

Aug. 6, 1940.

F. O. HESS

2,210,032

METHOD AND APPARATUS FOR DRYING PRINTING INK

Filed Dec. 29, 1937

4 Sheets-Sheet 1

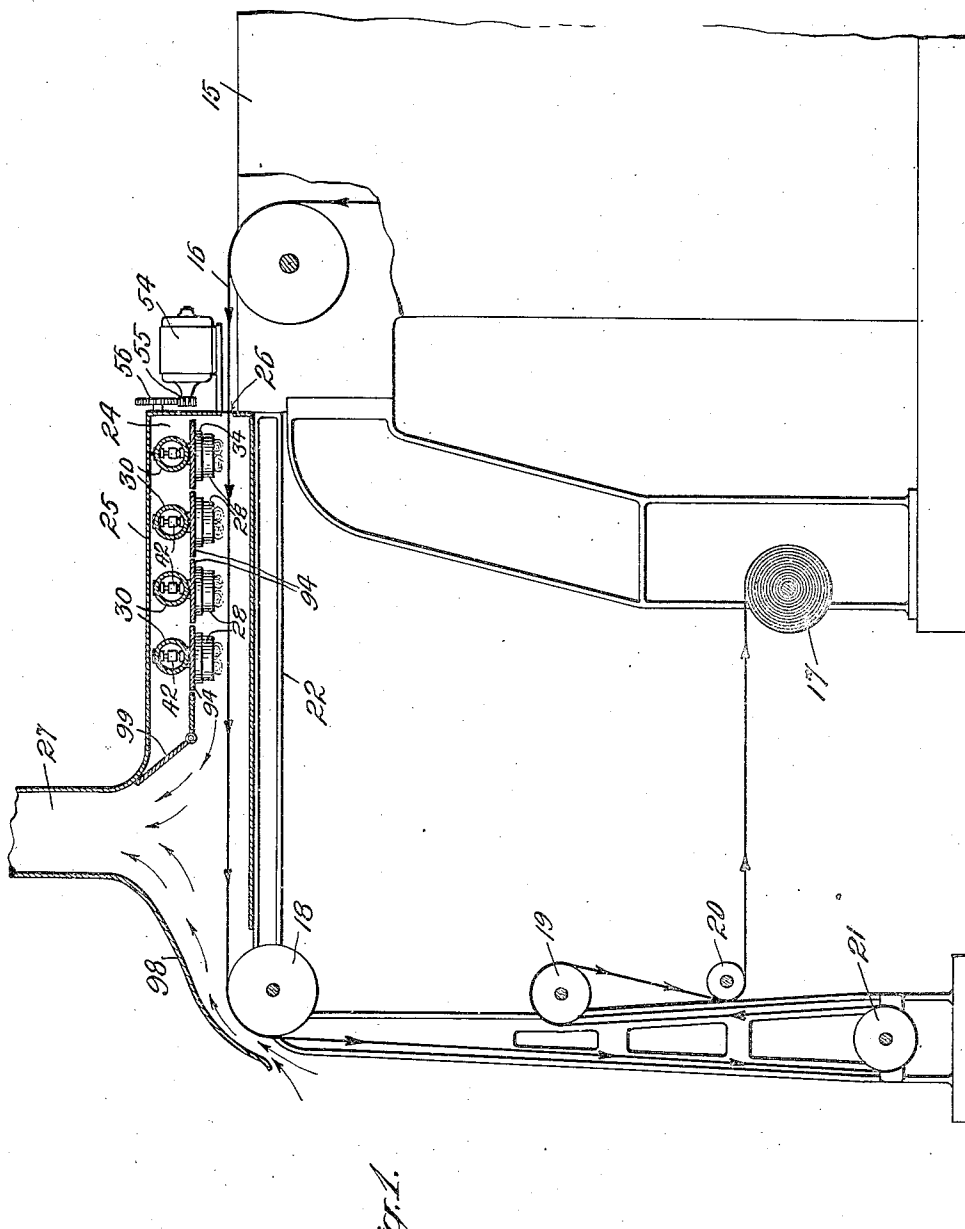


Fig. 1.

