Dec. 26, 1944. W. F. BUTLER 2,365,678

OVEN

Filed Sept. 25, 1942 3 Sheets-Sheet 1

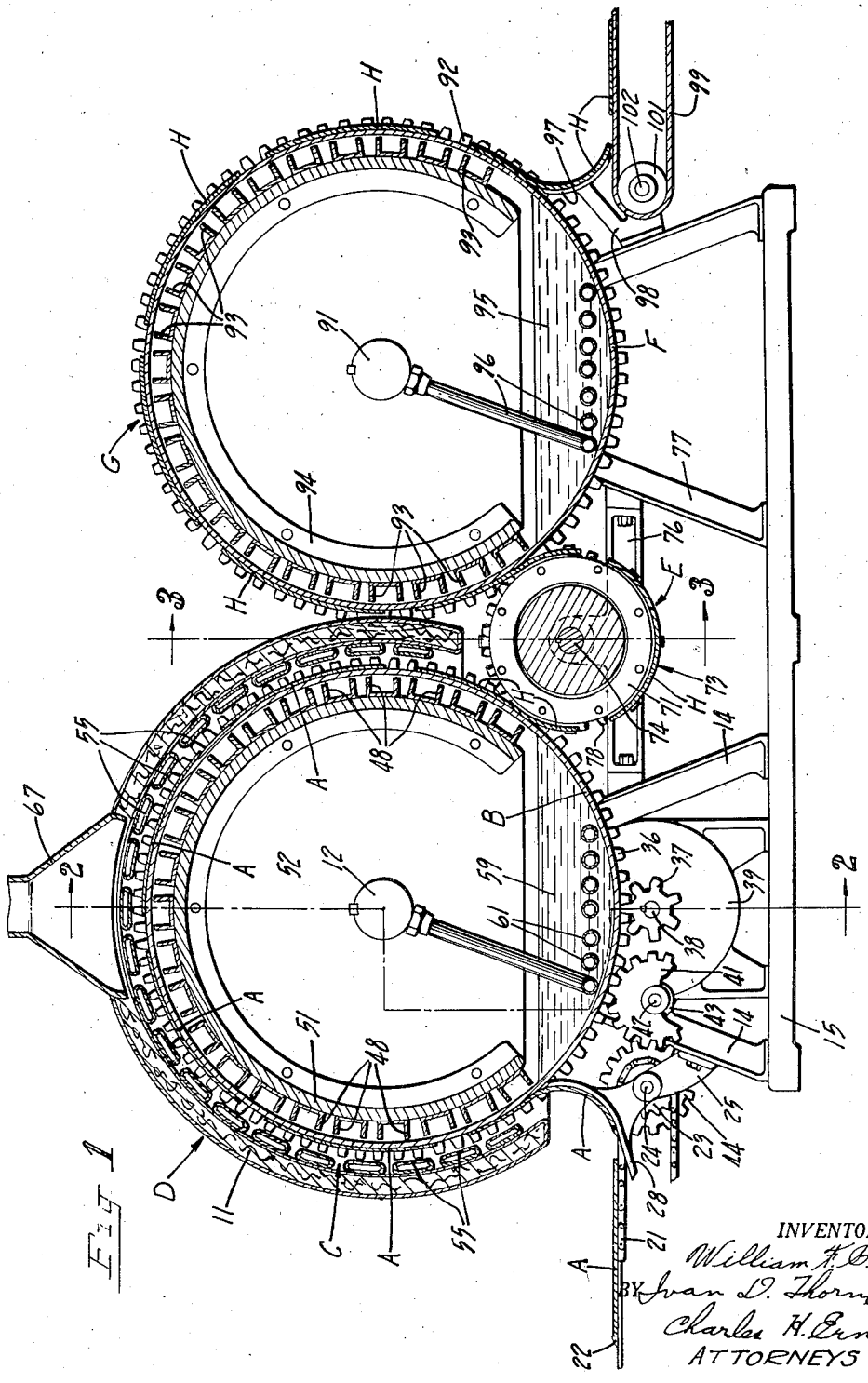


