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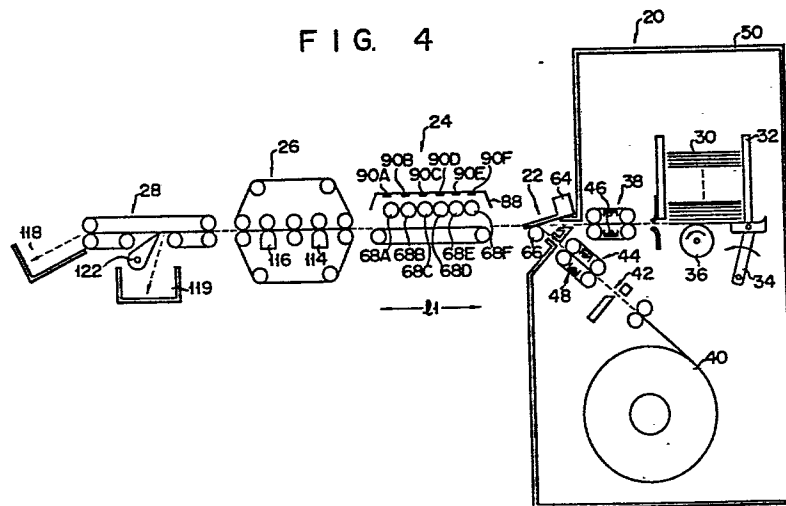
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(54) Thermal printing apparatus.

(57) A thermal printing apparatus is provided with a thermal printing section (22) for selectively heating a heatsensitive color developing printing medium coated with diazonium compound to form an image thereon, and a photo-fixing section (24) for illuminating the printing medium thermally printed with light to fix the image formed. In the photo-fixing section (24), the printing medium is illuminated with normal light, for example, light from a fluorescent lamp, and an amount of normal light is always detected. When the light amount is insufficient, the light amount is compensated for by lighting an auxilliary fluorescent lamp (120), increasing the lamp current, or the like.

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FIG. 4



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Thermal printing apparatus

5 The present invention relates to a thermal printing apparatus for making a print on a printing medium which develops color by the heat applied, but loses the color developing function when it is exposed to light.

10 Recently, the thermal printing apparatuses have widely been used for printing passenger tickets in the field of transportation such as railroads and buses, securities issued in banking organs, and certificates issued in government offices. One of the reasons for this is it is almost impossible to alter the contents of the printed matter of this type. The printing medium develops color when it is heated to form an image such as characters, graphical configuration, etc.

15 The printing medium is unable to develop color when exposed to light. Because of this nature, if the printing medium is exposed to light after an image is formed thereon, the non-image-formed portion (non-color-developed portion) of the printing medium never produces color, viz. the formed image is fixed. In the conventional apparatus, a xenon flash lamp is used as a light source, and in the fixing process it instantaneously fixes the image formed with the flash light.

25 Use of the xenon flash lamp makes large the size of the thermal printing apparatus for the following

reasons. A large capacitor capable of storing large energy must be used for discharging the flash lamp, leading to increase of the size of the apparatus. Since the capacitor is charged up to a high tension voltage 800 V, there is danger of electric shock to human body. If some measure is taken for avoiding such danger, it also contributes to the increase of the size. Further, the light rays emitted from the flash lamp include much ultraviolet rays, such rays must be shielded for the safety of human. This also results in the increase of the size.

One may consider that the size reduction of the light source is effective for solving the size increase problem. However, an insufficient illumination for the fixing which results from the size reduction of the light source, is accompanied by poor fixing performance, possibly allowing the alternation of the contents on the printing matter.

Accordingly, an object of the present invention is to provide a small-sized thermal printing apparatus with a good safety and a reliable fixing performance.

To achieve the above object, there is provided a thermal printing apparatus comprising a thermal printing section for selectively heating a printing medium which develops color by the heat applied and loses the color developing function when it is exposed to normal light, thereby to form an image on the printing medium, and a fixing section for illuminating the printing medium bearing the image formed thereon by the thermal printing section with normal light.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Fig. 1 shows a cross section of a printing medium used in the present invention;

Fig. 2 shows an example of a printed pattern on the printing medium;

Figs. 3A and 3B illustrate printing steps when the printing medium is printed;

Fig. 4 is a schematic illustration of an embodiment of a thermal printing apparatus according to the present invention;

Fig. 5 illustrates the details of a hopper for storing a batch of printing mediums and its vicinity;

Figs. 6A and 6B are plan views illustrating arrangements of fluorescent lamps used in a fixing section;

Fig. 7 illustrates a geometry of the fluorescent lamp in comparison with the printing medium;

Figs. 8A and 8B are cross sectional views of the fluorescent lamp;

Fig. 8C is a perspective view of the fixing section;

Fig. 9 is a circuit diagram of a circuit for increasing a lamp current of the fluorescent lamp;

Fig. 10 is a perspective view of a transfer mechanism of the fixing section;

Fig. 11 shows a flow chart useful in explaining a sequence of operations of the embodiment;

Fig. 12 illustrates an example of a printed pattern used in a ticket discarding processing in the operations of the embodiment;

Figs. 13 and 14 illustrate cross sectional views of an arrangement of an auxiliary fluorescent lamp used in a second embodiment of the invention;

Fig. 15 is a circuit diagram of a circuit for lighting the auxiliary fluorescent lamp;

Figs. 16A to 16C show a timing chart useful in explaining an operation of the circuit of Fig. 15; and

Figs. 17 and 18 illustrate views of a transfer mechanism in a fixing section used in other embodiments of the present invention.

A preferred embodiment of a thermal printing apparatus according to the present invention will be

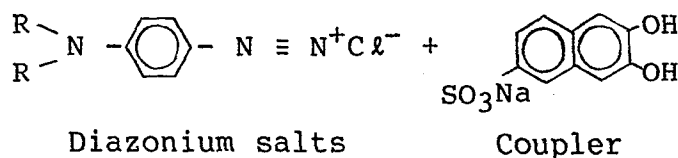


described referring to accompanying drawings. In the description to follow, a printing medium is a commutation ticket widely used in railroads or buses, for example. A cross section of the printing medium is illustrated in Fig. 1. Some of the commutation tickets are sealed with a transparent film by a laminating process, but the commutation ticket used here is of a called sealless type. The printing medium has a three-layer structure that a heatsensitive color developing layer 12 and a magnetic recording layer 14 are layered on both sides of a base 10, such as a sheet or plastic plate. The heatsensitive color developing layer 12 gives rise to color when it is heated and forms an image thereon. The heatsensitive color developing layer 12 loses the color developing function when it is exposed to light. This indicates that the image formed on the heatsensitive color developing layer 12 is fixed when it is exposed to light. A photosensing characteristic of the heat-sensitive color developing layer 12 is so selected that an absorption wavelength region is centered in a range 300 to 450 nm. This is because that the heat-sensitive color developing layer 12 is insensitive to flash light, but sensitive to the light which appears continuous to the naked eye, for example, the light emitted from the fluorescent lamp, and insensitive to the light emitted from ordinary room lamps. The light rays, which appears continuous to the naked eye will be herein called normal light, to thereby distinguish qt from flash light. A ground design may be thinly printed on the surface of the heatsensitive color developing layer 12. As shown, a ticket available section, a valid period, name, age, etc. are printed on the surface of the heatsensitive color developing layer 12. The magnetic recording layer 14, although not relating to the thermal printing under discussion, is provided so as to be applicable for an automatic

