

(12) PATENT
(19) AUSTRALIAN PATENT OFFICE

(11) Application No. **AU 199720026 B2**
(10) Patent No. **716885**

(54) Title
High velocity, hot air dryer and extractor

(51)⁶ International Patent Classification(s)
B41F 023/04 F26B 009/04
B41L 023/20

(21) Application No: **199720026** (22) Application Date: **1997 .05 .05**

(30) Priority Data

(31) Number (32) Date (33) Country
132584 1993 .10 .06 US

(43) Publication Date : **1997 .07 .31**
(43) Publication Journal Date : **1997 .07 .31**
(44) Accepted Journal Date : **2000 .03 .09**

(62) Divisional of:
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(56) Related Art
US 4233901

ABSTRACT

A hot air dryer 10 utilizes high velocity air jets which scrub and break up
5 the surface of a freshly printed sheet 5. High velocity air is heated to a high
temperature as it flows along a resistance heating element within an air
delivery baffle tube 64. The heated, high velocity air pressurizes a plenum
chamber 46 within an air distribution manifold. High velocity jets of hot air are
discharged through multiple air flow apertures 54 onto the wet ink side of a
10 printed sheet 5 as it moves through the dryer exposure zone z. An extractor 4
removes the moist air layer, high velocity hot air and volatiles from the printed
sheet 5 and exhausts it from the press 12.



AUSTRALIA

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**COMPLETE SPECIFICATION
(ORIGINAL)**

Application Number: Class Int. Class
Lodged:

Complete Specification Lodged:
Accepted:
Published:

Priority

Related Art:

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Invention Title:

HIGH VELOCITY, HOT AIR DRYER AND EXTRACTOR

Our Ref : 489456
POF Code: 87692/200202

The following statement is a full description of this invention, including the best method of performing it known to applicant(s):

"HIGH VELOCITY, HOT AIR DRYER AND EXTRACTOR"

This is a divisional application divided out of Australian patent application number 68953/94, the entire contents of which are incorporated
5 herein by reference.

This invention relates generally to accessories for sheet-fed, rotary offset and flexographic printing presses, and in particular to a dryer for printed materials which utilizes high velocity, hot air flow and extraction.

In the operation of a rotary offset press, an image is reproduced on a
10 web or sheet of paper of some other printable substrate by a plate cylinder which carries the image, a blanket cylinder which has an ink transfer surface for receiving the inked image, and an impression cylinder which presses the paper against the blanket cylinder so that the inked image is transferred to the paper. In some applications, a protective and/or decorative coating is applied
15 to the surface of the freshly printed sheets. The freshly printed sheets are then transported to a sheet delivery stacker in which the printed sheets are collected and stacked.

The relatively wet condition of the printing ink composition and its solvent and/or diluent components and a layer of moisture laden air which
20 clings to the surface of the freshly printed web or sheet may interfere with the quality of the images as they are printed at each succeeding printing unit. For example, the quality of coloured images, half-tone illustrations and the like undergo degradation in the uniformity of their appearance and color because of the presence of the wet ink, volatiles, and

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moisture within the printed substrate. Moreover, protective coatings will undergo dilution and surface degradation causing a dull finish if the underlying substrate is not dried sufficiently before the coating is applied.

5 Such defects, including uneven surface appearance of protective/decorative coatings, detract from the appearance of the underlying images or photographs, particularly in the case of multi-colored images or photographs. The defects are caused by residual volatile

10 solvents, diluents, water and the like within the oleo-resinous inks of the images, and the presence of moisture in the printed material, at the time that the next successive image is printed or the protective/decorative coating is applied. Because the defects are compounded as the

15 printed material moves through successive printing units, it is desirable that curing and drying be initiated and volatiles and moisture laden air be extracted at each interstation position, as well as at the delivery position.