FIG 1

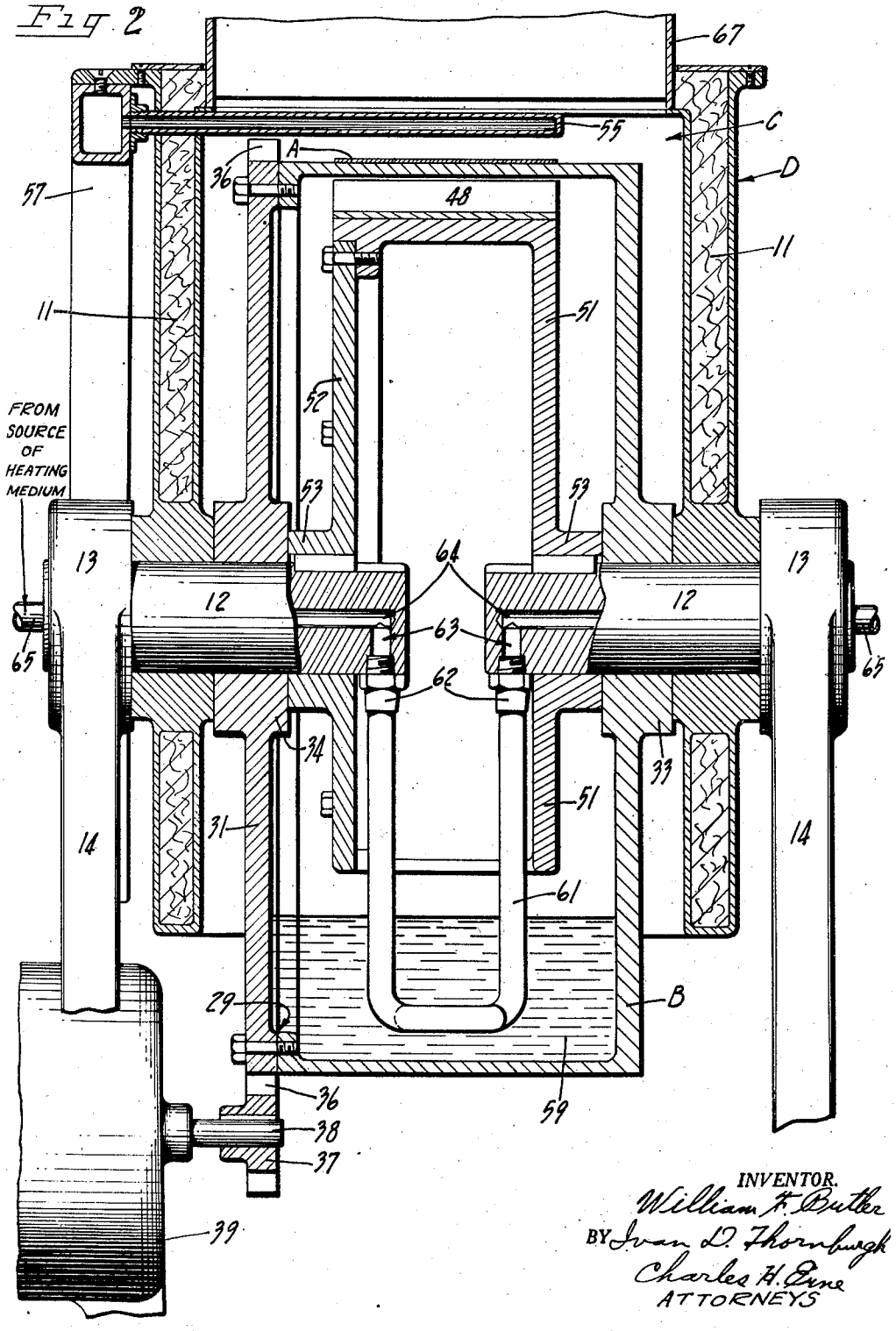
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Fig. 2



