May 29, 1945. W. F. BUTLER 2,376,866

OVEN

Filed Sept. 25, 1942 2 Sheets-Sheet 1

Fig 1

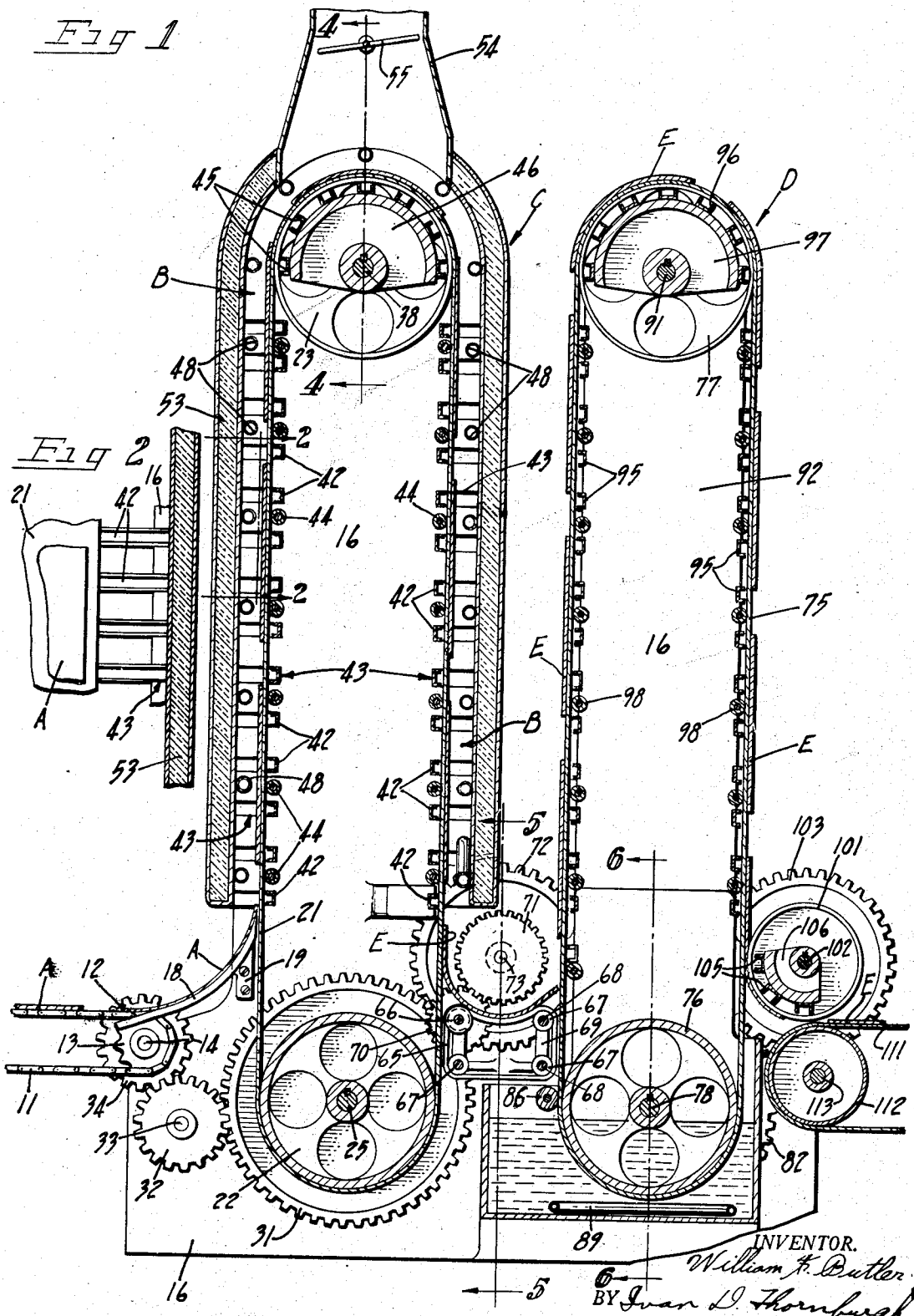


Fig 2

INVENTOR.
William F. Butler
BY Ivan D. Thornburgh
Charles H. Gene
ATTORNEYS

May 29, 1945. W. F. BUTLER 2,376,866

OVEN

Filed Sept. 25, 1942 2 Sheets-Sheet 2

Fig 4

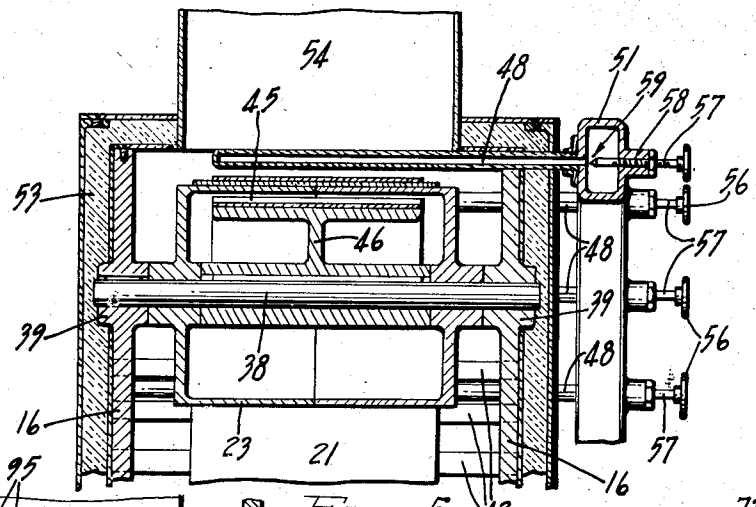


Fig 6

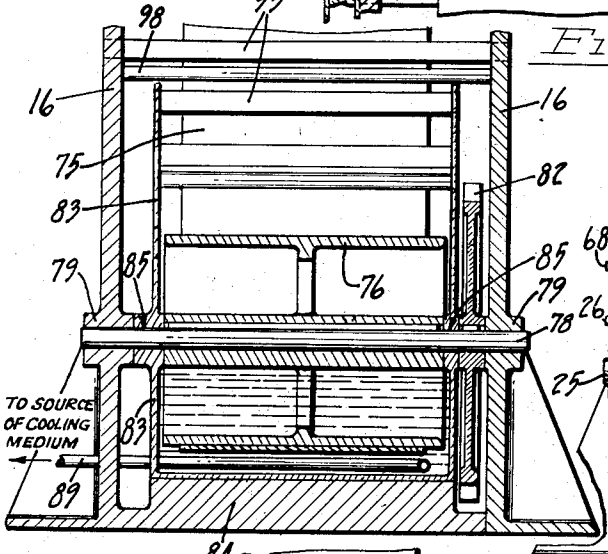


Fig 5

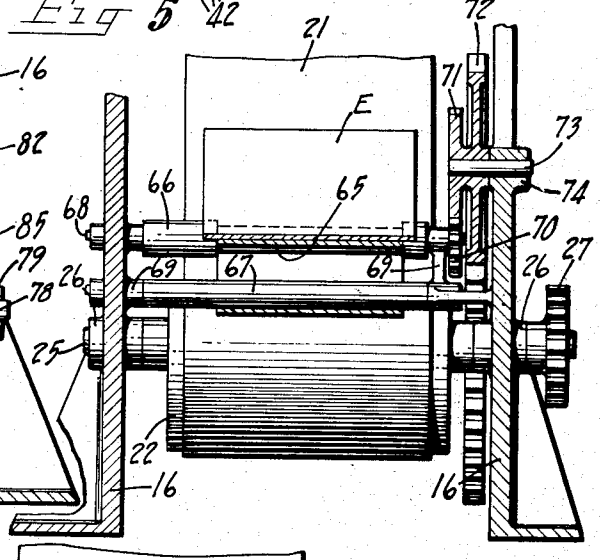
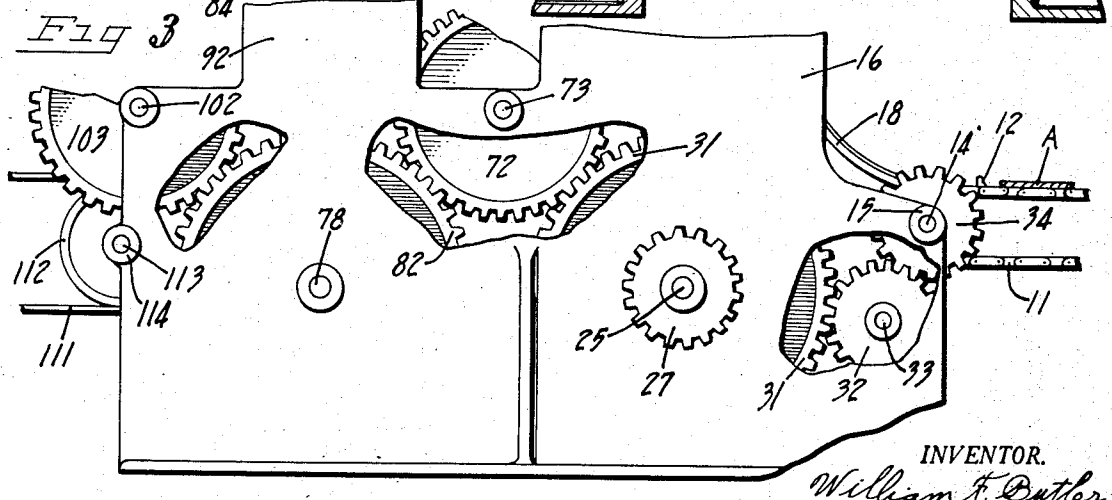


Fig 3



INVENTOR.
William F. Butler
BY Ivan D. Thornburgh
Charles H. Erne
ATTORNEYS

Patented May 29, 1945

2,376,866

UNITED STATES PATENT OFFICE

2,376,866

OVEN

William F. Butler, Hillside, N. J., assignor to American Can Company, New York, N. Y., a corporation of New Jersey

Application September 25, 1942, Serial No. 459,727

7 Claims. (Cl. 263—8)

The present invention relates to conveyor ovens for heat treating flexible metallic sheets having freshly applied lithographing or other coating material on a surface thereof, such coating being dried by heat while the sheet is in an oven following which the dried sheet is cooled in a second oven before discharge from the machine and has particular reference to maintaining the conveyors of the ovens at predetermined temperatures to facilitate quick heating and quick cooling of the sheets.

