May 2, 1944. R. T. BLAKELY 2,348,051

MACHINE FOR READING PERFORATED RECORD CARDS

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FIG.4.

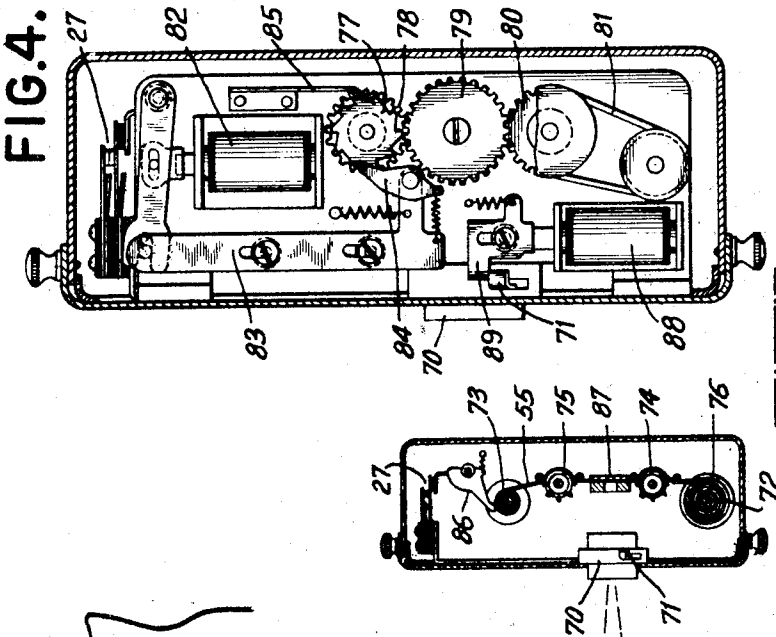
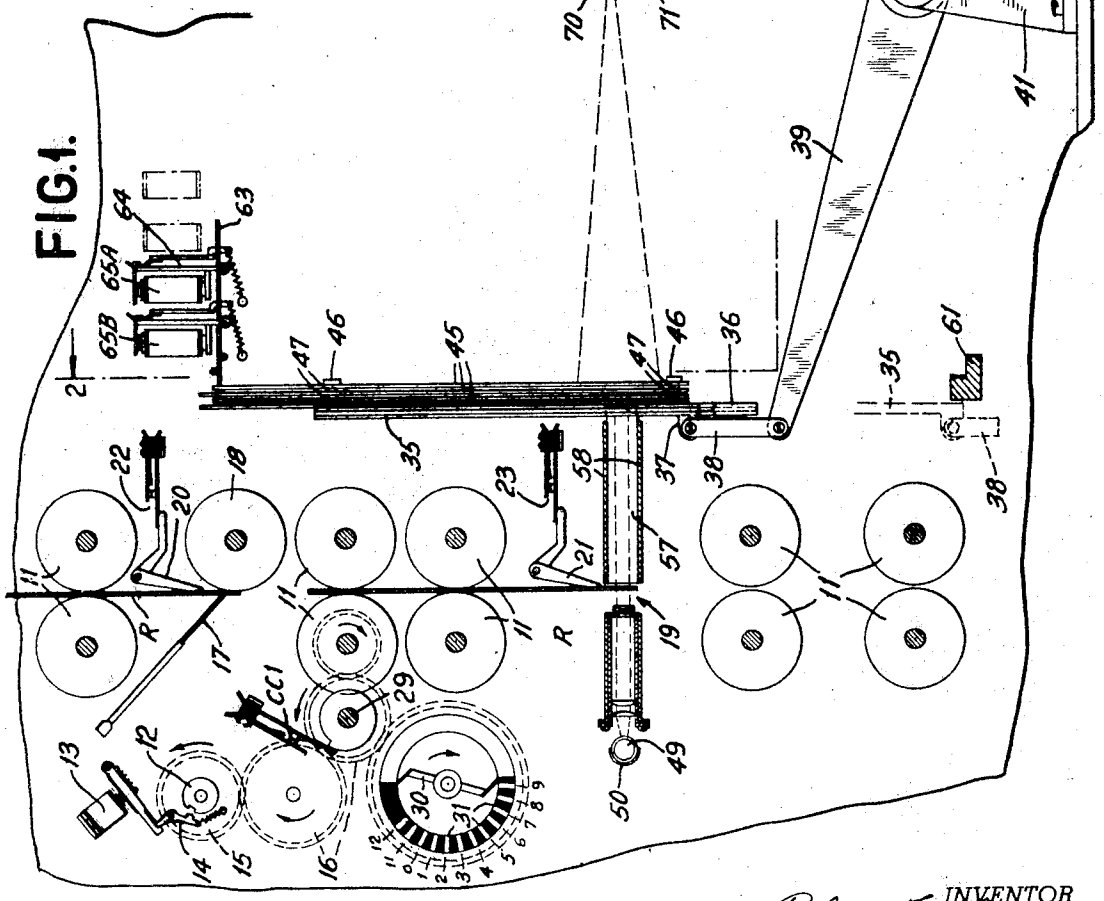


FIG.1.



