

June 5, 1945.

J. W. BRYCE

2,377,754

RECORDING APPARATUS

Filed Nov. 16, 1940

21 Sheets-Sheet 1

FIG. 1.

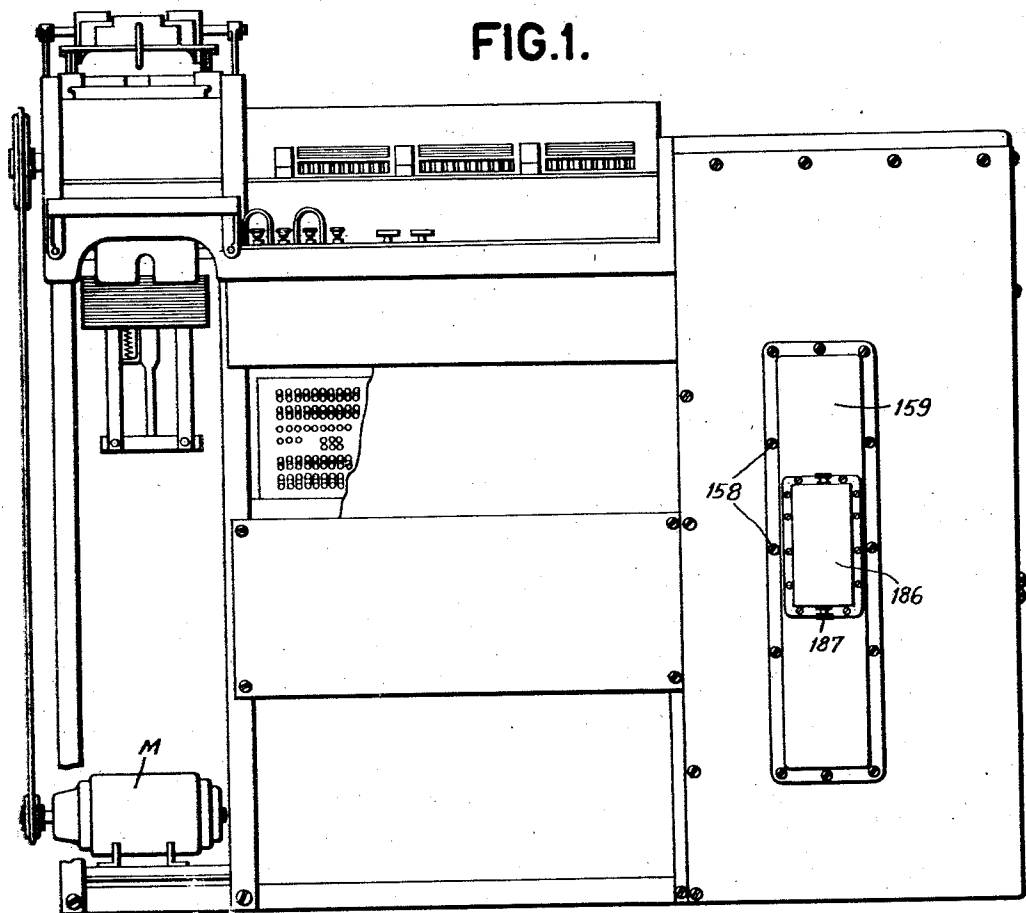
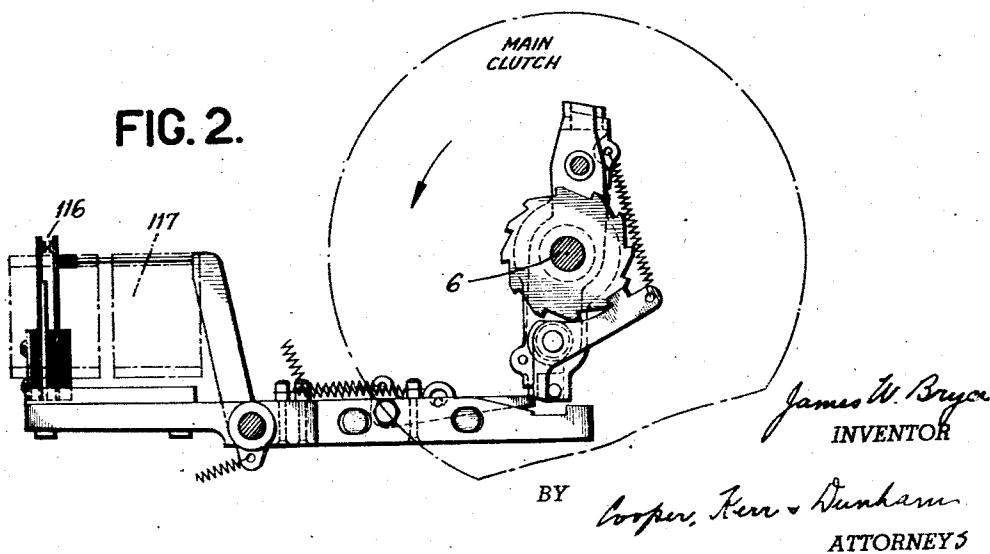


FIG. 2.



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FIG. 3.

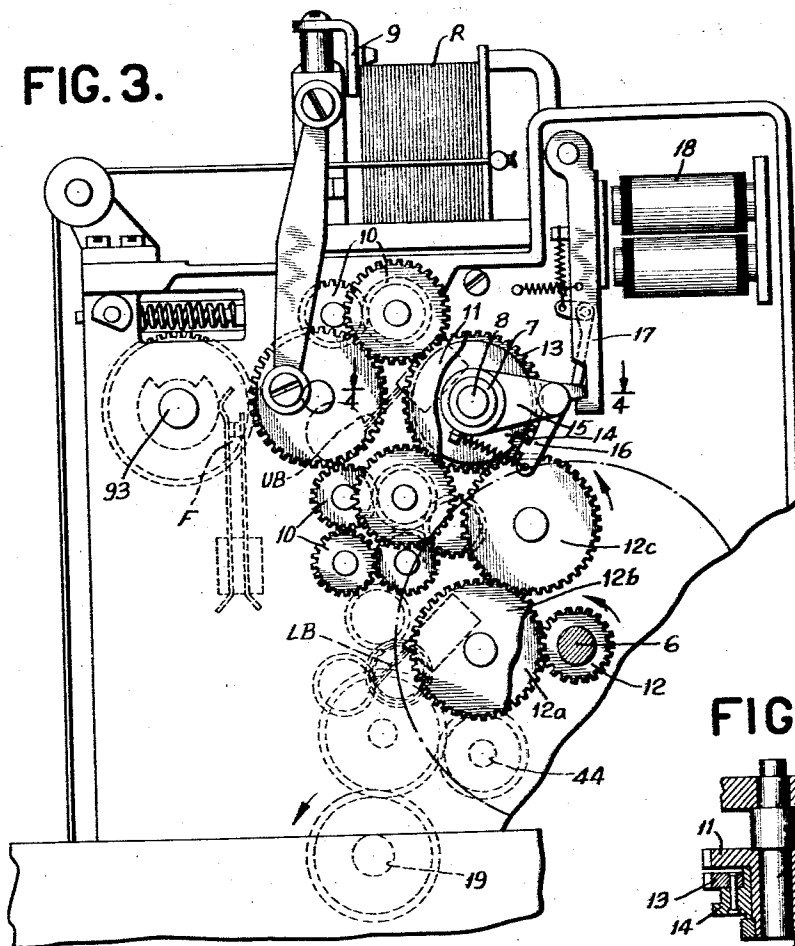


FIG. 4.

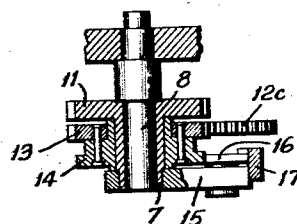
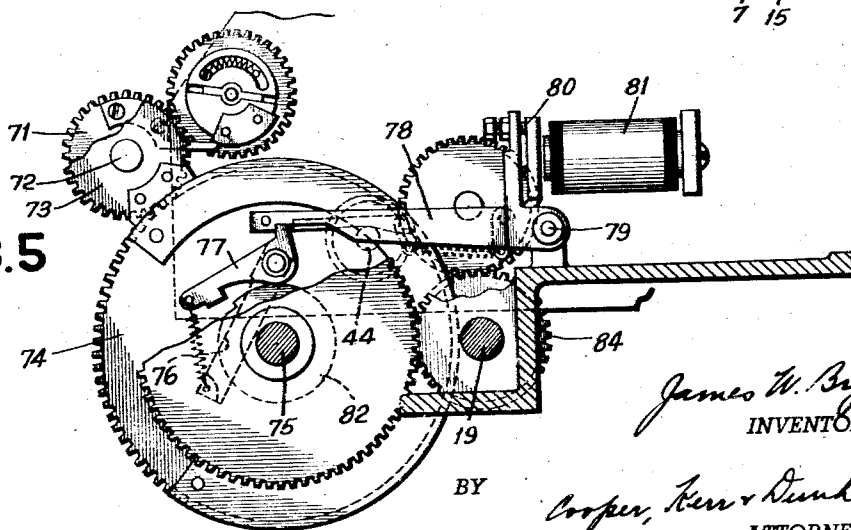


FIG. 5



James W. Bryce
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ATTORNEYS

June 5, 1945.

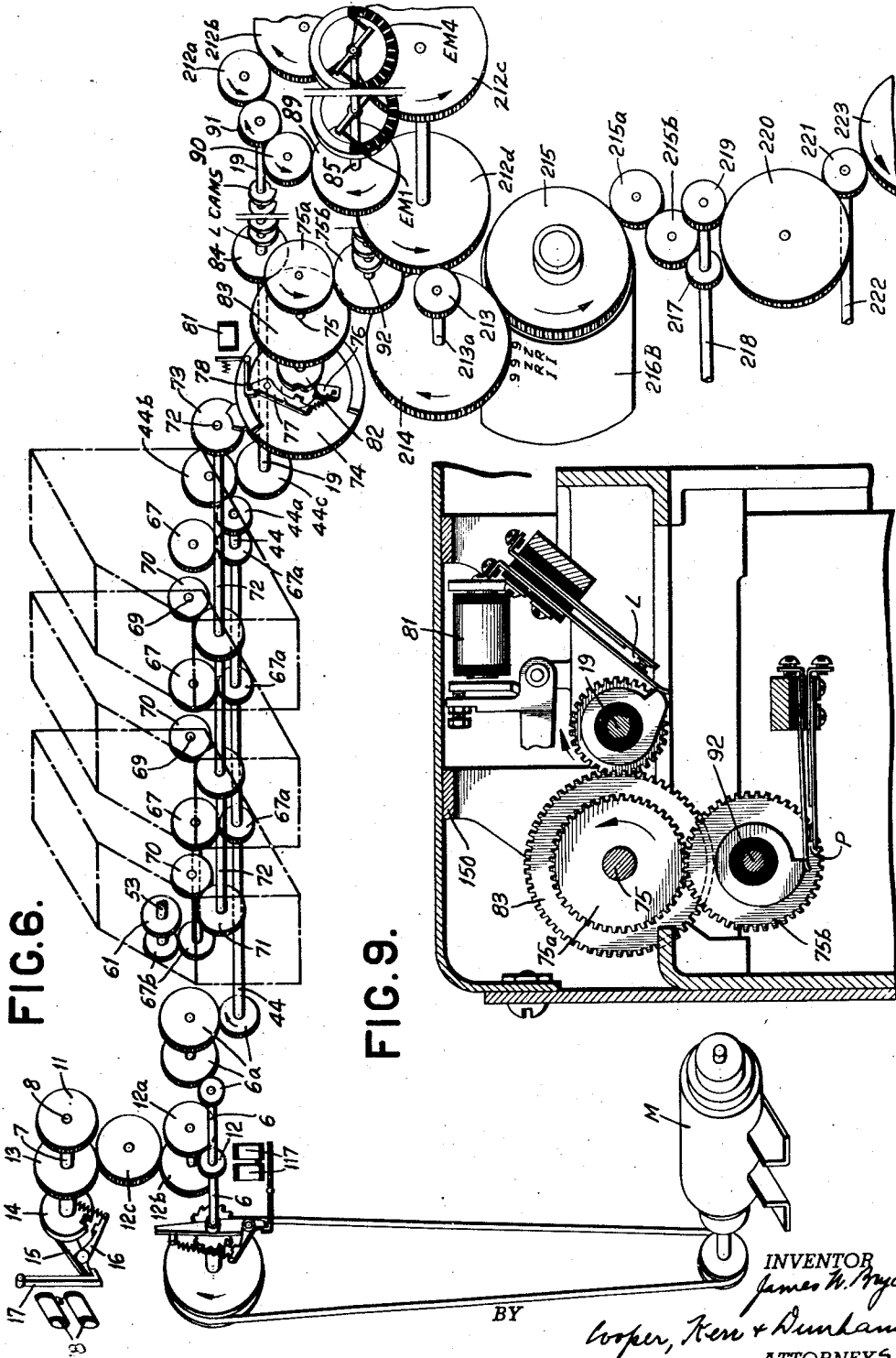
J. W. BRYCE

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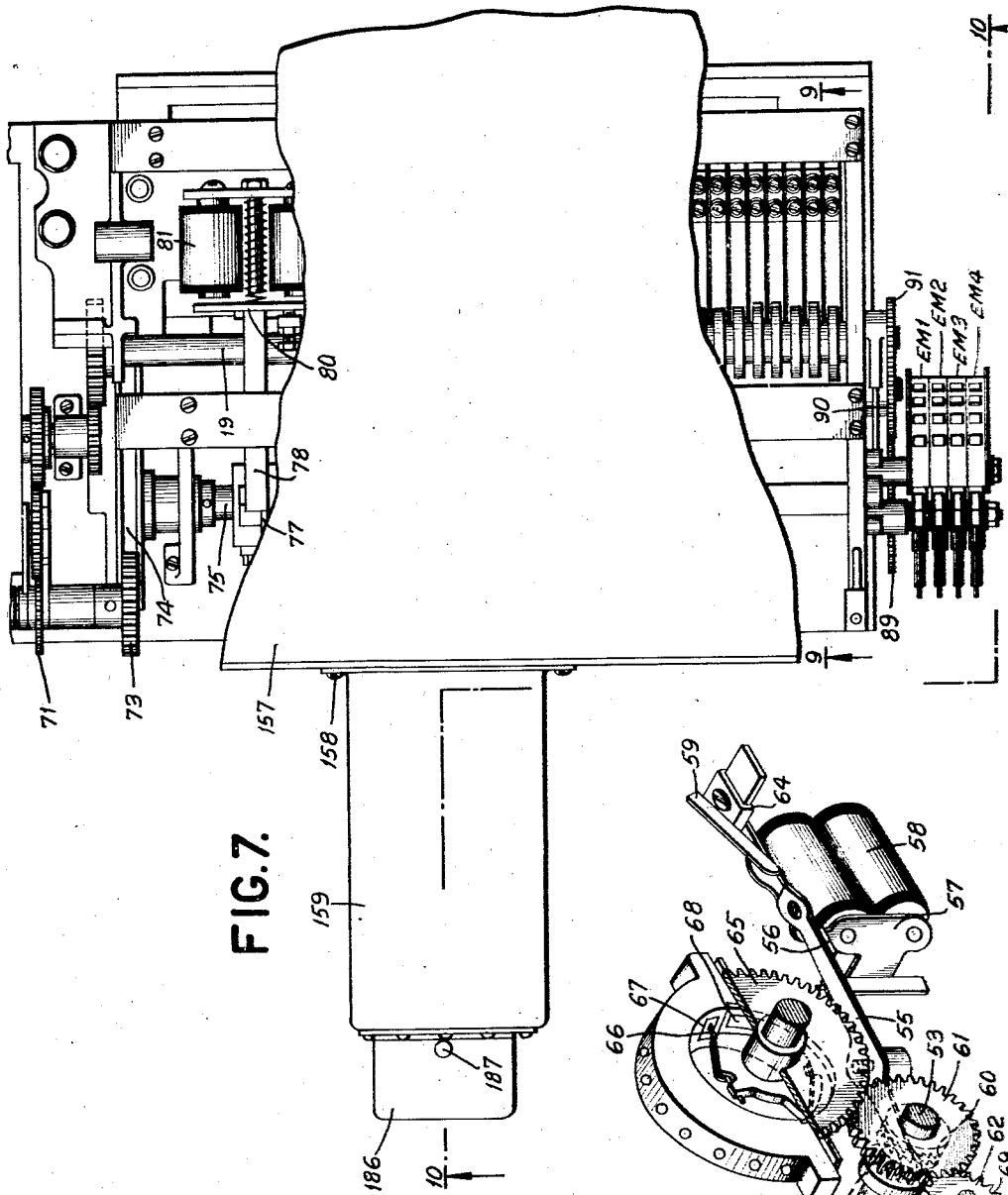


FIG. 7.

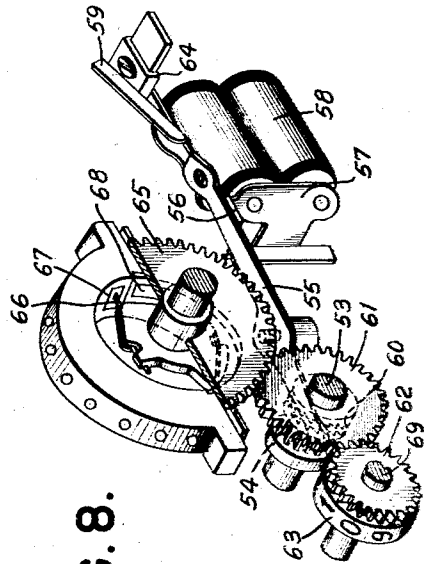


FIG. 8.

BY

INVENTOR
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June 5, 1945.

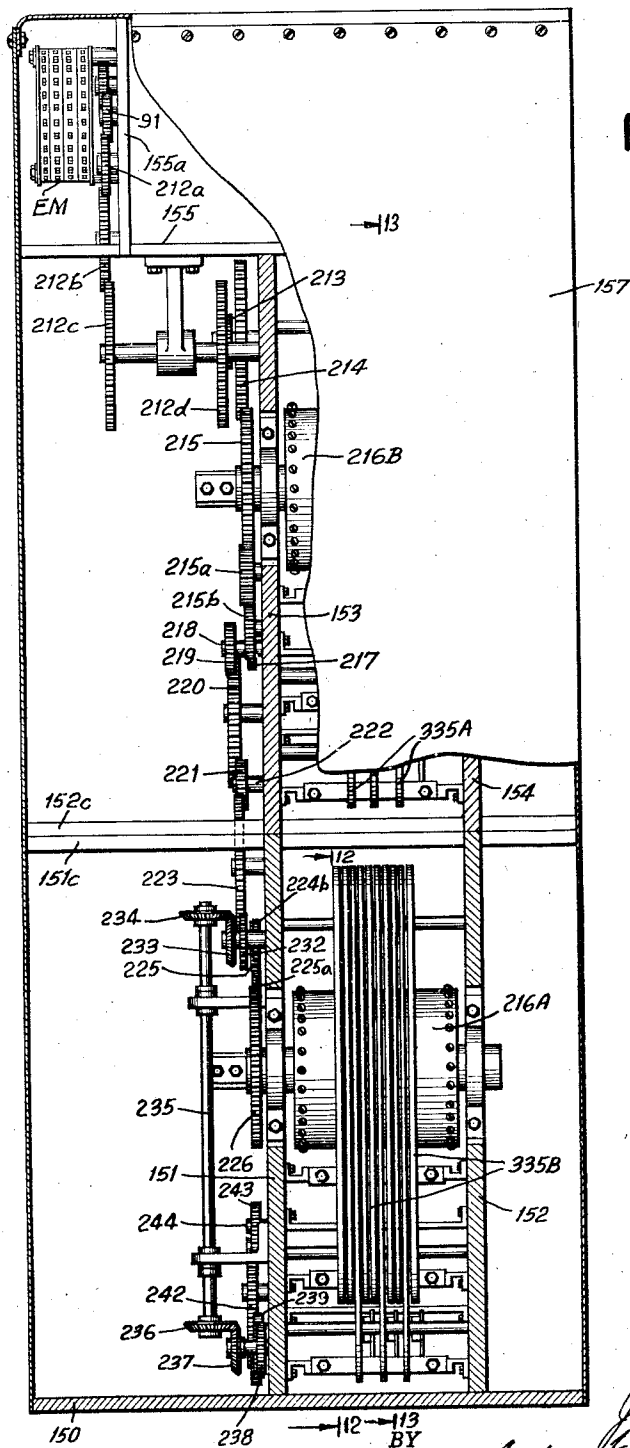
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RECORDING APPARATUS

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FIG. 11.



