

July 5, 1960

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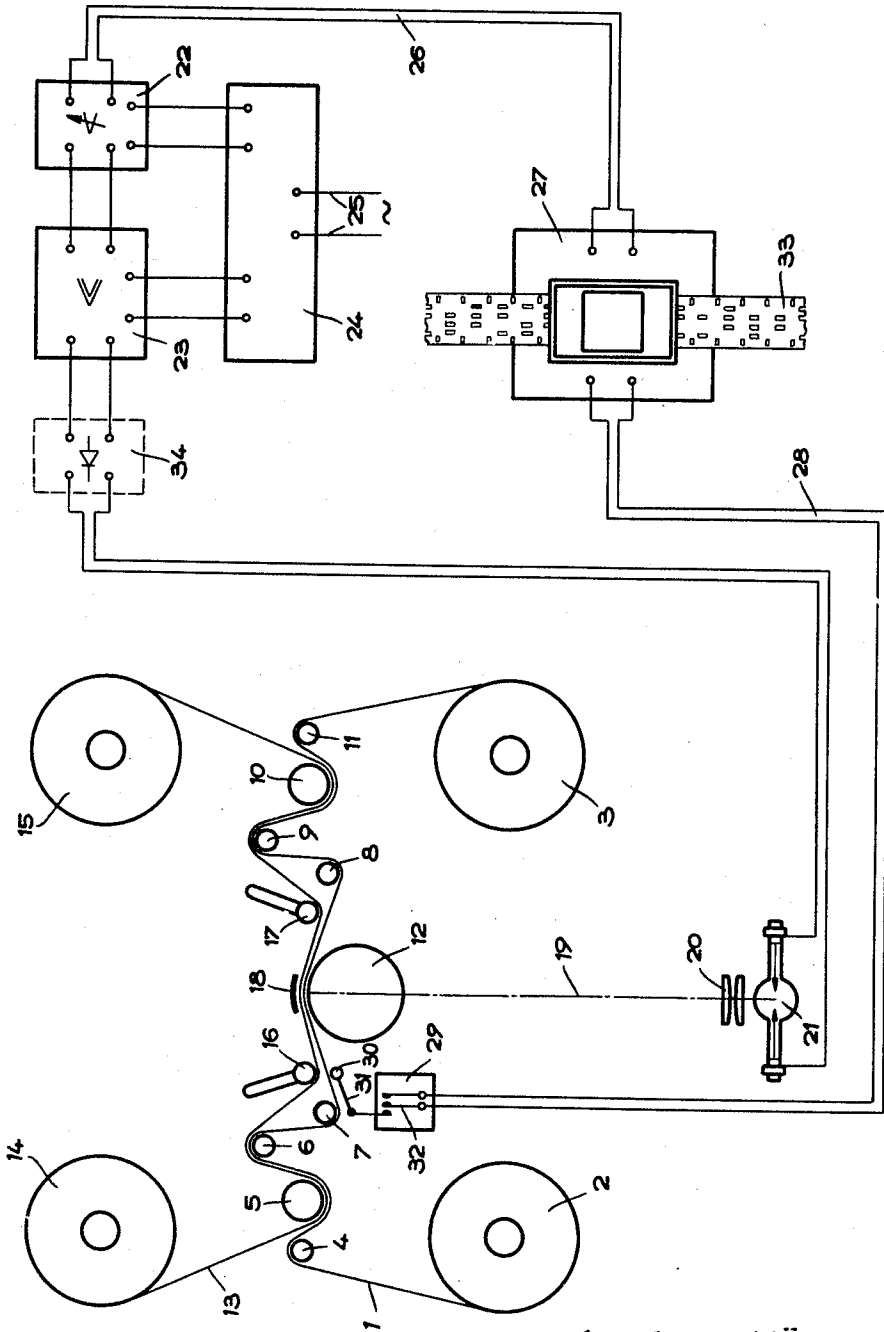
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FILM PRINTING MACHINE