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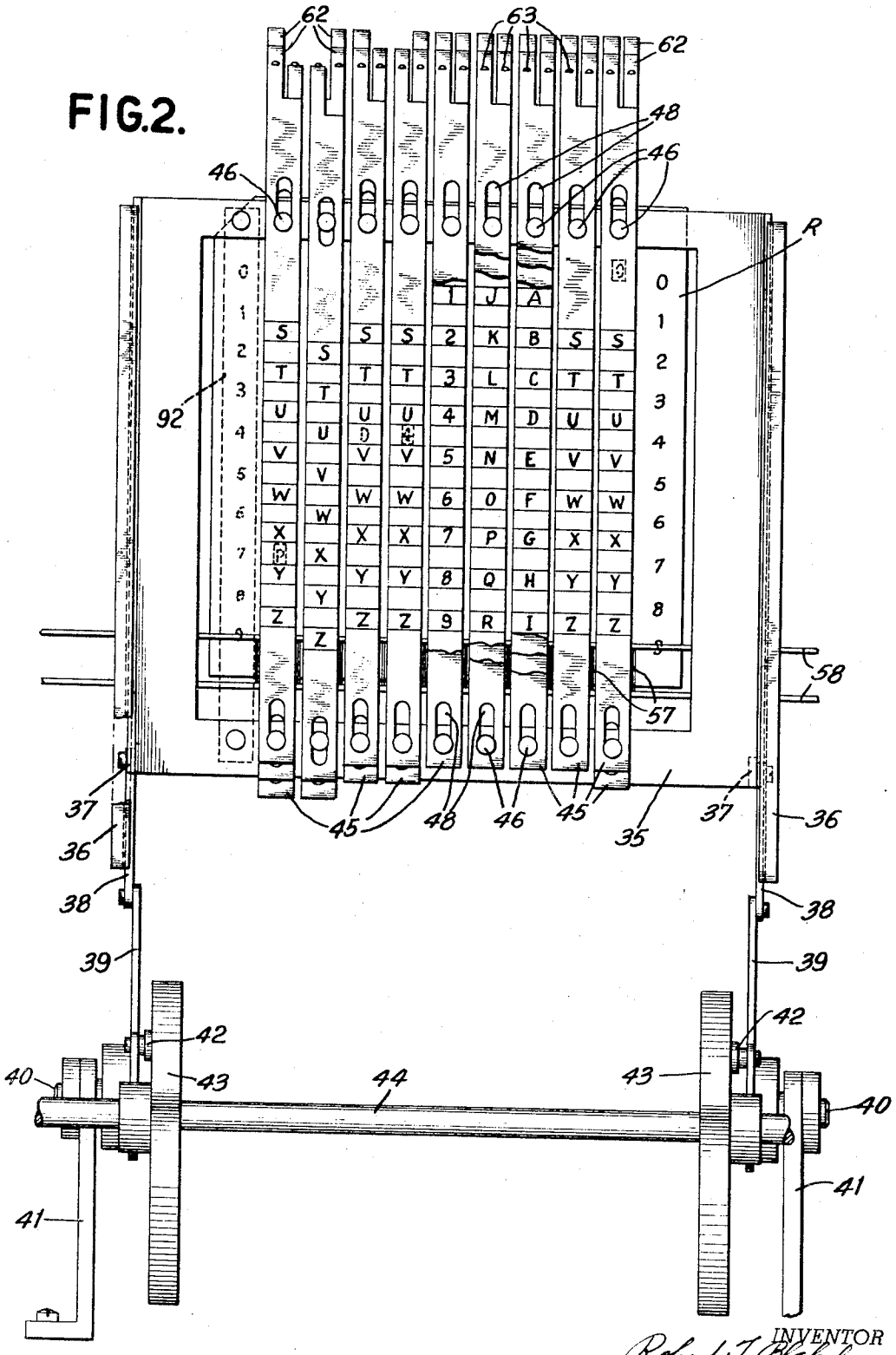
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MACHINE FOR READING PERFORATED RECORD CARDS

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FIG.2.



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MACHINE FOR READING PERFORATED RECORD CARDS

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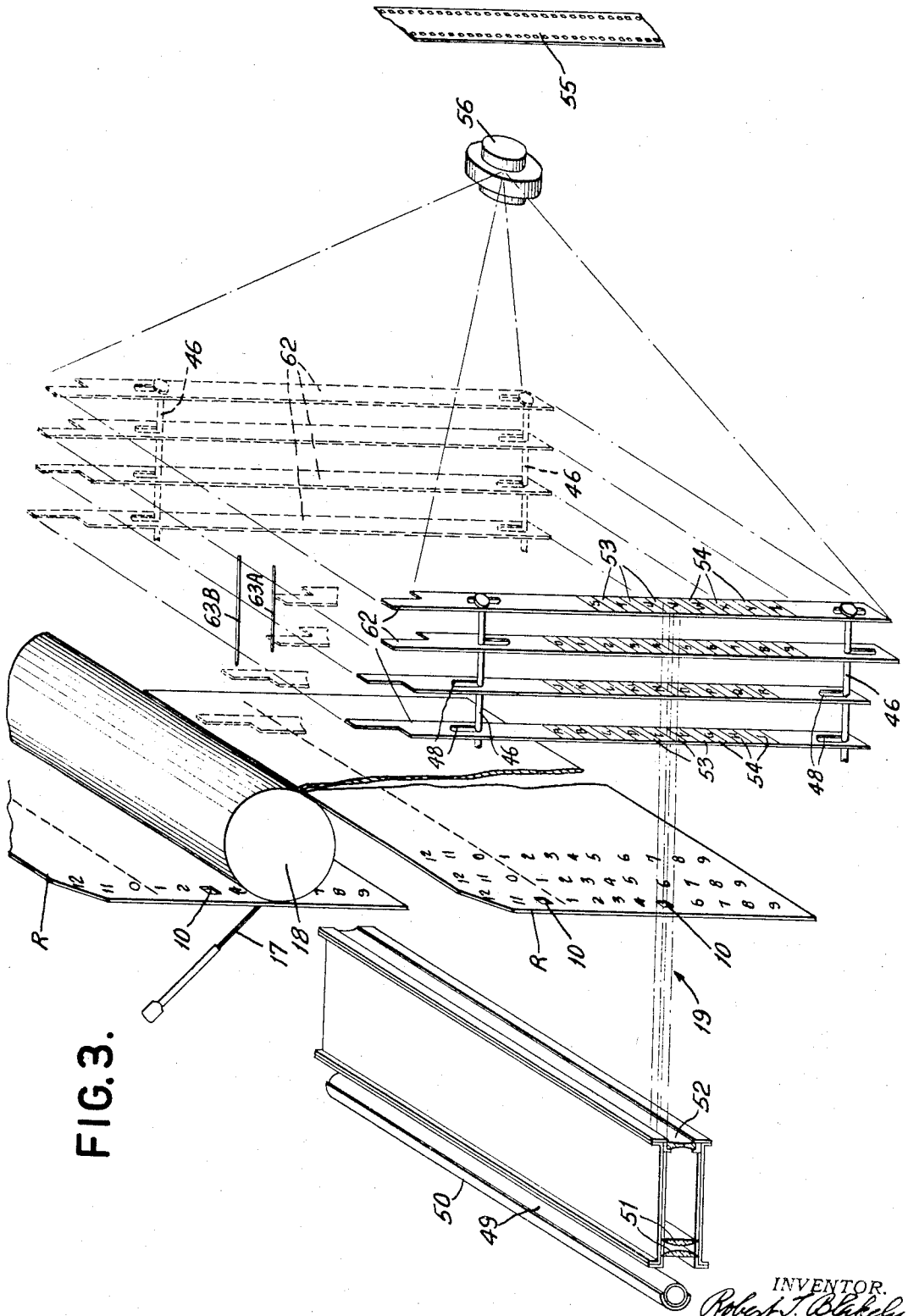