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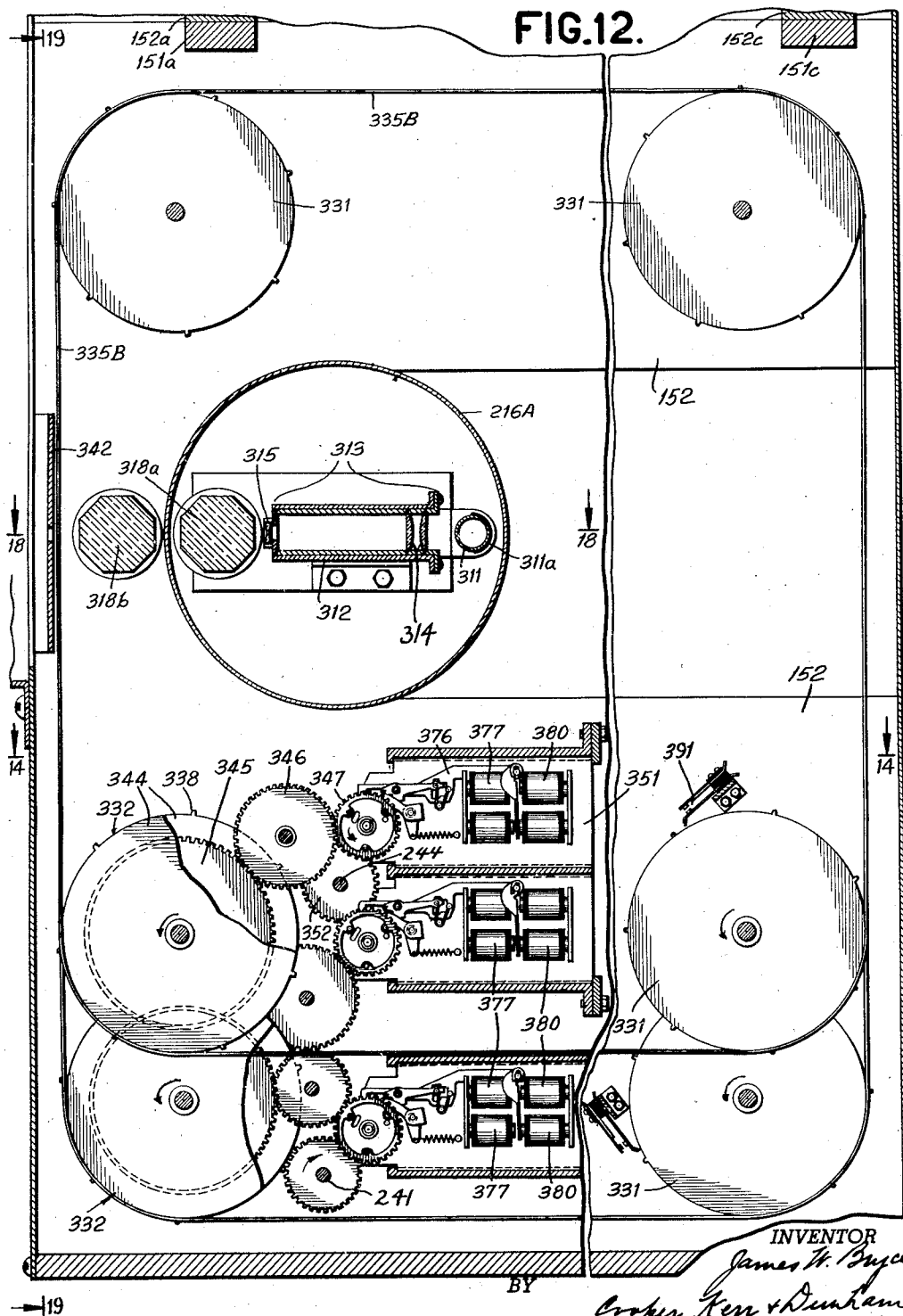
2,377,754

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FIG. 12.



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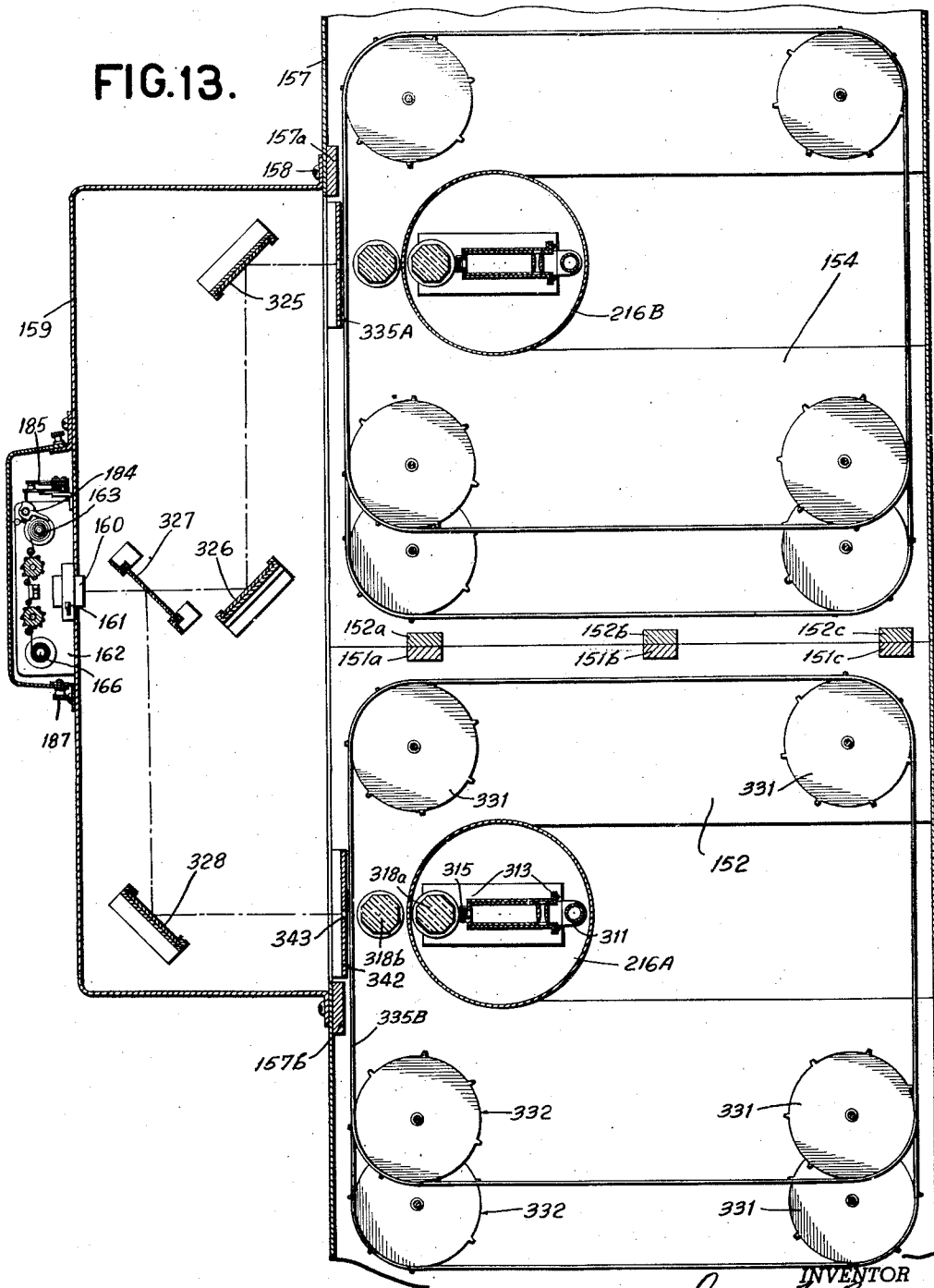
J. W. BRYCE

2,377,754

RECORDING APPARATUS

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21 Sheets-Sheet 8



BY

INVENTOR
James W. Bryce
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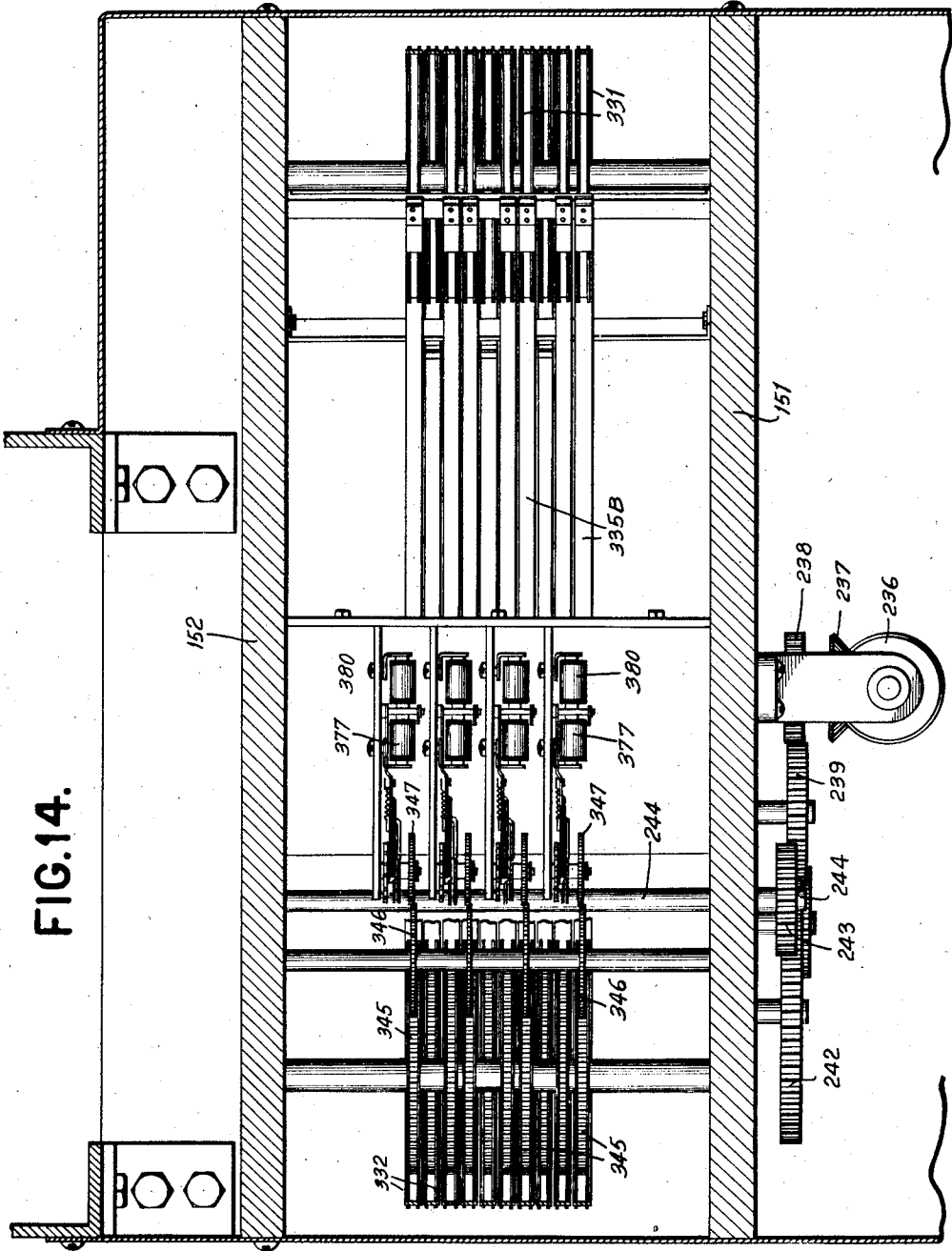


FIG. 14.

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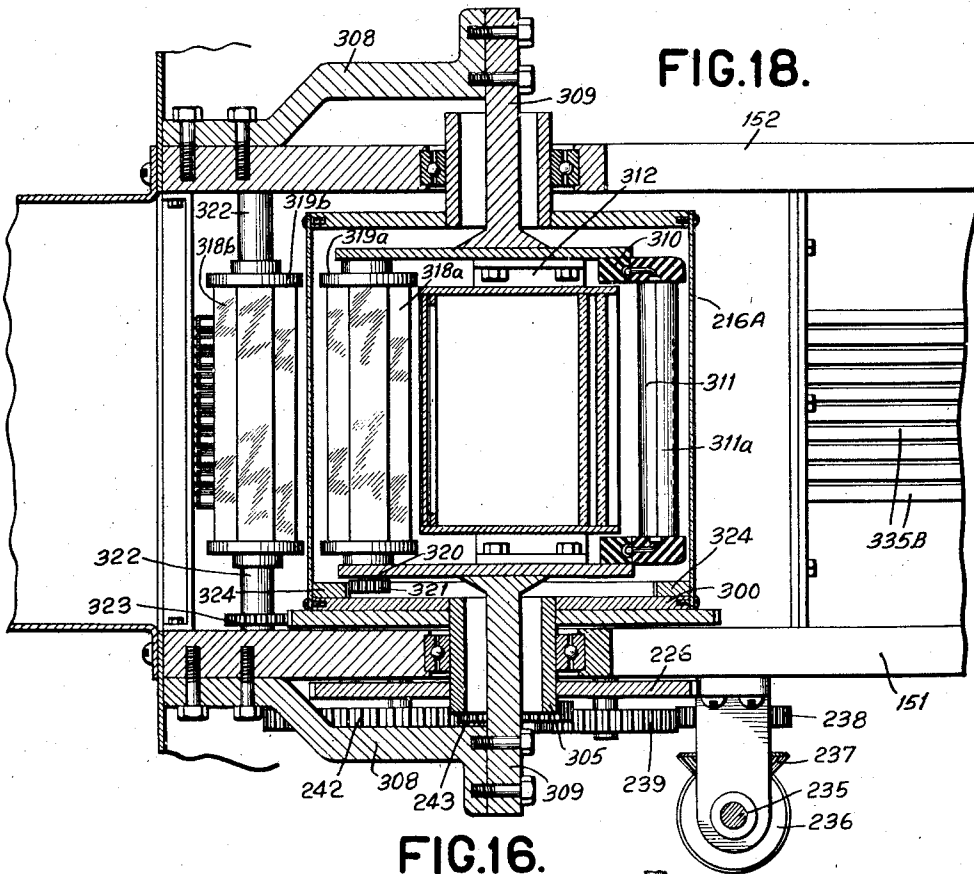


FIG. 16.

FIG. 17.

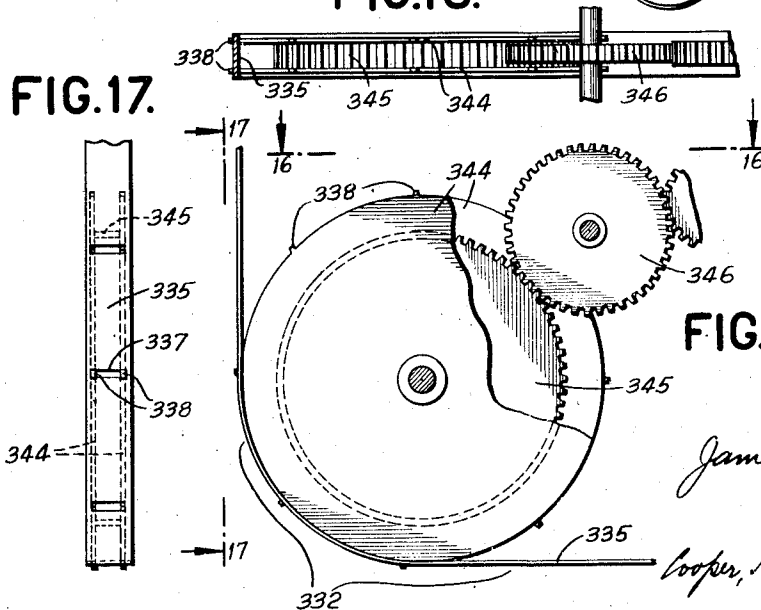


FIG. 15.

James W. Bryce
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June 5, 1945.

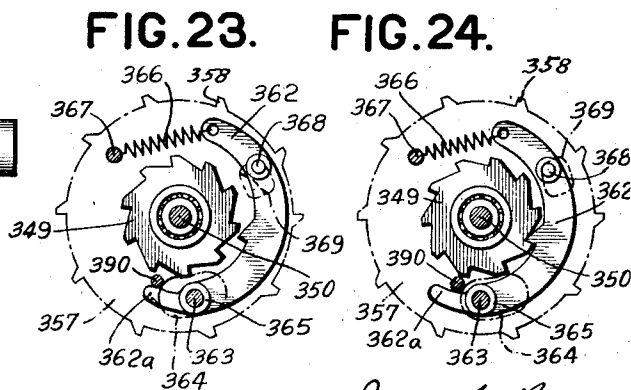
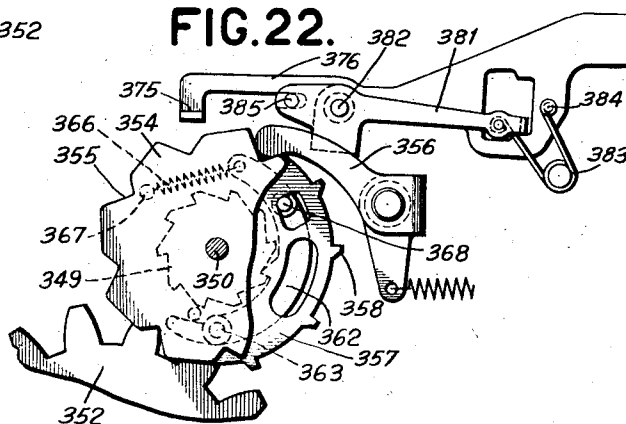
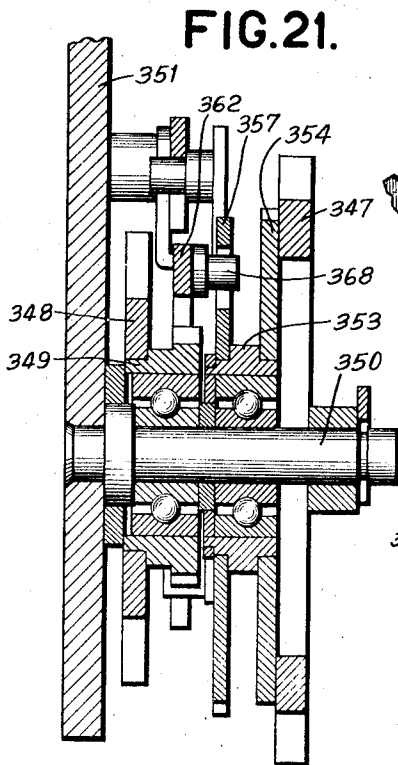
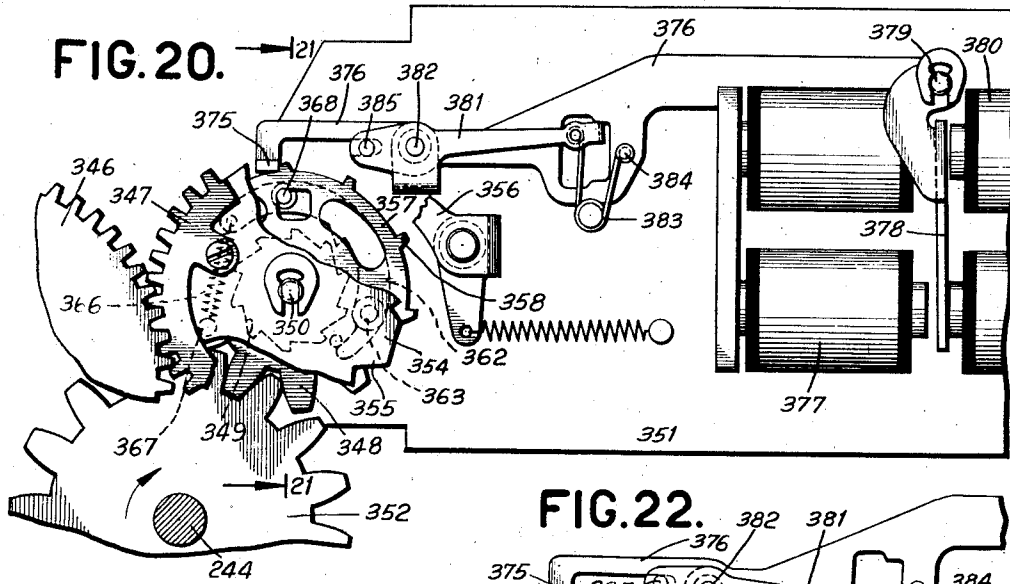
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2,377,754

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FIG. 25.

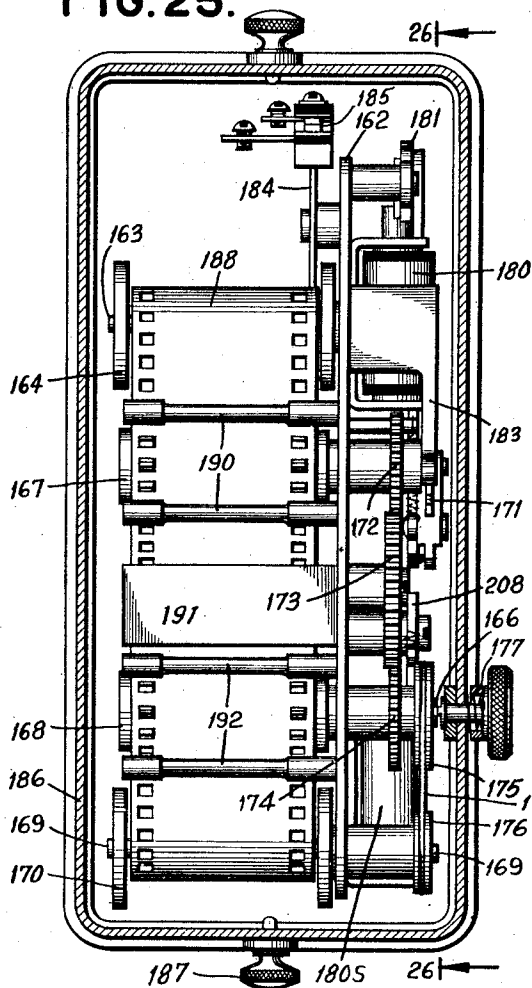


FIG. 26.

