Feb. 9, 1954 R. G. ZIMMERMAN 2,668,700

DRIER FOR PRINTING PRESSES

Filed May 25, 1949 9 Sheets-Sheet 1

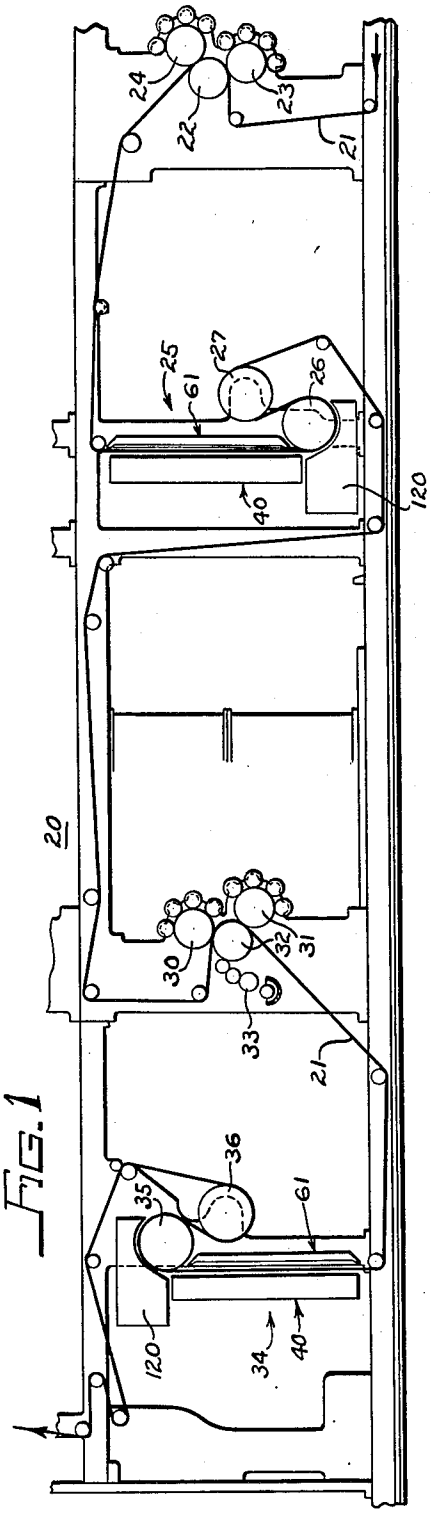


FIG. 1

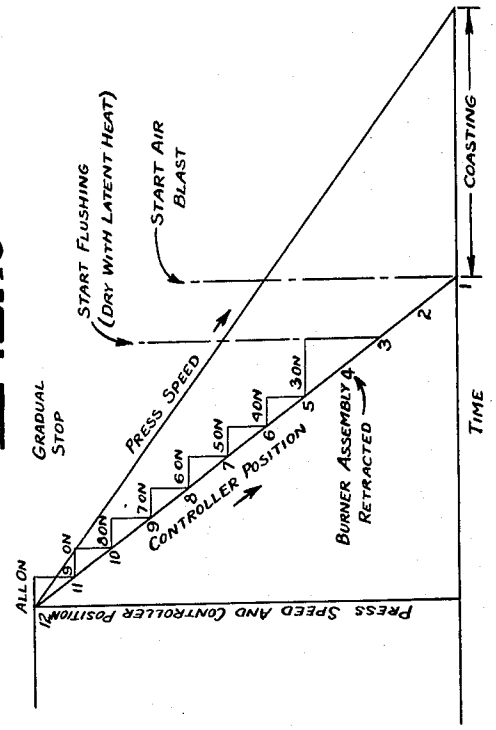


FIG. 16

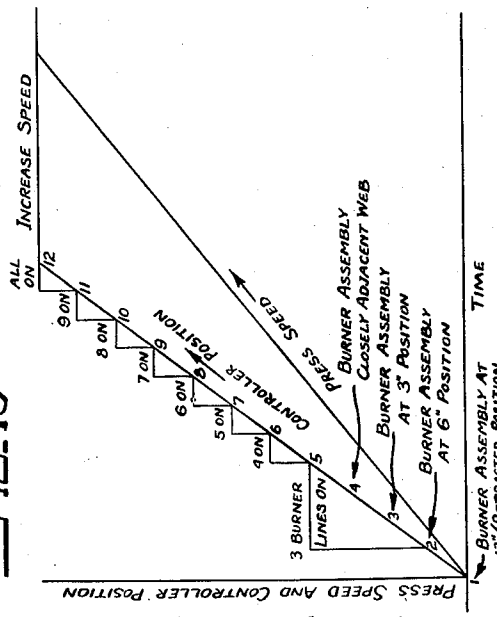


FIG. 15

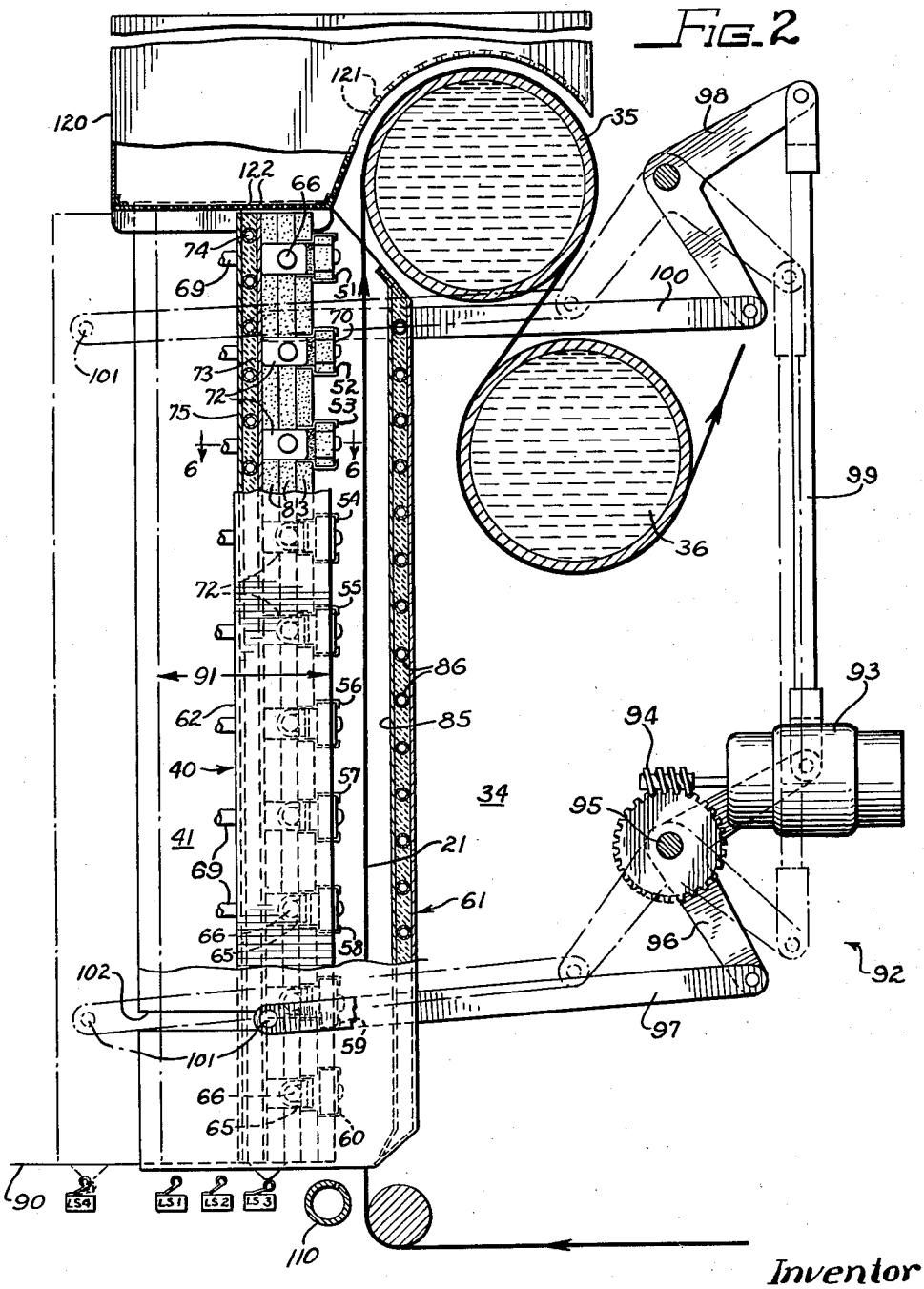
Inventor
Richard G. Zimmerman
by: Carlson Pitzner, Hubbard & Hoefle
attys.

Feb. 9, 1954 R. G. ZIMMERMAN 2,668,700

DRIER FOR PRINTING PRESSES

Filed May 25, 1949 9 Sheets-Sheet 2

FIG. 2



Inventor
Richard G. Zimmerman
by: Carlson, Pitzner, Hubbard & Wolfe
Attys.

Feb. 9, 1954 R. G. ZIMMERMAN 2,668,700

DRIER FOR PRINTING PRESSES

Filed May 25, 1949 9 Sheets-Sheet 3

FIG. 3

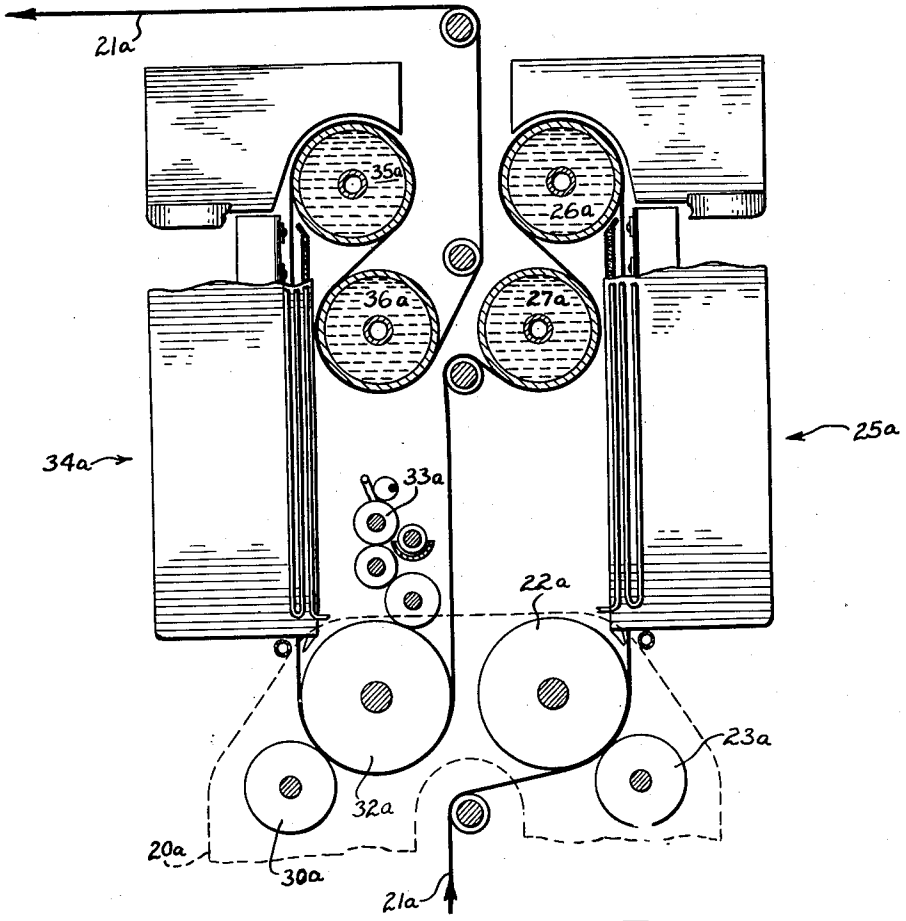
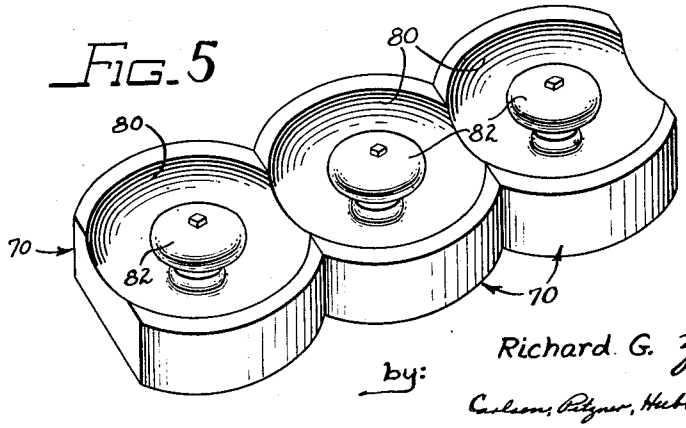


FIG. 5



Inventor
Richard G. Zimmerman
by:
Carlson, Pilgrim, Hubbard & Wolfe
Attys.