FIG. 3.

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MACHINE FOR READING PERFORATED RECORD CARDS

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FIG.5.

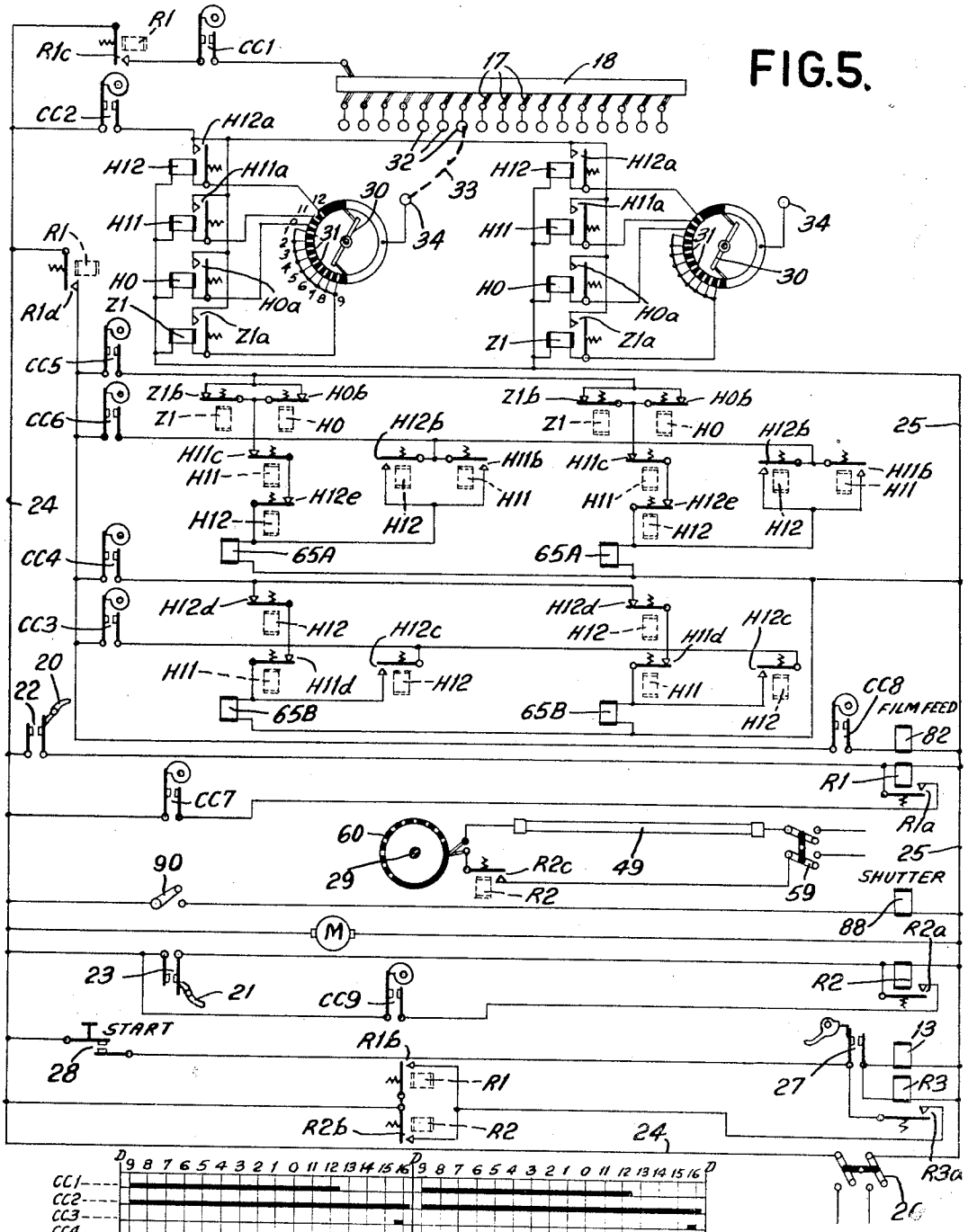
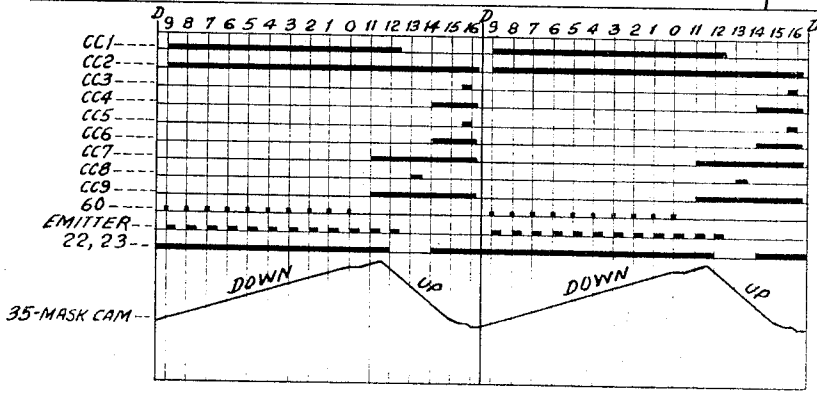


FIG.6.



