to predetermine the number of records in a succession fed by each feed mechanism and means controlled by said counting means for selectively controlling the two feed mechanisms to cause a succession fed by one feeding mechanism to follow a succession fed by the other feeding mechanism.

5. In a machine of the class described, a plurality of record feeding means, a record counting device with means to predetermine at will the number of records to be fed by any feed mechanism, and means controlled by the counting device for causing the feed mechanisms to operate successively to feed alternate successions of counted groups.

6. In a machine of the class described, two record feeding mechanisms, each for feeding a succession of records, a record counting device, manual means to preset the counting device to count a predetermined number of records for each succession fed by each feed mechanism, means controlled by said device for selectively controlling the feed mechanisms to cause them to alternate in feeding successions of records, and means to automatically reset the counting device after the required number of records have been fed.

7. In a machine of the class described, two converging feed mechanisms, a common receptacle for receiving the records fed by said mechanisms, a record counting device, and means controlled by the counting device for causing each of the feed mechanisms to operate successively a predetermined number of times in advance of the other to deposit succession comprising a predetermined number of records in said pocket ahead of each succession of records fed by the other feeding mechanism.

8. In a machine of the class described, two converging record feeding mechanisms, a common receptacle for receiving the records fed by said mechanisms, a record counting device, means to predetermine the number of records fed by each feeding mechanism, means controlled by the counting device for rendering the feeding mechanisms alternately operative, each a predetermined number of times, according to the predetermining means whereby to feed alternating successions of records, and means to automatically reset the counting device after the each feeding means has operated the required number of times.

9. In a machine of the class described, two converging record feeding mechanisms, means to receive the records from both feeding mechanisms, a record counting device having two sections, means to condition the sections to separately count the records fed by each feeding mechanism, means to predetermine the number of records counted by each section, and means rendered operative by each section associated with a feeding mechanism to start the other feeding mechanism after the required number of records have been fed.

10. In a machine of the class described, a plurality of record feeding mechanisms, manually settable means to limit the number of records fed by each feeding mechanism to any one of a predetermined number of quantities, and means controlled by the limiting means for preventing operation of more than one feeding mechanism at a time.

11. In a machine of the class described, two record feeding mechanisms for feeding two separate batches of records, means to select one of said

mechanisms for operation; and means to count the number of records in a succession fed by a selected feeding mechanism and operative when a predetermined number of records have been fed by the selected feeding mechanism, to actuate the selecting means to cause the other feeding mechanism to operate to feed a succession of records, said counting means having means presettable at will to determine the number of records counted and fed by each feeding mechanism selected for operation.

12. In a machine of the class described, two record feeding mechanisms, each for feeding a separate batch of records; means to count the number of records fed by one feeding mechanism, means to count the number of records fed by the other feeding mechanism, and means controlled by counting means to alternately select the feeding mechanisms and the counting means therefor for operation to feed and count groups of records alternately.

13. In a machine of the class described, two record feeding mechanisms, each for feeding a separate batch of records; means to count the number of records fed by one feeding mechanism, means to count the number of records fed by the other feeding mechanism, means controlled by counting means to alternately select the feeding mechanisms and counting means therefor for operation to feed and count groups of records alternately, and means to preset each counting device to predetermine the number of records to be fed by the associated feeding mechanisms.

14. In a machine of the class described, a plurality of record feeding mechanisms each for feeding a separate batch of records, a plurality of counting devices each associated with one of said feeding mechanisms for determining the number of records to be fed by said feeding mechanisms, and selecting means controlled by said counting devices for causing the record feeding mechanisms and the associated counting devices to be operative in rotation.

15. In a machine of the class described, a plurality of record feeding mechanisms, each for feeding a separate batch of records; a plurality of counting devices, each associated with one of said feeding mechanisms for determining the number of records to be fed by said feeding mechanisms; selecting means controlled by said counting devices for causing the record feeding mechanisms and the associated counting devices to be operative in rotation, and means to preset each counting device to determine the number of records counted and fed by the associated feeding mechanism.

16. In a machine of the class described, a plurality of record feeding mechanisms for feeding to a common destination a plurality of separate batches of records; a record counting device having a plurality of sections, means to condition the sections to separately count the records fed by each feeding mechanism, and means to preset each section of the counting means to enable different numbers of records to be counted by the different sections and operative to limit the number of records fed by each feeding means; and selective means controlled by the counting device for limiting operation of the feeding means to one at a time and operative when a predetermined number of records have been fed, to stop said feeding mechanism and select another feeding mechanism for operation.

17. In a machine of the class described, two

record fed mechanisms, each for feeding a succession of records to a path common to both feeding mechanisms; a plurality of counting devices, each associated with a record feeding mechanism, means to preset the counting devices to render each record feeding mechanism operative to feed a succession comprising a predetermined number of records to the common path, and means controlled by the counting devices for causing one of the two feeding mechanisms to be selected for operation after the other feeding mechanism has fed the requisite number of records to the common path.

