Dec. 5, 1967 R. E. ZIMMER 3,355,815

DRYER FOR PHOTOPRINTS

Filed June 22, 1966 3 Sheets-Sheet 1

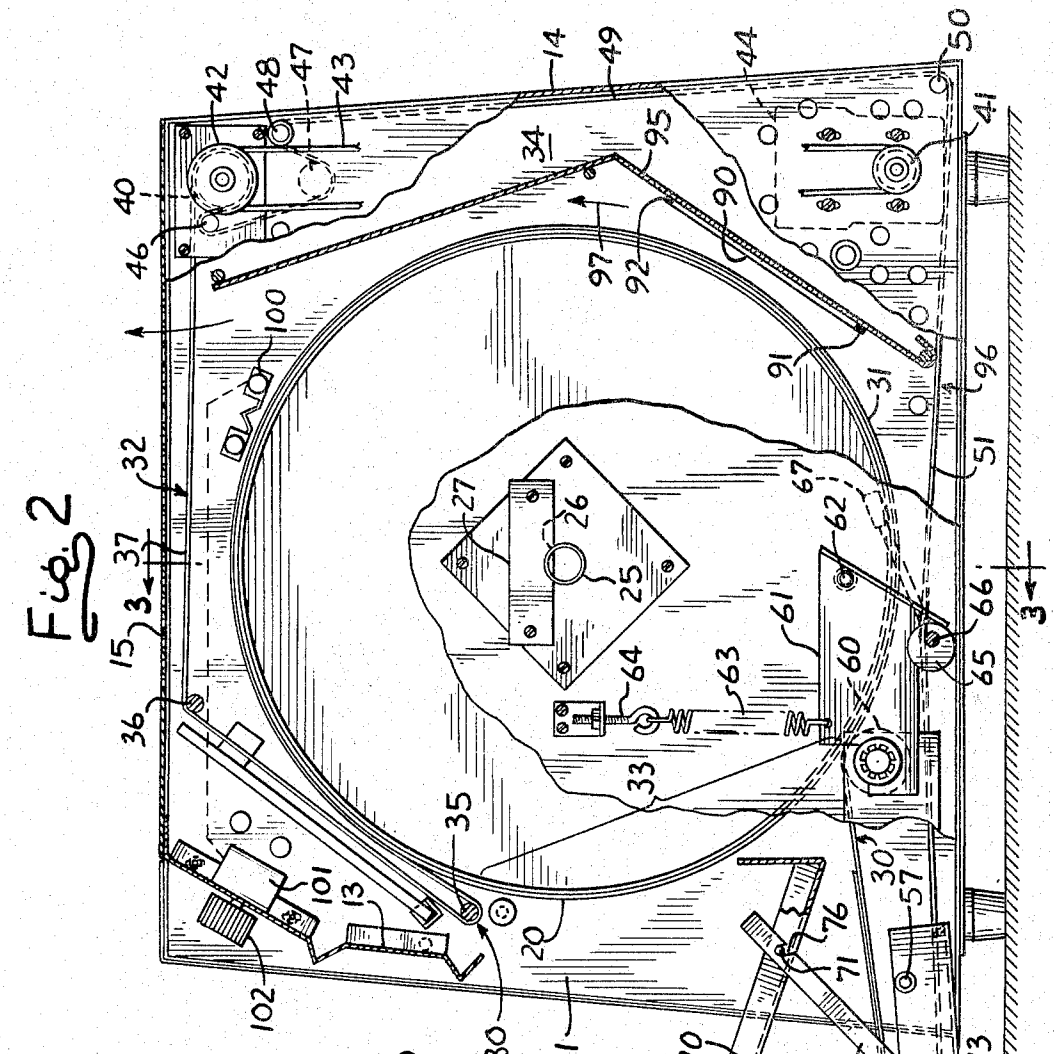


Fig. 2