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MACHINE FOR READING PERFORATED RECORD CARDS

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FIG.7.

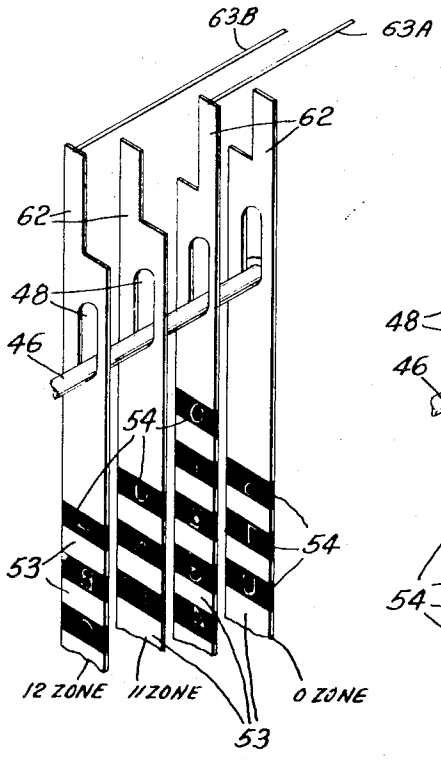


FIG.8.

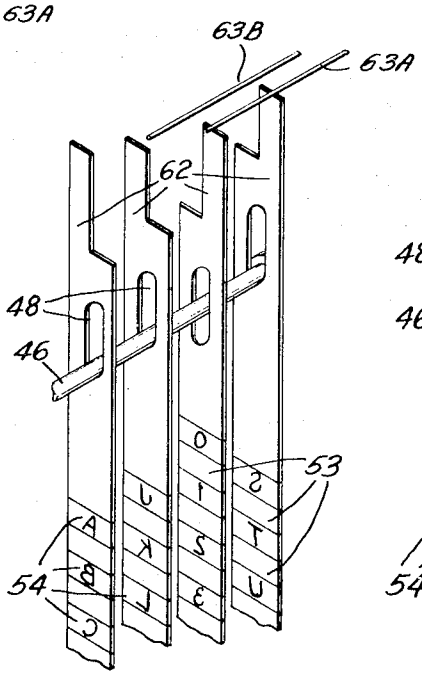


FIG.9.

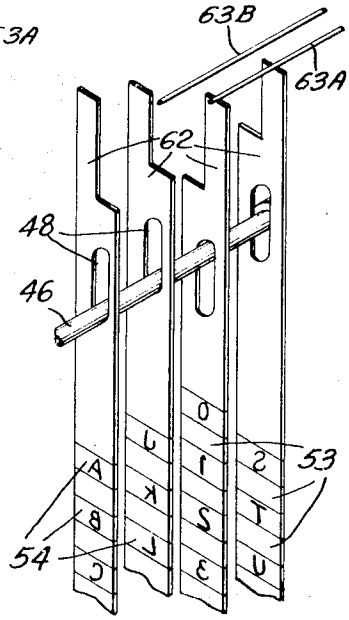


FIG.10.

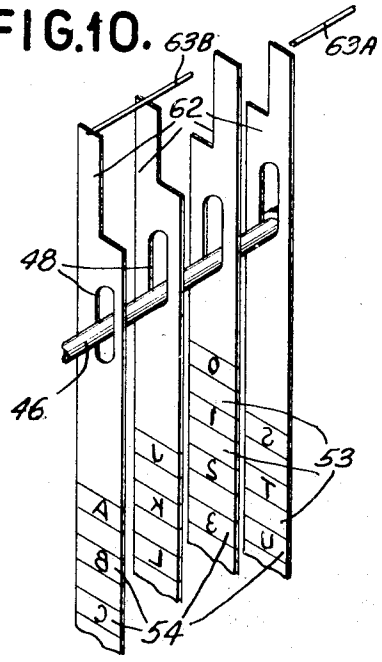
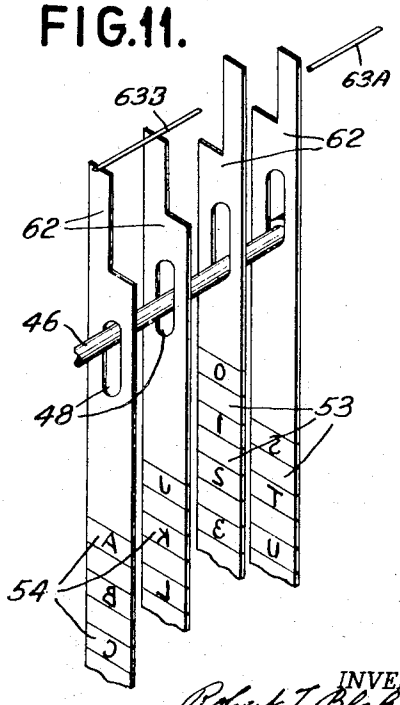


FIG.11.