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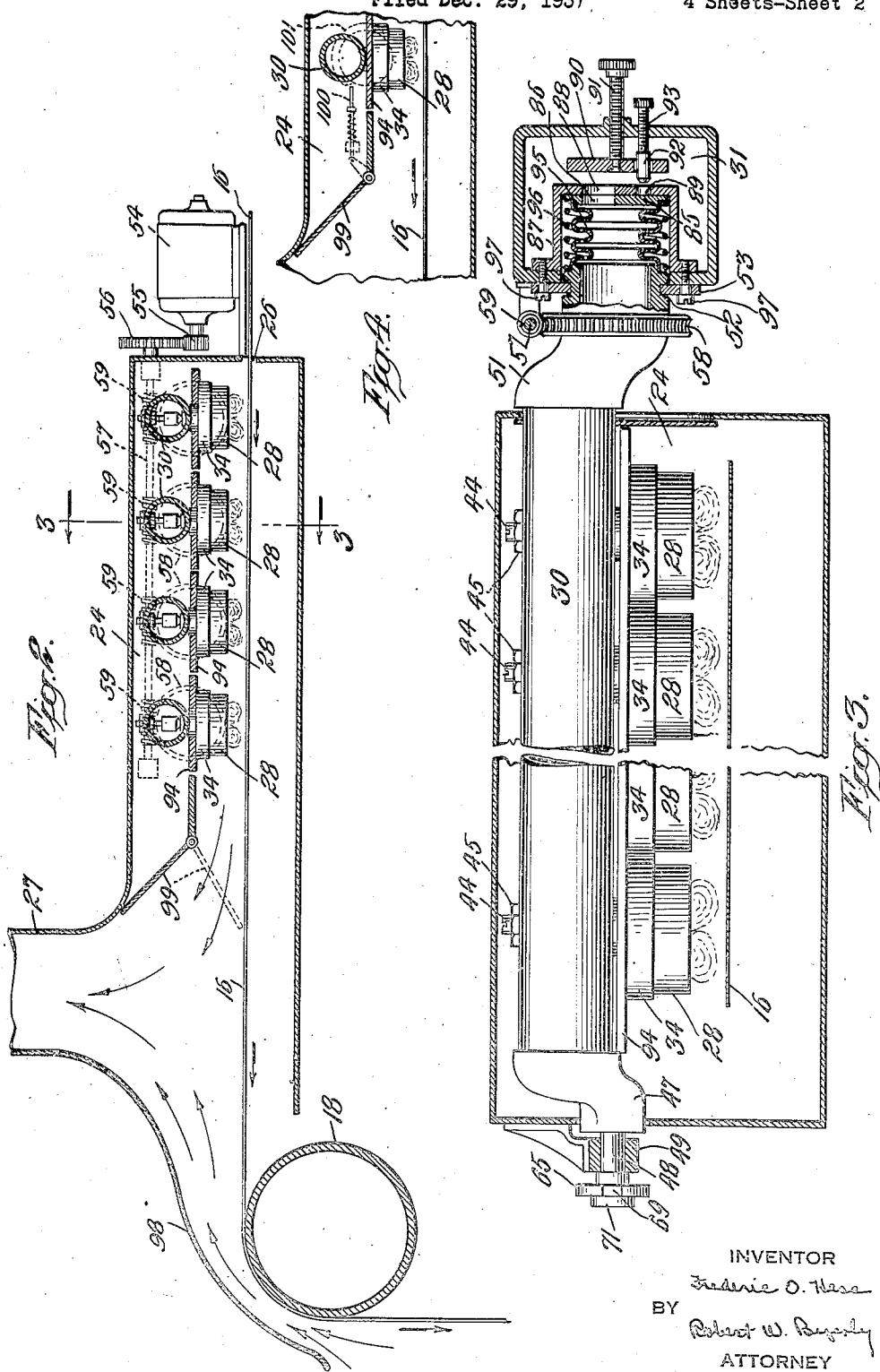
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METHOD AND APPARATUS FOR DRYING PRINTING INK

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4 Sheets-Sheet 2



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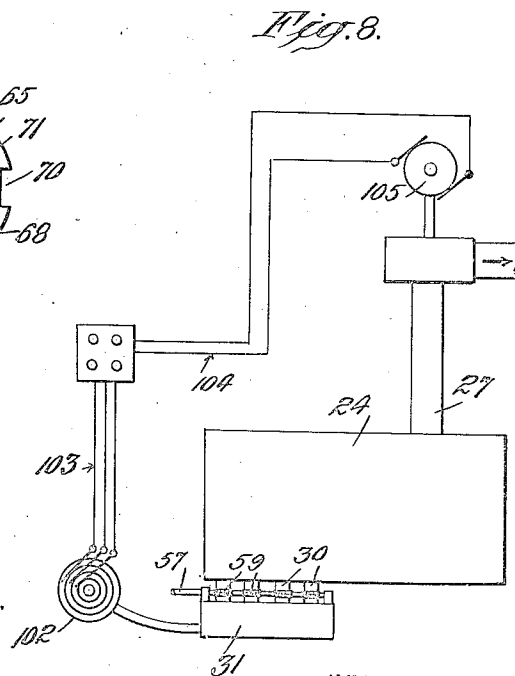
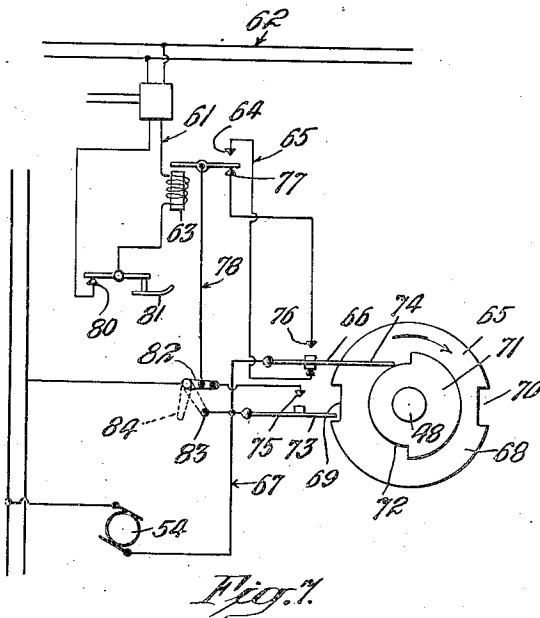
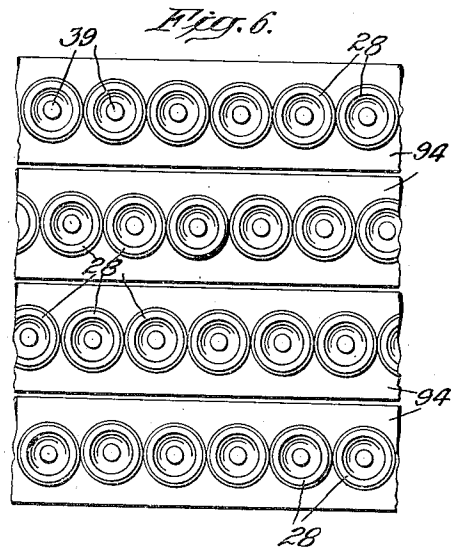
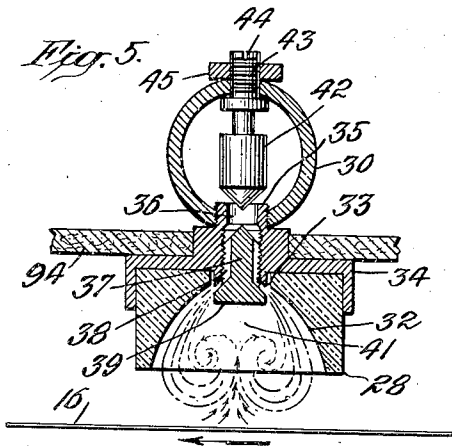
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METHOD AND APPARATUS FOR DRYING PRINTING INK

