April 27, 1965 T. C. MURRAY ETAL 3,180,971

XEROGRAPHIC FUSING APPARATUS

Filed Oct. 1, 1962 3 Sheets-Sheet 1

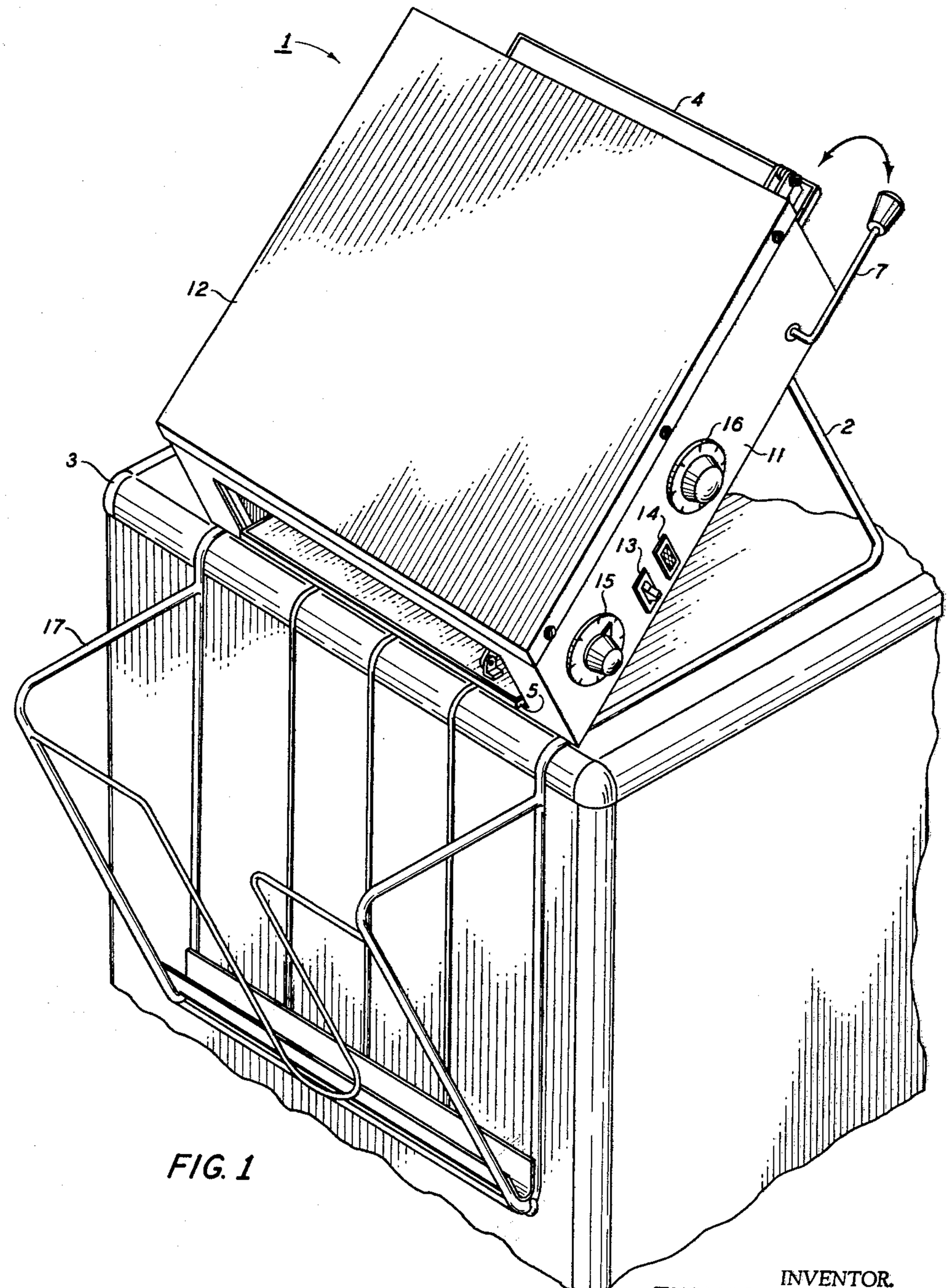

FIG. 1

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XEROGRAPHIC FUSING APPARATUS