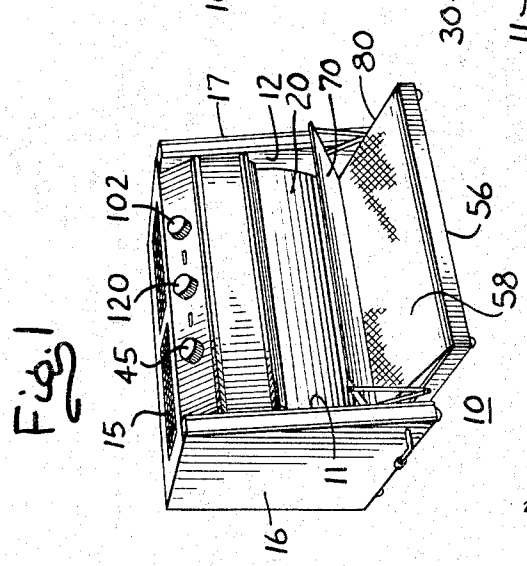


Fig. 1

INVENTOR
ROBERT E. ZIMMER

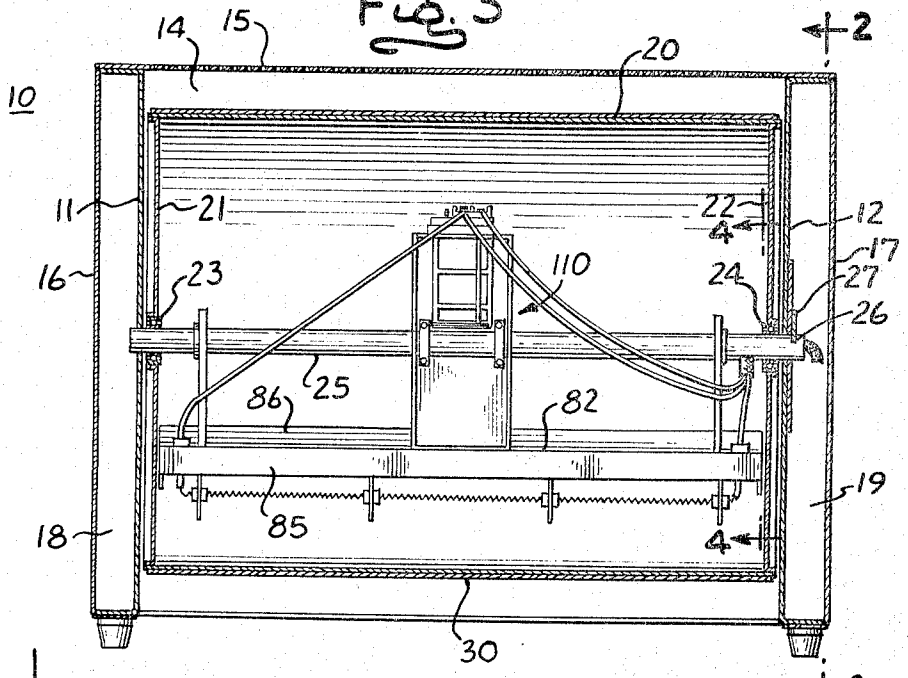
by: Wolfe, Hubbard, Voit & Osann
ATTYS.