Feb. 9, 1954 R. G. ZIMMERMAN 2,668,700

DRIER FOR PRINTING PRESSES

Filed May 25, 1949 9 Sheets-Sheet 4

FIG. 4

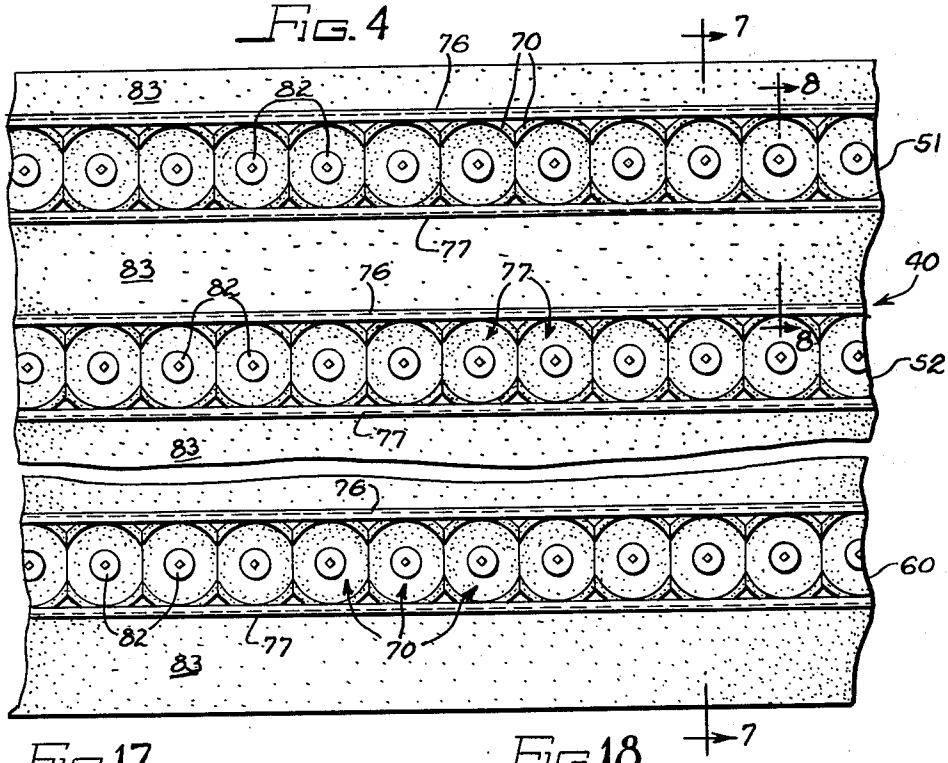


FIG. 17

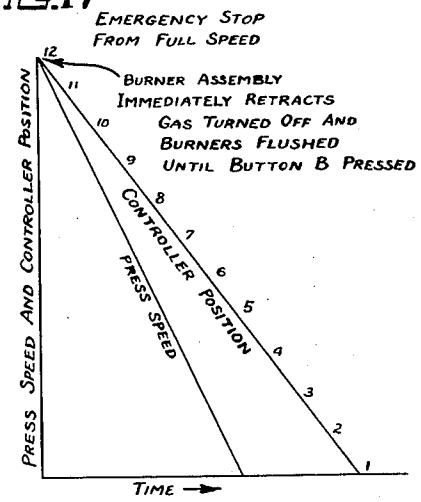
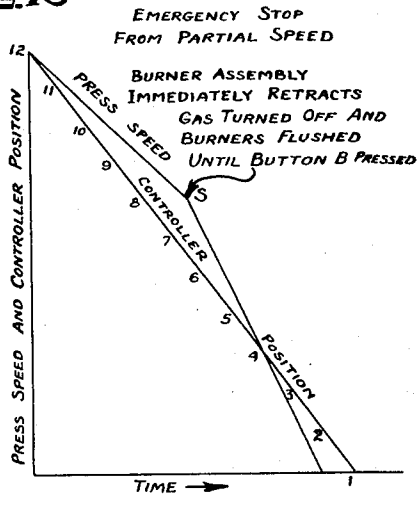


FIG. 18



Inventor
Richard G. Zimmerman

by: Carlson Pitzner Hubbard & Wolfe

Attys.

Feb. 9, 1954 R. G. ZIMMERMAN 2,668,700

DRIER FOR PRINTING PRESSES

Filed May 25, 1949 9 Sheets-Sheet 5

FIG. 6

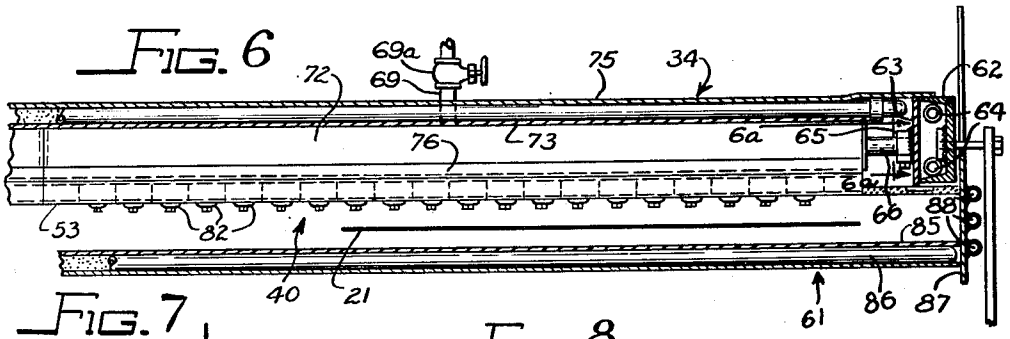


FIG. 7

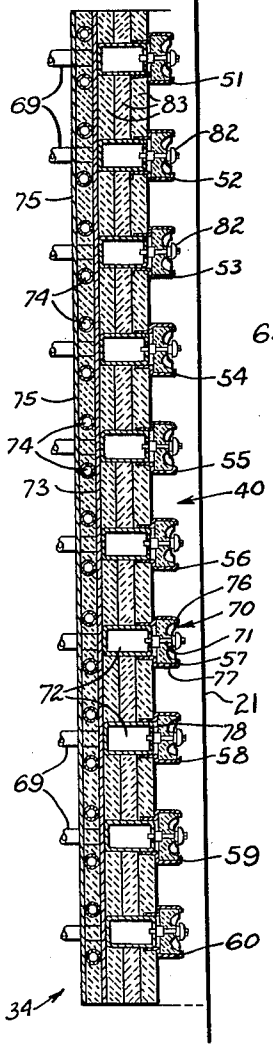


FIG. 8

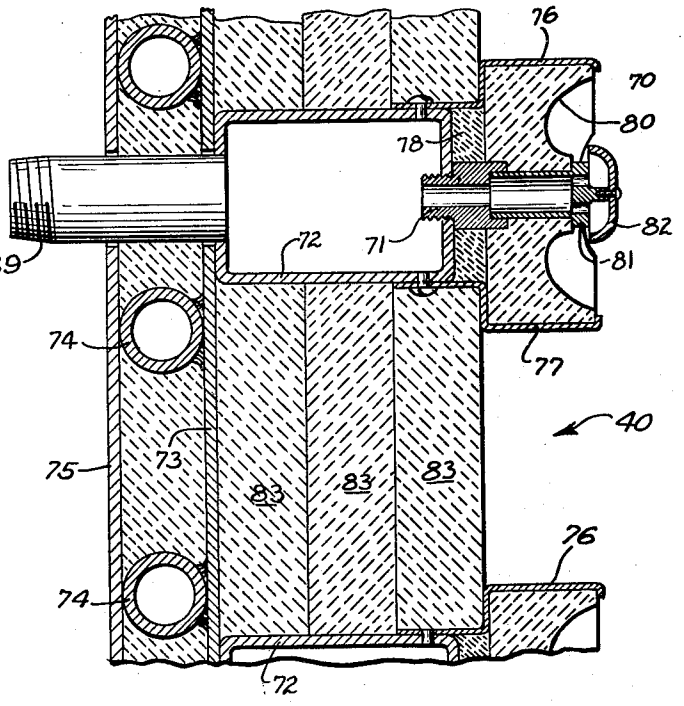
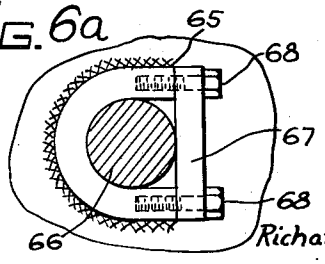


FIG. 6a



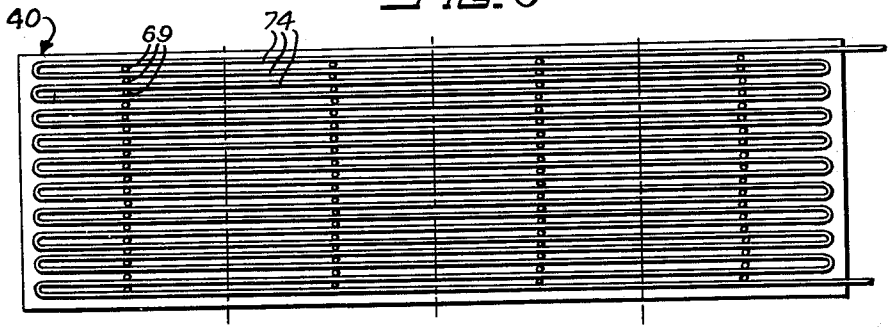
Inventor
Richard G. Zimmerman
by
Carlson, Pitzner, Hubbard & Wolfe
Attys.

Feb. 9, 1954 R. G. ZIMMERMAN 2,668,700

DRIER FOR PRINTING PRESSES

Filed May 25, 1949 9 Sheets-Sheet 6

FIG. 9



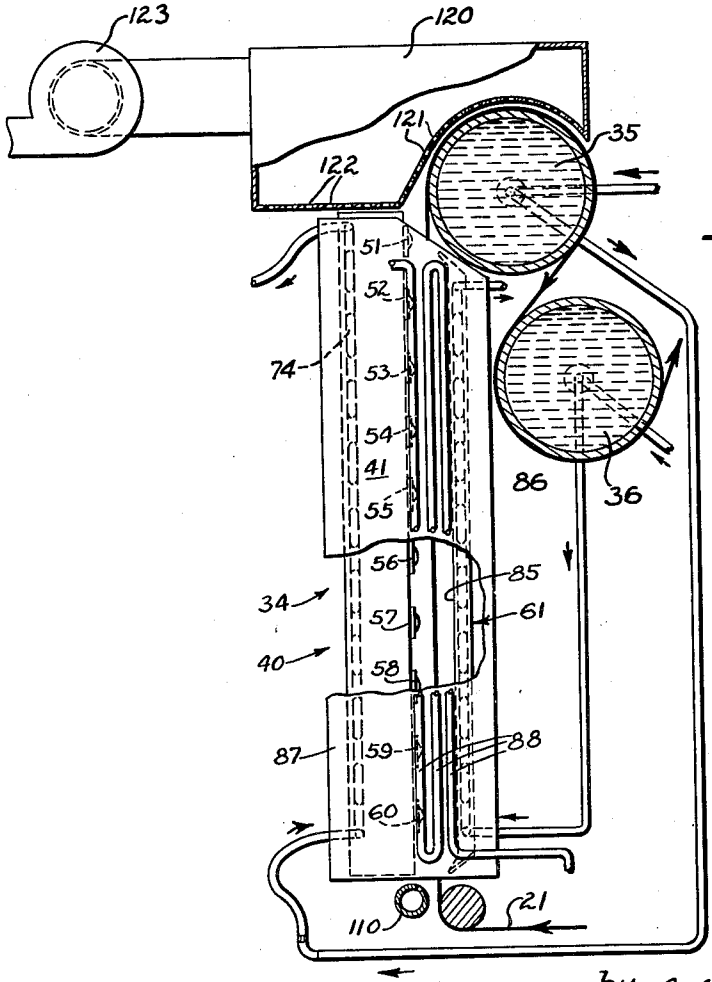


FIG. 10

Inventor
Richard G. Zimmerman
by Carlson, Pilgrim, Hubbard & Wolfe
Attys.