In high speed production of drying of freshly coated metallic sheets, such as tin-plate and the like material, it has been found that for quick results it is just as important to apply heat directly to the sheet stock including its under or uncoated side as it is to apply the heat as by radiation to the freshly coated side.

An important factor of the instant invention in the drying of sheets appertains to raising the the temperature of the sheet to its limit in a minimum of time and upon its initial entrance into the oven following which this high heat is maintained on the sheet for sufficient time to complete the drying action. Such invention contemplates the embodiment of these features in an apparatus which will permit of efficient drying of sheets on a high speed production schedule.

An object therefore of the invention is the provision of a 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 belt conveyor which is maintained at a constant predetermined temperature so that the heat of the belt will be transmitted by conduction to the body of the sheet by way of the surface of the sheet opposite to that carrying the freshly applied coating material thus resulting in thoroughly drying the coating material on the sheet in a minimum of time.

Another object is the provision of such a drying oven wherein the temperature of the moving sheets may be controlled at all points in the oven so that a maximum heat may be applied to a sheet as soon as it enters the oven and a lower or equal heat may thereafter be maintained throughout the remainder of the travel of the sheet in the drying oven to rapidly dry the coating material.

Another object is the provision of an apparatus of this character wherein cooling of the dried sheets is effected in a manner similar to that of heating, that is, by heat conduction as well as heat radiation 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 a fragmentary sectional detail taken through a drying oven embodying the instant invention, with parts broken away;

Fig. 3 is a side elevation of the frame housing for driving mechanism in the lower portion of the machine, with parts broken away; and

Figs. 4, 5 and 6 are transverse sectional details taken substantially along the respective lines 4—4, 5—5, 6—6 in Fig. 1.