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Fig 3

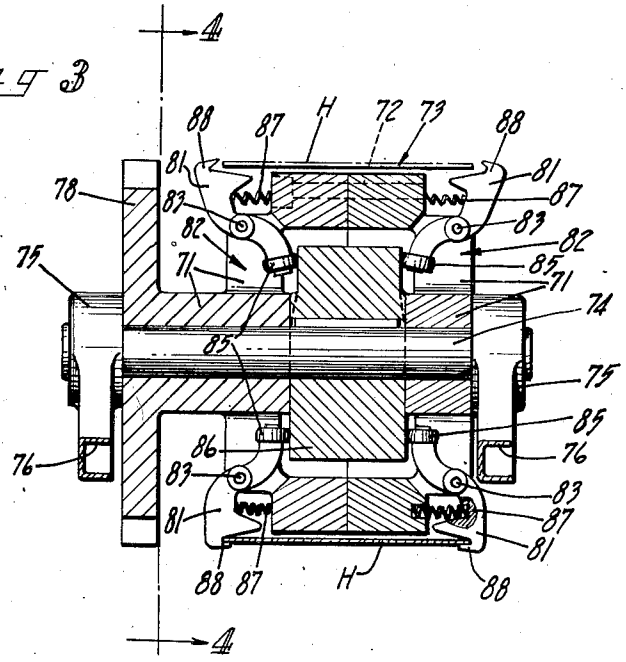
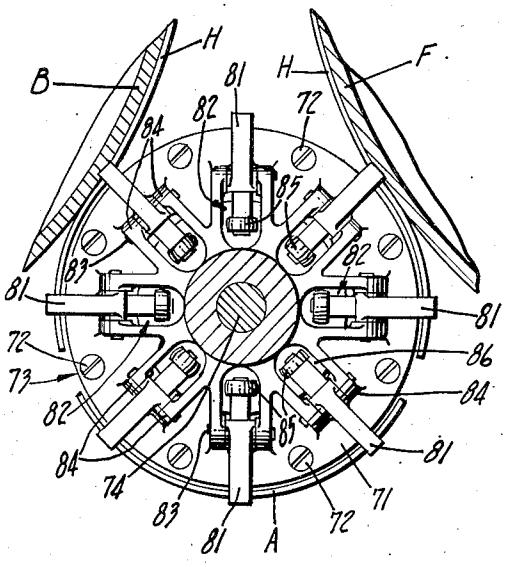


Fig 4



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UNITED STATES PATENT OFFICE

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OVEN

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Application September 25, 1942, Serial No. 459,728

8 Claims. (Cl. 34—62)

The present invention relates to ovens for heat treating flexible metallic sheets having freshly applied lithographing or other coating material on a surface thereof and has particular reference to a rotary oven having a sheet carrying drum which is maintained at a predetermined temperature to facilitate treating of the sheets.

In the ovens used for drying metallic sheets having a freshly applied coating thereon it has been found that drying of the coating is greatly facilitated when heat is applied directly to the sheet itself as by conduction as well as superficially to the wet coated side as by radiation. This method of drying sheets is particularly adaptable to h'gh speed production.

An object of the invention is the provision of a rotary drying oven for freshly coated sheet material wherein the sheets are propelled along a predetermined path of travel and are held in firm contact with a rotating drum which is ma'ntained at a constant predetermined temperature so that the heat of the drum will be transmitted by direct contact with and to the sheet itself by way of its dry surface for rapidly and thoroughly treating the sheet to dry the coating material thereon.

Another object is the provision of such a drying oven wherein cooling of the sheets after drying is effected in a manner similar to that of heating them and wherein high speed and uniform continuous production may be maintained in a minimum space.