Filed April 22, 1957

2 Sheets-Sheet 1

Fig. 1



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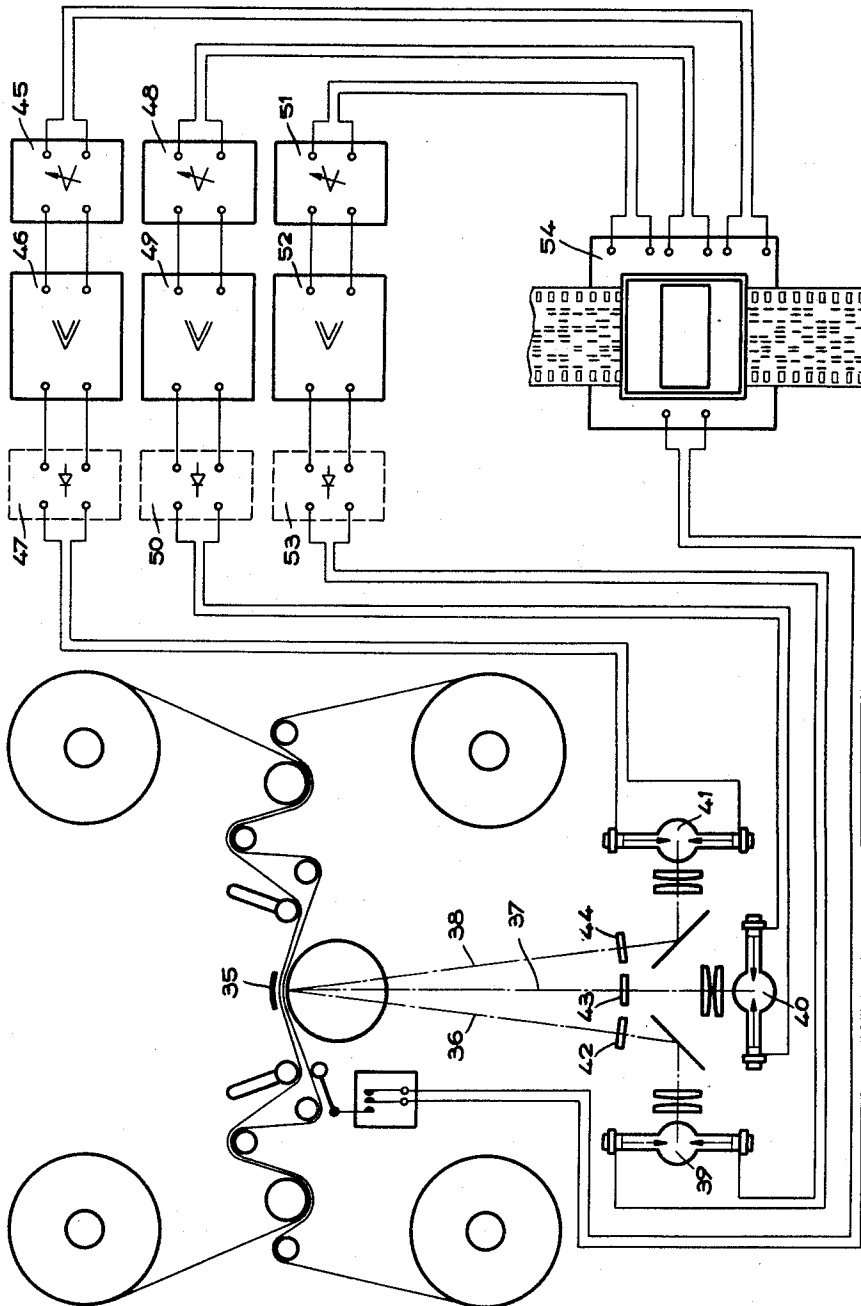
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Fig. 2



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FILM PRINTING MACHINE

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1 Claim. (Cl. 95—75)

The film printing machines of known construction are classified in two categories, the first category comprising those film printing machines which are operated in a step-by-step manner, i.e. the machines of the so-called pull-down claw type, the second category comprising machines which are designed for continuous operation. In the case of machines using the step-by-step principle of operation, even where high-performance machines are involved, it is impossible to attain the output performance of which the continuous-type machines are capable. This is due to the fact that the film feed mechanism must be alternately started and stopped for each individual frame, this action requiring additional time. Furthermore, the step-by-step method subjects the film material to additional stresses which place a limit on the speed at which even a high-performance machine of this type may be operated.