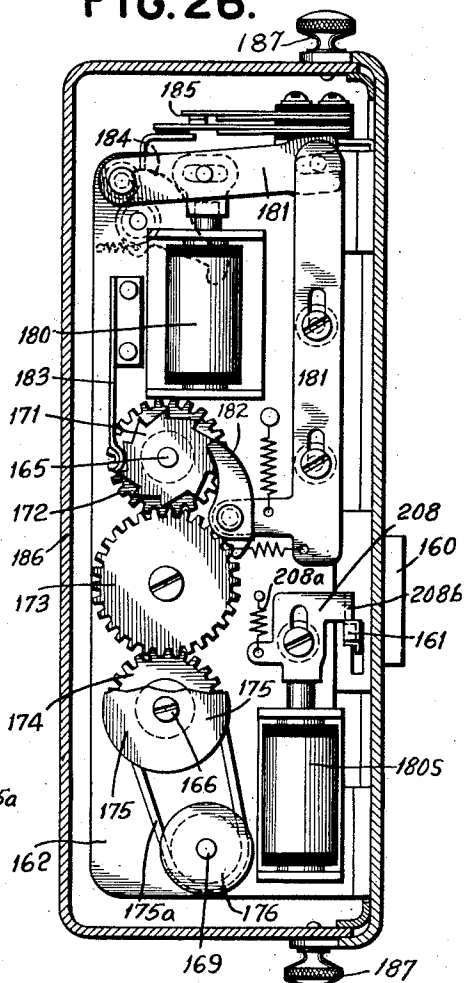


FIG. 27.

ZONE VALUE	DIGIT or INTRAZONE VALUE										ZONE STEPS
	0	1	2	3	4	5	6	7	8	9	
12		A	B	C	D	E	F	G	H	I	3
11		J	K	L	M	N	O	P	Q	R	2
0	0		S	T	U	V	W	X	Y	Z	1
NONE		1	2	3	4	5	6	7	8	9	0
12-11		a	b	c	d	e	f	g	h	i	3
12-0		j	k	l	m	n	o	p	q	r	2
11-0			s	t	u	v	w	x	y	z	1
12-11-0		%	*	.	:	;	&	1/4	1/2	3/4	0

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FIG. 30. FIG. 30a.

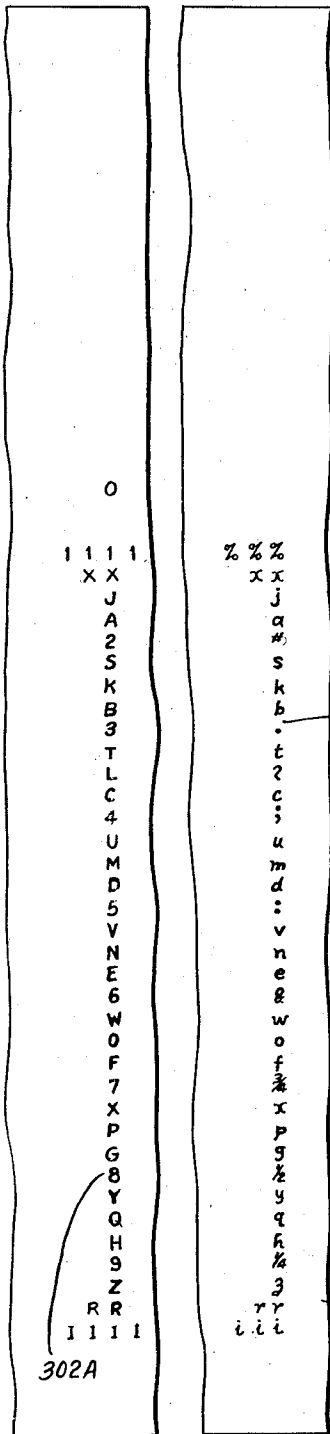


FIG. 29.

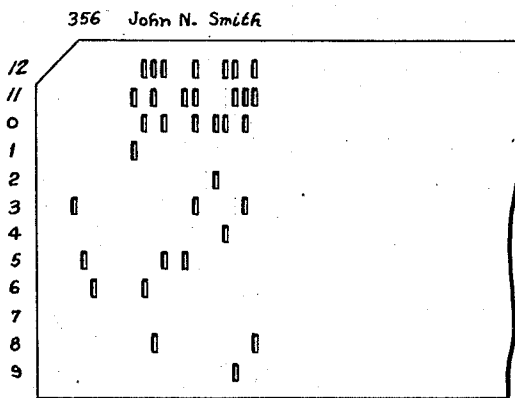
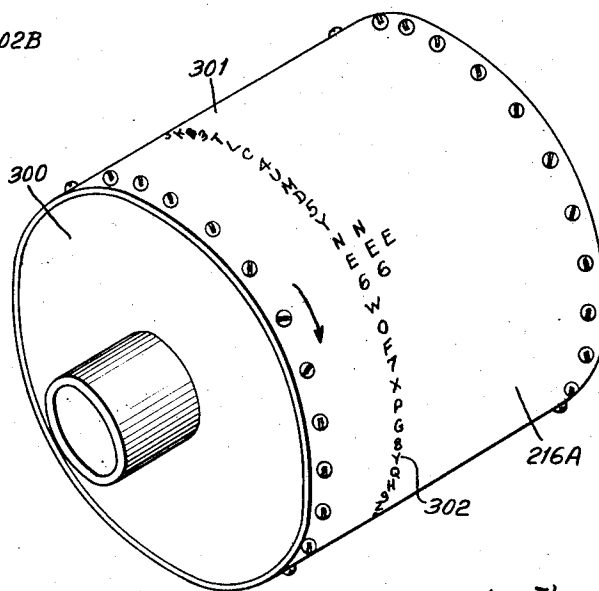


FIG. 28.



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June 5, 1945.

J. W. BRYCE

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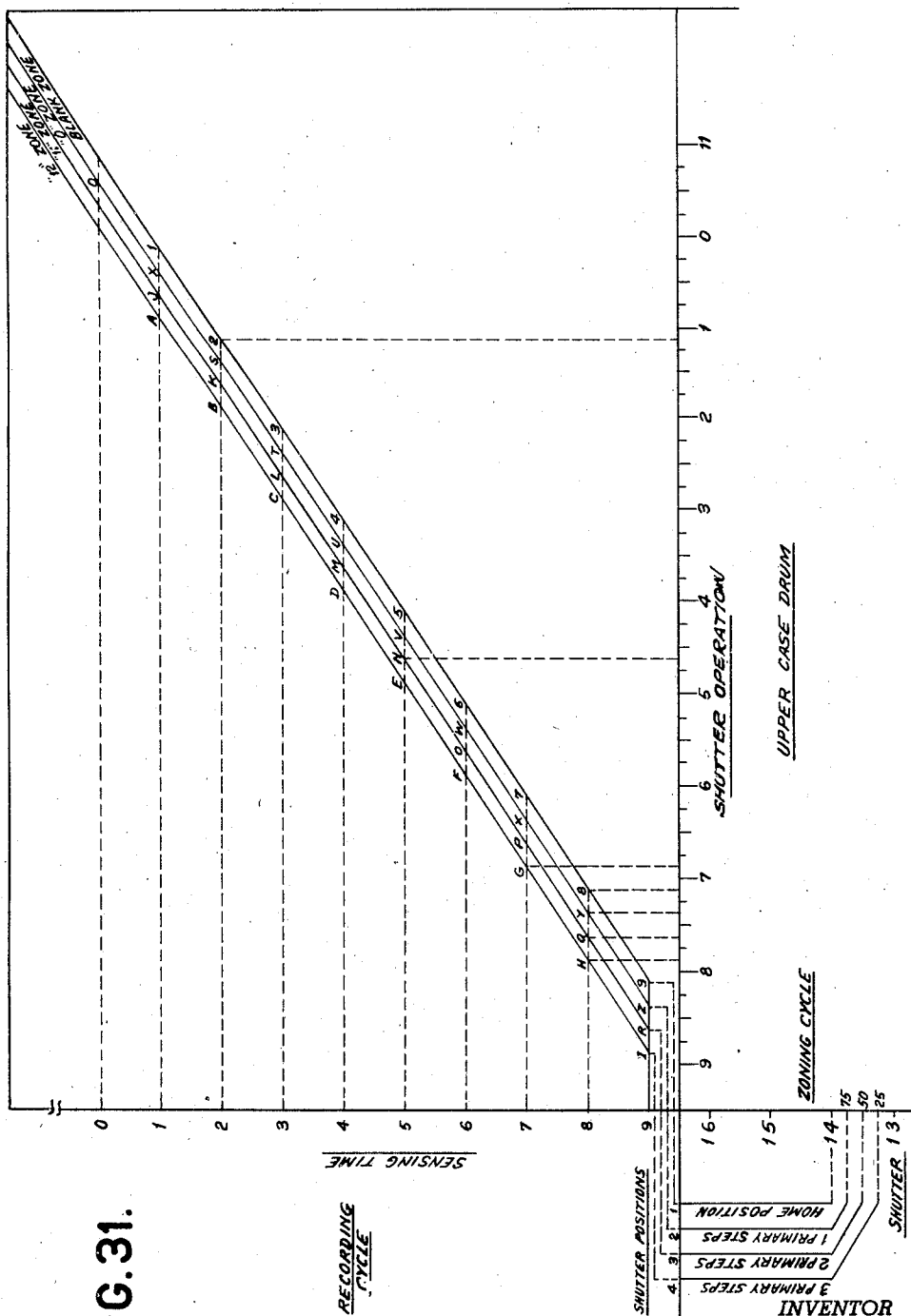


FIG. 31.

BY

INVENTOR
James W. Bryce
Cooper, Kern & Runkman
ATTORNEYS

June 5, 1945.

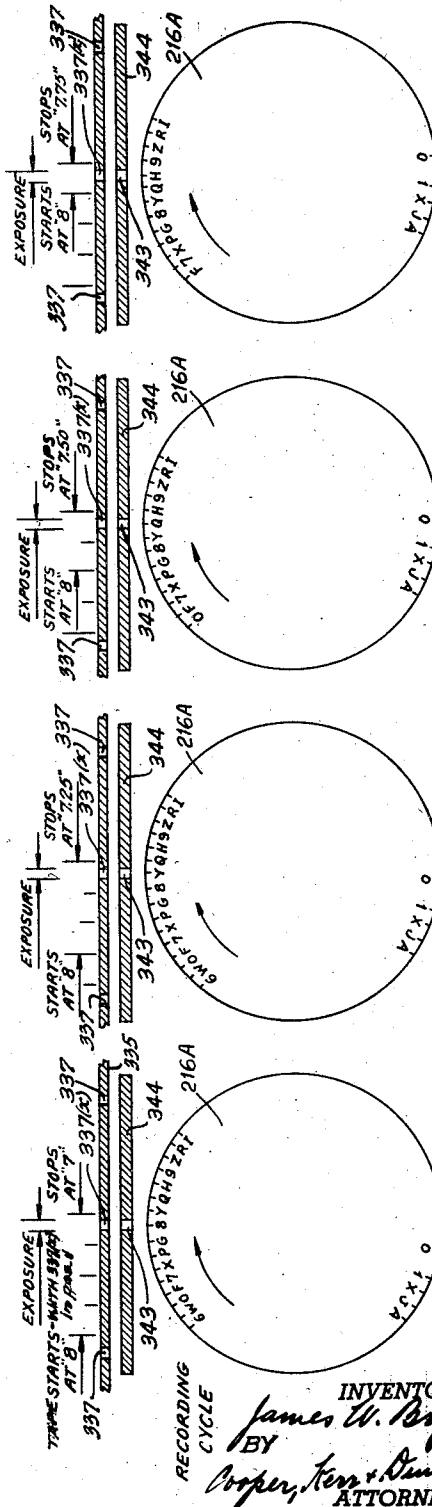
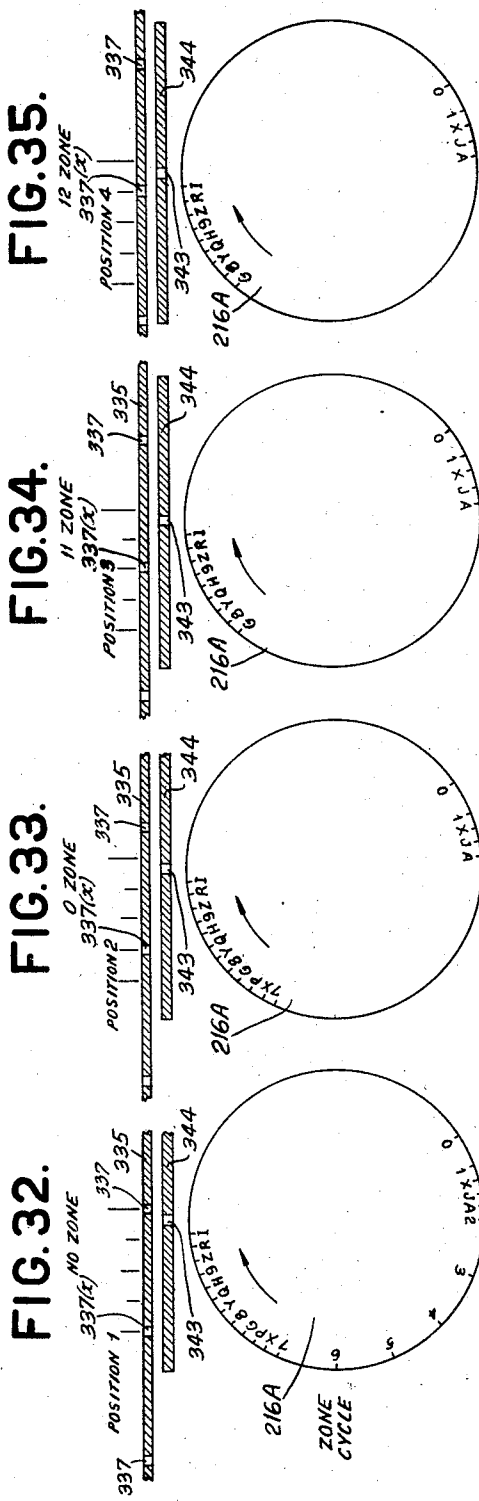
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2,377,754

RECORDING APPARATUS

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INVENTOR
James W. Bryce
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June 5, 1945.

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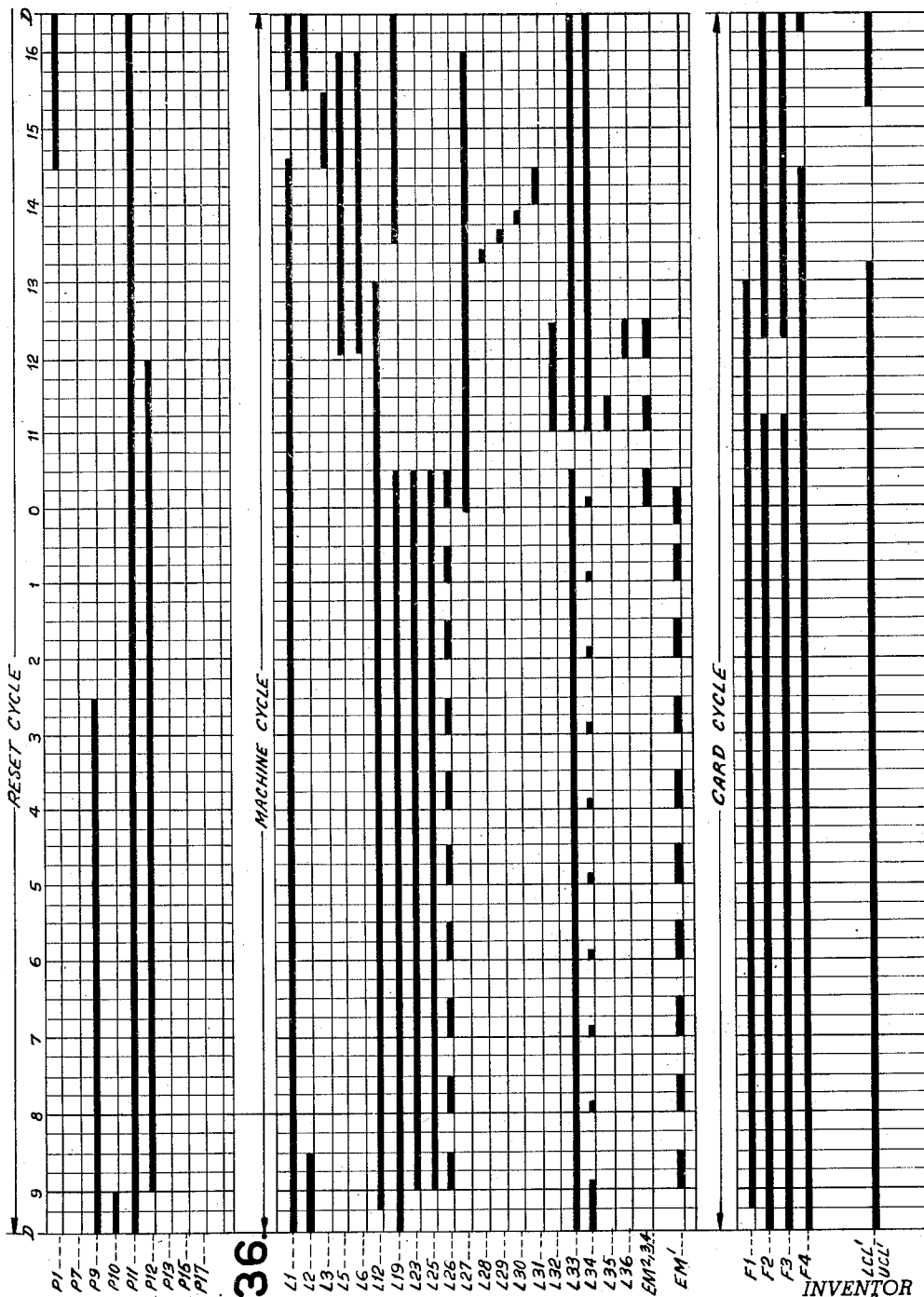


FIG. 36.

BY

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Cooper, Ken & Dunham
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INVENTOR

June 5, 1945.

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2,377,754

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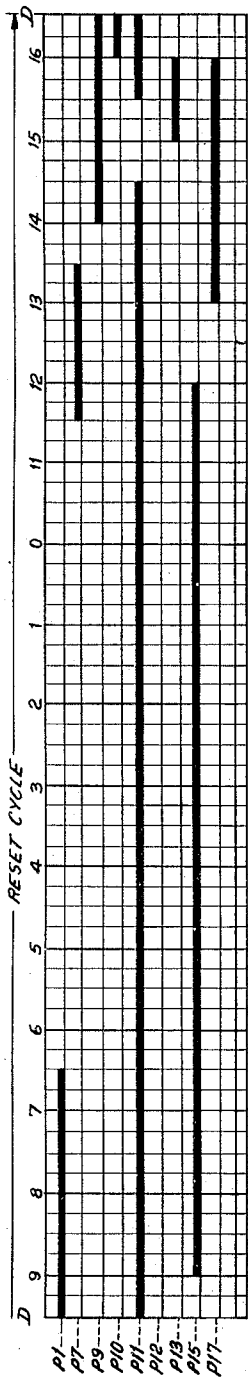


FIG. 36a.

FIG. 38.

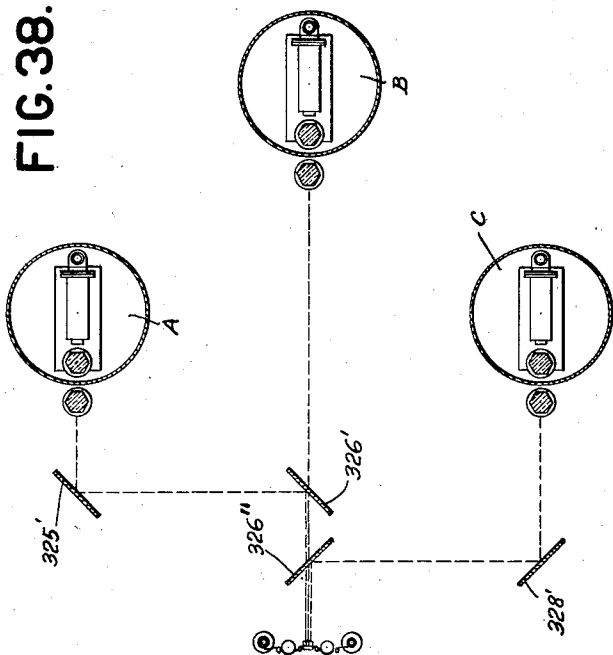


FIG. 37.

356 John N. Smith	10.00	15.36
10 #3 Drills	5.36	
5 #1 Planes		
378 Harry Brown		

BY

James W. Bryce
Cooper, Ken & Buchanan
INVENTOR
ATTORNEY S

June 5, 1945.