Filed Dec. 29, 1937

4 Sheets-Sheet 3



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METHOD AND APPARATUS FOR DRYING PRINTING INK

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4 Sheets-Sheet 4

Fig. 9.

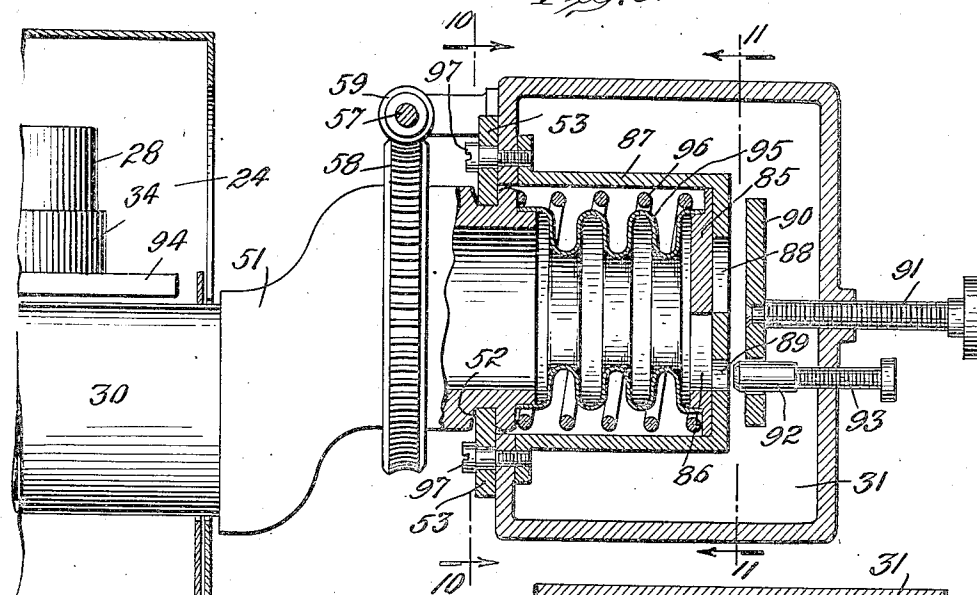


Fig. 10.

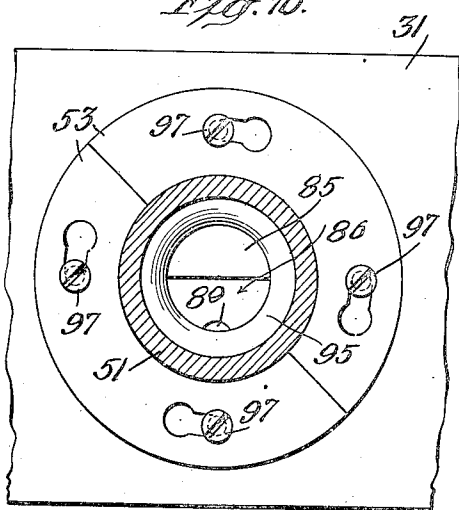
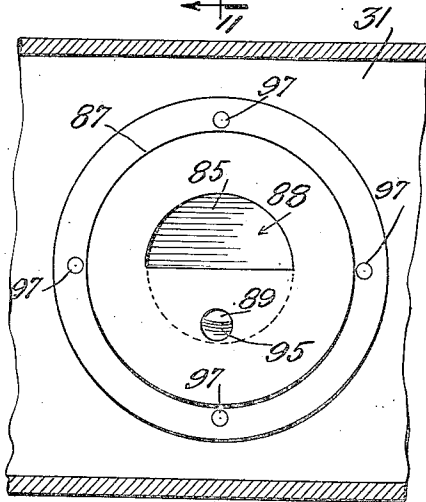


Fig. 11.