20 Hot air dryers and radiant heaters have been used as delivery dryers and as interstation dryers. Interstation dryers employing radiant heat lamps are best suited for slow to moderate press speeds in which the exposure time of each printed sheet to the radiant heat is long enough to initiate ink setting. For high speed press
25 operation, for example, at 5,000 sheets or more per hour, there is not enough available space at the interstation position to install a radiant heater having sufficient

number of heat lamps for adequate drying purposes.

As press speed is increased, the exposure time (the length of time that a printed sheet is exposed to the radiant heat) is reduced. Since the number of lamps is limited by the available interstation space, the output power of the radiant lamps has been increased to deliver more radiant energy at higher temperatures to the printed sheets in an effort to compensate for the reduction in exposure time. The increased operating temperatures of the high-powered radiant heat lamps cause significant heat transfer to the associated printing unit and other equipment mounted on the press frame, accelerated wear of bearings and alterations in the viscosities of the ink and coating, as well as upsetting the balance between dampening solution and ink. The heat build-up may also cause operator discomfort and injury.

To handle high speed press operations, an off-press heater has been utilized from which high velocity, heated air is conveyed through a thermally insulated supply duct to a discharge plenum which directs high velocity, heated air onto the printed stock as it moves across the interstation dryer position. Such off-press heaters have proven to be relatively inefficient because of excessive heat loss and pressure drop along the supply duct. Attempts to overcome the heat loss and pressure drop have resulted in substantially increased physical size of the heater equipment (blower fan and supply duct) along with a

substantial increase in the electrical power dissipated by the off-press heater.

According to one aspect of the invention there is provided a hot air dryer for use in combination with a printing press of the type having conveyor apparatus for transporting a processed substrate along a sheet travel path including, in combination:

first and second elongated dryer heads coupled together in side-by-side relation for installation in an operative position adjacent the freshly processed side of a substrate as it moves through a dryer exposure zone along the sheet travel path, each dryer head having a housing member defining an air distribution manifold chamber, each air distribution manifold housing member including an inlet port for receiving high velocity air and having one or more discharge ports for directing pressurized air toward the sheet travel path, and the dryer heads being separated from each other by a longitudinal air gap;

first and second elongated heating elements disposed within the air distribution manifold chambers of the first and second dryer heads, respectively, for heat exchange contact with the pressurized air directed through the respective air distribution manifolds; and,

an extractor head coupled to the dryer heads, the extractor head including a housing defining an extractor manifold chamber coupled in airflow communication with the longitudinal air gap, and having an extractor port coupled in airflow communication with the extractor manifold chamber for exhausting air and volatiles from the dryer exposure zone.

According to another aspect of the invention there is provided a method for drying a freshly printed press including the steps of:

installing first and second dryer heads in side-by-side relation on the printing press in an operative position adjacent a dryer exposure zone, the dryer heads being separated from each other by a longitudinal air gap;

discharging heated air from each dryer head into the dryer exposure zone and onto the freshly printed sheet; and

extracting heated air from the exposure zone through the longitudinal air gap.



Heated, high velocity air is discharged out of the air delivery tube into the plenum chamber of the housing member. Preferably, the high velocity air is supplied to the manifold plenum chamber through an inlet port having an inlet flow area which is greater than the outlet flow area of the hot air discharge
5 port. By this arrangement, heated air will be supplied to the plenum chamber faster than it can be discharged, so that the heated air will be compressed within the manifold plenum chamber. This assures that jets of hot air which are discharged through multiple outlet apertures are uniform in

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pressure and velocity along the length of the dryer head, so that the printed sheet is dried uniformly as it is transferred through the exposure zone of the dryer.

5 The moist air layer may be displaced from the surface of the printed sheet by high-velocity hot air jets which scrub and break-up the moisture-laden air layer that adheres to the printed surface of the sheet. The high-velocity hot air jets create turbulence which overcomes the
10 surface tension of the moisture and separates the moisture laden air from the surface of the printed material. The moisture vapor and volatiles become entrained in the forced air flow and are removed from the printing unit by a high volume extractor.