Feb. 9, 1954 R. G. ZIMMERMAN 2,668,700

DRIER FOR PRINTING PRESSES

Filed May 25, 1949 9 Sheets-Sheet 7

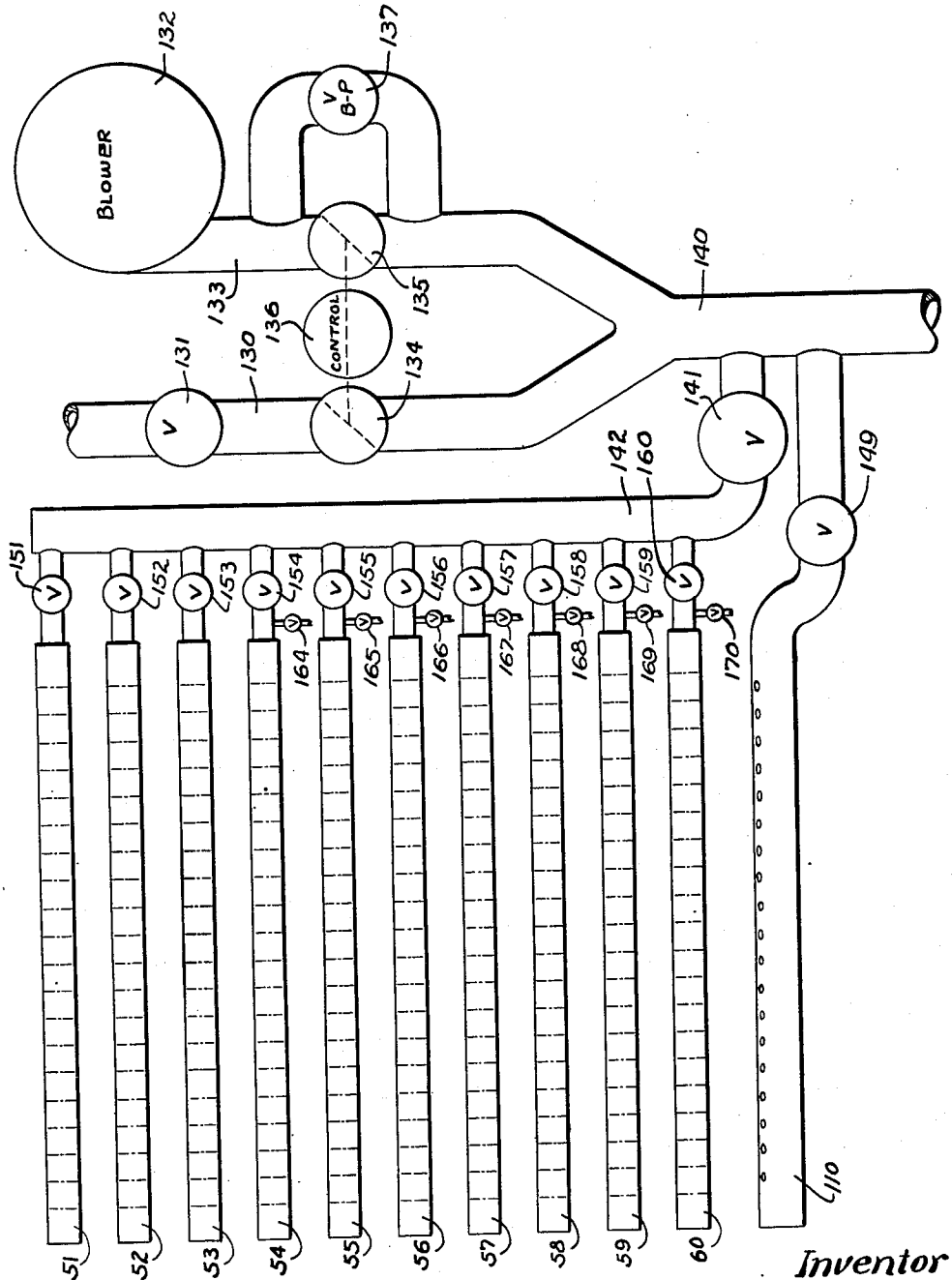


FIG. 11

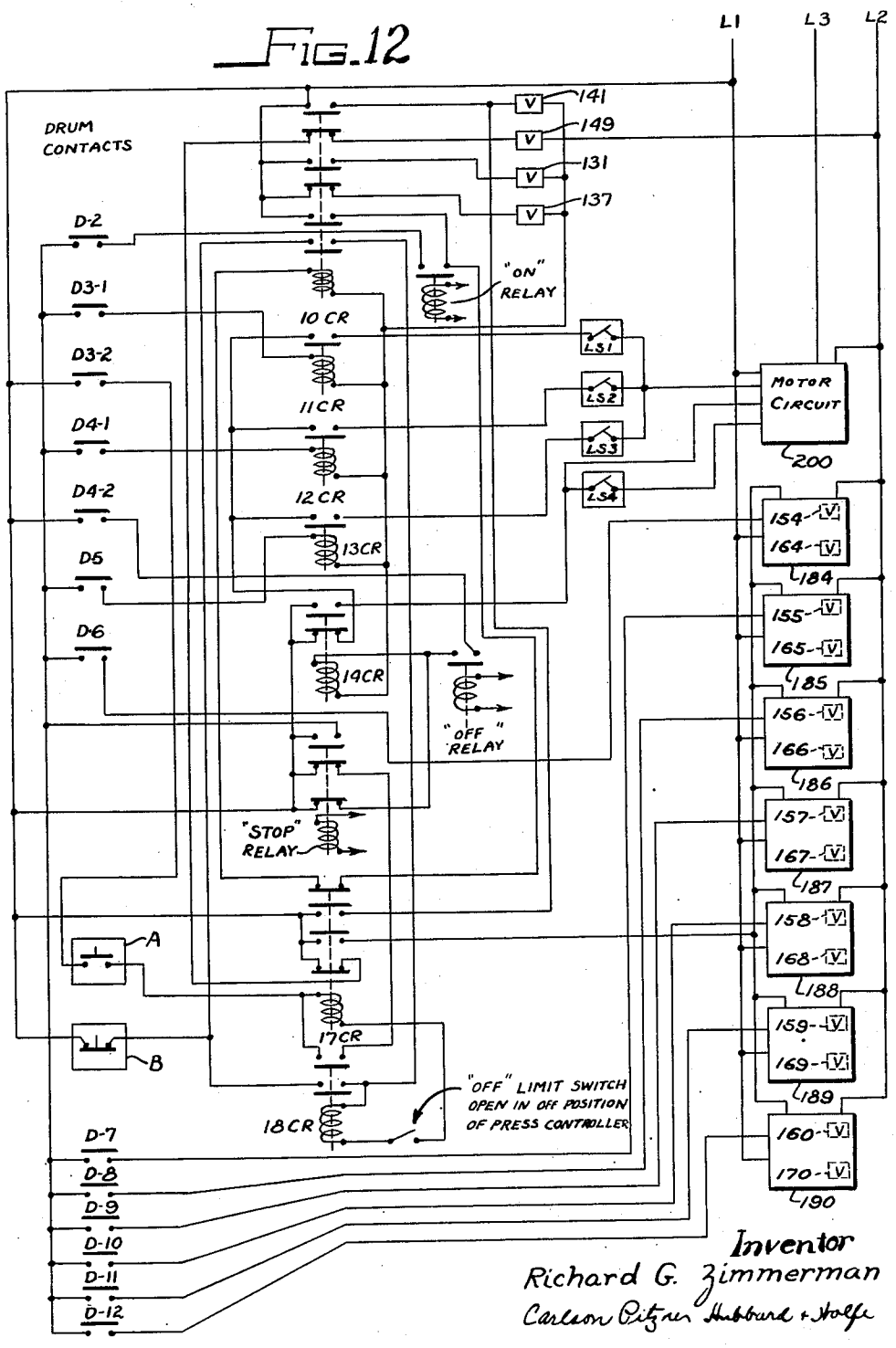
Inventor
Richard G. Zimmerman
by: Carlson Pitzner Hubbard & Wolfe
Attys.

Feb. 9, 1954 R. G. ZIMMERMAN 2,668,700

DRIER FOR PRINTING PRESSES

Filed May 25, 1949 9 Sheets-Sheet 8

FIG. 12



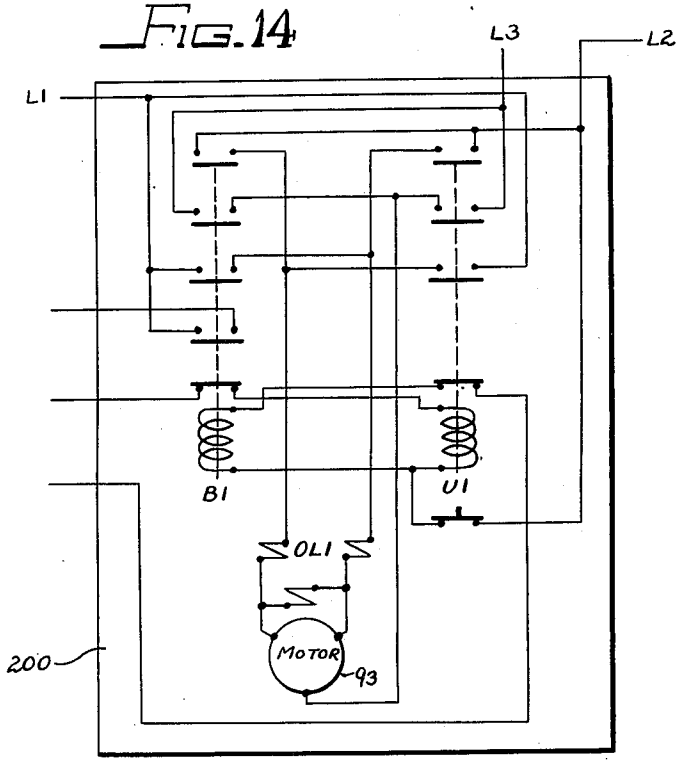
Inventor
Richard G. Zimmerman
Carlson Pitzner Hubbard + Wolfe
Attys.

Feb. 9, 1954 R. G. ZIMMERMAN 2,668,700

DRIER FOR PRINTING PRESSES

Filed May 25, 1949 9 Sheets-Sheet 9

Fig. 14



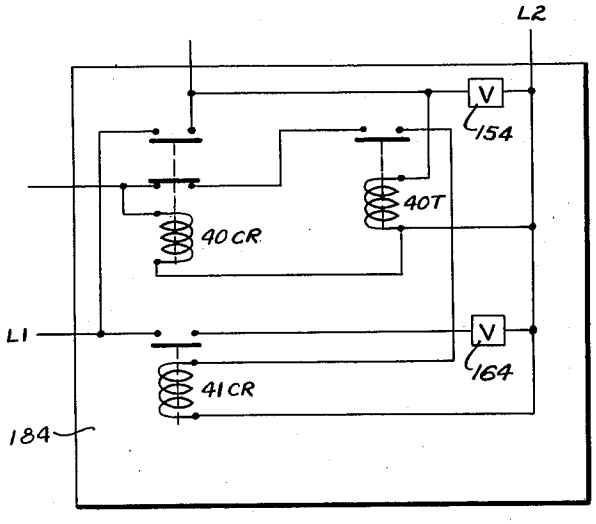


Fig. 13.

Inventor
Richard G. Zimmerman
by: Carlson Pitzner Hubbard & Hoeye
Attys.

