Jan. 20, 1959 J. C. WESTERVELT 2,870,312

FIXER FOR ELECTROSTATIC PHOTOGRAPHY

Filed March 18, 1957

FIG. 1

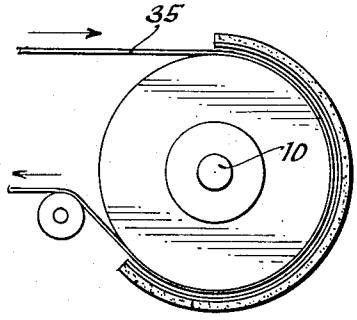


FIG. 2

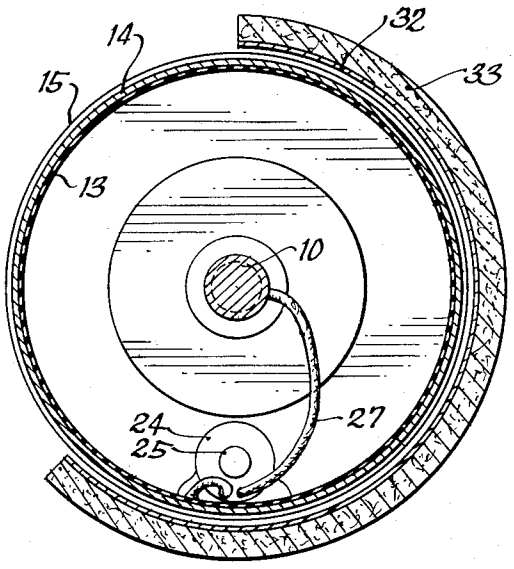
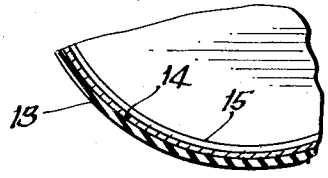


FIG. 4



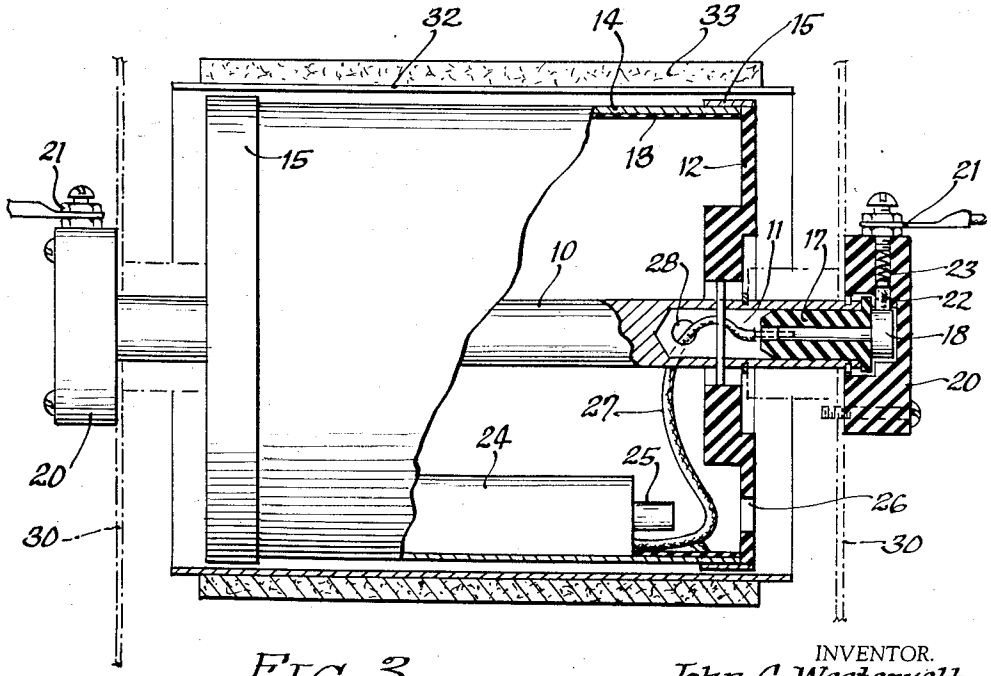


FIG. 3

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FIXER FOR ELECTROSTATIC PHOTOGRAPHY

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1 Claim. (Cl. 219—19)

This invention relates to an improved means for fixing developed images in the art of electrostatic photography.