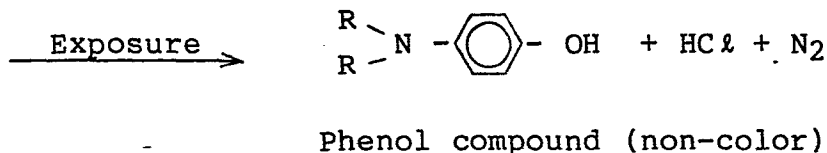
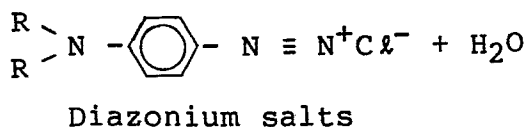
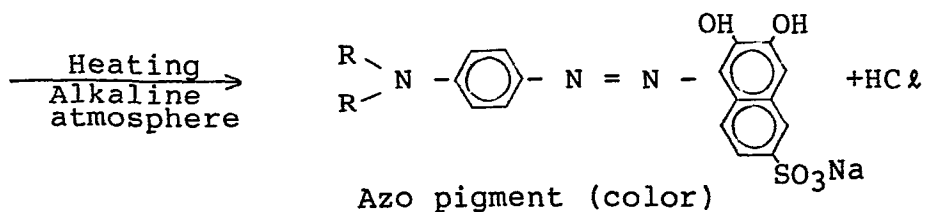
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ticket gate, too. The magnetic recording layer 14 also stores the information as those printed on the heat-sensitive color developing layer 12 in a coded form.

The heatsensitive color developing layer 12 is a diazo photosensitive layer of the thermodeveloping type comprising a diazonium compound, a coupling agent, a base yielding agent which is transformed into bases by the heat applied, and a stabilizer such as an organic acid. When the diazo photosensitive layer is used as a photosensitive sheet, a non-image formation portion of the photosensitive sheet is selectively exposed to light, so that the diazonium compound thereon is optically decomposed. Then, the entire photosensitive sheet is heated at temperature 100 to 200°C. The base yielding agent in the layer is pyrolyzed into bases, and the not pyrolyzed diazonium compound and the coupling agent in an image formation portion thermochemically react with each other, yield color azo dyes. In this way, the image is formed. The image formation on the diazo photosensitive layer is also possible by heating. In the image formation process, the diazo photosensitive layer is heated according to a configuration of an image to be formed. Through this heating process, the diazonium compound and the coupling agent in the heated portion thermochemically react with each other. Then, the diazo photosensitive layer is entirely illuminated with normal light, for example, the light emitted from the fluorescent lamp. Under this illumination, the unreactive diazonium compounds are optically decomposed. After the decomposition, no color is developed even if it is further heated. The reaction formulae are



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Actual components of the heatsensitive color developing layer 12 will be given below by way of example.

1.5 wt.% of zinc chloride double salt of N,N dimethylamino paraaniline diazonium chlorite is dissolved into 1.5 wt.% of methanol, and is filtered to remove most of the zinc chloride. Then, it is added with 1 wt.% of acrylic acid - methacrylic ester copolymer resin. The obtained coating agent is applied to a paper and the coated paper is dried. The surface of the resin layer containing the photosensitive diazonium compound is coated and dried with another coating agent in which 2 wt.% of naphthol AS-D as a coupling agent, 2 wt.% of urea as a base yielding agent, and 3 wt.% of butyl rubber and 1 wt.% of ester gum as a binder are dispersed into benzene.

This thermodeveloping diazo photosensitive paper is heated, by a thermal head, for example, to 70 to 90°C according to a configuration of a picture to be formed. By the heating, the diazonium compound and the coupling agent in the resin layer thermochemically react with each other to yield color dyes, resulting

in a coloration configured according to the picture. Then, the photosensitive paper is illuminated with light from the fluorescent lamp, so that the diazonium compound is optically decomposed. Therefore, even if
 5 the photosensitive paper is heated again, coloration never occurs in the non-image formation portion in the paper.

In a second example of the heatresistive color developing layer 12, a coupling accelerating agent such
 10 as steroamide, an accelerating agent for accelerating the pyrolysis of the steroamide, such as stearic acid zinc, and a stabilizer for preventing the coupling in storage such as ascorbic acid are dispersed into a solvent including a diazo compound stabilized in a
 15 double salt with a polyvalent metal salt such as zinc chloride and a coupling agent containing β -naphthol and its derivative. With this, a paper is coated. Also in this example, the coupling is carried out between the diazo compound and the coupling agent,
 20 when the coated paper is heated. For the fixing, normal light is used as in the previous example.

A printing process when a print is carried out on the printing medium will be described referring to Figs. 3A to 3B. As shown in Fig. 3A, the heatsensitive
 25 color developing layer 12 is selectively heated by a dot type thermal head or a thermal stamp according to a configuration of an image to be printed. In the figures, arrows as indicated by solid lines indicate conduction or radiation heat. The heated portions of
 30 the heatsensitive color developing layer 12 develop color as indicated by black painted portions. In the unheated portions, the diazonium compounds as decomposed lie as indicated by dotted portions. As shown in
 Fig. 3B, then, the entire surface of the heatsensitive
 35 color developing layer 12 is illuminated with normal light (arrows as indicated by broken lines). With the illumination, the diazonium compound in the unheated

portion (non-color developed portion) is optically decomposed, so that a further coloration is impossible, and the image formed by the heating is fixed. The white portions in Fig. 3B indicate the portion where the diazonium compound is optically decomposed to disappear.

A structural arrangement of a thermal printing apparatus for performing a print on such a thermal printing medium will be described. Fig. 4 illustrates in cross-sectional form an overall structure of the thermal printing apparatus. This apparatus generally comprises a feeder section 20, a thermal printing section 22, a photo-fixing section 24, a magnetic recording section 26 and a discharge section 28. The feeder section 20 is so designed that it accepts both the printing mediums cut in a definite form like cards and a continuous rolled printing medium. A batch of card like printing mediums 30 is stored in a hopper 32 and is taken out sheet by sheet from the lower part of the hopper 32 by a combination of a picker 34 and a roller 36, which are provided below the hopper 32, and transported outside from the feeder section 20 through a first take-out path 38. A rolled printing medium 40, disposed under the hopper 32, is cut to a predetermined size and is transported outside through a second take-out path 44. Each of the first and second take-out paths 38 and 44 includes a pair of endless belts each with a wide width which endlessly rotate. In transferring the printing medium, the pair of the endless belts rotate, while nipping the printing medium therebetween. Input sensors 46 and 48 for sensing the passage of the printing medium are provided in the middle of the first and second take-out paths 38 and 44, respectively. The thermal printing is carried out in synchronism with the sensing by the input sensors 46 and 48. The feeder section 20 is housed in a housing 50 with a light shielding ability,

since the printing mediums 30 and 40 can not be printed if it is exposed to light.

Even if such light shielding means is provided, however, there is still a probability that the sunlight
5 or room light enters the inside of the feeder section 20 when an operator erroneously operates. In such a case, although rarely occurring, the uppermost printing medium of a batch of printing mediums 30 would be exposed to light in the hopper 32. For this reason,
10 in practical use, the uppermost printing medium is not used for the actual commutation ticket.

To this end, an empty detector 52 is provided near lower part of the hopper 32. The empty detector 52, provided in a holder 54, comprises a spring 56, a rod
15 58, and a microswitch 60. The spring 56 presses the rod 58 toward the hopper 32. Normally, however, the pressing against the rod 58 is constrained by the printing mediums 30 stacked in the hopper 32. Normally, the microswitch 60 is in contact with the end of the
20 rod 58. When the last printing medium is taken out from the hopper 32, the rod 58 is detached from the microswitch 60. At the time of the empty detection, the printing medium taken out from the hopper 32 is not used for the regular printing but for printing
25 statistical characters, as will be described later.