As a preferred embodiment of the invention the drawings illustrate a vertical drying oven in which freshly coated sheets A are propelled upwardly through a drying chamber B of a heat treating section C and thence downwardly through the chamber to a transfer mechanism. The transfer mechanism delivers the hot and dried sheets to a vertical cooling section D for cooling, when cooled the sheets are discharged to a suitable place of deposit for subsequent operations or for storage.

The freshly coated sheets A are delivered into the heating section C of the oven in a horizontal position and with the freshly coated wet surface up, in any suitable manner, such as for example, by way of an endless chain entrance conveyor 11 (Figs. 1 and 3) having feed dogs 12 secured thereto at spaced intervals along the chain. The oven end of the entrance conveyor operates over a driving sprocket 13 mounted on a cross-shaft 14 journaled in bearings 15 formed in the base of a pair of spaced vertical side frames 16. These frames constitute the main frame of the oven.

Adjacent the oven end of the entrance conveyor 11 the feed dogs 12 propel the entering sheets upwardly along a curved guide rail 18 which is secured by brackets 19 to the side frames 16. The inner or upper end of the curved guide rail terminates adjacent the path of travel of a vertically disposed and constantly moving endless belt conveyor 21. This belt conveyor is made preferably of stainless steel although other non-magnetic materials may be used with equally good results.

The belt conveyor 21 constitutes a drying conveyor and operates over a lower driving pulley 22 and an upper drum-shaped and hollow idler pul-

ley 23. The driving pulley 22 is mounted on a main drive shaft 25 (see also Fig. 5) which is journaled in bearings 26 formed in the oven side frames 16. This drive shaft is rotated in any suitable manner, such as for example, by driving rotation applied through a spur gear 27 mounted outside of the frame on a projecting end of the shaft.

This drive shaft 25 also drives the entrance conveyor 11 by way of a large spur gear 31 which is mounted on the drive shaft adjacent the pulley 22. The gear 31 meshes with an idler gear 32 mounted on an idler shaft 33 journaled in suitable bearings formed in the side frames 16. The idler gear meshes with and drives an entrance conveyor actuating gear 34 which is mounted on the conveyor shaft 14 adjacent the driving sprocket 13.

The upper pulley 23 of the drying conveyor 21 rotates freely on a stationary shaft 38 (see also Fig. 4) carried in bearings 39 formed in the upper ends of the vertical side frames 16. One end of the shaft 38 is keyed in its bearing to hold the shaft stationary.

Adjacent the inner face of the drying conveyor 21 there are a plurality of stationary magnets 42 disposed at spaced intervals along both of the vertical runs of the conveyor. The result is a magnetic field throughout the area. These magnets preferably are permanent magnets but electro-magnets may be utilized if desired. The magnets extend transversely of the belt conveyor between the two side frames 16 and have their ends secured in notches 43 formed in the frames, as best shown in Figs. 1 and 2.

Idler rollers 44 disposed at spaced intervals between the magnets 42 engage against the moving conveyor belt 21 and thus maintain it in a predetermined spaced relation to the magnets so that the conveyor will not drag across the face of the magnets. These rollers have trunnions which are carried in suitable bearings in the side frames 16.

Hence as an entering freshly coated sheet A moves upwardly along the curved guide rail 18 its lower or uncoated surface comes into engagement with the moving drying belt conveyor 21 at a place adjacent one of the magnets 42. The magnets draw the sheet into close contact with the conveyor and thus cause the sheet to cling to and ride with the conveyor. In this manner a sheet clinging to the conveyor is carried upwardly passing through the magnetic field along one side of the oven from one magnet to the next and on up to the top of the oven.