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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR DRYING
PRINTING INK

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Application December 29, 1937, Serial No. 132,209

27 Claims. (Cl. 101—416.1)

This invention relates to printing and aims to provide an improved method and apparatus for drying printing ink.

There are typographic printing inks in extensive use at the present time whose vehicles consist of a binder dissolved in a solvent which is substantially non-volatile at ordinary press room temperatures (about 25° C.) and which becomes highly volatile at temperatures of about 150° C. When such inks are applied to a web, the speed at which the web is fed from the printing press to the web rewind roller may be in excess of four hundred feet per minute. It is necessary that the ink printed upon the web traveling at this high rate of speed be dried in the short space between the printing press and the rewind roller to prevent offsetting or smudging of the ink. Merely volatilizing the solvent of the ink is not sufficient for the solvent vapors are dragged along with the traveling web and recondense upon its surface, softening the ink and causing offsetting or smudging. It is necessary that the solvent vapors be removed from proximity to the printed surface. In the past this has been done through destroying the solvent vapors by igniting them as they emerge from the ink.

I have discovered that the efficiency and effectiveness with which the solvent may be removed and the solvent vapors destroyed may be increased by causing the printed web to travel past a battery of cup-shaped gas burners which subject the printed surface of the web to heat of such great intensity that the solvent is instantaneously volatilized and by causing solvent vapors to be withdrawn from the surface of the web into the burners where they are burned. The period during which the printed web is subjected to this intense heat is so brief that, even though it consists of paper or other inflammable material, it is not charred.

In accordance with my invention, the material upon which an ink such as that referred to above has been printed is drawn past a battery of burners directed toward the printed surface of the material, so that the solvent of the ink is volatilized and solvent vapors are withdrawn from the surface of the material into the burners and burned.

My invention also includes apparatus by means of which the intense heat necessary to volatilize the ink solvent and burn the solvent vapors in a very brief period of time may be efficiently and safely supplied.

In the form which I now consider most desirable, the apparatus includes a gas furnace lo-

cated in the path of the printed material. A series of gas burners are attached to manifolds so that the intense heat generated in the burners may be directed upon the printed surface of the material. Those manifolds are mounted for orbital movement within the housing of the furnace and are connected with a fuel chamber from which a mixture of air and gas is fed to the burners.

A specific embodiment of apparatus for carrying out my invention is illustrated in the accompanying drawings in which:

Fig. 1 is a side elevation of the furnace attached to the frame of a printing press;

Fig. 2 is an enlarged view of the furnace shown in Fig. 1;

Fig. 3 is an enlarged transverse section of the furnace taken on the line 3—3 of Fig. 2;

Fig. 4 is a fragmentary view illustrating the apparatus for operating the member preventing communication between the manifold compartment of the furnace and the suction duct;

Fig. 5 is a transverse section of one of the burners;

Fig. 6 is a fragmentary plan view of a battery of burners;

Fig. 7 is a diagram of the burner manifold electric control;

Fig. 8 is a diagram of the gas supply electric control;

Fig. 9 is an enlarged section showing the details of the connection between a manifold and the fuel chamber;

Fig. 10 is a section taken on the line 10—10 of Fig. 9; and

Fig. 11 is a section taken on the line 11—11 of Fig. 9.

The apparatus illustrated in the drawings includes a typographic press 15 of standard construction for printing upon a web of material 16 fed from the press to the usual rewind roller 17. As the printed web emerges from the press, it is led, in the direction indicated by the arrows in Figs. 1 and 2, through a drying apparatus, to be described, over cooling roller 18 and guide rollers 19, 20 and 21 to rewind roller 17.

The drying apparatus is mounted upon a frame 22 attached to the delivery end of the press and comprises a gas furnace 24 having a housing 25 provided with a narrow slit 26 at its front end for the entry of the printed web 16 and communicating with a suction duct 27 at its rear end. Heat is supplied to furnace 24 by means of cup-shaped burners 28 attached to manifolds 30 which communicate with a fuel chamber 31. A

mixture of gas and air is supplied under pressure to fuel chamber 31 by a mixer (not shown) of conventional type.

The burners 28, as best illustrated in Fig. 5, are of refractory material having a cup-shaped inner surface 32 and a central opening 33. Each burner is attached to its manifold 30 by means of a holder 34 having an externally threaded end 35 screwed in the threaded opening in the manifold. Screwed in central opening 36 of holder 34 is a member 37 having a plurality of passageways 38 and a conical end 39 extending into the burner below opening 33.