A remainder detector 62 for detecting the remainder of the printing medium in the hopper 32 is located at the middle height of the hopper 32.

Actually, it is sufficient that either of the
30 rolled and card like printing mediums is provided in the feeder section 20.

The first and second take-out paths 38 and 44 meet each other in the vicinity of an outlet hole of the feeder section 20. The thermal printing section
35 22 comprises a thermal head 64 and a platen roller 66, which are oppositely disposed with respect to the transfer path of the printing medium. The thermal



head 64 also shields the printing medium from light. The printing medium, of course, is transported with the heatsensitive color developing layer facing the thermal head 64, i.e. upward as viewed in the drawing.

5 The thermal head 64 with the printing surface facing the platen roller 66 is pushed toward the platen roller 66, by an appropriate resilient member. The platen roller 66 transports the printing medium at a given speed pressing the printing medium against the
10 printing surface of the thermal head 64. The thermal head 64 selectively heats the heatsensitive color developing layer 12 to develop color, as shown in Fig. 3A.

 The printing medium color developed by the thermal
15 printing section 22 is transferred to the photo-fixing section 24 having fluorescent lamps 68A, 68B, 68C, 68D, 68E, 68F as a light source. The photo-fixing section 24 is provided near the thermal printing section 22. This leads to a size reduction of the apparatus and
20 reduces a time period from the end of printing to the end of fixing. Further, since the normal light source, not the flash lamp, is used for the light source, the increase of the size of the apparatus is prevented. Further, the operation of the apparatus is safety since
25 there are no application of a high tension and a large dosage of ultraviolet rays. The fluorescent lamps 68A to 68F are specially designed so that an intensity of the light emitted is high in the region of the wave-length from 300 to 450 nm so as to satisfy the fixing
30 sensitivity characteristic of the heatsensitive color developing layer 12. These six fluorescent lamps 68A to 68F are arranged orthogonal to the transfer direction of the printing medium 30, as illustrated in a plan view of Fig. 6A. Since one fluorescent lamp is
35 much smaller than the printing medium 30, a plurality of fluorescent lamps must be arranged in order to uniformly illuminate the printing medium. If the

fluorescent lamps are arranged along the transfer direction of the printing medium, as shown in Fig. 6B, the portions of the printing medium corresponding to the spaces each adjacent fluorescent lamps are insufficiently illuminated. Further, since the end portions of the fluorescent lamps, that is, the portions not contributing to the light illumination, are present on the transfer path. Therefore, the transfer path is longer by the length corresponding to the non-illumination parts. The group of the fluorescent lamps are not necessary orthogonal to the transfer path, but a slight amount of inclination of the lamps to the transfer path is allowed.

To effect the fixing quickly and perfectly, it is desirable that the fluorescent area of the fluorescent lamps 68A to 68F is larger than the area of the printing medium. In the present embodiment, a length l_1 (Fig. 4) of the lamps 68A to 68F along the transfer path is longer than the length l_2 (Fig. 7) along the transfer path of the printing medium 30 ($l_1 > l_2$). An effective fluorescent length l_3 of one fluorescent lamp 68 (length of the fluorescent lamp except the length of the blackened parts BE of the fluorescent lamp when it is lit for a long time), is also longer than the width l_4 of the printing medium 30 ($l_3 > l_4$). The effective fluorescent lengths l_3 of the fluorescent lamps slightly vary. However, this length variation is negligible if $l_5 - l_4 \geq 10$ mm (l_5 is the filament length), it is empirically showed that a satisfactory fixing is ensured.

To shorten the fixing time by the fluorescent lamps 68, it is necessary to collect light rays emitted from the fluorescent lamps 68 on the surface of the printing medium 30. To this end, it is desirable to employ the fluorescent lamp of the aperture type, as shown in Fig. 8A. This fluorescent lamp, except a necessary projection window 78 (angle α), is coated

with a reflecting film and fluorescent material or a reflecting fluorescent material 80. The preferable angle α is 70 to 120° in order to ensure an efficient projection of fluorescent light. In use of the aperture
5 type fluorescent lamps 68, the projection windows 78 of the fluorescent lamps 68 must be aligned in the same direction. For this reason, it is preferable to use the fluorescent lamps 68 with a fixed relative angle of cap terminal pins 82 to a center of the projection
10 window 78, as shown in Fig. 8B, and further to use connectors 86 with lined holes 84 for holding the cap terminal pins 82. To further improve the projection efficiency of the fluorescent lamps 68, it is preferable to provide a reflecting mirror 88 above the fluorescent
15 lamps (Fig. 4).

Soils on the fluorescent lamp and aging of the fluorescent lamp result in decrease of the light emission, possibly providing a cause of poor fixing. As shown in Fig. 4, the reflecting mirror 88 is
20 preferably provided with photosensors 90A, 90B, 90C, 90D, 90E, 90F corresponding to the fluorescent lamps 68A to 68F, in order to compensate for the decrease of emitting light amount. The photosensor 90 and the fluorescent lamp 68 are interconnected, as shown in
25 Fig. 9. The output signal from the photosensor 90 is applied through an amplifier 92 to a comparator 94 where it is compared with a reference level V_{th} . The output signal of the comparator 94 is supplied to a switch 96 provided in a current path for lamp current
30 increment. Reference numeral 98 designates a switch for lighting the fluorescent lamp. With such an arrangement, when the amount of emitting light from the fluorescent lamp 68 is decreased, the lamp current is increased to increase the amount of the emitting
35 light. The amount of emitting light may also be increased by increasing the power voltage.

Generally, the illumination of the fluorescent

lamp reduces in winter. To cope with this, a temperature sensor is provided and the lamp current or the power voltage is controlled on the basis of the result of the temperature sensed, thereby to prevent the imperfect fixing. Further, if the fluorescent lamp 68 is turned on at the start of the printing work, and is turned off at the end of the work, frequent turn on and off operations are avoidable, elongating a lifetime of the fluorescent lamp. Use of a rapid start tube or a rapid type starter could light the fluorescent lamp quickly, for about one second, enabling the thermal printing apparatus to be ready for use instantly.

Fig. 10 shows a perspective view of a transfer mechanism of the photo-fixing section 24. Two pairs of take-in belts 100 and 102 respectively comprise upper endless belts 100A and 102A and lower endless belts 100B and 102B, which transfer the thermally printed printing medium 30 from the thermal printing section 22 to the photo-fixing section 24 while nipping the printing medium 30. The lower belts 100B and 102B are provided extending to the photo-fixing section 24, and carry the printing medium 30 released from the upper belts 100A and 102A. A moving table 104, which is movable vertically and horizontally, is provided below the lower belts 100B and 102B. The trailing edge of the printing medium 30 is appropriately set by a backup hook 106 projecting from the moving table 104, thereby ensuring a reliable transfer of the printing medium 30. The printing medium 30 travels and stops for several seconds or slows down at the location near the center of a fluorescent lamp box 108 disposed above the photo-fixing section 24, for ensuring a perfect fixing. Then, the printing medium 30 together with the moving table 104 moves to the entrance of two pairs of take-out belts 110 and 112 comprising upper belts 110A and 112A and lower belts 110B and 112B. Then,

the printing medium 30 is transferred to the endlessly running take-out belts 110 and 112. Although not illustrated, a sensor for sensing the passage of the printing medium 30 is provided between the take-out
5 belts 110 and 112, which are provided at the outlet of the photo-fixing section 24. The output signal from the sensor is used for stopping the light emission of the fluorescent lamp, and in cooperation with the input sensors in the feeder section 20 detects a jam.