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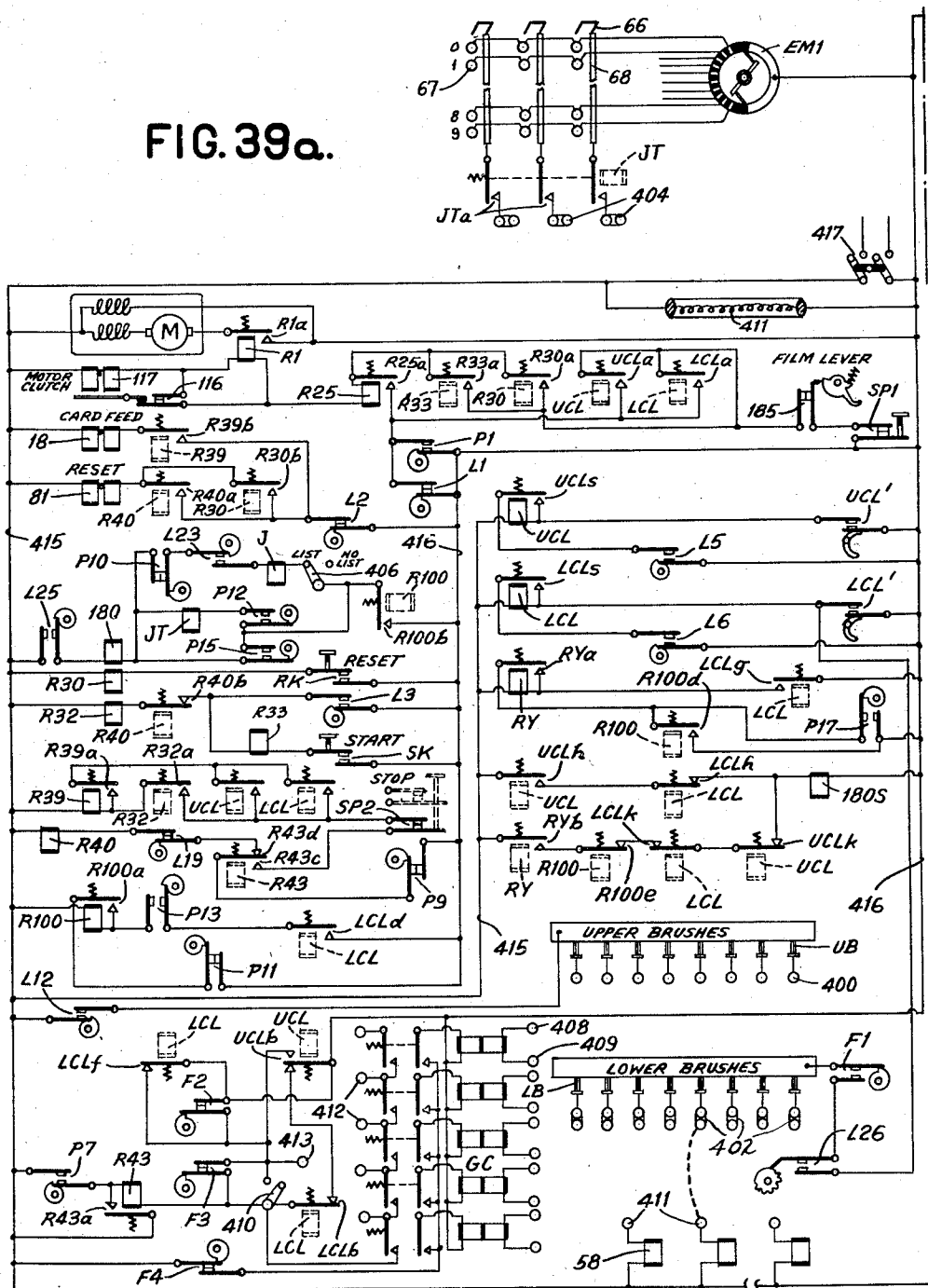
2,377,754

RECORDING APPARATUS

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FIG. 39a.



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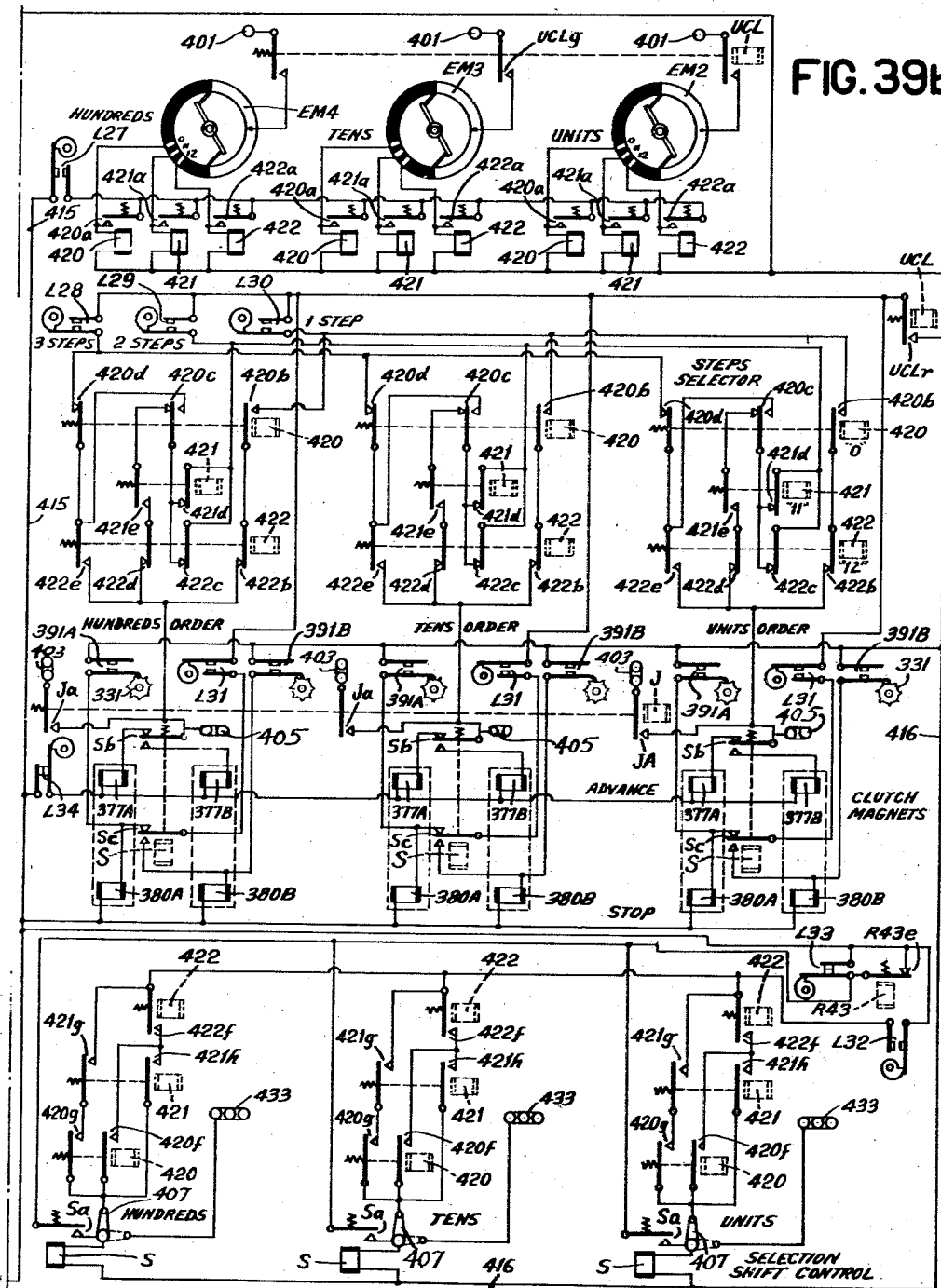
2,377,754

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FIG. 39b.



BY

INVENTOR
James W. Bryce
Cooper, Ken & Dunham
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June 5, 1945.

J. W. BRYCE

2,377,754

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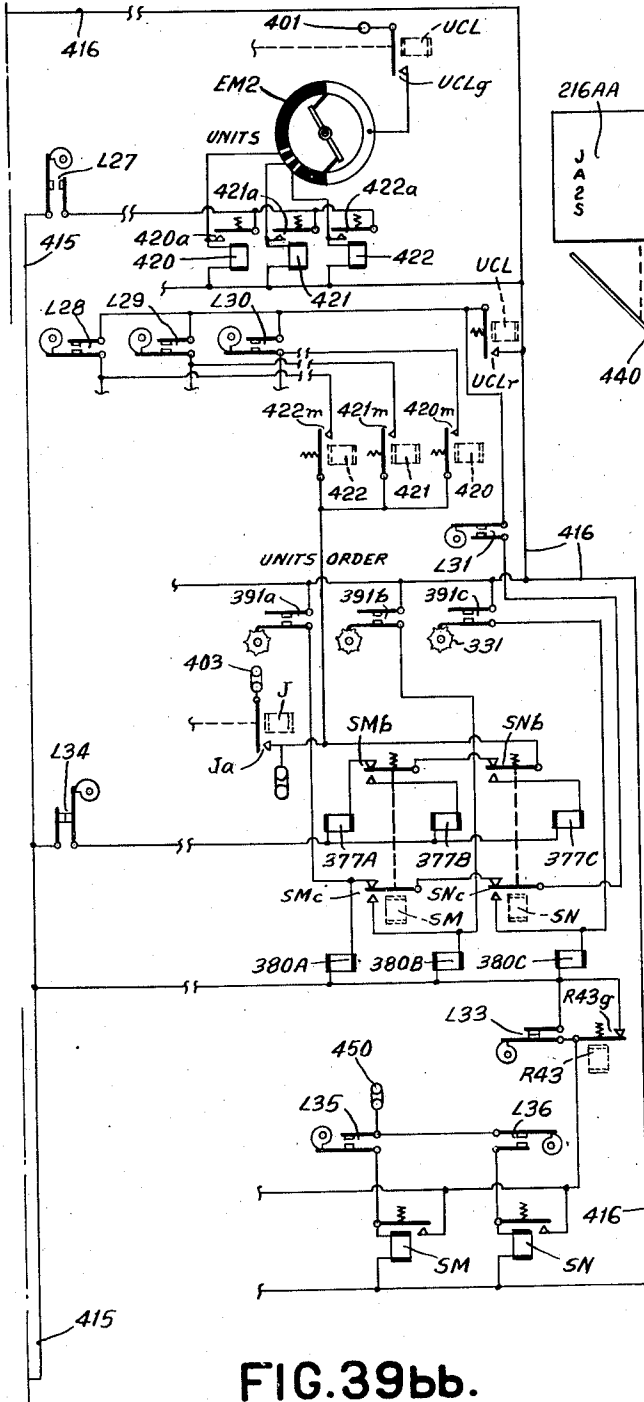
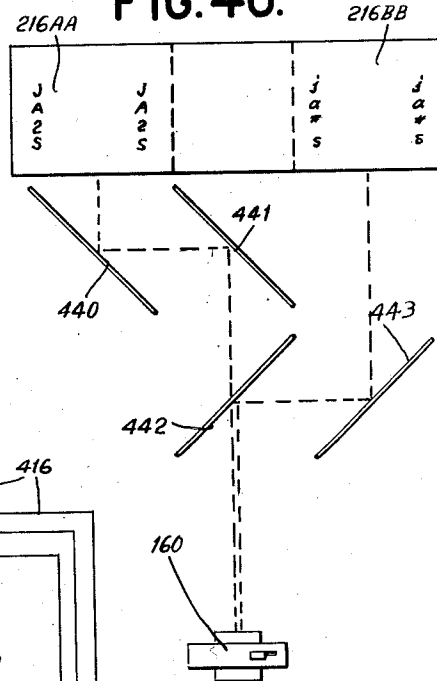


FIG. 39bb.

BY

Cooper, Kerr & Simkane
ATTORNEYS

FIG. 40.



James W. Bryce
INVENTOR

UNITED STATES PATENT OFFICE

2,377,754

RECORDING APPARATUS

James W. Bryce, Glen Ridge, N. J., assignor to
International Business Machines Corporation,
New York, N. Y., a corporation of New York

Application November 16, 1940, Serial No. 365,865

11 Claims. (Cl. 95—4.5)

This invention relates to photographic accounting apparatus of the type disclosed in my prior application, Serial No. 321,391, filed February 29, 1940, now patent No. 2,343,397.

The machine of my prior application employed a character bearing drum having columns of characters adapted to be selected and photographed upon a film during continuous movement of the drum. The number of different characters which could be selected was limited by the size of the character column. For a given machine speed there is an optimum exposure time for the individual characters which limits an increase in the number of different characters obtainable by spacing them together or by increasing the drum diameter. Accordingly, were the number of different characters to be increased by spacing them closer together or by increasing the drum diameter, the machine speed would have to be decreased in proportion.

One of the objects of the present invention is to provide an improved construction of photographic recording apparatus wherein the recording capacity or number of characters available for exposure may be increased without sacrifice of machine speed.

More specifically, an object of the invention is to provide multiple sets of character columns or series, each set having different characters and to select characters from the multiple sets for photographic exposure as they move in synchronism past exposure positions.

Further, an object of the invention is to provide a plurality of sets of different character columns and under control of character representing orders of control means common to the multiple sets to select characters from the different sets for photographic exposure as they traverse exposure positions.

A further object of the invention is the provision of a set of controls for selecting characters from multiple sets of character columns and photographically recording the characters on a common film line as the characters traverse exposure positions, with characters from one column set adapted to be interspersed with characters from another column set on the film line.

A further object of the invention resides in the provision of a plurality of character series or columns, characters from one or another of which may be selected by a single order of character representing means to be exposed, as the characters traverse spaced exposure positions, upon a common single character space of the film.

A further object of the invention resides in the

provision of an improved photographic recording machine having multiple character drums with provisions for selecting a drum from the plurality of drums and for also selecting which character upon the selected drum is to be exposed.

A further object of the invention is to provide character representing control means for jointly determining character and drum selection.

Another object of the invention is to provide alternative means to select a drum and separate means to select a character on the selected drum for exposure.

It is a further object to provide a photographic recording means adapted to photograph upon a film both numerical and alphabetic characters and novel controls for character selection.

A further object of the invention is the provision of a photographic recording machine adapted for selection and photographic exposure of characters under combinational code control.

A further object of the invention is the provision of an improved photographic recording machine in which the characters of a column of the drum are in multiple sets with provision for selecting a set and a particular character thereof for exposure to the film during continuous motion of the drum.

A further object is the provision of improved recording apparatus in which a plurality of characters from a plurality of the character columns may be selected by combinational code control means and concurrently photographed on a film.

A further object of the invention is the provision of photographic recording means with novel shutter means.

A further object is the provision in a photographic recording apparatus of unidirectionally movable shutters having successively acting exposure apertures.

Further and other objects of the present invention will be hereinafter set forth in the accompanying specification and claims and shown in the drawings which show by way of illustration a preferred embodiment and the principle thereof and what I now consider to be the best mode in which I have contemplated applying that principle. Other embodiments of the invention employing the same or equivalent principle may be used and structural changes made as desired by those skilled in the art without departing from the present invention and within the spirit of the appended claims.

In the drawings:

Figure 1 is a front elevational view of the machine;

Fig. 2 is a detail view of the main clutch of the machine;

Fig. 3 is an outside view of the card feeding and analyzing mechanism. This figure also shows the card feed de-clutching devices;

Fig. 4 is a detail sectional view taken on line 4—4 of Fig. 3;

Fig. 5 is a detail view of the accumulator reset mechanism and clutch therefor;

Fig. 6 is a somewhat diagrammatic view of the drive mechanism of the machine;

Fig. 7 is a top view of the recording section of the apparatus with certain cover parts broken away to show the interior construction;

Fig. 8 is an isometric view of certain elements of one denominational order of an accumulator;

Fig. 9 is a detail view taken on line 9—9 of Fig. 7;

Fig. 10 is a partly end elevational and partly sectional view of the recording apparatus, taken substantially on line 10—10 of Fig. 7;

Fig. 11 is a rear elevational view of the recording section of the apparatus with certain portions of the cover plates removed. The view is taken substantially along lines 11—11 of Fig. 10;

Fig. 12 is a sectional view showing one of the drums, the shutter tapes and the drive mechanism, the view is taken substantially on line 12—12 of Fig. 11 and is on an enlarged scale;

Fig. 13 is a sectional view taken substantially on line 13—13 of Fig. 11, showing both drums, the shutter tapes therefor and certain projecting apparatus. In this view certain of the drive parts for the shutter tapes are omitted. This view is on an enlarged scale with respect to Fig. 11.

Fig. 14 is a transverse sectional view taken on line 14—14 of Fig. 12. Certain portions of the shutter tapes are broken away. This view is on an enlarged scale with respect to Fig. 12;

Fig. 15 is an enlarged elevational view showing a shutter tape sprocket and the drive therefor;

Fig. 16 is a top view of the parts shown in Fig. 15, looking in the direction of the arrows 16—16 of Fig. 15, and showing the shutter tape in cross-section;

Fig. 17 is an elevational view taken on line 17—17 of Fig. 15;

Fig. 18 is a transverse sectional view taken on line 18—18 of Fig. 12;

Fig. 19 is a front elevational view taken substantially on line 19—19 of Fig. 12;

Fig. 20 is an enlarged detail view of the shutter driving mechanism shown on Fig. 12;

Fig. 21 is a sectional view of the parts shown in Fig. 20, the section being taken on line 21—21 of Fig. 20;

Fig. 22 is a detail view showing certain parts of the mechanism of Fig. 20 in displaced and moved position;

Fig. 23 is a detail view of certain drive parts in their normal position; and

Fig. 24 is a similar view of like parts in operated position.

Fig. 25 is an inside elevational view of the camera unit, the view is taken substantially on line 25—25 of Fig. 10;

Fig. 26 is a detail sectional view of the camera unit, the section being taken substantially on line 26—26 of Fig. 25;

Fig. 27 is a table which shows the code for the various characters on the drum;

Fig. 28 is an isometric detail of the drum showing however, only one complete column of characters;

Fig. 29 is a fragmentary view of one of the con-

trol records which is used in the machine. Only certain characters are here shown;

Fig. 30 is a developed view of one of the drums showing the disposition of the characters thereon;

Fig. 30a is a similar view showing the characters on the other drum;

Fig. 31 is a chart or graph showing the relation of the shutter positions and the characters exposed at different cycle times for the different shutter positions;

Fig. 32 is a diagrammatic view showing the shutter in home position at the end of the zone cycle and the relation of the drum thereto;

Figs. 33 to 35 are similar views showing the relation of a shutter to the drum for different zone conditions. Fig. 33 shows a zero zone condition; Fig. 34 an 11 zone condition; Fig. 35 shows a 12 zone condition;

Figs. 32a to 35a are corresponding views showing the relation of the shutter to the drum during the recording cycle. All views showing the shutter tripped at the same time in said cycle.

Figs. 36 and 36a taken together with Fig. 36a to the right of Fig. 36 is a timing diagram showing the timing relation of the various cam contacts and other devices in the machine;

Fig. 37 is a fragmentary view of a portion of an exposed and developed film record;

Fig. 38 is a diagrammatic view of a modified arrangement wherein three drums are used instead of two drums as in the other embodiment; and

Figs. 39a and 39b, taken together with Fig. 39b to the right of Fig. 39a, show the complete circuit diagram of the main embodiment of the invention. Fig. 39bb taken with Fig. 39a shows the circuit diagram for the modification shown in Fig. 38; and

Fig. 40 is a diagrammatic view of another modification wherein the plurality of drums are replaced by a single equivalent drum.

General description of the machine

Before describing the machine in detail, its general features will be briefly pointed out. According to my previous construction, disclosed in my copending application, Serial No. 321,391, filed February 29, 1940, now Patent No. 2,343,397, only a single character bearing drum was employed, whereas according to the present invention a plurality of drums are employed, data from any of which drums may be recorded upon a common film. The multiple drums are continuously rotated and an optical system is provided for projecting character images from any of the drums to a common location upon a film. For each drum there is a separate set of shutters adapted to be selectively operated individually by differential driving mechanism. Provision is made for this driving mechanism to differentially position the shutters according to the presence of zoning designations of combinational character representations on controlling records. After having preliminarily positioned the shutters according to zoning controls, the differential driving mechanism is again brought into operation under control of intra-zone portions of the character representations on the records to effect character exposing movement of the shutters. The selection of characters which are exposed from any one drum is determined conjointly by the zoning control of the shutter and the intra-zone control of said shutter. Suitable controls are provided to enable some characters to be recorded from one drum (for example, upper case char-

acters) and other characters such as lower case characters to be recorded from another drum. In lieu of using shutters of the reciprocating type which have to be tripped and subsequently restored by return movement, the present machine employs shutters which are in the form of continuous bands or tapes together with mechanism for advancing the tapes in one direction only. Each shutter tape has a plurality of shutter apertures disposed at equi-distant intervals along the tape and successive shutter apertures along each tape are used for successive exposures on a film of characters from the drum. A camera unit and film carrying and feeding means of the same type as in my prior machine are provided.

The new photographic recording apparatus is part of an accounting machine of the record-controlled type wherein characters are represented on records. Such records have parallel columns of index positions 9 to 0, 11, and 12. The digits are represented by a simple Hollerith type of code wherein perforations in positions 9 to 0 represent these digits, and alphabetical and other special characters are represented by combinational codes wherein various zone designations in positions 0, 11 and 12 are combined with intra-zone perforations in the 1 to 9 positions. The records are fed in the usual way past upper and lower analyzing brushes. The upper brushes sense the zone designations to control preliminary zoning adjustment of the shutters. The preliminary shutter adjustment for zoning varies the initial extent of offset of the shutter apertures with respect to a fixed aperture through which apertures the characters upon the moving drum are exposed when the shutter is subsequently advanced. Such subsequent advance of each shutter is controlled by the sensing by the lower brushes of intra-zone perforations of the controlling record. The selection of a particular character for exposure is determined both by the initial offset of the shutter and by the timing of the subsequent advance of the shutter. The zoning controls may also determine whether certain characters are to be printed in upper or lower case, i. e., from one drum or another. Alternatively, drum selection may be determined by special controls governed by special designations in record columns other than those containing character representations.

A suitable optical system is provided to enable character images which are derived from one drum or another drum to be projected to a film. This optical projecting system enables characters from corresponding columns upon the multiple drums to be exposed at a common point on the photographic film and also enables characters from non-corresponding columns to be concurrently exposed side by side upon the film.

Machine drive

Referring to Fig. 6, the drive motor M, through a belt and pulley connection, drives the usual ratchet of the main clutch (see also Fig. 2). When clutch magnet 117 is energized, a shaft 6 is clutched in for drive by motor M. Shaft 6, through gearing designated 6a, drives a main shaft 44. Gears 67a on the main shaft drive the gears 67, each of which through the usual shafting and gearing 67b, as indicated for the left hand accumulator only in Fig. 6, drives the clutch shaft 53 of a known type of accumulator.