15 The scrubbing action of the high velocity hot air jets is improved by adjacent rows of multiple discharge apertures which are oriented to deliver a converging pattern of high velocity hot air jets into an exposure zone across the sheet travel path. The high velocity hot air
20 jets are produced by a pair of elongated dryer heads in which high velocity air is heated by heat transfer contact with a resistance heating element within an air delivery baffle tube. Since the release of moisture and other volatiles from the ink and printed material occurs continu-
25 ously in response to the absorption of thermal energy, the moisture laden air layer is displaced continuously from the printed sheet as the printed sheet travels through the

dryer exposure zone in contact with the converging hot air jets.

The moisture-laden air volatiles and hot air completely
5 exhausted from the printing unit by a high volume extrac-
tor. An extractor manifold is coupled to a pair of
elongated dryer heads and draws the moisture-laden air,
volatiles and high velocity hot air from the exposure zone
through a longitudinal air gap between the dryer heads.
10 According to this arrangement, the setting of ink on each
printed sheet is initiated and accelerated before the sheet
is run through the next printing unit.

Operational features and advantages of the
present invention will be understood by those skilled in
15 the art upon reading the detailed description which follows
with reference to the attached drawings, wherein:

FIGURE 1 is a schematic side elevational view in
which multiple dryers of the present invention are in-
stalled at interstation positions in a four color offset
20 rotary printing press;

FIGURE 2 is a simplified side elevational view
showing the dryer of the present invention installed in an
interstation position between two printing units of FIGURE
1;

25 FIGURE 3 is a bottom plan view showing installa-
tion of the dryer assembly of FIGURE 2 in the interstation
position;

FIGURE 4 is a perspective view of the inter-station dryer shown in FIGURE 2;

FIGURE 5 is a sectional view of the improved dryer of the present invention taken along the line 5-5 of
5 FIGURE 4;

FIGURE 6 is a longitudinal sectional view of the dryer assembly shown in FIGURE 2;

FIGURE 7 is a sectional view of the dryer assembly shown in FIGURE 2, taken along the line 7-7 of
10 FIGURE 6;

FIGURE 8 is a perspective view of a resistance heating element used in the dryer of FIGURE 2;

FIGURE 9 is a perspective view similar to FIGURE 8, with the resistance heating element enclosed in a
15 support sheath;

FIGURE 10 is a view similar to FIGURE 4 which illustrates an alternative embodiment of the dryer head in which the discharge port is formed by an elongated slot; and,
20

FIGURE 11 is a perspective view, partially broken away, of the dryer head shown in FIGURE 10.

As used herein, the term "processed" refers to various printing processes which may be applied to either side of a sheet, including the application of inks and/or
25 coatings. The term "substrate" refers to sheet material or web material.

Referring now to FIGURE 1, the high velocity hot

air dryer 10 of the present invention will be described as used for drying freshly printed substrates, which are successively printed at multiple printing units in a sheet-fed, rotary offset printing press. In the exemplary
5 embodiment, the dryer 10 of the present invention is installed at an interstation position between two printing units of a four color printing press 12 which is capable of handling individual printed sheets having a width of the approximately 40" (102 millimeters) and capable of printing
10 10,000 sheets per hour or more, such as that manufactured by Heidelberg Druckmaschinen AG of Germany under its designation Heidelberg Speedmaster 102V.

The press 12 includes a press frame 14 coupled on the right end to a sheet feeder 16 from which sheets,
15 herein designated S, are individually and sequentially fed into the press, and at the opposite end, with a sheet stacker 18 in which the printed sheets are collected and stacked. Interposed between the sheet feeder 16 and the sheet stacker 18 are four substantially identical sheet
20 printing units 20A, 20B, 20C and 20D which can print different color inks onto the sheets as they are moved through the press.