10 Returning to Fig. 4, the magnetic recording section 26 is provided downstream of the photo-fixing section 24. In this section, the same contents as those thermally printed are recorded, by means of a recording head 114, into the magnetic recording layer
15 14 of the printing medium after it is fixed. A playback head 116 is also provided on the transfer path in the magnetic recording section 26 to check whether or not the magnetic recording is properly done. The discharge section 28 with first and second discharge
20 ports 118 and 119 is further provided downstream of the magnetic recording section 26. The printed matter is directed to either of these first and second discharge ports by a directing gate 122 which swings according to the data read out by the playback head 116. When
25 the magnetic recording is proper, the printing medium is directed to the first discharge port 118, while if it is improper, the printing medium, to the second discharge port 119.

30 The operation of the embodiment thus arranged will be described referring a flow chart shown in Fig. 11. In the description to follow, the printing medium used is a sheet like one. Upon start of the thermal printing apparatus, data to be printed (Fig. 2) is input by key operations on a keyboard (not shown),
35 as shown in a step 1000. In a step 1005, a sheet of the printing medium is picked out from the hopper 32. At this time, the detection of decrease of the printing

mediums stored in the hopper by the remainder detector 62 is judged in a step 1010, and if no decrease of the printing mediums is detected, a step 1035 is immediately executed. When it is decreased, the result of detection

5 by the empty detector 52 is judged in a step 1015. If the empty is not detected, an alarm of the decrease of the printing medium remainder is issued in a step 1020 and a step 1035 is executed. When the empty is detected, an empty alarm is issued in a step 1025.

10 And in a step 1030, the data for discarding processing is prepared as the printing data in stead of the data input in the step 1000. The discarding process will subsequently be described. A step 1035 is executed following the step 1030. In the step 1035, it is

15 judged whether or not the printing medium has passed the input sensor 46. If it has passed, in a step 1040, the heatsensitive color developing layer 12 of the printing medium is selectively heated and color-developed according to the data input in the step 1000.

20 Then, the fluorescent lamps 68A to 68F are turned on to disable the subsequent coloration of the heatsensitive color developing layer 12, as indicated by a step 1045. In a step 1050, the light emitting amounts of the fluorescent lamps 68A to 68F are respectively sensed

25 by the photosensors 90A to 90F. When the sensed light amount is sufficient, the process flows to a step 1060. If it is insufficient, as in a step 1055, the lamp current is increased and the process flows to a step 1060. The increase of the lamp current is performed

30 by the circuit shown in Fig. 9. When the light amount is insufficient, an alarm is issued for notifying a replacement of the defective fluorescent lamp to an operator. After the end of the fixing, as indicated by the step 1060, the same data as the thermally

35 printed data is coded and recorded into the magnetic recording layer 14. Then, in a step 1065, depending on the magnetic recording state, good or wrong, the

printing medium is directed to either of the first and second discharge ports 118 and 120. At this point, the ordinary commutation ticket issuing processing ends.

5 Explanation to follow is the discarding processing when the printing medium is taken out from the hopper 32 and the empty is detected. When this is detected, the last printing medium is picked out, viz. this printing medium is the uppermost one of the stack
10 of the printing mediums stored in the hopper 32, and it might erroneously be exposed to light. Therefore, this last printing medium is not used and hence is not printed as the commutation ticket. More specifically, as shown in Fig. 12, the data representing the number
15 of the tickets sold after the previous empty detection and the sales amount as well, not the data input in the step 1000, are supplied to the thermal head 64.

As described above, in the present embodiment, normal light source (e.g. the fluorescent lamp) is
20 used for the fixing light source. Therefore, an excellent safety and a size reduction of the apparatus are attained. Since the fixing light amount is detected, there is eliminated a danger that the fixing is unsatisfactory and the printed characters/numerals
25 may be altered. Further, since the printing medium is shielded from light before the thermal printing, there is no case that the printing medium is disabled in the color developing before the thermal printing.

A second embodiment of a thermal printing
30 apparatus according to the present invention will be described. In the second embodiment, the decrease of the emitting light is compensated for by lighting an auxiliary fluorescent lamp, not increasing the emitting light amount of each fluorescent lamp by increasing
35 the lamp current. Most of the arrangement and operation of the present embodiment are substantially equal to those of the first embodiment. Accordingly, only the

portions different from those in the first embodiment will be described. Fig. 13 shows a cross section of the photo-fixing section 24 in the second embodiment. As shown, an auxiliary fluorescent lamp 120 is provided in addition to the regular fluorescent lamps 68A to 68F. The auxiliary fluorescent lamp 120 is provided at the last place as viewed in the traveling direction of the printing medium. Alternatively, the auxiliary fluorescent lamp 120 may be provided in the discharge port 118, as shown in Fig. 14. According to this arrangement, since the inside of the first discharge port 118 is illuminated, one rarely fails to pick up the prepared commutation ticket.

Fig. 15 shows a lighting circuit for the fluorescent lamps containing the auxiliary fluorescent lamp 120. As shown, the regular fluorescent lamp 68 is connected to an AC power source 124, and the auxiliary fluorescent lamp 120 is connected through a relay switch 126 to the same. A photosensor 90 for sensing a total amount of the light emitted from the regular fluorescent lamp 68 produces an output signal which in turn is supplied to a comparator 130 via an amplifier 128. The comparator 130 compares the output signal of the photosensor 90 with a reference level V_{th} . The output of the comparator 130 is supplied to the gate of a thyristor 132 to connect the anode of the thyristor 132 to the relay switch 126. The relay switch 126 is also connected to a driver 138 for driving an alarm lamp 134 and an alarm buzzer 136.

How to compensate for the decrease of the fixing light amount by the second embodiment will be described referring to timing charts shown in Figs. 16A to 16C. At the time of fixing, the photosensor 90 produces a signal in a level representing the total amount of the light emitted from the regular fluorescent lamp 68. As the light amount is larger, the signal level is lower. On the other hand, as the light amount is smaller, the

signal level is higher. Assume now that the total amount of the light from the regular fluorescent lamp 68 decreases, and the output signal level of the photosensor 90 rises, and further that the output
5 signal of the amplifier 128 rises as shown in Fig. 16A to reach the reference level V_{th} as indicated by a broken line shown in Fig. 16A. At this time, the output signal from the comparator 130 is in "1" level as shown in Fig. 16B, so that the thyristor 132 is
10 turned on as shown in Fig. 16C. Upon the turn on of the thyristor 132, the relay switch 126 is conducted to light the auxiliary fluorescent lamp 120 to increase the amount of the fixing light. Also at this time, the driver 138 is energized to sound the alarm buzzer
15 136 and to lit the alarm lamp 134 to notify the decrease of the fixing light amount from the regular fluorescent lamps 68 to an operator.

In this way, the decrease of the fixing light is compensated for by the auxiliary fluorescent lamp.

