

Sept. 1, 1942.

M. MAUL

2,294,679

ANALYZING DEVICE FOR STATISTICAL MACHINES

Filed July 21, 1939

2 Sheets-Sheet 1

Fig. 1

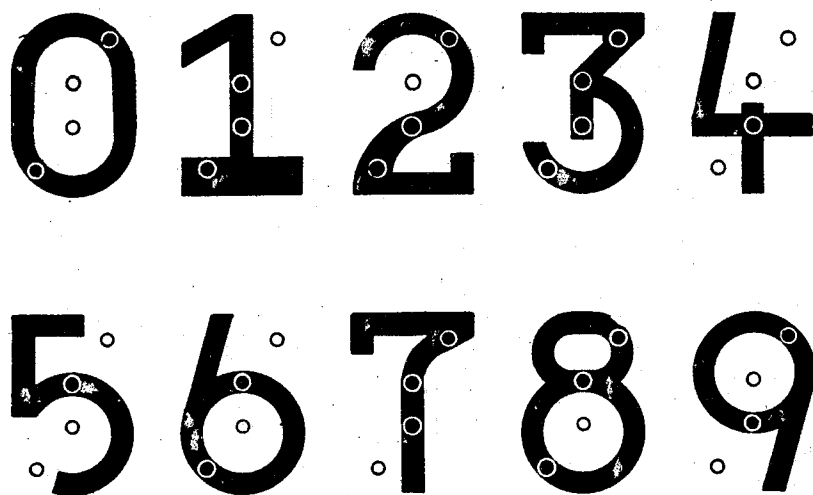


Fig. 2

275	320	7	50000
	3000	579	328
225	37542	250	77
400	2559	6	328

a
b
c
d

10

BY

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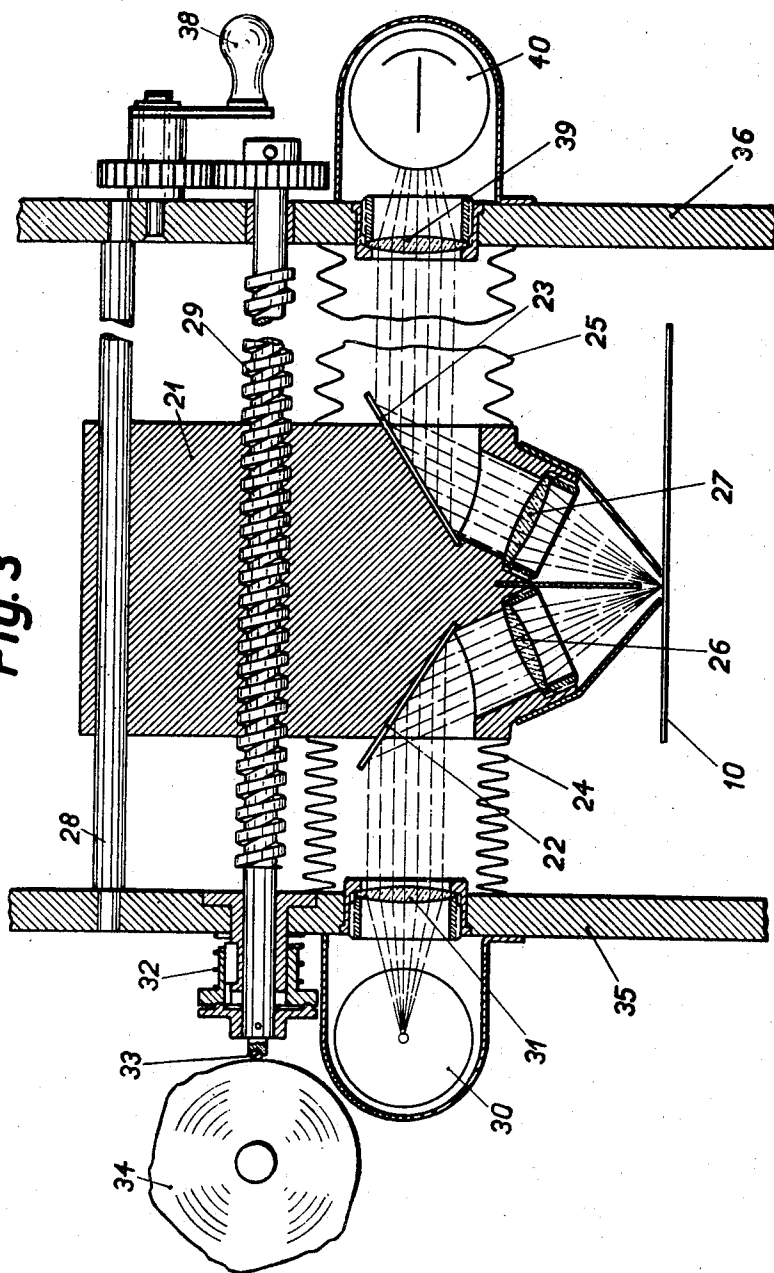
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Fig. 3



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ANALYZING DEVICE FOR STATISTICAL MACHINES

Michael Maul, Berlin-Johannisthal, Germany,
vested in the Alien Property CustodianApplication July 21, 1939, Serial No. 285,735
In Germany August 6, 1938

1 Claim. (Cl. 235—61.11)

The present invention relates to a light-responsive analyzing device for sorting machines wherein record cards are automatically sorted into different pockets in accordance with the characters provided thereupon.