Dec. 5, 1967 R. E. ZIMMER 3,355,815

DRYER FOR PHOTOPRINTS

Filed June 22, 1966 3 Sheets-Sheet 2

Fig. 3



5 Fig. 4

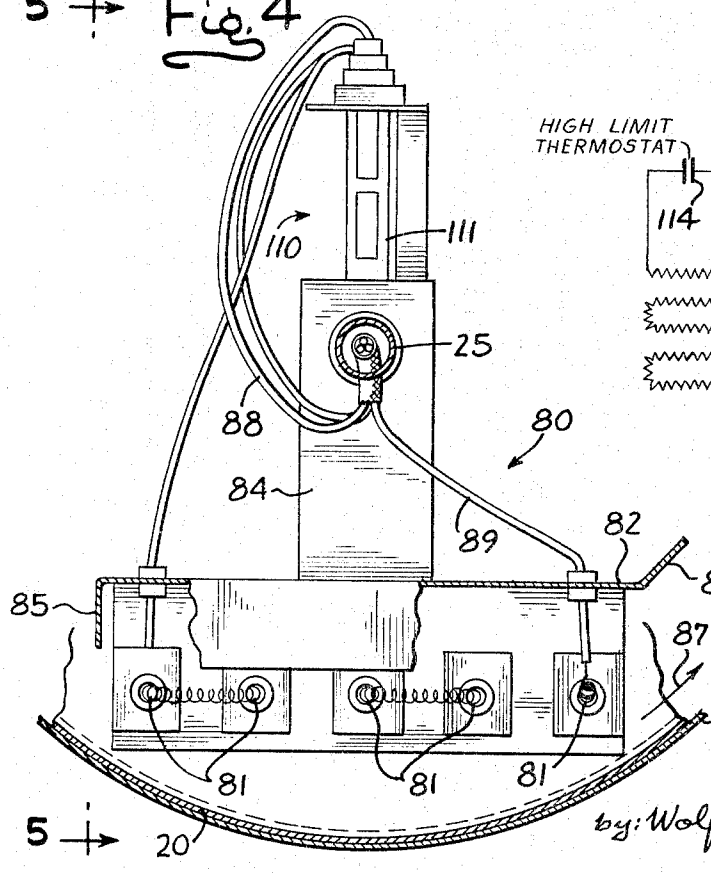
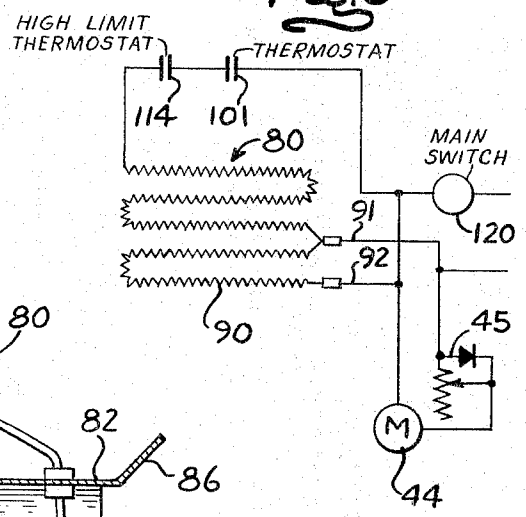


Fig. 6



INVENTOR
ROBERT E. ZIMMER
by: Wolfe, Hubbard, Voit & Osann
ATTYS.