20 It should be understood that the present invention may further be changed and altered variously. A modification of the photo-fixing section is shown in Fig. 17. In this modification, the moving table for backup of Fig. 10 is not used, but the transfer belt
25 142 per se is magnetized alternately S, N, S, N, ... along its extension. When the magnetized belt 142 rotates endlessly, the magnetic recording layer is attracted by the belt to ensure the transfer of the printing medium. In case that only the total amount
30 of the light is needed, the photosensors are not provided for the fluorescent lamps, respectively, sufficient is the use of only a single photosensor 146 to which the light of the fluorescent lamps is led by an optical fiber 144. Fig. 18 shows another
35 modification of the transfer mechanism in the photo-fixing section. In place of the moving table of Fig. 10, a moving table of which the surface is

magnetized is provided movable along guide rails 150 and 152 by means of a motor 154. Also this modification can reliably transfer the printing medium by the magnetic force. Further, the printing medium is not
5 limited to the commutation ticket, but may be any other things.

Claims:

1. A thermal printing apparatus comprising thermal printing means (22) for selectively heating
5 a printing medium which develops color with heat applied and loses its color developing function by light applied, thereby to form an image on the printing medium, and photo-fixing means (24) for illuminating the printing medium bearing the image formed by said
10 thermal printing means (22) with light, thereby to disable the color development in the portions not heated of the printing medium, characterized in that said photo-fixing means (24) irradiates normal light.
2. A thermal printing apparatus according to
15 claim 1, characterized in that said printing medium is coated with diazonium compound sensitive to normal light with a wavelength from 300 to 450 nm.
3. A thermal printing apparatus according to
20 claim 1, characterized in that said printing medium is shielded from light until said printing medium is heated by said thermal printing means (22).
4. A thermal printing apparatus according to
25 claim 1, characterized in that said printing medium is shaped like a card, a plurality of said printing medium are stored in a hopper, and supplied sheet by sheet to said thermal printing means (22), and the uppermost of those printing mediums is not used for ordinary printing.
5. A thermal printing apparatus according to
30 claim 1, characterized in that said photo-fixing means (24) comprises a plurality of fluorescent lamps arranged at an angle with respect to the transfer direction of said printing medium.
6. A thermal printing apparatus according to
35 claim 5, characterized in that said fluorescent lamps are disposed orthogonal to the transfer direction of said printing medium, and the portion except the

blackened portions when the fluorescent lamp is used for a long time is used for the fixing.

5 7. A thermal printing apparatus according to claim 6, characterized in that the gap between the filaments of said fluorescent lamp is at least 10 mm longer than the dimension orthogonal to the transfer path of said printing medium.

10 8. A thermal printing apparatus according to claim 5, characterized in that said fluorescent lamp is of the aperture type having an aperture facing the transfer path of said printing medium.

15 9. A thermal printing apparatus according to claim 1, characterized in that said photo-fixing means (24) has photosensing means for sensing the illuminated light, and increases the illuminating light amount when an amount of the detected light is below a predetermined amount.

20 10. A thermal printing apparatus according to claim 9, characterized in that said photo-fixing means (24) includes a plurality of fluorescent lamps and increases the lamp current or the power voltage of said fluorescent lamps.

25 11. A thermal printing apparatus according to claim 9, characterized in that said photo-fixing means (24) includes regular fluorescent lamps and an auxiliary fluorescent lamp (120) used when the illuminating light amount decreases.

30 12. A thermal printing apparatus according to claim 9, characterized by further comprising means (134, 136) for issuing an alarm when the illuminating amount is below a predetermined amount.

35 13. A thermal printing apparatus according to claim 10, characterized in that said photo-fixing means (24) includes a plurality of photosensors provided respectively for said fluorescent lamps.

14. A thermal printing apparatus according to claim 11, characterized in that said photo-fixing means

- 3 -

(24) includes a photosensor for sensing a total amount of the light from said regular fluorescent lamps.