In the type of electrostatic photography for which my invention is particularly adapted, an electrostatic "charge pattern" is formed on the surface of a special paper, variations in the charge intensity corresponding to areas of light and dark in the optical image to be photographically reproduced. This electrostatic charge pattern is then converted into a visible image by being sprinkled under controlled conditions with a thermoplastic powder, usually called "toner." The toner adheres to the paper surface in varying density according to the charge distribution thereon, resulting in a faithful monochrome reproduction of the optical image originally projected on the paper.

It is the major object of my invention to provide an improved means for "fixing" the toner powder thus applied to the paper surface, in order to achieve a permanent visual record and to prevent the toner from being mechanically dislodged from the paper surface by subsequent handling, contact with other objects, etc.

Various means have been employed in the prior art for fixing developed electrophotographic images, all involving the application of heat to fuse the toner and hence to bond it to the paper carrier. Among the expedients resorted to for this purpose in the prior art have been application of radiant heat, hot-air blasts, and baking in suitable ovens. All of these techniques have been successful to some degree, but they have all possessed serious disadvantages.

In the case of fixing by radiant heat, extremely precise timing has been necessary to achieve the desired fusion of the toner without charring the paper carrier.

Fixing by the use of hot-air blasts has required uneconomical amounts of powder in applications wherein fixing had to be accomplished at relatively high speeds.

Baking procedures, while reasonably satisfactory and economical for intermittent or "batch" operations, do not lend themselves well to continuous processes.

In the present invention, I have provided an apparatus for fixing electrophotographic images continuously under conditions of precise temperature control, eliminating all danger of charring the paper. The achievement of this desirable result is another object of my invention.

Still another object of my invention is to provide an apparatus for fixing electrophotographic images recorded continuously on an elongated strip of paper carrier, my apparatus being capable of developing such images continuously with low power consumption, under precisely controllable conditions, and with no danger to the operator.

The foregoing and other objects of my invention will be clear from a study of the following detailed description of a typical embodiment thereof.

Broadly considered, my invention consists of a cylindrical drum having, on or immediately within its outer surface, a homogeneous electrical heating element, the

temperature of which can be adjusted with great precision to heat the drum sufficiently to fuse the toner quickly but below the charring temperature of the paper carrier. The drum is mounted for rotation and normally will be turned continuously during the fixing procedure. Because of the precise temperature control achievable with my invention, however, the drum can be stopped during operation for long periods of time without any damage either to the paper or to the images in contact with the drum during such periods of stoppage.

Because my invention is so well adapted for fixing electrophotographic images in a continuous operation, it is particularly well suited for use in the field of electrophotographic oscillography, wherein oscillographic traces are recorded on a long strip of paper fed continuously off of a stock roll, through the oscillograph, and onto a storage roll.

In the accompanying drawing, I have shown my invention in a form adapted for such applications. Figure 1 of the drawing is a diagrammatic end view of my fixer drum, bringing out the manner in which the elongated strip of image-carrying paper is fed around the drum and carried off to storage. Fig. 2 is a transverse sectional view of my fixer drum, Fig. 3 is a side view, partly in axial section, bringing out a number of structural details, and Fig. 4 is a fragmentary sectional view showing an alternative construction.

In the Fig. 1 form of the invention, the drum is mounted on a central shaft **10** bored axially at each end to provide cylindrical recesses **11**. The drum proper comprises a pair of end pieces **12** suitably secured and keyed to the shaft **10** in any desired manner. The end pieces **12** may be formed of any suitable heat-resistant materials, but at least the outer portions of the end plates **12** should be made of electrically insulating material.

The shell of the drum comprises a cylindrical support member **13**, which may be made of any electrically nonconducting material capable of withstanding the normal operating temperatures, coated by a layer of electrically resistive material **14**, uniformly distributed over the entire outer surface of the supporting shell **13**.

The film **14** is formed of a blend of thermosetting resins and metallic pigments providing a homogeneous heating element uniformly distributed over the outer surface of the drum. Various materials suitable for film **14** are obtainable commercially, one suitable type being that which is manufactured and sold by Electrofilm Corporation of North Hollywood, California. In addition, other suitable materials for making the resistance film **14** have been developed in connection with the printed-circuit art and are being used in the radio industry for making resistive circuit elements.

Since the particular composition of the resistance film **14** is not per se a part of the present invention, no detailed description of its composition or manner of preparation need be included herein. For information bearing on the preparation of such films, reference may be had to Product Engineering, issue of October 1953, and to National Bureau of Standards Circular 530 entitled "Printed Circuit Techniques."