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Patented May 2, 1944

2,348,051

UNITED STATES PATENT OFFICE

2,348,051

MACHINE FOR READING PERFORATED RECORD CARDS

Robert T. Blakely, Amityville, N. Y., assignor to International Business Machines Corporation, New York, N. Y., a corporation of New York

Application December 1, 1942, Serial No. 467,493

5 Claims. (Cl. 95—4.5)

This invention relates to apparatus for making a photographic record of data recorded in record cards in the form of perforations.

The principal object is to provide improved apparatus for effecting a photographic interpretation of alphabetic data consisting of combinational perforations in a record card column.

A further object of this machine is to control photographic recording of data from a record by having the record itself act as a light control means. This permits optical recording of data by the record directly to a photo-sensitive medium. The data to be recorded is derived from a mask which is provided with light pervious characters in an opaque surrounding. The masks and record card are fed in synchronism past a recording position. Normally, a mask is positioned so that the characters thereon are intermediate the perforation receiving positions on the record card. When it is desired to record a character from a particular mask, certain controls are actuated and the mask is displaced with respect to the record card a distance sufficient to cause the characters on the mask to be aligned with the perforation receiving positions on the record. Thus, a perforation in the record, when it is at recording position, permits light from a timed light source to pass through the character on the mask to the recording medium. Each column of recording mechanism is provided with four masks, one for each zone in the usual four zone code.

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

In the drawings:

Fig. 1 is a view of the recording mechanism with certain parts in section.

Fig. 2 is an end elevational view taken on line 2—2 of Fig. 1.

Fig. 3 is a diagrammatic view of the recording mechanism.

Fig. 4 is a detail view of the camera control mechanism.

Fig. 5 is a circuit diagram.

Fig. 6 is a timing diagram of the machine.

Figs. 7 to 11 are diagrammatic views showing operation of certain positioning devices.

Card feeding mechanism

The controlling record card R (Fig. 3) is the well known Hollerith record card which is provided with vertical columns of perforation receiving positions, in which perforations 10 are made to record the digits by a single perforation in the correspondingly designated position. Alphabetic characters are designated by the usual combination arrangement consisting of a perforation in a digit position accompanied by a second perforation in one of the three uppermost positions. For example, the letter V is represented as in Fig. 3 by perforations in the 0 and 5 positions.

The system of representing all the alphabetic characters and the digits is as follows:

Holes	Characters	Holes	Characters
0	0		
1	1	11, 1	J
2	2	11, 2	K
3	3	11, 3	L
4	4	11, 4	M
5	5	11, 5	N
6	6	11, 6	O
7	7	11, 7	P
8	8	11, 8	Q
9	9	11, 9	R
0, 1		12, 1	A
0, 2	S	12, 2	B
0, 3	T	12, 3	C
0, 4	U	12, 4	D
0, 5	V	12, 5	E
0, 6	W	12, 6	F
0, 7	X	12, 7	G
0, 8	Y	12, 8	H
0, 9	Z	12, 9	I

Referring to Fig. 1, the record cards R are fed downwardly from a supply source (not shown) by a series of pairs of feed rollers 11 which are suitably interconnected by gearing to rotate in unison. Power is derived from a constantly running clutch element 12 which, when clutch magnet 13 is energized, will engage dog 14 pivoted to gear 15, so that through the train of gears 16 the rollers 11 are driven to feed cards in succession past the sensing brush 17 and a cooperating contact roller 18. A plurality of brushes 17 is provided, one for each card column, arranged in a horizontal row.

After passing brushes 17, the card traverses a light path indicated at 19, the timing being such that as any horizontal row of perforation receiving positions is at brushes 17, the corresponding row of the preceding card is in line with the light path 19. Disposed in the path of the cards are the usual card levers 20 and 21 which hold contacts 22 and 23, respectively, closed as cards are passing the related stations.

Referring to the circuit diagram (Fig. 5), current is supplied to lines 24 and 25 from a suitable

source and, when switch 26 is closed, motor M is in constant operation to drive the clutch element 12 of Fig. 1. A pair of contacts 27 (lower right of Fig. 5) are normally closed, as will be explained in connection with the film mechanism, so that when start key contacts 28 are closed, the magnet 13 is energized and cards commence to feed. The upper card lever contacts 22 close to complete a circuit through a relay R1 which closes its contacts R1*a* to provide a holding circuit through cam contacts CC7. In the same manner, the lower card lever contacts 23 close to energize a relay R2 which closes its contacts R2*a* to provide a holding circuit through contacts CC9. The contacts CC7 and CC9 are closed during the interval between cards when the card lever contacts open, so that as long as cards continue to feed in successive order the relays R1 and R2 will remain continuously energized and hold their contacts R1*b* and R2*b* (bottom of Fig. 5) closed.

A relay R3 wired in parallel with clutch magnet 13 closes its contacts R3*a*, so that with cards feeding the clutch magnet circuit is maintained from line 24, contacts R1*b* or R2*b*, contacts R3*a*, film contacts 27, clutch magnet 13 and relay R3 to line 25. The cam controlled contacts generally designated CC and whose timing is shown in Fig. 6 are operated by cams secured to shaft 29 (Fig. 1) which makes one revolution for each card or cycle of the machine. Driven from this shaft 29 at a 1 to 2 ratio are so-called "emitter brushes" 30, of which several are provided. These brushes contact fixed segments 31 labeled 9, 8, 7, etc., which are engaged by the brush in order as the correspondingly designated positions in the card column are sensed by brush 17.

Record card sensing

Referring to Fig. 5, a row of brushes 17 is shown connected to plug sockets 32 for selective sensing. Thus, in columns to be sensed a plug connection 33 is made to a socket 34 wired to the common of one of the emitters or distributors. As a card passes brush 17, a circuit or circuits will be completed through the perforations in the plug connected column traceable as follows: from line 24, relay contacts R1*c* (now closed), cam contacts CC1, contact roller 17, hole in the card, brush 17, socket 32, connection 33, socket 34, brush 30, segment 31 and from here through several branches as follows: if the perforation is in positions 9 to 1 inclusive, the circuit goes through the related segment 9 to 1, and relay Z1 to line 25; if the perforation is in the 0 position, the circuit goes through the 0 segment 31 and relay H0 to line 25; if the perforation is in the 11 position, the circuit goes through the 11 segment 31 and relay H11 to line 25; and if the perforation is in the 12 position, the circuit goes through the 12 segment 31 and relay H12 to line 25.