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FIG. 1

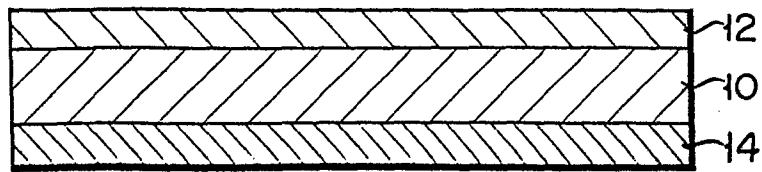


FIG. 2

COMMUTATION TICKET

A station $\longleftrightarrow$ B station

DEC. 9 1982

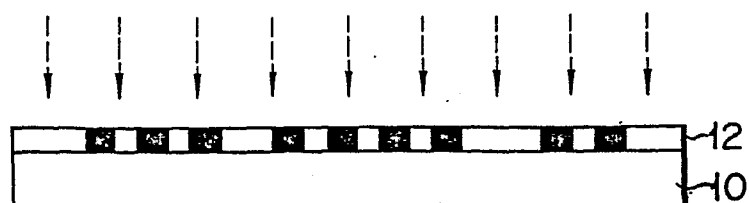
valid for 6 months from issue DATE

JUN. 10 1982 Mr. T. Toshiba Age: 27

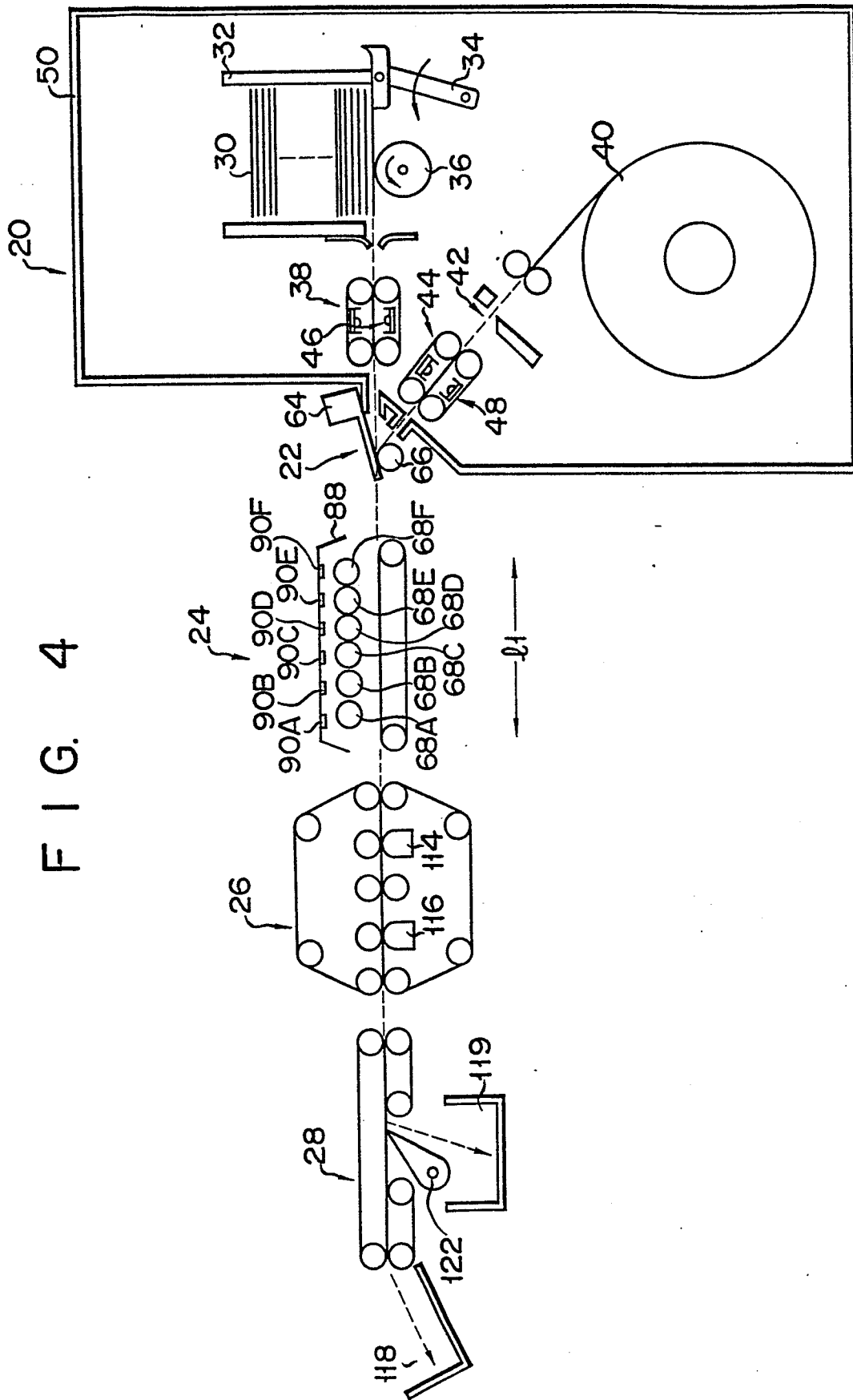
FIG. 3A



FIG. 3B



4
G
—
E



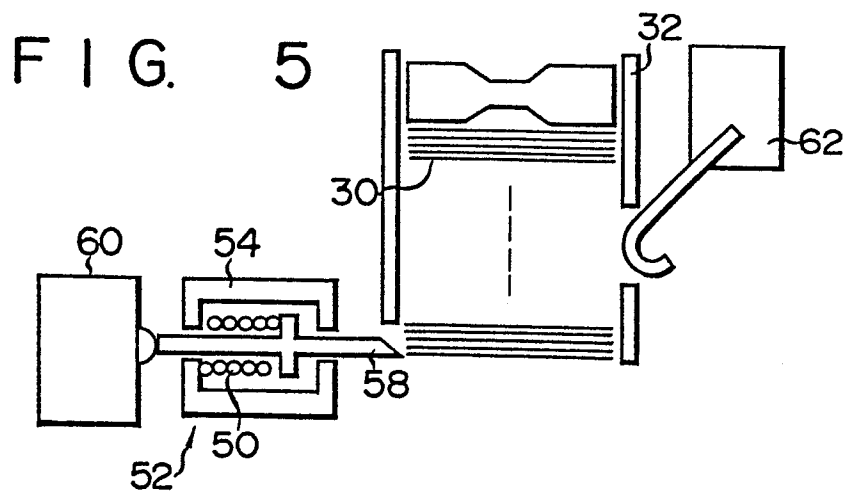