Filed Oct. 1, 1962 3 Sheets-Sheet 2

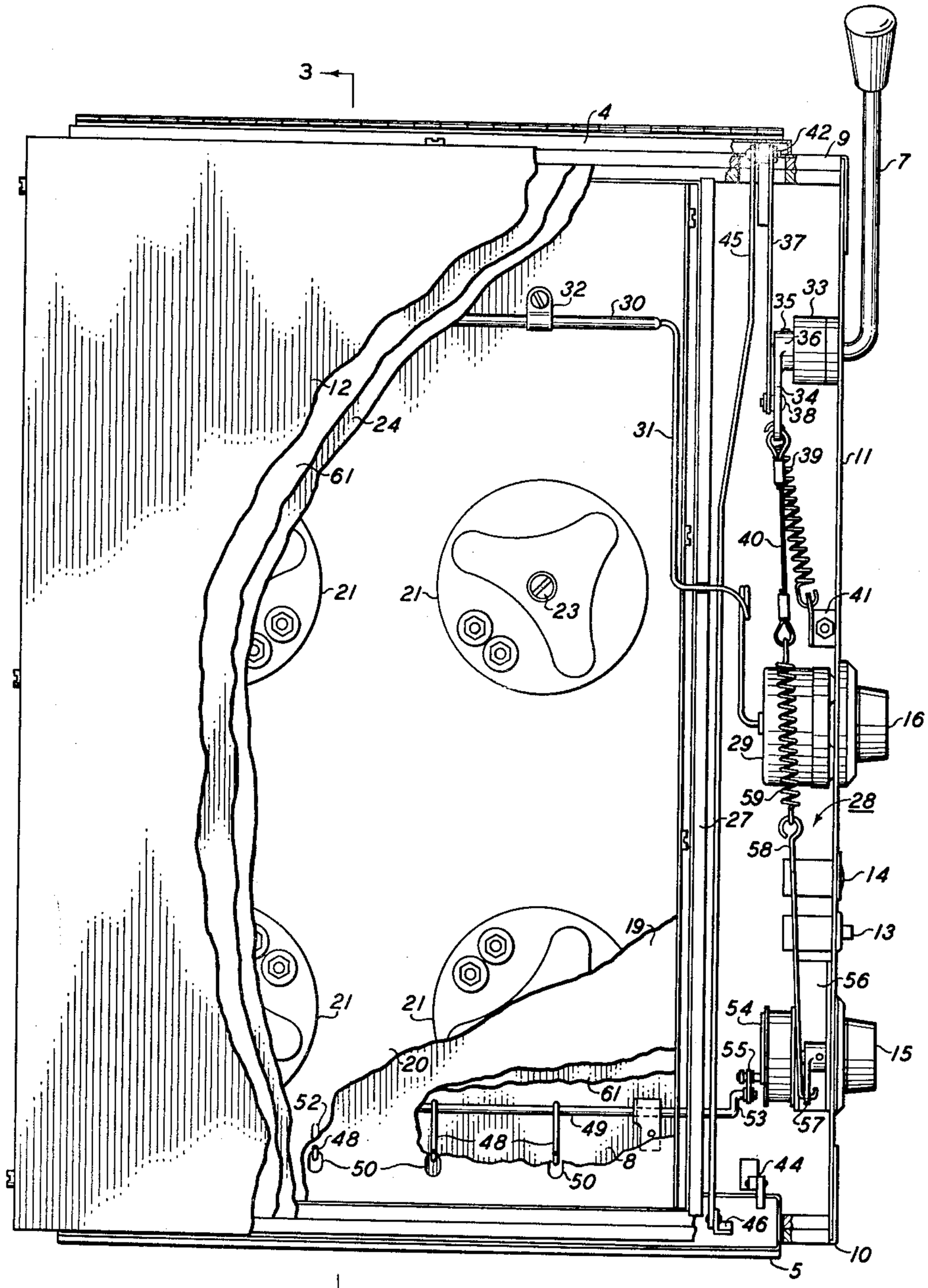

FIG. 2

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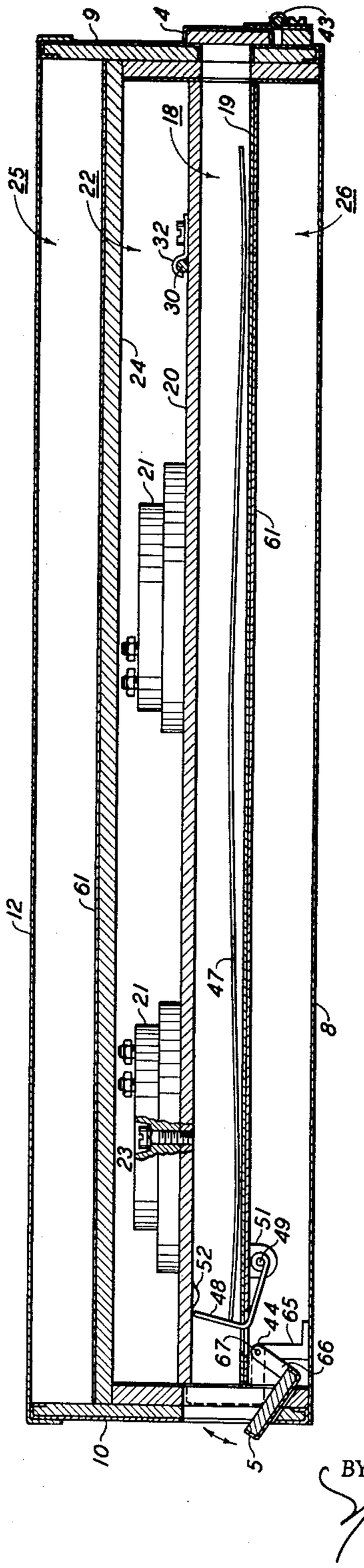

FIG. 3

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XEROGRAPHIC FUSING APPARATUS

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3 Claims. (Cl. 219—216)

This invention relates to improvements in fusing apparatus and particularly to fusing devices for permanently bonding xerographic powder images to paper and to either paper or metal lithographic masters.

More specifically, the invention relates to an improved fusing device that will accept a sheet of material with an image to be fused, and, after a predetermined length of time, eject the sheet of material with the image bonded thereon. Although the invention is considered to have general application wherever material of any type must be heated to a required temperature for a specific length of time, it is particularly useful in the field of xerography and has an important application in the fusing of resinous powder images deposited on sheets of paper, or the like, and retained thereon by electrostatic latent charge. Therefore, for convenience of illustration, the invention is described with reference to its use as a heat fuser for xerographic powder images. However, it is to be understood that it may be employed with equal facility in other fields.

In the xerographic process, a light image of the copy being reproduced is flashed onto the electrostatically charged surface of a xerographic plate. The plate comprises a layer of photoconductive insulating material on a conductive backing. The area of the plate exposed to light, discharges the electrostatic charge leaving a latent electrostatic charge opposite to that of the plate. The plate is then exposed to a toner material containing an electrostatic chcarge opposite to that of the plate. The toner material adheres to the plate in the areas containing the electrostatic charge, thus producing a powder image of the copy being reproduced. This powder image is then transferred to a support material, such as paper or a lithographic master. The process of exposing and developing the xerographic plate is more fully described in the copending application