Accordingly, for a significant digit representing hole the relay Z1 is energized, for a zero hole the relay H0 is energized, while for an alphabetic character the relay Z1 as well as one of the H0, H11 or H12 relays is energized. These relays close contacts 21*a*, H0*a*, H11*a* and H12*a* to provide holding circuits therefor through cam contacts CC2 (see Fig. 6) which keep the relays energized until the end of the cycle. Concurrently, of course, similar circuits are completed through other brushes 17 and other similar sets of relays, another one of which is shown in Fig. 5.

These relays control the selection of the characters for recording. The mechanism involved will first be explained and later the manner in which the relays control the same will be set forth.

Character masks

Referring to Figs. 1 and 2, a mask supporting frame 35 is provided and mounted for vertical reciprocation in grooved side guides 36. The lower extremity of frame 35 has lugs 37 to which links 38 are pivoted, the opposite ends of the links having connection with levers 39 pivoted at 40 to fixed brackets 41. Levers 39 have follower rollers 42 coacting with box cams 43 secured to shaft 44. This shaft 44 is driven by suitable gearing from the feed roller shafts so as to make one revolution per card or cycle, and as a result frame 35 is reciprocated once each cycle.

Slidably mounted on the frame 35 are a series of the masks 45 (see Fig. 2). These are arranged in a plurality of columns, four masks to each column and are frictionally held in position by a stud 46 and separator washers 47. Each mask is provided with slots 48 to permit a small amount of relative movement of the mask 45 with respect to the frame 35.

Referring to Fig. 3, there is shown a light source 49 which is of a gaseous type, such as a neon tube. Preferably, the back half of the light is silvered as shown at 50 to provide a reflector. Light from the source 49 is received by a pair of condensing lenses 51 which direct the light upon a small double concave lens 52. This system of lenses will direct a straight beam of light of proper depth to impinge upon one horizontal row of the record card R. Wherever there is a perforation 10, the light beam is permitted to pass and reach masks 45. These masks comprise a series of translucent and opaque portions 53 and 54, respectively (see Fig. 7). In the center of each opaque portion is a translucent character. The characters on the masks are spaced from each other a distance equal to the index point separation on the record card R. This distance will hereafter be referred to as "index point separation distance." Normally, the masks are moved downwardly as the card descends, so that the index point positions on the record card are in alignment with the translucent portions 53 of the masks 45. The masks 45 are moved in synchronism with the record card R past the light beam.

Prior to passage of the card past the light beam, it passes a row of sensing brushes 17 and contact roll 18, which analyze the record R in each column and determine which mask 45 carries that particular character. In a manner which will be described later, the mask bearing this character is shifted relative to the other masks a distance equal to the height of a translucent portion 53 or one-half the index point separation distance. In this position the mask 45 which has been shifted has the characters thereon aligned with the index point positons on the record card, so that a position on the card where there is an index point perforation will permit the beam from light source 49 to pass through and transilluminate the character on the displaced mask 45. The beam will pass through the transparent position 53 of the remaining masks 45.

The transilluminated character will then be

recorded on the film 55 under control of lens system 56. It may be mentioned that the light source 49 operates for a fraction of a second during each index point just as the index position on the record card and the character on the mask are in line.

Intermediate the record card R and the masks 45 there is provided a series of separator plates 57 to prevent light from a perforation in one column affecting the mask of an adjacent column. These plates 57 (see also Fig. 2) are secured to upper and lower frame members 58.

Referring to Fig. 5, the lamp 49 is connected to a high voltage source through switch 59 and to a commutator 60 mounted on the one revolution shaft 29. When cards are passing the light path, relay R2 is energized as explained to close contacts R2c, thereby completing the circuit through the commutator 60 and lamp 49 to flash as each hole position arrives at the light path 19.

Referring to Fig. 6, the relative action of the mask operating cam 35 is represented as a uniform motion moving the masks down from the beginning of the cycle until the 0 card column is at the light path 19. Then, there is a short dwell and a further movement. During this further movement the lower edges of the masks 45 strike against a fixed stop 61 (Fig. 1) to slide any displaced masks upwardly with respect to the frame 35.

Thereafter, with all masks aligned in their upper positions the frame moves rapidly up during the latter part of the cycle, and in accordance with the occurrence of holes in the 0, 11, or 12 positions in the card which was passing the brushes 17 during this cycle a displacement will be made of one of the masks 45. The manner in which the displacement is effected will now be explained.

Each mask 45 is provided with a notched portion 62 (Figs. 2 and 7) at its upper end. These notched portions are in such a position as to cooperate with stops 63. Each stop 63 is connected to the armature 64 of a magnet 65 in the manner shown in Fig. 1. For a set of four masks related to a card column, one stop cooperates with the 0 and numerical zone masks and the stop and magnet associated therewith will be termed 63A and 65A. Another stop cooperates with the 11 and 12 zone masks and will be designated 63B and its magnet 65B. When the armature 63A or 63B is not in actuated position, it will engage the related mask 45 as the mask carrier moves up under control of lever 39 and cam 43.