At the top of the oven where the conveyor belt 21 passes over the upper pulley 23, the sheets continue to be maintained in place on the conveyor and over the top by a plurality of spaced and parallel auxiliary top magnets 45 which are identical with the magnets 42. These top magnets are disposed inside the hollow upper pulley and the outer faces of the magnets are near the inner surface of the pulley. Magnets 45 are secured in a stationary segmental barrel shaped bracket 46 which is disposed inside of the hollow pulley and is keyed in place on the stationary shaft 38. With this construction the pulley 23 freely rotates around the magnets and thus permits of the continuous travel of the conveyor and its sheets over the pulley. Following this over-the-top movement the sheets pass down the opposite side of the oven, being still held magnetically on the moving conveyor by the row of magnets 42. It will be understood that the pulley 23 is a split pulley composed of two half sections which allow for easy assembly outside of the bracket 46.

During this up, over and down travel of the sheets, the freshly applied coating on the outer sheet surface is thoroughly and quickly dried. This drying action is brought about by a plurality of heating elements 48 which are disposed adjacent to the outer surface of the conveyor along its vertical runs and around the top of the upper pulley 23. These heating elements preferably are long tubular heaters which extend transversely of the conveyor and which are formed for the internal combustion of a gas and air mixture which is within 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 conveyor.

One end of each tubular heater 48 projects through one of the side frames 16 (see Fig. 4) and is secured into a gas manifold 51 located adjacent and outside of the frame. This manifold leads from any suitable source of supply of heating gas.

Thus as the coated surfaces of the sheets A move past the heaters 48 with the conveyor, the heat created adjacent the conveyor helps dry the coating on the sheets. In order to concentrate this radiated heat on the conveyor and the sheets thereon, the major upper portion of the conveyor is enclosed by surrounding sides, ends and top of an insulated housing on casing 53. This casing is secured to the side frames 16 and extends upwardly, close to the vertical runs of the conveyor and around the upper pulley 23. The casing entirely encloses the heating elements 48 and the magnets and sets off between its inner walls the heating chamber B hereinbefore mentioned. At the top of the casing a vent stack 54 having an adjustable damper 55 is provided to permit escape of fumes from the drying coating material of the sheets.

Hence with the greater portion of the moving conveyor 21 enclosed in the casing 53, the conveyor belt is continually maintained in a heated condition at a predetermined temperature. The incandescent heating elements 48 between the sheets radiate heat directly to the belt and compensate for any heat losses. In other words, when a sheet enters the heating chamber by way of the curved guide rail 18, its rearmost or uncoated surface immediately comes into engagement with the hot surface of the conveyor and thereby begins the immediate transfer of heat by conduction to the sheet through the rear surface.

By this means a sheet may be quickly and thoroughly heated throughout its entire thickness in a minimum of time and in fact before actual drying of the coating material begins to take place. With such favorable drying conditions present, it will be apparent that the drying of the coating material takes place from the inner surface as well as its outer surface. This not only greatly expedites the drying action but results in a more uniform bake than heretofore attained.

Since direct conduction of heat to a cold sheet from the hot belt results in heat losses at the beginning of the drying action, it is desirable to maintain a greater temperature adjacent the entrance end of the chamber B than throughout the remainder of the chamber. This is accomplished very effectively in the present oven for each heating element 48 is provided with a manually oper-

able control device. Thus each heater may be regulated independently of the others, thereby providing complete control of the temperature at any heater throughout the chamber.

In the present disclosure such control devices are shown as hand valves 56 (Fig. 4) having valve stems 57 which are threaded into bosses 58 formed on the gas manifold 51. The inner end of each of the stems cooperates with a valve seat 59 formed in the manifold end of the particular heater 48 involved. Hence by rotating the valve stems, the entrance to the heaters may be opened up or restricted as desired and thus the volume of gas entering the heaters is under complete control.

Upon the completion of the travel of a sheet A through the drying chamber B the sheet is dried but is still slightly tacky. In this condition it is ready for delivery into the cooling section D of the oven. In this cooling section the coating is hardened and this eliminates the tacky condition. Transfer of the dried sheet (indicated by the letter E) from the drying section C to the cooling section D is brought about by a transfer device which includes a non-magnetic transfer belt 65 which is disposed adjacent the drying conveyor 21 (Figs. 1 and 5). This transfer belt operates over a magnetic driving pulley 66 and three non-magnetic idler pulleys 67 which are arranged in a rectangular pattern as shown in Fig. 1. These pulleys are mounted on cross-shafts 68 carried in bearings and bearing brackets 69 which extend out from the inner faces of the side frames 16.