Driving for resetting and for total recording

Shaft 44 near its right hand end is provided with a gear 44a which, through gears 44b and

44c, rotates a shaft 19. Fixed to shaft 19 is a gear 84 which drives a gear 83 rigidly carrying a clutch driving element 82. Gear 83 is freely rotatable upon a reset-total shaft 75. Shaft 75 has fixed to it a gear 74 and an arm 76 (see also Fig. 5) which carries a spring-pressed clutch dog 77 normally held in the position shown in Fig. 5 by a latching arm 78 supported by the armature shaft 79 of an armature 80 of reset clutch magnet 81. Energization of magnet 81 will release dog 77 for engagement with the clutch driving element 82. The gear 74 provides the usual reset drive to main reset shaft 72 through a gear 73 (corresponding to gear 278 of Fig. 26 of the Lake et al. Patent No. 1,976,617). On reset shaft 72 are gears 71 driving gears 70, each affording individual reset drive to the index wheel shaft 69 (see Figs. 6 and 8) of an accumulator unit.

From the foregoing, it is clear that accumulator reset will be effected when clutch magnet 81 is energized.

Recorder drive

Referring to Figs. 6, 10 and 11, shaft 19 carries a gear 91 which, through gearing 212a, b, c, and d, drives a gear 213 fixed to a shaft 213a. Also fixed to shaft 213a is a gear 214 which meshes with a gear 215 secured to an upper character bearing drum 216B. Gear 215, in turn, through idlers 215a and 215b drives a gear 217 secured to a shaft 218. Shaft 218 rigidly carries a gear 219 serving through an idler gear 220 to drive a gear 221 and its shaft 222. Further drive through gears 223, 224 (see Fig. 10) rotates a shaft 224a to which is fast a gear 224b. Gear 224b, through idlers 225 and 225a, drives a gear 226 fixed to the hub of a lower character bearing drum 216A. By the foregoing driving mechanism the drums 216A and 216B are rotated through one revolution for every revolution of shaft 19.

Card feed drive and record analyzing means

Referring to Fig. 3, main clutch shaft 6, through a gear 12, drives a pair of gears 12a and 12b fixed upon a common shaft. Gear 12b in turn drives a gear 12c which meshes with a gear 13 rigid with a clutch drive disk 14, freely mounted on a sleeve 7 (also see Fig. 4). Fixed to sleeve 7 is an arm 15 which carries a spring pressed clutch dog 16 normally held disengaged from clutch drive disk 14 by an armature latch 17 controlled by a card feed clutch magnet 18. When magnet 18 is energized, the clutch dog 16 is released and sleeve 7 is set in rotation. Fixed to sleeve 7 is a gear 11 which affords drive to successive pairs of the usual feed rolls 10 and to the customary card pickers 9. During each card cycle, pickers 9 feed a record card from the supply stack to a pair of feed rolls 10. During successive cycles, the feed rolls 10 feed a card past the usual upper and lower analyzing brushes UB and LB. Card feeding and analyzing operations will continue as long as magnet 18 remains energized. The magnet is de-energized during total taking cycles; hence, card feeding will not occur during such cycles.

Accumulating mechanism

Fig. 6 diagrammatically illustrates three accumulator banks. Each of these accumulator banks is of the form fully described in the Lake et al. Patent No. 1,976,617.

The mode of operation of accumulator elements of one order will be briefly described below.

Referring to Fig. 8, previously mentioned shaft 53 has slidably mounted thereon, but keyed for rotation therewith, clutch elements 54, one for each denominational order of the accumulator. Element 54 is provided with a groove which fits the short arm of a lever 55 provided with a block 56 normally latched by armature latch 57 of an add magnet 58. When magnet 58 is energized by the sensing of a digital value, armature latch 57 releases lever 55 which is thereupon rocked in a counterclockwise direction. This movement brings the clutching member 54 into engagement with cooperating teeth 60 integral with a gear 61 freely rotatable on shaft 53. Gear 61, when thus coupled to shaft 53, rotates a gear 62 of an accumulator index wheel 63 freely mounted on a shaft 69. The usual clutch release is provided and comprises a finger 64 moved at a cyclic time to engage the rearward extremity of lever 55 for disengaging the clutch element 54 from teeth 60 and relatching block 56 on armature 57. The index wheel 63 is thereby advanced an amount corresponding to the sensed value.

Readout mechanism

Also driven by index wheel driving gear 61 (Fig. 8) is a gear 65 of the usual readout commutator. The ratio of gears 65 and 62 is 2 to 1 so that the former will turn a half revolution for each revolution of the latter. Carried by and insulated from gear 65 are two electrically connected brushes 66. During half a turn of gear 65, one of the brushes cooperates successively with ten digit segments 67 while the other brush is wiping an arcuate conducting strip 68. During the next half turn of gear 65, the brushes reverse their positions and functions. The relationship of the parts is such that when the index wheel 63 is in its zero position, one of the brushes 66 is in contact with the zero digit segment 67 and the other brush is in contact with common trip 68.

The brushes 66, segments 67, and common strip 68 provide a readout mechanism for reading out amounts standing on the accumulator, an amount being represented by the position of one of the brushes with respect to the digit segments. The shaft 69 (Fig. 8), upon which the index wheels of an accumulator are freely mounted, is slotted for cooperating with the usual reset pawls (not shown) carried by the individual index wheels in such a manner that a counterclockwise revolution of shaft 69 during a reset cycle will advance the index wheels 63 to zero positions. Reset drive for shaft 69 is provided for in the manner previously described.

Cam contact devices and machine timing

Referring to Figs. 6 and 9, the shaft 19 makes one revolution each machine cycle (Fig. 36) and is adapted to drive certain L cams of the cam contact devices. The same shaft 19 through gearing 91, 90 and 89 drives the emitter drive shaft 85. This shaft drives the usual two brushes of conventional emitters designated EM. The two emitter brushes of each emitter make one revolution for every two revolutions of shaft 19, but during each half a revolution of the brushes, one of the brushes is successively wiping the emitter spot and the opposite brush is wiping the common segment. Suitable gears 75a, 75b are provided to drive from reset totaling shaft 75, a shaft 92 which in turn drives the P cams of the machine. Such P cams rotate through one complete revolution in two machine cycles

and function during reset and total taking cycles (Figs. 36 and 36a).

The present arrangement differs from the machine disclosed in the Daly Patent No. 2,126,621 wherein the P cams make a complete revolution in one machine cycle.

Referring now to Fig. 3, a shaft 93 driven from the card feed gear train operates the F cam contact devices during card feeding cycles only.

The timing relations of the various cam contact devices are substantially shown in detail in the timing diagram (Figs. 36, 36a). A card cycle is equal to the period of one revolution of shaft 93 and to the period between the arrival of corresponding points of successive cards at a reference point such as an analyzing station. The card cycle occurs during one machine cycle. During each card cycle, the F cams make one revolution. A machine cycle is equal to a revolution of shaft 19 during which the L cams make one revolution and an emitter brush of emitter EM is successively wiping the emitter spots. The reset or total cycle occurs when shaft 75 (Fig. 6) makes one revolution as a result of energization of reset magnet 81. The drive relations of machine cycle shaft 19 and reset cycle shaft 75 are such that during one revolution of the shaft 75, there will be two revolutions of shaft 19. Hence each reset cycle is co-extensive with two machine cycles. During each reset cycle, the P cams make one revolution.

The photo-transferring section of the machine will now be described.

Drum frame assembly

Referring to Fig. 11, 150 designates the base frame of this section of the machine. Secured to it are two upright frames 151 and 152 which at their upper end are attached to cross-members 151a, b and c (see Fig. 10). Fast to these cross-members are upper cross-members 152a, b and c which have secured thereto a pair of vertical frame members 153, 154. Supported by the members 153, 154 are cross-frame members 155 which provide support for a plate 155a which supports shaft 19 and gear 91. Suitably carried upon these frames is a cover 157 provided with braces 157a and 157b which support the housing 159. The housing carries a camera unit including a lens and shutter assembly generally designated 160, provided with a shutter trip lever 161. To the left of the lens and shutter assembly is the film supporting and feed assembly of the camera unit. Fixed to the housing 159 is an assembly plate 162 (see also Fig. 25). A stud 163 carried by plate 162 as shown in Fig. 25 affords a support for a film supply spool which is generally designated 164 (see also Fig. 10). A pair of shafts 165 and 166 (Fig. 26) are also rotatably supported by the assembly plate 162 and on these shafts are film feed sprockets 167 and 168 (see Fig. 10). Another shaft 169 affords a support for a takeup spool 170.

Referring now to Fig. 26, shaft 165 has fast to it a ratchet 171 and a driving gear 172. Driving gear 172 meshes with an intermediate gear 173 which is meshed with a gear 174 fixed on shaft 166. A belt 175a transmits motion from a pulley 175 fixed to shaft 166, to a pulley 176 on takeup spool shaft 169. Shaft 166 is slotted at one end to receive a winding key generally designated 177, normally in the retracted position, as shown in Fig. 25. Also carried by the assembly plate 162 is a film feed operating sole-

noid 180, energization of which will depress an actuating member 181. This member 181 is suitably spring-restored to upper position and upon restoring movement, a pawl 182, carried by the member, actuates the film feed ratchet 171 to advance the film one line space. A flat spring 183 serves as a detent for the ratchet 171.

Referring again to Fig. 10, within the camera housing there is provided a pivoted lever 184 (see also Fig. 26) which is spring-pressed into contact with the film on the supply roll. When the film is exhausted, member 184 swings clockwise to such an extent that a pair of contacts 185 open. At other times with film available on the supply spool, the lever 184 maintains these contacts closed. The camera unit is provided with a suitable housing or cover designated 186. This cover is held in position on the housing by a pair of knurled thumb screws 187. The film which is designated 188 in Fig. 25 is provided with the usual feeding sprocket holes. The film passes successively under the first two film guides 190, through a film gate 191 (see Fig. 25) and then under another pair of film guides 192 (Fig. 25). The film guides 190 and 192 and the film gate 191 are suitably mounted on the assembly plate 162. Also carried by the assembly plate is a solenoid 180S (Fig. 26). Fixed to the plunger of the solenoid is a plate 208 which is normally held in upper position by a spring 208a. Plate 208 is provided with a lug 208b engaged with the shutter control lever 161. Upon each energization of the solenoid 180S, the plate 208, through its lug 208b will operate lever 161 to actuate the main shutter mechanism of the camera unit. According to the present arrangement, the main shutter mechanism is set for a so-called time exposure operation, that is to say, the first actuation of member 161 will open the shutter mechanism and the next actuation will close it.

Rotating character drums and auxiliary shutter mechanism

From the previous description it will be understood that the character drums 216A and 216B are in continuous rotation as long as the drive shaft 44 is rotating (see Figs. 10 and 6).

According to the main embodiment, a pair of drums 216A and 216B each rotate through a complete revolution during each machine cycle. Each drum is provided with end plates 300 (see Fig. 28). Secured to these end plates is a cylindrical drum which is preferably opaque on its surface except at the character displaying portions where the drum is transparent or translucent. While the cylinder may be made of glass and coated with opaque material except for the character areas, it is preferred to utilize a suitable synthetic translucent or transparent plastic material to avoid possibility of breakage. Such transparent or translucent cylinder would then be covered over with an opaque surface except at the character displaying portions. These character displaying portions may be termed "character patterns."

In the drawings, for clarity of illustration, the characters are shown opaque and the drum transparent, but in actual practice the characters would be transparent and the background surface opaque. The lower drum 216a is provided with a plurality of columns of characters; one such column is designated 302A in Fig. 30. This column of characters comprises the entire alphabet and the digits from 9 through 0 inclusive.

It will be noted that the alphabetical characters are interspersed between the successive digital characters. The various characters are disposed so that each different character has a predetermined differential position around the periphery of the drum. The circumference of the drum may be considered to be divided into sixteen equal parts to correspond with the sixteen divisions or index points in the cycle of the machine (Fig. 36). With the drum in continuous rotation, i. e. rotating in the direction of the arrow shown in Fig. 28, the various characters are successively presented to an exposing position. It may be explained that in normal home position, no character is at the exposing position, then if the drum commences rotation, the first character to be brought to the exposing position is the letter I (see Fig. 30). The next character is the letter R, the following character is the letter Z, followed by the numerical character 9. The four characters I, R, Z and 9 of the first group pass the exposing position at successive intervals during the "9" index cycle point of the machine cycle. The four characters of the next group are similarly exposed during the "8" cycle point and so on. The action is the same for the lower case alphabetical characters and special characters which are shown on Fig. 30a. It will be noted that in this instance, the numerical characters are replaced with special characters such as asterisks, punctuation marks, etc. It will also be understood that the lower case characters *i*, *r* and *z* and the $\frac{1}{4}$ fraction character of the first group of drum 216B are passed by the exposing point during the "9" index point cycle of the machine, and so on.

For simplicity of illustration, the present machine is shown with structure to provide for the exposure of ten columns of characters. In practice, the columnar capacity may be increased to any suitable extent according to the desired columnar capacity of the machine.

Before describing the details of the construction which is employed, it may be briefly explained that individual shutters are provided, one for each circumferential band or column of characters on each drum. By opening an individual shutter at the proper differential time in a cycle point, a related digit, character or symbol in a column on the drum will be exposed and selected for photographic transfer to the film. Suitable illuminating means is provided within the drum for projecting the character to the film. A suitable lens and reflecting system projects character images from the drum on spaced portions of a film line when the various shutters are open. Accordingly, by proper timed actuation of the individual shutters in relation to the machine cycle any character on either of the drums may be projected on the film or light sensitive element in the camera unit. It may also be mentioned that film feed is effected at the time in the machine cycle when the characterless, fully opaque portion of the drum is traversing the exposure line or position. The upper case drum 216A is continuously driven in the manner previously described from gear 91 by a train of gears which ultimately effects rotation of gear 226 (Figs. 10 and 18). Gear 226 is fixed to a hub 305 on the right hand end plate 300 of the drum 216A. This hub and the other hub are preferably mounted for rotation in suitable ball bearings supported by the end frames 151 and 152. It will be noted that the drum supporting hubs are hollow and

accordingly, it is possible to provide within the drum a source of light which is fixed and not rotatable. It is preferred to dispose the source of light within the drum in order to secure brilliance of illumination. By a source of light within the drum, light may be transmitted through the drum chamber to brilliantly contrast the translucent or transparent characters with respect to the opaque portion of the drum chamber. It is also desirable to provide the source of light within the drum to afford more space without the drum for the shutter mechanism.

Referring again to Fig. 18, fixed to the side frames 151 and 152 are a pair of brackets 308. Secured to these brackets are other brackets 309 which extend through the hollow hubs to a point within the drum 216A. Mounted on the brackets 309 are a pair of terminal sockets 310 for receiving a tubular incandescent light 311. Preferably the rear part of this incandescent lamp is silvered as indicated at 311a to provide a reflector. The brackets 309 also support a cross bracket 312 which provides a support for a lens system generally designated 313 (see Fig. 12). Such lens system may comprise a pair of condensing lenses 314 to direct the light received from the light source 311 upon a small double concave lens 315. This system of lenses will direct a straight beam of light of proper height and width through one horizontal row of characters across the drum periphery when the row of characters is at the exposure position or station. The lens system is also of such character as to direct the rays of light in a substantially parallel direction towards the drum periphery. The lenses are preferably long or so-called horizontal or cylindrical lenses.

It is desirable to compensate for the motion of the drum during film exposure to avoid any possibility of slight blurring of characters when the device is operated at extremely high rates of speed. Accordingly, there is provided in association with the drum a compensating prism system. Such compensating system comprises prisms 318a and 318b which are, respectively, inside and outside the drum (see Fig. 12). These prisms are of octagonal shape and they are mounted in octagonally recessed end plates. The carrying plates for prism 318a are designated 319a and those for prism 318b are designated 319b (see Fig. 18). Right hand end plate 319a is rigidly carried by a shaft 320 which has a gear 321 fast thereto. Gear 321 meshes with an internal ring gear 324 fixed to the right hand (lower in Fig. 18) side plate 300 of the drum. Right hand end plate 319b is fast to a shaft 322 which has fixed to it a gear 323 receiving drive from an external spur gear 324 which is fixed to the right hand side plate of the drum.

It will be clear that through the above gearing, both prisms associated with a drum will rotate during rotation of the drum and that their rotation will be synchronous with the rotation of the drum. Drive relations between the drum and the prisms 318a and 318b are such that the prisms rotate one eighth revolution during the passage of a character row or line past the beam of light projected from or which emerges from the lens system. The arrangement of the gearing is, further, such that the prisms 318a and 318b rotate in opposite directions. Prism systems of this character are described in the United States patent to Hopkins No. 1,204,771. Briefly stated, the action of the dual prism system is such that the inner prism during the motion of the drum bends the light beam downwardly and the outer

prism corrects this downward motion so that during the interval when the picture is being taken, the effect is equivalent to halting the motion of the drum or momentarily arresting the character row at the exposure station. Accordingly, even though the actual object, i.e. the translucent or transparent character is in motion, its image while it is being photographed remains stationary during exposure time. A compensating prism system is provided for each of drums 216A and 216B.

The above correcting prism system is deemed desirable when extremely high speed of operation is desired. In practice, however, such correcting prism systems may be omitted when slower speeds are employed.

Auxiliary optical system

It has been previously explained that upper case characters and digit values may be derived from the lower drum 216A and lower case characters and symbols from the upper drum 216B. An auxiliary optical system is provided to direct exposed characters from both drums to a common film line. This optical system provides for projection of characters from both drums in interspersed relation upon a film line and for projection of a character from one drum or the other upon a common single character space of the film line. The optical system is interposed between the outer rotating prisms of the vertically spaced pair of drums and the shutter and lens assembly 160 of the camera unit. The part of the optical system for directing characters from the upper drum 216B comprises a pair of mirrors 325 and 326. From mirror 326, the light rays are projected through a partially silvered mirror 327 and thence to the lens 160. From the lower drum the rays are reflected by a mirror 328 to the partially silvered mirror 327 and thence reflected to the lens 160.

By the above construction, including the partially silvered mirror, it is possible to project a character from one drum or the other or from both drums on a common film area. It will be understood that characters of non-corresponding columns of both drums may be exposed concurrently, in which case, they will be projected to different columnar areas on the film.

It will also be understood that considering corresponding columns on both drums, any character from either of such columns may be exposed at the same lateral, single-character position on the film, but exposure of characters from the corresponding columns cannot be concurrent and may not occur while the same film line is in image receiving position.

Shutter construction

Referring to Figs. 12 and 15, disposed on suitable shafts between the side frames 151 and 152, are a plurality of freely rotatable sprockets 331 and driving sprockets 332. Passing over and around these sprockets are parallel, endless tapes 335. These tapes are preferably of thin flexible metal. It will be understood, as clearly shown in Fig. 13, that there is one set of tapes for the upper drum 216B and a separate and independent set of tapes for the lower drum 216A. The set of tapes for each drum includes an individual tape for each column of characters on the related drum. Each tape is provided with a plurality of horizontal slots 337 (Fig. 17) to engage the sprocket teeth 338 of the various sprockets. These slots not only are for the enabling of the tape to be driven but the slots also afford exposure

apertures through the tape. The manner of driving the various shutter tapes will be explained subsequently.

Between the side frames supporting each drum and in front of the outer compensating prism of each drum, there is provided a fixed plate 342 provided with a plurality of fixed exposure apertures 343 (Figs. 13 and 19) arranged along the exposure line. These apertures 343 are in columnar alignment with the tape apertures and with the character columns. Accordingly, when it is desired to effect exposure of a particular character, a shutter tape is so actuated that one of its apertures 337 passes the fixed aperture 343 at the time when the desired character on the drum is at exposing position behind aperture 343.

As stated before, there is a separate loop-like endless shutter tape for each different column of characters for each drum, that is, there is a set of endless tapes for the upper drum and another set of endless tapes for the lower drum. Each tape, as also stated before, has a plurality of exposure apertures 337 equi-spaced along its length (see Figs. 17 and 19). Normally, all of the tapes are stationary with an exposure aperture in a tape in its normal position, which is a position spaced a certain distance back lengthwise from the fixed exposing aperture 343. This initial position may hereinafter be termed the normal position, designated "1" in Fig. 32, and the distance at which the shutter aperture in normal position is back from the fixed aperture may be termed the normal offset distance.

When a character on the drum is to be exposed, the tape is set in motion in such a way that the tape aperture comes into alignment with the fixed aperture just at the time this character on the drum aligns with the fixed aperture. The tape moves uninterruptedly during and after exposure, but after exposure, the tape motion is again stopped in such a position that the next following exposure aperture in the tape is in the normal position, i. e. the normal offset distance from the fixed aperture.

From the foregoing it will be appreciated that the time that a tape aperture passes the fixed aperture primarily determines which character is to be exposed upon the assumption that the tape motion is synchronous with the drum motion and with the further assumption that the tape always starts moving when a certain point on the drum is passing the fixed aperture. If, however, the tape is preliminarily advanced lengthwise one or more steps before it is subsequently set in motion to effect exposure, the ultimate effect will be to change the time when the tape aperture passes the fixed aperture assuming the tape to start in exposing motion at the same time as before. Character selection is therefore made dependent upon two factors, one, whether or not and to what extent or degree the tape is preliminarily advanced; two, upon the differential time in the machine cycle when the tape is set in motion upon its exposure producing travel.

It should be further noted that regardless of the preliminary position of the shutter aperture before exposure advance of the tape occurs, the tape is always arrested after exposure in a position in which the next following aperture of the tape is in normal position relative to the fixed aperture. Tape motion for either preliminary (zoning) or tape motion for exposure advance is brought about by energization of a tape advancing magnet as will be later described. Likewise stopping of tape motion after exposure is effected

upon energization of a stop magnet as will be hereinafter described.

It will be further understood that there is a shutter advance magnet and stop magnet for each of the shutter tapes.