Numerous other objects and advantages of the invention will be apparent as it is better understood from the following description, which, taken in connection with the accompanying drawings, discloses a preferred embodiment thereof.

Referring to the drawings:

Figure 1 is a longitudinal sectional view taken through a drying oven embodying the instant invention, with parts broken away;

Fig. 2 is an enlarged transverse section taken substantially along the vertical broken line 2—2 in Fig. 1, with parts broken away;

Fig. 3 is an enlarged section taken substantially along the l'ne 3—3 in Fig. 1, with parts broken away; and

Fig. 4 is a sectional view taken substantially along the line 4—4 in Fig. 3, with parts broken away.

As a preferred embodiment of the instant invention the drawings illustrate a rotary drying oven in which freshly coated sheets A (Fig. 1) are propelled by a heated rotating element B through a cylindrical drying chamber C of a sheet drying unit D for quickly drying the coating material on the sheets. When dried, the hot sheets are delivered by a rotating transfer mechanism E to a cooled rotating element F of a cooling unit G for reducing the temperature of the sheets so that they can be handled for subsequent operations. The sheets while traveling with the cooling element F are exposed to the outside atmosphere which facilitates rapid cooling thereof. When cooled, the sheets are discharged to any suitable place of deposit.

The drying unit D includes a cylindrical insulated housing or casing 11 (Figs. 1 and 2) which is disposed in a horizontal position and which is open at the bottom. The housing is stationary and at its ends is mounted on two short aligning studs 12 which are secured in hubs 13 formed in a pair of side frames 14 bolted to a base plate 15. These frames constitute a portion of the main frame of the oven. The housing encloses the drying chamber C.

The freshly coated sheets A enter the oven, for delivery into the drying chamber C, in a horizontal position and with the wet or coated side disposed upwardly, in any suitable manner, such as for example, by way of an endless chain entrance conveyor 21 (Fig. 1) having feed dogs 22 secured thereto at spaced intervals along the chain. The oven end of the conveyor operates over a driving sprocket 23 mounted on a cross shaft 24 journaled in bearings formed in a bracket 25 secured to the side frames 14.

Adjacent the oven end of the entrance conveyor 21 the feed dogs 22 propel an entering sheet upwardly along a curved guide plate 28 which is secured to the bracket 25. The inner or upper end of the curved guide plate terminates adjacent the path of travel of a rotating drum which constitutes the rotating element B. This drum is made preferably of stainless steel although other non-magnetic materials may be used with equally good results.

The drum B constitutes a drying conveyor and is disposed within the stationary housing D. One end of the drum is formed with an opening 29 (Fig. 2) having a cover plate 31 for assembly purposes. The drum is mounted rotatably on the two studs 12 which extend through a bearing 33 formed in the closed end of the drum and through a bearing 34 in the cover plate.

The drum B is continuously rotated by gear power applied through teeth 36 which are formed on the periphery of the cover plate 31. These gear teeth mesh with a driving pinion 37 which

is mounted on a rotor shaft 38 of an electric motor 39 bolted to the base plate 15. This motor constitutes the main source of power for the entire oven.

The gear teeth 36 on the drum B also drive the entrance conveyor 21 through an idler gear 41 which meshes with the plate teeth. The idler gear is mounted on a stud shaft 42 secured in a bearing 43 formed on a leg of the side frames 14. The idler gear meshes with and drives a gear 44 which is mounted on the conveyor sprocket shaft 24. It is this connection that drives the entrance conveyor in time with the rotating drum B.

Within the drum B there are a plurality of stationary magnets 48 disposed at spaced intervals adjacent the inner surface of the drum. These magnets are arranged in an arc which extends upwardly from the entrance guide plate 28 toward the top of the drum and thence downward along the other side thus covering approximately three quarters of the inner circumference of the drum and creating a curved magnetic field throughout this area. The magnets preferably are permanent magnets but electromagnets may be utilized if desired.

