

June 25, 1946.

L. M. POTTS

2,402,771

IMAGE TRANSLATING APPARATUS

Original Filed Jan. 7, 1938

19 Sheets-Sheet 1

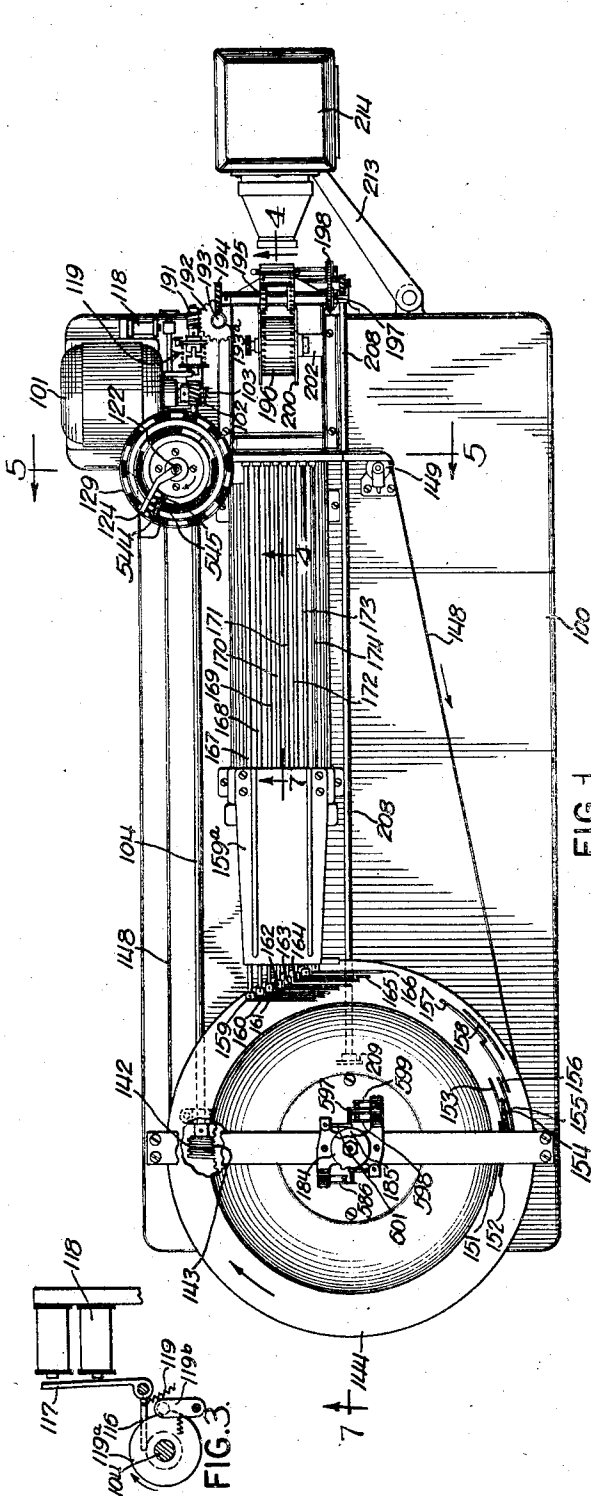


FIG. 1

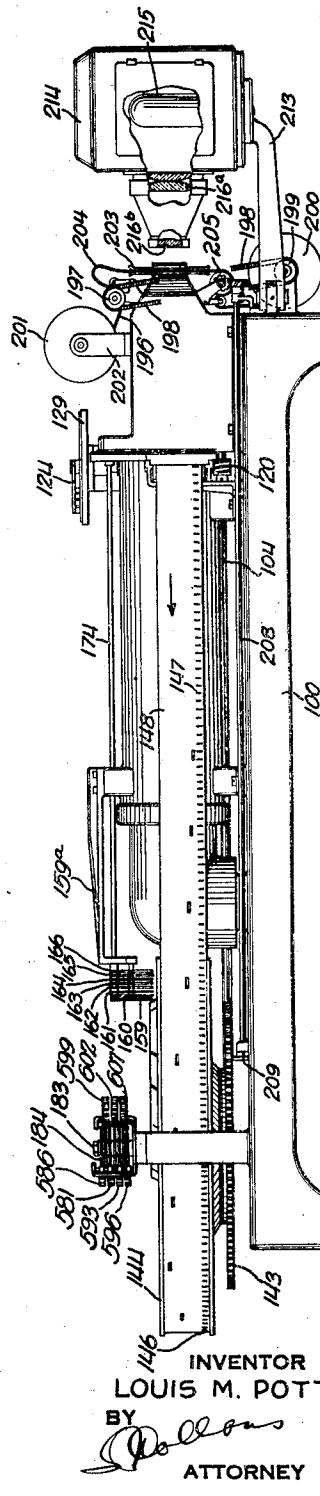


FIG. 2

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IMAGE TRANSLATING APPARATUS

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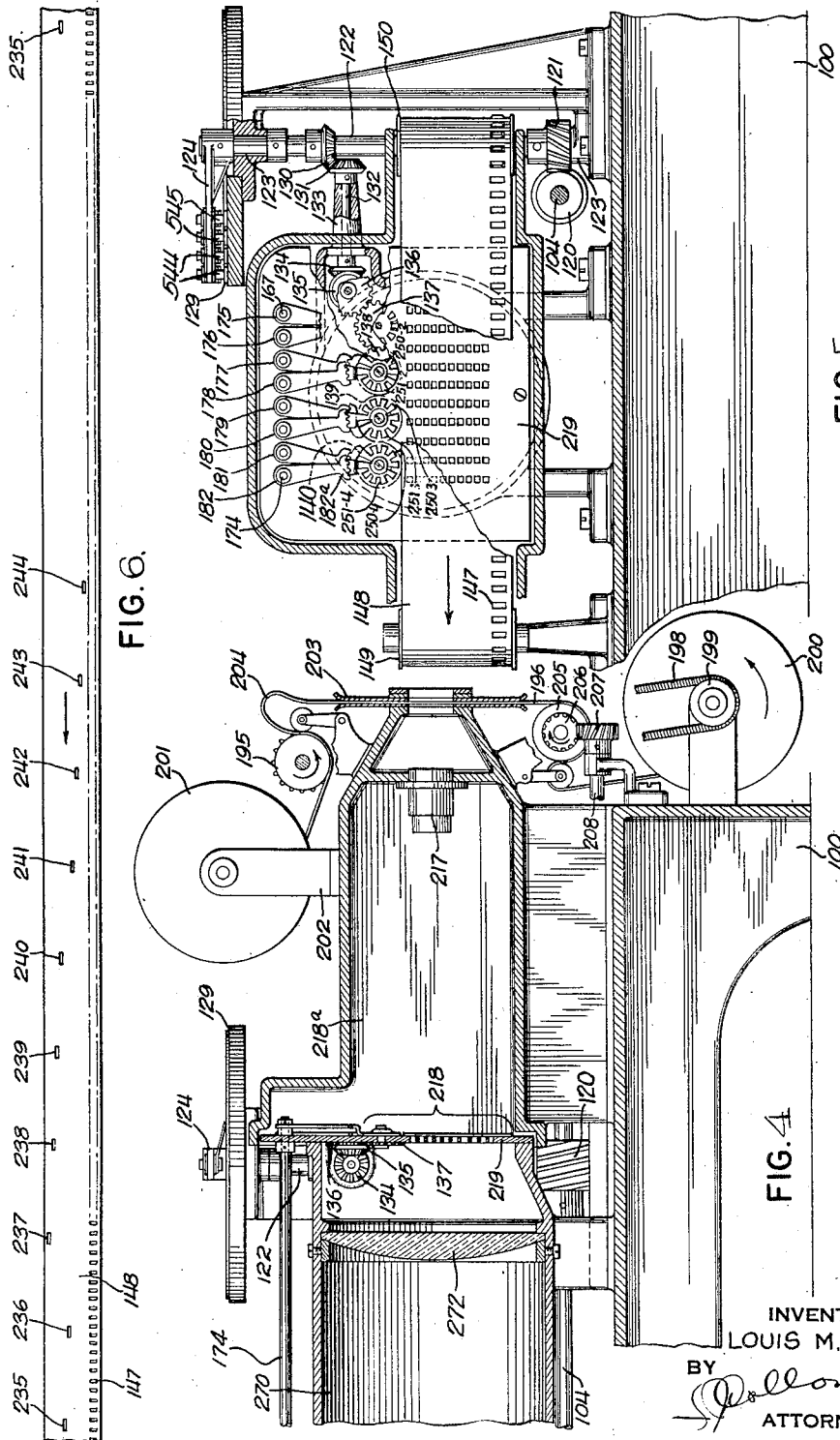


FIG. 4

FIG. 5

FIG. 6

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19 Sheets-Sheet 3

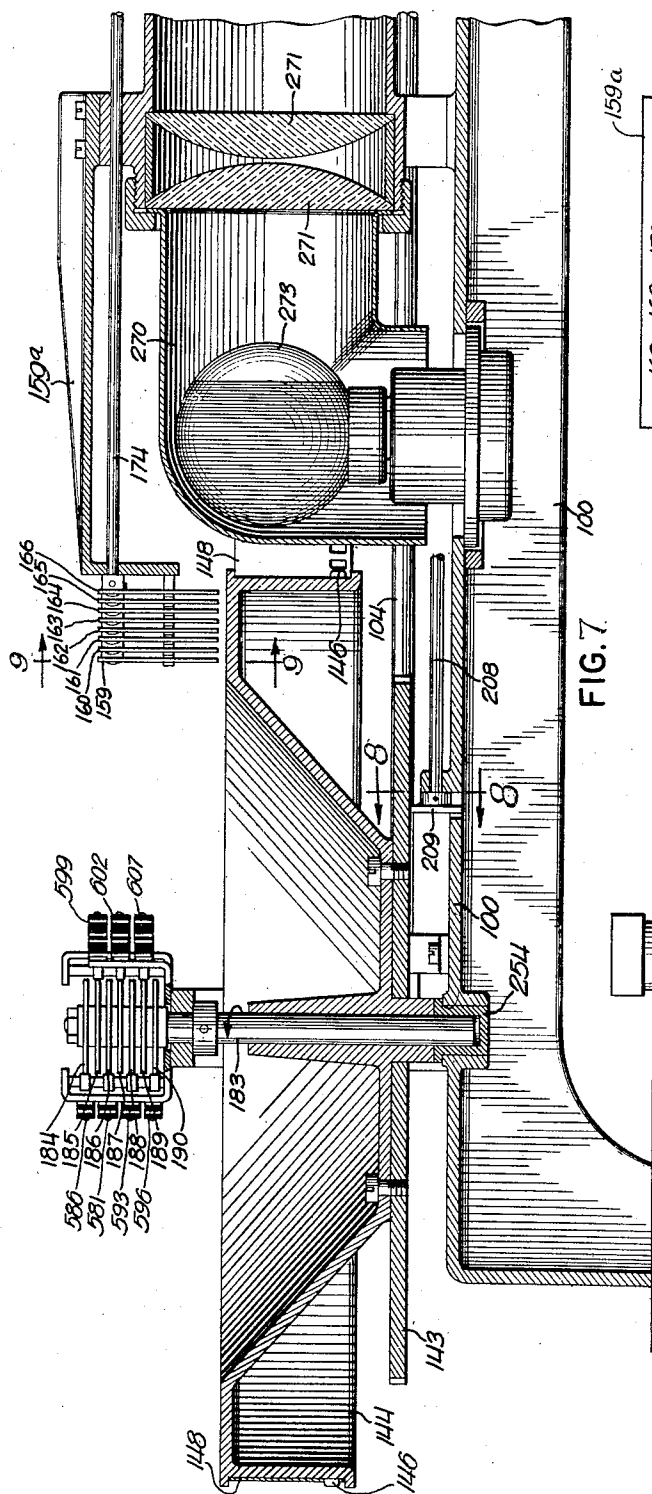


FIG. 7

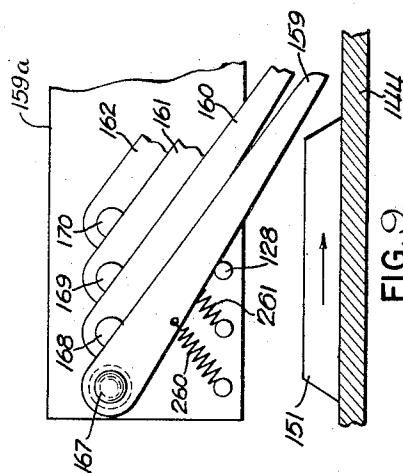


FIG. 9

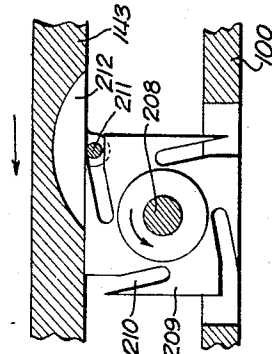
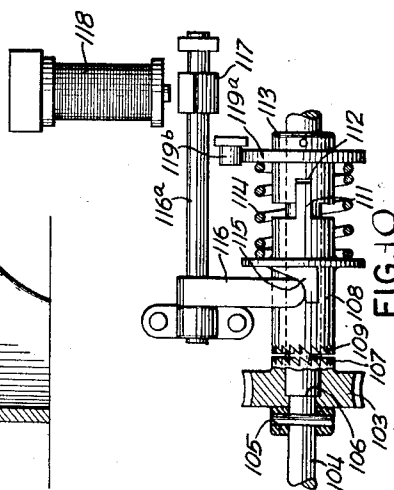


FIG. 8



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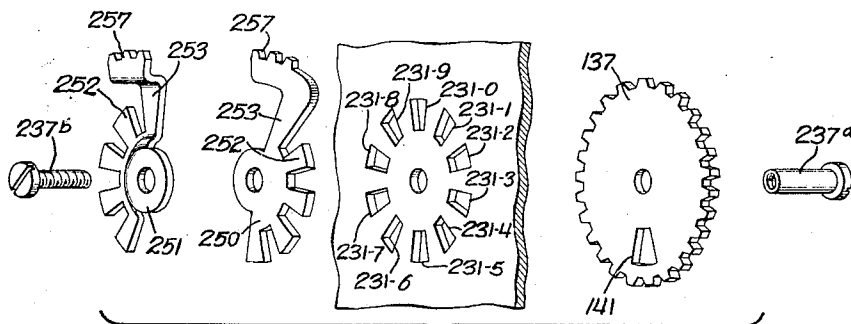


FIG. 11.

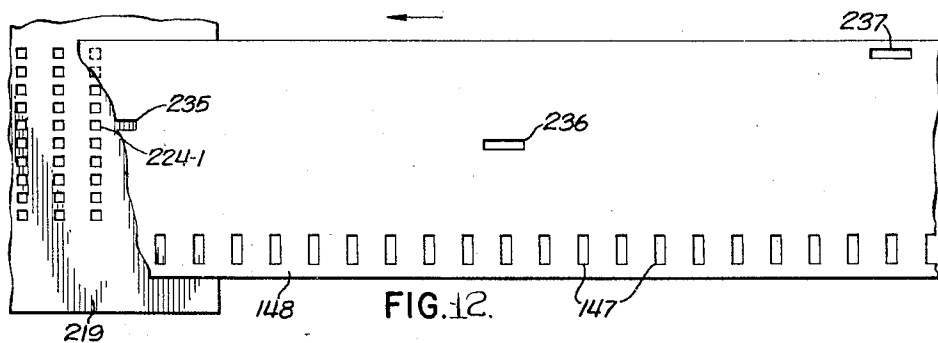


FIG. 12.

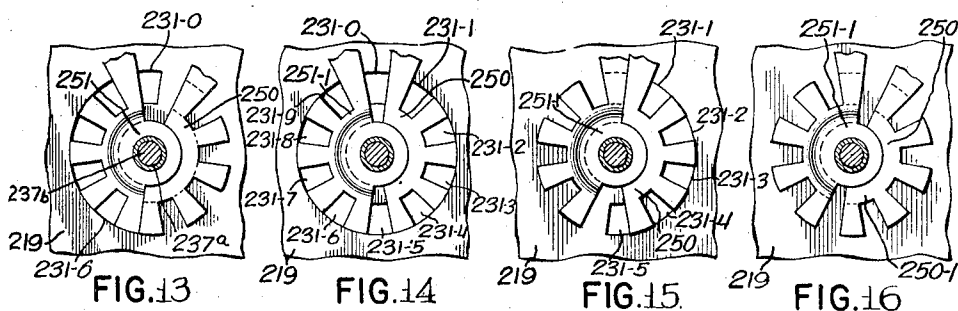


FIG. 13

FIG. 14

FIG. 15

FIG. 16

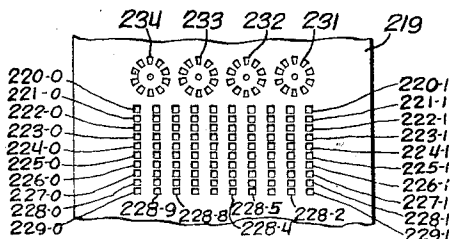


FIG. 17

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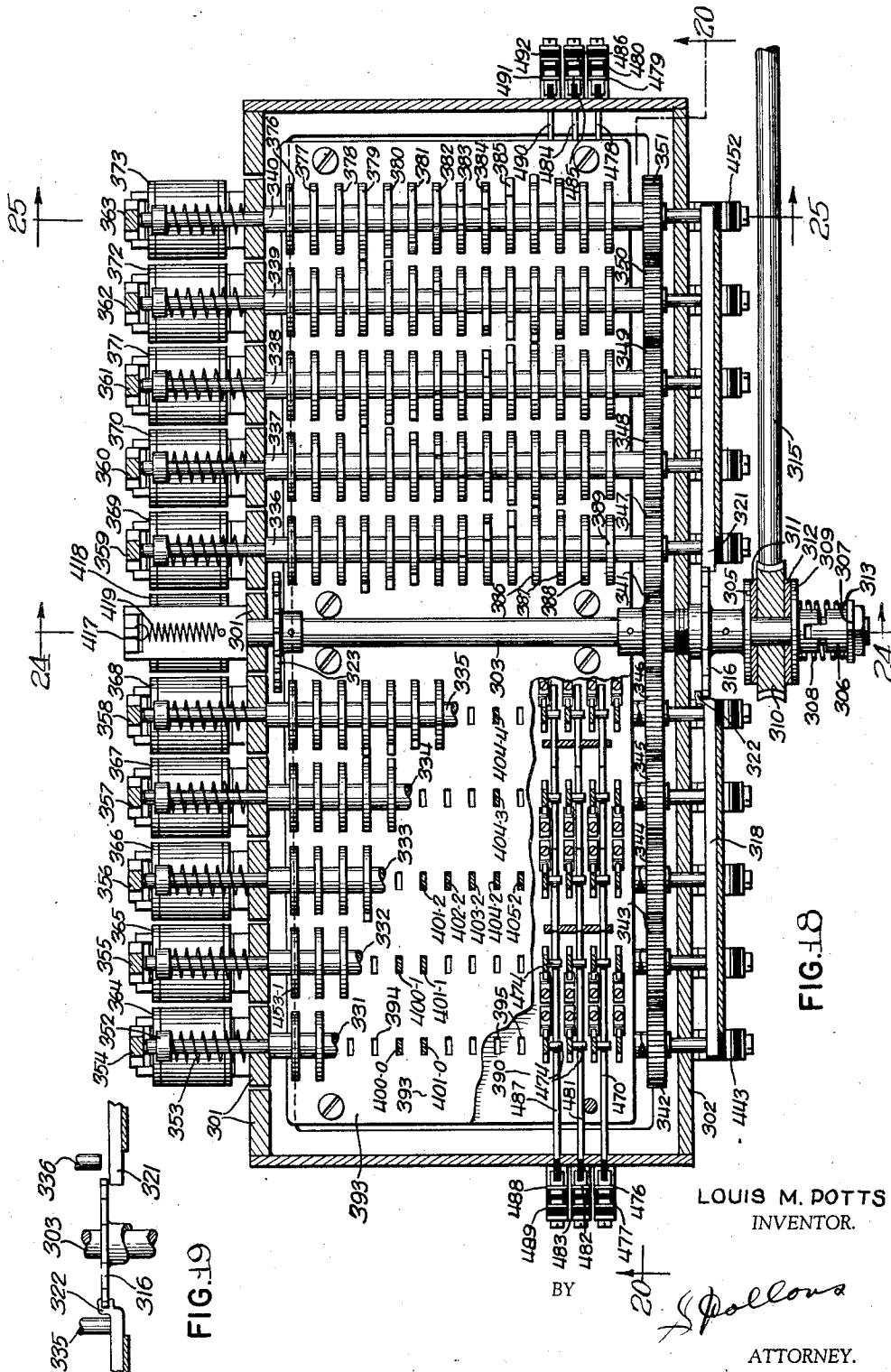
L. M. POTTS

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IMAGE TRANSLATING APPARATUS

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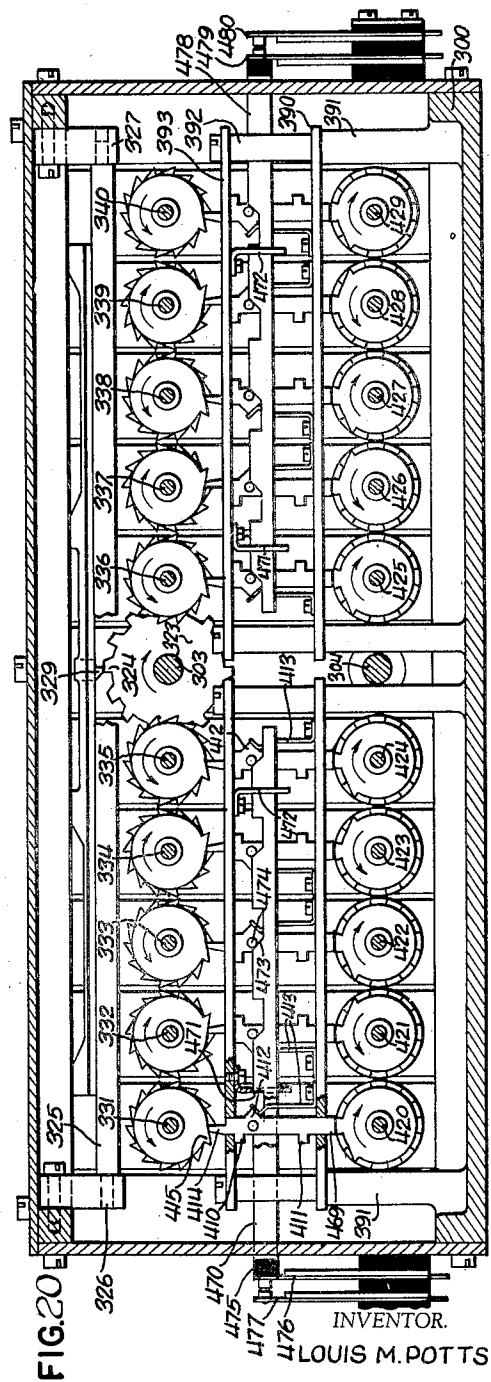
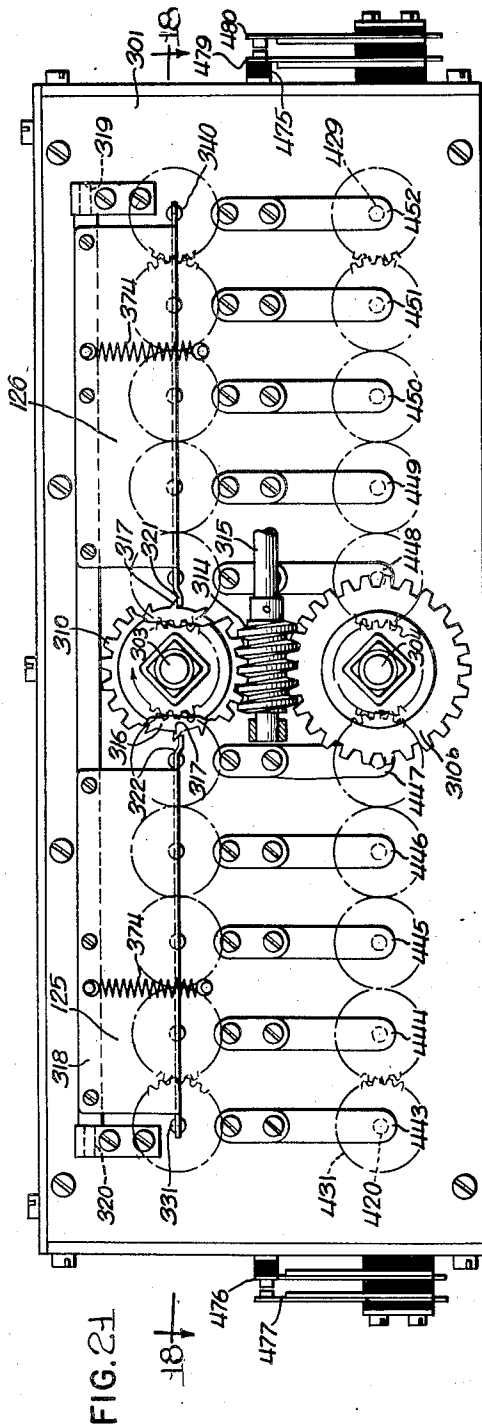
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IMAGE TRANSLATING APPARATUS