Patented Feb. 9, 1954 2,668,700

UNITED STATES PATENT OFFICE

2,668,700

DRIER FOR PRINTING PRESSES

Richard G. Zimmerman, Lawrence, Kans.

Application May 25, 1949, Serial No. 95,340

16 Claims. (Cl. 263—3)

1

The present invention relates to printing presses and more particularly to heaters for drying the ink film.

Throughout the course of printing press development there has been a sharp line of demarcation between newspaper presses and magazine presses. Newspaper presses enable high speed printing not only of newspapers but of other printed matter where quality and appearance are not of paramount importance. Such printing is done on absorbent paper and using non-drying ink. Because of the absorption of the ink in the pores of the paper, the printing is characteristically dull and even the brighter colors are dead and lifeless. Furthermore, the ink film must be kept relatively thin since the absorbent quality of the paper is limited—otherwise smearing will result.

For high quality printing of heavy films and brilliant colors it has in the past been necessary to resort to the more expensive and complicated magazine press. Magazine printing is done with driable ink usually having a volatile solvent and on coated or non-absorbent paper.

When using volatile solvent inks, the ink must be artificially dried, this being conventionally done by the use of steam drums or by gas burners. Steam drums are disadvantageous since they are extremely expensive, of heavy construction, and require a large amount of space, to say nothing of the problem of furnishing steam. In addition, since drying depends upon conducted heat, the velocity of the web must be kept relatively low. Conventional gas burners also have rather serious limitations. Even where the flame is played directly on the web, the drying process is superficial and inefficient. Solvent is driven from the surface of the film and not from the "body" of the film or from the pores of the paper, and the maximum speed is consequently limited. An even more important limitation has to do with operation at reduced speeds or upon emergency shutdown. The normal heat output combined with the heat stored in the burners and surrounding metal parts frequently results in scorching when the web is slowed and complete burnout when the web is brought to a more sudden stop. The surface of the ink after drying by conventional gas burners is often excessively rough to the touch and the flame playing on the web tends to introduce wrinkles, giving rise to uneven drying and scorch streaks. In addition, conventional burner arangements require frequent maintenance and replacement due to the extreme operating temperatures.

2

Because of the expense of a magazine press many printing establishments have attempted to do high quality work on a newspaper press by using inks having a volatile solvent. However, this involves so many disadvantages and complications that it has never before been accomplished from a practical standpoint. In the first place the available room in the vicinity of a newspaper press is severely restricted and conventional heaters for drying the ink cannot be accommodated. Even when such heaters are used it is necessary to reduce the speed considerably from the normal value in order to insure that the ink is dried sufficiently so as not to stick to the successive rollers with which the printed face comes into contact. If enough heat is applied to the paper to dry the ink at the normal web speeds, it is found that the paper will invariably be scorched as the press is slowed down to a stop.

While it is known that radiant heaters are particularly effective in the drying of films because of the penetration of the heat below the surface of the films, attempts to use radiant heaters in printing presses have been found in general to be disappointing and impractical, the possibilities of scorching on shut-down being greatly increased. The reason for this will be apparent when it is considered that a radiant heater by its very nature must operate in the "red" or radiating temperature range. Particularly when using gas-fired radiant burners it is found that the radiating element does not immediately fall to a safe temperature when the supply of fuel is cut off in the normal way, but continues for some time to radiate energy at a rate which is more than sufficient to cause scorching. Any attempts to reduce the residual radiation by cutting down on the capacity of the burners will, of course, produce a corresponding sacrifice of heat under normal running conditions, particularly the extremely high speed conditions characteristic of a newspaper press. In an endeavor to overcome the effects of the residual heat and to control the heat under reduced speed conditions elaborate pivoting and linkage arrangements have been used so that the burners are twisted bodily to direct the residual heat away from the web. This in general requires that the individual burners be manipulated which leads to mechanical complexity, excessive cost and large volumetric requirements. Besides, any burner movement involves jarring and vibration which is very destructive of the fragile refractory material of which the radiating surfaces are formed.

Where attempts have been made to mount conventional burner arrangements in confined spaces nearby parts of the press are so overheated that rubber rollers, lubricated bearings and other parts of the press are put in jeopardy to say nothing of the discomfort of the press operators. Additional difficulties arise from the problem of disposing of the fumes and inflammable condensate in the ducts.

Accordingly it is an object of the invention to provide an improved dryer for a printing press which is capable of large heat output enabling drying of magazine-type inks at high speeds, even at speeds approaching the standard operating speed of a modern newspaper press. It is another object to provide a high capacity web drier in which radiation and convection are so co-ordinated that scorching is avoided under all conditions, both transient and steady state, which may be encountered in the practical operation of a press. More particularly, it is an object to provide a dryer employing radiant heat in which the temperature is brought to a safe level when the press is brought slowly to a halt or suddenly stopped as under emergency conditions. It is a further object to provide a dryer which is of large heating capacity but which nevertheless occupies less volume than conventional dryers, being adapted for installation on existing newspaper and magazine presses with a minimum of modification thereof and without danger of overheating the rubber rollers or any other parts of the press.

It is still another object to provide a gas-fired dryer for volatile inks in which the gas is more efficiently utilized than in conventional dryers. It is a related object to produce a gas-fired dryer capable of not only evaporating solvent from the surface of an ink film but which is also effective to drive the solvent from the body of the film and from the paper itself, the freed solvent being then completely burned to furnish additional heat and to prevent the solvent from passing into the atmosphere or from condensing in the exhaust ducts to form a fire hazard and to endanger exhaust fans and other equipment.

It is a further object of the invention to provide a dryer having gas-fired burners with an improved arrangement for co-ordinating the supply of gas and supply of cooling air with the speed of the web. In one aspect it is an object to co-ordinate the degree of exhaust with the supply of cooling air.

It is an object to provide a novel control scheme which acts automatically upon varying the speed of the web driving motor to cause the valves supplying the burners as well as the burner positioning means to go through a predetermined cycle of operations both upon increasing the speed of the web and upon slowing down the web prior to shut-down for maintaining the web at a safe drying temperature.

It is an object allied with the foregoing to provide a radiant dryer in which the latent heat that is stored under normal running conditions is not only kept to a minimum but safely utilized during deceleration for drying purposes, with the remainder of the latent heat being so completely dissipated after the press comes to a stop that the danger of scorching is eliminated. In one of its aspects it is an object of the invention to provide a control scheme in which the timing of the operations may be manually controlled by an operator.

It is a further object to provide a drier which

embodies an improved burner arrangement in which the burners are mounted for movement as a unit, minimizing the number of moving parts. It is a related object to provide a dryer which is safe and fool-proof in operation but which is nevertheless simple and straight-forward and in which the cost per foot of drying the web is reduced to a minimum. It is a more detailed object of the invention to provide a burner construction and arrangement which is extremely long-lived in spite of extreme operating conditions, and which requires a small fraction of the replacement and maintenance demanded by conventional web dryers.

Other objects and advantages will become apparent upon reference to the specification and to the detailed drawings appended hereto in which:

Figure 1 is a diagrammatic side elevation of a magazine press including driers embodying the present invention.

Fig. 2 is a detailed elevation of a web drier as used in the magazine press of Fig. 1 with the near side wall partially removed to show the burner assembly.

Fig. 3 is a more or less diagrammatic representation of the improved dryer installed on a conventional newspaper press.

Fig. 4 is a partial face view of the burner assembly.

Fig. 5 shows in perspective several successive burner faces.

Fig. 6 is a horizontal section of a line of burners taken along the line 6—6 in Fig. 2.

Fig. 6*a* is a fragmentary detail view along line 6*a*—6*a* of Fig. 6 showing clamping means for maintaining the burner manifold in assembled position.

Fig. 7 is a vertical section looking along the line 7—7 in Fig. 4.

Fig. 8 is an enlarged fragmentary section taken along the line 8—8 in Fig. 4.

Fig. 9 is a rear view of the burner assembly back plate elevation with the cover plate removed to show the arrangement of cooling water tubes.

Fig. 10 is a diagrammatic elevation similar to Fig. 2 but showing the water circulation system in greater detail.

Fig. 11 is a schematic layout of the fuel and air supply including solenoid-operated control valves.

Fig. 12 is a diagram of the electrical control arrangement partially in block form.

Fig. 13 is a burner valve control circuit as included in block form in Fig. 12.

Fig. 14 shows a control circuit for the motor which positions the burner assembly and included in block form in Fig. 12.

Fig. 15 shows graphically the operating sequence of the control circuit on starting up the press.

Fig. 16 shows a typical operating sequence on slowing the press to a normal stop.

Figs. 17 and 18 show the sequence during an emergency stop from full and partial speed conditions, respectively.

Referring to Figure 1 there is shown a portion of a magazine press 20. The incoming web 21 passes over a first impression cylinder 22 and the first side of the web is printed by a plate cylinder 24. The printed web then passes downwardly into a dryer indicated generally at 25. This dryer is constructed in accordance with the present invention and is shown in detail in the figures to be discussed. The web then passes

around cooling drums 26, 27 and into a subsequent section of the press so that the remaining side of the web may be printed. This is accomplished by plate cylinders 30, 31, the web passing around an impression cylinder 32. If desired, a conventional oil offset arrangement 33 may be used in conjunction with the impression cylinder 32. The web subsequently passes upwardly through a dryer 34 which is similar to that previously referred to and around cooling drums 35, 36. The outgoing run of the web may then be fed into a slitter, cut-off cylinder and folder as required for putting the printed matter into a form for distribution.

Turning now to Fig. 2 the dryer 34 and the associated drums 35, 36 are set forth in greater detail. The dryer includes a burner assembly 40 which is preferably enclosed in a box-like housing 41 and arranged parallel to the vertical run of the web 21. The burner assembly includes lines of burners which extend horizontally and spaced vertically from one another along the web. These lines designated 51—60 inclusive, project radiant heat outwardly in the direction of the web. Arranged parallel to the web on the opposite side from the burner assembly is a back-up plate 61 which serves to reflect the heat back onto the web and to conduct away the unreflected heat.

Before proceeding with the more detailed structural features it will be helpful to refer briefly to Fig. 3 which shows an equivalent installation in a newspaper press. Corresponding elements will be designated with the same reference numerals used in the magazine press but with the subscript *a*. The printing unit 20*a* includes two printing couples for printing on both sides of the web. The incoming web 21*a* is fed around an impression cylinder 22*a* and the web is printed on its first side by a plate cylinder 23*a*. The web subsequently passes upwardly through a dryer 25*a* and around water filled cooling drums 26*a*, 27*a*. The web next passes downwardly into contact with the second impression cylinder 32*a* which co-operates with a plate cylinder 30*a*. An oil offset arrangement 33*a* rides in contact with the impression cylinder 32*a*. After the second impression has been made the web rises vertically through a dryer 34*a* after which it passes about cooling drums 35*a*, 36*a*. After thus being printed on both sides, the web 21*a* leaves the press unit for subsequent slitting and folding and combination with other similar webs. Since the dryer installation may be substantially identical in the two types of presses the subsequent discussion will concern itself only with the installation as made in a magazine press.

In accordance with one of the aspects of the invention means are provided for generating radiant heat at refractory surfaces having low heat storage capacity and for maintaining the burner mounting, the fuel supply lines, and other metal objects within the region of radiation at a temperature which is extremely low compared to that of the burner. The manner in which this is accomplished in the present instance will be made clear by inspection of Figs. 2 and 5 to 8 inclusive. Each of the burners in the lines 51 to 60 has a refractory face portion 70 which is heated to brilliant red heat by the combustion of gas-air mix in contact therewith. Centrally arranged in the face portion 70 and serving to physically support it is a stem 71. The latter is threaded into a tubular manifold 72 of rectangular section which supports

a line of burners. The refractory burner material is reinforced by metal walls 76, 77 which are anchored by screws or the like to the manifold 72. These walls are preferably of light gauge metal and perforated to reduce heat transmission as well as the amount of heat which may be stored therein. Direct rearward flow of heat from the burner is reduced by spacing the burner from the associated manifold and filling the space with insulating material as indicated at 78. The manifold 72 is preferably divided into sections, each supplied by a pipe 69 and under the control of a valve 69*a* so that a portion of the burner line may be shut off when running webs less than four pages in width.