At each end of my fixer drum I provide a metallic band **15**, formed of copper, brass, or other highly conductive metal, the function of which is primarily to insure uniform flow of electric current through the entire surface of resistance film **14**. Bands **15** also provide mechanical protection and reinforcement for the edges of the film **14**. The bands **15** may be secured over the outer surface of the drum in any suitable manner, such as shrink fitting.

Into each of the cylindrical recesses **11** at the respective ends of shaft **10**, I provide an insulating plug **17**, having a central aperture in which is carried a conduct-

ing element 18 formed at its outer end with a cylindrical head through which electrical current may be passed during rotation of the drum.

The ends of the shaft 10 are received in journal boxes 20, formed of insulating material and bored to receive threaded contact terminals 21 and brushes 22. The brushes 22 are urged into contact with the metal members 18 by means of compression springs 23.

Carried within the drum is a thermostat device 24 which, in a manner well known to the art, controls the current fed to resistance element 14 to maintain its temperature at a desired level. Thermostat 24 may be fixed as to temperature characteristics, or it may be provided with adjustment means 25 accessible through aperture 26 in one of the end plates 12.

Suitable electrical conductors 27 are provided within the drum to afford electrical connection between the bands 15 and the metal contact elements 18, the thermostat 24 being normally wired in series between one of the bands 15 and its corresponding contact element 18. Apertures 28 are provided in the shaft 10 near the inner ends of the recesses 11 to accommodate the conductors 27.

It will of course be understood that the journal boxes 20 are rigidly secured to the supporting frame 30 on which the apparatus is mounted.

Mounted also on the frame 30 in any suitable manner (not shown) I provide an arcuate baffle 32, preferably covered by a layer of thermal insulating material 33. Baffle 32 closely overlies the drum around the major portion of its circumference, serving the dual functions of reducing heat loss and protecting the operator from danger of burning.

In the operation of my invention, a suitable source of electric current is connected to the terminals 21, and the film 14 thereupon rapidly heats up to the desired temperature, under the control of thermostat 24, the temperature being selected at a value sufficient to fuse the toner without charring the paper being passed around the drum. The paper, indicated on Fig. 1 with the reference numeral 35, is passed around the drum at whatever speed the conditions of use of the electrophotographic apparatus may require. Since the drum is held at a temperature which cannot damage the paper, it is not necessary with my invention to keep the paper moving continuously, and the speed of advance of the paper may be any speed desired, so long as it is not so great as to pass the paper completely around the drum before the toner has had time to fuse. In practice, with a typical embodiment, I have found that the speed of advance may range between ⅛ inch per second and 8 inches per second without necessity for changing the thermostat adjustment.

Since the paper is normally driven through the apparatus by a driving means responsive to some parameter of the data being studied, it is not necessary to provide independent means for driving the drum, the paper itself

performing that function. Obviously, however, should any specific application require it, an independent drive motor may be provided for turning the drum.

In Fig. 4 I show an alternative construction in which the relative positions of the shell member 13 and the homogeneous resistance element 14 are reversed; that is, the resistance element 14 is disposed on the inner surface of shell 13. In this form of the invention, the bands 15 are disposed on the inside of the resistance element 14, serving the same functions as in the Fig. 1 embodiment.

The Fig. 1 and Fig. 4 arrangements work in essentially the same manner. The Fig. 4 embodiment has the advantage that the resistance element is protected from mechanical damage, as by scratching. Since the shell 13 is thin, its temperature follows that of resistance element 14 very closely, with negligible time lag.

While I have in the present specification described in considerable detail a typical embodiment of my invention, it should be understood that that description is illustrative only, and the scope of my invention should be determined primarily by reference to the appended claim.

I claim:

In combination with an elongated paper sheet carrying electrophotographic images defined by toner powder distributed non-uniformly over one surface thereof, said toner powder having an optimum fusion temperature and said paper having a characteristic charring temperature somewhat higher than said fusion temperature, apparatus for fixing said images on said sheet comprising a cylindrical drum having a homogeneous film of electrically resistive material uniformly deposited over its outer surface, electrical contact means at the respective peripheral edges of said film for feeding electric current uniformly therethrough, thermostat means carried within the drum closely adjacent the inner side of said film, circuit means interconnecting said thermostat means and said film for controlling the quantity of electric current through said film to maintain its temperature above said fusion temperature and below said charring temperature, and means for advancing said sheet progressively relative to the outer surface of said drum, said drum being disposed with its outer surface in contact with the other surface of said sheet and being mounted to revolve as said sheet is advanced.

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