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IMAGE TRANSLATING APPARATUS

Original Filed Jan. 7, 1938

19 Sheets-Sheet 7

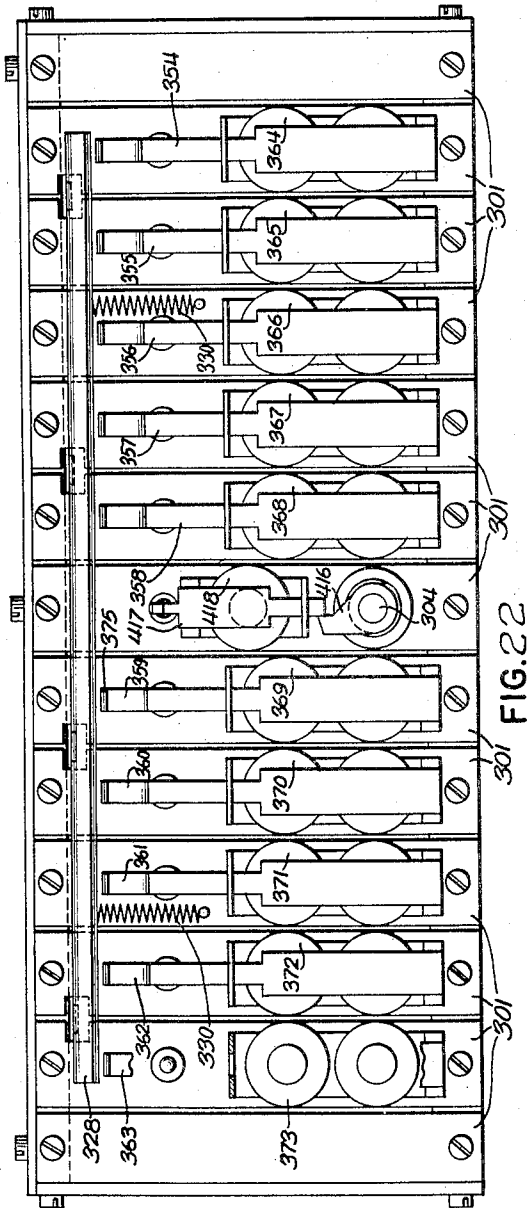


FIG. 22

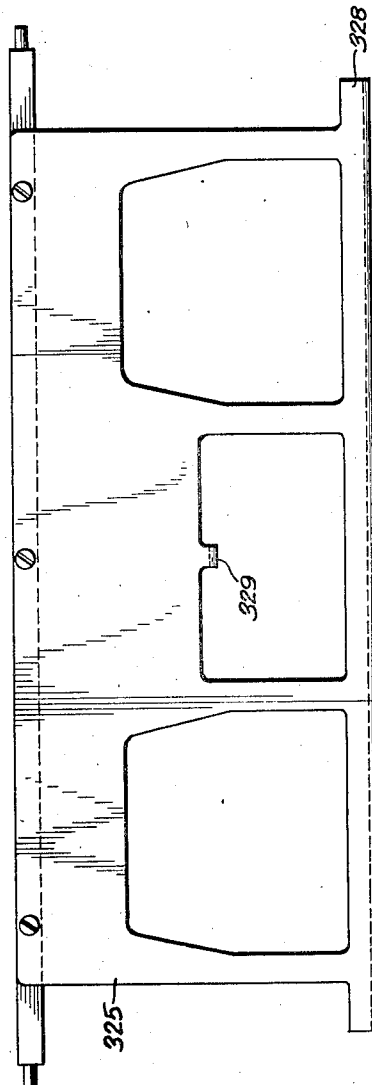


FIG. 23

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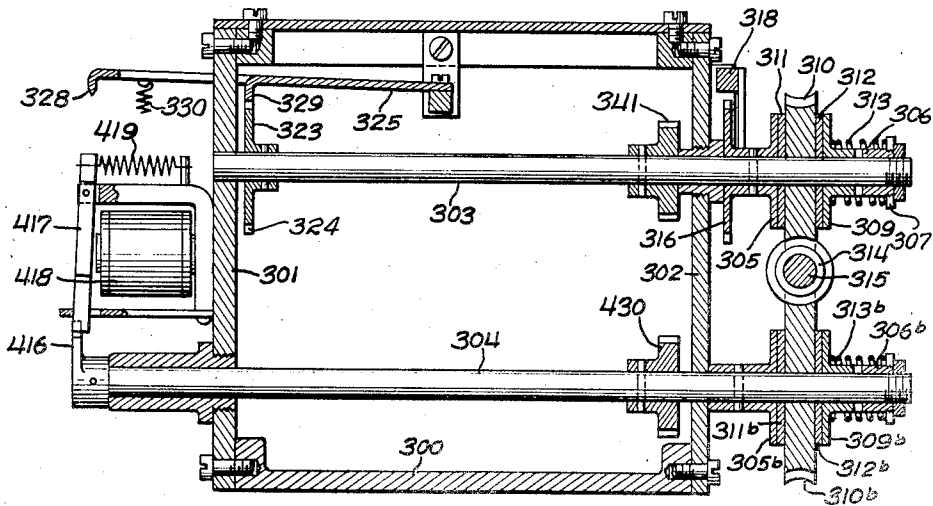


FIG. 24.

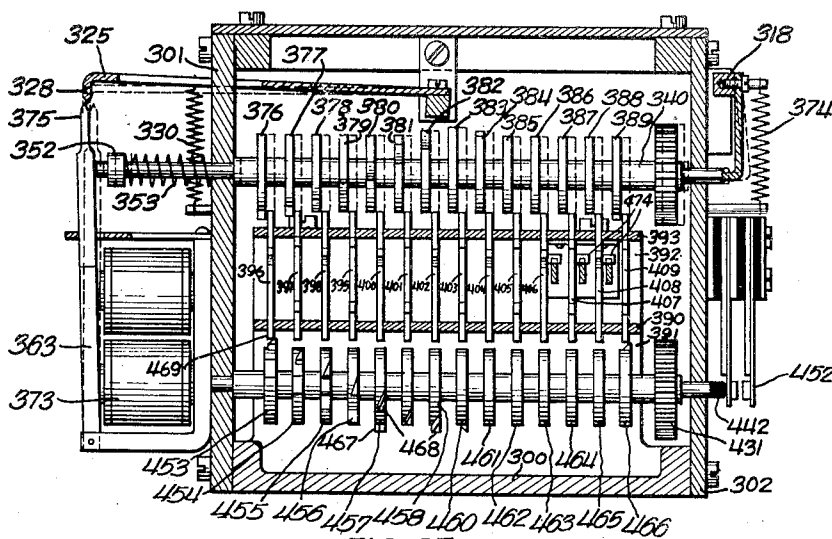


FIG. 25

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IMAGE TRANSLATING APPARATUS

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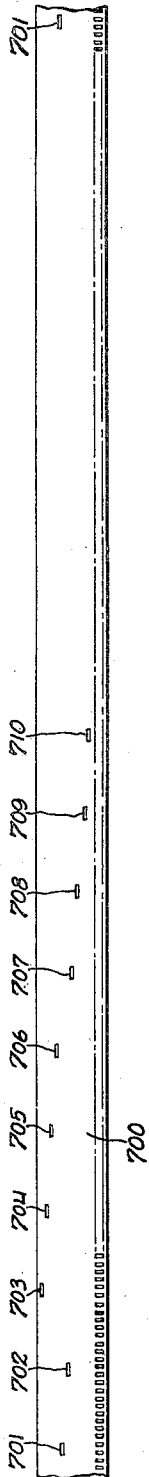


FIG. 28.

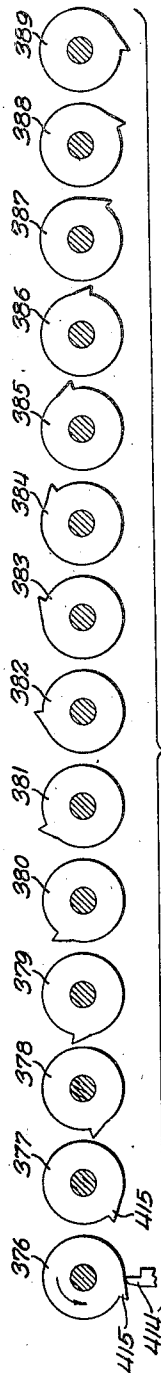


FIG. 26.

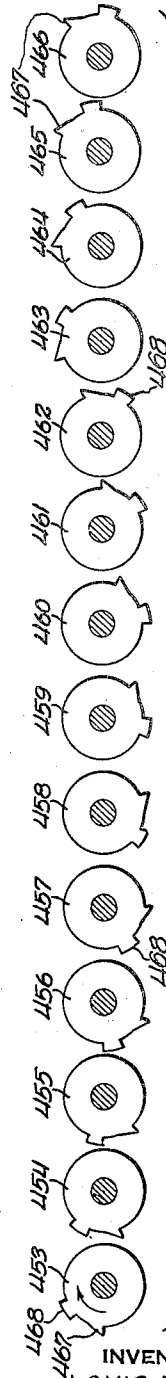


FIG. 27.

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FIG. 29.

FIG.30.FIG. 31

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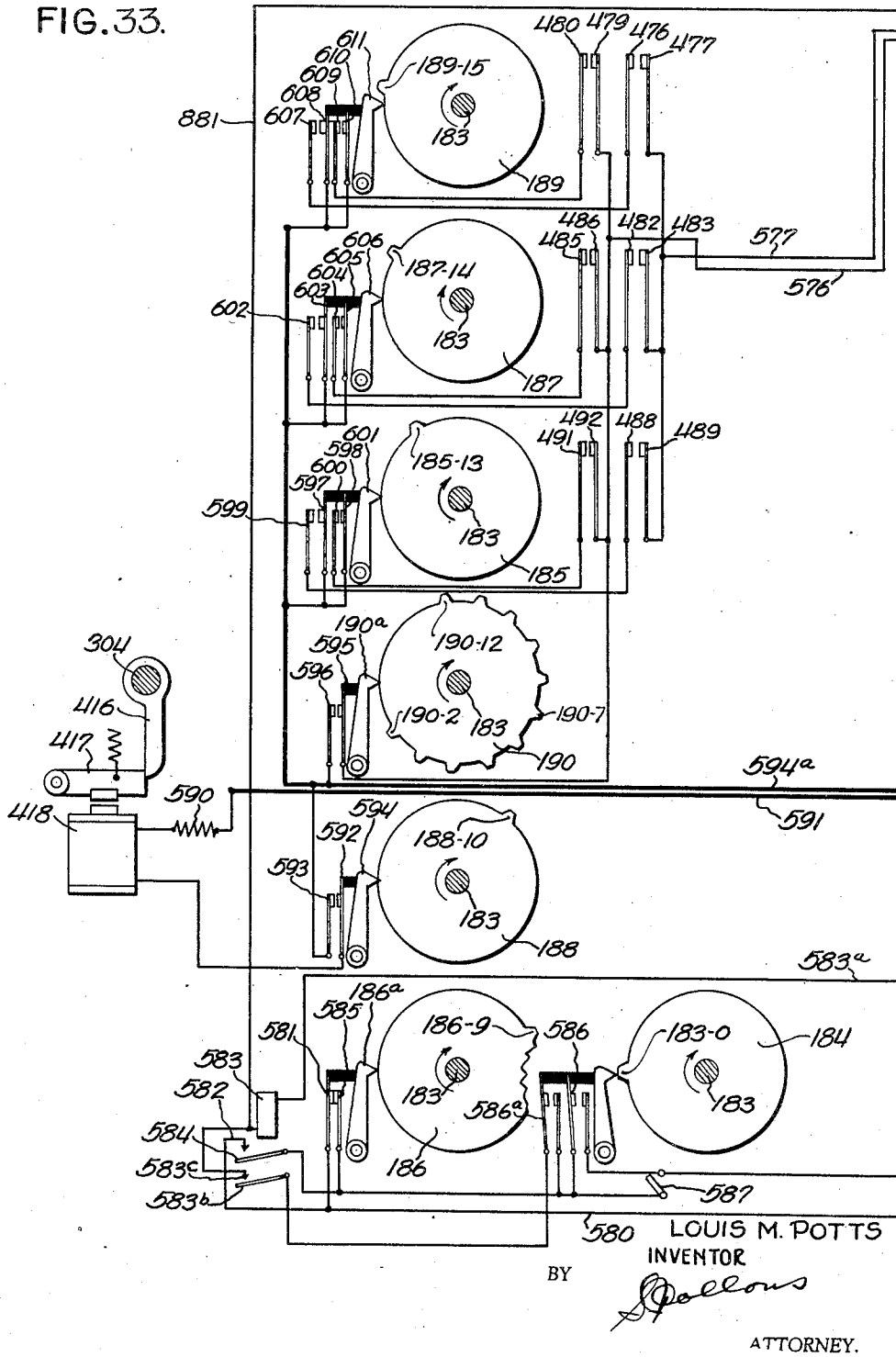
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FIG. 33.



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IMAGE TRANSLATING APPARATUS

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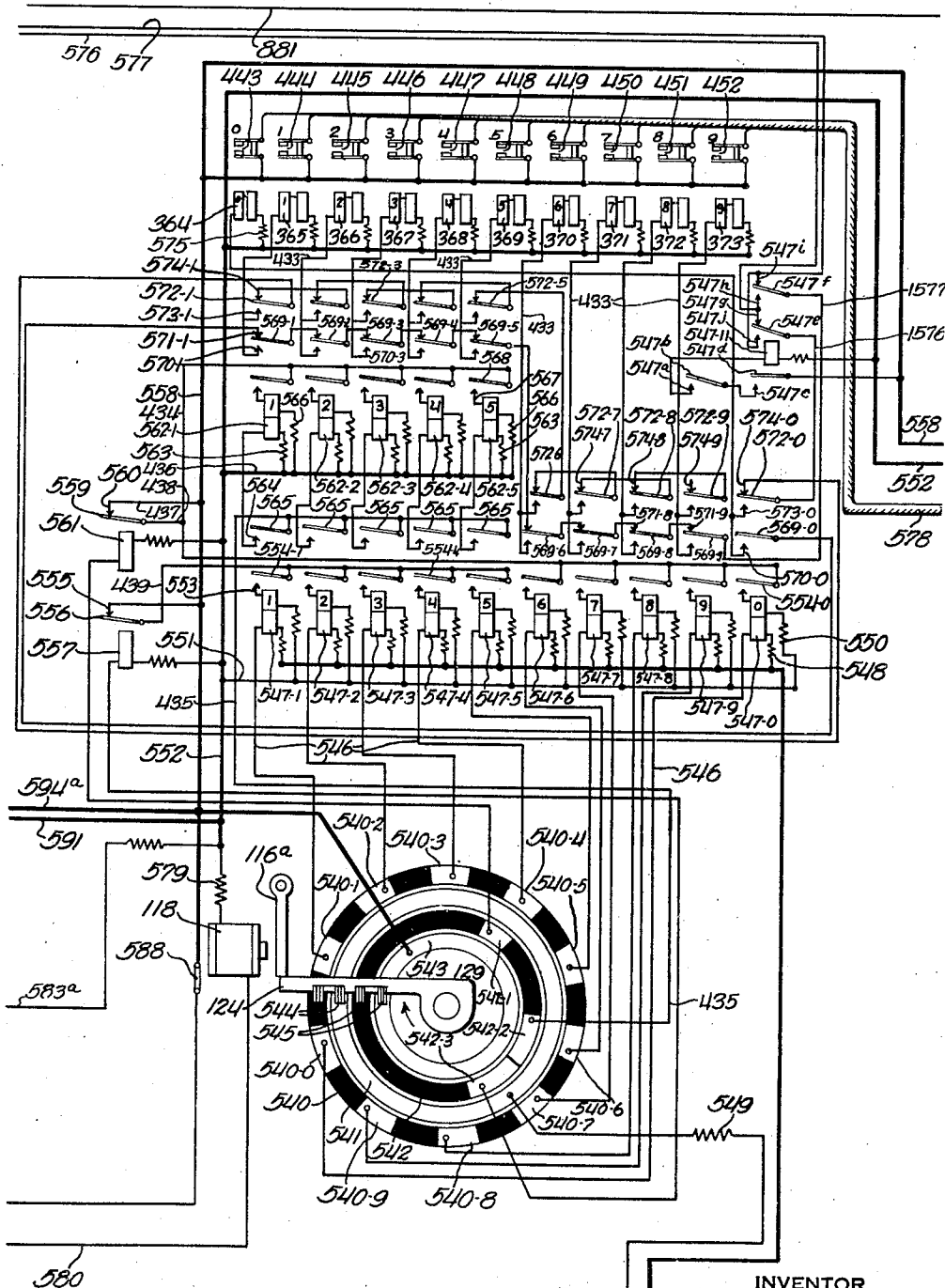


FIG. 34.

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IMAGE TRANSLATING APPARATUS

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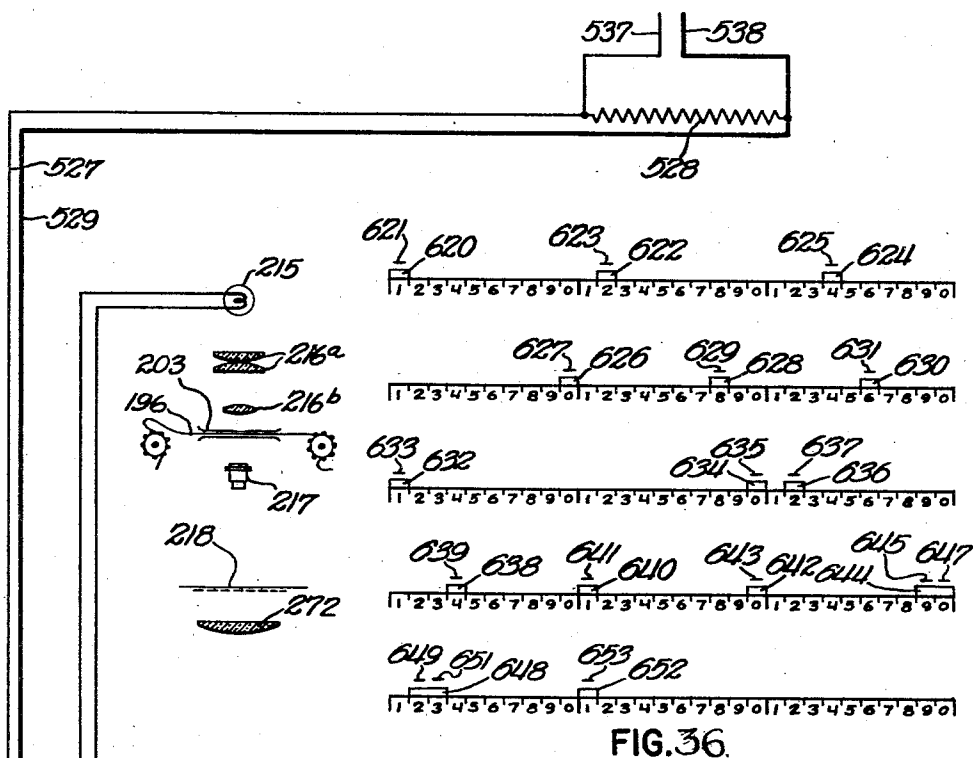
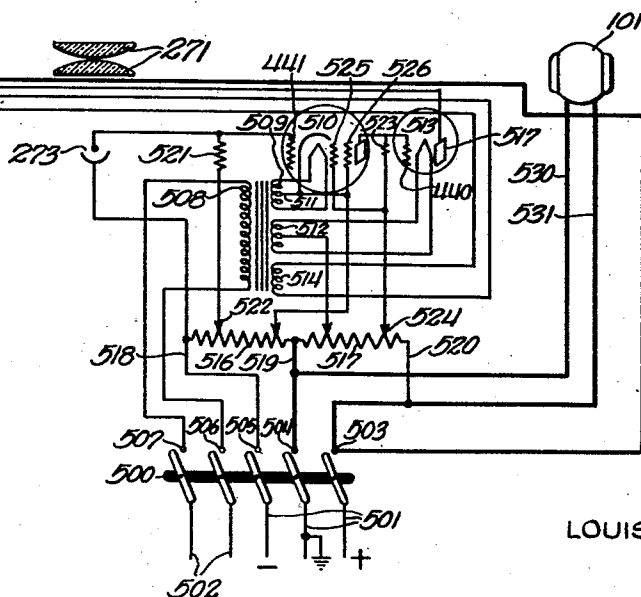


FIG. 36.

FIG. 35



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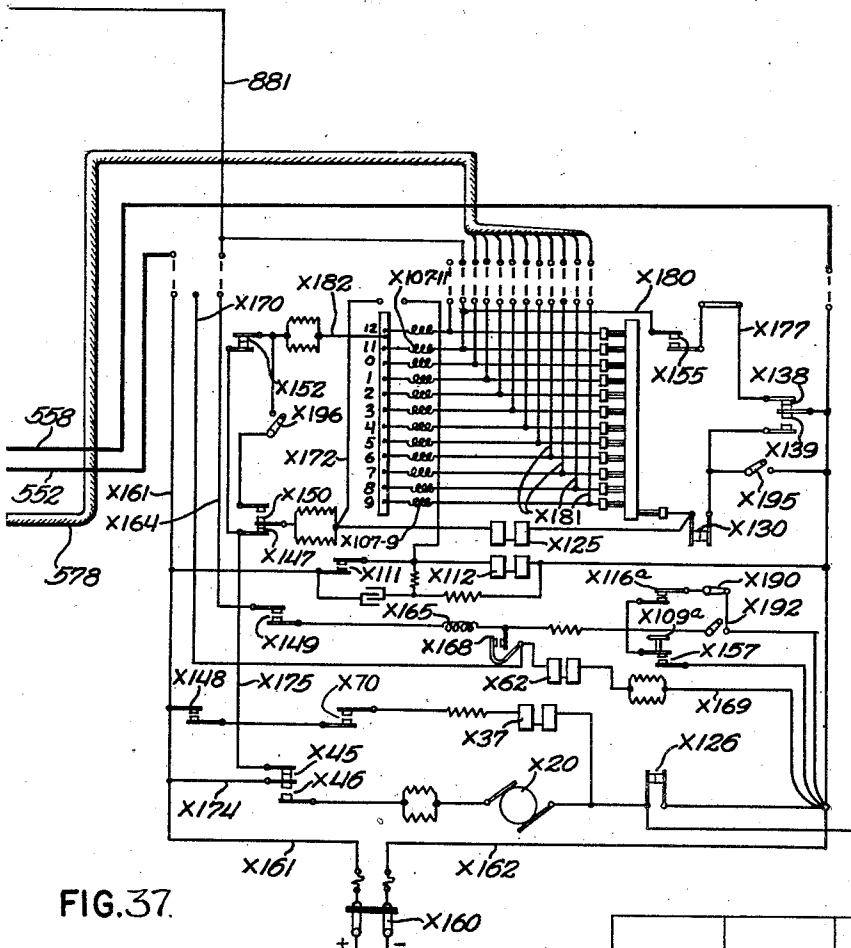


FIG. 37.