As illustrated in FIGURE 1, each sheet fed printing unit is of conventional design, each unit including
25 a plate cylinder 22, a blanket cylinder 24 and an impression cylinder 26. Freshly printed sheets S from the impression cylinder 26 are transferred to the next printing

unit by transfer cylinders T1, T2, T3. A protective coating may be applied to the printed sheets by a coating unit 28 which is positioned adjacent to the last printing unit 20D.

5 The freshly printed and coated sheets S are transported to the sheet stacker 18 by a delivery conveyor system, generally designated 30. The delivery conveyor 30 is of conventional design and includes a pair of endless delivery gripper chains 32 carrying laterally disposed
10 gripper bars having a gripper element for gripping the leading edge of a freshly printed sheet S as it leaves the impression cylinder 26. As the leading edge of the printed sheet S is gripped by the grippers, the delivery chains 32 pull the gripper bar and sheet S away from the impression
15 cylinder 26 and transports the freshly printed and/or coated sheet to the sheet stacker 18.

 Prior to delivery, the freshly printed sheets S pass through a delivery dryer 34 which includes a combination of infra-red thermal radiation, forced air flow and
20 extraction.

 Referring now to FIGURE 2, FIGURE 5 and FIGURE 6, the interstation dryer 10 includes as its principal components a dryer head 36, a resistance heating element 38, and an extractor head 40. As shown in FIGURE 3, the
25 dryer head 36 is mounted on the press side frame members 14A, 14B by side frame flanges 42, 44. In this interstation position, the dryer head 36 is extended laterally

across and radially spaced from the interstation transfer cylinder T2, thereby defining an exposure zone Z.

The dryer head 36 includes a tubular sidewall 36W which encloses an air distribution manifold chamber 46. 5 The air distribution manifold housing is sealed on opposite ends by end plates 48, 50, respectively, and is sealed against the extractor head 40. The manifold housing has an inlet port 52 for admitting high velocity, pressurized air through a supply duct 52 from an off-press compressor 53, 10 and has a discharge port for delivering pressurized hot air into the exposure zone Z.

As shown in FIGURE 6, the air distribution manifold sidewall 36W is intersected by multiple discharge apertures 54 which collectively define the discharge port. 15 The apertures 54 are oriented for discharging pressurized jets of high velocity, hot air toward the interstation transfer cylinder T2, and are longitudinally spaced along the dryer head 36. According to this arrangement, pressurized air jets are directed along a straight line across the printed side of a sheet S as it moves through the dryer 20 exposure zone Z. In an alternative embodiment, as shown in FIGURE 10 and FIGURE 11, the discharge port is formed by an elongated slot 55 which intersects the dryer head sidewall 36W and extends longitudinally along the dryer head.

25 Referring now to FIGURE 6 and FIGURE 7, the resistance heating element 38 is coupled to the dryer head 36 by an end block 56. The end block 56 has a body

portion which is intersected by an axial bore 58, a counterbore 60 and a radial inlet bore 62 which communicates with the counterbore. The heating element 38 has an end portion 38A which projects through the axial bore 58 and counterbore 60, with the elongated body portion of the heating element 38 extending into the plenum chamber 46.

The plenum chamber 46 is partitioned by an elongated air delivery baffle tube 64 which extends substantially the entire length of the dryer head 36. The air delivery baffle tube 64 has an inlet port 66 for receiving high velocity airflow from a remote supply and has a tubular sidewall 64A extending through the plenum chamber. The tubular sidewall 64A has an inner airflow passage 68 which connects the inlet port 66 in airflow communication with the plenum chamber 46 through its open end 64E. The air delivery baffle tube 64 has an end portion 64B projecting through the axial bore 60 of the end block 56, with its inner airflow passage 66 in airflow registration with the radial bore 62.

A pneumatic connector 70 is coupled to the radial inlet bore 62 of the end block 56 for connecting the inner airflow passage 68 to an off-press source of high velocity air. The end block 56 is sealed against the end plate 50, the tubular sheath 78 and against the pneumatic connector 70. High velocity, pressurized air is constrained to flow from the air duct 52 into the airflow passage 68 where it

is discharged into the air distribution plenum chamber 46 after absorbing heat from the heating element 38.