When the burner is lighted, fuel passes from manifold 30 through the passageways 38 in separate streams to provide diverging jets of flame. The relationship between the conical end 39 of member 37 and the cup-shaped inner surface 32 of burners 28 is such that the flame jets extend substantially parallel to the surface 32 thereby heating it to incandescence and forming an area 41 of reduced pressure within the burner.

The intense heat directed from incandescent burner 28 upon the printed surface of web 16 causes the solvent of the ink to volatilize instantaneously and the diverging flame jets occasion a vortex action which sucks the solvent vapors from the surface of the web to the area 41 of reduced pressure where they are burned. As illustrated in Fig. 6, the various series of burners 28 are mounted upon their respective manifolds 30 in staggered relation so that intense heat is directed upon all portions of the web equally and streaking of the web is thereby prevented.

Means are provided for cutting off or regulating the amount of fuel supplied to each of the burners individually: A needle valve 42 having an externally threaded end 43 is screwed in a threaded opening in manifold 30. By inserting a screwdriver in kerf 44, the needle valve 42 may be screwed up or down to open or close the passageway through holder 34. A lock nut 45 is provided to hold needle valve 42 in the position desired. Thus if the printed surface of web 16 passing through furnace 24 is not coextensive with the series of burners 28, those burners which are not serving an effective purpose may be shut off. Furthermore, the adjustable valves 42 permit control of the amount of heat supplied by each of the various burners 28.

Means are provided for shifting the burners 28 from the operative position illustrated in Figs. 1, 2 and 3 to an inoperative position and at the same time cutting down the supply of gas issued to the burners when movement of the web 16 past the burners is interrupted so that the web will not be set on fire. As illustrated in Fig. 3, each manifold 30 is provided with a closure 47 at one end from which extends a shaft 48 journaled in bearing 49. The other end of manifold 30 has an extension 51 provided with a groove 52 which serves as a seat for the bearing 53 fixed to fuel chamber 31. To place burners 28 in operative position, manifold 30 is rotated through an angle of 180° with shaft 48 serving as the axis of rotation.

It will be noted that closure 47 and extension 51 are bent so that the manifolds 30 are offset from the axis of rotation and the manifolds describe an orbital path when the burners are turned from operative to inoperative position and vice versa. This permits the construction of a compact furnace in which the burners 28 are brought into close proximity to the printed surface of web 16 when they are in operative position

without requiring a deep space at the top of the furnace 24 when they are in inoperative position.

Rotation of the manifold 30 is effected by means of an electric motor 54 having a gear 55 meshing with gear 56 attached to shaft 57. Fixed to extension 51 of each manifold 30 is a gear 58 which meshes with worm 59 fixed on shaft 57. Thus, the manifold 30 rotates with motor 54, which in turn is placed in operation automatically whenever web 16 begins or stops traveling through furnace 24.

The means for starting and stopping motor 54 are illustrated diagrammatically in Fig. 7 in which the various members occupy the position which they assume when the press is not in operation. A circuit 61 is connected with the press circuit 62 and, when the press circuit is closed, solenoid 63 is energized, closing switch 64 and circuit 65 connected through switch 66 with circuit 67 of motor 54.

Fixed to shaft 48 for rotation therewith are cam 65 having dwells 69 and 70 and cam 71 having dwell 72. When circuit 67 is closed and motor 54 is placed in operation as aforesaid, rotation of shaft 48 causes cam 68 to bear against finger 71, thus closing switch 75. Thereafter, but before shaft 48 has rotated through an angle of 180°, cam 71 bears against finger 74, opening switch 66 and closing switch 76. As soon as shaft 48 has rotated through an angle of 180°, finger 73 falls in dwell 70, thus opening motor circuit 67 and stopping the motor with the burners in the operative position illustrated in Figs. 1, 2 and 3.

When press circuit 62 is opened, the solenoid 63 is de-energized, closing switch 77, circuit 78 and motor circuit 67. Rotation of shaft 48 then causes the cam 68 to bear against finger 73, closing switch 75, and further rotation of that shaft through an angle less than 180° causes finger 74 to rest in dwell 72. When shaft 48 has rotated through an angle of 180°, finger 73 reaches dwell 69, opening switch 75 and motor circuit 67, thus stopping the motor with the various parts in the position illustrated in Fig. 7.

When travel of the web 16 through furnace 24 is stopped while the press is in operation, solenoid 63 will also be de-energized by opening switch 80, thus causing the burners 28 to be rotated to an inoperative position as described above. Switch 80 is actuated by shoe 81 which rides upon web 16. If web 16 should be broken so that its travel through the furnace is interrupted, shoe 81 will fall, opening switch 80.

Means are provided also for rotating manifolds 30 through an angle less than 180° and then stopping them so that repairs or adjustments may be effected when the press is not in operation. Motor circuit 67 may be closed by moving switch 82 to contact 83 until the desired rotation has been effected and the switch is then moved to the position indicated by dotted lines at 84. After the desired repairs or adjustments have been effected, switch 82 is returned to its initial position and normal operation of the motor control mechanism is resumed.