The manifolds for the various lines of burners are all mounted in intimate thermal contact with a back plate 73 which is preferably formed of copper or other good conducting metal. In contact with the back plate 73 are successive convolutions of a cooling coil 74 which conducts cooling water. The cooling coil may also be formed of copper sweated or brazed to the conductive back plate 73.

In order to minimize the direct transfer of heat to the back plate 73 and the horizontally arranged manifolds 72, the spaces between the manifolds are filled with high temperature insulation 83 having extremely low heat storage capacity. Preferably such insulation consists of a series of slabs or layers of asbestos, the layers being retained in place by the overhang of the edges of the burners as shown.

While it is possible to use various types of burners having refractory heat radiating surfaces the illustrated form of burner has been found to work out most satisfactorily. The construction of the individual burners is set forth in some detail in Figs. 5 and 8. Here it will be seen that the face portion 70 of the burners is cupped to form a recess 80. Centrally positioned within the recess and at the end of the stem 71 is a nozzle 81. A concave deflector 82 positioned opposite the nozzle serves to deflect the gas-air mix downwardly into the recess so that it is burned in intimate contact with the refractory material. In axial section the burners are generally cylindrical but flattened on opposite sides so that the individual burners may be stacked side by side with the recesses of successive burners intersecting one another. This produces a continuous band of radiation across the entire width of the web and also facilitates lighting the burners since the flame from a pilot will quickly travel from one end of the line to the other.

To complete the discussion of the burner assembly 40, it includes at each end an upright channel 62 (Fig. 6) which is covered with a plate 63 welded or otherwise fixed thereto. The channel includes cooling coils 64. In order that an entire line of burners including its manifold may be maintained in contact with the back plate yet readily removed from the burner assembly, a clamp 65 is used at each end of the manifold which is so constructed as to enable forward withdrawal. In the present instance the clamp, which is C-shaped, is mounted on the plate 63 with its open side facing forwardly for receiving a stub projection 66. The latter is butt welded to the closed end of the manifold 72. As shown in the detailed view Fig. 6*a*, the open side of the clamp 65 is spanned by means of a removable bridge 67 which is maintained in place by suitable bolts or the like 68. To facilitate withdrawal of a burner line, the pipes 69 supplying gas thereto

extend rearwardly from the manifold and pass through suitable apertures in the back plate 73 of the cover plate 75. It will be understood that each of the pipes 69 is threaded so that it may be readily disconnected from the supply line. It will be apparent then, that any one of the lines of burners may be withdrawn for maintenance or replacement merely by uncoupling the rear ends of the pipes 69, removing the bridges 67 and drawing the selected burner lines forwardly.

Since all of the burner assembly parts having any substantial heat storage capacity are not only shielded against the direct transference of heat from the burners but are in intimate heat transferring relation to the cooling coils 74, it will be apparent that they will be kept at a low temperature. The surface presented toward the web by the burner assembly is formed almost entirely of refractory burner faces and insulating material, all having low heat storage capacity.

On the opposite side of the web from the burner assembly 40 is the back-up plate 61 providing a reflecting surface 85. For the purpose of completely enclosing the web and defining an air flow channel about the web as well as for preventing the escape of heat to the surrounding portions of the press, the back-up plate abuts a pair of side walls 87 which are spaced from one another just sufficiently to enable the slidable reception of the burner assembly 40 between them. In order to conduct away the excess heat striking the back-up plate 61 and the side walls 87, cooling coils 86, 88 are provided. These coils are preferably of copper or similar good conducting metal and are fastened in place by sweating or brazing. The side walls are preferably mounted for edgewise sliding on the press frame so as to provide access to the web for threading and inspection.

It will be apparent from the foregoing that the burners and web are surrounded by cooling coils arranged about all four sides. The manner in which these coils are supplied with cold water will be apparent on inspection of Figs. 9 and 10. Fig. 9 shows the arrangement of the cooling coils in the burner assembly while Fig. 10 is a diagrammatic view of the preferred form of circuitory system. It will be noted that the cooling coils 74 and 86 are arranged so that the successive convolutions are horizontal with the cooling water admitted at the bottom and drawn off at the top. This causes any steam which may be generated in these coils to be immediately flushed out and replaced by the relatively cooler water. The latter avoids uneven cooling or hot spots and correspondingly reduces maintenance to a minimum. As shown in Fig. 10 the water is drawn from a cold water supply line directly into the cooling drums 35, 36 which are thereby kept at a very low temperature. The water exhausted from the cooling drums is then used in the remainder of the system. The cooling coils 64 and 88 arranged along the side walls of the burner assembly are supplied with cooling water independently. Vertical convolutions can be used at this point since the temperature is normally lower and there is less danger of developing steam.

To keep down the heat radiated rearwardly from the burner assembly as well as to even out the temperature thereof a light metallic cover plate 75 is used. The spaces 79 between the coil convolutions may be filled with insulation if desired to reduce the temperature of the plate 75.

In accordance with one of the aspects of the invention means are provided for turning on the burners and advancing the burner assembly 40 upon accelerating the web and for turning off the burners and bodily retracting the burner assembly away from the web when it is brought to a stop. Still further in accordance with the invention, means are provided for directing a blast of air through the enlarged space resulting from retraction of the burner assembly and for simultaneously uncovering additional area of exhaust duct to facilitate withdrawal of the air. The control scheme for accomplishing this in response to the web speed setting will be discussed in a following section. Attention will first be given to the mechanical positioning arrangement used in the present embodiment as set forth in Fig. 2. The burner assembly 40 is mounted on suitable ways 90 which permit the face of the burner assembly to move through a range 91. Movement in this range is affected by means of a burner assembly adjusting mechanism indicated generally at 92. This includes a motor 93 driving a reduction worm gear 94 to apply torque to a cross-shaft 95. Rigidly mounted for rotation with this shaft is a bell crank 96, the latter being connected to the burner assembly 40 by means of a suitable link 97. An equivalent crank and link are arranged at the opposite side of the burner assembly. For moving the upper end of the burner assembly in unison with the lower end, a bell crank 98 and link 100 are employed, rotary motion being transferred to the crank by means of a vertical push rod 99. The links 97, 100 are each connected to the burner assembly 40 by pivot pins 101 which project outwardly therefrom. To enable the pins 101 to move unobstructedly slots 102 are cut in the side walls 87.

Turning attention now to the lower portion of Fig. 2, an air blast line 110 is arranged parallel to the lower edge of the burner housing and in a position to direct air upwardly in the space between the burners and the web. Preferably the line 110 has a series of holes or nozzles spaced along its length capable of discharging a large volume of air. The valve arrangement for controlling the flow of air to the line 110 will be discussed in connection with Fig. 11.

Arranged at the upper end of the burner assembly to exhaust the cooling air as well as the products of combustion of the gas and ink solvent is an exhaust duct 120. This duct extends the width of the press and has a series of apertures or air inlets 121 along its lower surface. As will be noted from the profile view of this duct in Fig. 2, the underside is concavely formed so as to closely follow the curvature of the cooling drum 35. In this way any vapor which tends to cling to the moving web is effectively withdrawn and does not escape into the atmosphere. In carrying out the invention the exhaust duct 120 includes an additional set of apertures 122 which are substantially blocked off when the burner assembly 40 is in its normal position closely adjacent the web. However, upon retraction of the burner assembly the apertures 122 are successively uncovered in order to increase the effective duct area and thus increase the capacity of the exhaust system. Vacuum is produced in the duct 120 by means of a suitable exhaust fan 123 (Fig. 10). As will be understood by one skilled in the ventilating art, the exhaust fan will consume energy in accordance with the area of the inlet duct. It will be clear, therefore, that uncovering the ducts 122 serves automatically to increase the volume of air exhaust from the system.

In carrying out another aspect of the present invention means are provided for turning off the burner lines on shutdown and for discharging cooling air directly through the fuel system of the burners and into contact with the radiating surfaces thereof. The effect of this is to reduce the radiating surfaces immediately to a safe temperature, the action being facilitated by the low specific heat of the refractory burner material. In addition the cooling air is heated by such contact and the convected currents of heated air are directed from the burner toward the web. Thus, such latent heat as may be present in the burners is effectively utilized to complete the drying as the web is slowed and brought to a stop.

The system here used in accomplishing the above is set forth diagrammatically in Fig. 11. Gas is supplied through a line 130 having a solenoid gas valve 131. The latter valve as well as the remaining valves in the system are controlled by means of the control circuit (Fig. 12) which will be described in detail as the discussion proceeds. Air is supplied by means of a blower 132 feeding a compressed air line 133. In series with the lines 130, 133 respectively are dampers 134, 135 which are adjusted by a combustion controller 136. The latter is of conventional design capable of producing an optimum fuel-air ratio for all rates of flow. The amount of gas-air mix at the discharge of the combustion controller may be adjusted manually and left in an adjusted position, the generated heat being controlled by the other solenoid valves in the system.

The damper 135 in the air line is by-passed by means of an air by-pass valve 137. Assuming that the main gas valve 131 is shut off, opening the air by-pass valve 137 will enable air at high velocity to pass through the system for cooling purposes.

Under normal operating conditions the gas mixture passes through a mixture supply line 140, through a valve 141, and into a header 142 which supplies all of the burner manifolds with fuel. Interconnecting the header 142 to the lines of burners are valves 151—160 respectively. The air blast line 110 which directs air upwardly between the burners and the web is connected to the supply line 140 by means of a valve 149.

In order to prevent the burners from "blowing back" when the supply of gas is cut off, each of the burners 54—60 is provided with an auxiliary valve 164—170 connected to any desired source of compressed air. The latter valves are electrically interlocked with the valves 154—160 so that after the valve is shut off compressed air is supplied to the burner for a short interval of time, on the order of five seconds. The manner in which the interlock is effected will be made clear during the discussion of the control diagram in Fig. 12. The compressed air admitted by the auxiliary valves 164—170 assists in bringing the temperature of the burner faces down to a value which will not produce scorching of the web. Although not shown in the drawings it will be apparent to one skilled in the art that flame detectors and other safety devices may be applied to the present burner arrangement in the conventional manner.

As previously mentioned means responsive to the web speed setting are provided for controlling the gas and air valves shown in Fig. 11 as well as for controlling the motor 93 which positions the burner assembly relative to the web. The circuit for causing operation of these and associated elements in a predetermined sequence is set forth in Figs. 12, 13 and 14. Fig. 12 is a diagram of the controller circuit partially in block form while Figs. 13 and 14 set forth blocks in greater detail. Voltage for operating the control circuits and motor is obtained from the thru phase A. C. lines L1, L2, and L3.

Prior to discussing the functions of the control system it will be helpful to refer briefly to the various circuit components and to bring out the relationship between such components and the speed controller used in a conventional printing press. As appreciated by one skilled in the art, a printing press has a large driving motor and a small driving motor which together act to vary the speed of the web from standstill to full running condition. Speed control is accomplished by means of a motor driven controller operated by a manual pushbutton to cover a series of speed points. In describing the present embodiment it is assumed that the controller has a graduated series of twelve points.

In practicing the present invention a modified controller is used which has an auxiliary contact drum having contacts which are operated in sequence as the web speed controller is moved in the increase and decrease directions. These contacts include the prefix "D" and are shown along the left hand edge of Fig. 12. The present disclosure need not be burdened by a physical showing of the controller. It will suffice to set forth in tabulated form the relationship between the speed points and the contacts as follows:

Increase speed

Controller Point	Drum Contact
1	
2	D2 closes.
3	D3–1 closes.
4	D4–1 closes.
5	D5 closes.
6	D6 closes.
7	D7 closes.
8	D8 closes.
9	D9 closes.
10	D10 closes.
11	D11 closes.
12	D12 closes.

Under conditions of decreasing web speed, the drum contacts in Fig. 12 will be operated as follows:

Decrease speed

Controller Point	Drum Contact
12	
11	D12 opens.
10	D11 opens.
9	D10 opens.
8	D9 opens.
7	D8 opens.
6	D7 opens.
5	D6 opens.
4	D5 opens. D4–2 closes.
3	D4–1 opens. D3–2 closes.
2	D3–1 opens.
1	D2 opens.