S.N. 227,340, filed October 1, 1962. The process of transferring the powder image from the plate surface to a sheet of support material is described in the copending application of S.N. 234,686, filed November 1, 1962. For the purposes of this application, it is sufficient to note that the image is transferred by placing a sheet of support material in contact with the powder image on the plate surface and charging the surface with an electrostatic charge of the same polarity as the original charge on the plate surface. When the support material is removed from the plate surface, the powder image adheres thereto by means of the electrostatic charge.

The basic process of xerography is described in Carlson Patent 2,297,691, issued October 6, 1942. It is noted in the Carlson patent that a variety of types of finely divided electroscopic powders may be employed for developing electrostatic latent images. However, as the art of xerography has progressed it has been found preferable to develop line copy images with a powder or toner formed of any of a variety of pigmented thermoplastic resins that have been specifically developed for the purpose. These resinous powders are specifically compounded for producing dense images of high resolution and to have characteristics permitting convenient storage and handling. Such developing materials are compounded to permit them to be fixed or bonded to the surface of a transfer material either by heat fusing or vapor fusing techniques, in accordance with the particular application in which they are

employed. The individual particles of resin soften and coalesce when heated or plasticized by solvent, so that they become sticky and readily adhere to the surface of the transfer material.

In order to fuse resinous powder images, it is necessary to heat the powder, and the paper to which it is to be fused, to a relatively high temperature. The temperature must be kept fairly constant, if the temperature fluctuates too low or the time that the support material is exposed to the temperature is too short, the resinous powder will not properly adhere to the support surface; and if the temperature is too high or the time of exposure too long, there is a tendency for the support material to discolor or scorch.