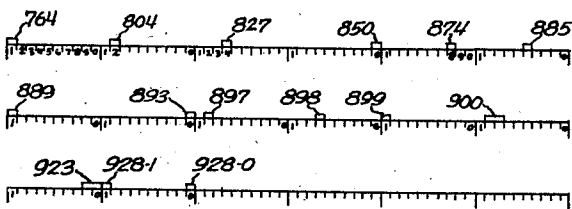


FIG. 40

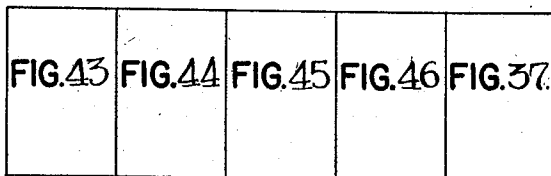


FIG. 39

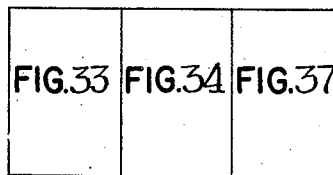


FIG. 35

FIG. 38

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IMAGE TRANSLATING APPARATUS

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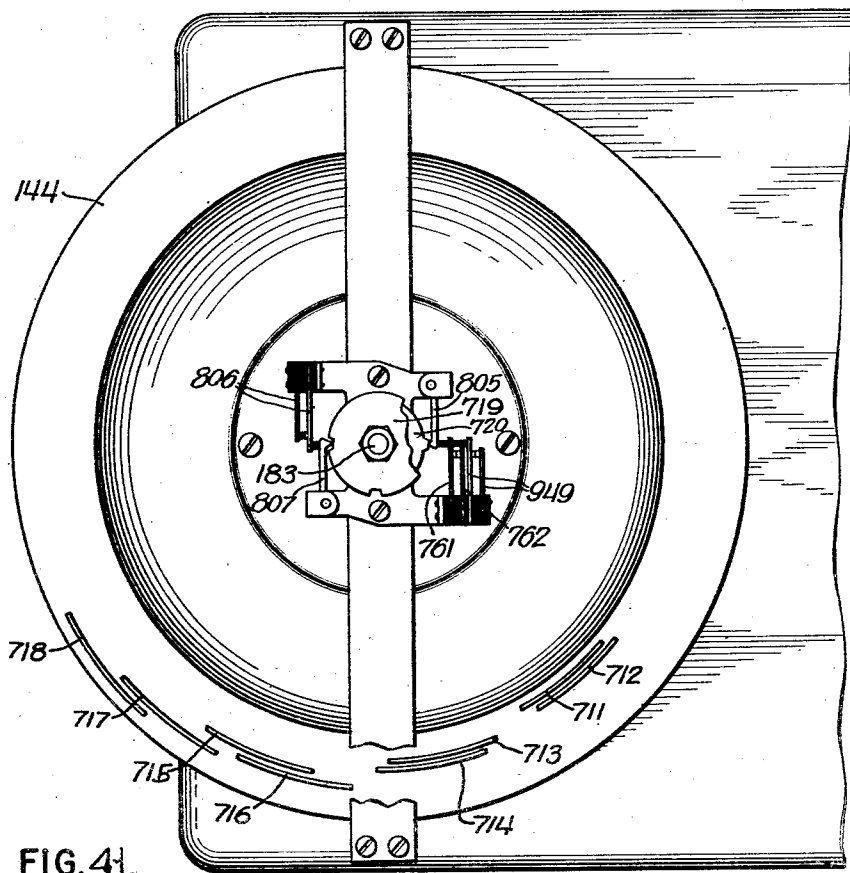


FIG. 41

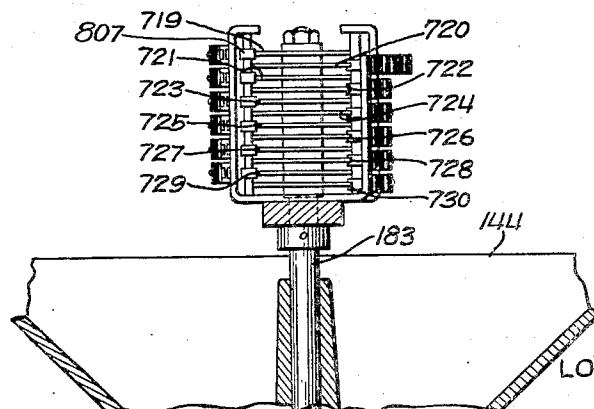


FIG. 42

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IMAGE TRANSLATING APPARATUS

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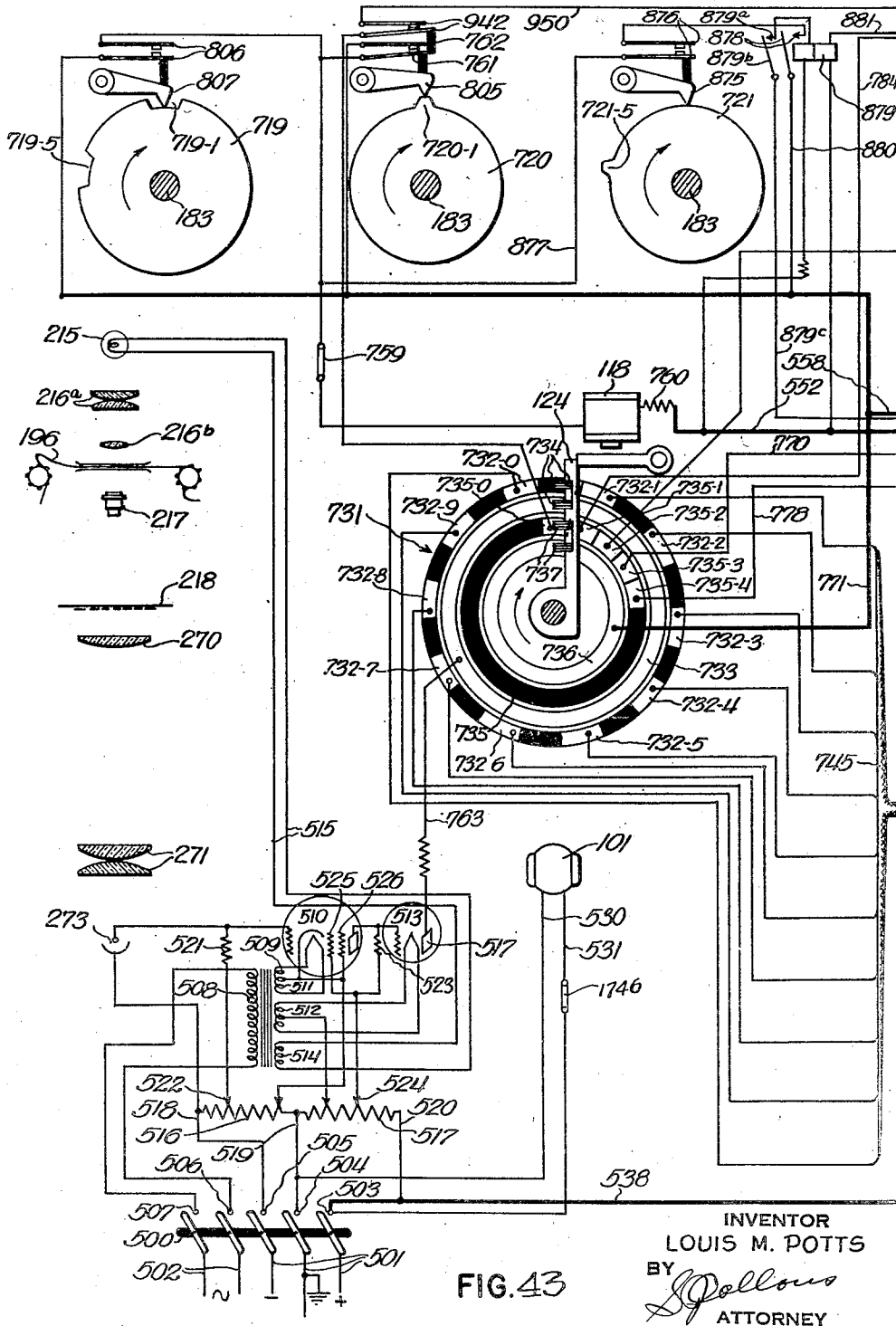


FIG. 43

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IMAGE TRANSLATING APPARATUS

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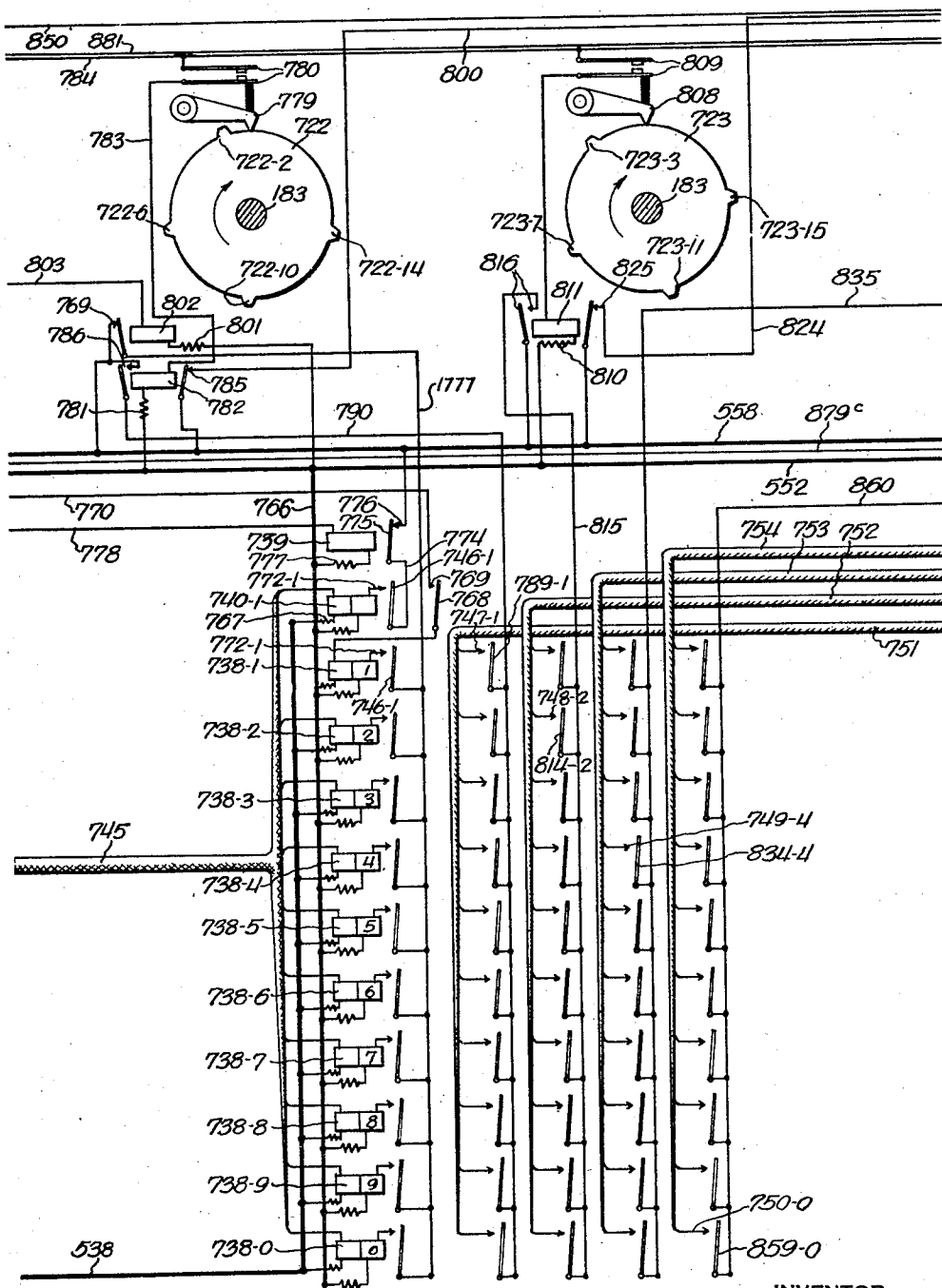


FIG. 44.

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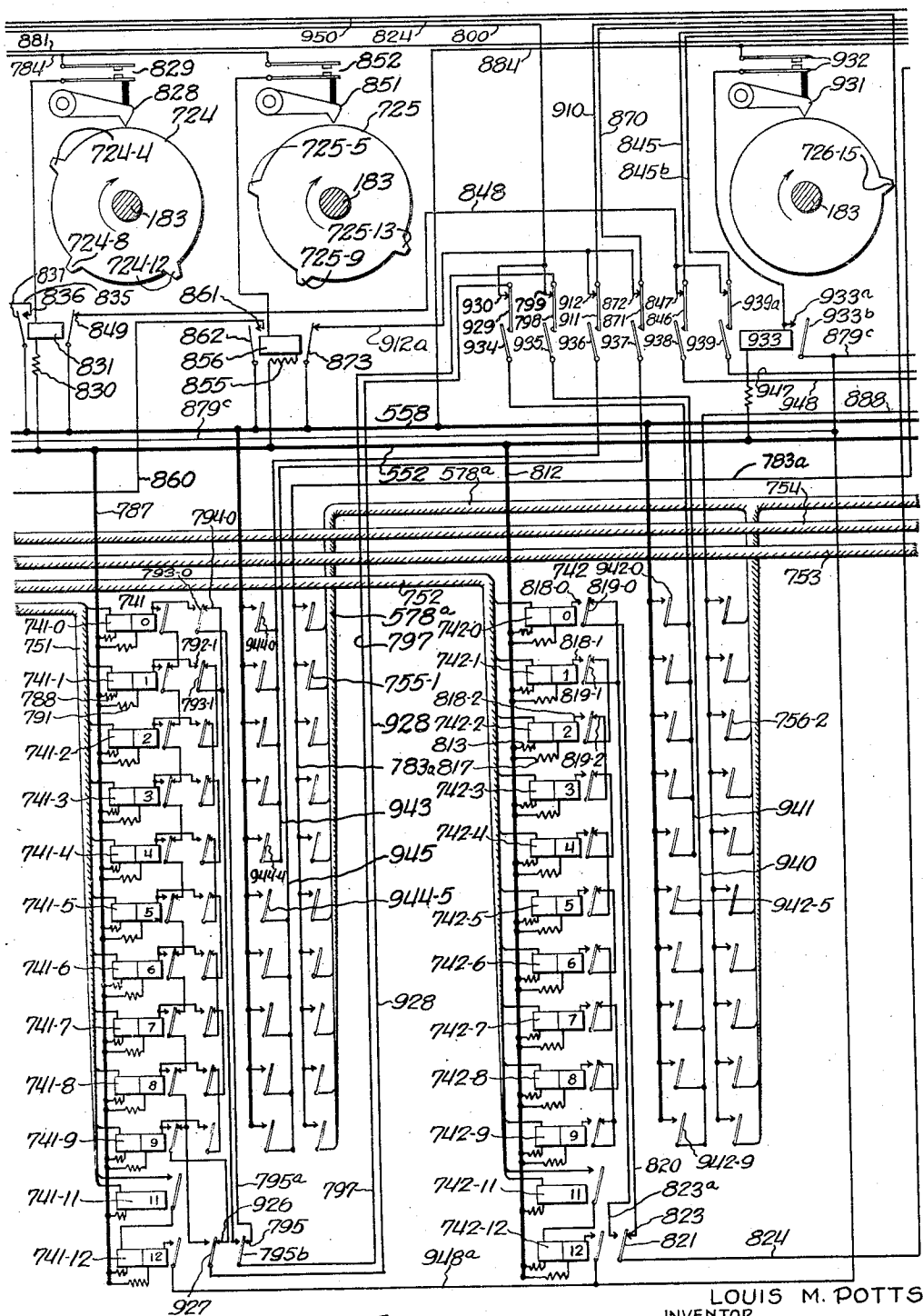
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2,402,771

IMAGE TRANSLATING APPARATUS

Original Filed Jan. 7, 1938

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BY  LOUIS M. POTTS
INVENTOR
ATTORNEY

2,402,771

Original Filed Jan. 7, 1938

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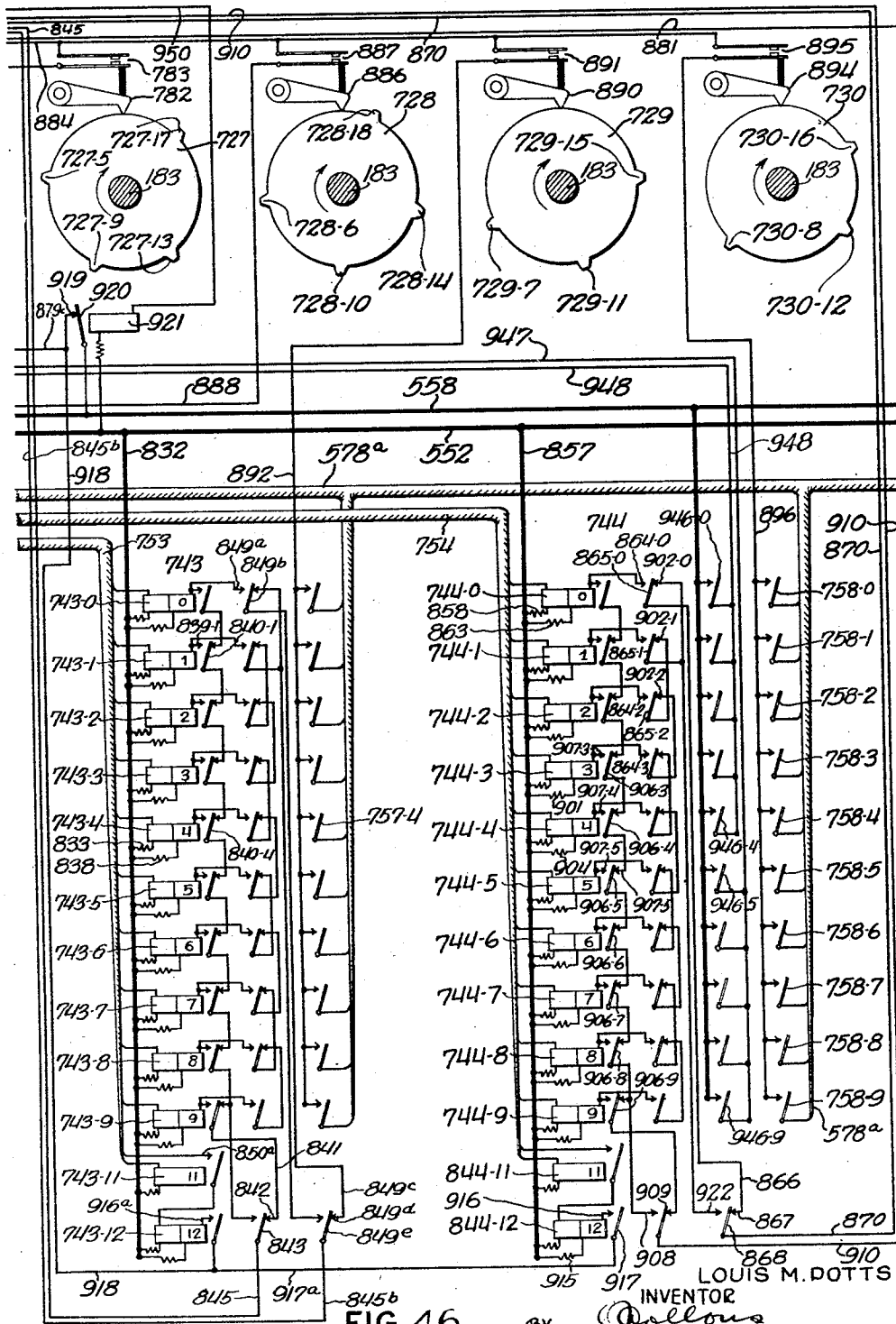


FIG. 46.

BY *S. J. Collins*

ATTORNEY

UNITED STATES PATENT OFFICE

2,402,771

IMAGE TRANSLATING APPARATUS

Louis M. Potts, Evanston, Ill.; Martha W. C. Potts executrix of said Louis M. Potts, deceased

Original application January 7, 1938, Serial No. 183,861, now Patent No. 2,313,088, dated March 9, 1943. Divided and this application March 4, 1943, Serial No. 477,933

30 Claims. (Cl. 178—7.1)

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The present invention relates to a system of meter reading and recording apparatus and particularly to mechanism for photoelectrically scanning reduced scale images of public service commodity meters in order to generate a system of electrical pulsations identified with the information borne by the meter images.

The present application is a division of the subject matter illustrated and described in copending application Serial No. 183,861, filed January 7, 1938, now Patent No. 2,313,088, issued March 9, 1943.

A principal object of the present invention is to provide apparatus for scanning various types of information bearing images and for generating and distributing characteristic impulses which may thereafter be stored and which will accordingly denote integer values in correspondence with the information borne by said images.

The apparatus to which the present invention relates will be termed a scanning device and its essential purpose is to trace circular as well as rectilinear meter integer designations, by passing a ray of light along a prescribed path and by generating electrical impulse in accordance with the impingement or penetration thereof upon a light sensitive medium such as a photoelectric cell. The electrical impulses thus generated are distributed according to a periodicity and location method of integer translation to be received by a series of primary storage elements as, for example, of the type claimed and disclosed in the above-referred to patent.

Since the information recorded and carried by the individual consumer's metering devices may be of a character having a transitory position along a circular dial or of a type having an inert position in accordance with a coordinate or rectangular field, both types of scanning implements are here incorporated within a single and concurrently performing mechanism.

The circular field type of scanning is performed by passing a beam of light through a sequence of timed shutters disposed along the path of the circular field so that the projection of said beam upon the photoelectric apparatus will vary in accordance with the location of a characteristic light conductive or light blocking local area. The photoelectric cell is then made to operate a control circuit for energizing one of a series of storage elements whereat the information is momentarily stored pending the performance of certain corrective functions and prior to their final transposition into perforated record cards, as explained in the patent referred to. Translations

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from a rectilinear field are made by the use of a scanning belt which correspondingly probes for the presence of a characteristic light conducting or light impeding area following which the translation may be made directly to the card perforating storage control elements depending upon the particular requirements and variations of the recorded information.

For a more comprehensive understanding of the present invention, reference will now be had to the accompanying drawings and to the detailed specification following hereinafter wherein similar reference characters designate corresponding parts throughout and wherein;

Fig. 1 is a plan view of the scanner apparatus; Fig. 2 is a side elevational view of the scanner apparatus;

Fig. 3 is a detail view of the scanner clutch release mechanism;

Fig. 4 is a longitudinal section of the scanning device, and is taken approximately on line 4—4 of Fig. 1;

Fig. 5 is a sectional view of the scanner taken approximately on the line 5—5 of Fig. 1;

Fig. 6 is a developed view illustrating approximately one-half of the scanning belt;

Fig. 7 is a sectional view of the rear end of the scanner, and is taken approximately on line 7—7 of Fig. 1;

Fig. 8 is a fragmentary sectional view on line 8—8 of Fig. 7 showing the intermittent feed mechanism for advancing the film;

Fig. 9 is a fragmentary sectional view taken on line 9—9 of Fig. 7 showing the operating levers for part of the scanning apparatus;

Fig. 10 illustrates a single revolution clutch mechanism such as may be used with the scanner apparatus;

Fig. 11 is an exploded perspective view of the dial-scanning shutter mechanism.