In order to further tie in the present circuit with the normal speed control of the web attention is drawn to the fact that three of the relays in Fig. 12 are energized from a source of current external to the diagram. These are a "Stop" relay, an "On" relay and an "Off" relay. The "Stop" relay is energized whenever the press is running, regardless whether it is driven by the

small or large driving motor. This relay drops out whenever the "Stop" emergency button is operated or when a detector switch opens as a result of a web break. A suitable current source is provided so that the "On" rlay is closed whenever the press is accelerated and the "Off" relay is closed whenever the press is decelerated.

In order to locate the burner assembly successively closer to the web as the web speed increases, limit switches LS1, LS2, LS3, and LS4 are used. These limit switches are positioned relative to the burner assembly for operation thereby as illustrated in Fig. 2. Associated with these limit switches respectively are relays 11CR, 12CR, 13CR and 14CR. The latter are controlled by the drum contacts in a manner which will become apparent as the discussion proceeds.

Referring now to the upper portion of the circuit diagram, solenoid valves 141, 149, 131 and 137 are shown connected to the contacts of a main relay 10CR. It will be recalled that the functions of these valves on being energized are as follows:

141—permits flow to burner manifold.
149—admits compressed air to air blast line 110.
131—turns on supply of gas from gas line.
137—by-passes air around combustion controller.

For the purpose of getting cooling air directly to the burners, a flushing relay 17CR is used. This relay operates automatically under emergency conditions and may also be operated manually in a manner which will be more fully covered hereinafter. To enable the flushing to be terminated and the system restored fully to the "Off" condition by manual control, a pushbutton B is used which is connected in a series with the contacts of a relay 18CR. The latter in conjunction with an off limit switch DLS on the press controller operates the restoring circuit in the event the operator does not operate pushbutton B.

In order to operate the individual valves 154–160 inclusive for admitting a combustible mix or air to the lines of burners 54—60, sub-control circuits 184—190 are employed. These circuits serve also to control the auxiliary valves 164—170. As will be apparent from inspection of the diagram, these circuits are under the control of drum contacts D6 to D12 inclusive. The circuit diagram for the valve control circuit 184 is typical and is shown in detail in Fig. 13. It includes a relay 40CR for operating the burner solenoid valve 154 together with a relay 41CR for operating the auxiliary valve 164. In order to limit the time that the auxiliary valve is open a time delay relay 40T is used having a delayed drop-out on the general order of five seconds.

The contactor circuit for the motor 93 which adjusts the positioning of the burner assembly is indicated in block form at 200 and shown in detail in Fig. 14. It includes contactors U1 and B1 for operating the motor in the forward and reverse directions respectively. The motor is protected by an overload device OL1 and includes a brake to prevent overtravel when the motor is de-energized. For the purposes of simplicity, only one adjusting motor has been included in the present circuit. It will be understood, however, that the invention is not limited to the use of but one motor and includes the use of additional motors and limit switches for adjusting the remaining burner assemblies which may be included in a complete set-up. Any additional motor circuits may be connected in parallel across the supply lines L1, L2 and L3, and parallel connections may also be made to the left hand or input side of the associated limit switches.

The above completes the cataloging of the various elements in the control circuit. Since control circuits of this general type are well understood by those skilled in this art, the present application will not be burdened by a detailed recitation of the electrical connections. The latter are specifically set forth in the drawings and the reasons for the same will become apparent in the discussion of the operating sequence.

Control sequence upon increasing speed

The operation of the control circuit just discussed for the increasing speed condition may be visualized by reference to Fig. 15 which is a graph of controller position and press speed as a function of time. It will be assumed that the press is started from rest and that the controller is moved uniformly from the first position to the twelfth or maximum speed position. This causes a progressively increased press speed. Because of the inertia of the rollers in the press, the press speed will lag the movement of the controller as shown. While the press speed is shown to increase linearly, this is merely a simplifying assumption and the actual speed curve may have portions which are concave upwardly or downwardly.

In accordance with one of the aspects of the invention the burner assembly starts out from a position fully retracted from the web, movement of the press controller causing (1) at least a portion of the burners to be lighted, (2) the burner assembly to move up close to the web and (3) the heat generated by the burner assembly to be increased as the web speed setting is increased. In the preferred embodiment the heat produced by the burners is increased by progressive, step-by-step lighting of additional burners so that under full speed running conditions the burners will be fully "on" and so close to the web that the flame may actually graze the surface thereof. It will be apparent to one skilled in the art that the invention in its broader aspects is not limited to an arrangement in which burners are turned on successively but would also include arrangements in which the increased heat output is obtained by increasing the supply of gas-air mixture. The present arrangement is preferred since variation in drying capacity is attained increasing the burner and, while the burner temperature remains relatively constant over the speed range. In Fig. 15 the stepped curve indicates the successive lighting of the burners at the various controller points. The numbers applied to the steps indicate the number of the burners (in the series 51–60) which are in operation at each point. The manner in which the above operating sequence has been achieved in the present embodiment will be made clear by the following step-by-step description.

When the press is at rest the following conditions prevail:

Valve 131 closed—gas supply turned off.
Valve 141 closed—burner manifold closed.
Valve 137 open—air by-pass turned full on.
Valve 149 open—air blast provided by line 110.

Preferably the press includes provision in the main drive circuit for "inching." This is conventionally accomplished by an "inch" button

which may be operated even though the main controller is set in the "off" position. Thus, the press cylinders may be advanced, say, for threading the web without having any effect whatsoever on the dryer system.

When the controller is moved to point 2, drum contact D2 closes. This turns on the first three lines of burners, namely, 51, 52, and 53. The circuit for accomplishing this is the following: Since both the "Stop" relay and "On" relay are closed, closure of D2 causes relay 10CR to be energized. The latter relay remains closed because of a circuit which includes a normally closed contact on relay 17CR, a normally open contact on the "Stop" relay, and a normally open or "sealing in" contact on relay 10CR. As soon as relay 10CR closes the solenoid valves are operated as follows:

Valve 137 closed—air by-pass turned off.
Valve 141 closed—air blast turned off.
Valve 131 open—gas admitted from supply line.
Valve 141 open—gas mixture admitted to burner manifold.

The valves 151—153 associated with the first three lines of burners are normally open. Burner lines 51, 52, 53 fed by such valves are thus lit automatically upon admission of combustible gas, a continuously burning pilot (not shown) being associated with each of the burner lines. At this point burner valves 154—160 are closed. Due to the slow movement of the web at this time, the radiant heat from the first three lines of burners is sufficient to produce drying even though the burners are in the fully retracted position.

On point 3, drum contact D3–1 closes to run the burner assembly to its semi-retracted position approximately six inches from the web. This results because of the energization of relay 11CR which closes the circuit to motor contactor U1 (see Fig. 14). When the burner assembly reaches the six-inch position it automatically opens the limit switch LS1 and the motor contactor U1 is dropped out, stopping the motor.

On point 4 drum contact D4 closes to pick up relay 12CR. This causes the motor contactor U1 to close resulting in additional forward movement of the burner assembly until the contactor is dropped out by the limit switch LS2. At this time the burner assembly is approximately three inches from the web.

On point 5 drum contact D5 closes to energize relay 13CR which operates in a similar manner to 11CR to run the burner assembly to the fully advanced or closed position. In this position the burner ceramic is about 1½ inches from the web. The web is by this time moving at about one-quarter speed and only three lines of burners are lit so that there is no danger of scorching in spite of the closeness of the burners.

When the controller is moved to point 6 the burner control circuit 184 (see Fig. 13) is energized. Relay 40CR is picked up which energizes the solenoid valve 154 causing admission of gas to the burner line 54. Relay 40CR at this time also energizes timing relay 40T and the contacts on this relay close. However, the relay 41CR connected in series therewith does not respond since the normally closed contacts on 40CR hold this circuit open. Accordingly, the auxiliary air valve 164 is not energized. The function of the air valve 165 will be made clear in the portion of the discussion covering shut-down of the press.

As the controller is next advanced to point 7, drum contact D7 closes to energize the control circuit 185 shown in block form in Fig. 12. This results in the turning on of burner valve 155 in the same manner as discussed above for valve 154. Similarly, the remaining valves 156—160 are turned on one-by-one as the controller is moved from point 8 to the full speed position at point 12.

Operation of dryer under high speed running conditions

The web now is traveling through the press at maximum speed and all of the burners are ignited for applying both radiant heat and convected heat to the web at close range. It will be helpful at this point to observe the nature of the drying which takes place. Referring to Figs. 2–8, and particularly to Fig. 8, gas flows into the manifold 72 from the associated one of the valves 151—160, and thence through the stem 71 and nozzle 81. The gas flowing through the nozzle is directed toward a cup-shaped deflecting plate 82 and then backwardly in a smooth toric layer along the refractory material forming the surface of the recess 80. Burning of the gas adjacent the refractory material of the burner causes such material quickly to become red hot and the radiant heat therefrom is beamed along the burner axis in the direction of the web.

Upon striking the ink film the radiant energy releases solvent from the body of the film as well as from the surface thereof. In addition, any of the solvent which has been absorbed in the pores of the paper is driven off into the space surrounding the web. The solvent in vapor form is ignited by the burners and serves to increase the temperature of the web above the point which would result from the action of the burners themselves. Studies have shown that before the web completes its journey through the dryer, substantially all of the solvent is liberated and burned which not only contributes to the efficiency of the dryer but prevents the solvent from being discharged into the atmosphere or condensing in the exhaust ducts to create a fire hazard. The convected heat and the products of combustion are drawn off at the upper end of the web by the exhaust duct 120. Since the lower surface of the duct 120 includes apertures 121 closely following the surface of the cooling drum 35, even the combustion products which are drawn along the web are efficiently removed and no harmful products are permitted to escape into the atmosphere.

A large portion of the heat produced by the burners is drawn off through the exhaust system. To fully understand the advantages of the present construction, it will be helpful to trace the disposition of the remaining heat. A certain portion of the heat will be used in raising the temperature of the web itself. This heat is subsequently subtracted from the web by the cooling drums 35, 36. The radiated heat which passes through the web strikes the back-up plate 61 (see Fig. 2). Because of the reflecting surface 85 thereon most of this radiated heat is reflected back onto the web where it serves to drive off additional solvent. Some heat, however, passes into the plate 85 whence it is removed by the cooling coil 86.

Although the side walls 87 and the ends of the burner assembly are not in the direct radiation path, a certain amount of heat from the burners will flow to the ends of the burner assembly. The heat is removed in this region by the cooling coils 64, 88.

Attention may next be given to the flow of heat

in the burner assembly itself under normal operating conditions. As previously stated, the refractory surfaces of the burners are rendered red hot. Very little of this heat, however, travels through the refractory material since it is an extremely poor heat conductor. It might be expected that the metallic burner walls 76, 77 (Fig. 8) would conduct heat from the face of the burner to the manifold. However, because of the thin cross section of these walls and because of the foraminated structure thereof, only a very limited amount of heat will follow this path. As previously described, the burners are spaced at some distance from the manifold 72 which supplies them. This space indicated at 78 in Fig. 8 is filled with insulating material to minimize the direct rearward flow of heat from the burners. The only remaining metallic heat path, then, from the burner to the manifold is through the stem 71 arranged centrally in the burner and threaded to the manifold. However, it will be apparent that if the cross section of this heat path is kept small, the amount of heat flowing to the walls of the manifold may be correspondingly reduced.

In the present construction means are provided for keeping the auxiliary portions of the burner assembly far below the temperature of the burner. This is accomplished in great measure by the back plate 73 which engages the manifold 72 over an extensive area and which has sweated thereto the cooling coil 74. On each side of the manifold 72 the layers of insulation 83 prevent the passage of heat to which the latter is subjected as a result of convection and the reflection of radiant heat from the back-up plate 61. As a result of the foregoing structure, therefore, it will be appreciated that all of the parts of the burner assembly which have appreciable heat storage capacity remain cool by comparison to the burners which operate at a red heat. Since the back-up plate and the side walls are similarly cooled by water cooling coils, the heated space is effectively isolated from the rest of the press. The rubber rollers, mounted closely adjacent the dryer are kept at about the same temperature as in presses not employing a dryer.