As may be seen in Fig. 2 and as explained previously, there is one mask for each zone. The front or uppermost mask is that for the zero zone bearing the characters S, T, U, V, W, X, Y and Z. The second from the top is the mask for the numerical zone bearing the digits 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. The third from the top is the mask for the eleven zone bearing the characters J, K, L, M, N, O, P, Q, R. The lowermost mask is that for the twelve zone bearing the characters A, B, C, D, E, F, G, H, I. The mask carrier 35 reciprocates vertically as was previously explained, and near the top of the stroke the masks engage the stops 63 of the magnets 65 that have not been moved to the right in Fig. 1. Near the end of the upward movement of the masks, the twelve zone mask 45 engages its armature at the 16 point of the cycle (see Fig. 6). If it is desired to shift the twelve zone mask, the stop 63B remains in engagement therewith as shown in Fig. 10 for ½ cycle point and the magnet 65B is then actuated to retract the stop 63B. There is a momentary dwell in cam 43 which stops the mask carrier while the magnet 65B is being actuated to insure correct positioning of the twelve zone mask. Thereafter, the mask carrier 35 continues upward with a shift between the mask 45 and carrier 35 of ½ the index point separation distance. Such a shift is shown in the third from the left column in Fig. 2 and in Fig. 10.

In Fig. 2, the card has a hole at the 4 position thereby causing the character D to be in a position for recording during the downward movement of the card as the 4 index position on the card passes the recording position, this being the position where the light beam impinges on the card.

The mask for the eleven zone is also controlled by the same armature stop 63B as the mask for the twelve zone, but the eleven zone mask is shorter than the twelve zone mask and does not engage the armature stop 63B until 15½ in the cycle. If it is desired to shift this eleven zone mask, the armature stop is permitted to remain in engagement with the mask. The mask carrier stops ½ a cycle point later, thereby moving the eleven zone mask ½ an index point position relative to the carrier (see Fig. 11). The twelve zone mask being also controlled by the same armature stop will be in engagement therewith for one index point of movement to cause the twelve mask to be displaced relative to the carrier, one whole index position. This will have no effect on recording since it merely moves a different translucent portion 53 into alignment with the character D.

The zero zone and numerical zone armatures both function in a similar manner and are controlled by a common stop 63A. The zero zone mask engages at the 15 point in the cycle (see Fig. 9) and the numerical zone mask engages at 15½ (see Fig. 8).

Control of stop magnets

Referring now to Fig. 5, it will be explained how the stop magnets 65A and 65B are energized. As already explained, the relays Z1, H0, H11 and H12 are set up as the card passes brushes 17 and before it passes the light path 19. Assuming that the card contains a 12 hole, then relay H12 will be energized and its contacts H12b, H12c, H12d and H12e will be shifted from the position shown in Fig. 5. When cam contacts CC6 close at the 14 point in the cycle, a circuit is completed from line 24, contacts CC6, contacts H12b, magnet 65A, to line 25. As a result, rod 63A is withdrawn from over the numeral and zero zone masks as in Fig. 10 to allow this to remain undisturbed. Later in the cycle, when cam contacts CC3 close, a second circuit is completed from line 24, contacts CC3, contacts H12c and magnet 65B to line 25. This energization occurs after the 12 zone mask has been stopped by rod 63B and the 12 zone mask displaced ½ step and during a dwell in the upward movement of the mask carrier 35, i. e., while the first two masks on the left are in the relative positions of Fig. 10. Energization of magnet 65B at such time withdraws the rod 63B so the four masks assume the relative positions of Fig. 10 and with such relative positioning they then descend as the card passes the light path 19 presenting the characters I, H, G, F, E, D, C, B and A as the card positions 9, 8, 7, 6, 5, 4, 3, 2 and 1 pass the same path. Accordingly, if during such pas-

sage a hole occurs in any such position in the card, light will pass through to transilluminate the related character and project the same on the film 55.

Assume now that an 11 hole had been sensed. Then, when cam contacts CC6 close, a circuit is also completed from line 24, contacts CC6, contacts H11b and magnet 65A to line 25, thereby withdrawing rod 63A so that the numeral and zero zone masks remain undisturbed. When contacts CC3 close, however, no circuit is completed since contacts H12c are open and rod 63B remains in position to displace the 12 zone mask 45 a full step and the 11 zone mask ½ step as represented in Fig. 11. Now the masks descend so that the 11 zone characters R, Q, P, O, N, M, L, K and J pass light path 19 as the card positions 9, 8, 7, 6, 5, 4, 3, 2 and 1 pass the same path, and a hole occurring in any such position will cause projection of the related image.

Assume now that a zero hole had been sensed with an accompanying digit hole. Then, when cam contacts CC4 close, a circuit is completed from line 24, contacts CC4, contacts H12d, H11d and magnet 65B to line 25, thus withdrawing rod 63B from over the 12 and 11 zone masks as in Fig. 9, leaving these two masks undisturbed. Later, when cam contacts CC5 close, no circuit will be completed as contacts Z1b and H0b are both open and as a result magnet 65A is not energized. Consequently, the numeral zone mask is shifted down a full step and the 0 zone mask ½ step as in Fig. 9, with subsequent projection of one of the characters in the zero zone.

Assume now that a significant digit alone had been sensed. Then, when contacts CC4 close, magnet 65B is energized as before to withdraw rod 63B. However, when contacts CC5 close at the time the masks are in the relative position of Fig. 8 with the numeral mask displaced ½ step, a circuit is completed from line 24, contacts CC5, contacts H0b, H11c, H12e and magnet 65A to line 25. The masks subsequently descend with the numerals in perforation aligned position and are selectively projected depending upon the location of the perforation in the card column.

A final condition occurs where a zero hole occurs alone. In such case there is no second hole. The action is the same as in the last case, except that when contacts CC5 close, the circuit is through contacts Z1b instead of contacts H0b and the resulting displacement of the masks is as in Fig. 8.

Camera unit

For the purpose of recording data from the mask to the film, there is provided a camera unit shown to the right in Fig. 1. The camera includes a casing which carries a suitable lens and shutter assembly generally designated 70 and including a shutter lever 71.