Dec. 5, 1967 R. E. ZIMMER 3,355,815

DRYER FOR PHOTOPRINTS

Filed June 22, 1966 3 Sheets-Sheet 3

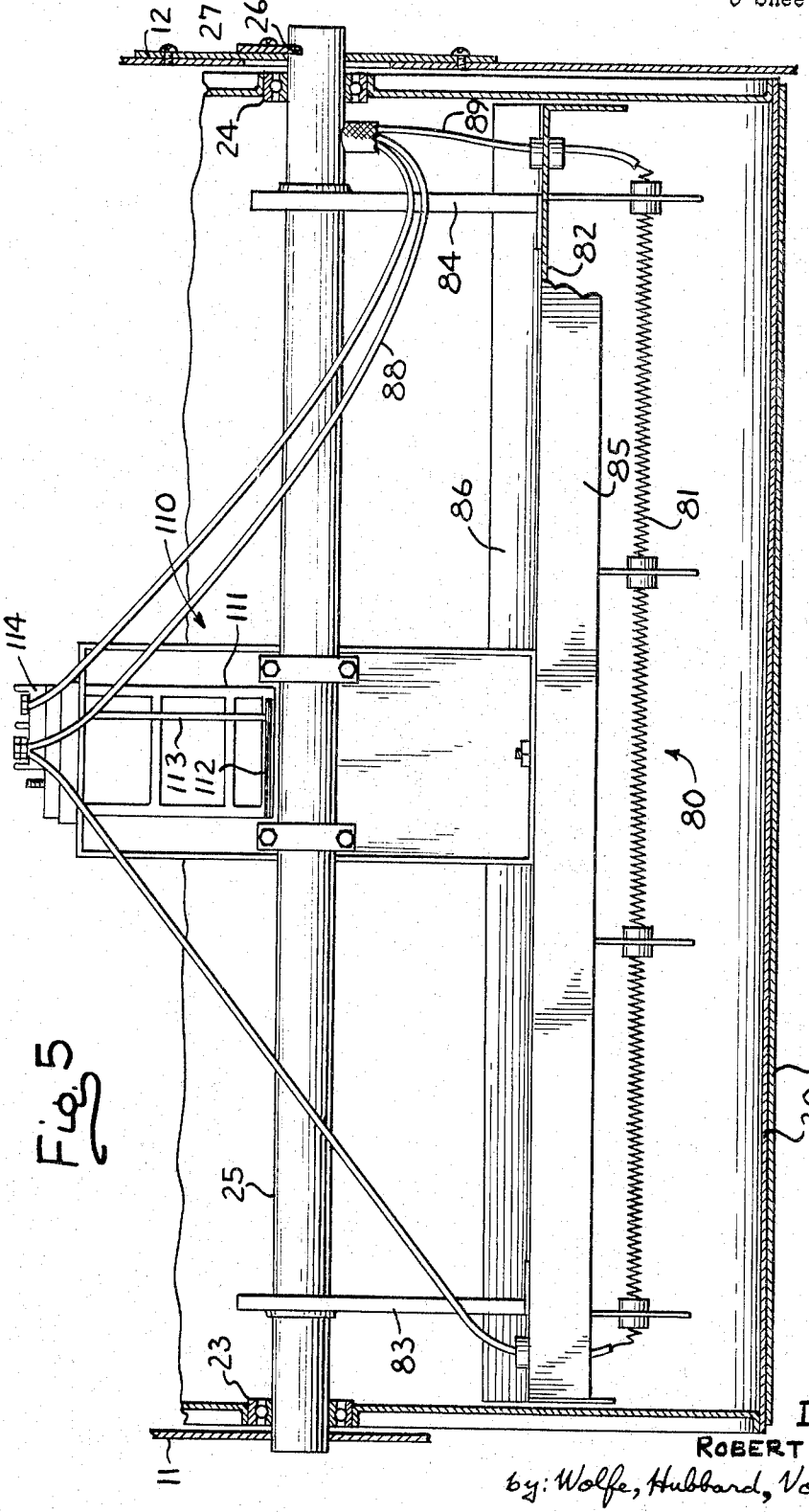


Fig. 5

INVENTOR
ROBERT E. ZIMMER
by: Wolfe, Hubbard, Voit & Osann
ATTYS.

United States Patent Office 3,355,815
Patented Dec. 5, 1967

3,355,815

DRYER FOR PHOTOPRINTS

Robert E. Zimmer, Niles, Ill., assignor to American Photocopy Equipment Company, Evanston, Ill., a corporation of Illinois

Filed June 22, 1966, Ser. No. 559,607
9 Claims. (Cl. 34—48)

ABSTRACT OF THE DISCLOSURE

A dryer for photoprints or the like employing a drum and a fabric belt, distinguished by use of main and auxiliary heaters with controlled application of radiant and convected heat.

It is an object of the present invention to provide a dryer for photoprints which is highly efficient, acting simultaneously on the back and front sides of the prints and which is capable of operating at a high rate on a production basis. It is a related object to provide a dryer for photoprints capable of continuous operation, which is easily adjusted to the conditions of use, and in which the operation is automatically controlled for consistent operation over long periods of time. In this connection it is an object to provide a print dryer which avoids any possibility of scorching the prints, or the belt which carries them, either as a result of overshooting of the temperature on start-up or as a result of temperature buildup in the machine when continuously operated over long periods of time.

It is another object of the present invention to provide a print dryer which is capable of handling all types and sizes of prints normally produced in a photographic workroom, either black and white or color, and which tolerates a wide range of water content. It is a more specific object to provide a print dryer which not only removes the moisture absorbed in the prints but which presses out excess water as the prints are fed into the machine, continuously disposing of the excess without care or attention on the part of the operator.

It is yet another object of the present invention to provide a print dryer which is capable of operating at a high commercial rate but which is nevertheless highly compact, semi-portable, and more economical both in first cost and in operation, than commercial print dryers in conventional use.

Other objects and advantages of the invention will become apparent upon reading the attached detailed description and upon reference to the drawings in which:

FIGURE 1 is a perspective view of a print dryer constructed in accordance with the invention;

FIGURE 2 is a vertical section of the machine taken along the line 2—2 in FIGURE 3;

FIGURE 3 is a vertical section taken through the axis of the machine along the line 3—3 in FIGURE 2;

FIGURE 4 is a fragmentary section taken through the drum along the line 4—4 in FIGURE 3;

FIGURE 5 is a fragmentary view looking along the line 5—5 in FIGURE 4; and

FIGURE 6 is a wiring diagram.

While the invention has been described in connection with a preferred embodiment, it will be understood that I do not intend to be limited to the embodiment shown but intend to cover the various alternative and equivalent constructions included within the spirit and scope of the appended claims.