Fig. 12 is a fragmentary detail view showing the scanning belt associated with the scanning plate;

Figs. 13, 14, 15, and 16 illustrate the scanning shutters of one of the dials in several operated positions;

Fig. 17 is a detail view of the fixed plate of the scanner apparatus;

Fig. 18 is a plan view of the translator and storage unit partially in section on the line 18—18 of Fig. 21;

Fig. 19 is a fragmentary detail view featuring the escapement mechanism for the recording shafts;

Fig. 20 is a side sectional view taken approximately on the line 20—20 of Fig. 18;

Fig. 21 is a side elevational view of the power transmitting side of the translator;

Fig. 22 is a side elevational view of the translator looking in the opposite direction to that of Fig. 21;

Fig. 23 is a detail view of the locking ball for the magnet armatures;

Fig. 24 is a transverse sectional view of the translator and is taken approximately on line 24—24 of Fig. 18;

Fig. 25 is a sectional view taken approximately on line 25—25 of Fig. 18;

Fig. 26 shows progressively one set of cams for transmitting the stored readings;

Fig. 27 shows progressively a set of cams on one of the shafts 331 to 340 which serves in setting the storage elements;

Fig. 28 is a developed view of approximately one-half of the scanning belt which may be employed in accordance with a modified method of operation;

Figs. 29 and 31 show record cards perforated with a previously stored reading;

Fig. 30 illustrates a record card which resembles the one in Fig. 29, but upon which there has been applied a subsequent reading;

Fig. 32 is a diagrammatic view of a pair of skip bars associated with the card perforator;

Fig. 33 is a portion of the wiring diagram which features the timing cams of the scanner apparatus;

Fig. 34 is a portion of the wiring diagram which features the commutator, the storing relays, and the translator circuits;

Fig. 35 is a portion of the diagram featuring the photo-electric element control circuit;

Fig. 36 is a diagrammatic representation of typical signals transmitted by the scanner apparatus;

Fig. 37 is a portion of the electrical circuit featuring the card perforator apparatus;

Fig. 38 is a pattern chart showing how the circuits of Figs. 33, 34, 35, and 37 may be assembled to constitute a complete wiring diagram;

Fig. 39 is a pattern chart showing how the circuits of Figs. 43-46 and 37 may be assembled to constitute a complete wiring diagram which features a modified method of operation;

Fig. 40 illustrates by example certain impulses generated by the scanning device for accomplishing a modified method of operation;

Fig. 41 is a plan view of a scanning apparatus drum for a modified method of operation;

Fig. 42 is a fragmentary sectional view showing the apparatus featured in Fig. 41;

Fig. 43 illustrates a circuit including the photo-electric element for a modified method of operation; and

Figs. 44-46 illustrate other parts of the electrical circuit shown in Fig. 43.

Figs. 1-17 illustrate a preferred embodiment of scanning apparatus. When a film such as that illustrated in Fig. 6 of the referred to patent has been developed and fixed, it or a copy thereof is fed into a scanning mechanism as may be noted in Fig. 4. It is to be understood that the circuit shown in the drawings is adapted to respond properly when the film used in the scanner is a negative film and would usually be the film used in the camera after it has been developed. In this film the pointers and the code marks are transparent and all other parts of the film are opaque. Here the film supply roll is illustrated

by the reference character 201 and a film winding arbor by the reference character 200. This unit is provided with scanning or analyzing elements and with a photoelectric device for interpreting or converting the record images received by the recording tape into corresponding electrical impulses.

The scanner unit, Figs. 1 and 2, comprises a supporting frame 100 and an electric motor 101 upon whose rotor is a driving gear 102 meshing with a driven gear 103 idly supported on a longitudinal shaft 104, Fig. 10. It will be noted that driven gear 103 is provided with crown clutch teeth 107 adapted to mesh with similar teeth 109 in a sleeve member 108 from whose opposite end there extend sliding tenons 111 receivable within slots 112 in a collar 113 anchored to shaft 104. A clutch spring 114 urging between a flange formed intermediate sleeve 108 and the side of a cam 119a integral with collar 113 urges the sleeve leftwardly so that its teeth 109 may engage those 107 of driven gear 103. This tendency of spring 114 is resisted however, when a surface cam 115 on sleeve 108 is engaged by the extremity of a control arm 116 fixed on a shaft 116a. Arm 116 is biased by a spring 119, Fig. 3, so that under dormant conditions sleeve 108 is withdrawn from engagement with gear 103. An armature 117 keyed to shaft 116a is operated by its magnet 118 to withdraw arm 116, permitting clutch spring 114 to influence sleeve 108 leftwardly, as viewed in Fig. 10. In order to overcome a chattering or singing condition characteristic of spring-loaded tooth clutches, a cam 119a is provided with a detent jockey 119b which passes over an apex extremity in its periphery and partially retards the return tendency as influenced by spring 114 in cooperation with the disconnect cam 115. Magnet 118 is energized, causing to be withdrawn the clutch disengagement arm 116. Shaft 104 is continuously rotated during the energized period of magnet 118, which prevails until pursuant to a hereinafter described condition the control circuit of magnet 118 is opened, whereupon shaft 104 is arrested invariably in a definite position.

Shaft 104 drives the brush arm 124 and for this purpose carries a worm gear 120 which meshes with a worm wheel 121 keyed to the distributor shaft 122, a vertical element featured in Fig. 5 and journaled in bearings 123. A power take-off from the distributor shaft 122 to the scanning shutters is effected by a beveled driving gear 130 anchored to shaft 122, which drives a beveled gear 131 secured to one end of a stub shaft 132, journaled in bearing 133 and having at its opposite end a beveled pinion 134 which meshes with a driven gear 135. The latter is carried upon a short pivot stud and is integrally associated with a spur gear 136 which drives a series of four intermeshing scanning gears of which gears 137 and 138 are visible in the illustration, Fig. 5. Similar gears meshing successively are provided with the other shutters but have been broken away in the illustration. In the exploded view, Fig. 11, the several elements associated with one of the shutters are featured. Each scanning gear such as gear 137 is provided with an aperture 141 and is rotated at the same speed as shaft 104 so as to pass successively into alignment with the radially distributed apertures or windows 231-1 to 231-0. The angular span of aperture 141 is sufficient to permit its leading edge to overtake and begin to expose a succeeding window before its trailing edge has traversed completely a preceding one. Pivoted on a stud screw 237a

and bolt 237b with the gears 137, 138, etc., are a pair of shutter elements 250 and 251, each having five radial vanes 252 and 253. Two of the vanes indicated 253 extend beyond the circumferential limit of the other vanes 252, and have integrally formed therewith gear segments 257 which mesh with corresponding segments of arms 175 to 182, see Fig. 5. In their unoperated position, the shutter elements 250 and 251 are disposed so that their vanes 252 and 253 cut off each its associated window 231—1 to 231—0. Upon being actuated, however, each shutter is rotated about its stud 237a, exposing its five windows, as will be described.

Shaft 104 propels the scanning belt 148 and for this purpose carries a worm gear 142, which meshes with a gear 143 secured to a vertically pivoted drum 144, Figs. 1, 2, and 7. The gear ratio between worm 142 and gear 143 is such that drum 144 completes a revolution for each scanning cycle which consists of an individual operating period or division for each of the several dials and indicator rows, and an extra revolution of shaft 104 for a purpose to be described later. In the particular embodiment, this ratio is one to fifteen. Flexed about the circumference of drum 144 is a scanning belt 148 which serves in the capacity of a focal plane shutter. This belt 148 is provided with feed holes 147 which mesh with feed pins 146 of the drum 144 as well as with those of idler rollers 149 and 150, Figs. 1 and 5. The belt 148 is preferably of a length to afford two complete scanning lengths each having a series of scanning apertures indicated 235—244 in Fig. 6. Drum 144 and its associated gear 143 are carried upon a vertical spindle 183 seated in an end socket 254, Fig. 7. At its upper end, spindle 183 carries a set of seven cams indicated 134 to 190, each having associated with it a stack of contacts to be described in connection with the wiring diagram featured in Fig. 32.

The top of drum 144 extends horizontally for a short distance near its periphery, then angles downwardly to form a frustum of a cone. From Figs. 1 and 9, it will be noted that upon the face of drum 144 are a series of arcuate cams indicated 151—158, distributed in accordance with a predetermined arrangement. A set of shutter control rods 167—174 pivotally supported at one end in a bracket 159a, Fig. 7, extend from a position approximately above the drum 144 as described across and through the scanning wall 219, Fig. 4. Upon the opposite face of wall 219 each rod 167—174 has secured to it one of the aforementioned segment arms 175—182, see Figs. 4 and 5. At their ends above the drum 144, each rod 167—174 carries a tracker arm 159—166, best illustrated in Figs. 1, 2, and 9, the free end of which is presented in the path of one of the aforementioned arcuate cams 151—158. As shown in Fig. 9, each shaft or rod 167—174 has an extreme clockwise normal position determined by the contact of its associated tracker arm with an individual stop pin 128, and this position is influenced by an individual spring 260 or 261.

Noting especially Fig. 1, on the right-hand end of shaft 104 there is provided a driving worm 191 which meshes with a worm wheel 192 fast to a vertical shaft 193 whose upper end carries a driving worm 193a that meshes with a worm gear 194 associated with the feed sprocket 195, see also Fig. 4. The teeth of sprocket 195 are designed to mesh with the feed holes in the margin of a control film 196. The gear ratio of the aforementioned train is such that sprocket 195 will feed

a linear amount of film equivalent to one picture frame for each time that drum 144 undergoes one single revolution. On a shaft common with that of sprocket 195, see Fig. 2, there is secured a pulley 197 which drives a spring belt 198 which encircles a driven pulley 199 fast to the winding arbor of spool 200. As the diameter of the wound roll increases, a slippage of the belt 198 is relied upon to compensate for the increased peripheral travel.

As has been said, the tape supply is carried upon a reel 201 mounted on a bracket 202. The film 196 emanating from the supply roll 201 passes under the sprocket 195 and a tensioning roller associated therewith, the film looping upwardly as at 204 and then threading through a film gate 203. Thereafter the film circles an intermittent feed sprocket 205 and its associated idler or tensioning roller, and is received upon the winding spool 200. The intermittent feed sprocket 205 receives its motion from a gear 206 carried by a common shaft which meshes with a driving gear 207 carried by a driving shaft 208, which extends longitudinally of the base 100 and carries at its opposite end a Geneva cam 209, see especially Figs. 7 and 8. Cam 209 is a quadrate having tangential slots 210 radiating at equally spaced intervals into which there may be received an actuator pin 211 carried upon the under surface of gear 143. As the actuator pin 211 enters a notch 210, it begins to rotate the quadrate cam 209 until it positively engages the side of a slot 210, imparting a sharp angular movement to the quadrate and accordingly to shaft 208. Above pin 211 the gear 143 is recessed so as to receive the corners of the quadrate 209 during the actuating interval. As will be noted, the engagement imparts a 90° rotation to shaft 208, following which, the flat face of gear 143 resting against a side of quadrate 209, locks the shaft 208 against further rotation.

A lamp house 214 is mounted upon a swinging arm 213, Figs. 1 and 2, and within it there is found an incandescent exciter lamp 215 facing the condenser lenses 261a and 216b. This system projects a light beam coextensive with a complete film frame aligned in the film gate 203, see Fig. 4. On the opposite side of the film gate 203 and in alignment with the projected beam is a lens 217 for projecting an enlarged image of the frame upon the scanning area indicated 218. The intervening compartment 213a is light tight to exclude all light from external sources.

The scanning plate 219, see also Figs. 5 and 17, has ten horizontal rows of apertures indicated 220—229, for definitely framing and aligning the projected light beams. The apertures of each row are indicated with a sub-reference character such as 220—1 to 220—0. These apertures are situated beneath the aforementioned dial windows 231—234 in a manner conforming with the particular distribution of meter indicators featured in Fig. 1. In projecting the image, lens 217 is designed to allocate the image where a mark may occur to the corresponding ones of the apertures 220—229 as well as to the windows 231—234.

The scanning belt 148 moves across the scanning plate 219 as indicated in Fig. 12, covering the apertures 220—229 but not the windows 231—234. Each of the scanning apertures 235—244 tracks a horizontal row 220—229, aligning with the apertures of each row successively. In its stop position, belt 148 is arrested with its aperture 235 in readiness to scan the horizontal row of apertures 224 of the scanning plate 219. As

the belt moves leftwardly, Figs. 5, 6, or 12, the scanning apertures register with their plate holes in the sub-reference character digital order 1, 2, 3, 4 . . . 0. As one aperture, for example 235, completes its circuit across its associated scanning row, a succeeding aperture, for example 236, enters upon its course, and so on until the entire rectangle of apertures has been scanned.

It will be perceived that in accordance with the contemplated practice a complete photograph of a reading will comprise, in addition to the photographic images of the circular dial indexes 92 and the identification number markings 93 which are reproduced from the characteristics representative of and associated with the meter face, additional sets of information markings denoted by the reference characters 94 and 95, which markings are reproductions of the meter reader's gate 85 having the colored markers 89 described above. The order in which this information is scanned may, in accordance with the present embodiment, depend solely upon the relative arrangement of the scanning apertures 235 to 244 of belt 148, Fig. 6. That is, the foremost apertures in the sequence may align horizontally with any one or ones of the rows of images on film 196, while succeeding ones may align with any other ones of the rows, etc. There is therefore to be noted an adaptability in the system which affords accommodation for preference and variations requiring but a corresponding design in the arrangement of the apertures of scanning belt 148.

In the illustration, Fig. 6, apertures 235 and 236 align with scanning plate rows 224 and 225 and come first in the indicated sequence followed by apertures 237 to 240 which align with scanning plate rows 220 to 223 and then follow apertures 241 to 244 which align with scanning plate rows 226 to 229. A certain part of the belt 148, corresponding to the last five revolutions of shaft 104, is provided with no apertures. During the first four of these five revolutions of shaft 104 the dial indications are scanned through the windows 231—234. The fifth revolution, corresponding in time to the last interval, is provided in order to afford an additional margin of time and to safeguard thereby the correct operation of the system. It is to be understood that the particular sequence of scanning is arbitrary, and in the instant illustration corresponds to the sequence and arrangement chosen in the photographic record.

As the scanning of the rectangular apertures 220—229 draws near completion, a cam 151, see Fig. 9, on the face of drum 144 encounters and operates its tracker arm 159, rocking shaft 167 and through it the segment arm 175. Through its engagement with shutter 250, arm 175 exposes a series of five openings 231—1 to 231—5 of the units integer. This operation occurs during the tenth cyclic scanning division and while gear 137 enters upon a circuit whereat its aperture 141 registers successively with the windows 231—6 to 231—0. If the film has its recording mark or marks within the range of these five windows, a beam of light will be permitted to pass during the instant when aperture 141 registers with the particular window or windows, exciting the photoelectric cell and initiating an electrical impulse as will be described hereinafter.

While the scanning gear 137 is completing its circuit passing over windows 231—1 to 231—5, a succeeding cam 152 of drum 144 operates tracker arm 169, rocking shaft 168 and rotating shut-

ter 251 to expose the remaining openings or windows 231—5 to 231—0, which will then be in readiness for the scanning gear 137 as its aperture 141 enters upon the second half-revolution. Meanwhile, cam 151 passes under its tracker arm, permitting spring 260 to restore arm 159, shaft 167, and its associated shutter 250. Thus, in succession, during each cycle the cams 151—152 effect the rotation of shutters 250 and 251, causing the dial readings to be executed in a predetermined sequence. The manner in which the dial shutters operate is illustrated graphically by Figs. 13 to 16.

In the course of the following description concerning the scanning apparatus as well as other apparatus, a complete operation will be considered as a cycle and each digital part thereof a division. Accordingly, there will now be described generally the cyclic divisions of the scanning unit. During the first division, the aperture 235 of belt 148 traveling leftwardly, as viewed in Fig. 12, scans the openings of plate 219 beginning with opening 224—1 and continuing through opening 224—0. This record corresponds to one of the digits which relates, in the instant example, to the identification of the metering camera. Somewhere along its course of travel, aperture 235, registering with one of the afore-enumerated openings, passes a light beam which filters through a transparent spot in the film 196. Since each division is constituted of ten subdivisive parts, the passing of this light beam during one of the sub-divisional intervals will result in the registration upon the photo-electric cell 273 of a light impulse which is immediately converted into an electric impulse, and lasting for approximately one tenth of a revolution of shaft 104.

During the second division, a similar performance occurs, during which the light beam may appear at the same or a different sub-divisional interval. This process is repeated until all of the holes in the scanning plate 219 are read or sensed in accordance with the following order: Aperture 235 will scan the row 224, aperture 236 will scan the row 225, then aperture 237 will scan the row 220, aperture 238 will scan the row 221, aperture 239 will scan the row 222, aperture 240 will scan the row 243, then aperture 241 will scan the row 226, aperture 242 will scan the row 227, aperture 243 will scan the row 228, and finally aperture 244 will scan the row 229.

Thus far, there have been described ten divisions of the cycle. When the tenth row is about three-quarters executed, cam 151 of drum 144 will engage and operate its scanning shutter member 250, as already described, exposing as it does so the dial apertures or windows 231—1 to 231—5. When the system enters upon the eleventh division, the scanning gear 137 will traverse the afore-enumerated five apertures or windows 231—1 to 231—5 in sequence, and before this operation is half completed another cam 152 of drum 144 operates its shutter 251, exposing the apertures or windows 231—6 to 231—0, which comprise the other half of the afore-mentioned indicator dial. Shortly thereafter, scanning gear 137 traverses the recently opened apertures 231—6 to 231—0 in sequence, and before half of its course is completed, a third cam 153 actuates its shutter member 250, etc. This process continues until each of the shutters 250 and 251 has been rocked to and fro sequentially, permitting its associated scanning gear 137—140 to seek out the position or positions whereat a beam of light registers with the aperture 141 as well as one of the windows 231.

As each cam 151—158 passes beyond the proximity of its tracker arm, its shutter 250 or 251 is restored, permitting but one of the scanning gears 137—140 to be effective at a time. During the fifteenth and final division, the last shutter 251 is permitted to close and also during this division, a slot 210 of quadrate 209 is entered by the pin 211 rotating shaft 208 one-quarter revolution. This movement of shaft 208 actuates feed sprocket 205 sufficiently to advance a new picture frame in front of the object plane of the lens. This length of film is drawn from the loop 204, which meanwhile has been enlarged due to the slow movement of feed sprocket 195, which occupies nearly an entire cycle in supplying a length of film that is withdrawn in a single division by the action of the intermittent feed sprocket 205.

The foregoing timing and allotment is quite arbitrary, and lends itself extensively to variation. Where it is desired to alter the sequence of scanning, it will be deemed obvious that the apertures 235—244 may be redistributed upon a belt 148 and also the occurrence of cams 151—158 may be re-allocated upon the surface of the drum 144. Beyond the scanning plate 219, see Figs. 4 and 7, there is found a light-tight compartment 270 containing a system of condensing lenses 272 and 271, which converge the light rays, directing them onto the cathode plate of a photo-electric cell 273.

Storage translator

The scanning operation constitutes a continuous cycle during which a number of electrical impulses are issued. For certain reasons, such as to permit of the intervention of an overlap and to afford a means for instituting a cumulative correction, it is desirable to provide a storage mechanism from which the signals may be withdrawn in simultaneous groupings or in a different order from that in which they are installed. A device for accomplishing this purpose is featured in the accompanying Figs. 18—27.

This unit comprises a base frame 300, at opposite sides of which are secured the bearing plates 301 and 302. Bearing plate 301 may be fabricated preferably of thirteen individual panels as has been indicated in Fig. 22, so as to permit convenience in manufacturing assembly. Plate 302 is a single partition, as may be noted best in Figs. 18 and 24, and upon its side there protrude the driven ends of shafts 303 and 304. Shaft 303 is provided with a friction clutch comprised of a secured disc 305 and a floating collar 309. Intervening disc 305 and collar 309 is a worm gear 310 cushioned between a pair of friction washers 311 and 312. Collar 309 maintains a slot-and-tenon relationship with member 306 which is secured to shaft 303 and which affords a flange 307. Between the flange 307 and collar 309 there is disposed under compression a coil spring 313 which maintains a pressure against collar 309, causing a driving torque, between gear wheel 310 and shaft 309.

A driving worm 314 meshes with the worm wheel 310 as well as with another worm wheel 310b of shaft 304, and is secured to a shaft 315 which may be driven by a motor not shown. An escape wheel 316 has fourteen equally spaced teeth 317, each of which is allocated to one of the fourteen effective divisions of each scanning cycle, no tooth being provided for the fifteenth or what may be termed an idle division.

Journalled on one side of the storage unit and best indicated in Fig. 21 is a bar 318 supported

in journal brackets through which extend its end pintles 319 and 320. The bar 318 carries a pair of plates 125 and 126, with which are formed the protruding escape lugs 321 and 322, the shape of which is best revealed in Fig. 19 (operated position). Under normal conditions, escape lug 321 engages one of the escape teeth 317 of wheel 316, barring the rotation of shaft 303 and causing gear 310 to slip between its friction discs 311 and 312. As may be seen from Fig. 32, its associate escape lug 322 is diametrically opposite between a pair of escape teeth 317, and moreover, is out of registration with wheel 316. When bar 318 is rocked in opposition to its return springs 374, so as to withdraw lug 321 outwardly, tooth 322 is moved into alignment as is its position in Fig. 19, permitting wheel 316 and shaft 303 to rotate through a small arc or until lug 322 encounters an oncoming escape tooth 317. Thereafter, bar 318 is returned to its original or normal position, lug 322 is withdrawn, and lug 321 again interposed. This permits escape wheel and shaft 303 to rotate another angular fraction, the two escape movements together constituting a rotation corresponding to one tooth interval, or one-fourteenth of a revolution.

Also mounted on shaft 303 at the interior of wall 301 is a cam 323, Figs. 18 and 24, which resembles generally the escape wheel 316, having fourteen projections 324, as indicated in Fig. 20, while aback the plate 302 shaft 303 supports a secured driving pinion 341 intermeshing with ten gears 342 to 351 associated with a series of ten parallel cam shafts 331—340. The contiguous gear train imparts alternately reverse rotation to the shafts 331 through 340, the power being derived at an intermediate point from the driving gear or pinion 341. Since the gears 342—351 are of identical size, shafts 331—340 are rotated at the same rate, and in addition to their rotational movement each shaft is capable of being shifted longitudinally through a limited distance as will be described hereinafter. Each shaft is provided with fourteen setting cams, 376 to 389, having apices as indicated in Fig. 27, disposed from each other in a helical progression. In accordance with the direction of rotation, the helixes of contiguous shafts are inverse and the shapes of their corresponding cams are similarly inverse.

Observing now shaft 304, it will be noted that this driving member carries a power distributing pinion 420 comparable generally to the afore-described pinion 341, see Fig. 24. As in the case of shaft 303, the power originating with shaft 304 is communicated to a series of alternate and oppositely driven shafts 420—429, Fig. 20, each of which carries fourteen cams progressively indicated in Fig. 26 and bearing the reference numerals 453 to 466. The contour of these cams differs from those on shafts 331 to 340, however, as may be noted by comparing Figs. 26 and 27. Each cam 453 to 466 carries a sidewardly beveled tooth 468 and a peripherally beveled tooth 467. Moreover, each of the shafts 420 to 429 is longitudinally shiftable throughout a limited distance, as may be noted in Fig. 25, terminating at its protruding end with an insulated portion 442. As may be noted from Figs. 20 and 25, the setting cams 376 to 389 and the restoring cams 453 to 466 are arranged in approximate alignment vertically, and each alignment will be considered as constituting a pair. Intervening each cam pair there is disposed a storage bar 396 to 409, whose upper end 414 terminates with an inclined

surface to rest against the periphery of a setting cam 376 to 389 and whose lower end is a square-cut portion 469. The storage bars 396 to 409 are maintained in vertical alignment by being slidably accommodated within rectangular notches formed in a pair of plates 390 and 393, which in the present embodiment are illustrated as being longitudinally divided intermediate the unit and between shafts 303 and 304, Fig. 20. Each of the storage members 396 to 409 is capable of assuming two positions, an upper and a lower, and in this connection it will be noted that each has formed with it a V-shaped detent lug 412 with which there cooperates an individual detent spring 413. The limits of movement of a storage bar are determined by the stop lugs 410 and 411 which collide with the plates 393 and 390, respectively. Noting now particularly Fig. 25, wherein the several setting cams 376 to 389 have been illustrated in their normal and shifted positions by solid and broken lines respectively, it will be seen that when in their normal positions these cams are offset slightly and out of alignment with respect to their associated storage bars 396 to 409, and that only during the time when they and their associated shafts 331 to 340 have been shifted rightwardly do they align vertically with the uppermost portions 414 of the storage bars 396 to 409.