The sources of light used in the heretofore known film printing machines have in the majority of cases been incandescent light bulbs. However, the amount of light produced by such bulbs will follow any changes in operating voltage sluggishly; in most cases, this fact has been taken into account by adjusting the lamps for a fixed maximum amount of radiation and by reducing the strength of illumination by means of masks and/or filters. These, however, are mechanical devices the use of which again introduces inertia effects into the process of controlling the amount of printing light. Moreover, especially in the case of color prints, this method makes it necessary continuously to operate the lamp or lamps at full power, this involving a considerable expenditure of electric energy.

The aforementioned drawbacks inherent in known film printers in which the printing light is subject to fully automatic control are eliminated according to the invention by the use of gas or vapor discharge tubes as sources of light, the said discharge tubes being supplied through inertia-free power and control amplifiers. In contrast to the known sources of light and the known control methods just referred to, the present invention, while affording the aforementioned advantages which are for the most part due to the inertia-free method of control, affords still another advantage which resides in the fact that the spectral range of the discharge tubes will not be shifted appreciably, whereas incandescent lamps are subject to considerable spectral range shifting whenever the operating voltage of such lamps is changed in order to control the printing illumination.

According to a preferred embodiment of the invention, it is possible, where a plurality of discharge tubes are used, as is especially the case where color films are to be printed by the additive process, to associate one power and control amplifier with each of the said discharge tubes.

Where the discharge tubes are to be operated on direct current voltage, the invention, according to another aspect thereof, contemplates the use of rectifiers connected to the output terminals of the respective power-ampli-

2

fiers. On the other hand, also according to the invention, where the discharge tubes are operated on an alternating voltage, the said tubes are operated with a frequency selected in such a manner that differences in exposure are avoided.

These and other objectives and advantages of the invention will be apparent during the course of the following specification, when read in connection with the accompanying drawings, in which:

Fig. 1 is a schematic diagram of a film printing machine for black-and-white films; and

Fig. 2 is a schematic diagram of a film printing machine designed to print color films by the additive process.

In the embodiment of Fig. 1, the negative film copy 1 to be duplicated by printing is unwound from a supply reel 2 and rewound on a take-up reel 3. Between these two reels, the negative 1 is guided by the idler and drive rollers 4 to 11. Disposed between the rollers 7 and 8 is the printing drum 12 which supports that portion of the negative 1 which is being printed.

The positive film material 13 is unwound from a supply reel 14 and rewound on a take-up reel 15. Between these two reels, the film 13 is guided by the drive and idler rollers 5, 6, 9 and 10 which also serve to guide the negative film 1. Two additional rollers 16 and 17 are provided for the purpose of guiding the film 13. At the printing position there is provided a pressure shoe 18 which has the function of bringing the two film strips 1 and 13 into intimate contact at the point at which the printing action occurs. The exposure is effected along the light beam axis 19 by way of a condenser 20, the light being supplied, for example, by a gas discharge tube 21 which is filled with xenon. In the path 19, i.e. the axis of the beam of light, there will be arranged, besides the condenser 20, further suitable optical means serving to collect the light and to distribute the illumination evenly on the film section to be printed; the latter means are, however, not shown in the drawing.

The discharge tube 21 is supplied by way of the control amplifier 22 from the power amplifier 23 in connection with the power pack 24 which latter is connected to the power supply conductors by the wires 25.

The amplifiers 22 and 23 are controlled via the wires 26 by the printing controller 27 which is supplied with pulses produced by a pulse generator 29, which pulses are applied to the printing controller 27 by the conductors 28. The roller 30 associated with the lever mechanism 31 scans the negative film 1 and is arranged to cause the pulse generator to apply the said pulses through the switch contacts 32 whenever suitable notches provided in the negative film 1 pass the roller 30.

Whenever the roller 30 acts upon any of the said notches, the switch control belt or tape 33 of the automatic printing controller 27 is indexed by one step, this causing a control pulse to be applied to the control amplifier 22 by way of the wires 26, the said pulse corresponding to the combination of holes present in the control tape 33 at the respective point.