The magnetic drive pulley 66 is continuously rotated by a spur gear 70 which is mounted on the pulley shaft 68. This gear meshes with a driving gear 71 which is formed integrally with a gear 72 which is mounted on a short shaft 73 (Fig. 5) carried in a bearing 74 formed in the adjacent side frame 16. The gear 72 meshes with and is driven by the main driving gear 31.

In this construction of transfer unit the driving pulley 66 is located adjacent the heating conveyor 21 on the approach side of the sheet so that the transfer belt will be pulled tight along all runs excepting the top run. The belt is purposely made loose so that there is a predetermined amount of slack along the top run and thus gives this run a concave effect.

As a dried sheet E on the drying conveyor 21 moves into position adjacent the transfer device it passes almost entirely out of range of the magnets 42 in the drying chamber B and reaches a position where its lower portion hangs loosely on the conveyor while its upper portion is still held by the lowermost magnet 42. In this loosely hanging position the magnetic driving pulley 66 attracts the lower edge of the sheet and draws it away from the conveyor, carrying it over the pulley and into engagement with the slack run of the conveyor belt and with the tacky side of the sheet facing upwardly away from the belt. The belt carries the sheet to the cooling section D in this position and thus prevents smearing of the tacky coating on the sheet during the transfer of the latter.

The cooling section D includes a vertically disposed cooling belt conveyor 75 (Figs. 1 and 6) which is disposed adjacent the transfer belt 65 and operates over a lower driving pulley 76 and an upper hollow, drum shaped idler pulley 77. The driving pulley 76 is mounted on a drive shaft 78 which is journaled in bearings 79 formed in the side frames 16. Pulley 76 is rotated by a spur gear 82 which is mounted on the drive shaft and which meshes with and is rotated by the transfer drum gear 68. This pulley rotates in a bath of cold water, which is retained within a tank 83 mounted on a base 84 connecting the side frames 16. The tank extends up above the pulley and is formed with bearing outlets 85 for the drive shaft 78. A wringer roller 86 is disposed within the tank 83 above the level of the water bath therein and frictionally rotates with the outer surface of the belt to wipe off the water clinging thereto.

The water within the tank 83 is maintained at a low cooling temperature by brine or other cooling medium which is circulated through a pipe coil 89 located in the bottom of the tank and immersed in the water of the tank. One end of the pipe coil leads from a suitable source of the cooling medium while the opposite end leads to a return pipe or to a suitable place of disposal for the used coolant. The cold water in the tank maintains the belt conveyor 75 which operates over the driving pulley, in a constantly cooled condition.

The upper or idler pulley 77 of the cooling conveyor 75 rotates freely on a stationary shaft 91, the ends of which are fixed in bearings formed in a vertical extension 92 of the side frames 16. This idler pulley is identical in construction and operation with the idler pulley 23 in the drying section C of the oven.

Between the lower and upper pulleys 76, 77 of the cooling section D there are a plurality of spaced stationary magnets 95 which are disposed adjacent the inner surfaces of the vertical runs of the cooling conveyor 75. The ends of these magnets are secured to the frame extensions 92. In like manner to the magnets within the heating section pulley 23 there are a plurality of transverse top magnets 96 disposed inside the idler pulley 77. These top magnets 96 are stationary and are secured to a stationary segmental barrel shaped bracket 97 which is keyed to the stationary pulley shaft 91 inside the pulley. Main magnets 95 and auxiliary magnets 96 hold the sheets for cooling. Idler rollers 98 disposed between the magnets 96, as in the heating section B, prevent dragging of the cooling conveyor across the face of these magnets.