Turning now to the drawings, the print dryer **10** has a frame including a pair of side members **11, 12** joined by cross members **13**, a rear panel **14** and a top panel or grill **15**. The side frame members **11, 12** are fitted with cover plates **16, 17**, respectively, which are removable to provide access to spaces **18, 19** which accommodate wiring and certain accessory parts as will be discussed.

Largely filling the central space between the side members is a hollow drum **20** of thermally conductive material enclosed by ends **21, 22** and having bearings **23, 24** mounted on a hollow stationary shaft **25**. The shaft may be prevented from rotating by cutting, in one or both ends, a transverse keyway **26** engaged by a key plate **27**. The walls of the drum may, for example, be formed of stainless steel, chromium plated and highly polished to impart gloss to a so-called "glossy" print.

For the purpose of holding the prints with face to the drum as they are dried, a web or belt **30** is provided having a drum engaging portion **31** which extends most of the way around the drum, and a return portion **32**, leaving the front of the drum freely accessible for discharge as indicated at **33**. The belt **30** is preferably of woven fabric having a width extending substantially the full length of the drum and seamed so that it is endless. The return portion of the belt in the machine is guided by a set of transversely extending shafts to define a rear chamber **34** at the back of the drum. Whether a shaft is in the form of a polished stationary bar or in the form of a journalled roller is largely a matter of choice, a bar being less expensive. Thus the belt is passed about a first bar **35** at the front of the machine, upwardly about a bar **36**, and then rearwardly along a horizontal run **37** to a drive roller **40**. The drive roller is rotated by a drive pulley **41** and driven pulley **42** interconnected by a belt **43**. The drive pulley is connected through a gear train (not shown) to a drive motor **44** which may, for example, be of the shaded pole type having a speed control unit **45**.

To provide adequate wrap-around on the driven roller **40**, the belt **30** passes around a shaft **46**, a take-up roller **47** and shaft **48** from which the belt passes downwardly along a vertical run **49** along the back of the machine. The belt then makes a right-angle turn **50** and proceeds along a horizontal run **51** forwardly to an apron roller **53**. At the rear end of the apron roller (FIG. 2) is a hub **54** having an adjusting screw **55** to adjust tracking. The apron roller is supported in an apron tray **56** having alined pivots **57**. Thus the apron roller, in its forwardly extended position at the front of the machine, defines a run of belt **58** which may be referred to as the "apron" on which the prints are placed, for example, a print **59**, face up, for feeding into the machine.

For defining a nip between the belt and the surface of the drum and for applying pressure resiliently to squeeze excess water out of the prints, a squeegee roller **60**, of rubber or the like, is provided. Such roller is mounted on a pair of arms **61**, only one of which is shown, pivoted to the side members indicated at **62** and biased upwardly by individual biasing springs **63**. Each spring has an adjustable anchor **64** for setting the roller pressure. Throw-off is achieved by cams **65** having a shaft **66** and throw-off arm **67**. The pressure applied by the squeegee roller is sufficient to press out the excess moisture which overflows onto the belt and which is immediately absorbed by the belt fabric. Any moisture which might drip through the apron is caught by the lower pass of the belt immediately below the apron. After passing through the nip, the prints are conducted in face contact with the moving drum until the discharge region **33** at the front of the drum is reached, at which point the prints peel off falling into a receiving tray **70** extending the width of the drum and spaced above the apron. The receiving tray is pivoted at **71** to the side members and is connected to the apron tray by a pair of links **72**, only one of which is shown, having pivots **73, 74**. For the purpose of limiting the downward swing of the apron tray and receiving tray, a pair of drop

links 75 are provided which are connected at their lower ends to the pivot 73 and which are formed with hooks 76 at their upper ends for hooking onto the pivots 71. Where the dryer is mounted on an extensive supporting surface, the supported position of the apron tray is defined by one or more pads 77 along the edge of the tray.

For the purpose of heating the drum, a heating assembly 80 is provided (see FIGS. 4 and 5) in which the heater 81 is in the form of parallel conductors such as nichrome wire or the like supported in a reflector 82 adjacent the inside "bottom" surface of the drum. The reflector is suspended on hangers 83, 84 from the stationary shaft 25. As indicated in FIG. 4, the reflector is partially enclosed at the left-hand or "upstream" end by a downwardly turned lip 85 while at the opposite end an upturned lip 86 is provided for escape of the heated air along the moving inner surface of the drum in the direction of the arrow 87. The heater leads 88, 89 are brought out through the hollow shaft 25. It will be apparent, then that as the drum rotates the inner surface is subjected to both radiant and convected heat, with all portions of the drum being acted upon uniformly as it revolves.