Drive means for shutter tapes

The gear train for driving character bearing drums 216A and 216B, as previously described under the heading "Recorder drive," includes a gear 217 fixed to a shaft 218 (see Fig. 10). The gear ratio between shaft 19, making one revolution a cycle, and gear 217 is such that shaft 218 makes four revolutions a cycle. Also as previously described, under the heading Recorder drive, gear 219 on shaft 218 drives a gear 221 on shaft 222 and gear 221, in turn, drives a gear 223. As indicated in Figs. 10 and 11, gear 223 drives a gear 232 rigid with a bevel gear 233 meshing with a bevel gear 234. Gear 234 is fixed to a vertical shaft 235, the lower end of which has a bevel gear 236 meshing with a bevel gear 237. Rigid with gear 237 is a gear 238 serving through gears 239 and 240 to rotate a shaft 241. Gear 240, through an idler 242 drives a gear 243 on a shaft 244. The gear ratio between shafts 218, 222, 241, and 244 is one to one, so that each of these shafts makes four revolutions a machine cycle. Fixed to shafts 241 and 244 are a set of drive gears 352 for the set of shutter tapes of the lower drum 216A and fixed on shafts 218 and 222 are a set of similar gears (not shown) for the shutter tapes of the upper drum 216B.

As previously explained, each shutter tape 335 passes around three idler sprockets 331 and a drive sprocket 332 (Fig. 12).

Referring to Figs. 14 to 17, each driving sprocket 332 comprises a pair of side sprocket plates 344, each provided with seven equi-distant sprocket teeth 338. Intermediate the side plates of each side plate assembly is a gear 345. In mesh with each gear 345 is an idler 346 driven by a gear 347 (see also Fig. 12). Each gear 347 constitutes a differentially driven element of what may be termed a shutter drive unit. Each drive unit includes a gear 348 (see Figs. 20 and 21) which is fixed to the hub of a driving ratchet 349. This hub is rotatably mounted on a suitable bearing disposed on a stub shaft 350 fixed at one end to a supporting plate 351. Meshing with gear 348 is one of the previously mentioned gears 352. Also rotatably mounted upon a suitable bearing on stub shaft 350 is a driven assembly which comprises a collar 353 to one side of which is secured a notched plate 354 having ten ratchet notches 355 (see Fig. 22) adapted to coact with an impositive detent 356. Rotatably mounted on the opposite side of the collar 353 is a toothed disk 357 which is provided with ten teeth 358. The notched plate 354 carries a clutch pawl 362 which is pivoted at 363. As viewed in Fig. 21, the pawl 362 lies in the plane of the driving ratchet 349 and the toothed disk 357 lies between the pawl 362 and its supporting plate 354. The toothed disk 357 (see Fig. 24) is provided with an opening 364 through which a spacing sleeve 365 and its supporting pin extends. A spring 366 connected to the upper end of pawl 362 is connected with a pin 367 carried by the plate 354. This pin also extends through a suitable opening in disk 357. Secured on pawl 362 is a pin 368 which engages a camming surface 369 on the disk 357. The relationship of the parts is shown in Fig. 23 which shows the pawl 362 normally held out of engagement with the ratchet

teeth 349 by the camming surface 369 against the pin 368. If the toothed disk 357 is permitted to move counterclockwise with respect to the pivot point of the pawl 362, the camming surface 369 will move away from the pin 368 and will permit the spring 366 to rock the pawl 362 into engagement with the ratchet 349. This relation of parts is shown in Fig. 24.

Plate 354 is normally held against displacement by an impositive detent 358. With the plate 354 thus restrained against movement, the tension of spring 366 (see Fig. 23) tends to cause the pin 368 to act against the camming surface and urge the toothed disk 357 in a counterclockwise direction. The teeth 358 of the driven member 357 are normally engaged by a latching extension 375 of a lever 376 (see Fig. 20). If the extension 375 is raised out of engagement with a tooth 358 the notched disk 357 may then rock counterclockwise to permit the pawl 362 to move from the position of Fig. 23 to that of Fig. 24, thereby engaging the constantly rotating driving ratchet 349 so that the plate 354 will be advanced until the pawl 362 is again disengaged from the driving ratchet 349. This disengagement is brought about by lowering the extension 375 into the path of one of the teeth 358, thus holding the disk 357 and causing the camming surface 369 to cam the pawl 362 out of engagement of the driving ratchet. The device just described is more fully described in U. S. Patent No. 2,150,277, wherein an accumulator clutching means is described.

The initial elevation of the extension 375 to permit clutching of the plate is controlled by a double coil magnet 377 which upon energization attracts an armature 378. The armature is pivoted at 379 so that when it is attracted lever 376 is rocked clockwise. A second double coil magnet 380 is provided which attracts the armature 378 to cause rocking of the lever 376 in a counterclockwise direction. The lever 376 is provided with a toggle mechanism for maintaining the lever in either position. This toggle comprises a lever 381 pivoted at 382 to the plate 351 and also comprises a hair spring 383, one end of which is secured to the end of lever 381 and the other end of which is secured to a pin 384 on the lever 376. Lever 381 also has a pin and slot connection with lever 376 as shown at 385. Accordingly, as the lever 376 is rocked clockwise under control of the magnet 377 the pin and slot connection 385 will cause lever 381 to rock clockwise throwing the toggle 381, 383 across dead center to the position shown in Fig. 22. The parts will be held in this position by the spring 383 until the lever 376 is rocked back to its initial position (shown in Fig. 20).

This return rocking of the lever 376 may be effected by the magnet 380 which when energized rocks lever 376 to the position of Fig. 20. Accordingly, upon energization of the magnet 377 the notched plate 354 is clutched to the driving ratchet. It will thus be seen that upon energization of magnet 377 lever 376 rocked clockwise releasing detent 375 from plate 357 causing clutching of the driven assembly to the driving ratchet 349. Also upon energization of magnet 380, the lever 376 is rocked counterclockwise, placing the detent 375 in the path of a tooth 358 of cam disk 357, therefore causing unclutching of the driven part from the driving part of the shutter drive unit.

Referring now to Figs. 23 and 24 pawl 362 is provided with a tail 362a which lies in the path of a pin 390 carried by the disk 357. With pawl 362 in disengaged position the relative position

of the pin 390 and the tail 362a is as shown in Fig. 23. With the pawl in engaged position the position of pin 390 relative to the pawl tail is as shown in Fig. 24. In either position of the pawl, the pin 390 coacts with the pawl tail to prevent chatter of the pawl.

As previously explained the drive gear 352 makes four revolutions a machine cycle. The ratio of gearing between gear 352 and a drive sprocket 332 is such that the sprocket 332 turns a distance between successive sprockets 332 for each quarter of a revolution of the gear 352. This quarter of a revolution of gear 352 is equivalent to one of the sixteen cycle points of the machine cycle (see Fig. 36). Thus, if pawl 362 is clutched to the drive ratchet 349 for an interval during which the gear 352 makes a quarter revolution, drive sprocket 332 will rotate the distance between successive sprocket teeth 338. Further, if pawl 362 is clutched in while the gear 352 is making one sixteenth of a revolution, i. e., the equivalent of one quarter of a cycle point, the drive sprocket 332 will turn through one quarter of a distance between successive sprocket teeth. It may be stated now that a zone or primary step of movement of a shutter tape is the distance the shutter tape is moved when its drive sprocket turns one quarter the distance between a pair of sprocket teeth. Further, if a shutter tape has not been preliminarily advanced through a zone step, an exposure advance of the shutter is effected when its drive sprocket turns through the distance between a pair of sprocket teeth. If, however, a shutter tape has been preliminarily advanced one or more zoning steps, then its exposure advance is the distance through which it moves when its drive sprocket turns through the remaining distance between successive sprocket teeth.

It may also be noted that the idler sprockets 331 are of the same size as drive sprocket 332, move through corresponding distances and their teeth are spaced the same distance apart as on drive sprocket 332.

The details of construction and mode of operation of a shutter drive unit have been described above in detail and an explanation will now be given of the manner in which the shutter operating parts are timed in relation to other parts of the machine. Figs. 30 and 30a show developed views of the two drum surfaces. Each drum surface may be considered as divided along the circumference into sixteen equal parts which correspond to the index point positions of the machine cycle (Fig. 36). As the drum rotates, a group of four characters from each column of each drum will pass the exposure openings 343 at the exposure station during each of certain of the cycle points. Remembering that drum 216A has upper case characters thereon, consider such drum during the first quarter of the interval between index point 9 and index point 8 on the timing chart. The letter I will pass the exposure opening during this quarter interval. During the second quarter of such index point interval, the letter R will pass the opening 343, during the third quarter the letter Z will pass the opening and during the last quarter the digit 9 will pass the exposure station. If a shutter 335 for the 216A drum is actuated so that a slot 337 in the shutter tape passes the aperture 343 during the first quarter of the 9th cycle point, the character I will be exposed for recording on the film. If the shutter slot passes the opening 343 during the second quarter of the 9th cycle point, the

character R will be recorded, and so on. Likewise if the shutters of the lower case drum 216B were actuated at like times, the characters exposed for recording would be i, r, z and $\frac{1}{4}$ (see Fig. 30a).

Summarizing, it may be explained that the different characters of a column on the drum pass the exposure station at quarter cycle point intervals.

Fig. 29 shows a fragment of one of the controlling records which is used in the machine. This card, as is customary in tabulating machine practice, is divided into columns, each of which has twelve index point positions. For numerical recording, the only index point positions which will be used are those from 0 through 9 inclusive. For alphabetical recording, the 0, 11 and 12 index point positions are utilized for what may be termed zoning control purposes and the 9 to 1 positions are used for what may be termed intra-zone control purposes.

The code table shown in Fig. 27 indicates that if the card is perforated in a column with a single index point perforation in one of the positions, 0 through 9, the corresponding digit will be represented. On the other hand if there are multiple perforations in the column, one or more of which are in the zone positions, alphabetic characters or special symbols will be represented. For example, if a column contained a perforation at the 12 index point position and there be another perforation at one of the positions 1 through 9 inclusive, the characters represented will be upper case alphabetical characters as shown. Thus with a perforation at the 12th position and another perforation at the 2 position, the represented character will be B and so on. Perforations in both the 12 and 11 positions of a column will call for lower case recording as is evident from the table. Special and lower case character recording will also be afforded with perforations at 12-0, 11-0 and at 12-11-0 of a column. In combination with the zone perforation or perforations, there will also be a perforation in positions from 1 to 9 inclusive.

In the operation of the machine, which will be explained fully later in connection with the circuits, and considering one card, the zoning perforations are sensed during a zoning cycle which precedes a recording cycle. It is clear that each shutter tape has what may be termed a "normal relation" to the fixed exposure aperture 343. During the cycle which precedes recording, if no zoning perforations are sensed, the shutter will remain in its normal relation to the fixed aperture until the numeral designating perforation is sensed. For convenience in subsequent description the positions from 9 to 1 on a card may be referred to as "intra-zone positions" perforated to designate "intra-zone values."

As indicated in Figs. 32 to 35, the shutter for one column of a drum may take any of four zone positions designated 1, 2, 3 and 4. Position 1 is the normal position spoken of before, position 2 with respect to the shutters for the upper case drum is the position to which a shutter is moved when a 0 zoning perforation is sensed in the corresponding card column during the cycle preceding recording. Position 3 with respect to the upper case drum is a position to which a shutter is moved when an 11 perforation is sensed in the corresponding column of the card during the cycle preceding the recording. If a 12 perforation is sensed during the zoning cycle, a shutter

for upper case drum 216A is moved to position 4.

Fig. 31 is a chart or graph indicating the operation of a shutter with respect to the upper case drum. The ordinate on the chart represents the sensing time expressed in cycle points. The abscissa represents shutter operation and portrays the particular time in the cycle the shutter operation occurs. More particularly the ordinate shows the cycle time when different index point perforations are sensed. The abscissa represents the exposure point or shutter operation to expose a particular character and denotes the relative time in one cycle in which a plurality of characters may be exposed for different shutter positions. The four diagonal lines in the chart represent four different zone positions of a single shutter. It will be noted that during the zoning cycle, if a zoning position 0, 11 or 12 was not sensed, the shutter remains in its 1 position until the end of the zoning cycle. If during the zoning cycle, the "12" zone perforation was sensed, the shutter starts moving at "13.25" of the zone cycle and moves three steps to position 4. If a zoning perforation 11 was sensed, the shutter movement will be initiated at "13.5" of the zoning cycle and the shutter will move to position 3. The presence of a "0" zoning perforation causes the shutter to move to position 2, this movement being initiated at "13.75" of the zoning cycle. The shutter remains in either of these four positions until the end of the zoning cycle and until an intra-zoning or digit perforation is sensed during the following recording cycle. For example, with the shutter in its home position during the recording cycle, if a 9 perforation is sensed, the shutter will begin moving at "9" and an exposure aperture 337 will reach the fixed aperture 343 at about "8.13" of the cycle at which time the digit 9 will also reach the aperture 343. Accordingly, the digit 9 will be exposed and recorded on the film. If the shutter is in position 2 during the recording cycle and a perforation, say 8, is sensed, the shutter will start moving at "8" of the recording cycle and an aperture 337 will cross a fixed aperture 343 while character Y is behind the fixed aperture. The character Y will thereby be exposed on the film. If the shutter is in position 3 and say a perforation 4 is sensed, the shutter will start moving at the "4" time and an aperture 337 thereof will reach the exposure position at the same time as the character M on the upper case drum reaches the exposure position and character M will be recorded on the film. If the shutter is in position 4 and say a perforation 1 is sensed during the recording cycle, the shutter will start moving at "1" and will register with the fixed aperture 343 at the same time as the character A registers therewith and this character will be exposed on the film.

Referring now to Figs. 32 to 35 and Figs. 32a to 35a, Fig. 32 shows the relation of the upper case drum to the fixed shutter and to the tape shutter for normal position and with the drum in home position. This is the relation of these parts at the end of the zoning cycle and shows a shutter aperture 337(x), through which the next exposure is to be made, in 1 position at normal offset distance from the fixed aperture 343. Considering now Fig. 32a, this view shows diagrammatically the same parts at the positions they assume when index point 8 is sensed on a card during a recording cycle. The shutter has started from its normal position at cycle point 8 and the

aperture 337(x) aligns with the fixed aperture 343 at the time the 8 character on the drum is in alignment with aperture 343.

Fig. 33 shows the relation of parts after zoning and ascertaining a 0 zoning condition. It will be noted that tape 335 has been advanced lengthwise one preliminary or zone step into position 2. With the shutter in the 2 position, if an 8 perforation is sensed in the recording cycle, then as indicated in Fig. 33a, the character Y will be exposed when aperture 337(x) aligns with fixed aperture 343. Fig. 34 shows the relation of parts after zoning for an 11 zone condition. Here the tape has been stepped two steps of advance to position 3. Fig. 34a shows the relation of parts, assuming index point 8 sensed after the zoning condition of Fig. 34. The aperture 337(x) will align with the 343 aperture to expose character Q. Fig. 35 shows the 4 position of the shutter tape after zoning under control of a 12 index position perforation. Fig. 35a shows the recording phase wherein character H is in alignment with the fixed aperture 343 and in alignment with the shutter aperture 337(x) as a result of sensing an 8 index point on the record following the 12 index point.

The foregoing figures illustrate how four different characters may be recorded as a result of the sensing of an 8 index point in the recording cycle. The different characters will be recorded according to the preliminary zoning control over tape advance.

It will be understood that the sprocket teeth 338 are spaced apart on each drum 331 the distance equal to the distance between adjacent shutter openings. The sprocket teeth of one of the drums 331 of a shutter tape are used for actuating contacts 391 (Fig. 12). The contacts are so disposed with respect to the teeth 338 that they close just after a slot 337 in the shutter tape has passed the fixed aperture 343 and exposed a selected character. Upon closure of the contacts, the shutter tape stop magnet 380 (Fig. 20) is energized to stop movement of that shutter tape. It is to be understood there is a pair of contacts 391 for each shutter tape. If a given shutter tape has had a preliminary zoning advance then the following sprocket tooth will initially be correspondingly closer to the contacts 391 than that shown in Fig. 12. The closure of contacts 391 in any case will occur, however, when the shutter tape has completed an exposure advance and the shutter aperture 337, following the aperture 337(x) through which the exposure has just occurred, is practically in home position; i. e., at the normal offset distance from its related fixed aperture 343.

Operation and circuit diagram

(Figs. 39a and 39b)

Before starting up a run, certain preliminary plug connections and switch settings are made, depending on the type of operation desired. Assuming, for example, it is desired to list on the film alphabetical and numerical data represented on each record of the run and that totals of amounts accumulated from a group of records also are to be recorded on the film, plug connections are made as follows: from upper brush plug sockets 400 (Fig. 39a) plug connections are made to sockets 401 (Fig. 39b, top). These plug connections bring upper brushes UB, for sensing desired card columns, into zone detecting circuits traced hereinafter. From the lower brush sockets 402 (Fig. 39a) plug connections are made

to sockets 403 (middle of Fig. 39b). These plug connections bring lower brushes LB for sensing the same card columns as the selected upper brushes into intra-zone and digit detecting circuits, traced later. Plug connections are also established between sockets 404 (top of Fig. 39a) to sockets 405 (middle of Fig. 39b) for controlling the shutter control magnets from the accumulator during total-taking operations. Entry circuit connections from desired ones of the lower brushes to the accumulator are provided by plug connections between selected sockets 402 and sockets 411 wired to add magnets 58 (Fig. 39a). For auto-control purposes, the usual plug connections are made from corresponding upper and lower brush sockets to sockets 408 and 409 of group control relay magnets GC. Auto-control switch 410 is thrown to the illustrated position and a plug connection is established from a socket 412 to a socket 413. Switch 406 (Fig. 39a) is thrown to LIST position. Switches 407 (Fig. 39b, bottom) are placed in full line positions.

Assuming a stack of records has been placed in the supply hopper (Fig. 3), the machine is now ready for operation. The operator now closes main line switch 417 (Fig. 39a, right), connecting opposite circuit lines 415 and 416 to a suitable current source. With current supplied to lines 415 and 416, relay coil R40 (Fig. 39a, left) is energized, since contacts L19, R43d and P9 are initially closed. With relay coil R40 energized, its contacts R40a (Fig. 39a, upper left) are closed and as the L2 contacts are initially closed, a circuit is established through the reset magnet 81 (see also Fig. 5). With this magnet energized, the reset shafts 75 and 92 (Fig. 6) are clutched to the main drive shaft. Reset does not occur at this time however because the main clutch shaft 8 has not been set in operation. The operator now depresses the reset key to close contacts RK (Fig. 39a). This results in energizing a relay coil R30 which closes its contacts R30a to complete the following circuit (Fig. 39a): From line 416, through stop key contacts SP1, film lever contacts 185, relay contacts R30a, relay coil R25, main clutch magnet contacts 116, main clutch magnet 117, to the opposite line 415. When magnet 117 energizes, contacts 116 open, thus opening the shunt around the relay coil R1 and permitting said relay to be energized. Relay R1 closes contacts R1a and establishes the circuit of motor M. With the motor in operation and clutch magnet 117 energized, the main drive is in action and since reset magnet 81 is energized, the reset cams P (Fig. 6) advance from the start or the D position (Figs. 36, 36a). The L cams also rotate because they are on the shaft 19 which is always driven whenever the main drive is in operation. A reset cycle now takes place and as explained before, there are two machine cycles co-extensive with one reset cycle. As soon as the relay coil R25 (Fig. 39a) was energized by the above circuit, it closed contacts R25a to shunt out the reset key relay coil contacts R30a through cam contacts L1 or P1. Near the end of the first machine cycle, the L1 cam contacts open, but at that time the reset cam contacts P1 are closed and prevent opening of the motor clutch circuit, so that the motor and main clutch continue in operation for the next machine cycle and until the end of the reset cycle. When coil R30 was energized, it closed contacts R30b to provide a shunt circuit for reset magnet 81. When the reset key is released, coil R30 de-energizes and contacts R30b open. During the

reset cycle, cam contacts P9 open, deenergizing coil R40, whose contacts R40a open. With contacts R40a and R39b open, reset clutch magnet 81 will be de-energized and conditioned to interrupt the reset means at the end of the reset cycle. Towards the end of the reset cycle, contacts P1 close, energizing auto-control relay coil R43 by a circuit extending from line 415, through P1 (lower left of Fig. 39a), coil R43, lower card lever relay contacts LCLb, upper card lever relay contacts UCLb and back to line 416. Coil R43 closes contacts D43a to shunt contact P1 and establish a stick circuit for R43. Near the end of the second machine cycle, cam contacts L1 open and with reset cam contacts P1 also open and contacts R30a having been previously opened because of release of the reset key, the relay coil R25 and motor clutch magnet 117 are de-energized and the motor circuit broken.

At the end of the above reset cycle, coil R43 is energized, contacts R43d in the circuit of coil R40 are open, and with the latter coil de-energized, its contacts R40b (Fig. 39a, left) are closed. The operator now depresses the start key to close key contacts SK completing a circuit through coil R33, contacts R40b and coil R32. Coil R33 closes contacts R33a which replace contacts R30a in completing the circuit through coil R25 and motor clutch magnet 117, followed by the motor circuit. Coil R32 closes contacts R32a (Fig. 39a, left) and with contacts R43c now closed, due to energization of coil R43, a circuit is completed through a coil R39, through contacts R32a, stop key contacts SP2, contacts R43c, cam contacts P9, to line. Coil R39 closes contacts R39b (Fig. 39a, upper left) forming the circuits of card feed clutch magnet 18 (see also Fig. 3). A card feed cycle now occurs and the first card is fed to the upper brushes. Concurrently, with the card feed cycle, a machine cycle takes place during which cam contacts L1 open, causing the main clutch to disengage and the motor M to stop at the end of the cycle. Near the end of the first card feed cycle, the first card closes upper card lever contacts UCL' (Fig. 39a, right) to energize coil UCL which closes contacts UCLa to form a stick circuit through cam contacts L5. Coil UCL closes UCLh contacts to form a circuit through main shutter operating solenoid 180S (right center of Fig. 39a) and extending through the still closed contacts LCLh. Solenoid 180S (also see Fig. 26) now opens the main shutter of the camera unit explained hereinbefore.