18. In a machine of the class described, two converging record feeding mechanisms, a common receptacle for receiving the records fed by said mechanisms, a record counting device and means controlled by the counting device for causing first one and then the other of the feeding mechanisms to operate a predetermined number of times to deposit alternate successions of records in said common receptacle, each succession having a predetermined number of records; and means to reset the counting device and cause an operation of one feeding mechanism after the required number of records have been fed by the other feeding mechanism.

19. In a machine of the class described, a plurality of record feeding mechanisms each having a magnet for causing operation of the feeding mechanism, said feeding mechanisms feeding records to a common path; circuits for said magnets, a selection relay for selecting said circuits one at a time; record counting means, including a stepping relay associated with each feeding mechanism and having means to advance said relay one step for each record fed by the associated feeding mechanism, and means controlled by the stepping relays to close circuits to the selecting relay after each feeding mechanism has fed a predetermined number of records to thereby select another feed mechanism for operation.

20. In a machine of the class described, two record feeding mechanisms for feeding successions of records to a common path, each feeding mechanism including a magnet for causing operation of the feeding mechanism; a selection relay operative to select one or the other of said magnets, means to close circuits to said magnets through said relay according to which of said magnets is selected by said relay; a record counting device having two sections, each section associated with one of the feeding mechanisms and including circuit closing means rendered operative when any section has counted a predetermined number of records; means controlled by the circuit closing means of one of said sections, when the associated feeding means has fed and counted the number of records predetermined by said section, to energize the selection relay to cause the other feeding magnet to be energized and the magnet of the operative feeding mechanism deenergized, and means controlled by the circuit closing means of the second relay for causing the selection relay to select the first feeding mechanism after the second feeding mechanism has counted and fed a predetermined number of records.

21. In a machine of the class described, a plurality of record feeding mechanisms for feeding to a common destination a plurality of separate batches of records, each feeding mechanism including a magnet for rendering the feeding mechanism operative; a record counting device having a plurality of sections, each section having circuit closing means; means to condition the sections to separately count the records fed by each feeding mechanism, means to preset each section to render the circuit closing means effective to close a circuit when said section has counted a predetermined number of records, and selection relays controlled by the contact means of said sections for selectively closing circuits to said magnets which circuits remain closed to maintain the feeding mechanisms operative only so long as the section of the counting device associated with the feeding mechanism continues to be short of reaching the predetermined number, and operative to open the circuit to the selected feeding mechanism when the said feeding mechanism has fed a succession of records corresponding to the predetermined number.

22. In a machine of the class described, a plurality of record feeding mechanisms for feeding records to a common path, means for selecting the feeding mechanisms for operation one at a time, and a record counting device having a section for each feeding mechanism for counting the number of records to be fed by said feeding mechanism, said recording counting device controlling said selecting means to cause the record feeding mechanisms to operate in rotation each a plurality of times, said counting device having means for presetting each section of said device to vary the number of records in a succession fed by each feeding mechanism.

23. In a machine of the class described, the combination of two record feeding mechanisms for feeding to a common destination two separate sets of records, each feeding means including a selectable device for rendering the feeding means active; and control means for alternately selecting said devices, including two separate presettable means; each for determining the number of records fed by a particular feeding means, and alternatively operative to cause a predetermined number of records to be fed in a continuous succession by one feeding means and a predetermined number of records to be fed by the other feeding means alternately.

24. In a machine of the class described, the combination of a plurality of record feeding means for feeding to a common destination a plurality of separate sets of records, each feeding means including a selectable device for rendering such feeding means operative; and control means for selecting said devices alternately, said control means including a plurality of separate presettable means each associated with a feeding means for predetermining the number of records to be fed by such feeding means, said control means being operative to select one of said devices and maintain the feeding means in operation continuously to feed a group of records before selecting another device, said control means causing said feeding means to operate in rotation to feed successive groups of records, each group containing a number of records determined by one of the predetermining means.

25. In a machine of the class described, a plurality of record feeding mechanisms, means for selecting the feeding mechanisms for operation in rotation; and a counting device for selectively counting records fed by each of the feeding mechanisms, said counting device comprising a plurality of separate counting sections, each section being associated with a feeding mechanism and including means to predetermine the number of records to be fed by the associated feeding mechanism, said counting means controlling the select-

ing means to cause a different feeding mechanism to be selected for operation after each operative feeding mechanism has fed the number of records predetermined by the corresponding section of the counting device.

26. In a machine of the class described, a plurality of record feeding mechanisms; a counting device for separately counting records fed by the feeding mechanisms, said counting device having a plurality of separate sections each section associated with one of the feeding mechanisms and including means to preset the counting device to limit the number of records fed by the related feeding mechanism; and means for selecting the feeding mechanisms for operation in rotation one at a time and rendered operative, when each feeding mechanism has fed the number of records predetermined by presetting the counting device, to select a different feeding mechanism for operation.

27. In a machine of the class described; two record feeding mechanisms, each for feeding a succession of records; a record counting device, variably settable means to set the counting device to determine the number of records in each succession fed by each feeding mechanism, said variably settable means being settable to two numbers, one for each feeding mechanism, to

designate the number of records in each succession fed by the associated feeding mechanisms; and means to place both feeding mechanisms under selective control of the counting device.

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