Existing commercial fusing equipment usually consists of either an oven where the support material is placed on a plate and is inserted into the oven and manually withdrawn after a predetermined length of time, or as in automatic xerographic reproducing machines, the support material is carried on a belt or conveyor mechanism past a heat fuser at a predetermined rate. The present invention encompasses an oven wherein the support material may be inserted into the oven and will automatically be ejected at the proper time. There is no requirement of an automatic conveyor or any manual timing process by the operator.

It is therefore the primary object of this invention to improve apparatus used to bond resinous powder images to a support material surface.

It is a further object of this invention to improve heat fusing apparatus so that a sheet of material containing a resinous powder image may be inserted into an oven by an operator and be automatically ejected without any further act on the part of the operator.

It is a further object of this invention to provide a heating oven wherein the material heated in the oven is ejected at the termination of a predetermined length of time.

It is a further object of this invention to provide heat fusing apparatus that permits insertion of the material to be fused into an oven without being deflected by escaping warm air.

It is a further object of this invention to provide heat fusing apparatus with an inclined heating chamber that does not lose appreciable amounts of warm air when material is inserted into the chamber.

These and other objects of the invention are attained by means of an oven containing an entrance door which when opened sets an automatic timer. The material to be fused is inserted into said oven and the timing device opens means provided at the opposite end of the oven to permit the material to pass by gravity through an exit opening. An entrance door and an exit door are provided so that one door is closed at all times preventing a rush of warm air out the entrance opening when material is being inserted.

The invention is disclosed in the appended drawings, in which:

FIG. 1 is an isometric view of a preferred embodiment of the present invention;

FIG. 2 is a detailed planned view of the present invention with parts broken away to show the internal structure of the heat fuser;

FIG. 3 is a detailed sectional view taken along line 3—3 of FIG. 2.

For the purpose of illustration, the heat fuser described herein is shown, as in FIG. 1, as a table top or desk-type heat fuser. Although size is not a limitation, the preferred embodiment shown in FIG. 1 is capable of receiving any standard size sheet of paper and paper or metal lithographic masters. The heat fuser, generally designated 1, is supported by a support stand 2, mounted

on a desk or table 3. The fuser 1 is generally of box-like configuration and mounted on support stand 2 at an angle of approximately 50 degrees with the horizontal.

The fuser 1 consists of a receiving door 4 mounted in the elevated end of the fuser, and a discharge door 5 located in the lower end of the fuser. The receiving door 4 is operated by means of handle 7 and the discharge door 5 is connected to the receiving door 4 through a door linking rod 45, as seen in FIG. 2. The fuser is enclosed by a top panel 12, a bottom panel 8, a receiving end panel 9, a discharge end panel 10 and a pair of side panels 11. Mounted in the side panel 11 is a heater switch 13, an indicator light 14, a calibrated timer dial 15, and a thermostat dial 16.

The support stand 2, may be of any convenient type of stand to support the fuser at the appropriate angle. The stand shown herein consists of metal rods bent in a manner to support the fuser in the desired position, and is integral with a metal basket 17 located beneath the discharge door 5 so as to receive the material ejected from the fuser.

Referring now to FIGS. 2 and 3, there is shown the internal structure of the fuser wherein a passageway 18, referred to herein as the fusing chamber, extends through the fuser from receiving door 4 to discharge door 5. Fusing chamber 18 extends substantially across the width of the fuser and is enclosed by a flat stainless steel plate 19 on the bottom and sides, and on the top by an aluminum plate 20. Mounted on the top of plate 20 are a plurality of heating elements 21. Heating elements 21 are located in chamber 22 and are fastened to the aluminum plate 20 by means of bolts 23. These heating elements may be of any conventional design such as resistance coils or as shown herein, commercially obtainable ring heaters, and are approximately positioned on plate 20 to provide a uniform temperature level throughout chamber 18. Heating elements 21 and chamber 22 are separated from top panel 12 by means of transit sheet 24 and air space 25. The fuser bottom panel 8 is separated from the fusing chamber 18 by air space 26. Air spaces 25 and 26 may be filled with any suitable bulk-type insulation, such as fiber glass or, as shown herein, by a reflective insulation, such as aluminum foil 61. The size of air spaces 25 and 26 and the type and amount of insulation provided therein is determined by the operating temperatures of heating elements 21 and chamber 18, so that the temperature of panels 12 and 8, do not exceed a safe working temperature. The amount of insulation used in chamber 25 may be reduced or the temperature in chamber 22 may be increased without producing an unsafe condition merely by using a protective shield over panel 12. End panels 9 and 10, side panel 11 and interior wall 27 are also suitably insulated to retain the heat in chamber 18 and to maintain the temperature of the exterior portion of the heat fuser at a safe working level.