In accordance with the present invention, a second heater, serving as an auxiliary source of heat, is provided at the rear of the drum, in the chamber 34 formed by the return pass of the fabric belt, with an associated, vertically extended guide surface, or plate, spaced from the back of the drum defining a chimney for vertical convection of the heated air closely adjacent the rear surface of the drum and with a temperature controlling thermostat spaced close to the drum in the path of the flow. Referring to the drawings and particularly to FIG. 2, I provide in the chamber 34 at the rear of the drum a heating element 90 having supply lines 91,92. Such heater is preferably in the form of a resistive plate having terminals at its edges and commercially available under the name "Cellotherm" from Chemelex, Incorporated, of Danbury, Conn. For guiding the upwardly convected air with chimney action about the surface of the drum a guide plate 95 is provided which bridges the space between the two side members 11, 12 and which is bent at the center to follow the contour of the drum. Such plate is preferably formed of aluminum or other good conductor so that, in addition to acting as guides for the air stream, they also serve, particularly the plate 95, to distribute over a broad area the heat generated in the heating element 90. It will be apparent therefore, that the heat from the element 90 is transferred in three possible modes: conduction into the plate 95, direct radiation from the surface of the plate, and convection, augmenting the convection caused by the heated drum itself. Thus the air entering at 96 through the bottom of the housing, both through and around the edges of the belt passes along the plate to begin its upward ascent. Between the two sources of heat, the air is heated, taking on the moisture given off by the prints and rises along the path of the arrows 97, being vented at the top through the horizontal run 37 of the fabric belt. As the heated air passes through the pores of the fabric it tends to carry off what remains of the moisture from the prints including that due to the action of the squeegee roller 60. Further drying takes place along the vertical run 49 and horizontal run 51. Thus by the time that any portion of the belt finally returns to the loading apron, it is substantially dry and ready to absorb moisture from the prints including that which is pressed out at the squeegee roller. For the purpose of thermostatically controlling the heating element within the drum, there is a thermostat positioned at the upper end of the chimney air stream and in proximity to the drum surface. The thermostat, indicated at 100, is preferably of the type, well known in the art, having a responsive bulb and bellows operating switch contacts 101 and having adjusting knob 102.

In accordance with one of the important features of the present invention, a high limit thermostat is provided within the drum, and preferably in the space above the heating element for insuring that the temperature in the drum does not exceed a safe value either during start-up or under any running conditions. Thus I provide a thermostat 110 (see FIGS. 4 and 5) having a frame 111 in which is mounted a temperature responsive element in the form of a bimetal 112 connected by a plunger 113 to a switch contact assembly 114. The contacts are connected in series with the contacts 101 of the main thermostat as shown in FIG. 6 so that the heating element is effectively turned off in the event the temperature within the drum tends to exceed a certain, safe value and even then the main thermostat may be calling for heat. This function is particularly important when the unit is first turned on, at which time the temperature tends to rise within the drum with only limited initial effect upon the main thermostat 100. In a practical case the high limit thermostat may be set to cut off flow of current at, say, 260° F. whereas the main thermostat may be set within a range of, say, 180–200° F. As a result of using the high limit thermostat, a large wattage element may be used within the drum for rapid response and heavy load carrying ability while nevertheless insuring against the creation of a temporary high temperature during the interval immediately following turn-on or following a sudden change in the setting of the control knob or a sudden change in loading. It is found that with the present set-up prints may be fed into the dryer within a short time after the device is turned on without risk of overheating or scorching the prints or the fabric belt on which they are carried. If desired the wattage of the heater in the drum may be in excess of 800 watts and the wattage of the auxiliary heater 90 may be some fraction of this. Since the auxiliary heater is of lesser wattage and coupled more loosely to the prints, serving to augment the main heater, the auxiliary heater is preferably constantly energized.