The shifting of shafts 331 to 340 is impelled by associated armatures 354 to 363 which are influenced by magnets 364 to 373. In response to a timed electrical impulse, one of the electromagnets 373 becomes energized, attracting its armature 363, Fig. 25, and through it shifting the shaft 340 rightwardly. This displacement, though initiated by an electromagnet 373, is maintained for a time through the instrumentality of a common latching ball 325 which is provided with a wedge 328, adapted to engage and latch the several armatures 354 to 363 in either of their alternative positions. Latch ball 325 is also provided with an intermediate projection 329, Fig. 24, which is disposed in alignment with the periphery of multi-lobe cam wheel 323 whose cam projections 324, Fig. 20, engage the toothed extremity of projection 329, camming ball 325 upwardly and in a clockwise direction about its pivotal beam which is journaled in the end bearings 326 and 327. The counterclockwise movement of ball 325 is urged by restoration springs 330, Figs. 22 and 25, and the angular position of cam wheel 323 is such that during its normal or stop position, one of its teeth 324 aligns with projection 329, holding the ball away from the armature extremities 375.

Opposing the afore-described magnet armatures, each shaft 331 to 340 is provided with a return spring 353 which is supported under compression between the end wall 301 and a collar 352 carried by each of the afore-mentioned shafts, and each serves to restore its shaft and armature when permitted to do so by the withdrawal of ball 325. The protruding ends of shafts 331 to 340 engage and actuate the afore-described escapement bar 318, and upon their restoration, bar 318 is permitted to resume its normal position, after having permitted a single tooth escape movement of driving shaft 303. The energization of a magnet 364 to 373 causing an associated shaft 331 to 340 to be shifted longitudinally therefor, rocks the escape bar 318 and permits a slight rotation of all shafts under impetus of the driver 303, but before a full fourteenth of a revolution has been consummated, a succeeding tooth 324 of cam 323

restores latch ball 325, releasing the operated armature and permitting its shaft to resume its normal longitudinal position.

The afore-mentioned fourteen cams 376 to 389 with which shafts 331 to 340 are provided relate to and are effective during one of the afore-described cyclic divisions discussed in connection with the scanning apparatus. The radial extent of a cam projection 415 is preferably less than one-fourteenth of a revolution, to insure ample margin so that its operative effect may take place after its shaft has started to rotate and will be completed before the shaft comes to rest. It will be noted that during the rotation of the several shafts 331 to 340, one of the magnets 373 is energized, and a certain cam thereof will depress one of the storage bars 396 to 409, depending, of course, upon which of the fourteen cams happens at the particular interval to be engaging with its apex one of the afore-mentioned storage slides or bars. During each division, one slide of a transverse row (for example 396, 397, etc.) may be set and thereafter upon a succeeding step, another slide relating to a succeeding row may be set. There being ten slides in a transverse row and each relating to an integer, there is effected in this way a digital selection corresponding to each numerical value.

Each of the slidable storage bars 396 to 409 discussed above may be considered as corresponding to a position on a record card where a perforation may be made. The ten storage bars 396 constituting a row as viewed in Fig. 20, correspond to the digits 1, 2, 3, 4, etc., and may represent, for example, the tens digits of the record reader. Correspondingly, the row of slides 397 represent, for example, the units digit. In like manner the remaining rows of slides represent each of the integers, the sum total of which constitutes fourteen in the present embodiment.

Shaft 304, Fig. 24, receives its motion through a driven gear 310b which is supported between friction washers 311b and 312b, compressed between a flange 305b whose collar is keyed to shaft 304 and a flange 309b which is slidable longitudinally upon shaft 304 and which is urged by a compression spring 313b. At its opposite end shaft 304 carries a stop arm 416 which is restrained from revolving when it engages the tip of an armature 417 associated with magnet 418. A spring 419 maintains the armature 417 in its unattracted position and cyclically arrests shaft 304 after each single revolution. Driven gear 310b is preferably larger than is driven gear 310 so that shaft 303, which is intermittent in its movement, may rotate faster than shaft 304 to compensate for the former's larger number of rest periods.

After a slide bar has been depressed, there follows a rotation of its associated transfer shaft 420—429, bringing into engagement one of the restoring cam projections 468 with the protruding end 469, and causing the particular shaft to be shifted longitudinally. This thrusts the endmost portion carrying insulation 442 against an adjacent contact pair 443 to 452, closing it momentarily. Trailing each of the side shift operating cam projections 468 is the peripheral restoring cam projection 467 which upon engaging any one of the protruding ends 469 of the storage bars, restores the latter by overcoming its jockey spring 413. It will be noted specifically in Fig. 26, that while certain of the cams; namely, 453 to 462 are arranged in spiral succession, the

remaining cams 463 to 466 are at variance therefrom, with cam 466 following cam 462 in the order 465, 464, and 463. This arrangement conforms with an incident in the design of the particular embodiment, since the scanner functions to scan the meter in a reverse order; namely, units, tens, hundreds, etc., while the conventional card perforator devices operate in a descending order; namely, thousands, hundreds, tens, etc.

Cumulative correction

Referring now particularly to Figs. 18 and 25, it will be noted that storage bars 406, 407, and 408 are provided with sidewardly extending pins 474, and that transversely of the intervening space occupied by said pins 474 there are disposed slidable bars 470, 478, 481, 484, 487, and 490, each extending substantially half-way of the longitudinal extent of the unit and each protruding as indicated in Fig. 20 with an insulated section 475, which engages a contact pair as will now be described.

Slide bar 470 engages with its insulated tip 475 a contact spring 476, and when actuated, thrusts the latter against an associated contact spring 477. In a similar manner, slide bar 481 thrusts contact spring 482 against its associated spring 483, bar 487 thrusts contactor 488 against its associated contact spring 489, bar 478 thrusts its contactor 479 against its associated contact spring 480, bar 484 thrusts contactor 485 against its associated contact spring 486, and bar 490 thrusts contactor 491 against its associated spring 492.

The spring tension of the afore-enumerated contactors suffices to maintain its associated bar in a normal position, as illustrated in Fig. 20, maintaining the contactors spaced from their contact springs. Slide bars 470, 481, etc., are designated to slide freely within journal notches in the end frame and associated supporting brackets 471 and 472. The movement of a slide bar is effected when one of the storage bars 406, 407, or 408 is depressed, causing its pin 474 to engage the cam surface 473, Fig. 20, forming one side of a plurality of notches provided with each of the bars 470, etc. Thus, upon the depression of these certain storage bars, there is closed one or more of the afore-enumerated contact pairs. Slide bar 470 is illustrated as being associated with the five storage bars 406 which relate to the numerical digits 0, 1, 2, 3, and 4, while slide bar 478, aligning longitudinally with bar 470, cooperates with the five storage bars 408 relating to the digits 5, 6, 7, 8, and 9 of the hundreds integer. In the same manner the other bars 481 and 487 serve the lower digits of the tens and units integers while the bars 484 and 490 serve the higher digits of these integers. Thus, when in accordance with a particular integer one of the slide bars 406, 407, or 408 is depressed, depending upon whether the represented digit is of the lower or higher series of numerical values, one or the other of the pairs of bars 470—478, 481—484, etc., will be operated, closing its electrical contact pair for a particular purpose identified as a cumulative integer correction to be described hereinafter. It should be noted that as between the contact pairs relating to a transverse row, that is to say, as between the contact pairs 476—477 and 479—480, the closure of one pair is effected to the exclusion of the closure of its associated pair. This is true since but one integer may be registered in a

transverse row represented by any one class of storage elements 406 to 408, as will be explained later.

Perforating mechanism

The perforating apparatus forms no part of the present invention. The accompanying drawings do not include a complete disclosure thereof, and for the sake of a more comprehensive understanding, reference may be had to U. S. Patent No. 1,914,263 issued to C. D. Lake et al. wherein a typical card perforating device is fully described and illustrated. To one skilled in the art of automatic devices of this nature, it will be apparent that divers structures and apparatus may be employed in the preparation of perforated control cards, and that these mechanisms and apparatus may be suitably adapted to be controlled by electrical impulses such as are transmitted by the translating mechanism just described.

A diagrammatic representation of a perforating mechanism such as the one disclosed in the patent referred to has been illustrated in Fig. 37. To permit the correlation of Fig. 37 with Fig. 17 in said patent, similar reference characters have been employed here preceded by a character integer X.

In Fig. 32 two so-called skip bars X140 and X143 have been illustrated which are comparable to the skip bars shown in Figs. 13 and 14 in the patent. Bar X140 has a recessed portion occurring in the proximity indicated 1491 which corresponds to the vertical column 655 in Figs. 29 and 30, and a recessed portion 1492 corresponding to the vertical columns 656 and 657. Bar X143 has a recessed portion 1494 corresponding to a vertical column wherein the present reading is to be applied. The skip bars as disclosed in the patent, control the period of effectiveness with respect to a given series of operations in perforating a set of cards and other allocations are contemplated where, pursuant to another set-up, additional columns are to be thus employed.

Electrical circuit

Figs. 33, 34, 35, and 37, arranged in the manner illustrated in the pattern Fig. 38, constitute a complete wiring diagram for the supervision of a card perforating mechanism. Referring particularly to Fig. 35, the reference character 500 denotes a gang switch having five contactors which lead from an alternating current source indicated 502 and a three-wire grounded neutral direct current source indicated 501. The contactors of switch 500 when closed communicate with terminals 503 to 507 of the amplifier circuit of which terminals those indicated 506 and 507 connect to a primary winding 508 of a power input transformer whose secondary winding 509 is connected to a filament circuit of a vacuum tube 510. A middle tap 511 of the secondary winding is connected to the suppressor grid 526 as well as to the cathode element of tube 510.

Another secondary winding 512 is connected to the filament circuit of a vacuum tube 513 while a third secondary winding 514 is connected to a circuit 515 which leads to the exciter lamp 215 of the scanning device. The reference numerals 516 and 517 denote potentiometers which are connected across the direct current leads 518, 519, and 520 for regulating the voltage which operates the vacuum tube circuit. The control grid 441 of tube 510 is connected through a resistance element 521 to a suitable potentiometer point 522

and is also connected to the anode of a photo-electric cell 273. The cathode of photo-electric cell 273 is connected to the negative terminal of potentiometer 516, while the plate element of tube 510 is connected to the control grid 440 of tube 513 and through a resistance 523 to a suitable potentiometer point 524 on the potentiometer 517. Screen grid 525 of tube 510 is also connected to the potentiometer point 524. The plate 517 of tube 513 is connected over a lead 527 with one end of a resistance 528, the other end of which communicates over lead 529 to the positive terminal 503, while the continuation of leads 537 and 538 which connect with the same terminals of resistance 528, continue on into Fig. 34 as will be described later.

The scanning mechanism's electric motor 101 is connected through leads 530 and 531 to the neutral and positive terminals 504 and 503 and is controlled by a suitable speed control medium (not shown) though if preferred, motor 101 may be of the synchronous type actuated from an alternating current source.

When the switch 500 is closed, the scanning device is conditioned for operation. A light beam originating at the exciter lamp 215 is condensed through lenses 216a and 216b so as to project a beam of light on the record film 196, see also Figs. 2 and 4. The beam is intercepted by the image on the film and proceeds through the photographic lens 217, casting an image of the film in proper registration upon scanning area 218. As the several unit record areas are successively opened by the scanning mechanism, selected beams are permitted to proceed through the concentrating lens system 272 and 271 which direct the beam onto the cathode plate of photo-electric cell 273.

When a beam of light below a predetermined minimum intensity falls upon photo-electric cell 273, the grid of tube 510 continues to maintain a positive potential sufficient to permit current to flow in the plate circuit of tube 510 of a value such that the grid of tube 513 remains sufficiently negative to cut off completely the current in the plate circuit of said tube 513. On the other hand, when photo-electric cell 273 receives a beam of light greater than said certain minimum intensity, the grid of tube 510 becomes sufficiently negative to cut off the current in the plate circuit of tube 510. Accordingly, the current in the plate circuit of tube 513 is determined by the voltage at point 524 and the electrical constants of the circuit, and any increase in the amount of light over and above the said minimum intensity does not change the plate current in tube 513. As a result of this feature, minute leakage of light into the chamber of the photo-electric cell has no effect. Until the intensity of a light beam passes a regulated minimum, no signaling impetus is inaugurated and as an advantage of this feature, microscopic adjustments of light intensity are not necessary.

Referring now momentarily to Fig. 36, it may be noted that current flowing through resistance 528 for the period of one cycle is of a series of electric impulses representing the record reader No. 12, the meter No. 4086, the date 10-24 (October 24), and the meter reading 1300. In this case the cycle is also considered as made up of fifteen intervals corresponding to the afore-discussed fifteen divisions of a scanning cycle. Moreover, each division will be considered as divided into ten sub-intervals, each allocated to a digit. The representations indicated 620, 622,

etc., in Fig. 36 denote graphically intervals during which the photo-electric cell 273 is illuminated and current flows through resistance 528.

During the operation of the scanning device, brush arm 124 rotates in synchronism with the scanning mechanism and the movement of the scanning belt 148, so that its brushes 544 and 545 wipe across the commutator segments during exact instants when the corresponding areas of the record reader are being scanned. Thus, the distributor segment corresponding to the impulse 620 of Fig. 36 is wiped by the brushes 544 in the time interval indicated by the graphic representation 621. The impulse interval 621 may be made of considerably shorter time duration than the duration of impulse 620 so that its period of occurrence is not critical.

In the schematic illustration of Fig. 33, there are portrayed the contact pile-ups of the scanning apparatus which are situated at the upper end of vertical shaft 183 (Figs. 1 and 2). The several cams 184 to 190 have been illustrated in Fig. 33 with their contacts arranged on one side, whereas in the assembly views these contacts are variously distributed and on opposite sides of the cams. In Fig. 34 the scanner apparatus release magnet 118 has been conventionally illustrated as directly presented to release the brush arm 124 as though its own driving shaft 122 were frictionally actuated. These and other diagrammatic conventions have been employed for the sake of simplifying the circuit illustration.

Commutator 129 will be observed in Fig. 34 as an assembly of four concentric rings 540 to 543, the outer ring 540 of which is divided into ten segments indicated 540-1 to 540-9, between which there intervene insulation or spacer segments. Ring 542 affords three conductor segments indicated 542-1, 542-2, and 542-3, while rings 541 and 543 are continuous conductors. The brushes 544 are connected together and wipe across rings 540 and 541, while the brushes 545 are connected together and wipe across rings 542 and 543. During its stop position, brush arm 124 is disposed with its brushes 144 contacting an insulated portion intervening the conductor segments 540-1 and 540-9.

Ten leads 546 connect the segments 540-1 to 540-9 with the operating windings of a series of primary storage relays 547-1 to 547-9. The outgoing terminals of these windings are connected through individual resistances 548 to the common lead wire 538 which, as noted in Fig. 35, is a continuation of positive supply line 528. The continuous ring 541 is electrically connected through a resistance element 549 over lead wire 537 to the opposite terminal of the shunt resistance 528, and thence continues over line 527 to the plate 517 of vacuum tube 513. Accordingly, the amplifier circuit emanating from tube 513 is traceable through the commutator brushes 544 and relay 547 as arm 129 rotates over the several segments 540. Locking windings of primary storage relays 547 have one of their terminals connected through an individual resistance element 550 and thereafter are joined to a common lead 551, which in turn connects with a positive bus wire 552 which continues to the positive terminal of the perforator device, Fig. 37. The other terminals of the locking windings of each of the relays 547-1 to 547-9 are connected to individual front contacts 553 with which there cooperate a similar plu-

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ality of contactors 554—1 to 554—0. It will be observed that the contactors 554—1 to 554—5 are connected together to a line 439 leading therefrom through a contact pair 555 and 556 of a supervisory relay 557 joining the negative bus wire 558, which continues over into Fig. 37 where it too communicates with the perforator mechanism. The locking circuits of relays 547 hold stored signals throughout the duration of an interval which exceeds that of the signaling impulse distributed by the commutator 129. The contactors 554—6 to 554—0 of relays 547—6 to 547—0 are likewise connected together, having a common lead wire 438 which passes through the contact pair 559 and 560 of a supervisory relay 561 and thence over line 437 to the negative bus 558. These circuits too are locking circuits and are grouped separately for a purpose which will become apparent hereinafter.

Considering the two groups of primary storage relays 547—1 to 547—5 and 547—6 to 547—0 as the first and second group respectively, attention is now directed to a third group of relays indicated 562—1 to 562—5, each of which constitutes a secondary storage relay and is associated with a corresponding relay of the first group 547—1 to 547—5. The operating windings of relays 562—1 to 562—5 are connected each through a resistance element 563 to a common lead 436 which joins with the positive bus wire 552 while the opposite terminals of said windings lead each to a contact point 564 located near and influenced by an associated primary storage relay 547 of the first group. The locking windings of said secondary storage relays 562 are connected on the one hand through resistances 566 to the lead 436 which connects to positive bus 552 and on the other hand to individual locking contact points 567.

A group of contact tongues 565 are connected parallelly together over a lead 435 which communicates to the commutator segment 542—2, each of said contactors 565 being associated with one of said contact points 564. Since the companion ring 543 communicates with the negative bus wire 558, it will be observed that the movement of brush arm 129 causes an impulse to be communicated once during each revolution through the operating winding of any of the secondary storage relays 562 if its associated relay 547 has been operated. The contact tongues 568 which cooperate with the contact points 567 of the locking windings of relays 562 are connected parallelly over a line 434 through the contact pair 559 and 560 to the negative lead 558 so that the secondary storage relays 562 are locked concurrently with the second group of relays 547—6 to 547—0, and are released when the supervisory relay 561 is operated to open the contact pair 560 and 559.

The first and third relay groups 547—1 to 547—5 and 562—1 to 562—5 correspond to and represent the numeral integers 1, 2, 3, 4, and 5 and cooperate to provide an overlap in the signal storage of these enumerated digits. After the brush 544 has passed segment 540—5, brush 545 encounters segment 542—2, causing the setting of primary relays 547—1 to 547—5 to be transferred to secondary storage relays 562—1 to 562—5 and the setting of relays 547—6 to 547—0 proceeds. As a result of the transfer, the first group of relays 547—1 to 547—5 may be released so as to be available for a succeeding record while the secondary storage relays 562—1 to 562—5 maintain the storage setting to ac-

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commodate the perforating mechanism. This is accomplished when brushes 545 of commutator arm 129, upon leaving segment 542—2, enter upon segment 542—3, closing an obvious circuit which energizes the release magnet 557 of locking circuit 439.

Referring again to the second group of relays 547—6 to 547—0 and also to the secondary storage group 562—1 to 562—5, it will be noted that each is provided with a contact set comprised of a contactor 569 having a back contact terminal 571 and a front contact terminal 570 and a contactor 572 having a back contact terminal 574 and a front contact terminal 573. In each case as is the practice throughout this description, the reference numeral is associated with a dash integer (—1, —2, etc.) corresponding to the numerical integer of the particular element. The front contacts 570 and 573 of each set are connected together over a lead 433 which continues through the winding of an associated translator unit magnet 364 through 373. The other terminals of said magnet windings passing through individual resistance elements 575 are connected to the positive lead bus 552.

Of the series of tongues 572 it will be noted that tongue 572—1 is connected to the contact point 574—0, tongue 572—2 to the contact point 574—1, etc., throughout the series including tongue 572—9 which is connected to the contact point 574—8. The tongue 572—0 however, is not connected to contact point 574—9 but is instead connected to a lead wire 1576 which communicates with a switching device under the supervision of a relay 547—11 to be described later. Of the series of tongues 569, it will be observed that tongue 569—8 is connected to contact point 571—9, tongue 569—7 to contact point 571—8, etc., and tongue 569—0 will be observed as leading to contact point 571—1. The tongue 569—9 connects over a lead 1577 to tongue 547 of the aforementioned switching device 547—11. Thus there are described two series of contact chains or chain circuits which are controlled by the second and third storage relay groups 562—1 to 562—5 and 547—6 to 547—0.

The two chain circuits just traced perform, under the supervision of the cams 185, 187, and 189, a two-fold selective function, as will later be described. This arrangement of apparatus selects the lower of two consecutive integer signals which may be received concurrently due to the overlapping characteristic of the indicator dials 1, see Fig. 1 of the referred to compending application, which may, under certain instances, cause to be transmitted two consecutive digit signals for a single decimal indication. The apparatus featured functions in conjunction with the contacts 476—477, 479—480, etc., to effect what has been referred to as a cumulative correction. That is to say, when two signal impulses are received in a given decimal position, this circuit and apparatus functions to determine under the supervision of the adjacent lower decimal indication the proper one of the two signals to be recorded.

For example, if, in the event of a particular integer, two secondary storage relays 562—3 and 562—4 are simultaneously energized when impulses over commutator 129 are received, only one of the translator magnets 367 or 368 properly should become energized, in the particular case the magnet 367.

It should be noted that negative supply origi-

nating from branch bus 594a may be introduced over either of the circuits 576 or 577 under the control of the timing cams 180, 185, 187, or 189. During the cyclic divisions including the second to the twelfth, cam 180 through its apices 190—2 to 190—12 closes the contact pair 595—598, routing negative current directly to the circuit 576, but during the thirteenth, fourteenth, and fifteenth divisions, cams 185, 187, and 189 prepare the negative supply paths to the point of the cumulative correction contacts 476—477, 479—480, 485—486, etc., leaving to these contacts the final determination of whether the negative supply shall continue over circuit 576 or 577. As explained in the description of the translator and scanning units, contacts 476—477 and 479—480 serve the hundreds indication and control the cumulative correction of the thousands indication, the contacts 482—483 and 485—486 serve the tens indication and control the cumulative correction of the hundreds indication, while the contacts 488—489 and 491—492 serve the units indication and control the tens indication.

Accordingly, if a units storage is to be effected relating to the meter readings, its signal or signals are due to be transferred to the translator magnets 364 to 373 during the twelfth division of the scanner, at which time apex 190—12 of cam 180 routes negative to circuit 576. If at this time the two contemporaneous signals taken for example, above, should be received, primary storage relays 547—3 and 547—4 would receive a setting, transferring it immediately to their secondary relays 562—3 and 562—4.

Negative current will then be traceable from circuit 576 through contact pair 547g and 547e, lead 1576, contact pairs 572—0 and 574—0, 572—1 and 574—1, 572—2 and 574—2, through contact pair 572—3 and 573—3 instead of 572—3 and 574—3 because magnet 562—3 is operated. This routes negative over the associated lead 433 to the winding of translator magnet 367. The foregoing described interruption at contactor 572—3 breaks the chain at that point, cutting off negative supply and preventing magnet 368 from becoming energized. Instead, negative is available only to magnet 367 and the circuit continues through its winding and resistance 575 to the common positive branch which connects with bus 552. Thus in the case of the units digit of the meter reading where two integers have been recorded for one decimal (units) position, the lower of the two is invariably recorded to the exclusion of the higher. In subsequent decimal positions (tens, hundreds, etc.), the choice is selective as between a higher and lower integer value and is controlled by its next lower integer. Where the reading of the next lower integer is 0 to 4, the choice of a given decimal position as between two values should be determined in favor of the higher one and on the other hand, if the next lower integer is 5 to 9, the particular decimal position should be resolved in favor of the lower of two recorded values.

For accomplishing this, there is provided the already described contact pairs 476—477, 479—480, etc., in the translating unit and the above mentioned conditioning cams 185, 187, and 189. It will be evident from Figs. 18 and 20 that if a units, tens, or hundreds digit is of the lower numerical order, there will be closed one of the contact pairs 488—489, 482—483, or 476—477, and that if either of said digits is of the higher numerical order, there will be closed one of the contact pairs 491—492, 485—486, or

479—480. Accordingly, negative current supply will be carried to circuits 576 or 577, respectively.