The magnets 48 extend transversely of the drum B and are secured in a double segmental hollow bracket 51 located within the drum. One side of the bracket is open and is fitted with a cover plate 52 for assembly purposes. The bracket and the cover plate at the center are formed with hubs 53 which are keyed in place on the inner ends of the stationary studs 12. With such a construction the bracket and its magnets remain stationary while the drum B rotates around them.

Hence as an entering freshly coated sheet A moves up the entrance guide plate 28 its under or uncoated surface comes into engagement with the rotating drum B at a place adjacent the lowermost magnet 48 in the set grouped adjacent the inner surface of the drum. The magnet attracts the leading edge of the sheet to the drum and thus pulls the sheet up from the guide plate onto the drum. As the drum continues to rotate the sheet is carried upwardly with it over the magnets and these cause the sheet to cling tightly to the drum in close contact with its outer surface. In this position a sheet is carried through the drying chamber C along a curved path of travel, up over the drum and down the other side.

During the travel of the sheet the freshly applied or wet coating on its outer surface is thoroughly and quickly dried by heat conduction and by heat radiation which are applied both to the sheet itself and to the outer wet surface. Heat applied to the wet surface is effective through the medium of a plurality of heating elements 55 which are disposed within the drying chamber C and adjacent the outer surface of the rotating drum B. These heating elements preferably are long tubular heaters which extend transversely of the drum and which are formed for the internal combustion of a gas and air mixture which is supplied to and which burns inside of the tube. This causes the tube to become incandescent and to radiate heat across the path of travel of the sheets carried on the drum. One end of each tubular heater projects through a side of the drying chamber housing 11 and is secured into a gas manifold 57 located adjacent the outside of the housing. This manifold leads from any suitable source of supply of heating gas.

Heat applied at the inner dry surface of the sheets is brought about by direct contact with the drum, that is, by conduction for heat also is applied to the drum. Heating of the drum is effected indirected by a heating liquid 59 such as water or oil which is contained in the drum. There is only a small quantity of this liquid in the bottom of the drum and it is maintained at a level just below the lowest magnet 48.

The heating liquid 59 is maintained at a predetermined temperature by a fluid heating medium, such as hot water, hot oil, steam or the like, which is circulated through a pipe coil 61 immersed in the liquid. The two ends of the coil are connected to couplings 62 which are threaded into the inner ends of the studs 12. There is one coupling for each stud. The couplings communicate with short vertical bores 63 formed in the studs and these bores lead into longitudinal passageways 64 in the studs.

A passageway 64 extends along the center and to the outer end of each stud 12 and communicates with a pipe 65, there being two such pipes threaded into the ends of the studs. One of these pipes is an inlet pipe and leads from any suitable source of the heating medium while the other pipe is an outlet pipe and returns to the source of the heating medium or to a suitable place of discharge for the used medium. It is through this means that the outer surface of the rotating drum B is maintained in a heated condition.

Thus when the drum B picks up a wet or freshly coated sheet A from the entrance guide plate 28, the drum immediately heats the sheet by conduction through its inner uncoated or dry surface. In this manner the sheet is quickly and thoroughly heated throughout its entire thickness before actual drying of the coating material begins to take place. As the sheet clinging to the drum is carried around through the drying chamber C, the heat from the tubular heaters 55 is concentrated on the coating material. Hence the coating is dried simultaneously from its inner as well as its outer surfaces and this speeds up the drying action and results in a more uniform bake. A vent pipe 67 in the top of the drying chamber housing 11 permits of the escape of the fumes created within the drying chamber C.

Upon the completion of the travel of a sheet A through the drying chamber C the sheet is dry but is still slightly tacky. In this condition it is ready for delivery into the cooling unit G. This delivery of the sheet is effected by the transfer mechanism E which will now be explained.