Hence when a dried sheet E is carried by the transfer belt 65 into place adjacent the cooling conveyor 75, the sheet moves into the range of the magnets 95 along that side and is attracted to cooling conveyor. The constantly moving cooled conveyor carries the sheet upwardly, over the top of the idler pulley 97, and thence downwardly toward the bottom of the conveyor.

During this travel of the sheet it gives up its heat to the cooled conveyor 75 by heat conduction. The heat of the sheet then is dissipated in the cooling tank 83 as the conveyor passes therethrough. A certain amount of the heat of the sheet is dissipated into the cooler atmosphere surrounding the conveyor as by radiation for the cooling conveyor is exposed to the air and is not covered by a casing or hood as in the drying section of the oven.

As a dried and cooled sheet E approaches the bottom of the cooling conveyor D it is picked off by a discharge drum 101 (Fig. 1) which is disposed adjacent the bottom of the conveyor. This discharge drum rotates freely on a stationaary shaft 102 having its ends secured in bearings formed in the side frames 16. The drum is continuously rotated by a gear 103 (see also Fig. 3)

which is secured to the drum and which is driven by the cooling conveyor drive gear 82. Within the drum there is a plurality of transverse magnets 105 which are arranged near the inner surface of the drum. These magnets are bolted to a stationary segmental barrel shaped bracket 106 located within the drum and keyed to the stationary shaft 102.

Hence when a sheet E comes into position between the cooling conveyor 75 and the discharge drum 101, it moves out of the range of the magnets adjacent the conveyor and comes into the range of the magnets in the drum. The sheet is attracted to the discharge drum and moves with it as the drum rotates.

The discharge drum 101 carries a sheet E clinging to it, for approximately one-quarter revolution. Here the sheet moves out of the range of the magnets 105 within the drum and accordingly falls away from the drum. The freed sheet is received on an endless belt discharge conveyor 111 which carries the sheet to any suitable place of deposit. The oven end of this conveyor operates over a pulley 112 which is mounted on a cross shaft 113 journaled in bearings 114 formed in the side frames 16 (see also Fig. 3). This conveyor may be actuated in any suitable manner in time with the moving parts of the oven.

With such a construction of oven the vertical nature of the drying and the cooling conveyors saves considerable floor space while providing for a simple, durable machine which may be operated at high speeds and which is capable of uniform continuous production of sheet treatment with ease of machine maintenance.

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 an endless non-magnetic belt conveyor for propelling the sheets along a predetermined vertical path of travel, a plurality of magnets arranged inside of and adjacent both runs of said conveyor and creating a magnetic field for holding the sheets on the belt conveyor, a casing for partially enclosing both runs of said conveyor, heating elements located inside of said casing and adjacent said conveyor for maintaining the conveyor at a predetermined temperature to facilitate transfer of conveyor heat directly to the sheets by heat conduction when the sheets are received on said conveyor and for drying the sheet coating by radiating heat as the sheets move upwardly and downwardly inside of said casing, and means connecting with each of said heating elements for regulating its heat output so that the temperature along the conveyor may be controlled at desired places within said casing.

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 vertically disposed endless non-magnetic belt conveyor for propelling the sheets along a predetermined path of travel extended along both runs and over one end of said conveyor, upper and lower pulleys over which said conveyor operates, a plurality of magnets arranged inside of and adjacent to both runs of said conveyor, a plurality of auxiliary magnets disposed inside of said upper pulley, said magnets creating a magnetic field for holding the sheets on the conveyor while passing along said conveyor runs and over said upper pulley, a casing for partially surrounding said conveyor, and heating elements located outside of both runs of said conveyor and outside of said upper pulley for heating the conveyor and for creating a radiating heat inside of said casing whereby heat transfer by conduction is effected between the sheets and said conveyor, and whereby the coated surface of the sheets receives heat transfer by radiation while passing through said casing to the end that the coating on the sheets may be dried in a minimum of time.