As shown in FIGURE 6, the high velocity air flows longitudinally through the annular flow passage 68 in heat transfer contact with the heating element 38. The high velocity air is heated to a high temperature, for example 350°F (176°C), before it is discharged through the airflow apertures 54.

To provide uniform air jet discharge through the apertures 54, the inlet area of the inlet port 66 should be greater than the combined outlet area provided by the multiple airflow discharge apertures 54. In the preferred embodiment, the discharge apertures 54 have a diameter of 1/16 inch (0.158 cm), and for a 40" (102 mm) press there are 88 apertures spaced apart along the dryer head 36 on 0.446 inch (1.13 cm) centers. This yields a total airflow outlet area of 0.269 square inch (1.735 square cm). Preferably, the effective inlet area of the inlet port 66 is at least about 0.54 square inch (3.484 square cm).

In the alternative dryer head embodiment shown in FIGURE 10, the air discharge slot 55 has a length of 40 inches (102 mm) along its longitudinal dimension L, and has an arc length C of 6.725 mils (17×10^{-3} cm).

With the preferred inlet/outlet ratio of about 2:1 or more, the high velocity, heated air will be supplied to the plenum chamber 46 faster than it can be discharged, so that the heated air will be compressed within the

manifold plenum chamber. This assures that the jets of hot air which are discharged through the outlet apertures 54 are uniform in pressure and velocity along the length of the dryer head, so that the printed sheet is dried uniformly as it is transferred through the exposure zone Z.

The air distribution baffle tube 64 is supported on the inlet end by the end plate 50, and on its discharge end by flange segments 64F which engage the internal bore of the dryer head 36 and positions the baffle tube in the center of the plenum chamber 46.

Referring now to FIGURE 6, FIGURE 7, FIGURE 8 and FIGURE 9, the heating element 38 is preferably an electrical resistance heater having elongated resistance heater sections 38C, 38D which are integrally formed and folded together about at a common end 38E. The resistance sections 38C, 38D are substantially co-extensive in length with the air delivery baffle tube 64. Each section 38C, 38D is electrically connected to a power conductor 72, 74, respectively, for connecting the resistance heating element 38 to an off-press source of electrical power.

The resistance heater sections 38C, 38D are mechanically stabilized by an end connector 76, and are enclosed within a tubular, thermally conductive sheath 78. Radial expansion of the half sections 38C, 38D is limited by the sidewall of the sheath 78, thus assuring efficient heat transfer, while the sheath provides longitudinal support for the elongated resistance heater sections within

the inner airflow passage 68. The heating element half-sections 38C, 38D thus form a continuous loop resistance heating circuit which is energized through the power conductors 72, 74.

5 The tubular sheath 78 is received within the bore
58 and is welded to the end block 56. The tubular sheath
78 thus provides an opening through the end block 56 to
permit insertion and withdrawal of the heating element 38
for replacement purposes. The heating element 38 is
10 dimensioned for a sliding fit within the sheath 78 at
ambient temperature. The end cap 76 is releasably secured
to the end block 56 by a hold-down metal strap (not
illustrated). The distal end 78B of the sheath is sealed
by an end cap 78C to prevent leakage of high velocity air
15 out of the distribution manifold chamber 46.

Referring now to FIGURE 2, FIGURE 4, and FIGURE
5, the extractor head 40 is coupled to the back side of a
pair of identical dryer heads 36A, 36B. The dryer heads
36A, 36B are separated by a longitudinal air gap 80 which
20 opens in air flow communication with an extractor manifold
chamber 82, thereby defining a manifold inlet port. The
extractor manifold chamber 82 is enclosed by the end plates
48, 50 and by housing panels 40A, 40B, 40C and 40D. The
extractor housing panels 40C, 40D are secured and sealed by
25 a welded union to the dryer heads 36A, 36B.