The present application is an improvement over the co-pending application Serial No. 285,734 filed July 21, 1939.

If the record cards bear the characters as graphical characters, as has already been suggested, necessarily analysis by light sensing means must take place wherein the rays emitted by a source of light analyze the graphical characters and are then directed to the light-sensitive device.

The sorting of the cards is always effected according to certain columns or places—in the decimal numerical system according to decimal places of the card field to be sorted—and for this purpose in all machines now in use there is a single analyzing device provided for all columns which may be selectively adjusted to any desired column, namely to that column according to which sorting shall take place.

The primary object of the present invention resides in the provision of a light-responsive analyzing device on record card controlled machines for controlling the operations thereof in accordance with the graphical characters provided on the cards in different columns and having on the side-walls of the machine between which the card is being fed, a single light-source stationarily provided, from which a beam of rays is directed to light-responsive means which is also stationarily provided on the opposite side-wall and an optical system inserted therebetween for diverting the beam of rays upon the card for the purpose of the analysis of the characters, and in which system is provided manually adjustable means between the light source and light-responsive means for the purpose of column selection of the record card.

The arrangement according to the invention affords the great advantage that the light-source and light-cell which are sensitive to shocks are not subjected to any shocks caused by the frequently occurring change of columns and that further the movable optical system comprises no parts at all which are endangered by shocks. In spite of this stationary arrangement of light-source and light cell with changeable column selection, in the arrangement according to the invention the intensity of the light rays encountering the light-cell is independent from the column selection, and this is the primary condition

for a reliable analysis if graphical characters are analyzed according to their area. Further, of course, in the structural arrangement considerable advantages are obtained, if the light-source and light-cell are stationarily provided and if only a comparatively small optical device must be adjusted.

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 shows in an enlarged scale the configuration of graphical numerical characters as they may be printed upon record cards; in Fig. 1, however, also the position of the index points is indicated which are analyzed by the analyzing device.

Fig. 2 shows a record card with graphical characters of the type indicated in Fig. 1.

Fig. 3 shows in a section the light-electrical analyzing device on a card sorting machine, wherein the light-source and the light-cell are arranged on opposite side-walls of the machine and between which the optical system is adjustable.

There are different ways to choose the configuration and analysis of graphical characters. According to one of the suggestions known so far, the graphical characters may be so selected that they differ from each other by their contents in black area and the machine is controlled in accordance with the differential black area of the characters. According to another suggestion the graphical characters, such as for instance the numerals, are so selected in their configuration that in accordance with an index-point system to be assumed in a certain manner, a different combination of black and light analyzing points is obtained for each character, whereby again a differential control of the machine is made possible. The provision according to the invention may be applied in the same manner for both types of graphical characters just as well as for the analysis of perforated record cards.

In Fig. 1 there are shown in an enlarged scale the graphical characters according to the index-point system. The index-points to be analyzed are indicated by white or black circles respectively, and the following may be seen: If the machine will analyze in each character the four index-points coordinated thereto, depending

upon the meaning of the characters, distinct combinations of black and light points are obtained which may be used in a known manner (see U. S. Patent 2,000,403) for the control of statistical machines. The Fig. 2 shows a record card 10 serving for the control and having numeral characters of the same configuration as the numerals shown in Fig. 1, said characters being provided in four lines *a, b, c, d*.