The transfer mechanism E includes a pair of dish-shaped wheel discs 71 (Figs. 1, 3 and 4) which are secured together by bolts 72 to form a hollow rotatable transfer wheel 73. This wheel is disposed adjacent the discharge side of the drying chamber housing 11 and freely rotates on a stationary shaft 74 the ends of which are secured in bearing blocks 75 formed in a pair of longitudinal rails 76 secured to the side frames 14 of the drying unit D and to a similar pair of side frames 77 of the cooling unit G. These side frames are bolted to the base plate 15.

The transfer wheel 73 is continuously rotated in time with the drying drum B by a gear 78 which is formed on a hub of the wheel. This gear meshes with and is driven by the teeth 36 on the cover plate 31 of the drying drum B. The

outer surface of the transfer wheel is spaced away slightly from the outer surface of the drying drum so that the tacky coating on the sheets passing through the oven will not contact the wheel. This prevents smearing of the coating on the sheets.

The transfer wheel 73 carries a plurality of cooperating pairs of gripper fingers 81 disposed on opposite sides of the wheel. These fingers operate in openings 82 formed in the wheel discs 71. Each finger is mounted on a pivot pin 83 which is carried in bosses 84 formed on the outside of the wheel discs.

The inner end of each gripper finger 81 carries a cam roller 85 which operates against a side of a stationary cam 86 which is disposed within the hollow space of the wheel and which is keyed to the stationary shaft 74. This is a double sided cam and has cam surfaces on both of its sides for rocking the gripper fingers on each side of the transfer wheel. Compression springs 87 interposed between the outer ends of the fingers and the sides of the wheel hold the cam rollers in engagement with the side cam 86.

The outer ends of the gripper flanges 81 are formed with recessed gripping jaws 88 which are so located as to align with the outer edges of a sheet adjacent the outer surface of the turret wheel 73. As the wheel 73 rotates on the shaft 74, the cam rollers 85 traverse the cam surfaces on the stationary cam 86 and thus rock the fingers on their pivot pins 83. This opens and closes the jaws 88 of each pair of fingers as the wheel rotates. The normal position of the gripper fingers which is when they are not functioning to hold sheets is open, as best shown in the upper portion of Fig. 3.

Hence when a dried sheet (indicated by the letter H) on the drying drum B comes into position between the drum and the transfer wheel 73, the adjacent pair of jaws 88 of the gripper fingers 81 close against the outer side edges of the leading portion of the sheet and thus pull it away from the drying drum and toward the transfer wheel. In this manner as each pair of fingers comes adjacent a sheet they grip the outer edges of the sheet and thus clamp it in spaced relation to the outer surface of the transfer wheel holding it in a curved position so that the tacky coating on the sheet will not engage the wheel.

As the transfer wheel 73 rotates it carries the clamped sheet H down under the wheel in a counter-clockwise direction as viewed in Fig. 1 and thence upwardly toward the cooling unit G. Adjacent the cooling unit the gripper fingers 81 rock outwardly and this moves the jaws 88 away from the sheet and thus release it preparatory to the sheet entering the cooling unit.

In the cooling section the coating is hardened and this eliminates the tacky condition. This cooling unit G includes the rotatable element F which comprises a hollow drum which may be identical in construction to the drying drum B. This cooling drum F is mounted on a pair of short studs 91 (Fig. 1) which are secured in the side frames 77 in the same manner as the studs 12 for the drying drum B. The cooling drum is located adjacent the transfer wheel 73 in spaced relation therewith and is rotated by the transfer wheel by way of gear teeth 92 which are formed on the outer periphery of the cooling drum and which mesh with the teeth of the gear 78.

Hence when the transfer wheel 73 brings a dried sheet H into position into the cooling unit G, it is released in tangential engagement with the cooling drum F. The cooling drum immediately picks up the released sheet and carries it upwardly while cooling it. The sheet is held in position on the cooling drum by magnets 93 which are identical in construction and location with the magnets 48 in the drying drum B. The magnets 93 are fastened to a segmental bracket 94 which is disposed within the cooling drum and this bracket is carried on the stationary studs 91.