The large amount of fuel which must be furnished to the burners when they are in operative position is diminished automatically when the burners are placed in inoperative position to the amount necessary to keep the burners lighted: Attached to the extension 51 of each manifold 30 to rotate therewith is a valve 85 having a port 86. Each valve 85 is provided with a sleeve 87 fixed in the fuel chamber 31 and having a port 88 adapted

to register with port 80 when the burners are in operative position. Sleeve 87 also contains a second port 89 of restricted size which is closed by valve 85 when the burners are in operative position. When the burners are turned to inoperative position, valve 85 closes port 83 and port 86 registers with port 89 which admits just sufficient gas to the manifolds to maintain a pilot light in the burners. The volume of gas which may flow through open port 88 is regulated by plate 90 attached to adjustment screw 91 and the volume of gas that may flow through port 89 is regulated by the plug 92 fixed to adjustment screw 93.

The heat generated within the housing 25 while the burners 28 are in operation is so intense that the burner manifold 30 may become dangerously hot. To prevent this, a strip 94 of insulating material is fixed to each manifold 30 between the manifold and the burners 28. These strips are of such width that their adjacent edges nearly meet to form a partition providing separate burner and manifold compartments. Even when such a partition is provided, the manifolds 30 become sufficiently hot to be subjected to a certain amount of expansion, contraction and warpage. I provide for this by means of a flexible connection between the manifolds and fuel chamber 31.

The valve 85 is connected with extension 51 of burner manifold 30 by a flexible conduit 95. It is necessary that this conduit be composed of a material which will not be affected by the heat to which it is subjected or the gas which flows through it. In the embodiment illustrated in the drawings, conduit 95 constitutes a bellows-like tube with thin corrugated walls and is preferably constructed of copper. To assemble the connection between the burner manifolds 30 and the fuel chamber 31, the bearing 53 is formed of a split ring as illustrated in Fig. 10. A coil spring 96 is inserted between the end of extension 51 and valve 85, and the valve is inserted in sleeve 87, so that it bears against the end of that sleeve. Split ring bearing 53 is then placed in the groove 52 and is fastened to fuel chamber 31 and sleeve 87 by bolts 97.

Products of combustion and any vapors from the ink which may not have been burned are withdrawn from the furnace 24 through suction duct 27. In order that all such vapors will be withdrawn, suction duct 27 is provided with a skirt 98 which extends over roller 18 to provide a restricted opening to the press room. As indicated by the arrows in Figs. 1 and 2, fresh air is withdrawn through this opening from the press room in a direction counter to the travel of the printed web, and this counter-current of fresh air prevents the traveling web from dragging the products of combustion or solvent vapors with it to the press room.

Communication between suction duct 27 and furnace 24 is limited to the burner compartment of the furnace by means of a pivotally mounted member 99. When the burners 28 are in operative position, the burner compartment of furnace 24 constitutes the compartment below the partition formed by the strips of insulating material 94, and the manifold compartment of the furnace is above the strips. When the burners are swung to inoperative position, the positions of these compartments are reversed. Fixed to the member 99 is an arm 100 actuated by cam 101 attached to extension 51, so that the member 99 is swung down when the burners are moved to inoperative position and up when the burners are moved to operative position, thus maintaining connection

between suction duct 27 and the compartment of furnace 24 containing the burners.

It is of the utmost importance that the products of combustion and, in particular, any unburned solvent vapors be removed through suction duct 27. If the products of combustion be permitted to escape to the press room, they may render the atmosphere in the press room unendurable, and, if unburned solvent vapors should be allowed to accumulate, an explosion might be occasioned. To provide for this, the gas supply motor 102 is connected by circuit 103 with circuit 104 for suction motor 105 (see Fig. 3). Accordingly, the gas supply motor 102 cannot operate unless the suction motor circuit 104 be closed.

A mode of carrying out my invention will be apparent from the foregoing description. I will summarize it briefly:

As the web 16 emerges from the printing press 15 where an ink containing a volatilizable, inflammable solvent is applied, it passes through furnace 24. Within the furnace, each portion of the printed surface of web 16 is subjected, during a very brief period of time, to heat generated by burners 28 to which a controlled amount of fuel is supplied under pressure. This heat is of such great intensity that the solvent of the ink is immediately volatilized and solvent vapors are withdrawn from the surface of web 16 into burners 28 where they are burned.

The products of combustion and any unburned solvent vapors are withdrawn through duct 27, which communicates with the press room and the part of the furnace 24 containing burners 28, by suction means connected with the fuel supply so that no fuel can be supplied to burners 28 unless the suction means are in operation. After the printed web 16 emerges from furnace 24 and past suction duct 27, it travels to a web rewind roller 17.

The burners 28 are fixed to manifolds 30 which are mounted in the housing 25 of furnace 24 for orbital movement so that the burners are directed away from the web automatically whenever movement of the web through furnace 24 is stopped. The amount of gas supplied to the burners is diminished when the burners are turned to inoperative position by means of a valve 85 which closes port 83 and opens the restricted port 89 in the sleeve 87 fixed to the fuel supply chamber 31.

The intense heat generated by the burners 28 is kept from the manifolds 30 to which the burners are fixed by a partition formed of strips 94 of insulating material fixed between the burners and the manifolds. Warpage, expansion or contraction of manifolds 30 is permitted through the provision of a flexible conduit 95 connecting those manifolds with the fuel supply chamber 31.