According to another aspect of the present
invention, the multiple air flow apertures 54 of each dryer

head 36A, 36B are arranged in linear rows R1, R2, respectively, and extend transversely with respect to the direction of sheet travel as indicated by the arrows S in FIGURE 3. The rows R1, R2 are longitudinally spaced with respect to each other along the sheet travel path. Each air jet expands in a conical pattern as it emerges from the airflow aperture 54. Expanding air jets from adjacent rows intermix within the exposure zone Z, thereby producing turbulent movement of high velocity hot air which scrubs the processed side of the sheet S as it moves through the exposure zone Z. Preferably, balanced air pressure is applied uniformly across the exposure zone Z to ensure that the moist air layer is completely separated and extracted from the freshly printed sheets.

In the exemplary embodiment, the pressure of the high velocity air as it is discharged through the inlet port 66 into the heat transfer passage 68 is about 10 psi (7031 Kgs/m²). The inlet suction pressure in the longitudinal air gap 80 of the extractor is preferably about 5 inches of water (12.7 x 10³ Kgs/cm³).

As shown in FIGURE 3 and FIGURE 5, the extractor manifold inlet port 80 is coupled in air flow communication with the exposure zone Z for extracting heat, moisture laden air and volatiles out of the dryer. The extractor manifold chamber 82 is coupled in air flow communication with an exhaust fan 84 by an air duct 86. The air duct 86 is coupled to the extractor manifold chamber 82 by a

transition duct fitting 88.

The high velocity, heated air which is discharged onto the printed sheet S is also extracted along with the moisture and volatiles through the air gap 80 into the
5 extractor chamber 82. Ambient air, as indicated by the curved arrows, is also suctioned into the exposure zone Z and through the longitudinal air gap, thus assuring that none of the hot air, moisture or volatiles will escape into the press area. Extraction from the exposure zone Z is
10 enhanced by directing the hot air jets along converging lines whose intersection defines an acute angle alpha (α), as shown in FIGURE 5.

The air flow capacity of the exhaust fan 84 is preferably about four times the total airflow input to the
15 dryer heads. This will ensure that the exposure zone Z is maintained at a pressure level less than atmospheric thereby preventing the escape of hot air, moisture laden air and volatiles into the press room.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A hot air dryer for use in combination with a printing press of the type having conveyor apparatus for transporting a processed substrate along a sheet travel path including, in combination:

5 first and second elongated dryer heads coupled together in side-by-side relation for installation in an operative position adjacent the freshly processed side of a substrate as it moves through a dryer exposure zone along the sheet travel path, each dryer head having a housing member defining an air distribution manifold chamber, each air distribution manifold housing member
10 including an inlet port for receiving high velocity air and having one or more discharge ports for directing pressurized air toward the sheet travel path, and the dryer heads being separated from each other by a longitudinal air gap;

first and second elongated heating elements disposed within the air distribution manifold chambers of the first and second dryer heads,
15 respectively, for heat exchange contact with the pressurized air directed through the respective air distribution manifolds; and,

an extractor head coupled to the dryer heads, the extractor head including a housing defining an extractor manifold chamber coupled in airflow communication with the longitudinal air gap, and having an extractor port
20 coupled in airflow communication with the extractor port coupled in air flow communication with the extractor manifold chamber for exhausting air and volatiles from the dryer exposure zone.

2. A hot air dryer as defined in claim 1, wherein the one or more discharge
25 ports of each dryer head are arranged in first and second rows, respectively, the rows being separated from each other along the sheet travel path, and the one or more discharge ports of each row are oriented for directing pressurized air into the dryer exposure zone.

30 3. A hot air dryer as defined in claim 1 or 2, wherein the one or more discharge ports of the first and second dryer heads are oriented for directing pressurized air along first and second converging lines, respectively.