The determination of election of digits is performed as has been said by the cumulative correction contacts 476—477, 479—480, etc., during the three divisions when cams 185, 187, and 189 Fig. 33, are effective. During the thirteenth division, the apex 185—13 of cam 185 encounters contact lever 601, causing to be closed the contact pairs 597—599, and 598—600. This permits negative current from branch bus 594a to continue through the contact pairs 597—599 and 598—600 to the contactors 491 of the pair 491—492 and 488 of the pair 488—489, and since but one of these pairs of contacts may be closed to the exclusion of the other pair, negative current may be continued thereafter either over the chain circuit 576 or over 577. If the previously recorded integer (in the instant case the units digit) happens to be of the lower numerical order (0 to 4), then, the horizontal slide bar 487, Fig. 18, will cause to be closed the contact pair 488—489. This will cause negative supply current to be supplied to the chain circuit 577. On the other hand, if the preceding digit is an integer of the higher numerical order (5 to 9), then the horizontal slide bar 490 causes the closure of the contact pair 491—492, causing negative current to be forwarded over line 576. Chain circuits 576 and 577 differ from each other essentially in the order in which their chain elements are associated with the secondary storage relays 562 and 547—6 to 547—0. The chain circuit 576 for example, ordinarily enters through branch circuit 1576 and continues through the contact pairs 572 and 574 in an ascending sequence from 0 through 1, 2, 3, etc. Chain circuit 577 on the other hand, normally enters through branch circuit 1577, whence it continues through the contact pairs 569 and 571 in a descending sequence. Accordingly, each chain gives preference to the first relay in its path where two consecutive relays are energized and since the chain circuits traverse the several relay contact pairs in opposite orders, the preference in the one case is to the lower numerically assigned relay and in the other case to the higher one.

The rule of preference is general and applies to all digits which are in accordance with the present embodiment arbitrarily divided into the afore-said groups 0 to 4, termed the lower numerical order, and 5 to 9, termed the higher one. In the case of the integer 0 which may have a value of zero or one of ten, the special condition obtains to determine, in each case, the value to be assigned. The determination is left to the characteristic of the overlap, so that if the two integer signals received are 9 and 0, the value of 0 is to be ten, but if the two integer signals are 0 and 1, the value of 0 is to be zero. For accomplishing this determination there are provided in connection with the storage relays 547—9 and 547—0, two additional contactors indicated 547b and 547d which cooperate respectively with the contacts 547a and 547c. In the event that both relays 547—9 and 547—0 are energized, which condition occurs only upon the contingency of having received the double character signal in the 9 and 0 reading, there results the closure of the afore-described contact pairs, causing a circuit to be completed which is traceable in Fig. 34 from negative bus 558, contact pairs 547d, 547c, and 547b, 547a, winding of change-over relay 547—11 to positive bus 552.

As a result of the energization of changeover relay 547—11, the contactors 547e and 547f are withdrawn from their back contacts 547g and 547i, respectively, and are brought into engagement with their front contacts 547j and 547h. The effect of this changeover is to interchange the connection of negative lines 576 and 577, causing the former to proceed over branch circuit 1577 and the latter over branch circuit 1576. This changeover results in a reversal of the manner in which the preceding integer controls the election between two digits, one of which includes the numeral 0, so that whereas under normal conditions if the next lower integer belongs to the higher numerical order, it selects for recordation the lower of two simultaneous digits; the effect of having energized the changeover relay 547—11 causes an integer to select the higher of two such digits, and vice versa.

Taking as an example of a number to be recorded the reading 1300 featured in connection with the dial illustration of Fig. 1 of the referred to copending application, it will be observed that there happens to be an overlapping condition of the dials 1 in the units, tens, and hundreds indicators but no such condition in the thousands indicator. The units reading is arbitrarily resolved in the favor of the lower of two digits because apex 190—12, Fig. 33, of cam 190 invariably introduces during the units records interval, a negative potential from branch bus 594a over contact pair 595—596 to the chain circuit 576, which effects a minor integer preference. Since the recorded integer is 0 (the digit 0 being given the value of zero) and since this integer belongs to the lower numerical order, its recordation will cause to be closed the contact pair 488—489, giving a preference in the tens digit recordation to the higher or major integer which, in the instant example, is 0 (having the value of ten) in favor of 9.

Since the tens decimal position recordation is 0, which fundamentally belongs to the lower numerical order, it likewise will give a preference to the major of two companion signals in the hundreds position. Thus the integer 3 will be given preference over the integer 2. Had the thousands dial 10 been overlapped so as to cause to be transmitted a pair of signals instead of one signal, the control thereof by the hundreds dial would be such as to give a preference to the major signal, the integer 3 belonging, as in the previous cases, to the lower numerical order. At a subsequent point in the present description, the operation of the unit will be traced specifically.

While the primary and secondary storage relays 547 and 562 are arranged in an order beginning with the integer 1 and continuing 2, 3, 4, etc., to the integer 0, the translator magnets 364 to 373 are arranged in a different order, beginning with 0 and continuing 1, 2, 3, etc., to the integer 9. The circuit illustrated in Fig. 34 shows how two numerical orders differing from each other in this manner may be reconciled so that the sequence occurring in the scanner agrees with that occurring in the perforator-translator.

The energization of the translator magnets 364 to 373 controls the closure of contact pairs 443 to 452 which, in turn, are connected over a cable of leads indicated 578, Fig. 37, to corresponding magnets X107. The outgoing terminals of magnets X107 are parallelly connected to a bus bar from which a lead X182 communicates through a contact pair X152 with a line X175, contact pair X145, leads X174 and X161 to the positive bus

wire 552. The other contactors of contact pairs 443 to 452 are connected together and join with the negative bus wire 558. Upon the energization of any magnet 364 to 373, the particular one of the contact pairs 443 to 452 is closed following the operation of the shafts 420 to 429 of the translator unit, and in this way there is completed a circuit which causes the energization of one of the perforator magnets X107. As a result of the energization of a perforator-magnet X107, an associated punch is operated, causing to be made a hole in a corresponding position on the control card.

If negative is supplied to circuit 577 by a preceding recordation and a particular integer is recorded with two digital readings, for example 5 and 6, then primary storage will be had in relays 547—5 and 547—6. Promptly, relay 547—5 transfers to the secondary storage relay 562—5 and the resulting chain circuit is traceable from negative collector 577, contact pair 547i and 547j, lead 1577, contact pairs 569—9 and 571—9, 569—8 and 571—8, 569—7 and 571—7, 569—6 and 570—6 (because primary storage relay 547—6 is operated) thence over lead 433 through the winding of translator magnet 370 to positive bus 552. Because of the interruption of the chain at contactor 569—6, negative is cut off from the subsequent contactors and a choice is in effect favoring the highest digit. It may be observed that one of the described chain circuits is designed to favor the digits in a lower to higher progression while the other does so in an inverse progression.

Referring now more particularly to Figs. 33 and 34, it will be noted that the commutator start magnet 118 on the scanning apparatus is connected through a resistance 579 to the positive bus 552. The other terminal of magnet 118 continues over a line 580 to a contact pair 582—584 of relay 583. The tongue 584 of the aforementioned contact pair is connected with a contactor 585 whose associated contactor 581 also communicates with line 580. The continuation of the line leading from tongue 584 communicates with one contact of a contact pair 586 and also with a manual control switch 587. A line connecting the other terminal of contact pair 586 passes through a contact point associated with the manual switch 587 and continues on Fig. 34 to the manual switch 588, which connects with the negative bus 558. When manual switches 587 and 588 are closed, a circuit is completed through contact pairs 581—583, energizing magnet 118 to start the commutator 129. It will be recalled that the energization of magnet 118 controlling clutch 119, Fig. 3, initiates the entire scanner mechanism which continues to operate so long as the contact pair 581—585 remains closed. When the apex 186—9 of cam 186 encounters the follower arm 186a, contact pair 581—585 is opened and the scanner will then be arrested unless at that time contact pair 582—584 is closed, which is effected by the energization of relay 583. The circuit for energizing relay 583 is traceable from positive bus 552, through a branch lead 583a, winding of relay 583, outgoing wire 881, contact pair X149, element X165, manual switch X192 to a branch circuit which communicates with lead X162, and manual switch X160, to the negative source of current supply. The contact pair X149 is closed when a card is properly in position, and since the contacts 581—585 may still be opened, it is necessary to lock relay 583 in its operated position. Accordingly, a locking circuit is provided under the con-

trol of cam 184, which is traceable from negative bus 558, Fig. 34, manual switch 588, through the manual switch 587, contact pair 588a, contact pair 583b and 583c, to the negative lead of relay 583. This locking circuit is opened towards the conclusion of a cycle when the apex of cam 184 reopens the contact pair 588a.

General operation

Having particular reference to the afore-mentioned sheets containing the wiring diagram, and specifically to Figs. 33 to 37, let it be supposed that power switches 500 and X100 are closed, a record film 196 is properly inserted through the film gate 203, and that a blank card is appropriately positioned in accordance with the accommodations of the particular card perforating machine. Manual switches 587 and 588 are closed, causing magnet 118 to become energized and starting the scanner apparatus into operation. There will be reviewed hereinafter the precedent established above of considering the cycle as comprised of fifteen component divisions. The arbitrary record to be recorded is taken as that illustrated on the film in Fig. 6 and on the meter in Fig. 1 in the above-referred to copending application, which record, it will be supposed, is now in alignment on the scanner machine.

By comparing Fig. 6 of the copending application referred to, and Fig. 17, it will be noted that during the first division the opening 224-1 of the scanner plate will pass a light beam to the exclusion of all other openings. This will occur when the opening 235 of the scanning belt 148, Fig. 12, sweeps across the line of openings 224. The photoelectric cell 273, Fig. 35, will be activated, permitting current to flow through resistance 528 as has been indicated 620 in the timing chart, Fig. 36. During the time interval represented by the short line 621, the distributor segment 540-1, Fig. 34, will connect the operating winding of relay 547-1 to the leads 537 and 538, causing relay 547-1 to be operated and locked in its operated position by reason of its locking winding including contacts 553-1, 554-1. The locked condition of relay 547 prevails until release relay 557 is energized at a subsequent time as a result of the brushes 545 of distributor arm 124 encountering the segment 542-3. Had the particular integer related to the higher numerical order, its locking circuit would have been under the control of contact pair 559 and 560 of release relay 561 whose energization is likewise controlled by the brushes 545 of distributor arm 124 when the latter encounters the segment 542-1.

It will be noted that during the first division while a scanning operation is taking place, the impulse corresponding thereto is not yet delivered to the translator until the second scanning division is entered upon by the scanning apparatus. Hence, the translating and storage unit will customarily be one division late in terms of the scanning cycle. For this reason, no operation takes place in the translator at this time.

During the second division, the row of openings 225, Fig. 17, will be scanned and a light beam will be passed when the aperture 236 of scanner belt 148 comes into alignment with the scanning plate opening 225-2. The current which then flows through the photoelectric cell is represented by the line 622 in Fig. 36, and the time interval represented by the short line 623 thereafter corresponds to the instant when the distributor seg-

ment 540-2, Fig. 34, is connected by brushes 544 so that relay 547-2 receives an impulse over the circuit including leads 537 and 538. Accordingly, relay 547-2 will be energized and locked in its condition through its locking contacts 553-2 and 554-2, over the same locking circuit described before in the first division. During the remainder of the cycle, brushes 545 of distributor arm 124 encounter segments 542-1, 542-2, and 542-3, in the order indicated, operating the locking relays 561 and 557 but before the operation of relay 557 segment 542-2 affords a transfer impulse for transferring the setting of relay 547-2 to its associated transfer relay 562-2 as has been described. Meanwhile, and before brushes 545 encounter the first segment 542-1, the projection 190-2, Fig. 33, engages its contact lever 190-a, closing the contact pair 595 and 596. It will be recalled that shaft 183, which carries cams 184-190 is gear driven from a source common to the distributor shaft 122, Fig. 5. A circuit may then be traced from the positive bus 552 through one of the resistances 575 associated with the translator magnet 365, through the winding of magnet 365, contact 573-1 and its operated tongue 572-1, back contact 574-0, unoperated tongue 572-0, lead 1576, contactor 547-e (which is unoperated at this time), contact point 547-g, to the negative circuit 576.

Magnet 365 becoming energized, causes slide 396-1, Fig. 25, to be set into its operated position when its armature 355 is attracted, causing its shaft 332 to be shifted endwise to a position such as that illustrated in broken lines in Fig. 25. Lever 325, which had been poised by the intervention of a tooth 324 of sprocket cam 323 is permitted to descend, locking the armature 355 in its energized position. As a result of the movement of shaft 332, pallet bar 318 is rocked counterclockwise, causing its tooth 321 to be withdrawn from its particular associated tooth 317 of escape wheel 316, and permitting shaft 303 to respond to the urge of its driven gear 310 until an opposite escape tooth 317 encounters the projection 332 opposite the afore-mentioned projection 321. In accordance with the angular position of shaft 332 at this time, cam 377, see Figs. 25 and 28, will encounter the tip 414 of slide bar 396-1, camming the latter member downwardly against the tendency of its detent spring 413 and causing its bottom lug 469 to protrude a short distance beyond its normal presentment. Meanwhile, magnet 365 has become de-energized, and the position of shaft 332 is maintained solely as an effect of the latching bail 325. Shortly before escape tooth 317 encounters lug 322, a succeeding cam tooth 324 of cam 323 will encounter the cam projection 329, lifting the latch bail 325 back to its poised position. This immediately permits the restoration spring 353 to shift shaft 332 back together with its associated armature 355 and as a result of the return springs 374 pallet bar 318 will resume its normal position, withdrawing escape projection 322 from the path of escape tooth 317, and permitting escape projection 321 to again present itself in the path of the oncoming escape tooth 317.

The resultant rotation of main shaft 303 is communicated through the train 342-351 to each of the shafts 331-340, including of course, shaft 332. From the foregoing explanation it is to be observed that latching bail 325 serves a purpose of prolonging a signal condition which has been initiated by the energization of one of the magnets 364-373 and that its utility may be con-

sidered that of a safeguard, though the magnets 364—373 may themselves suffice to hold their associated shafts 331—340 provided that the energizing impulses are of correct duration and of properly timed occurrence.

At a time before distributor brush 545, Fig. 34, reaches segment 542—1, the projection 190—2, Fig. 33, of cam 190 passes lever 190—α, permitting the contact pair 595—596 to again open and releasing the energized magnet 365. The time during which this magnet remains energized is somewhat less than the time required for shaft 303, Fig. 24, to make one-fourteenth of a revolution.

Upon the termination of the second division, all of the shafts 331—340 come to rest after having rotated through one-fourteenth of a revolution, following which the unit enters upon the third division. Magnet 366 is energized, pulling up its armature 356 and shifting longitudinally its shaft 333. Driving shaft 303 and its auxiliary shafts 331—340 then proceed to consummate the second fourteenth of a revolution in accordance with the action of pallet bar 316 in the manner described above. During this rotation, the apex 415 of cam 376, which is located on shaft 323, engages the tip 414 of storage bar 390—2, overcoming its jockey spring 413 and setting bar 390—2 so that its protruding end 479 extends into the path of a cam 455—2. Thus far, the first numeral 1 has been stored in the translator while the second numeral 2 has been stored in the intermediate storage relay 562—2 awaiting further progress during the third division.

During the third division, the apertures 230 of the scanning plate, Fig. 17, are traversed by the scanner aperture 237 of the scanning belt 149. Referring now to Fig. 6 of the copending application above-mentioned, it will be noted that the light beam will occur when aperture 237 aligns with the scanning plate aperture 220—4. Meanwhile, in the manner already described, distributor brush arm 124 will enter upon a third revolution, causing photo-electric cell 273 to become activated at an instant represented in Fig. 36 by the line 624; while during the shorter time interval represented by the line 625, the distributor segment 540—3, Fig. 34, will connect the operating winding of relay 547—4 to the circuit leads 527 and 538. This will cause relay 547 to be operated and locked as in the previous examples.

Thereafter, when brushes 545 encounter segment 542—1, unlocking relay 561 will be operated, causing the intermediate storage relay 562—2 (of the preceding integer) to be released. Brushes 545 continue, encountering segment 542—2, transferring the setting of relay 547—4 to the intermediate storage relay 562—4 and relay 547—4 is released when finally brushes 545 encounter segment 542—3 which introduces a pulse to the unlocking relay 557, whose locking circuit serves the first five relays 547. Meanwhile, the brush arm 124 is undergoing its third revolution and projection 190—3, Fig. 33, encounters the projection of contact lever 190—α, closing the contact pair 595 and 596 and introducing negative to the circuit 576. A circuit may now be traced from the positive bus 552, Fig. 34, through the particular resistance 575 and winding of magnet 366, thence through the contact 573—2 and operated contact tongue 572—2 of relay 562—2 (which is still energized), back contact 574—1 and its unoperated contact tongue 572—1, back contact 574—0 and its unoperated contact tongue 572—0, lead 1576 and the unoperated contact

tongue 547—e, contact 547—g, and negative circuit 576. Negative current source is available to the circuit 576 because of the momentary closure of contacts 595 and 596 communicating to it negative current from the branch supply line 594—α. As a result, magnet 566 of the translator unit is operated, causing the storage slide member 397—2 to be set in its operated position. Thus, the second numeral has been stored in the translator unit while the third numeral, which comprises the first meter number integer, is stored in the intermediate relay 562—4.

From the foregoing examples, it may be noted that the circuit operation of the subject matter disclosed in Figs. 33 and 34 is repeated for each digital recording, so that the description thereof need not be repeated during the course of the ensuing divisions except to indicate where certain variations of operation enter.

During the fourth division, opening 221—0 passes the light beam, relay 547—0 is operated, but no transfer to the intermediate group takes place because the intermediate group 562 serves only the first five digital relays (the lower numerical order). Also during this division, magnet 360 is operated, causing to be set slide 398—6 in accordance with the preceding integer.

During the fifth division, opening 222—8 passes the light beam, and relay 547—8 is operated. Also during this division magnet 364 is energized, causing to be set the storage slide 390—8 in accordance with the preceding setting.

During the sixth division, opening 223—0 passes the light, causing relay 547—6 to store a signal. During this division, translator magnet 372 is operated, causing slide 400—6 to be set in accordance with the preceding digit.

During the seventh division, opening 226—1 passes the light, setting up a storage condition in relay 547—1 which is transferred to the intermediate relay 562—1. Meanwhile during this division, magnet 370 is operated, setting the storage slide 401—6 of the preceding digit.

During the eighth division, opening 227—0 passes light, causing storage relay 547—0 to receive a setting, which is immediately transferred to the intermediate relay 562—0. Meanwhile magnet 365 is operated in the translator unit, causing slide 402—1 to receive a setting.

During the ninth division, opening 228—2 passes light, setting up a storage condition in the primary relay 547—2 which is immediately transferred to the intermediate relay 562—2. Meanwhile, magnet 364 is operated in the translator unit, causing storage slide 403—0 to be set in storage condition.

At this time, cam projection 186—9, Fig. 33, moves the contact lever 186—α and causes to be opened the contact pair 581—585. This transfers the control of start magnet 110 to the contacts 582—584 of relay 583, which is controlled by the perforator contact X149. If for any reason the card perforator has not reached the last column of the preceding recording, contacts 582—584 will remain open, preventing magnet 118 from being energized and arresting the scanner at the end of the ninth division pending such a time that the card perforator will have completed recording its last column.

During the tenth division, opening 229—4 passes light, causes relay 547—4 to become energized and immediately to transfer its setting to the intermediate relay 562—4. Meanwhile, magnet 366 will become energized, causing slide 404—2 to be set in its storage condition.

At this time, cam projection 188—10, Fig. 33, will encounter its contact lever 594, closing the contact pair 592—593 and causing to be energized the translator magnet 418 which starts shaft 304, Fig. 24, into its cycle of operation. The operation of the translator at this time causes to be transmitted over the cable 578 the stored signals to the card perforator. However, since it does not rotate in exact relation with the receiving device, its further operation will be described separately hereinafter.

At the beginning of the eleventh division, cam projection 190—11 of cam 190 encounters its contact controlling lever 190—a, closing the contact pair 595—596 and completing the circuit for transferring the stored signal to its translator magnet 368 which, in turn, causes slide bar 405—4 to be set. The units digit of the meter reader is scanned, which, as may be noted from Fig. 1 of the copending application above referred to, finds the indicator covering both the 0 and the 1 indication. Accordingly, the photographic record will permit both openings 231—0 and 231—1, Fig. 11, to pass a light during their exposure intervals. The passing of the light in the two positions will cause relays 547—1 and 547—0 to become energized, the former immediately transferring its setting to its intermediate storage relay 562—1.

At the beginning of the twelfth division, cam projection 190—12, Fig. 33, encounters and operates its contact lever 190c, closing the contact pair 595—596 and completing a circuit which may be traced from positive lead 552, Fig. 34, through the resistance 575 and winding of magnet 364, front contact 573—0 and its operated contact tongue 572—0, unoperated contact tongue 547e and its contact 547g, wire 576, contact pair 595—596 which is now closed, and negative branch bus 594a. The energization of translator magnet 364 corresponds to the 0 digit, but it will be recalled that at the same time the figures 1 digit should also seek energization of magnet 365. This recordation will not result, however, for a reason which may best be revealed by tracing the chain circuit which includes the winding of magnet 365. Starting again from positive bus 552, this circuit continues through the resistance and winding of magnet 365, thence out through the contact point 573—1, operated contact tongue 572—1, and contact 574—0, but since contact tongue 572—0 is operated, the circuit is open at this point, preventing magnet 365 from becoming energized. Thus, it will be understood that in accordance with the sequential arrangement of contact tongues 572 and their contacts 573 and 574, there is effected a digital selection favoring the lower numerical series and giving preference to a lower indication over a higher one.

In the other chain circuit starting from positive bus 552, through the resistance 575 and winding of magnet 365, the circuit continues through a contact point 570—1, operated contact tongue 569—1, through the back contacts 571 and unoperated tongues 569 of relays 562—2 to 562—5, whence the circuit emerges continuing through the contact point 571 and contactors 569 of relays 547—6 to 547—9, thence out over circuit 1577 to the contact tongue 547f, its contact point 547i, to the lead 577, but since none of the contact pairs 476—477, 482—483, nor 488—489 are closed at this time, and moreover, since none of the cams 185, 187 nor 189 is effective to close its negative supply contact pair 597—599, etc., this circuit terminates for want of negative source. It will be noted therefore, that of the two chain

circuits 576 and 577, the former alone obtains negative source through the closure of contacts 595 and 596, invariably causing to be selected the lower of two consecutive integers.

During this division also the tens digit of the meter reading is scanned. Thus far in the translation it will be noted that the translator mechanism functions merely as a signal receiving device, converting an electrical signal impulse whose identity corresponds to its period of occurrence into a mechanical storage manifestation having the physical evidence of a depressed or dislodged slide bar 396 to 408. In connection with the succeeding and final three translations, however, there may be performed an additional function which is referred to here as the cumulative correction. In this capacity, the translator not only conditions a slide bar but may also determine which of two companion integers is to be selected where, in accordance with the characteristics of conventional meter indicators, slight increments of movement are imparted so as to leave certain ones of the integer indicators ambiguous and overlapping between two integer manifestations. In the tens dial indicator, too, two digits are covered, causing light to be passed through openings 232—0 and 232—9, see Fig. 1 of the above referred to copending application, and Fig. 17. As represented in Fig. 36, there will now be transmitted a long impulse 644 corresponding to the adjacent integer positions. In the distributor, segments 540—0 and 540—9 transmit short impulses represented in Fig. 36 by the lines 645 and 647 operating the storage relays 547—0 and 547—9.

In the translator unit, see especially Fig. 18, the operation of slide 406—0 causes the transverse slide 487 to close contacts 488—489, which will prepare a circuit for discarding an unwanted numeral record on the numeral relays for the tens digit in the event that two signals are communicated.

At this time, the changeover relay 547—11 is operated through a circuit traceable from positive bus 552, winding of relay 547—11, contact 547a, and its associated tongue 547b which is operated due to the energization of storage magnet 547—9, contact 547c, and its tongue 547b, which is operated due to the energization of storage relay 547—0, to negative lead 558. Thus it will be seen that changeover relay 547—11 is operated because both relays 547—9 and 547—0 have been operated concurrently. At this time cam projection 185—13, Fig. 33, engages and actuates the contact lever 601, closing the contact pairs 597—599 and 598—600. A circuit may now be traced from the positive bus 552 through the resistance 575 and winding of magnet 364, contact 573—0 and its operated tongues 572—0, lead 1576, operated contact tongue 547e and its contactor 547j, conductor 577, closed contact pair 488—489 (because horizontal slide 487 has been thrust leftwardly by a preceding digit of the lower order, Fig. 18), contact pair 599—597 (because projection 185—13 is effective), branch bus 594a, to negative bus 558. The energization of magnet 364 causes to be operated the storage slide bar 407—0, whose movement causes horizontal slide bar 481 to move to the left, closing the contact pair 482—483. The election thus made is a major preference because of the intervention of the changeover relay 547—11 and excludes the energization of translator magnet 373 whose circuit will be found open for the reason discussed in connection with the foregoing description of di-

vision twelve, the broken condition being found at contact pairs 491—492, Fig. 18, and also at contacts 574—0 and 572—0. In this manner the digit 0 has been given a value of ten instead of one of zero.