The first card cycle has been completed, the first card is just in advance of upper brushes UB and the machine is at rest. With coil UCL now energized through its stick circuit, contacts UCLb in the circuit of coil R43 are now shifted and a shunt circuit is maintained through came contacts F3. The start key is again depressed and, in the manner described before, a second card cycle is initiated. During this cycle, contacts F3 open and coil R43 is de-energized, contacts R43c open, breaking the circuit of coil R39 which in turn causes contacts R39b to open and de-energize card feed clutch magnet 18. Also, with coil R43 de-energized, its contacts R43d are closed and upon closure of contacts L19, coil R40 again is energized. Contacts R40a close and when cam contacts L2 close, the circuit of reset magnet 81 is formed and as a result a reset cycle will follow directly after the second card cycle. During this second card cycle the first card feeds through the upper brushes UB while the next card moves to the position just in advance of brushes UB. Toward the end of the

second card cycle, the first card closes lower card lever contacts LCL' (right center of Fig. 39a) to energize coil LCL which is held through stick contacts LCLs and cam contacts L6. Coil LCL now opens contacts LCLh to de-energize main shutter solenoid 180S. Contacts LCLg close and complete a circuit through a relay coil RY (Fig. 39a), the function of which will be described later. The upper card lever relay coil UCL and the lower card lever relay coil LCL are now energized; their "a" contacts (upper right of Fig. 39a) are closed and maintain a circuit through the main clutch magnet 117 and motor control coil R1 closed until cards are exhausted.

The reset magnet 81 was energized, as explained above, during the second card cycle and a reset cycle automatically follows the second card cycle. It will be recalled that card cycle clutch magnet 18 is now de-energized so that a card cycle and card feed do not occur during the reset cycle. Coil LCL is now energized and contacts LCLd are closed and upon closure of cam contacts P12, the relay coil R100 (lower left of Fig. 39a) is energized and held through stick contacts R100a and cam contacts P11. Previously, during the reset cycle, the contacts P1 were closed and coil R43 was energized through contacts F2 and F3. Contacts R43d open and relay coil R40 remains de-energized, having previously been de-energized by opening of contacts P9. Contacts R40a, therefore, are open and reset magnet 81 is de-energized to stop the reset means at the end of the reset cycle. Also contacts R40b are closed and coil R32 is energized when contacts L3 close. With R32 energized, contacts R32a close and a pickup circuit is established through coil R39 which circuit also extends through the cam contacts P9 and R43c contacts. With R39 energized, contacts R39b close and upon closure of contacts L2, card feed clutch magnet 18 is energized. Thus, after the second reset cycle, card cycles automatically ensue and the cards feed during successive card cycles past upper brushes UB and lower brushes LB. It should be noted that when relay coil R100 was energized during the last mentioned reset cycle, contacts R100d closed to provide an auxiliary holding circuit for coil RY (Fig. 39a).

Before describing further details of the circuit and of the machine operation in connection therewith, it may be pointed out that the zoning cycle with respect to a card is a cycle in which the card traverses the upper brushes UB, while the recording cycle with respect to the same card is the next following cycle during which the card traverses the lower brushes LB. During the zoning cycle the upper brushes sense the zone positions 0, 11, 12, of a column and set up zoning controls for the shutters determined by the zone designations of the corresponding card columns. Such controls are determined for all columns from which data is to be listed on the film. For each such card column, a different column of shutter tapes is to be controlled. To simplify the description, the circuits for only three such columns of card and shutters are shown in the circuit diagram in Fig. 39b. These columns are designated for convenience as the units, tens, and hundreds orders. Each different zone designation causes a different zoning control to be set up. Each zoning control determines the steps of zoning advance which the shutters are to be given before the recording cycle starts. In addition certain of the zoning controls effect a selection of the lower case drum shutters for

operation during the recording cycle. In general it may be stated that if no zone designations whatsoever are sensed during the zoning cycle, the shutters of the upper drum will be effective to afford recording of digit characters during the subsequent recording cycle. There is a special control effective for a 0 digit as will be subsequently explained.

As between upper case drum operation and lower case drum operation, generally it may be stated that if a single zoning representation is sensed in a column during the zoning cycle, the character represented in this column will subsequently be photographed from the upper case drum. However, if more than one zone representation is sensed in the column during the zoning cycle, the lower case drum will be effective for this column.

The 0, 11 and 12 zone designations set up controls for effecting preliminary zoning advance of the upper case drum shutters. The 0-11, 0-12, 11-12 and 0-11-12 zoning designations set up zoning controls for the lower case drum shutters. Each of the zoning operations controlled by the stated zoning designations will now be explained in detail.

In the previous mechanical description, the shutter control magnets have been generally designated 377 and 380. In the subsequent description, in order to distinguish the upper case shutter magnets from the lower case magnets, those pertaining to the upper case drum, viz. 216A, will be designated with an A suffix, i. e. 377A and 380A. Those pertaining to the lower case drum, i. e. 216B, will be designated with a B suffix, i. e. 377B and 380B. Similar suffixes will be used with other elements where there is a duplication of structure for the upper and lower case drums.

Zoning controls

Consider for example, the units order, and assume first that in the related card column, a 0 zone perforation is sensed. At the 0 time during the zoning cycle, a circuit will be completed from line 415 (Fig. 39a), through cam contacts L12 and upper brush UB in the column containing the 0 perforation, socket 400, via plug socket to socket 401 (Fig. 39b), through one of the UCLr contacts, through the 0 position of emitter EM2, through relay coil 420 and back to line 415. Relay 420 is maintained energized by the stick contacts 420a and by a cam contact L27. For a 0 zone control, the shutter is to be moved from its home position by one step of advance to position 2 (see Figs. 27 and 33). With coil 420 energized, a circuit is completed when cam contacts L30 close, from line 415, through relay contacts UCLr, cam contacts L30, through relay contacts 420b, now closed, through normally closed contacts 422b, relay contacts Sb in the position shown, through units order advance magnet 377A, and back to the other side of line 415 through cam contacts L34 now closed.

The foregoing zoning control circuit for the shutter advance magnet 377A is established when contacts L30 close at the time shown in the timing diagram (Fig. 36). Energization of the shutter advance magnet 377A initiates advance of the shutter corresponding to the column in which the 0 perforation is sensed. When the shutter has advanced one zoning step, cam contacts L31 close, completing the following circuit for energizing stop magnet 380A: From line 415, through UCLr, cam contacts L31, contacts Sc in the position

shown, through stopping magnet 380A, back to the other side of line 415.

Owing to the relation of the timing of cam contacts L30 and L31, and the previously described ratios of the various drive gears, the gear 347 will rotate $\frac{1}{4}$ of a revolution and move the shutter tape $\frac{1}{4}$ of the distance between two consecutive sprocket teeth on sprocket 338. This provides one step of zoning advance for the shutter tape.

If an 11 zone perforation alone is sensed in a column, two preliminary steps of shutter movement are required. The 11 perforation when sensed will cause energization of relay coil 421 (Fig. 39b) through a similar circuit to that previously traced with the exception that it will extend through the 11 position of emitter EM2. With 421 energized, relay contacts 421e are closed. When cam contacts L29 close at the time indicated in Fig. 36, a circuit is established through the shutter advance magnet 377A as follows: from line 415, through the UCLr contacts, cam contacts L29, relay contacts 422c, the left side of transfer contacts 420c, now closed, contacts 421e, contacts 422d, the Sb contacts in the position shown, magnet 377A and back to line through cam contacts L34. The energization of magnet 377A will clutch the shutter to the drive mechanism for advance movement. When cam contacts L31 close at about 14 of the cycle, the stop magnet 380A is energized through the circuit previously traced, arresting the advance movement of the shutter tape. It will be noted by reference to the time chart that the interval between the closure point of cam contacts L29 and L31 is twice as long as the interval between cam contacts L30 and L31, therefore the advance of the shutter tape under control of the 11 zone perforation is twice as far as the advance of the shutter tape under control of the 0 zone perforation. Thus for the 11 zone perforation, the shutter tape will have advanced two zone steps, i. e. from home or 1 position to position 3 (see Figs. 27 and 34).

If the card column is punched with a 12 zone hole, three steps of shutter movement are necessary. The 12 perforation will cause energization of relay coil 422 (Fig. 39b), it being noted that relay coil 422 is connected to the 12 segment of the emitter EM2. With relay coil 422 energized and with cam contacts L28 closing at the time shown in the timing diagram (Fig. 36), a circuit is completed as follows: From line 415, through cam contacts UCLr, (Fig. 39b), through cam contacts L28, through relay contacts 420d, through contacts 422e now closed, through contacts Sb in the position shown, through the advance magnet 377A and through contacts L34 to line 415. The energization of the shutter advance magnet will initiate advance of the shutter and termination of shutter advance will be effected when the stop magnet 380A is energized under control of cam contacts L31. The time relations of the various cam contacts will afford three zone steps of advance to the related shutter (see Figs. 27 and 35). In the event that no perforations are present in the sensing zone, none of the relays 420, 421 and 422 will be energized and there will be no preliminary stepping operation.

Consider now conditions with zone perforations representative of "11-0." Relay coils 421 and 420 will now be energized, through their individual circuits described before. Upon the closure of cam contacts L32 at the time shown in the timing diagram, the following circuit is completed. From line 415 (Fig. 39b), through

cam contacts L32, contacts 421g now closed, contacts 420g now closed, switch 407 in the position shown, relay coil S and back to line 416. Relay coil S is maintained energized through stick contacts Sa and cam contacts L33 which remain closed into the 0 time of the recording cycle; that is, until after the intra-zone perforations are sensed during the recording cycle.

It will be further noted that cam contacts L33 are shunted by relay contacts R43e. These contacts are opened by auto-control coil R43 during card cycles and close during total and reset cycles to hold over an energization of coil S should a reset cycle intervene between zoning and recording cycles on a record card, as upon a group change. When coil S is energized, contacts Sb and Sc shift and upon closure of cam contacts L30, the following circuit is completed. From line 416, through relay contacts UCLr, cam contacts L30, relay contacts 420b, now closed, contacts 422b in the position shown, through the shifted Sb contacts, through shutter advance magnet 377B and cam contacts L34 to line 415. Energization of shutter advance magnet 377B clutches in the drive unit for the related shutter of drum 216B causing one zoning step of advance of this shutter. Advance is terminated by energization of the stop magnet 380B. The energizing circuit is as follows: Line 416, through relay contacts UCLr now closed, through cam contacts L31, through relay contacts Sc now shifted, through magnet 380B and back to line 415. It will be noted that the shifted Sb and Sc contacts shift the shutter advance and stop magnet circuits from the magnets of the upper case shutters to the magnets of the lower case shutters.

Consider now zoning conditions for "12-0" perforations. Under these conditions relay coils 420 and 422 will be energized. With closure of cam contacts L32 at the time shown in the timing diagram, a circuit will be completed from line 415 through relay contacts 422f and 420f, both now closed, switch 407 in the position shown, relay coil S back to line 416.

Upon closure of cam contacts L29, a circuit will be completed from line 416 through contacts UCLr, through L29, the normally closed contacts 421d, through the right, now closed side of contacts 420c, relay contacts 422e now closed, contacts Sb now in shifted position, through advance magnet 377B and contacts L34 back to line 415. Energization of magnet 377B initiates advance of the related lower case shutter. When this shutter has been displaced through two steps of the zoning movement, cam contacts L31 close, and the stopping magnet 380B is energized through a previously described circuit.

Consider now zoning perforations "12-11," sensing of which is to cause three steps of preliminary shutter advance. Relay coils 421 and 422 will be energized, and during closure of cam contacts L32 at the time shown in the timing diagram, a circuit will be completed as follows: from line 415, through contacts L32, 422f and 421h now closed, a switch 407 in the position shown, coil S, to line 416. Closure of cam contacts L28 at the time shown in the timing diagram will complete a circuit from line 416 through UCLr, L28, 420d, 422e now closed, through relay contacts Sb now shifted, through advance magnet 377B, contacts L34, and back to line 415. The related shutter of the 216B drum will then move under control of the advance

magnet 377B for three steps of zoning advance. Stopping of shutter advance is affected upon energization of stop magnet 380B, through the now familiar circuit, through contacts L31 and Sc.

When the zoning designations are "12-11-0," relay coils 420, 421 and 422 will be energized. Under this zoning condition, relay coil S will be energized in the previously described manner. It should be noted that a circuit through magnet S is completed when any two or more of relay coils 420, 421 and 422 have been energized by a combination of zone perforations.

With all three coils 420, 421 and 422 energized and held through their stick circuits, normally closed contacts of these relay coils will be opened in the shutter stepping circuits which may be completed through cam contacts L28, L29 and L30. Thus, the 0, 11, 12 zone combination merely selects the magnet S for operation which, in turn, causes a selection of a shutter for the lower case drum. However, this shutter remains in its normal position.

The foregoing description has explained the manner in which the various zoning controls are set up and the manner in which shutters are selected for operation and stepped ahead for various degrees of zoning advance. The card which has been sensed at the upper brush station during a zone cycle is moved during the next card cycle past the lower brushes. This is the recording cycle for the card.

At the beginning of the card cycle, with relay coil R100 energized and its R100b contacts (middle of Fig. 39a) closed, a circuit is formed as follows: from line 416 through R100b, switch 406 in list position, a coil J, cam contacts L23, closed contacts P10, film feed magnet 180, cam contacts L25, back to line 415. This circuit remains energized until shortly after sensing of positions 9 to 0 of a card is completed. The magnet 180 is then de-energized and as previously described the film advances one line space in the camera unit.

During the sensing of the intra-zone portion of the card by the lower brushes, relay coil J is energized, as just described, holding a group of contacts Ja (Fig. 39b) closed and thereby connecting the shutter advance magnets to the plug connections extending to the lower brushes. Hence, during the recording cycle as the card is passing through the lower brushes, the sensing of intra-zone positions 9 to 1 will control the time of energization of the shutter advance magnets. Further, either the shutter advance magnets for the lower case or the upper case drum will be energized under control of the lower brushes, depending upon the previously determined position of the Sb contacts.

Still considering the units order, assume now that the intra-zone portion of the coded character is the digit 8. When the 8 perforation is sensed by the lower brush LB, a listing circuit is completed from line 416 (Fig. 39a), through the lower card lever contacts LCL', the usual circuit breaker contacts L26, cam contacts F1, to the contact roll of the lower brushes, through the brush sensing the 8 perforation to plug sockets 402, a plug connection to the 403 socket (Fig. 39b) and the related pair of relay contacts JA now closed. From there, the circuit proceeds through the upper side of the Sb contacts (assuming magnet S is de-energized), through shutter advance magnet 377A, and back to line 415 through the cam contacts L34. The related shut-

ter of the upper case drum 216A will then move downwardly, as viewed in Fig. 15, and cause a shutter aperture 337 to pass the fixed opening 343 for exposing the character represented in the units order card column.

It may be mentioned that if the magnet S was energized during the preceding zone cycle, the circuit instead of going through advance magnet 377A would go through shutter advance magnet 377B. The related shutter of lower case drum 216B would then start its exposure advance at the 8 cycle point and expose a character from the lower case drum. For example, codal representation 11-0-8 will have caused the shutter of the lower case drum to advance, preliminarily, one zone step under control of zone points 11-0 and will cause the shutter at the 8 time of the recording cycle to effect exposure advance. This shutter advance will expose character γ (see Fig. 27) from the lower case drum.

If the coil S has not been energized, then magnet 377A will have been energized at the 8 cycle point and will cause the related shutter of the upper case drum to expose one of four different upper case characters depending upon the previous zoning operation. If the coil S has previously been energized, then the advance magnet 377B will be energized at the 8 cycle point and will cause a related shutter for the lower case drum to be advanced and expose for recording one of four different characters from the lower case drum, depending upon the previous zoning operations with respect to the lower case characters. In all, a total of eight different characters are provided from which a selection may be made depending upon intra-zone sensing and upon zoning control.

As soon as the aperture 337 of a shutter 335 has passed the fixed exposure opening 343, contacts 391 (see Fig. 12) close in the manner previously described and establish a circuit to the shutter stop magnet in the following manner:

Assuming relay coil S de-energized and that exposure advance of an upper case shutter occurred, then thereafter when its sprocket 331 closes its related contacts 391A (Fig. 39b), a circuit is completed from line 416 through contacts 391A, relay contacts Sc in the position shown, stop magnet 380A and back to line 415. Assuming, instead, that magnet S is energized and that exposure advance of a lower case shutter occurred, when related contacts 391B close, a circuit will extend from line 416, through contacts 391B, through stop magnet 380B and back to line 415.

When a 0 digit is sensed during the zoning cycle, a shutter of upper case drum 216A is advanced one zone step. During the recording cycle, when the 0 perforation is sensed again, exposure advance of the shutter exposes digit 0 (see Fig. 31).

After the intra-zone and digit period 9 to past 0 of the recording cycle, contacts L23 and L25 open, deenergizing magnet 180 (Fig. 39a), and the film is advanced one line space in the manner previously described. During the passage of the next following card past the lower brushes, a new recording cycle will take place and a further row of characters will be recorded on the film. It may be mentioned that zoning for a following card occurs during the latter part of a cycle in which characters have been recorded under the control of a previous card.

Concurrently with recording, entry of amounts from selected card columns into the accumulator

is effected. Entry circuits are completed via the path previously traced to lower brush plug sockets 402 (Fig. 39a), thence through a plug connection to a socket 411, an accumulator magnet 58 and back to the other side of the line 415. Accordingly, while characters and values are being recorded from the record card, values may be accumulated from the same card.

Similar card cycles follow for the successive record cards of a group. In each card cycle there is an exposure on the film of characters derived from one or both drums. These characters are selected according to the digit or zone and intra-zone impulses differentially transmitted from the card. The codal combinations of differentially timed zone and intrazone impulses correspond to different characters and constitute combinational code signals which call or select characters from the drums for exposure. These operations continue until a change in card group occurs.

When a change in card group occurs, the usual shunt circuit through auto-control coil R43 (Fig. 39a) afforded by the group control unit around contacts F3 is broken. This, in a known manner, brings about the de-energization of relay R43 when contacts F3 open and causes operation of the card feed mechanism to be interrupted at the end of this cycle. With relay R43 de-energized, contacts R43d reassume the position shown and a circuit is established through P9 and L19 to energize relay R40. With relay R40 energized, contacts R40a close and reset magnet 81 is energized to cause a reset cycle to follow the last card cycle on a card group. Also, with relay R43 de-energized, contacts R43e (Fig. 29b, right) reclose, thereby maintaining a holding circuit through any of coils S which may have been energized during the zoning cycle when the group change occurred. The energized coil or coil S, therefore, will remain in effect for the recording cycle which will follow the reset cycle.

During the first half of the reset cycle, the total standing in the accumulators is read out and recorded on the film, while during the second half the accumulators are reset in the manner explained previously. In the reset cycle, upon closure of contacts P12, a circuit is made through coil JT (Fig. 39a) and the film feed magnet 180. Since contacts P10 are now open, coil J is de-energized and the contacts Ja are open to isolate the lower brushes from the shutter advance magnets. With coil JT active, a group of contacts JTa individually connected to the orders of the readout commutator (Fig. 39a top) are closed to prepare circuits for differentially operating the shutter advance magnets according to the total. For example, if digit 4 is in an order of the commutator, a circuit is made at the 4 cycle time as follows: through the 4 spot of the emitter EM1, the 4 segment of the commutator order, its brushes 66, its common 68, a pair of contacts JTa, connected plug socket 404, a plug connection to a selected socket 405 (Fig. 39b), through contacts Sb in the position shown, magnet 377a and back to line through cam contacts L34. This will result in photographically recording the character 4 on the film. It will be recalled that the spacing between significant digits on drum 216A (Fig. 30) correspond to a cycle point. Reference to this figure indicates that "0" is spaced, for selection under card control, three-fourths the cycle point spacing. As is customary in machines of this general class, the accumulator read-out emitter has its segments spaced to correspond

to the spacing of the numerals on a recording element. Hence, spot "0" of emitter EM1 is here spaced three-fourths as far from the "1" spot as the spacing between the significant digit emitter spots. Such spacing of the EM1 spots corresponds to the spacing of the characters 0 to 9 on the drum 216A. Accordingly, an accumulator order in zero position will be read out by a circuit routed via the "0" spot of EM1, and such circuit will be completed at such time (shown in Fig. 36) as to cause the shutter to expose the "0" character on the drum as this character crosses the exposure position at about $\frac{7}{8}$ of a cycle point interval following the "0" time (see Fig. 31).

After the digit readout period of the reset cycle, contacts P12 open, and coil JT and magnet 180 are de-energized. The de-energization of 180 results in line spacing of the film following recording of the total. To distinctly mark the presence of a total a supplementary line spacing of the film is effected due to energization of coil 180 within the second half of the reset cycle upon the closure of contacts P15 followed subsequently by its de-energization when contacts P15 reopen. This provides a blank space on the film between the total and the first line of items derived from the first card of the next group. The blank space signifies that the preceding line bears a total.

Last card conditions

As usual, in tabulating machines, special controls are provided for the operations pertaining to the last card of a run. Briefly, these may be summarized as follows: When the last card passes the upper brushes, relay UCL is de-energized. This does not occur until cam contacts F3 (Fig. 39a) have opened and reclosed. Upon the next card feed cycle, when the last card passes the lower brushes, auto-control coil R43 (Fig. 39a) is de-energized upon the opening of cam contacts F2 and F3, since the shunt through the upper side of contacts UCLb is now open as well as the shunt through still open contacts LCLf.