What I claim is:

1. The method of drying a printing ink containing a volatilizable inflammable solvent after the ink has been printed upon a material, which comprises drawing the material past a battery of burners directed toward the printed surface of the material volatilizing the solvent of the ink, withdrawing solvent vapors from the surface of the material into said burners, and burning said solvent vapors.

2. The method of drying a printing ink containing a volatilizable inflammable solvent after the ink has been printed upon combustible material, which comprises drawing the material past a battery of burners, volatilizing the solvent of the ink, withdrawing solvent vapors from the sur-

face of the material into said burners, and burning the solvent at such speed that the combustible material is not charred.

3. The method of drying a printing ink containing a volatilizable inflammable solvent after the ink has been printed upon a web, which comprises drawing the web past a battery of incandescent, cup-shaped gas burners, volatilizing the solvent of the ink, withdrawing solvent vapors from the surface of the web into said burners, and burning the solvent vapors.

4. The method of drying a printing ink containing a volatilizable inflammable solvent after the ink has been printed upon a web, which comprises drawing the web past a battery of gas burners having cup-shaped inner surfaces heated to incandescence by diverging flame jets extending substantially parallel to said inner surfaces, volatilizing the solvent of the ink, withdrawing solvent vapors from the surface of the web into said burners, and burning the solvent vapors.

5. The method of drying a printing ink containing a volatilizable inflammable solvent after the ink has been printed upon a material, which consists in causing the material to travel over a predetermined path, subjecting the printed surface of the material traveling along a short section of said path to heat of such intensity that the solvent of the ink is volatilized, burning solvent vapors thereby formed, drawing the resultant products of combustion along the material in the direction of the movement of the material to one end of said section, drawing air along the material in a direction counter to the movement of the material into admixture with said products of combustion, and then removing said mixture from proximity to said material and path.

6. The combination with a web printing press, of a gas furnace located in the path of the printed web and comprising a housing, a fuel chamber, a plurality of burner manifolds mounted for orbital movement within the housing and connected with the fuel chamber, and a series of burners mounted upon said manifolds so that intense heat is directed upon the printed surface of the web.

7. The combination with a web printing press, of a gas furnace located in the path of the printed web and comprising a housing, a fuel chamber, a plurality of burner manifolds mounted for orbital movement within the housing and communicating with the fuel chamber, a flexible connection between the manifolds and the fuel chamber, and a series of burners mounted upon said manifolds so that intense heat is directed upon the printed surface of the web.

8. The combination with a web printing press, of a gas furnace located in the path of the printed web and comprising a housing, a fuel chamber, a plurality of burner manifolds extending across the housing and communicating with the fuel chamber, means connecting the manifolds with the fuel chamber to permit rotary, longitudinal and lateral movement with respect thereto, and a series of burners mounted upon said manifolds so that intense heat is directed upon the printed surface of the web.

9. The combination with a web printing press, of a gas furnace located in the path of the printed web and comprising a housing, a fuel chamber, a series of burners, a burner manifold mounted for orbital movement within the housing so that the burners may be directed toward or away from the printed surface of the web, a valve sleeve containing a port fixed in the fuel chamber, and a valve fixed to the manifold and containing a port

adapted to register with the port in the valve sleeve when the burners are directed toward the printed surface of the web.

10. The combination with a web printing press, of a gas furnace located in the path of the printed web and comprising a housing, a fuel chamber, a series of burners, a burner manifold mounted for movement within the housing so that the burners may be directed toward or away from the printed surface of the web, a valve sleeve containing two ports fixed in the fuel chamber, and a valve fixed to the manifold and containing a port adapted to register with one of the ports in the valve sleeve when the burners are directed toward the printed surface of the web and with the other of the ports in the valve sleeve when the burners are directed away from the printed surface of the web.

11. The combination with a web printing press, of a gas furnace located in the path of the printed web and comprising a housing, a fuel chamber, a series of burners, a burner manifold mounted for movement within the housing so that the burners may be directed toward or away from the printed surface of the web, a valve sleeve containing a port fixed in the fuel chamber, a valve fixed to the manifold and containing a port adapted to register with the port in the valve sleeve when the burners are directed toward the printed surface of the web, and means for regulating the quantity of fuel flowing through said ports.

12. The combination with a web printing press, of a gas furnace located in the path of the printed web and comprising a housing, a fuel chamber, a series of burners, a burner manifold mounted for movement within the housing so that the burners may be directed toward or away from the printed surface of the web, a valve sleeve containing a port fixed in the fuel chamber, a valve containing a port adapted to register with the port in the valve sleeve when the burners are directed toward the printed surface of the web, and a flexible conduit connecting the burner manifold with said valve.

13. The combination with a web printing press, of a gas furnace located in the path of the printed web and comprising a housing, a fuel chamber, a series of burners, a burner manifold mounted for movement within the housing so that the burners may be directed toward or away from the printed surface of the web, a valve sleeve fixed in the fuel chamber and containing a port in its inner end, a valve containing a port adapted to register with the port in the valve sleeve when the burners are directed toward the printed surface of the web, a flexible conduit connecting the manifold with said valve, and resilient means urging said valve against the inner end of the valve sleeve.