Also during the thirteenth division, the hundreds dial is scanned. The openings 233—2 and 233—3 pass light through the film and in this case there happens also to be generated a long impulse (the two integers 2 and 3) which has been indicated in Fig. 36 by the reference character 548 with its two short distributor impulses 549 and 551, generated by the distributor segments 540—2 and 540—3. As a result, relays 547—2 and 547—3 are operated, and immediately the storage conditions are transferred to the intermediate or secondary relays 552—2 and 552—3.

At the beginning of the fourteenth division, cam projection 187—14, Fig. 33, engages and operates its contact lever 606, closing the contact pairs 602—603 and 604—605. A circuit may now be traced from positive bus 552 through the resistance and winding of magnet 367, contact 570—3, and its operated tongue 569—3, thence through the back contacts 571 and unoperated tongues 569 of the relays 562—4 to 562—5, thence through the corresponding contacts and tongues of relays 547—6 to 547—9, thence through the unoperated tongue 547f, contact 547i, lead wire 577, closed contacts 582—503 (the slide 481 being operated), closed contacts 602—603, branch bus 594a, to negative bus 558. As a result of the energization of magnet 367, slide bar 409—3, is set in storage condition, causing horizontal slide bar 470 to move leftwardly, Fig. 18, and close the contact pair 476—477. This prepares the cumulative correction for disposing of the unwanted integer signal in the thousands position, if the latter happens to record two integers. Also during the fourteenth division, the thousands dial is scanned, which finds but one integer (1) indicated. In accordance with the particular example, only the opening 234—1 receives a light beam, causing a short electrical impulse to be generated, indicated 552 in Fig. 36. Meanwhile, segment 546—1 transmitting a control impulse indicated 553 operates relay 547—1, whose storage condition is immediately transferred to its associated intermediate relay 552—1.

During the fifteenth division of the cycle, no scanning takes place, but the setting of the relay representing the thousands position is at this time transferred to its corresponding slide in the translator unit. At this time, cam projection 189—15 engages and operates its contact lever 611, closing the contact pairs 607—608 and 609—610. The major preference circuit may not be traced from positive bus 552, through the resistance and winding of magnet 365, front contact 570—1 and its operated tongue 569—1, the several contacts and unoperated tongues 571 and 569 of intermediate storage relays 562—2 to 562—5, thence through the same contacts and tongues of the primary storage relays 547—6 to 547—9, line 1577, thence through the unoperated tongue 547f, contact 547i, lead wire 577, closed contact pair 476—477 (horizontal slide 470 having been moved to the left by the preceding storage), closed contact pair 607—608 (whose closure is a result of cam projection 189—15), branch bus 594a, and negative bus 558. As a result of this circuit, magnet 365 is energized, setting its slide bar 409—1 in its storage position.

All of the record has now been scanned and transferred to the storage bars of the storage and

translator unit. During the fifteenth division, the film 196 is advanced to bring the next record into scanning position as has been previously explained. If manual control switch 587 is meanwhile opened, the scanner will continue operation until the scanning of a particular record is completed, but will stop at the end of its cycle due to the engagement of projection 183—0, Fig. 33, with its contact lever, which results in the openings of contact pair 586.

During the tenth division, magnet 418 was energized permitting translator shaft 304 to rotate, and as a result of its rotation shafts 420—429 are also rotated in accordance with their gear engagement. It will also be recalled that the translator unit functions in fifteen divisions, as does the scanner mechanism.

During the first division of the transmitting portion of the translator, contact pair 444, Fig. 21, is closed (due to the longitudinal shifting of shaft 332 by operated slide 398—1). A circuit may then be traced, see especially Figs. 34 and 37, from positive lead X—151, wire X—176, contact pair X—45, wire X—175, contact pair X182, wire X—182, through the junction block, magnet X—107—1 through its associated wire and cable 570, contact pair 444, to negative bus 558. The energization of magnet X—107—1 causes the perforator to make a perforation in the No. 1 position in the first column assigned to the tens digits of the reader number, see Figs. 29 and 31. The card is then advanced by suitable feed mechanism so as to present the second column into the perforating position.

During the second division, contact pair 445 is closed and in a similar manner the magnet X—107—2 is energized, causing a hole to be made in the No. 2 position in the second column corresponding to the reader number. The card is then advanced to the third column.

During the third division, contact pair 447 is closed and the thousands digit of the meter number is recorded, while during the fourth, fifth, and sixth positions contact pairs 443, 451 and 449 are correspondingly closed, causing perforations 4, 0, 8, and 6 to be made in the thousands, hundreds, tens, and units positions respectively.

Referring now to Fig. 32, it will be recalled that at this time a skip bar becomes effective to advance the card in the nature of a tabulation through distance so as to skip the intervening columns and to align the twenty-sixth column in position for receiving the month recording.

During the seventh division, contact pair 444 is closed for producing the tens digit 1 of the month, while during the eighth division contact pair 443 is closed for producing the units digit 0 of the month recording.

In a similar manner, during the ninth and tenth divisions, the tens and units records of the calendar day are made. During the eleventh, twelfth, thirteenth, and fourteenth divisions, the thousands, hundreds, tens, and units records are made relating to the meter reading, which records are placed in the thirtieth to thirty-third columns, inclusive. The card record is now completed and appears as illustrated in Fig. 29. Following this, an ejector removes the card to make room for a new card and prepare for a succeeding operation.

When the rolls of exposed film are received at the accounting office, they are developed and placed into the photo-electric sensing apparatus which is connected to a perforator such as the

one shown in the upper portion of Fig. 1 in U. S. Patent No. 1,914,263. A skip bar similar to the one indicated X140, Fig. 32, is placed into the perforator, the supply hopper is provided with blank cards, and then the apparatus is started into operation. From this arrangement cards may be prepared which will resemble the example shown in Fig. 29, since they will have the information perforated upon them indicated by the reference characters 655 and 656.

Following a subsequent reading of the same meters, another set of cards will be prepared in the manner just described and these cards will appear, for example, as the one indicated in Fig. 31, having on them the perforations represented by the columns identified by the reference characters 668 and 669. Of the two groups of cards relating to the first and second readings or any other sequence of readings, for that matter, corresponding cards (identifiable by similar meter numbers) will then be sorted together in any convenient manner, as by an automatic sorting machine which is sensitive to the meter numbers. Machines for doing this are now known in this art.

All of the cards of the first set arranged in a given order are then placed into the perforator hopper while those of the second set are placed into the feed trough of the sensing portion of said perforator. A skip bar is applied having the characteristics shown at X143, Fig. 32, and the apparatus is started. As a result of this arrangement, the class of cards placed into the perforator are modified to resemble those exemplified in Fig. 30 by the addition of a set of control perforations in column 670 which resembles the column 669 of Fig. 31.

The resultant cards bearing both classes of information (first and second readings) may then be used to control accounting machines which have means for recording a reading based upon a difference in the two perforated readings. The record is then employed in making out bills, entering into ledgers, or for any other accounting purposes.

Modified method of operation

There will now be described a modified system of record translation in which electrical relays are employed for storing and translating the perforated record.

In Fig. 28 there is illustrated a modified form of scanner belt 700, having sufficient length to embrace two complete cycles each of which is divided into eighteen divisions instead of the fifteen divisions employed in the preferred showing. Scanning apertures 701-710 correspond identically to the scanning apertures 235-244 illustrated in Fig. 6, and each performs a similar function, but whereas belt 148 provided a space intervening the cycles which corresponded to five divisions, belt 700 provides such a space corresponding to eight scanning divisions. The surplus divisions relate to three additional cyclic intervals or divisions which are required in the modified apparatus for performing certain operations peculiar to the modified system.

By comparing Fig. 41 with Fig. 1, it will be noted that in the instant case the surface cams of drum 144 are considerably rearranged in connection with the modified control of the scanning shutters 253. Cams 711-718, Fig. 41, correspond in number to the cams 151-158 of Fig. 1. The mechanical operation under the control of these cams is so arranged that the meter dials are

scanned in an inverse order; namely, thousands, hundreds, tens, and units. Also, the vertical shaft 183 carries a different arrangement of cams as may be noted from Fig. 42. In the instant case, twelve cams numbered 719 to 730 are mounted upon shaft 183 and each is adapted to operate an individual pair or pile-up of contacts the performance of which will be best understood when considered later in connection with the operation of the system.

The modified commutator 731 has an outer segmented ring 732 divided into ten live segments, with intervening insulated sections or blank segments. The live segments have been indicated by the reference numerals 732-1 to 732-0, and each is connected over an individual lead in a cable 745 to a set of double wound primary storage relays 738-2 to 738-0 and 740-1. A pair of brushes 734 carried by the commutator arm 124 bridge the segmented ring 732 with a solid ring 733. An inner ring indicated 735 is made up of five live segments grouped as indicated at 735-0 to 735-4, over which there wipes one of a pair of bridged brushes 737, the other of which pair rides an innermost solid ring 736.

The photo-electric circuit including tubes 510 and 513 is identical with the one shown in Fig. 35 and described in connection with the preferred embodiment above. In the instant case the output of the amplifier tube 513 is led directly over a line 763 to the solid ring 733 of the distributor 731. Due to the difference in timing of the scanning operation, a current cycle here will appear as indicated by the chart, Fig. 40, instead of the one illustrated in Fig. 36. In lieu of the translator mechanism, the present system contemplates, in addition to the afore-mentioned primary storage relays, the use of four sets of secondary relays generally denoted 741, 742, 743, and 744, within which a record is stored, four elements at a time before being transferred to the perforator. The operating windings of primary storage relays 738-2 to 738-0 and 740-1 receive operating pulses over cable 745, following which a signal is held over by a locking winding and a locking winding contact 746, which each relay controls, as well as four objective contacts 747, 748, 749, and 750. The several contacts 747-1 to 747-0 are connected over a cable 751 with the operating windings of a secondary relay group 741-1 to 741-0. The contacts 748-1 to 748-0 are similarly connected over a cable 752 to the operating windings of a secondary relay group 742-1 to 742-0. The contacts 749-1 to 749-0 are similarly connected over a cable 753 to the operating windings of a secondary relay group 743-1 to 743-0 and the contacts 750-1 to 750-0 are connected over a cable 754 to the operating windings of a secondary relay group 744-1 to 744-0.

Certain classes of contact tongues controlled by each of the afore-described secondary relays are indicated generically 755, 756, 757, and 758, from corresponding ones of each of which there extends a common conductor into a cable 578a which connects with cable 578 of Fig. 37, each conductor communicating with one of the perforator magnets X107 as already described.

Other incidents and structural details of the modified system of operation are quite simple to understand and need not be described apart from their manner of operation which will be discussed hereinafter in connection with a general description of operation. Also, the manner in which modified devices function instead of

their preferred form counterparts, will be noted as they are encountered.

General operation of modification

It will be assumed, of course, that manual control switch 759, Fig. 43, is closed, permitting a circuit to be traced from positive bus 552, Figs. 37, 46, 45, 44, and 43, through the resistance 760, the winding of distributor start magnet 118, switch 759, contact pair 761—762, to negative bus 558. Accordingly, magnet 118 will become energized, and will withdraw its armature from the path of brush arm 124, permitting the latter to rotate and to initiate also the other scanning and recording operations.

Let it be assumed also that in accordance with the modified embodiment, a similar record to the one described above will be recorded, comprised of a record reader No. 12, a meter No. 4086, the date 10—24, and a meter reading of 1300. Switches 500, X160, and 1796 are closed, which are conditions prerequisite to the operation of the circuit. Having in mind that the instant system contemplates eighteen divisions to each cycle, the following description shall consider the divisions successively.

During the first division, aperture 701 of the scanning belt 700 encounters the row of scanner openings 224, passing a light impulse through the particular one indicated 224—1 which represents the digit 1. This causes a negative impulse indicated by the line 764, Fig. 40, to be distributed by segment 732—1 through a wire in cable 745, to the operating winding of relay 740—1, whose opposite terminal connects with the positive supply bus 538. Thereupon relay 740—1 operates and is locked through the closure of its contacts 772—1 and 746—1 over a circuit starting with positive bus 552, branch conductor 766, through the resistance and locking winding of relay 740—1, its locking contact pair aforementioned, lead 774, contact pair 775—776 of relay 739 to negative bus 558. Shortly thereafter, brushes 737 of distributor arm 124 encounter the segment 735—3, establishing a circuit which may be traced from negative bus 558, branch conductor 771, the continuous inner ring 736 of distributor 731, brushes 737, segment 735—3, lead wire 770, contact pair 769 and 768 (which are now closed due to the operation of relay 740—1), the operating winding of relay 738—1 and its resistance 767, conductor 766, to the positive bus 552. As a result, relay 738—1 is operated and locked through its locking winding over a circuit traceable from positive branch wire 766, through its resistance 777 and its locking winding, through its contact 772—1 and its contact 746—1, common lead 1777, contact pair 769, to the negative lead 558. Thus, the setting of relay 740—1 is transferred to the storage relay 738—1.

Thereafter, brushes 737 encounter segment 735—4 and a circuit is established which may be traced from the negative branch line 771, through distributor ring 736, brushes 737, segment 735—4, lead line 778, thence through the winding of locking relay 739 and its resistance 777, common positive bus branch 766, and main positive bus 552. When locking relay 739 is operated, storage relay 740—1 is released, but an interval has been provided during which the first impulse is transferred to the settings of relay groups 741 to 744, as well as for other operations. Now, another setting of relay 740—1 may take place during the succeeding division while the settings of the

preceding division are being transferred for storage.

Meanwhile, apex 720—1 of cam 720 passing from beneath its contact lever 805 permits the contact pair 761—762 to open. Also, cam 719 withdrawing its low portion 719—1, forces its contact lever 807 to close the contact pair 806. As a result of this performance, the control of distributor start magnet 118 is transferred from cam 720 to cam 719 as will later appear.

Before the start of the second division, it will be noted that cam projection 722—2 has encountered its contact lever 779, closing the contact pair 780, and that thereafter as distributor brush arm 124 rotates, a circuit may be traced from the negative distributor ring 736, through the brushes 737, distributor segment 735—1, lead line 784, through the contact pair 780, lead line 783, through the winding of relay 782, resistance 781, to the positive bus 552. Thus, relay 782 is energized, opening its contact pair 785, and closing its contact pair 786. As a result of the closure of contact pair 786, a circuit is established which may be traced from negative lead 558, through the contact pair 786, wire 790, the operated contact tongue 789—1, its associated contact 747—1, a related wire within cable 751, through the operating winding of relay 741—1, its individual resistance 788, to the positive bus branch 787, causing the operation of relay 741—1. The opening of contact 785 releases any of the relays 741 which may have been locked by a preceding signal. Subsequent relays numbered 811, 831, and 856 which correspond in performance to relay 782 function similarly for the other groups of relays 742, 743, and 744. Upon the release of relay 782, contacts 785 are designed to close before contacts 786 are opened, so that the locking circuit for relay 741 will be established before the operating circuit is broken. The locking circuit of relay 741—1 may be traced from positive lead 552, through branch bus 787, resistance 791, locking winding of relay 741—1 and its front contact 792—1, operated tongue 793—1, back contact 794—0, unoperated tongue 793—0, wire 795a, back contact 795, unoperated tongue 795b, wire 797, contact tongue 798, and its normally closed contact 799, wire 800, contact pair 785, to negative lead 558. The operation of relay 741—12 is contingent upon the reception of an integer impulse in both the nine and zero positions, and functions in connection with the cumulative correction feature as will be described hereinafter.

When brushes 737 reach segment 735—2, a circuit is established which may be traced from negative ring 736, brushes 737, segment 735—2, lead wire 803, the winding of relay 802 and its resistance 801, to the positive bus 552. Upon the energization and operation of relay 802, contacts 769 are broken, opening the locking circuit of relay 738—1, described in division 1. The afore-described transfer operation takes place during each division and need not be reiterated. The performance thus far is coincident with the scanning of the meter number tens integer, following which the units integer, which happens to be digit 2, is scanned. Immediately thereafter an impulse indicated 804, Fig. 40, is distributed by the segment 732—2 to the operating winding of relay 738—2 in a manner described in connection with relay 738—1. Thereupon, relay 738—2 is locked through its individual locking circuit, which is similar to that of relay 740—1. At this time, the tens integer 1 which had been scanned in the first division is stored in relay 741—1, while the units

integer 2 which is scanned in the second division is stored in relay 738—2.

During the third division, the projection 723—3 of cam 723 encounters lever 808, closing the contact pair 809 so that when brushes 737 of distributor arm 124 reach segment 735—1, a circuit is completed from negative distributor ring 736, through brushes 737, segment 735—1, wire 784, contact pair 809, the winding of relay 811 and its resistance 810 to the positive bus 552. With the operation of relay 811, its contact pair 816 is closed and contact pair 825 opened. As a result of the closure of contact pair 816, a circuit may be traced from negative bus 558, through the contact 816, line 815, the operated tongue 814—2 of relay 738—2, its contact point 748—2, a related wire in cable 752, the operating winding of relay 742—2, its individual resistance 813, to the positive branch bus 812 which connects with the primary positive bus 552. Relay 742—2 is operated, and thereafter relay 738—2 is released, the former being locked to a circuit traceable from branch bus 812, the individual resistance 817 and locking winding of relay 742—2, contact 818—2 and its operated tongue 819—2, thence through the series chain including the back contacts and unoperated tongues of relays 742—1 and 742—0, wire 820, back contact 823 of relay 742—12, unoperated tongue 821, wire 824, contact pair 825 of relay 811, Fig. 44, and negative bus 558. Upon the opening of contact pair 825 of relay 811, there is released any relay 742 which may have been previously set.

During this division, the thousands digit of the meter number is scanned, and an impulse indicated 827 is distributed by the distributor segment 732—4, over a wire in cable 745, to the operating winding of relay 738—4, causing the latter to be operated and locked as previously described. At this instant, an integer 1 is stored in the relay 741—1, an integer 2 is stored in the relay 742—2, while a new integer 4 is stored in the relay 738—4.

During the beginning of the fourth division, an apex 724—4 of cam 724 engages and operates its contact lever 828, closing the contact pair 829, Fig. 45. When thereafter brushes 737 reach segment 735—1, a circuit is established that is traceable from the negative ring 736, brushes 737, segment 735—1, over wire 784 to the contact pair 829, thence through the winding of relay 831, its resistance 830, to the positive bus 552. As a result of the operation of relay 831, a circuit is established from negative bus 558, through the operated tongue 837 of relay 831, its associated contact 836, wire 835, operated tongue 834—4 of relay 738—4, its associated contact 749—4, a related wire in cable 753, the operating winding of storage relay 743—4, Fig. 46, its individual resistance 833, to the positive branch bus 832. As a result, storage relay 743—4 is operated, and when thereafter relay 831 is released, storage relay 743—4 will be maintained locked through a locking circuit traceable from positive branch bus 832, the individual resistance 838 and locking winding of storage relay 743—4, front contact 839—4, and its operated tongue 840—4, thence through a series of back contacts and unoperated tongues of the relays 743—5 to 743—9, emerging at wire 841 and continuing through contact 842, and unoperated tongue 843 of relay 743—12, wire 845, tongue 846 and its normally engaging contact point 847, wire 848, and contact pair 849 of relay 831 to negative at bus 558. The subsequent opening of contact pair 849 releases any relay other

than 743—4 which may be set in accordance with a previous operation. During this division, an impulse indicated 850, Fig. 40, is distributed through the segment 732—0 over a wire in cable 745 to the operating winding of relay 738—0, energizing the latter and causing it to be locked over a circuit similar to those previously described in connection with other relays 738.

At the beginning of the fifth division, the apex 725—5 of cam 725 engages and operates contact lever 851, closing the contact pair 852. Thereafter, when brushes 737 of distributor arm 124 encounter segment 735—1, a circuit is established traceable from negative distributor ring 736, brushes 737, segment 735—1, wire 784, contact pair 852, winding of relay 856, resistance 855, to positive bus 552. As a result of the energization of relay 856 a circuit is established from negative bus 558, operated tongue 862 of relay 856, contact 861, lead wire 860, operated tongue 859—0 and its associated contact 750—0, a related wire in cable 754, the operating winding of relay 744—0, resistance 858, to the branch positive bus wire 857. Relay 744—0 is now operated and locked when relay 856 is released traceable over a circuit from positive branch wire 857, through an individual resistance 863, the locking winding of relay 744—0, front contact 864—0, operated tongue 865—0, wire 866, contact 867, and unoperated tongue 868 of relay 844—12, wire 870, tongue 871 and its normally closed contact point 872, contact pair 873, to negative bus 558.

Meanwhile, an impulse denoted 874 is distributed by segment 732—8 through a wire in cable 745, to the operating winding of relay 738—8, causing the latter to be energized and locked as previously described. At this time an integer is stored in each of the storage relay groups 741 to 744, and since no more storage capacity is available, it is necessary that the storage conditions be relayed to the perforator where they may immediately perforate corresponding positions in a card.

At the beginning of the fifth division, contact lever 807, Fig. 43, falls into a depression 719—5 in cam 719, while at the same time contact lever 875 is engaged and operated by an apex 721—5 of cam 721, closing its contact pair 876 as the contact pair 806 is opened. This transfers the control of magnet 118 to the card perforator, and if the perforation of the preceding card has been duly completed, the energizing circuit for magnet 118 will be closed, as follows: from positive bus 552, through the resistance 760, winding of magnet 118, manual switch 759, lead 877, contact pair 876, contact pair 878 of relay 879, (which is energized upon the proper condition of the perforator), wire 880, to negative bus 558. The circuit for operating relay 879 is traceable from positive bus 552, winding of relay 879, wire 881, wire X164, contact pair X149 (which is closed by a predetermined arrangement of the control mechanism when a card is properly aligned in the perforator), through the control circuit of the card perforator to negative lead X162. A locking circuit for maintaining relay 879 closed is traceable from negative bus 558 through the locking winding of relay 879, contact pair 879a—879b, Fig. 46, lead 879c, contact pair 919—920 of relay 921 to the negative bus 558.

In the event that a previous card has not been duly completed, the scanner will be prevented from starting by a failure of magnet 118 to become energized. Upon its proper energization, however, the ensuing rotation of brushes 737 pass

over segments 735—1 at a time when cam projection 727—5 has operated lever 782 to close the contact pair 783. As a result, a circuit is established which may be traced from negative lead 558, Fig. 45, wire 884, contact pair 733, wire 783a, contact and operated tongue 755—1 of relay 741—1, one of the wires in cable 578a and its corresponding wire in cable 578, winding of a magnet X107, contact pair X152, wire X175, contact pair X45, wire X174, to the positive lead X151. Thus, there is ended the fifth division during which the integer stored in the relay group 741 has been converted into a perforation while the remaining relay groups 742, 743, and 744 retain their original storage setting.

At the beginning of the sixth division, an apex 722—6 of cam 722, Fig. 44, engages contact lever 779, closing the contact pair 780. Thereafter, when brushes 737 encounter segment 735—1, a circuit is completed for operating relay 782, opening its contact pair 785, and closing its contact pair 786. This releases the previously energized storage relay 741—1, and operates a new relay 741—8. Thereafter, when brushes 737 encounter segments 735—2, relay 738—8 is released in a manner already described. The distributor brushes 734 upon encountering segment 732—6, transmit an impulse indicated 885, Fig. 40, which is transmitted over a wire in cable 745, to the operating winding of relay 738—8, operating and locking the latter in a manner previously described. Before brushes 737 have passed over segment 732—1, an apex 728—6, Fig. 46, of cam 728 encounters and operates a contact lever 886, closing the contact pair 887. As a result, a circuit is established which may be traced from negative bus 558, over lead 884, through the contact pair 887, wire 888, the contact and operated tongue 756—2 of relay 742—2, an associated wire in cables 578a and 578, magnet X107—2, line X182, contact pair X152, line X175, contact pair X45, line X174, to positive lead X151, causing the energization of magnet X107—2. At the conclusion of this division, the integer 8 is stored in relay 742—8, the integer 2 in relay 742—2, the integer 4 in relay 743—4, the integer 0 in relay 744—0, the integer 6 in relay 738—6, and the tens column integer of the meter number perforated in its proper position in the card.