A compartment 28 is provided between the exterior side cover 11 and the interior wall 27. The compartment 28 contains the body of heat switch 13, controlling heater elements 21 and indicator light 14, which provides a visual indication that the heater elements are operating. The temperature in chamber 18 is controlled by means of thermostat 29 operatively connected to control the heat output of elements 21. Thermostat 29 has a thermostat expansion bulb 30 located in chamber 22 and held in intimate contact with aluminum plate 20 by means of brackets 32. The expansion of volatile fluid in bulb 30 is relayed to thermostat 29 through tubing 31, and thermostat 29 is set to respond to any desired temperature by means of thermostat dial 16. Dial 16 is shown herein as located on the exterior surface of side panel 11, however, it may be desirable in certain installations to locate thermostat dial 16 within compartment 28, thus preventing the possibility of accidentally increasing the temperature in chamber 18. For most operations, it will be found desirable to pre-set the temperature dial 16 and vary the time which material is left in chamber 18, rather than varying the temperature of chamber 18.

The door handle 7 is mounted in bearing member 33 which in turn is rigidly mounted on the interior side of wall 11. On one end of handle 7, located in compartment 28, is a collar 36 containing a lever arm 34 and secured to the end of handle 7 by means of a pin or set screw 35. The lever arm 34 is pivotably connected to a bar or rod 37 by means of pin 38, and to a tension spring 39, which is coupled to bracket 41 mounted on wall 11. The bar member 37 is pivotably connected to receiving door 4 by means of pin 42 so that movement of handle 7 in a downward direction, as seen in FIG. 1, produces an angular movement of lever arm 34 which is transmitted through bar member 37 and pin 42 to receiving door 4. Receiving door 4 pivots in a downward direction about hinge assembly 43.

The movement of receiving door 4 is transmitted through rod 45 to the discharge door 5. Rod 45 is pivotably connected to bracket 46 which is fastened to discharge door 5. Discharge door 5 pivots in a downward direction about two hinge assemblies 44 positioned on each side of door 5. Hinge assembly 44 consists of a brace 65 fastened to the bottom cover 8 and a bracket 66 connected to door 5. Bracket 66 is rotatably attached to brace 65 by pin 67. Receiving door 4 normally is in a closed position and discharge door 5 is normally in an open position, both as seen in FIG. 3. The discharge door and receiving door cannot be open at the same time. If both doors were open at the same time warm air in chamber 18 would rise upward and out of top opening in chamber 18, thus producing a movement of air at the receiving end of chamber 18 that would interfere with the paper or support material being inserted therein. The support material is commonly quite flexible and as one end is being inserted into chamber 18, the draft arising out of the chamber would tend to deflect the end of the support material, making the actual insertion quite difficult. Therefore, as receiving door 4 is opened, discharge door 5 is closed, preventing any flow of air through the fuser. After handle 7 is released from its down position, it is returned to its original position by means of spring 39 fastened to lever arm 34. At the handle returns to its normal position, receiving door 4 is closed and discharge door 5 is opened.

The paper or support material 47 located in chamber 18 is retained therein by means of a series of wire fingers 48 mounted on a shaft 49 and passing through openings 50 in plate 19. The shaft 49 is mounted on a bracket 51 fastened to the underside of plate 19. The fingers 48 are bent at right angles, as seen in FIG. 3, with one side of the angle passing upward through openings 50 to a position near or in contact with plate 20. As support material 47 is placed in chamber 18, there is occasionally a tendency for the support material to hug the top of chamber 18 and tend to ride over the top of fingers 48. To prevent this from occurring, a series of small indentations 52 have been made in the top of plate 20 along a path parallel to and just in front of fingers 48. The indentations in plate 20 result in a series of projections, in chamber 18 that will deflect the paper or support material downward onto fingers 48. Alternatively, a series of small holes could be provided in the top plate 20 to accommodate the fingers 48 thus eliminating any gap between the top of the finger member and the top plate.