Control sequence—gradually decreasing speed

In accordance with one of the aspects of the invention, the burner assembly is retracted and the burners are shut off and flushed with cooling air as an incident to slowing down the press. In the present embodiment a portion of the burners operating during the normal running of the press are turned off one by one as an incident to decreasing the speed of the press, after which the burner assembly is retracted and the remaining burners are extinguished. Provision is made for flushing all of the burners with cooling air applied through the same manifold which normally supplies the combustible air-gas mixture. Such flushing may be caused to occur at a predetermined point in the deceleration sequence or may be deferred until a later time in the event that the dryer has not achieved its normal running temperature. In addition the flushing air is utilized to continue the drying process, so that the latent heat removed in bringing the burner temperature down from the radiating range is not wasted but on the contrary is usefully employed for drying. Finally, after the burner assembly is retracted and the burners have been turned off, a blast of air is discharged through space vacated by the burner assembly and additional exhaust ports are uncovered to conduct away the air in the air blast. The manner in which these novel functions are performed will be apparent upon reviewing the step by step operating sequence characteristics of a normal and gradual shut-down. These steps are set forth diagrammatically in Fig. 16 which resembles Fig. 15 previously discussed in that the numerals 1–12 indicate various controller points and the steps show the number of burner lines in operation at each point.

With the controller at point 12, the conditions are the same as existed at the end of the "increase" cycle: the burners are all in operation and the burner assembly is closely adjacent the web. As the controller is moved to point 11, the solenoid valve 160 is turned off. This results from the fact that contact D12 opens to drop out a relay in circuit 190, which relay corresponds to relay 40CR shown in Fig. 13. Closing of the valve 160 is accompanied by a timed discharge of compressed air through the auxiliary valve 170 associated therewith. The manner in which this occurs may be made clear upon inspection of Fig. 13, where the corresponding circuit is shown. The normally closed contact on relay 40CR therein completes a circuit through the timing relay 40T, resulting in the picking up of relay 41CR. The contacts of the latter relay cause the auxiliary valve 170 to open, thereby causing a discharge of compressed air through the burners in line 60. This compressed air has two effects: The primary effect is to blow out of the burner the combustible air-gas mixture, thereby preventing blow-back in the burners and manifold. In addition the air flowing through the burner nozzles serves to cool the face of the burner to the extent that the temperature of the exhaust air is sufficiently high to be useful in further drying the web at the existing speed. The primary cooling effect, however, occurs at a later point due to the effect of the flushing air.

At the end of a predetermined time interval, for example, five seconds, relay 40T drops out thereby opening the circuit to the relay 41CR and turning off the valve 170. When the control is moved to point 10, contact D11 opens to deenergize the control circuit 189. This results in an operating sequence which is exactly similar to that mentioned in the preceding paragraph. The net effect is to close the solenoid valve 150 thereby turning off the burner 59 and injecting compressed air into the burner for a short space of time by opening the auxiliary air valve 169.

As the controller next is moved to point 9 and successively down to point 5 the contacts in the series D10–D6 inclusive cause shutting down of the burner lines 58—54. In each instance an auxiliary source of compressed air is briefly connected to the burner.

When the controller reaches point 4 retracting movement of the burner assembly occurs as follows: The drum contact D4–2 closes and since the "off" relay contact is closed indicating that the press is being decelerated, relay 14CR closes. A normally closed contact on the relay 14CR opens the circuit to the contactor U1 (Fig. 14). Normally open contacts in the relay 14CR energize the opposite motor contactor B1. This causes the motor 93 to rotate until the burner assembly is fully retracted, in the present instance to a distance of twelve inches from the web. At this point the burner assembly operates the limit switch LS4. This drops out contactor B1 to stop the motor. It will be understood that when

the burner assembly reaches its retracted position the remaining three burner lines 51, 52, and 53 are still lit.

At point 3 the drum contact D3-2 closes completing a circuit to the manually operated button A. Two options are available to the operator when the controller reaches this point depending upon whether the dryer has achieved full operating temperature prior to shutdown or whether it is still relatively cool as it would be after an extremely short run. First I will discuss the more normal case where the dryer has been operated for an extended period. The operator will, under such circumstances, keep his finger on the flushing button A as the controller is moved in the decrease speed direction. Thus, when point 3 is reached the flush relay 17CR will close automatically. A normally closed contact on relay 17CR drops out relay 10CR. Another normally closed contact on 17CR keeps the circuit open to solenoid valve 149. A normally open contact on relay 17CR keeps valve 141 open. The net effect of the foregoing is as follows:

Valve 131 closed—gas supply shut off.
Valve 149 closed—air blast remains off.
Valve 137 open—flushing air is by-passed around the combustion controller.
Valve 141 open—flushing air applied to manifold.
Valves 154—160 open—flushing air applied to burners 54—60 as well as 51—53.

The flushing air exiting through the nozzles of all the burners is brought directly into contact with the hot refractory surfaces of the burners as well as the deflector plate, nozzle, and other heated parts. As previously noted, the latent heat of the burners is extremely small considering the high temperature at which the burners operate. Such latent heat as is present, however, is immediately removed by the flushing air which passes from the burners upwardly along the web to be utilized in the termination of the drying process. This flushing action is continued until the controller returns to its off position at which time the line 110 is turned on to direct an insulating air blanket between the burners and the web.

If the flushing button A is released prior to the time that the press comes to a stop, the flushing will be immediately discontinued and the air blast from line 110 will be turned on ahead of time. The reason for this is that releasing button A drops out relay 17CR. Relay 10CR remains deenergized as this relay can only be picked up in the accelerated direction when the "On" relay and drum contact D2 are closed. With relays 10CR and 17CR open, solenoid valve 149 is open. Solenoid valve 137 remains energized. Solenoid valve 141 closes. Solenoid valve 131 remains closed and all of the individual burner valves 154—160 close as a result of the dropping out of relay 17CR. The effect of the above is to produce the following conditions:

Valve 131 closed—gas remains turned off.
Valve 141 closed—burner mainfold turned off.
Valce 137 open—air by-passed around combustion controller.
Valve 149 open—air blast is applied between web and burners by line 110.

The above condition is that which existed prior to the original starting up of the press and the press may be left in this condition until such time as it may next be operated.

In the event that the press has been running for only a very short time, the operator may delay application of the flushing air beyond point 3 of the controller. As an extreme case he may even omit flushing air entirely. In the latter event the above sequence including the turning on of the air blast will occur automatically as the controller is moved into the number one or at-rest position.

To summarize for the condition of normal shutdown, the flushing air applied through the burner nozzles (at point 3 of the controller in the present instance) brings down the burner temperature from red heat. The resulting heated air completes the drying after which the air blast is directed into the space between the retracted burner assembly and the web. The air in the air blast not only serves to complete the cooling of the burners to a point which is sufficiently low to eliminate the possibility of scorching, but also provides an air blanket which isolates the web from the burners as far as convection currents from the latter are concerned. Since retraction of the burner assembly uncovers additional exhaust ports, the air in the blast is disposed of without any tendency for pressure to be built up in the region surrounding the web.

Control sequence during emergency shutdown

The real test of a high capacity dryer appears during conditions of emergency caused by a web break or the like, when the speed of the web is brought to a standstill within a very few seconds. In accordance with the invention, the pressing of the emergency button (the so-called "red" button) or the operation of a web break detector produces a number of simultaneous effects.

In the first place the supply of gas is cut off and flushing air is simultaneously and automatically directed into the manifolds connected to all of the burners in the dryer. At the same time the dryer is retracted immediately into its backed off position uncovering additional exhaust ports as previously discussed. As a final step the flushing air is cut off as the press comes to a standstill and the air blast is turned on, thereby restoring the dryer to the position it had originally and in readiness for a successive run. Provision is additionally made for terminating the flushing air at any time during the emergency shutdown and for simultaneously turning on the air blast at the option of the operator.

The operating sequence for an emergency shutdown may be easily visualized by reviewing the graph of Fig. 17 which is quite similar to Fig. 16 previously discussed. It will be assumed that the emergency occurs while the press is operating at full speed. The main motor is immediately decelerated by means conventionally provided on a printing press, coming to a stop in a relatively few seconds. At the instant that the slowdown begins the "Stop" relay (Fig. 12) is dropped out to complete a circuit around the drum contact D3-2 to a normally open circuit on relay 17CR. This circuit is equivalent to operating the flushing pushbutton A and causes the flushing relay 17CR to be energized. The latter causes the relay 10CR to be deenergized. The result of the foregoing on the drying operation will be as follows:

Valve 149 remains closed—air blast remains off.
Valve 131 closed—gas supply cut off.
Valve 137 open—air is by-passed around combustion controller.

Valve 141 and valves 151—160 remain open—by-passed air is immediately applied for flushing purposes through the nozzles of all of the burners, absorbing the latent heat therein and reducing the burner temperature.

The flushing air, after acquiring the latent heat of the burners passes contact with the web to "taper off" the drying operation. Simultaneously, dropping out of the "Stop" relay causes a normally closed contact thereon to energize the relay 14CR. This relay energizes the contactor B1 to drive the burner assembly to its retracted position where it is brought to rest by operation of the limit switch LS4. When the controller rotates around to its "off" position, the "off" limit switch is operated to drop out the relays 18CR, 17CR, and 10CR to terminate the flushing and turn on the air blast from line 110.

While the present construction causes the temperature of the radiant burners to be dropped suddenly, particularly under conditions of emergency shutdown, it is important to note that drying is not terminating so quickly that undried web will pass through the dryer into contact with subsequent rollers in the press. Instead, the latent heat of the burners is utilized to produce convection currents which produce surface drying of the film at a lower temperature level than is normally produced by the radiation. The necessity for removing undried ink from the rollers after an emergency shutdown is thus eliminated.

Provision is made for terminating the flushing and turning on the air blast before the press is brought to a stop. This is accomplished by pressing pushbutton B. The latter deenergizes the relay 18CR which in turn drops out relay 17CR to establish the "off" condition which is as follows:

Valve 131 closed—gas shut off.
Valve 141 closed—burner manifolds shut off.
Valve 137 open—air by-passed around combustion controller.
Valve 149 open—air blast from line 110 turned on.

In the event that the operator does not push button B to turn on the air blast, the relay 18CR will be dropped out, in any event, when the controller reaches its "off" position. Conditions are then set up corresponding to those listed above.

Providing the pushbutton B and its associated circuits for cutting off the flushing process upon emergency shut-down adds flexibility to the operation of the dryer. If the press has only been in operation for a short time and the dryer is not up to full operating temperature, the operator may omit pressing button B. In this event the latent heat in the flushing air will continue to have a drying effect on the decelerating web even after the burner radiation is reduced to a safe point. However, where the press has been operated for a considerable period the operator may not wish to make use of the latent heat and may wish to merely reduce the radiation, following this immediately by an air blast to carry away as much of the heat in the dryer as possible. In such instance, the operator would press button B immediately as the press begins its emergency shut-down. The effect of flushing the burners by air conducted through them followed by an air blast forming a protector blanket has been found to safeguard the web against scorching even under the most abrupt conditions of shut-down.

In the above discussion it has been assumed that emergency shut-down took place from the normal running speed. It should be noted, however, that the emergency circuits are equally useful when the press is operating at a partial speed or during the course of deceleration. Referring to Fig. 18 it will be assumed that the speed controller has been moved down to point 8 when the emergency arises. This corresponds to a press speed S. The effect of the emergency is to drop out the "Stop" relay and to run the controller back to its "off" position. The press speed will suffer a correspondingly sharp decrease as indicated by the break in the press speed curve. As before, the emergency will result in the admission of flushing air to all of the burners to bring them below red heat, and the air blast may be turned on, if desired, prior to the return of the controller to the "off" position by pressing the pushbutton B.

Since the pushbuttons A and B offer a certain degree of manual control over the drying process, provision is made to insure that these buttons are not operated at such times as will endanger the web. It will be noted, for example, that if button B is operated by accident without preliminary flushing, the press will stop and flushing will occur automatically to bring the red heat of the burners down to a safe value. In the event that the press is accelerated to a partial speed point, for example point 5, the burner assembly will be closely adjacent the web. Decelerating to point 4 will cause the burner assembly to be run out to the retracted position. After the limit switch LS4 is operated in such retracted position, the burner assemblies will be turned to the position determined by the controller just as though acceleration were taking place. For example, if the controller has remained on point 4, the burner assembly will automatically move forward to the 3-inch position.