Cooling of the sheets H is just the reverse of their heating and the heat in the sheets is dispersed from both sides of the sheets, by radiation of heat to the outside atmosphere surrounding the cooling drum F and by conduction of the heat of the sheets into the drum itself which is maintained at a predetermined cold temperature. Cooling of the drum is brought about by a refrigerant liquid 95 such as water, which is retained within the drum at a level just below the magnets 93.

The cooling liquid 95 is kept at the desired predetermined temperature by a pipe coil 96 which is immersed in the liquid. The two ends of the coil are connected into the drum studs 91 and communicate with passageways therein in the same manner as in the drying drum B. These passageways communicate with an inlet pipe and an outlet pipe which are threaded into the outer ends of the studs and through which a cooling medium, such as cold water or brine, is circulated. The inlet pipe leads from a suitable source of the refrigerant while the outlet pipe may return to the source of the cooling medium or to any other suitable place of discharge.

Thus as a sheet H received on the cooling drum F is held tightly against the drum by the magnets 93, the heat of the sheet is extracted by conduction into the cooler drum while the sheet rotates with the drum. The sheet is carried upwardly over the top of the drum and thence downwardly along the opposite side to a place of discharge. This place of discharge is adjacent the lowermost magnet 93 on the exit side of the drum.

As the leading edge of a sheet passes this lowermost magnet 93, the sheet moves away from the cooling drum F along a line of tangency and is deflected by engagement with the upper edge of a curved guide rail 97 which is disposed adjacent the drum in spaced relation thereto. The guide rail is secured to a bracket 98 bolted to the side frames 77 of the cooling unit. This guide rail directs the sheet toward an endless belt conveyor 99 which operates over a pulley 101 mounted on a shaft 102 journaled in bearings formed in the bracket 98. The conveyor may be actuated in any suitable manner in time with the other moving parts of the oven. This conveyor carries the dried and cooled sheets H received thereon to any suitable place of deposit for further handling or storage as the case may be. This completes the travel of the sheets through the oven.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description, and it will be apparent that various changes may be made in the form, construction and arrangement of the parts without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the form hereinbefore described being merely a preferred embodiment thereof.

I claim:

1. In a machine for handling and heat treating flexible metallic sheets having freshly applied lithograph coating, the combination of a non-

magnetic conveyor for propelling the sheets along a predetermined path of travel, a plurality of magnets arranged adjacent said conveyor and creating a magnetic field for holding the sheets on the conveyor, heating means for applying heat to said conveyor for maintaining the conveyor at a predetermined temperature to enable transfer of conveyor heat directly to the sheets by heat conduction, and a heat insulated casing enclosing the major portion of said conveyor for confining the heat received by said conveyor from said heating means.

2. In a machine for handling and heat treating flexible metallic sheets having freshly applied lithograph coating on one side thereof, the combination of a non-magnetic conveyor for propelling the sheets along a predetermined path of travel, a plurality of magnets arranged adjacent the major portion of said conveyor and creating a magnetic field for holding the sheets on the moving conveyor, heating means disposed within said conveyor for applying heat directly to said conveyor for maintaining the conveyor at a constant predetermined temperature to enable transfer of conveyor heat directly to the sheets held thereon to dry the coating on the sheets outwardly from the inner surface of the sheets by heat conduction, and devices for feeding the sheets to said conveyor and for discharging them therefrom.

3. In a machine for handling and heat treating flexible metallic sheets having freshly applied lithograph coating on one side thereof, the combination of a non-magnetic drum conveyor for propelling the sheets along a circular path of travel, a plurality of magnets arranged interiorly of said drum conveyor and creating a magnetic field for holding the sheets on the moving conveyor, and fluid heating means contained within said drum conveyor for maintaining it at a predetermined temperature to insure transfer of drum heat to the sheets held in place on the conveyor by said magnets, whereby heat conduction is utilized to dry the coating on the sheets.