Coil LCL ultimately de-energizes, and its contacts LCLa (Fig. 39a) open and interrupt the circuit of clutch magnet 117 and motor relay coil R1. The contacts R1a open, breaking the circuit of the motor M. The machine now stops and the last total has to be recorded during a hand initiated reset cycle such as explained before. Coil R100 is still energized and contacts R100b are closed, so that the circuit of coil JT and magnet 180 is made and causes recording of a total and film feed in the manner previously stated. The supplementary film feed is also effected. After printing of the last total and resetting of the accumulators have occurred, contacts P11 open and de-energize coil R100. Coil RY (Fig. 39a) is maintained energized slightly longer than R100 under control of contacts P17. Accordingly, when contacts R100e of de-energized coil R100 close, a circuit is provided as follows: From line 415, contacts RYb now closed, contacts R100e, LCLk and UCLh, through shutter trip magnet 180S and back to the other side of line 416. Energization of magnet 180S will close the shutter in the camera unit.

Modified drum arrangement

Fig. 40 diagrammatically shows a modification in which the two drums 216A and 216B are replaced by a single drum. This single drum may be considered as equivalent to two laterally spaced drum sections 216AA and 216BB provided respec-

tively with upper and lower case characters. As in the main embodiment, a single shutter tape and its actuating means are provided for each character column of each drum section. Further, the drum 216AA-216BB makes one revolution each cycle and may be constructed the same as one of the drums 216A and 216B of the main embodiment and similarly mounted for rotation. The illuminating means will be suitably lengthened and fixed exposure apertures provided for each character column. The camera unit remains the same. A modified optical system is provided for this modification. This optical system comprises a mirror 440 for reflecting character images projected from drum section 216AA to a mirror 441. Mirror 441 reflects the images through a partially silvered mirror 442 to the camera. Character images projected from drum 216BB strike mirror 443 which reflect the images to the front face of partially silvered mirror 442 which, in turn, directs the images to the camera.

It will be understood that the optical system is such as to project characters from non-corresponding columns of the drum sections to laterally spaced portions of the film line in exposure position. Further, it will be clear that the optical system directs a character image from one column of drum section 216AA or from the corresponding column of drum section 216BB to the same single character area of the film. Thus, as in the main embodiment, during a recording cycle, a film line may record interspersed characters projected from non-corresponding columns of the two drum sections. During successive recording cycles, characters from corresponding columns of the drum sections may be photographed along vertically spaced portions of the same column of the film.

The circuit controls for the modification shown in Fig. 40 are the same as described for the main embodiment.

Modified lower case shutter selecting device

With the previously described construction, the selection of the lower case drum shutters for operation was effected by means of multiple zone perforations, forming part of a lower case character code. In certain instances it may be desirable to provide for alternative selection of the lower case drum by means of a designation in a special card column other than a character representing column.

As an illustration, it may be desired that all cards which lack a special perforation in a particular column should have their represented characters recorded in upper case. On the other hand, should a special perforation be detected in a particular column of any card, its represented characters would be recorded in lower case. The special perforation for this control is either an 11 or 12 perforation.

If such control is desired, a plug connection is made from an upper brush plug socket 400 (Fig. 39a) which connects with the brush for sensing the particular column on the card, which may or may not contain the extra special perforation, to one of the plug sockets 433 (Fig. 39b). The plug sockets 433 for all columns in which it is desired to record from the 216B drums may be plugged to one another. The several 407 switches related to these columns are shifted to dotted line position. When a card during a zoning cycle traverses brushes UB and has a special perforation in the particular column, parallel circuits will be completed as follows: From line 415 (Fig. 39a),

through cam contacts L12, the upper brush contact roll, through the upper brush UB sensing the special perforation, to plug socket 400, through the plug wire to the connected plug sockets 433, through switches 407, through all of the plugged-in S relay coils and back to line 416. Coils S when energized are held energized through stick contacts Sa and cam contacts L33 and shift the zoning control circuits to the magnets 377B and 380B. Also, when such card during its recording cycle traverses the lower brushes, it will control the shutter advance magnets 377B of the lower case drum, and the stop magnets 380B will control shutter stopping.

Summarized description of zone control, intra-zone control and shift to lower case control

For each order there are three zone relay coils 420, 421, and 422. If in any order a 0 index point is sensed, relay coil 420 will be energized. If an 11 index point is sensed, relay coil 421 will be energized and if a 12 index point is sensed, relay coil 422 will be energized.

It will also be apparent that combinations of these relay coils will be energized if there are combinations of index points present in any area in the zone area. These zoning relay coils when energized set up through their contacts zone step selector circuits extending selectively through cam contacts L28, L29 and L30 to the shutter advance magnets. The net result is that the shutters in the different orders are advanced during the zoning cycle, either not at all or by a number of steps which is dependent upon the particular zone designation which is sensed. The preliminary advance of the shutters under the influence of the zoning relay coils takes place in the zoning cycle and after the advances occur these zoning coils can be and are de-energized.

There is a further relay control which may be termed the intra-zone control. This intra-zone control includes relay coil J. Such relay coil J is energized each card cycle during the time the intra-zone and digit portion of the record is sensed. The purpose of the J relay coil is to close its relay contacts Ja to connect the lower brush circuits to the shutter advance magnets during each recording cycle. Termination of shutter advance during the zoning cycle is provided for by energizing all of the stop magnets. This, during the zoning cycle, is effected at a fixed cycle time in the operation of the machine by cam contacts L31 for all orders of stop magnets. The further control which is provided is the shift to lower case control. In the main embodiment, if the combination of the zoning relays determines that a shift to lower case is to be effected, a shift relay S is energized and this shift relay upon energization, shifts its Sb contacts and diverts the circuits from the upper and lower brushes away from the related order 377A magnets to the 377B magnets for this order.

The same shift magnet S also shifts its contacts Sc to divert the circuits of the stop magnets so that they go to the 380B magnets instead of the 380A magnets. On recording cycles, energization of the stop magnets is controlled by the 391 contacts; that is, the 391A contacts, for example, will energize the 380A stop magnet while the 391B contacts when closed will energize the 380B contacts.

In the modification described before, the shift magnet S is energized under control of the special perforation in a particular column when sensed during a zoning cycle.

Three-drum modification

The invention may be utilized with more than two drums. As an example, Fig. 38 shows, in skeleton view, an arrangement of three drums designated A, B, and C and an optical system for directing character images from all three drums to a common film area. It will be understood that there is a set of shutter tapes for each of drums A, B, and C and advance and stop magnets for controlling clutching of each tape drive unit to a drive gear. It will also be understood that there is a fixed aperture for each column of each drum through which a character from the column will be given an exposure advance. The shutter tapes, their actuating means and the fixed apertured bar are not shown in Fig. 38 since their constructions are the same as for the main embodiment of the invention. It will be understood further, that each of drums A, B, and C makes one revolution each machine cycle and is driven from cycle shaft 19 in a manner clear from the description and showing of the main embodiment of the invention. The camera unit including film supporting and feeding means and the main shutter are the same as previously described.

The optical system shown in Fig. 38 includes a mirror 325' for reflecting a character image projected from drum A to a partially silvered mirror 326' which, in turn, reflects the image through another partially silvered mirror 328'' to the film line in exposing position. From drum B, a projected character image passes through partially silvered mirrors 326' and 328'' to the exposed film portion. From drum C a projected character image is reflected from a mirror 328' to the partially silvered mirror 326'' which, in turn, directs the character image to the exposed film portion.

Drums A, B, and C may each have characters differing from each other. For example, drum A may have upper case letters as well as the digits; drum B may have lower case characters including various symbols, while drum C may have characters in italic form. According to this modification of the invention, a character may be selected from any of the three drums during a cycle and projected on the common film line. In the manner described before, the characters from only one of the three corresponding columns of the three drums may be projected during a recording cycle upon a single character space of the film line, whereas characters from non-corresponding columns of the three drums may be photographed in, interspersed relation along the film line. It will be understood that the corresponding columns of the drums are those from which exposure is under control of a selected card column.

The cards used for this modification represent characters by designations in a special column combined with designations in the character columns. As before, digits 9 to 0 are represented simply by singly perforating character columns in the 9 to 0 positions. Nine other characters are represented by combining the different intra-zone perforations 9 to 1 of the character columns with an 11 perforation in the special column, another nine characters by the same intra-zone perforations plus a 12 perforation in the special column. Likewise, the 0 zone designation combined with an intra-zone perforation may represent any of twenty-seven different

characters depending on whether the special column is blank in the 11 and 12 positions, or is perforated in the 11 position, or perforated in the 12 position. The 11 zone designation combined with an intra-zone perforation will similarly represent any of twenty-seven different characters depending on the condition of the special column. In the same manner, the 12 zone designation and intra-zone designations represent one set of nine characters if the special column is not perforated in the 11 or 12 positions, another set of nine characters if the special column has an 11 perforation, and still another set of nine characters if the special column has a 12 perforation.

Fig. 39bb is a circuit diagram illustrating the controls for the exposure means of the three corresponding columns of drums A, B, and C.

It will be understood, however, that there are as many such corresponding columns or orders as desired. Fig. 39bb may be considered as a substitution for Fig. 39b and an extension of Fig. 39a. The plug connection between an upper brush socket 400 (Fig. 39a) and the socket 401 (Fig. 39bb) is made as before to control energization during a zone cycle of either magnet 420, 421 or 422 or none, depending on whether a 0, 11, or 12 or no zone perforation is sensed in the character column of a card. The corresponding lower brush socket 402 is plugged to the socket 403 to place the exposure advance of a shutter during a recording cycle under control of the sensing of the intrazone perforation in the card column. It should be understood that all the other adjustments described with relation to the main embodiment are also made as before. In addition, for this modification, a plug connection is made from a plug socket 450 (bottom of Fig. 39bb) to the upper brush socket 400 of the brush UB for sensing the special card column which is adapted to be perforated in the 11 or 12 position as a part of the character code.

Assume a record card is traversing the upper brushes during its zoning cycle and that the character column has a 0 zone perforation, while the related special column is not perforated in the 11 or 12 position. When the 0 zone perforation is sensed by an upper brush, a circuit is established through magnet 420 in the same manner as described for the main embodiment. Magnet 420 closes its stick contact 420a to provide a holding circuit through cam contacts L27. The energized magnet 420 also closes its contacts 420m and when cam contacts L30 close, a circuit is completed as follows: from line 416, through contacts UCLr, L30, 420m, the upper side of transfer contacts SNb, the upper side of transfer contacts SMb, and through advance magnet 377A and cam contacts L34 to line 415.

Energization of magnet 377A initiates zoning advance of the related shutter tape for drum A. When the shutter has advanced one step, cam contacts L31 close, completing the following circuit: line 416, contacts UCLr, L31, the upper sides of transfer contacts SNc and SMc and through stop magnet 380A to line 415. Energization of magnet 380A stops the shutter tape of drum A after an advance of one zone step.

Assume now that instead of the special column being blank in the 11 and 12 positions, it is perforated in the 11 position, while the character column is perforated, as before, in the 0 zone position. When the 11 perforation in the special column is sensed by an upper brush, the following

circuit is established: Line 415 (Fig. 39a), cam contacts L12, the upper brush contact roll, the upper brush UB sensing the 11 perforation in the special column, its socket 400, the plug connection to the socket 450 (Fig. 39bb), cam contacts L35 (closed at the 11 time), the magnet SM, and back to line 416. Magnet SM is held through its stick points SMa and cam contacts L33.

Energization of magnet SM shifts its relay contacts SMb, SMc. Assuming magnet 420 has been energized by a 0 zone perforation and its contact 420m is closed, the following circuit is established when cam contacts L30 close; Line 416, contact UCLr, L30, 420m, the upper side of contact SNb, the lower side of shifted contacts SMb, advance magnet 377B, and through cam contacts L34 to line 415.

Energization of magnet 377B initiates advance of the shutter tape for drum B (Fig. 38). When cam contacts L31 close, a circuit is completed through the stop magnet 380B which extends through cam contacts L31, the normally closed side of contact SNc, the lower side of shifted contacts SMc, and through the stop magnet 380B to the line 415. Magnet 380B stops the advance of the shutter tape for drum B after one zone step.

Assume now that the perforation in the special column is a 12 perforation while the character column again has a 0 zone perforation. In that case when the upper brush senses the special 12 perforation, it completes a circuit which starts in the same manner as the circuit of magnet SM, previously traced, and continues from the socket 450 (Fig. 39bb), through cam contacts L36 (closed at the 12 time) and magnet SN, to line 416. Magnet SN shifts its contacts SNb and SNc. Accordingly, when cam contacts L30 close, a circuit extends from line 416, through contact UCLr, L30, 420m, the lower side of shifted contact SNb, advance magnet 377C, and through cam contacts L34 to line 415. Energization of magnet 377C initiates advance of a shutter tape of drum C (Fig. 38). The cam contacts L31 close when the latter shutter tape has moved one zone step and cause energization of stop magnet 380C, the circuit of which extends through the lower side of now shifted contacts SNc.

If the character column has an 11 perforation then, in the manner already clear, magnet 421 is energized and closes its contact 421m to cause energization of either magnet 377A, 377B, or 377C depending on the presence or lack of a perforation in the 11 or 12 perforation of the special column. The energization of the advance magnet through contact 421m is effected when cam contact L29 closes, so that the shutter of the selected drum will advance two steps. Similarly if the character column has a 12 zone perforation, magnet 422 will be energized, close its contacts 422m, and place the energization of a selected advance magnet under control of cam contact L28. Thus, either magnet 377A, 377B or 377C, depending upon whether magnet SM or SN or neither has been energized is operative to cause an advance of three zone steps of the selected shutter tape.

In the above manner, during the zoning cycle, a selection is made between the shutters of the three drums so that one of the shutters will be prepared for operation during the next following recording cycle, and in addition the selected shutter will have been zoned in accordance with the zone designations. It should be noted that the lack of a perforation in the 11 or 12 position of

the special column determines that a shutter of drum A should be selected; the presence of an 11 perforation in the special column determines that the shutter of drum B should be selected; and the presence of a 12 perforation in the special column determines that the shutter of drum C should be selected.

During the recording cycle, the intra-zone or digit perforations are read out in the same manner as explained before, except that the circuit of the advance magnet 377A will extend from contacts Ja (Fig. 39bb), through the normally closed sides of contacts SNb and SMb, while the circuit of magnet 377B will extend from contacts Ja, through the upper side of contacts SNb and the lower side of contact SMb, and the intra-zone circuit of magnet 377C will extend from the Ja contacts through the lower side of the SNb contacts.

What is claimed is:

1. In combination, photographing means including a shutter for photographing character patterns upon a film, carrier means for a column of character patterns adapted to be selectively exposed by said shutter upon exposing operations thereof, mechanism for moving the carrier means relatively to the photographing means to register the character patterns successively with a photographing position, character pattern selecting means including component control means corresponding to component characteristics representative of the character patterns, and means controlled by a component part of the control means for preliminarily adjusting the shutter with respect to the photographing position and thereafter controlled by another component part of the control means for operating the shutter to expose a selected character pattern as it registers with the photographing position.

2. In combination, rotatably mounted carrier means for a column of character patterns, cyclic mechanism for continuously rotating the carrier means to move successive groups of character patterns across an exposure position within successive differential periods of a cycle, with each successive character pattern of a group crossing the exposure position during one of successive differential fractional intervals of the differential period related to the group, photographing means including exposure effecting means for photographing selected character patterns upon a film, and character pattern selecting means including control means for conditioning the exposure effecting means for exposure operation at selected corresponding fractional intervals of the differential periods and other control means for rendering the exposure effecting means effective at a desired one of the selected fractional intervals to expose and cause photographing upon the film of the character pattern crossing the exposure position during the latter fractional interval.

3. A photographic recording machine including in combination a rotatable character bearing drum bearing characters adapted to be photographed, an optical system including illuminating means for projecting characters from the drum to a film, a member providing a fixed exposing aperture past which the characters on the drum successively move, a movable shutter having an aperture adapted to move past the fixed aperture, and means to cause exposure of the characters selectively and including means for effecting shutter opening movement at a particular time in a period of rotative movement of

the drum to expose one or another of the characters and differential advancing means for preliminarily advancing the shutter to differential extents to determine which of the characters is to be exposed by the subsequent shutter opening movement at said particular time.

4. A photographic recording machine, including a continuously rotatable character-bearing means having characters disposed in columns and with different characters differentially disposed in each column, photo-transferring means to transfer images from the character bearing means to a film, said photo-transferring means including independent endless shutter tapes one for each character column, each tape having a plurality of apertures therein adapted to be successively registered with a fixed exposure aperture, means to cause a selectively timed advance of a selected endless tape to effect exposure through one of the apertures of the selected tape of any one of the different characters in the related column in accordance with the selective timing of the tape advance and means to stop advance of each advanced tape in a position in which the next following tape aperture is positioned preparatory to exposing a selected character therethrough upon the next exposure advance of the tape.

5. A photographic recording machine comprising in combination a character carrying drum affording both digits and one style of alphabetical characters, another drum affording alphabetical characters in a different style, an optical system to direct images of characters exposed from either drum to a film, cyclic mechanism for moving the drums to register different significant characters upon the drums with exposure positions during differential intervals of a cycle, shutter means for one drum and independent shutter means for the other drum, each shutter means having actuating means therefor, selecting means to select which actuating means and which of the two shutter means are to be operative whereby characters may be exposed from one drum or the other and control means to control operation, by their actuating means, of the selected shutter means so that desired characters may be exposed therethrough.

6. In combination, movable carrier means for multiple sets of columns of characters, mechanism for continually driving the carrier means to move the characters, of each column, successively past a related column exposure position, photographing means including exposure effecting means, one for each column, for exposing characters from the columns and also including an optical system for projecting exposed characters from corresponding columns of the different sets upon a common column of a film and adapted for projecting characters from non-corresponding columns of the different sets concurrently in interspersed positions upon a line of the film, character selecting means for the different sets of columns, and means controlled by the character selecting means for causing the exposure effecting means to expose selected characters successively from corresponding columns of the different sets to be projected upon successive positions of a common column of the film and to expose selected characters concurrently from non-corresponding columns of the different sets to be projected by the optical system in interspersed relation upon the film line.

7. In combination, rotatably mounted carrier means for multiple sets of columns of character patterns, cyclic mechanism for continuously

rotating the carrier means to move the character patterns of each column successively across an exposure position, exposure effecting means for each column adapted to cause exposure of a selected character pattern from the related column as the character pattern crosses the exposure position, means for selecting the exposure effecting means of one or another of corresponding columns of the different sets for operation, means for selecting the character pattern to be exposed from the column associated with the selected exposure effecting means, means controlled by the character pattern selecting means for causing the selected exposure effecting means to expose the selected character pattern, and an optical system for projecting a selected and exposed character pattern from any of the corresponding columns of the different sets upon a common single character pattern space of a film.

8. In combination, carrier means for a set of duplicate columns of character patterns, carrier means for another set of duplicate columns of character patterns, mechanism for actuating the aforementioned carrier means to move the character patterns of each column successively across an exposure position, photographing means for photographing the character patterns upon a film and including exposure effecting means for each column for exposing the character patterns and also including an optical system for projecting character patterns from corresponding columns of the different sets upon a common area of a line of the film and for projecting character patterns from non-corresponding columns of the different sets upon laterally disposed areas of the film line, a single set of ordered selecting means with each order being adapted to select a character pattern from one or another of the corresponding columns of the sets to be photographed upon the area common to the corresponding columns, and means controlled by the selecting means for operating the exposure effecting means to expose concurrently character patterns from non-corresponding columns of the sets and cause such character patterns to be projected by the optical system and concurrently photographed upon the film line with character patterns selected from one of the sets interspersed with character patterns selected from another set.

9. In combination with a rotatable character bearing drum and mechanism for rotating the drum to register different characters therein successively with an exposure position during a cycle of rotative movement of the drum, of a movable shutter having an aperture through which any said character may be exposed as it registers with the exposure position, and means for causing

the characters to be exposed selectively and including means for differentially timing shutter opening movement with respect to the cycle of rotative movement of the drum and means for advancing the shutter differential extents preliminarily to the shutter opening movement, so that characters are selectively exposed depending upon both the differential extent of preliminary advance of the shutter and the differential time at which the shutter opening movement occurs.

10. In a record controlled machine for handling record material bearing designations combinationally representing characters, the combination with means to sense the record material for designations, of a plurality of cyclically operable continuously movable character carrying devices, photographing means for photographically recording characters from said carrying devices upon a film and including exposure effecting means for exposing the characters to be photographed, means selectively controlled by the sensing means, according to certain of the designations combinationally representing a character on a record, for preparing the exposure effecting means to expose any character of a set from one carrying device or any character of a set from another of the carrying devices, and means controlled by the sensing means, according to a remaining one of the designations combinationally representing the character on the record, for causing the exposure effecting means to operate for exposing a particular character from the set for which exposure has been prepared, said character being represented by the combination of designations sensed on the record.

11. In combination, movably mounted carrier means for a column of character patterns, cyclic mechanism continuously moving said carrier means so as to move successive groups of the character patterns across a photographing position within successive differential periods of a cycle, each successive pattern of a group moving across the photographing position during one of successive differential fractional intervals of the differential period related to the group, photographing means to photographically record selected character patterns upon a film, and character pattern selecting means including control means for preparing the photographing means for operation at selected corresponding fractional intervals of the successive differential periods of a cycle and other control means for rendering the photographing means effective at a desired one of the selected fractional intervals to photograph the character pattern then moving across the photographing position.

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