14. The combination with a web printing press, of a gas furnace located in the path of the printed web and comprising a housing, a fuel chamber, a plurality of burner manifolds mounted for orbital movement within the housing and connected with the fuel chamber, a series of burners mounted upon said manifolds so that intense heat is directed upon the printed surface of the web, and means for independently regulating the quantity of fuel supplied to each of said burners.

15. The combination with a web printing press, of a gas furnace located in the path of the printed web and comprising a housing, a fuel chamber, a plurality of burner manifolds mounted for movement within the housing and connected

with the fuel chamber, and a series of burners mounted upon said manifolds in staggered relation so that intense heat is directed upon all portions of the printed surface of the web.

16. The combination with a web printing press, of a gas furnace located in the path of the printed web and comprising a housing, a fuel chamber, a plurality of burner manifolds mounted for movement within the housing and connected with the fuel chamber, a series of burners mounted upon said manifolds so that intense heat is directed upon the printed surface of the web, and a partition extending between said manifolds and burners to form separate manifold and burner compartments.

17. The combination with a printing press, of a gas furnace located in the path of the printed web, and comprising a housing, a fuel chamber, a burner manifold mounted within the housing and connected with the fuel chamber, a burner mounted upon said manifold so that intense heat is directed upon the printed surface of the web, and a suction duct located between the furnace and the web rewind roller adapted to withdraw solvent vapors and products of combustion from the furnace and to draw fresh air past the printed surface of the web in a direction counter to its movement.

18. The combination with a printing press, of a gas furnace located in the path of the printed web and comprising a housing, a fuel chamber, a plurality of burner manifolds mounted for movement within the housing and connected with the fuel chamber, a series of burners mounted upon said manifolds so that intense heat is directed upon the printed surface of the web, and a suction duct located between the furnace and the web rewind roller adapted to withdraw solvent vapors and products of combustion from the furnace and to withdraw fresh air past the printed surface of the web in a direction counter to its movement.

19. The combination with a printing press, of a gas furnace located in the path of a printed web and comprising a housing, a fuel chamber, means for supplying fuel under pressure to said fuel chamber, a plurality of burner manifolds mounted for movement within the housing and connected with the fuel chamber, a series of burners mounted upon said manifolds so that intense heat is directed upon the printed surface of a web, suction means communicating with said furnace adapted to withdraw solvent vapors and products of combustion from the furnace, and means preventing the supply of gas to said fuel chamber when the suction means are not in operation.

20. The combination with a web printing press, of a gas furnace located in the path of the printed web and comprising a housing, a fuel chamber, a plurality of burner manifolds mounted for movement within the housing and connected with the fuel chamber, a series of burners mounted upon said manifolds so that intense heat is directed upon the printed surface of the web, a partition extending between the burners and the burner manifold to form separate burner and manifold compartments, a suction duct communicating with the burner compartment, and

means for preventing communication between the suction duct and the manifold compartment.

21. The combination with a web printing press, of a gas furnace located in the path of the printed web and comprising a housing, a fuel chamber, a series of burners, a burner manifold mounted for movement within the housing so that the burners may be directed toward the printed surface of the traveling web, and means for automatically directing the burners away from the web when movement of the web past the burners is interrupted during operation of the press.

22. The combination with a printing press, of a furnace located in the path of the printed material and comprising a housing, a fuel chamber, a burner manifold mounted for movement within the housing and connected with the fuel chamber, and a series of burners mounted upon said manifold so that intense heat is directed upon the printed surface of the material, each of said burners having an area of reduced pressure therein.

23. The combination with a printing press, of a furnace located in the path of the printed material and comprising a housing, a fuel chamber, a burner manifold mounted for movement within the housing, and a series of burners fixed to said manifold, each of said burners having a series of flame projecting orifices directed outwardly along a conical surface and a refractory member having a cup-shaped surface extending substantially parallel to the flames projected from said orifices.

24. Apparatus for drying printing ink comprising the combination with means for causing travel of a web to which the ink has been applied, of a gas burner located adjacent to a point of the travel of the web and mounted for rotation about an axis transverse the path of the web so that it may be directed towards or away from the web.

25. Apparatus for drying a printing ink comprising a combination with means for causing the travel of a web to which ink has been applied, of a heater adapted to apply intense heat to the printed side of the web at a point in its travel, said heater being mounted for rotation about an axis transverse the path of the web so that it may be directed towards or away from the web.

26. Apparatus for drying printing ink, comprising the combination with means for causing a traveling movement of the material to which the ink has been applied, of a plurality of rows of heaters adapted to direct intense heat toward the printed side of the material, each of said rows being mounted for rotation about an axis parallel with the axis of rotation of each other row so that the heaters may be directed toward or away from the material, said axes all lying in a plane parallel to the printed surface of said material.

27. Apparatus for drying printing ink, comprising the combination with means for moving a material to which ink has been applied, of a burner manifold disposed in the path of the printed material, and a plurality of cup-shaped gas burners mounted upon said manifold so that intense heat is directed upon the printed surface of the material.

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