Thus it will be seen that from the automatic printing controller 27 forward the control of the discharge tube 21 is effected in an inertialess manner since the operation of the amplifiers 22 and 23 is free of any inertia. The absence of any inertia in such a control system makes it possible at all times immediately to adapt the amount of light radiated by the source 21 to the printing conditions prevailing at any given moment. This inertialess mode of operation is of particular advantage in the case of film printers designed for continuous operation, since it permits the film strips to pass the printing zone at a high rate of speed without causing changes in illumination due to switching operations to produce over- or under-exposed frames.

If the roller 30 operating the pulse generator 29 through the linkage 31 is replaced by means serving to scan the negative 1 photo-electrically and arranged to influence the automatic printing controller 27 electrically, all mechanical means are excluded from this part of the control arrangement, and a completely inertialess operation is secured also on the input side of the automatic printing controller 27. It will be seen that the pulse generator 29 whether operated mechanically or photo-electrically pulses printing controller 27 which advances program control tape 33 which varies the intensity of light source 21 through control amplifier 22 and power amplifier 23 in accordance with the sequence of events provided on tape 33. This arrangement is particularly effective in color printing where a plurality of discharge tubes are employed.

Where the discharge tube 21 operates on an A.C. voltage, it is necessary to select the frequency of the said voltage in such a manner as to avoid fluctuations in light intensity which might produce differences in density which occur in the form of transverse strips on the print. To give an example, this condition prevails in the case of a printer operating at a printing speed of 1 metre per second, when the width of the printing slit is 4 millimetres and the source of light operates on a frequency of 1000 cycles per second. In order to introduce a safety factor, the width of the slit should correspond to a multiple summation of the exposure fluctuations produced by the operating frequency so as to compensate for such fluctuations. In the case of a greater or smaller printing speed or with a slit of greater or smaller width, the operating frequency of the printing lamp would have to be linearly changed to adapt it to the changed operating conditions.

It is also possible to operate the discharge tube 21 on a D.C. voltage both for voltage responsive light level control and/or pulsed on-or-off operation. In this case, amplifiers 34 will have to be provided on the output side of the power amplifier 23. Such amplifiers may also be used where a combination circuit organization is used to supply the discharge tube 21, i.e. where the lamp operates under certain base load conditions corresponding to the lowest level of printing light, and where only the regulated portion of the load is controlled by the amplifier.

In the case of the embodiment of Fig. 2, the light beams 36 to 38 of the discharge tubes 39 to 41 strike the printing zone 35. This makes it possible to produce color prints by the additive method, it only being necessary to admit to the printing zone 35 the respective color components of the light produced by the tubes 39 to 41, this being done by means of the filters 42 to 44. In the present case, the discharge tubes 39 to 41 are, for example filled with xenon. However, it is possible to use

any desired other gas or vapor filling for the discharge tubes.

Each of the discharge tubes 39 to 41 has associated therewith its own set of amplifiers 45 to 47, 48 to 50 and 51 to 53, respectively, the controller portions of which are again controlled by the automatic printing controller 54. For the sake of clarity the power supply portions of the amplifier units have been omitted in Fig. 2. The provision of one set of amplifiers for each of the discharge tubes is of advantage in that it is possible to control them individually in an inertialess manner.

It will be understood that modifications and variations may be effected without departing from the spirit and scope of the novel concepts of the present invention.

I claim:

In a film printing machine in which a negative film and a positive film to be printed are caused to travel together, a printing drum for supporting said portion of the negative which is being printed, a pressure shoe for bringing the positive and the negative into intimate contact on the printing portion, a pulse generator scanning the negative film for signal means and applying a pulse according to the signal means by conductors to an automatic printing controller, a program control tape mounted to be shifted forward step-by-step, the shifting movement causing a control pulse according to the program on said control tape at the respective step to be applied by way of wires to an electronic control amplifier, a gas discharge tube disposed to effect the exposure by way of a condenser, said discharge tube being supplied via said control amplifier from a power amplifier and a power pack connected to a power supply by wires, said amplifiers varying the intensity of said discharge tube, said discharge tube being supplied with non-controlled energy at a level corresponding to the lowest level of effective printing light, said discharge tube being additionally supplied during printing with that amount of energy only which corresponds to the range of controlling action.

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