FIG. 6A

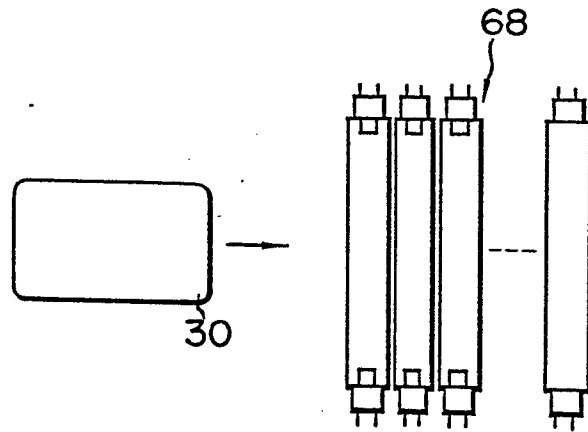


FIG. 6B

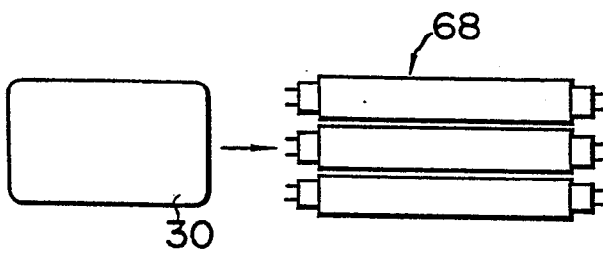


FIG. 7

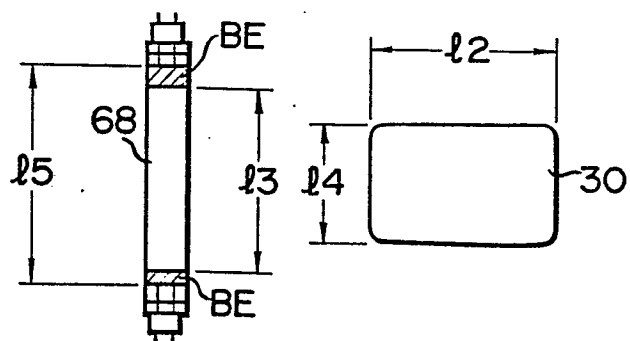


FIG. 8A

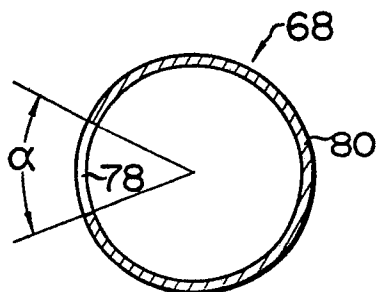


FIG. 8B

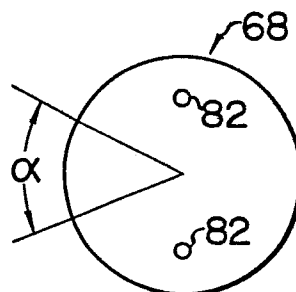


FIG. 8C

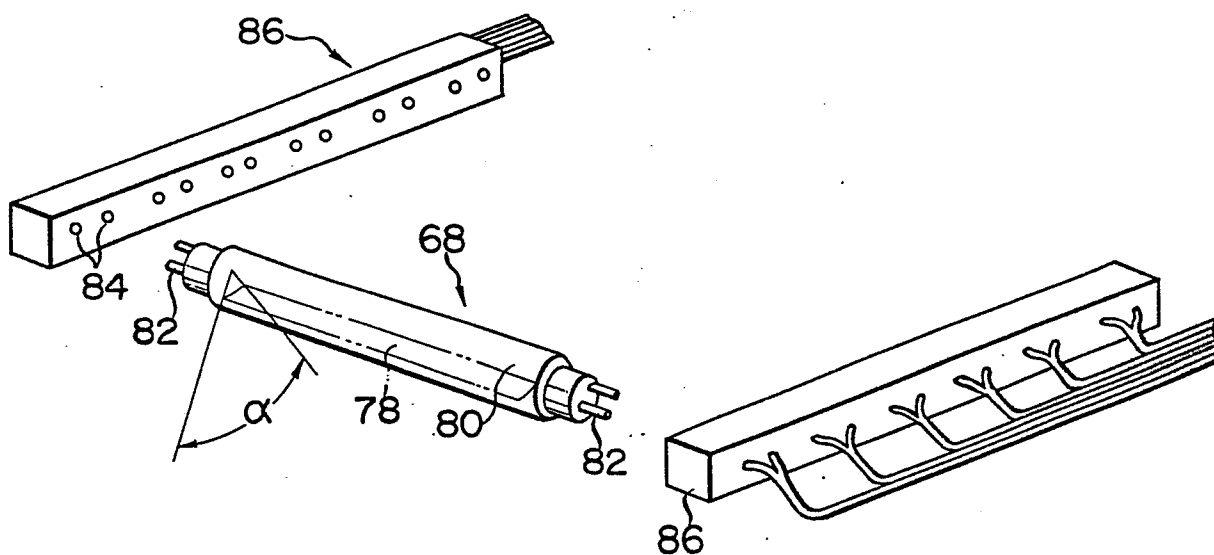


FIG. 9

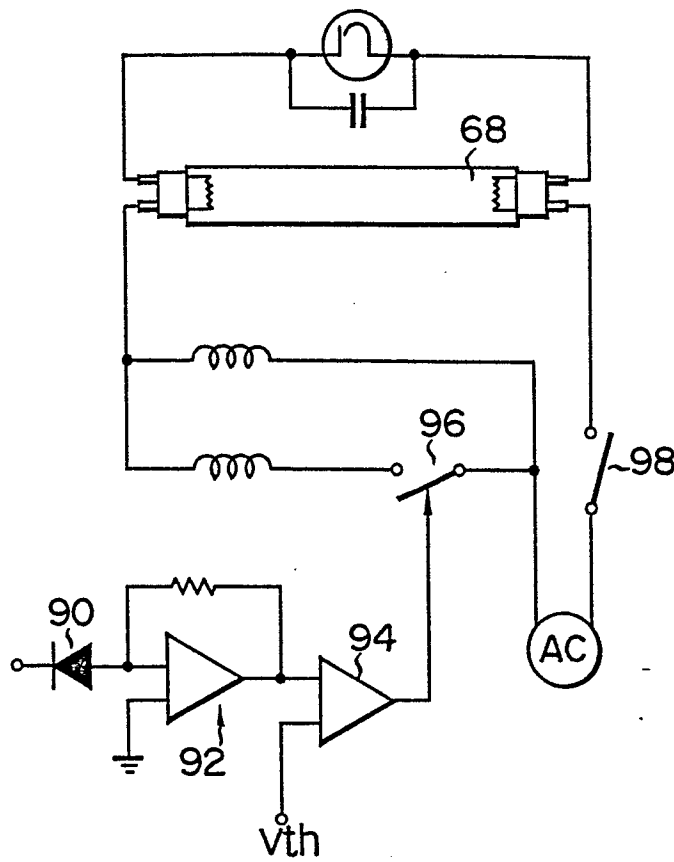


FIG. 10

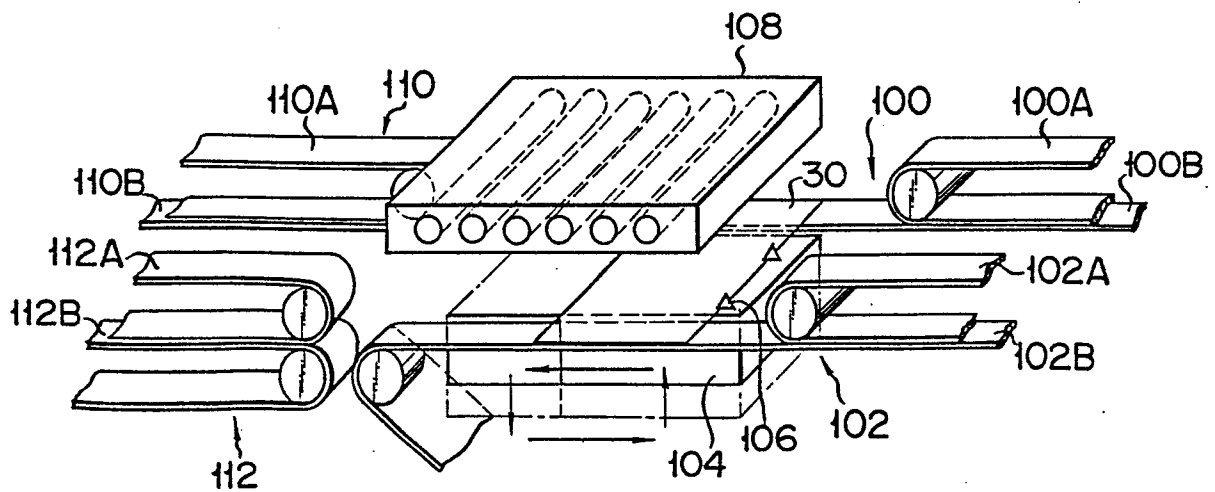