At the beginning of the seventh division, projection 723—7 of cam 723 encounters and operates its contact lever 808, closing the contact pair 809 so that when the distributor brushes 737 encounter segment 735—1, an operating impulse is transmitted to the relay 811 in a manner already described. As a result, the setting of relay 738—6 is transferred to the storage relay 742—8 over a wire in cable 742, while a previously stored impulse in relay 742—2 is released. Thereafter, when the same brushes encounter segment 735—2, the stored impulse in relay 738—6 is released in a manner already described. The distributor brushes 734 upon encountering segment 732—1 transmit an impulse through a wire in cable 745 to the operating winding of relay 740—1. The latter upon being operated transfers its setting to relay 738—1 as described in division one. At this time, projection 729—7 of cam 729, Fig. 46, engages and operates its lever 890, closing the contact pair 891 and establishing a circuit which transfers the stored signal of relay 743—4 to the perforating magnet X107—4, causing a perforation to be made in the third column and in the number 4 position while the card is advanced to present its fourth column.

At the beginning of the eighth division, the apex 724—8 of cam 724 engages and operates its lever 828, closing the contact pair 829. Thereafter when distributor brushes 737 reach segment 735—1 an operating impulse is transmitted to relay 831, Fig. 45, which causes the setting of relay 738—1 to be transferred to the storage relay 743—1 over a wire in cable 753 as described in connection with division four. Meanwhile, the previously stored relay 743—4 is released when brushes 737 reach segment 735—2 causing the signal in relay 738—1 to be released. When the distributor brushes 734 encounter segments 732—0, an impulse 893 is communicated over a wire in cable 745, operating relay 738—0. Thereafter, when brushes 737 have passed over segment 732—1, the apex 730—8, Fig. 46, of cam 730 engages and operates its lever 894, causing the contacts 895 to be closed and establishing a transfer circuit for communicating the storage setting of relay 744—0 to the perforating magnet X107—0. This causes a perforation to be made in the zero position of the fourth column, following which the card is advanced to present its fifth column.

During the beginning of the ninth division, cam apex 725—9 engages and operates its lever 851, closing the contact pair 852. Thereafter, when brushes 737 encounter segment 735—1, relay 856 is operated as in the fifth division, causing the setting of relay 738—0 to be transferred to the storage relay 744—0 over a wire in cable 754 which is the same relay that had been energized during the fifth division. As the brushes continue encountering segment 735—2, relay 738—0 is released. Meanwhile, an impulse indicated 897, Fig. 40, is distributed by brushes 734 as they encounter segment 732—2, causing relay 738—2 to be operated over a wire in cable 745. Cam apex 727—9, Fig. 46, engages and operates its lever 782, closing the contact pair 783 and causing a transfer to be made from relay 741—8 to the perforating magnet X107—8.

At the beginning of the tenth division, cam projection 722—10 engages and operates its lever 779, Fig. 44, closing the contact pair 780, and causing the setting of relay 738—2 to be transferred to the storage relay 741—2. Meanwhile, an impulse 898 issues through segment 732—4 operating the primary relay 738—4. Then cam projection 728—10, Fig. 46, engages and operates its lever 808, closing the contact pair 807 and transferring the storage signal from relay 742—6 to the perforating magnet X107—6, which causes a perforation to be made in the 6 position of the sixth column and advancing the card to its next columnar position, which happens to be the twenty-sixth column due to the action of the skip bar which has been described in connection with Fig. 32.

At the beginning of the eleventh division, the apex 723—11, Fig. 44, encounters and operates its lever 808, closing the contact pair 809 and causing to be transferred the setting of relay 738—4 to the storage relay 742—4. Meanwhile, an impulse 899, Fig. 40, operates relay 740—1, whose setting is transferred to the primary relay 738—1. Also, cam projection 729—11, Fig. 46, encounters and operates lever 890, closing the contact pair 891 and transferring an impulse from the storage magnet 743—1 to the perforating magnet X107—1, making a perforation in the number 1 position of the twenty-sixth column.

At the beginning of the twelfth division, cam projection 724—12, Fig. 45, engages and operates its lever 828, closing the contact pair 829

and transferring the setting of relay 738—1 to the storage relay 743—1, which happens to be the same relay of the group 743 previously energized during the eighth division. At this time, the distributor brushes 734 wiping over both segments 732—2 and 732—3 cause an elongated impulse 900 occupying two-tenths of a division to be transmitted to the primary relays 738—2 and 738—3 over associated wires in cable 745. Thereafter cam projection 730—12, Fig. 46, engages and operates lever 894, causing the contact pair 895 to be closed and transferring the signal stored in relay 744—0 to the perforating magnet X107—0. This causes a perforation to be made in the 0 position of the twenty-seventh column.

At the beginning of the thirteenth division, the apex 725—13 of cam 725, Fig. 45, engages and operates lever 851, closing the contact pair 852 and transferring the setting of relays 738—2 and 738—3 simultaneously to the storage relays 744—2 and 744—3, which are both locked over individual circuits as follows: the locking circuit of relay 744—2 is traceable from positive branch bus 857, the resistance 863 and winding of relay 744—2, contact 864—2 and its operated tongue 865—2, contact 902—1 and unoperated tongue 865—1, contact 902—0 and unoperated tongue 865—0, wire 866, contact 867 and unoperated tongue 868, wire 870, tongue 871 and its normally engaging contact 872, contact pair 873, to negative bus 558. At the same time, relay 744—3 is locked as follows: positive branch bus 857, the resistance 863 and locking winding of relay 744—3, contact 907—3, and operated tongue 906—3, the back contacts and unoperated tongues 907 and 906 of relays 744—4 to 744—9, contact pair 909, wire 910, tongue 911 and its normally engaging contact point 912, contact pair 873 to negative bus 558.

The first described locking circuit will lock the lower digital value of two operated relays, while the second described circuit will lock the higher of two operated relays. The determination is later made to elect one and discharge the other of the two relays 744, but meanwhile an elongated impulse 923 is issued by brushes 734 over segments 732—9 and 732—0, energizing the primary relays 738—9 and 738—0. Cam projection 727—13 now operates its lever 782, closing the contact pair 783 and transferring the setting from relay 741—2 to the perforating magnet X107—2 which causes a perforation to be made in the 2 position of the twenty-eighth column.

During the fourteenth division, cam apex 722—14, Fig. 44, engages and operates its lever 779, causing to be closed the contact pair 780 and transferring the setting from the primary relays 738—9 and 738—0 to the storage relays 741—9 and 741—0. Relay 741—11 is connected in parallel with relay 741—0, so that the two are operated simultaneously by relay 738—0 and also that relay 741—12 is connected in parallel with relay 741—9, through the contacts of relay 741—11, so that as a result of the energization of relay 741—11 relay 741—12 is also operated. It should be noted that relay 741—12 may be operated only upon the contingency that impulses corresponding to integers 0 and 9 are concurrently received. Relay 741—11 is first operated as a result of the 0 impulse and through it the 9 impulse permitted to reach the 741—12 relay. Upon the operation of relay 741—12, it is locked through its locking winding over a line 948a, wire 879c, contacts 918—920 of supervisory relay 921 to negative bus 558. When relay 741—12 is

energized, it serves to reverse the connections of wires 797 and 928 in a generally similar manner that relay 547—11 functioned in Fig. 34 in connection with the preferred embodiment.

Meanwhile, two impulses 928—1 and 928—0, Fig. 40, are distributed to the primary relays 740—1 and 738—0 over the segments 732—1 and 732—0. The setting of relay 740—1 is of course immediately transferred to its associate relay 738—1. At this time, cam projection 728—14, Fig. 46, encounters and operates its lever 886, causing to be closed the contact pair 887 and transferring a storage setting from the storage relay 742—4 to the perforating magnet X107—4. This causes a perforation to be made in the number 4 position of the twenty-ninth column.

At the beginning of the fifteenth division, the apex 723—15 of cam 723, Fig. 44, engages and operates its lever 808, closing the contact pair 809 and causing to be energized the relay 811 when brushes 737 reach segment 735—1. As a result, the setting of primary relays 738—0 and 738—1 is transferred to the storage relays 742—0 and 742—1 through wires in cable 752. Relays 742—0 and 742—1 will be locked up, the former over a circuit from positive branch bus 812, through resistance 817 and winding of relay 742—0, contact 818—0, operated tongue 819—0, wire 820, contact 823, and its unoperated tongue 821, wire 824, contact pair 825, to negative bus 558. The locking circuit for magnet 742—1 is traceable from positive branch bus 812 through the resistance and locking winding of relay 742—1, contact 818—1, and its operated tongue 819—1, and contact 823a. The circuit is here terminated for failure of negative source because of the open condition between contact 823a and its tongue 821. Thus, relay 742—0 remains locked while relay 742—1 is released. At this time, there having been concluded fifteen cyclic divisions, all of the scanning has been consummated, leaving only the meter reading signals to be transferred to the card perforator.

When brushes 737 pass segment 735—1, cam projection 726—15 having engaged its contact lever 931 to close the contact pair 932, there is issued an impulse for energizing the relay 933 over a circuit which may be traced from positive bus 552, through the winding of relay 933, contact pair 932, wire 884, to the negative bus 558. Relay 933 is locked when its armature 933b closes with contact 933a over a circuit traceable from positive bus 552, winding of relay 933, contact pair 933a and 933b, wire 879c, contact pair 919—920 of supervisory relay 92 to negative lead 558. In addition to its locking tongue 933b, relay 933 also controls tongues 934 to 939 which are so adjusted that tongues 934 and 935 make contact first, following which tongues 936 and 937 make contact, and finally tongues 938 and 939 make contact with their respective contact points 929, 798, 911, 871, 846, and 939a.

In practice, three separate relays individually timed may be employed in lieu of this successive order of operation. After tongues 934 and 935 have been operated, a locking circuit for relays 741—9 and 741—0 described in division fourteen is switched from wire 800 through contact 798, and tongue 935, to wire 940, which connects with the tongues 942—5 to 942—9 inclusive, of the relays 742. Since tongue 942—0 only is operated, the locking circuit of relay 741—9 is interrupted and this relay is released. Locking circuit of relay 741—0 described in division fourteen is switched from wire 800 through contact

929 and tongue 934 to wire 941, which is connected to the tongues 942-0 and 942-4, but since tongue 942-0 is operated, the relay 741-0 will remain locked.

This, it will be recognized, accomplishes cumulative correction through the medium of relay storage instead of mechanical storage as described in the preferred embodiment.

When tongues 936 and 937 have been operated, the locking circuit of relay 744-2 described in division eleven is transferred from wire 912a through contact 911 and tongue 936 to wire 943, which is connected to the tongues 944-8 to 944-4 of the relays 741, but since none of these tongues is operated, relay 744-2 will be released. The locking circuit of relay 744-3 is transferred from wire 912a through contact 871 and tongue 937, to wire 945, which is connected to the tongues 944-5 to 944-0 and since tongue 944-9 is operated relay 944-3 remains locked.

After tongues 938 and 939 have been operated, the locking circuit of relay 743-1 is transferred from wire 848 through contact 846, and tongue 938 to wire 948 which is connected to the tongues 946-0 to 946-4 of relays 744, and since tongue 947-3 is operated at this time, relay 743-1 remains locked.

The storage relays now have but a single relay operated in each of their four groups and are in condition to communicate their reading to the perforator magnets X107, which happens when cam projection 729-15 operates its lever 890 to close the contact pair 891. This causes perforator magnet X107-1 to receive the setting communicated to it from the storage relay 743-1, and a perforation to be made in the 1 position of the thirtieth column which corresponds to the thousands integer of the meter reading.

At the beginning of the sixteenth division, the apex 739-10 of cam 730 engages and operates its lever 894, closing the contact pair 895 and transferring a setting which had been stored in storage relay 744-3 to the card perforating magnet X107-3. This causes to be made a perforation in the number 3 position of the thirty-first column or the hundreds digit of the meter reading.

During the seventeenth division, apex 727-17 of cam 727 engages and operates its lever 782, closing the contact pair 783 and transferring a setting from storage relay 741-0 to the card perforating magnet X107-0. This causes to be made a perforation in the 0 position of the thirty-second column or the tens digit of the meter reading.

During the eighteenth division, apex 728-18 of cam 728 engages and operates its lever 886, causing to be closed the contact pair 887 and transferring a setting from storage relay 742-0 to its corresponding card perforating magnet X107-0. This causes to be made a perforation in the 0 position of the thirty-third column or units digit of the meter reading. At the conclusion of this division, cam apex 720-1, Fig. 43, engages and operates its lever 805, closing the contact pairs 761-762 and 942. Thereafter, brushes 737 of the distributor arm 124 encounter segment 735-0 and a circuit is closed traceable from negative distributor ring 736, through brushes 737, segment 735-0, contact pair 942, lead wire 950, winding of supervisory relay 921, to the positive bus 552. This causes the energization and operation of relay 921, as a result of which there are released the control relays 933, 879, 741-12, 742-12, 743-12, and 844-12, or any of the latter that might have been operated.

At this point, a particular card has been completely perforated and resembles the one illustrated in Fig. 29, while a new card is advanced with its first column in perforating position.

While the present invention has been explained and described with reference to a specific preferred embodiment and enumerated modifications, it should be understood that variations and departures may be instituted within the contemplated scope of the present invention. For this reason, it is intended that the foregoing description and the accompanying drawings shall constitute no restrictions upon the present invention except as indicated by the hereinafter appended claims.

The subject matter claimed is:

1. In a photo-electric scanning device, a scanning member, means to generate impulses according to the scanning, a commutator adapted to distribute the impulses to predetermined electrical circuits, and means to synchronize said commutator and said scanning member.

2. In a photo-electric scanning device, a scanning plate having a plurality of apertures arranged in circular paths corresponding to the divisions of a circular indicating scale, a plurality of shutters each covering some of said apertures, and means to uncover said apertures by moving said shutters in a predetermined sequence.

3. In a photo-electric scanning device, a series of apertures arranged in a circular path, each aperture corresponding to one of the digits 0 to 9, a rotating scanner adapted to expose the openings in succession, a shutter adapted to cover some of the openings, a shutter adapted to cover other of said openings, and means to operate one of said shutters while the scanner is traversing the openings corresponding to the other shutter.

4. A device for scanning a plurality of groups of numerical apertures, some of which are arranged in a linear alignment and some in a circular alignment comprising a belt having scanning openings for traversing said apertures in linear alignment, a rotating disc having an opening for traversing said apertures having a circular alignment, and means for regulating the sequence of operation of said belt and said disc.

5. A device for scanning consecutive frames of continuous record film comprising a system of light-projecting lenses for directing light rays from a light source through a tape feeding locus, a set of tape feeding gears, means for imparting intermittent motion thereto for moving a record film through the proximity of said locus intermittently frame by frame, means for projecting an image from said locus onto a scanning area, a scanning plate having openings corresponding to switches whereat there may occur light ray signals, and a scanning member comprising an endless belt having spaced apparatus in registration with said opening and adapted to occur each in parallel alignment with a series of said openings successively.

6. In a recording system, means to present a succession of photographic records of a plurality of index dials successively in a scanning position, a scanning device, means for locating each dial record to align predeterminedly on said scanning device, and means controlled by said scanning device to generate electric impulses to correspond with characteristics of said dial records.

7. The method of preparing control forms which includes the steps of, projecting images of indexes on masks having index positions corresponding to dial positions, rendering the index

positions in the masks successively light conducting, generating impulses corresponding to the positions where the images of the indexes permit light to pass, and setting individual registering elements according to the positions where the light is permitted to pass.

8. In a system for converting the indications of indexes having infinite angular variations of position into a registration composed of exact integer values, apparatus for projecting beams of light tracing the paths of said indexes, a light sensitive device electrically responsive to particular integer positions as evidenced by said light beam, and means under the control of the electric response of said device to register an integer characteristic interpretative of said particular integer position.

9. The method of registering a sequence of integer values which comprises the steps of projecting a scanning light through a light penetrable record having index characteristics and onto a scanning master, generating electrical impulses in accordance with each index characteristic as it passes through a corresponding portion of said master, and distributing the impulses to establish a storage condition of a sequence of values.

10. In an apparatus for scanning images of meter dials, a plurality of rotatable scanning elements each adapted to scan a dial image, means to rotate all said scanning elements simultaneously, shutters associated with said scanning elements, and means to open said shutters successively during each scanning cycle.

11. In a photoelectric scanning device, a template having a plurality of apertures arranged in a circle each aperture corresponding to one of the integers 0 to 9, means to cast an image of a meter dial pointer in alignment with said circle so that the apertures correspond to integer positions of a dial, means to generate single impulses when the image of a pointer is situated in an exact integer position and two impulses when the image is in an intermediate indicating position.

12. In a device for photoelectrically scanning a film bearing circular arrangements of integer elements, a template having a series of apertures arranged in a circular path corresponding each to each with said elements, means to isolate integer pointers marking said integer elements, means to cast an image of the pointers on said template, said isolating means comprising shutters opening successively, and means to advance said film after each such scanning operation.

13. In a device for scanning films comprised of frames carrying circular images with meter dial pointers and linear arrangements of pointers, a template providing a circle of apertures for each of said circular image pointers and including an aperture for each of the integers 0 to 9, and having corresponding linear rows of apertures in which each aperture in a row corresponds to each of the integers 0 to 9, means to advance the film frame by frame, and means effective when the film is at rest between successive feeding operations to cast an image of the circular pointers and the linear pointers so that they fall in alignment with the corresponding apertures of said template, and means to expose said alignments successively in a predetermined sequence.

14. In a scanning device for reading a series of records each having a plurality of groups of areas, representing numerical integers and having specific markings in certain of said areas of a group to indicate an integer value, means to

position said records one after another in a scanning position successively with an interval of rest for each in said scanning position, and means effective while each record is at rest in said scanning position to scan one area after another in each group and one group after another in a predetermined sequence.

15. The combination set forth in claim 14 in which said scanning means is photoelectrically performed and includes a segmented distributing commutator having a segment corresponding to each integer of a series of numerical integers, a commutator brush arm, and means to rotate said brush arm once during the scanning of each one of said groups.

16. In a photoelectric scanning device, a template providing a plurality of groups of numerical integer apertures, each group arranged in a circle, a plurality of groups of numerical integer apertures in linear arrangement, means to project an image containing light controlling marks in alignment with corresponding apertures in said template, an apertured belt having an aperture corresponding to each of said linear arrangement groups, means to move said belt transversely of said template cyclically so that each belt aperture is exposed once in alignment with one of said template apertures, and means to scan said circular aperture groups in corresponding integer succession.

17. In a scanning device, the combination comprising a series of circular numerical integer apertures, a series of linear numerical integer apertures, a single photoelectric integer distributor, and shutter means to project a light beam successively through the apertures of said circular series and said linear series during corresponding cycles of said distributor.

18. In a scanning apparatus, a plurality of circular arrangements of integer apertures in which each circular arrangement comprises an opening representing each one of the numerical integers from zero to nine, a light beam projection system common to all of said plurality of arrangements, a shutter system individual to each of said circular arrangements, and means for operating said shutters in succession to expose the apertures of each arrangement in succession and of said plurality in predetermined sequence.

19. In an apparatus for scanning circular indexes comprised of peripherally disposed integer elements, a light mask cyclically rotatable having an opening to register with each of said elements successively, means for expressing a light beam upon said light mask during its cycle of rotation, and a shutter for exposing said light beam to said mask and said circular indexes coincident with the instants of registration of said opening with each of said elements.

20. In an apparatus for scanning successive frames on a continuous film in which each frame consists of a plurality of circular and rectilinear numerical integer recording areas, a series of scanning shutters for scanning circular areas, a scanning shutter for scanning a rectilinear area, means for operating said shutters successively to cooperate with a single photoelectric light beam system, and advancing mechanism for moving said film from one scanning frame alignment to another after completion of scanning of said pluralities of areas.

21. In an apparatus for scanning successive frames on a continuous film in which each frame carries a plurality of groups of marks whereby

their positions in an assigned area of a frame indicates an integer 0 to 9, means to scan each area assigned to one of said groups in succession, a commutator containing a single segment corresponding to each of the integers 0 to 9, a brush rotatable over said segments, means to rotate said brush once during the scanning of each area, separate registering elements for successive groups, means to generate impulses according to the scanning, and means including said commutator to delegate said impulses to different ones of said registering elements in successive revolutions.

22. In a photoelectric scanning device, a series of photographic records of a pointer movable over a graduated scale, a fixed template having a series of apertures, each aperture corresponding to one of the graduations on the scale, means to project an image of one of said records on the template so that the image of the pointer occupies the same position with respect to the apertures that the pointer occupied with respect to the graduated scale, means to uncover each aperture in said series once and once only while said selected record is in scanning position, means to move another one of said records into scanning position after said first selected record has been scanned, and means to generate electrical impulses according to the alignment of the pointer image with the series of apertures during each scanning operation.

23. In a photoelectric scanning device, a stationary template having a plurality of groups of apertures, the apertures of each group being arranged in a circle, a movable element associated with each group and having a single aperture, means to simultaneously rotate all said movable elements so that each single aperture describes a circular path adjacent to its associated circle of apertures so as to uncover each aperture in succession, a shutter device associated with each group of apertures, means to operate each shutter device in each scanning cycle so that each group of apertures is open during one of said revolutions and all others are closed, means to close certain apertures in each group in each scanning cycle variably, and means to generate electrical impulses according to the apertures closed.

24. In a photoelectric scanning device, a stationary template, having therein a plurality of apertures arranged in a circle, a disc having a single aperture, rotatable on the same axis as the axis of the circle of apertures and in a plane adjacent thereto, means to rotate the disc during a scanning cycle, a shutter element associated with the template and adapted to close some of the apertures in the circle, a second shutter device similar to the first mentioned shutter but adapted when operated to close the remaining apertures in the circle, means to operate each shutter device while the single aperture is traversing openings corresponding to the other shutter, and means to operate both said shutter de-

vices during other revolutions of said disc in the same scanning cycle.

25. In a photoelectric scanning device, a template having a plurality of apertures arranged in a circle, a disc having a single aperture, means to rotate said disc so as to uncover the apertures in said circle in succession, a commutator having a segment corresponding to each aperture in said circle, a brush arm, means to rotate said brush arm over said segments in synchronism with the passage of said single aperture over said circle of apertures, means to uncover apertures in said circle variably in succeeding scanning cycles, means to generate impulses in each cycle according to the apertures uncovered, a register corresponding to each aperture, and means including said commutator and said brush arm to distribute said impulses to corresponding ones of said registers.

26. In a photoelectric scanning device, a stationary template having therein a plurality of apertures arranged in a line, means to uncover said apertures in sequence, a commutator having a segment corresponding to each aperture in said line, a brush arm, means to rotate said brush arm over said segments in synchronism with the uncovering of said apertures, means to cover said apertures variably in succeeding scanning cycles, means to generate electric impulses in each cycle according to the apertures uncovered, a register corresponding to each aperture, and means including said commutator and said brush arm to distribute said impulses to corresponding ones of said registers.

27. The method of preparing control forms which includes the steps of, projecting an image of a pointer moving over a scale having index positions upon a master template having similar index positions, and generating impulses when the image of the pointer registers with an index position on the template.

28. In a photoelectric scanning device, means to scan an image of a pointer moving over a graduated scale, means controlled by the image of the pointer to generate impulses only at points corresponding to exact decimal positions on the scale and means to register the decimal positions according to the impulses generated.

29. In a meter indication interpreting device, means to present images of different meter faces having moving indicators successively in a scanning plane, means to scan the images when presented, and means controlled by the positions of the moving indicators to generate impulses corresponding to exact integer positions only.

30. In a scanning device, a single photo-cell, a scanning member to control the impingement of light on the photo-cell, means to generate impulses according to the activation of said photo-cell, a commutator, a recording device, and means to distribute said impulses into a plurality of channels corresponding to the segments of said commutator to operate said recorder.

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