For the sake of easy understanding the circuit diagram shown in FIG. 6 has been considerably simplified, having a switch 120 in series with the regular A-C supply line. In use, the apron tray 56 and receiving tray 70 are pulled down from the vertical nested position to the extended position shown in FIGS. 1 and 2. The switch 120 is turned on and the speed control 45 and thermostat at 110 serving to keep the peak temperature within the drum within safe limits until the main thermostat 100 outside the drum can take over its automatic control function. Prints are placed face-up upon the apron and pass around the drum as discussed. In the event that a print has not completely dried during a single circuit, it simply remains on the drum for a second pass. The speed and temperature are so adjusted that under a given set of conditions the prints are dry by the time that they are circulated around to the space 33 at the front of the machine, peeling off automatically and dropping into the receiving tray 70. It has been found that a machine of the construction described above is capable of continuous operation on a production basis, replacing in many instances the larger and heavier machines which have been previously thought to be necessary. Since the present machine is inherently inexpensive and compact, it may be employed, not only on production work, but in a photo laboratory or the like where the machine may be turned on and off repeatedly during the course of a day's work.

As the drum rotates the air which has been heated by the heating element within the reflector 82 passes upwardly and rearwardly along the inside surface of the drum as indicated by the arrow 87 in FIG. 4, losing heat to the drum wall in the process. Such air is transferred to the top half of the drum where it affects the thermostat 110 and, upon being progressively cooled, flows downwardly along the front side of the drum and into the space below the reflector to replenish the air under the reflector, with the cycle being endlessly repeated. By reason of the circulation, quick response of the thermostat 110 is assured to prevent any uncontrolled peaks of

temperature regardless of the load or regardless of the setting of the controls.

In the claims the term "guide surface" refers to any surface spaced adjacent the back side of the drums and the term "lower portion" refers to a position sufficiently low as to create an upwardly rising current of heated air along the backside of the drum.

I claim as my invention:

1. In a dryer for photoprints or the like, the combination comprising, a frame, a hollow drum of thermally conductive material rotatable therein, an endless fabric belt of porous construction having a drum engaging portion which extends about the major portion of the drum periphery while leaving the face of the drum accessible and a return portion defining a rear chamber, a set of shafts for guiding the return portion of the belt including a shaft arranged forwardly of the drum defining an apron, a motor for driving the belt, a first electric heating element in the drum for heating the face of the photoprints thereon, a second electric heating element in the lower portion of said chamber and spaced from the rear of the drum for simultaneous heating of the backside of the photoprints, thermostatic means for controlling the temperature of at least one of the heating elements, the second heating element having an associated vertically extending guide surface spaced from the back of the drum to define a chimney for the vertical flow of heated air closely adjacent the rear surface of the drum.

2. The combination as claimed in claim 1 in which the second heating element has an associated vertically extending guide plate bent to conform to the back of the drum and extending vertically to a position adjacent the return portion of the belt to define a chimney for the vertical flow of heated air along the rear surface of the drum for passage of at least a portion of the heated air upwardly through the pores in the return portion of the belt for drying the belt prior to its return to the drum.

3. In a dryer for photoprints or the like, the combination comprising, a frame, a hollow drum of thermally conductive material rotatable therein, an endless fabric belt having a drum engaging portion which extends about the major portion of the drum periphery while leaving the face of the drum accessible and a return portion defining a rear chamber, a set of shafts for guiding the return portion of the belt including a shaft arranged forwardly of the drum defining an apron, a motor for driving the belt, a first electric heating element in the drum for heating the face of the photoprints thereon, a second electric heating element in said chamber and spaced from the rear of the drum for simultaneous heating of the backside of the photoprints, thermostatic means for controlling the temperature of at least one of the heating elements, the second heating element including a plate of heat conducting metal extending vertically and spaced from the back of the drum for conductive distribution of the heat from the element as well as for defining a chimney for the vertical flow of heated air along the rear surface of the drum.

4. In a dryer for photoprints or the like, the combination comprising, a frame, a hollow drum of thermally conductive material rotatable therein, an endless fabric belt having a drum engaging portion which extends about the major portion of the drum periphery while leaving the face of the drum accessible and a return portion defining a rear chamber, a set of shafts for guiding the return portion of the belt including a shaft arranged forwardly of the drum defining an apron, a motor for driving the belt, a first electric heating element in the drum for heating the face of the photoprints thereon, a second electric heating element in said chamber and spaced from the rear of the drum for simultaneous heating of the backside of the photoprints, thermostatic means for controlling the temperature of at least one of the heating elements, the second heating element having an associated vertically extending surface spaced from the back of the drum for defining a chimney for the vertical flow of heated air along the rear surface of the drum and in which the thermostatic means is located in the upper portion of the path of flow of the heated air in the chimney.