A stud 72 (see Fig. 1) affords a support for a film supply spool which is generally designated 73. On cross shafts are film feed sprockets 74 and 75 and a takeup spool 76.

Referring now to Fig. 4, the shaft of the upper sprocket wheel has fast to it a ratchet 77 and a driving gear 78. Driving gear 78 meshes with an intermediate gear 79 which in turn is meshed with a gear 80 fixed on the shaft of the lower sprocket. A belt 81 transmits motion to a pulley on the takeup spool shaft.

A film feed operating solenoid 82 is provided, energization of which will depress an actuating member 83. This member 83 is suitably spring restored to upper position and upon restoring movement a pawl 84 carried by the member actuates the film feed ratchet 77 to advance the film one line space. A flat spring 85 serves as a detent for the ratchet 77.

Referring again to Fig. 1, within the camera housing there is provided a pivoted lever 86 which is spring pressed into contact with the film on the supply roll. When the film is exhausted, member 86 swings clockwise to such an extent that a pair of contacts 27 opens. At other times with film available on the supply spool, the lever 86 maintains these contacts closed. The film which is designated 55 in Fig. 1 is provided with the usual feeding sprocket holes. The film passes successively under the first two film guides, through a film gate 87 (see Fig. 1) and then under another pair of film guides. Also carried by the casing is a solenoid 88 (see Fig. 4). Fixed to the plunger of the solenoid is a plate 89 which is normally held in upper position by a spring. Plate 89 is provided with a lug engaged with the shutter control lever 71 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 "bulb" exposure operation," that is to say, downward movement of lever 71 opens the shutter and it remains open until the solenoid 88 is deenergized to permit lever 71 to return to the position shown.

Referring to Fig. 5, the shutter solenoid 88 is energized when switch 90 is closed which is done when the machine is started. The film feed magnet 82 is energized through a circuit from line 24, upper card lever relay contacts R1d, cam contacts CC8 (timed to close as in Fig. 6) and magnet 82 to line 25.

After the last card is sensed by the brushes 17, the card lever contacts 22 and cam contacts CC7 open to deenergize relay coil R1. This prevents further energization of the mask setup relays. After the recording is effected from this last card, the card lever contacts 23 open and prevent further current supply to light source 49 via distributor 60.

In the event that only straight numerical recording is to be effected, the mask carrier may have affixed thereto a numerical mask which is permanently in a shifted position for recording purposes. Such a mask 92 is shown in dotted outline at the left of Fig. 2. No presetting of the mask is necessary and direct recording under control of light source 49 would be effected as before described.

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

What is claimed is:

1. In a machine arranged for control by record cards having columns of index point positions, each column containing a plurality of differentially located positions divided into zone and subzone positions, perforations in both a zone and a subzone position of a column being representative of any of the alphabetic characters, a

plurality of masks bearing character images thereon, each mask having a different set of images and each being separately positionable in cooperative relationship with a record card to bring the images thereon into alignment with the subzone positions of a card column, means for sensing the zone hole positions of a record card, means controlled thereby for selectively positioning one of the masks in cooperative relationship with the record card, light responsive record material, a light source, and an optical system arranged to project light from said source through the subzone perforations of the card on to the aligned images to record the images on said material.

2. In a machine arranged for control by record cards having columns of index point positions, each column containing a plurality of differentially located positions divided into zone and subzone positions, perforations in both a zone and a subzone position of a column being representative of any of the alphabetic characters, a plurality of masks bearing character images thereon constructed to pass light through the image configuration, each mask having a different set of images and each being separately positionable in cooperative relationship with a record card to bring the images thereon into alignment with the subzone positions of a card column, means for sensing the zone hole positions of a record card, means controlled thereby for selectively positioning one of the masks in cooperative relationship with the record card, light responsive record material, a light source, and an optical system arranged to project light from said source through the subzone perforations of the card and through the image configuration to record the images on said material.

3. In a machine arranged for control by record cards having columns of index point positions, each column containing a plurality of differentially located positions divided into zone and subzone positions, perforations in both a zone and a subzone position of a column being representative of any of the alphabetic characters, a sensing station, means for moving the record card past said sensing station, means for projecting a beam of light against the card at said station, a mask having character images thereon spaced according to the spacing of the card positions, said mask being positioned in a plane parallel to the card with the image positions normally out of alignment with the card positions, means for shifting the mask to bring the images and card positions into alignment, means for moving the mask and card in synchronism to bring aligned images and positions concurrently to said sensing station, a film positioned along the line of said light beam, the occurrence of a perforation at said station enabling the light beam to pass through the perforation to project the related image on said film.

4. In a machine arranged for control by record cards having columns of index point positions, each column containing a plurality of differentially located positions divided into zone and subzone positions, perforations in both a zone and a subzone position of a column being representative of any of the alphabetic characters, a plurality of masks bearing character images thereon, each mask having a separate set of images with light transmitting spaces therebetween, said masks being arranged in parallel planes with the sets of images in superposed relationship, means for sensing the zone hole positions of a record card, means controlled thereby for selectively effecting relative movement of one of the masks to bring its images into line with the light transmitting spaces of the other masks, a light source, a film, and means controlled by the subzone hole positions of the card for selectively projecting light from said source through a selected one of the images of the said one mask and the light transmitting spaces of the other masks to record said selected image on said film.

5. In a machine of the class described, an optical system, a light source, said optical system projecting a beam of light from said source, means for moving a record card in a plane transverse to said light beam to successively present the spaced positions of a perforation receiving column of the card to said beam for projection of the light beam through the perforations, a mask having character images thereon spaced to correspond to the spacing of the card positions, means for moving said mask transversely to said light beam to successively present the spaced images to said beam as the corresponding card positions are presented, a film positioned in the path of said beam, the occurrence of a perforation enabling the beam to pass therethrough and project the corresponding image on to said film.

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