4. In a machine for handling and heat treating flexible metallic sheets having freshly applied lithograph coating on one side thereof, the combination of a non-magnetic drum conveyor for propelling the sheets along a predetermined path of travel, a plurality of magnets arranged inside of and adjacent said drum conveyor and creating a magnetic field for holding the sheets on the moving conveyor, fluid heating means contained within said drum conveyor for maintaining it at a predetermined temperature for heat treating the sheets held in place on the conveyor by said magnets, and means for maintaining the enclosed fluid heating means at a predetermined temperature.

5. In a machine for handling and heat treating flexible metallic sheets having freshly applied lithograph coating on one side thereof, the combination of a non-magnetic drum conveyor for propelling the sheets along a predetermined path of travel, a plurality of magnets arranged inside of and adjacent said drum conveyor and creating a magnetic field for holding the sheets on the moving conveyor, fluid heating means contained within said drum conveyor for maintaining it at a predetermined temperature, a pipe coil immersed in said heating fluid, and means for circulating a heating medium through said pipe coil whereby heat conduction acting between the heated conveyor drum and the sheets held thereon by said magnets assists in quickly drying said lithographed coating.

6. In a machine for handling and heat treating flexible metallic sheets having freshly applied lithograph coating on one side thereof, the combination of a non-magnetic drum conveyor for propelling the sheets along a predetermined path of travel, means for rotating said drum conveyor, a plurality of stationary magnets arranged inside of and adjacent said drum conveyor and creating a magnetic field for holding the sheets or the moving conveyor, heating elements located adjacent to and outside of said drum conveyor for creating radiating heat, a housing partially surrounding said drum conveyor and said heating elements and providing a heating chamber through which the sheets pass, and heating means contained within said drum conveyor for maintaining it at a predetermined temperature whereby the heat of said conveyor is transferred by heat conduction to the sheets as they are held thereon and as they are subjected to radiating heat in said heating chamber to quickly dry said lithograph coating.

7. In a machine for handling and heat treating flexible metallic sheets having freshly applied lithograph coating on one side thereof, the combination of a pair of rotatable drum conveyors for propelling the sheets along a circuitous path of travel, means for rotating said drum conveyors in unison, a plurality of magnets arranged inside of each drum conveyor and creating a magnetic field adjacent each outer periphery for holding the sheets in place on the moving conveyors, a transfer mechanism disposed between said drum conveyors for receiving a sheet from one conveyor and for delivering it to the other conveyor, heating means disposed within one of said drum conveyors for maintaining it at a relatively high temperature for heat treating the sheets held thereon, and cooling means disposed within the other of said drum conveyors for maintaining it at a relatively low temperature for cooling the heated sheets when they are delivered thereto by said transfer mechanism.

8. In a machine for handling and heat treating flexible metallic sheets having freshly applied lithograph coating on one side thereof, the combination of a pair of rotatable drum conveyors for propelling the sheets along predetermined paths of travel, means for rotating said drum conveyors in unison, a plurality of stationary magnets arranged within said conveyors for creating a magnetic field adjacent the outer periphery of each drum conveyor to hold the sheets in place thereon, heating means contained within one of said drum conveyors for maintaining them at predetermined temperatures for heat treating the sheets as they are held in place thereon by said magnets, a rotatable transfer wheel disposed between said drum conveyors and located in spaced relation thereto, actuating means for rotating said wheel in time with said conveyors, a plurality of gripper fingers carried on said wheel for gripping the side edges of a sheet as it leaves the magnetic field of one of said conveyors and for carrying it into place onto the other of said conveyors and into its magnetic field, and means for actuating said fingers in time with the rotation of said wheel for gripping and for releasing the sheets at the proper time.

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