In Fig. 3 the light-source 30 and the light-cell 40 are provided on opposite sidewalls 35, 36 of the sorting machine. The optical system is provided on the carrier 21 which may be adjusted by the worm shaft 29 to different columns and which is kept in vertical position by the guide bar 28. The columnary adjustment of the carrier 21 is effected by rotation of the crank 38. On the carrier 21 are provided two mirrors 22, 23 and two systems 26, 27 of lenses, the system 26 directing the rays of light upon the card so that the characters on the card are in focus, and the reflected rays are concentrated by the system 27 of lenses and directed to the light-cell. It may be seen that the rays of light are directed from the light-source 30 over the system 31 of lenses, within the bellows 24 to the mirror 22, from there to the system 26 of lenses, and will then encounter the card. From the card the light rays are reflected more or less depending upon the presence of a light or dark spot, through the system 27 of lenses they are directed upon the mirror 23 and from there within the bellows 25 over the system 39 of lenses to the light-cell 40. Upon the analysis of the numerals represented in Fig. 1 analyzing impulses must be initiated at four successive predetermined moments, i. e. if the four index-points are advanced past the system 26, 27 of lenses and since, as is shown in Fig. 1, the outmost and lowermost index-points are set off sidewardly, this circumstance is taken into consideration so that the worm shaft 29 and therewith also the optical system on the carrier 21 may be sidewardly moved by the cam 34. The worm shaft 29 is kept under the pressure of the spring 32 with its end 33 against the cam 34. The same, however, rotates synchronously with the passage of the four lines of characters *a, b, c, d* on the card 10 past the analyzing station. Accordingly, through each of the four raised portions of the cam 34 which are shown in the drawing, the worm shaft 29 and therewith the analyzing device is moved upon the passage of a numeral line from the position illustrated to the right. For a more detailed description of this operation reference should be made to the above mentioned co-pending application.

It is now assumed that the cards pass through the machine so that first the uppermost and finally the lowermost index-point (Fig. 1) will arrive under the analyzing device. If the uppermost index-point is being analyzed, the character 21 is not yet moved by the cam 34. If, however, both middle index-points are analyzed the carrier 21 has been slightly moved to the right and immediately thereupon a further slight movement to the right will occur, so that the left hand lower index-point, shown in Fig. 1 will be analyzed, whereupon the device will again return to its home position due to the shape of the cam. Upon the passage of the next lines past the analyzing device each time, however, the same operation will take place. In the electrical circuits—which are not illustrated—there is a line-selection-switch which is adjustable to the line in which the column to be sorted is selected so that

each time only the column of this line may become effective. These circuits are shown in the said co-pending application and since they form no part of the present invention need not be shown.

If the graphical characters are represented in the other system mentioned in the introduction and if accordingly they are distinct from each other by their different black area, it is absolutely necessary that the light rays impinging upon the light-cell are independent from the column selection since the intensity of the light is the sole characteristic of the meaning of the analyzed character. This independence from the column selection is obtained in the device according to the invention, if the light-source and light-cell are provided on opposite side-walls of the machine and if therebetween the optical device is adjustable as is shown in Fig. 3. In this arrangement the weakening of the rays through dampening and the absorption in the optical system and on the card is independent from the position of the optical system between light-source and light-cell.

It may be designated by:

- L_1 = the light current passing from the light-source.
- L_2 = the light current encountering the light-cell.
- a = the distance between light-source and light-cell.
- x = the distance of the optical system from the light-source.
- k = the part of the light absorbed by the optical system and the analysis of the card.
- f = a factor for the dampening and absorption of the light per unit of way.
- $e = 2,71828$ = the basis of the natural logarithm.

The current of light passing from the light-source is L_1 . The current of light L' arriving at the optical system is dependent upon the distance x and the factor f ; L' is therefore obtained as

$$L' = \frac{L_1}{e^{fx}}$$

Since the absorption through the optical system and through the card analysis is k , there remains from the arriving current L' of light behind the optical system the light current $L'' = (1-k) \cdot L'$ or

$$L'' = \frac{L_1}{e^{fx}} (1-k)$$

This light current L'' is again weakened and this weakening is dependent upon the remaining distance $(a-x)$ and f . The light current L_2 arriving at the light-cell is then

$$L_2 = \frac{L''}{e^{f(a-x)}}$$

If therein the value for L'' is inserted, it is obtained

$$L_2 = (1-k) \frac{L_1}{e^{fx} \cdot e^{f(a-x)}} = (1-k) \frac{L_1}{e^{fx+fa-fx}}$$

or after calculation

$$L_2 = (1-k) \cdot \frac{L_1}{e^{fa}}$$

It may be seen that the distance x is eliminated from the formula and this means; the light current arriving at the light cell is entirely independent from the adjustment of the optical system between light-source and light-cell. Therewith the condition is fulfilled made above for the analysis of graphical characters with differential black area.

While there has 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 claim.

What is claimed is:

A machine controlled by record cards which are fed along a predetermined path and which have graphical characters disposed thereon in different columnar areas having means for analyzing the characters comprising a source of light

rays, light responsive means and related lens systems, said source and relative lens system, and said light responsive means and related lens system fixedly secured to opposite side walls of the machine, respectively, individual optical systems for directing the rays of light from the said source in the path of the record cards and from the said cards to the light responsive means, respectively, said directing systems being mounted on a settable carrier disposed between the said side walls, and adjustable means cooperating with said carrier for positioning the carrier and light ray directing systems for directing the rays of light to and from the different columns of characters on the record cards.

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