FIG. 11

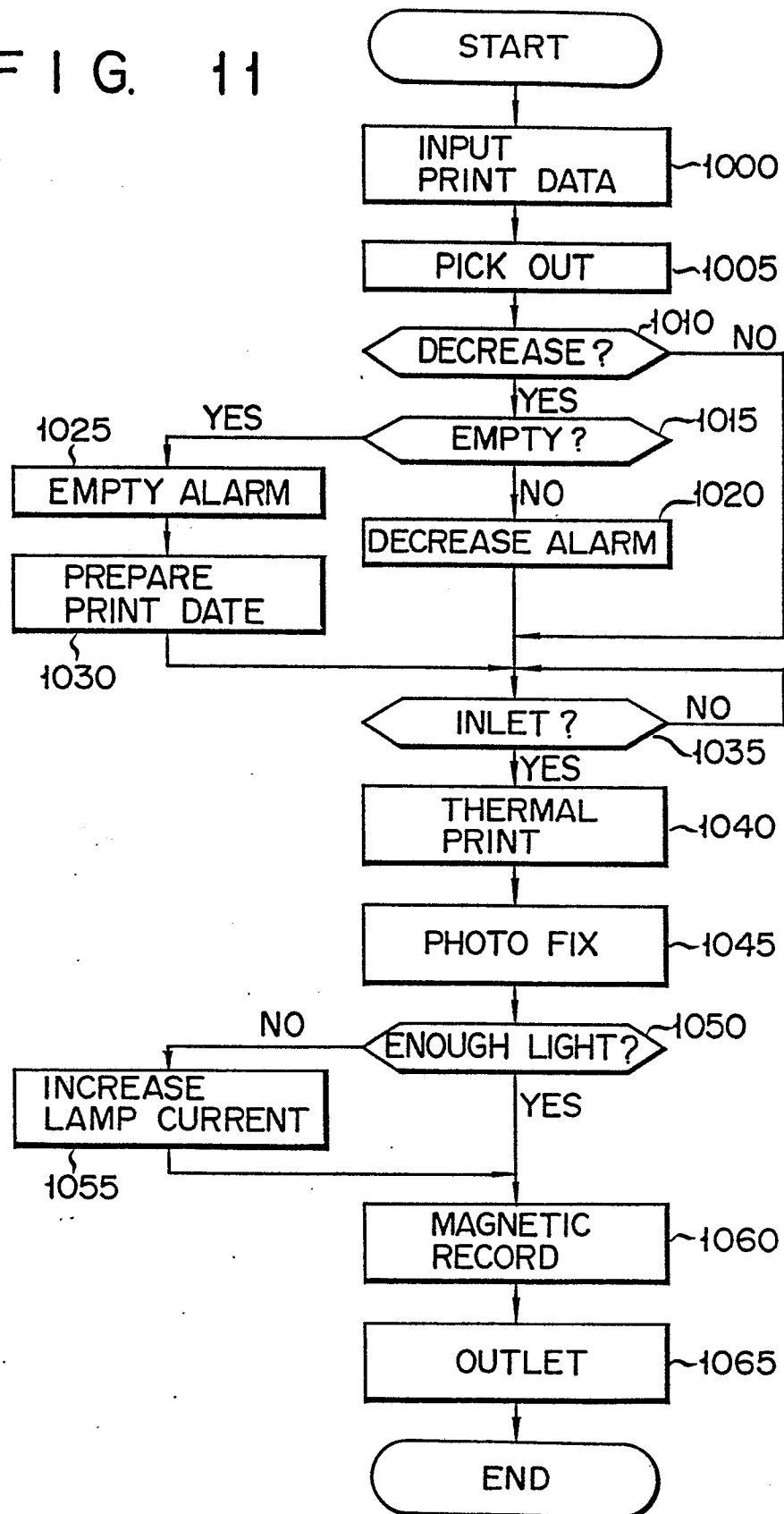


FIG. 12

NUMBER OF TICKETS SOLD	---250
SALES AMOUNT	---2.755\$

FIG. 13

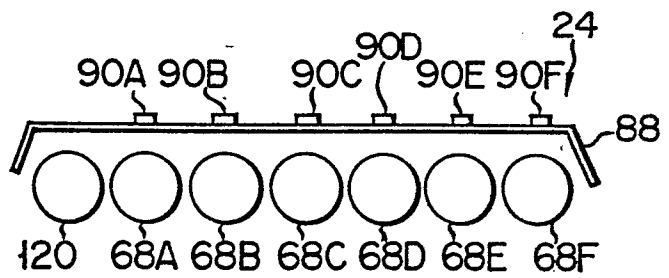
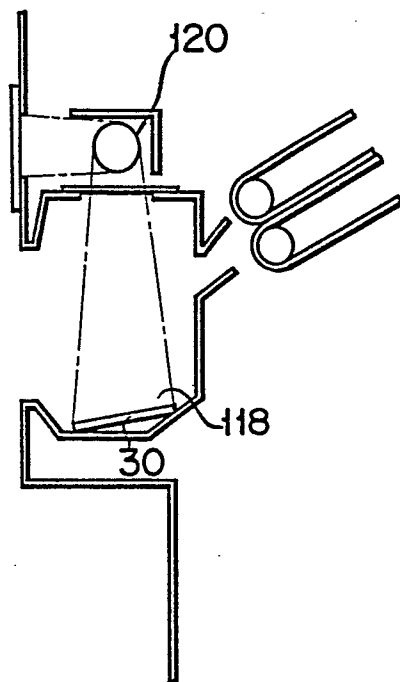
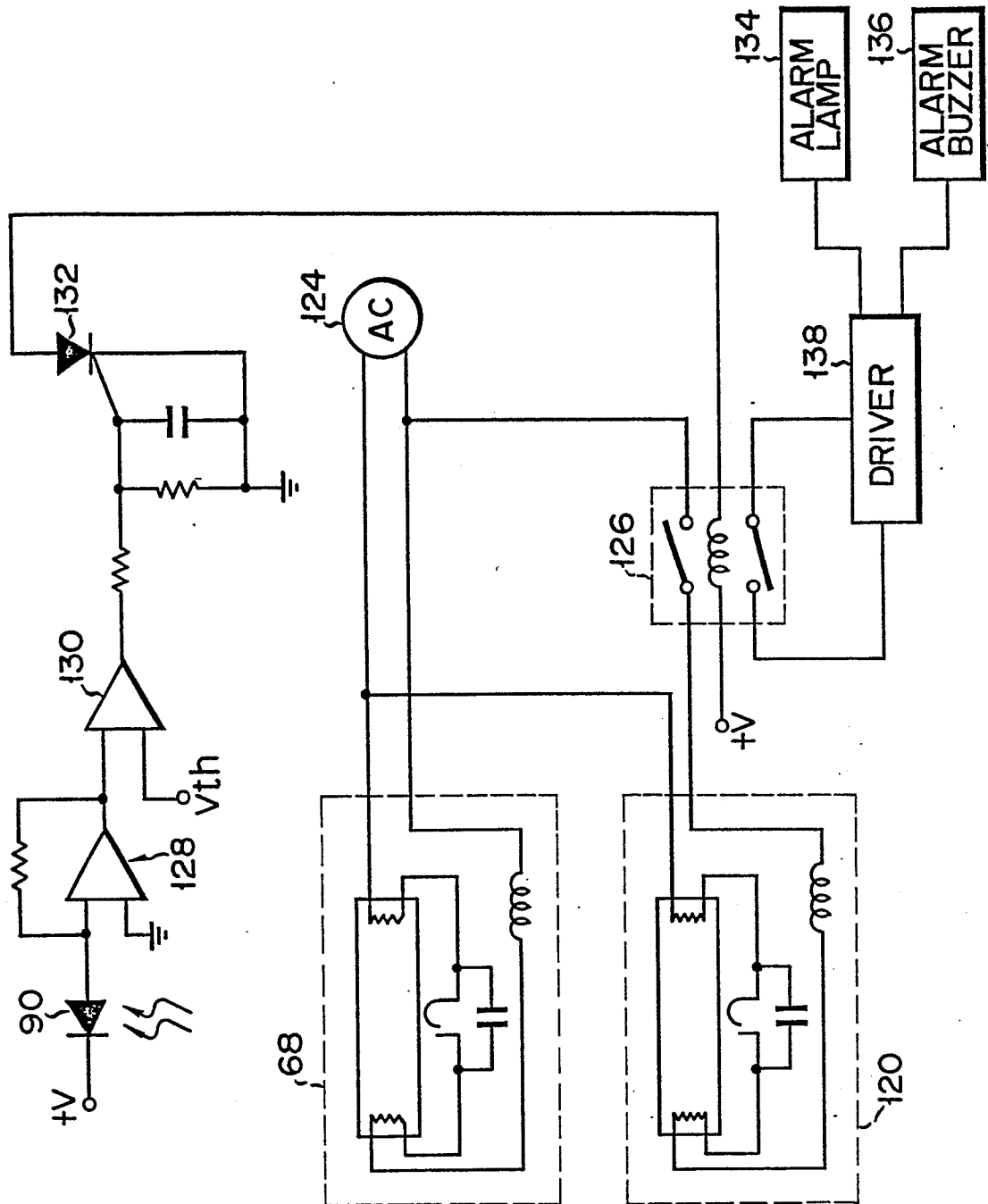


FIG. 14



15-6-F



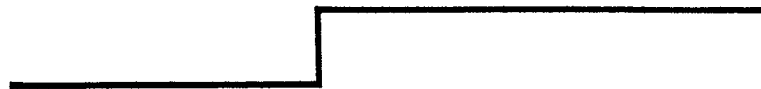
F I G. 16A



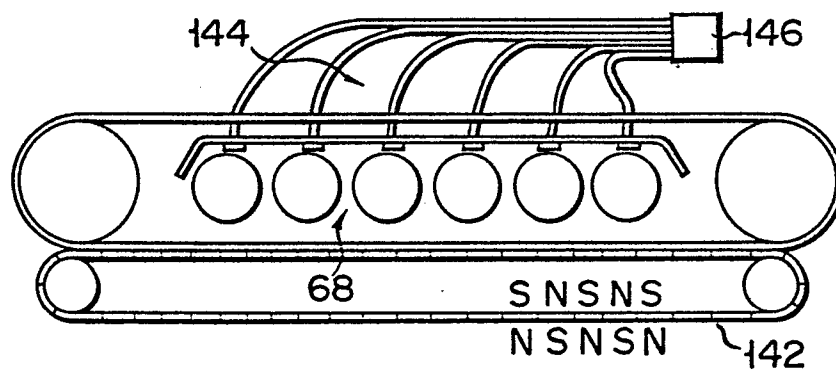
F I G. 16B



F I G. 16C



F I G. 17



F I G. 18