The shaft 49, holding fingers 48, contains a crank arm 53 which is connected to mechanism timer 54 through linkage 55. The timer 54 is operated by a lever arm 57 mounted on the timer shaft, and is connected to the lever arm 34 of the door handle 7, by means of a flexible wire member 40, a tension spring 59 and a connecting rod 58. As the handle 7 is rotated, the movement is transmitted from the lever arm 34, to lever arm 57, through the intermediate linkage, and produces a rotational movement. The rota-

tional movement of lever **57** winds and sets the timer **54**, which in turn, after the lapse of the predetermined time, activates linkage **55** and crank **53** causing rotation of shaft **49**. As the shaft **49** is rotated, the fingers **48** are withdrawn from chamber **18**, permitting the support material **47** to pass under its own weight out of chamber **18** into basket **17**. When the receiving door is again opened, the timer mechanism is rewound and fingers **48** are moved through openings **50** into chamber **18**. The linkage system shown for rotating lever **57** is one embodiment of many possible variations. For example, if a larger rotational movement is desired to produce a greater winding and a longer time interval for timer **54**, then a flexible member may be attached from lever arm **34** to a rotatable drum in place of lever **57**, and wrapped around the drum so that movement of handle **7** would produce an unwinding of the flexible member from the drum, producing the desired degree of rotation. In this method, the degree of rotation is determined by the length of lever arm **34** and the angular movement of handle **7**. The timer **54**, shown herein, is a conventional mechanical timer with a 0–1 minute time interval.

In operation, the heating elements **21** are energized through switch **13** and the desired temperature of chamber **18** is set on thermostat dial **16**. After a lapse of time to allow chamber **18** to reach operating temperature, usually 10–15 minutes, and the amount of time that the support material is to remain in chamber **18** is set on timer dial **15**, the handle **7** is rotated in a clockwise direction as seen in FIG. 1, setting timer **54** and opening receiving door **4** and closing discharge door **5**. Support material **47**, containing a resinous powder image, is inserted through the fuser opening at the receiving door **4** into chamber **18** and is retained therein by means of fingers **48**. The handle **7** is released, spring **39** returns it to its normal position and closes receiving door **4** and opens discharge door **5**. At the termination of the time lapse set on timer dial **15**, the timer **54** actuates linkage **55** and crank arm **53** rotating shaft **49**, thus pulling fingers **48** through openings **50** into chamber **26**. The support material **47** is no longer retained by fingers **48** and passes under its own weight through the exit opening into basket **17**. The resinous powder image contained on the support material **47** has been tackified and bonded to the support material producing a permanent image thereon. This operation may be repeated for subsequent sheets of support material.

Although the invention is described herein as used for bonding resinous powder images to a support material surface, it will be apparent to those skilled in this or related arts, that it may readily be applied to any system in which it is required to heat material to a predetermined temperature for a predetermined length of time. Therefore, since changes could be made in the above construction, and different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the specification and drawings be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. Apparatus for fusing xerographic powder images to a support material surface including:

an inclined heating chamber with an opening in the upper and lower ends and inclined at an angle to the horizontal sufficient to permit a sheet of support material inserted in the opening at the upper end to be gravity fed through the chamber and out the opening at the lower end,

means to heat the chamber to a temperature sufficient to fuse a xerographic powder image to a sheet of support material and including means to control the temperature of the chamber,

a plurality of finger-like elements supported on a movable member adjacent the heating chamber and extending into the chamber and traverse the path of movement of a sheet of support material through the chamber,

an automatic timing device operatively connected to the movable member to withdraw the finger-like extensions from the path of movement of the support materinal after a predetermined time interval,

and means to initiate operation of the automatic timing device prior to insertion of a sheet of support material into the heating chamber.

2. Apparatus for fusing xerographic powder images to a support material surface including:

an inclined heating chamber with an opening in the upper and lower ends and inclined at an angle to the horizontal sufficient to permit a sheet of support material inserted in the opening at the upper end to be gravity fed through the chamber and out the opening at the lower end,

means to heat the chamber to a temperature sufficient to fuse a xerographic powder image to a sheet of support material and including means to control the temperature of the chamber,

a normally closed entrance door operatively associated with the opening in the upper end of the heating chamber,

means to open said door for the insertion of a sheet of support material into the heating chamber,

retaining means mounted in said chamber to hold a sheet of support material in the chamber during fusing of the pwder image,

an automatic timing device operatively connected to the retaining means to release the support material for continued passage through the chamber after a predetermined time interval,

and a linkage member connected between the entrance door and the automatic timing device to initiate operation of the timing device upon the opening of the entrance door.

3. The apparatus of claim 2 also including:

a normally opened exit door operatively associated with the opening at the lower end of the heating chamber and including a linkage member connected between the entrance door and the exit door to close the exit door upon opening of the entrance door thereby minimizing the loss of heat from the heating chamber when the entrance door is open.

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