In spite of the high capacity of the dryer described above the volume which it occupies is only a small fraction of that required for conventional dryers used in the past. The dryer may be readily accommodated within the frame of a conventional magazine press without any substantial modification thereof. In the case of a newspaper press the dryers are sufficiently small as to enable mounting above the press unit. The supporting frame for the dryer in the latter instance may be very light permitting the dryer to be installed directly on the press frame. No additional floor space is consequently required. One of the factors contributing to the compactness of the present arrangement is the fact that the burner lines are fixedly oriented in the burner assembly. This not only facilitates cooling as will be clear from the foregoing description but also enables the burner lines to be arranged more closely together and permits more efficient placement of insulation while enabling utmost simplification from a mechanical standpoint. Regardless of whether the dryer is used in a magazine or newspaper press, and in spite of the large amount of heat generated therein, practical experience has shown that heat is efficiently confined and the surrounding parts of the press are not subjected to high temperature even after many hours of continuous operation.

In the above description it has been assumed for simplicity that the burners are successively turned on and turned off at successive evenly spaced controller positions. It will be apparent to one skilled in the art that the invention is not necessarily limited thereto and the points at

which the drum contacts are operated need not correspond to the numbered controller points. In a practical installation the drum contacts are so positioned that a sufficient number of the burner lines are turned on to produce the optimum drying effect for a given controller setting and web speed.

I claim as my invention:

1. In a dryer for a web in a printing press, a burner assembly comprising a back plate, burner lines arranged on said plate and spaced from one another, each of the burner lines having a longitudinally extending manifold and a burner of refractory material superimposed thereon for producing radiant heat, said manifolds each having an extended surface in contact with said back plate, high temperature insulation having low heat storage capacity filling the interstices between said manifolds, and a water cooling line in intimate thermal contact with said back plate for maintaining said plate and said manifolds at a low temperature to minimize the stored heat of the burner assembly after a sustained period of operation.

2. In a dryer for a web in a printing press the combination comprising a burner assembly having a plurality of burner lines therein fixedly oriented to supply radiant heat simultaneously to an extended surface of web, each of said burner lines including a metallic base having a face of refractory material superimposed thereon which is cup-shaped in cross section, means including a nozzle for conducting combustible gas mix into said cup-shaped face so that the latter becomes radiantly red during combustion of the gas, a cooling pipe having cooling water circulating therein and in intimate thermal contact with said base to maintain it at a low temperature during operation of the burner, said refractory material having low latent heat under normal operating conditions, and means for simultaneously turning off the supply of gas and admitting cooling air directly on the radiating surfaces to quickly reduce the temperature thereof upon shut-down of the press.

3. In a dryer for a web in a printing press a burner assembly including a plurality of burners arranged substantially parallel to the web, said assembly having a series of radiant gas burners mounted thereon and directed toward the web, means for bodily advancing and retracting said burner assembly to change the spacing between the burners and the web, and control means for (1) first turning on said burners in the assembly in sequence and advancing the burner assembly toward the web as an incident to increasing web speed and (2) retracting the burner assembly and turning off said burners in sequence as an incident to decreasing the web speed.

4. In a dryer for a web in a printing press a burner assembly oriented substantially parallel to the web and having a plurality of radiant burners arranged in both directions therealong, said burners being fixedly mounted in said burner assembly so that the radiant heat generated thereby is directed toward the web, a series of air jets along one edge of the burner assembly and positioned to discharge a blanket of air between the burner assembly and the web, exhaust means along the opposite edge of the burner assembly and means operating incident to a reduction of speed of the web for supplying air to said air jets and for retracting said burner assembly away from the web to provide a channel of large cross section which extends substantially unobstructed between the jets and the exhaust means for the accommodation of a large volume of air in said blanket.

5. A dryer for a web in a printing press a burner assembly oriented parallel to the web and having a plurality of radiant burners arranged in both directions therealong, said burners including nozzles for transmitting a combustible mix to the radiant face thereof and fixedly mounted in said burner assembly so that the radiant heat generated thereby is directed toward the web, and means operated as incident to a reduction of the speed of the web for bodily retracting said burner assembly from the web, turning off said source of gas, and supplying cooling air to said nozzles for cooling said radiating surfaces.

6. A dryer for a web in a printing press including a burner assembly extending the width of the web and oriented parallel thereto, the burners in said assembly being arranged therein so that radiant heat is directed toward the web, exhaust means including exhaust ducts arranged along one side of the burner assembly and normally covered thereby when the latter is in normal running position, and means for retracting the burner assembly in a direction away from the web so that the exhaust ducts are simultaneously uncovered thereby to facilitate the heat removing action thereof with the result that the temperature of the air adjacent the web is lowered.

7. In a dryer for a web in a printing press the combination comprising a burner assembly having a box-like housing for said burner assembly, said housing including a plurality of gas burners fixedly mounted thereon and having a relatively flat end surface, said housing being open on the side toward said web so that the heat radiated from said burners is applied to the web, an exhaust duct along an edge of said box-like housing and arranged to be normally at least partially covered by the end surface thereof, means including a plurality of air jets arranged along the opposite edge of said housing for directing an air blanket between the burner assembly and the web, and means for retracting said housing away from said web upon slowdown of the web, such retraction serving to uncover an additional area of said exhaust ducts and serving to increase the cross section of the air channel between said web and said housing to facilitate removal of the air from said air jets.

8. In a dryer for a web in a printing press a burner assembly comprising in combination a plurality of burner lines arranged horizontally and spaced vertically from one another equidistant from the web, a water-cooled back plate, each of said burner lines including a longitudinal manifold of rectangular cross section, a plurality of radiant burners of refractory material spaced along said manifold and in communication therewith, the space between adjacent manifolds being filled with insulating material so that substantially the entire face of said burner assembly is composed of material having poor heat transmission characteristics, and means for normally clamping said manifolds into intimate thermal contact with the water-cooled back plate but permitting a selected burner line to be forwardly withdrawn as a unit for purposes of replacement or maintenance.

9. A system for supplying a gas-fired radiant burner in a printing press web dryer comprising in combination a source of gas, a source of com-

pressed air, a mixture line, means including a combustion controller for causing proportioned amounts of gas and air to flow into the mixture line, a burner, a burner valve interposed between said mixture line and said burner for normally admitting combustible gas mixture to said burner, a valve for controlling the admission of gas from said source, a by-pass valve arranged to by-pass air from said compressed air source around said combustion controller and means for simultaneously closing said gas valve and opening said by-pass valve so that the combustible mixture delivered to said burner is replaced by compressed cooling air.

10. In a dryer for a web in a printing press the combination comprising a plurality of radiant gas-fired burners arranged to constitute a burner assembly parallel to a web, a gas line, a compressed air supply line, said lines being connected to a mix line, an air blast outlet arranged adjacent said burner assembly, means including a burner valve and an air blast valve for connecting said burners and said air blast lines respectively to said mix line, a valve in said gas line for controlling the admission of gas to said mix line, and means actuated as an incident to decelerating the web for shutting off the gas valve and admitting compressed air first to said mix line and then to said air blast outlet for the purpose of cooling said burners below the radiant temperature and covering them with a blanket of air thereby to prevent scorching of the web.

11. A dryer for a web in a printing press comprising a plurality of radiant gas-fired burners arranged parallel to a web and having a mix line, said burners having radiant surfaces and means for directing combustible mix from the mix line thereon, a gas line, a compressed air supply line, said lines being connected to said mix line, a valve for controlling the admission of gas to said mix line, and means actuated as an incident to bringing the web to a stop for shutting off the gas valve and admitting unmixed air through said mix line so that the same is directed upon the radiant surfaces of said burners for the purpose of cooling said burners below the radiant temperature to reduce the tendency toward scorching of the web on shutdown.

12. In a dryer for a web in a printing press the combination comprising a plurality of gas-fired radiant burners mounted for movement in unison between a retracted position spaced from the web and an operating position closely adjacent the web, a source of air-gas mix and a source of compressed air, means including valves for alternative supply of air-gas mix and compressed air to said burners, control means actuated as an incident to shutting down the press for successively turning off a portion of said burners and then retracting the burner assembly away from the web with the remaining portion of the burners still lit, and manually operable means for controlling said valves to connect all of said burners to said source of compressed air for flushing the same to bring the temperature thereof down from the normal radiating temperature and means for finally stopping said flushing and inserting an air blanket between said burners and said web to isolate the same and thereby prevent scorching of the web.

13. In a dryer for a web in a printing press a burner assembly oriented parallel to the web and having a plurality of radiant burners spaced therealong in the direction of movement of the web, said burners being fixedly mounted in said burner assembly so that the radiant heat generated thereby is directed toward the web, means for moving said burner assembly bodily while maintaining it parallel to the web, control means operated automatically upon an increase of web speed for advancing said burner assembly into face-to-face engagement with the web and then effecting a step-by-step increase in the heat output of the burners, and control means for causing such operations to be performed in the reverse order upon slowdown of the web.

14. In a dryer for a web in a printing press the combination comprising a burner assembly including a plurality of burners extending the width of the web and spaced at intervals therealong, means including a nozzle for directing a gas flame onto the face of each of said burners for elevating the same to radiant heat, said burner assembly being bodily movable between a normal position in close face-to-face relation with the web and a retracted position spaced from the web, a back-up plate coextensive with said burner assembly and arranged parallel thereto on the opposite side of the web, side walls in edge-to-edge engagement with said back-up plate and in overlapping relation with said burner assembly so that an enclosed heated space is maintained about said web for all positions of said burner assembly, and cooling water tubes in intimate thermal contact with said back-up plate, said end walls, and said burner assembly for conducting away the heat therefrom and substantially isolating the enclosed space from the surrounding portions of the press.

15. In a dryer for a web in a printing press, a combination comprising a burner assembly, said burner assembly including a plurality of burners arranged side by side parallel to the run of the web, said burners being comprised of refractory material, metallic conduit means for directing a combustible mixture onto the surface of said burners for the production of radiant heat in the direction of the web, means including a water cooling line in intimate thermal contact with said conduit means for maintaining said conduit means at a relatively low temperature minimizing the quantity of latent heat in the burner assembly after a sustained period of operation, control means for shutting off the supply of said combustible mixture in timed relation to the stopping of said printing press, means for flushing said burners by admitting compressed air to said metallic conduit incident to shutting off said combustible mixture, means for retracting said burner assembly from the web, and exhaust ports at one end of said burner assembly disposed transversely to the direction of the run of said web and located in depth for progressive opening in timed relation with the retraction of said burner assembly.

16. In a dryer for a web in a printing press, a combination comprising a burner assembly, said burner assembly including a plurality of burners arranged side by side parallel to the run of the web, said burners being comprised of refractory material and having metallic conduit means for directing a combustible mixture onto the surface thereof for the production of radiant heat in the direction of the web, means providing exhaust ports adjacent said burner assembly, retracting means for moving said burner assembly away from said web while simultaneously uncovering said exhaust ports, an air blast outlet along one edge of said burner assembly positioned to dis-

charge an air blast between the burner assembly and the web, and control means arranged to deliver air from said compressed air source to said air blast outlet when the burner assembly is retracted.

RICHARD G. ZIMMERMAN.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,802,001	Brooke	Apr. 21, 1931
2,157,388	MacArthur	May 9, 1938
2,204,802	Gessler	June 18, 1940
2,210,032	Hess	Aug. 6, 1940
2,268,986	Hess et al.	Jan. 6, 1942
2,282,226	Hoop	May 5, 1942
2,288,129	Fieldhausen et al.	June 30, 1942
2,394,061	Horstkotte	Feb. 5, 1946
2,409,431	Hess	Oct. 15, 1946
2,414,891	Offen	Jan. 28, 1947
2,417,011	Offen	Mar. 4, 1947
2,473,629	Andrews	June 21, 1949
2,532,032	Offen	Nov. 28, 1950