5. In a dryer for photoprints or the like the combination comprising a frame, a hollow enclosed drum of thermally conductive material rotatable therein, an endless fabric belt having a drum-engaging portion extending about the drum periphery while leaving the face of the drum accessible and a return portion defining a rear chamber, a set of shafts for guiding the return portion of the belt, a motor for driving the belt and engaged drum, a first electric heating element in the drum for heating the drum surface by radiation and convection, a second electric heating element in said chamber closely spaced from the rear of the drum for heating the backside of the prints by radiation and for augmenting the flow of a convection current of heated air along the back of the drum, a thermostat in the convection current of air controllingly coupled to the first heating element, and a high limit thermostat in the upper portion of the drum overridingly coupled to the first heating element for limiting the temperature in the drum to a value safely below the scorching temperature.

6. The combination as claimed in claim 5 in which the first heating element is in the form of radiant conductors at the bottom of the drum having an associated reflector vented to permit escape of heated air along the inside surface of the drum and in which the first heating element has an output when energized which is substantially greater than the output of the second heating element.

7. In a dryer for photoprints or the like the combination comprising a frame, a hollow enclosed drum of thermally conductive material rotatable therein, an endless fabric belt having a drum-engaging portion extending about the major portion of the drum periphery while leaving the face of the drum accessible and a return portion defining a rear chamber, a set of shafts for guiding the return portion of the belt, a motor for driving the belt and engaged drum, an electric heating element in the lower portion of the drum for heating the drum surface by radiation and convection, means in said chamber for producing a rising current of heated air along the back of the drum to carry away the moisture from the prints, a main thermostat outside of the drum but in the air adjacent thereto and connected to the heating element for correctively controlling the drum temperature, and a high limit thermostat in the upper portion of the drum having contacts effectively connected in series with the main thermostat for limiting the temperature in the drum.

8. In a dryer for photoprints or the like combination comprising a frame, a hollow enclosed drum of thermally conductive material rotatable therein, an endless fabric belt having a drum-engaging portion extending about the drum periphery while leaving the face of the drum accessible and a return portion defining a rear chamber, a set of shafts for guiding the return portion of the belt, a motor for driving the belt and engaged drum, a first electric heating element in the drum for heating the drum surface by radiation and convection, a second electric heating element in said chamber closely spaced from the rear of the drum and having a heating capacity less than that of the first element for heating the backside of the prints by radiation and for augmenting the flow of a convection current of heated air along the back of the drum, and a thermostat in the upper portion of the drum controllingly coupled to the first heating element for limiting the temperature in the drum.

9. In a dryer for photoprints or the like the combination comprising a frame, a hollow enclosed drum of thermally conductive material rotatable therein, an endless fabric belt having a drum-engaging portion extending

about the major portion of the drum periphery while leaving the face of the drum accessible and a return portion defining a rear chamber, a set of shafts for guiding the return portion of the belt, a motor for driving the belt and engaged drum, a radiant electric heating element closely adjacent to the lower portion of the drum for heating the drum surface, a reflector overlying the heating element and having lips extending along the length thereof, the lips being dimensioned to facilitate escape of heated air in the direction of movement of the bottom surface of the drum for flow of air upwardly along the back of the drum in a circular path and downwardly along the front surface to replenish the air under the reflector, means in said chamber for directing a rising current of heated air along the back of the drum to carry away the moisture from the prints, and a thermostat in the upper portion of the drum having contacts connected in series with the heating element for limiting the temperature in the drum.

References Cited

UNITED STATES PATENTS

1,593,161	7/1926	Denham et al.	34—234 X
2,184,663	12/1939	Dye	34—123 X
2,526,318	10/1950	Battin	34—116 X
2,896,336	7/1959	Shoumatoff	34—116 X
3,002,290	10/1961	Abdoo	34—123
3,157,390	11/1964	Douglas	34—48

JAMES W. WESTHAVER, *Primary Examiner.*

FREDERICK L. MATTESON, JR., *Examiner.*

A. D. HERRMANN, *Assistant Examiner.*