3. In a machine for handling and heat treating flexible metallic sheets having freshly applied lithograph coating, the combination of a pair of endless non-magnetic belt conveyors for propelling the sheets along predetermined vertical paths of travel, a plurality of magnets arranged adjacent both runs of each of said conveyors and creating a magnetic field for holding the sheets on the conveyors during passage therewith, transfer means disposed between said conveyors for receiving the sheets from one and for delivering the sheets to the other of said conveyors, heating elements located adjacent one of said conveyors for heating the belt conveyor and for creating radiating heat to dry the fresh lithograph coating on the sheets as the sheets move with said heat conveyor, and a tank containing a cooling liquid located adjacent the second conveyor and in a position so that said second belt conveyor passes into the cooling liquid and heat is thereby extracted whereby the sheets are cooled by transfer of heat by conduction from sheet to belt conveyor in addition to heat radiated from the sheet while carried by said second conveyor.

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 pair of vertically disposed endless non-magnetic first and second belt conveyors for propelling the sheets along predetermined paths of travel and to which conveyors the said coated sheets are fed in series, means for actuating said conveyors in unison, a plurality of magnets arranged adjacent each run of each of said conveyors and creating a magnetic field for holding the sheets with their uncoated surface against said runs of the moving conveyors, a transfer mechanism disposed between said conveyors for receiving the sheets from the first and for delivering them to the second of said conveyors, heating elements located adjacent the first of said conveyors for heating the same and for creating radiating heat to dry the fresh lithograph coating on the sheets as the sheets move with the first conveyor, a casing surrounding the first of said conveyors for confining the heat emanating from said heating elements, a tank containing a cooling liquid located beneath the second conveyor and in a position so that said second conveyor dips into the cooling liquid and its temperature is reduced, and means for maintaining the cooling liquid at a predetermined low temperature whereby the sheets are cooled by transfer of heat by conduction from sheet to conveyor in addition to heat radiated from the

sheet while carried by said exposed second conveyor.

5. In a machine for handling and heat treating flexible metallic sheets having freshly applied lithograph coating, the combination of a vertically disposed endless non-magnetic belt conveyor for propelling the sheets up, over and down a predetermined vertical path of travel, a plurality of magnets arranged inside of both runs of said conveyor and around one end thereof, said magnets creating a magnetic field for holding the sheets on the conveyor throughout the entire path of the sheets with the conveyor, heat treating means located outside of the sides and top of said conveyor for heating the conveyor and for creating a heating zone through which the coated sheets pass while on said conveyor whereby the sheets are heated by heat conduction from said conveyor and the coated surface is subjected to a radiating heat in the heating zone to quickly dry the coating, and devices for feeding the freshly coated sheets to said conveyor at the bottom and for discharging the dried sheets also at the bottom of the conveyor.

6. In a machine for handling and heat treating flexible metallic sheets having freshly applied lithograph coating, the combination of a pair of endless non-magnetic belt conveyors for propelling the sheets along predetermined vertical paths of travel, a plurality of magnets arranged adjacent both runs of each of said conveyors and creating a magnetic field for holding the sheets on the conveyors during passage therewith, transfer means disposed between said conveyors for receiving the sheets from one and for delivering them to the other of said conveyors, heat treating means located exteriorly of the first of said conveyors for maintaining the belt conveyors at the desired temperatures for heat treament of the sheets so that the first of said conveyors transfers heat to the sheets and the second conveyor extracts heat from the sheets, and cooling means located exteriorly of said second conveyor.

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 juxtaposed endless non-magnetic belt drying and cooling conveyors for propelling the sheets along a predetermined vertical path of travel, a plurality of magnets arranged adjacent both runs of each of said conveyors and creating a magnetic field for holding the sheets on the moving conveyors, a casing partially surrounding the first and drying conveyor and enclosing a heating chamber, gas heaters located inside of said heating chamber for heating said first conveyor and for creating radiating heat for application to the freshly coated surface of the sheets carried by said conveyor to facilitate quick drying of the coating by direct heat conduction from conveyor to sheet and by heat radiation against the coated surface, a manually operable valve connecting with each of said gas burners for regulating its heat output so that the temperature in said heating chamber may be controlled, means for transferring the sheets from the first drying conveyor to the second cooling conveyor, and means for cooling said second conveyor.

WILLIAM F. BUTLER.