4. A hot air dryer as defined in any one of claims 1 to 3, including:
first and second elongated air delivery tubes disposed in the first and
second air distribution manifold chambers, respectively, each air delivery tube
having an inlet port for receiving pressurized airflow and having an inner airflow
5 passage connecting its inlet port in airflow communication with the air
distribution manifold chamber; and
the first and second elongated heating elements are disposed within the
inner airflow passages of the first and second delivery tubes, respectively.

10 5. A method for drying a freshly printed sheet in a printing press including
the steps of:

installing first and second dryer heads in side-by-side relation on the
printing press in an operative position adjacent a dryer exposure zone, the
dryer heads being separated from each other by a longitudinal air gap;

15 discharging heated air from each dryer head into the dryer exposure
zone and onto the freshly printed sheet; and

extracting heated air from the exposure zone through the longitudinal air
gap.

20 6. A method for drying a freshly printed sheet as defined in claim 10,
including the step of:

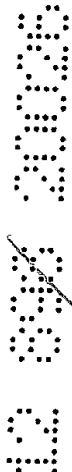
extracting air from the exposure zone through the longitudinal air gap at
a volume flow rate which exceeds the total volume flow rate of heated air
discharged from the first and second dryer heads.

25 DATED: 11 August 1999

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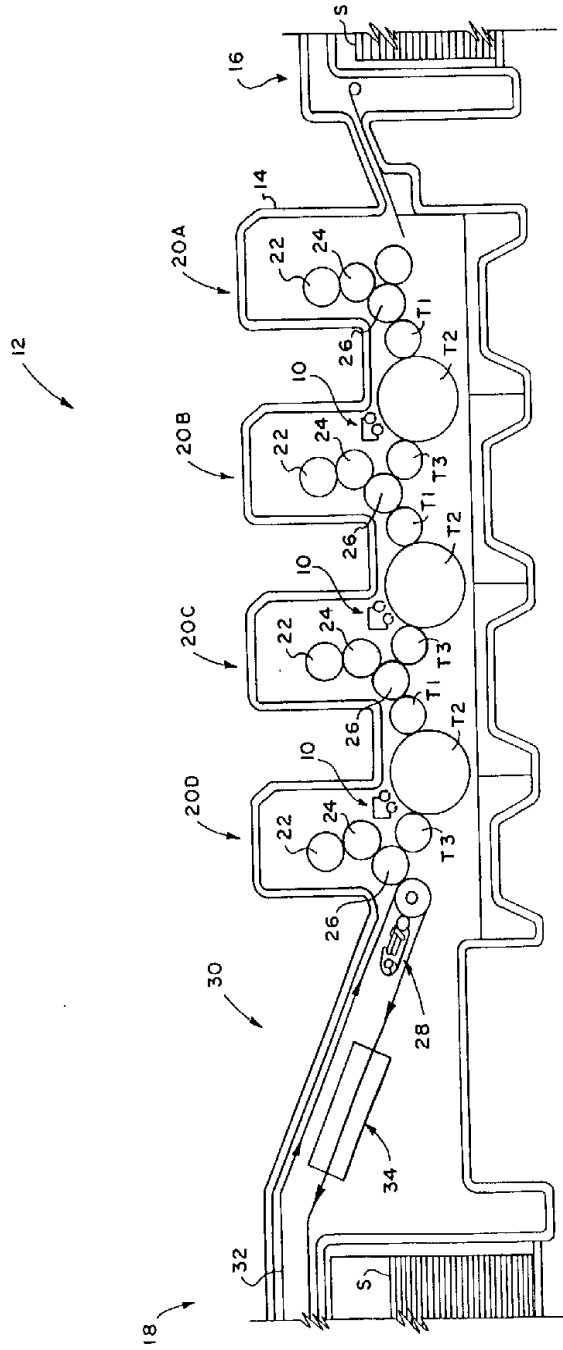


FIG. 1

5 05 97 0003

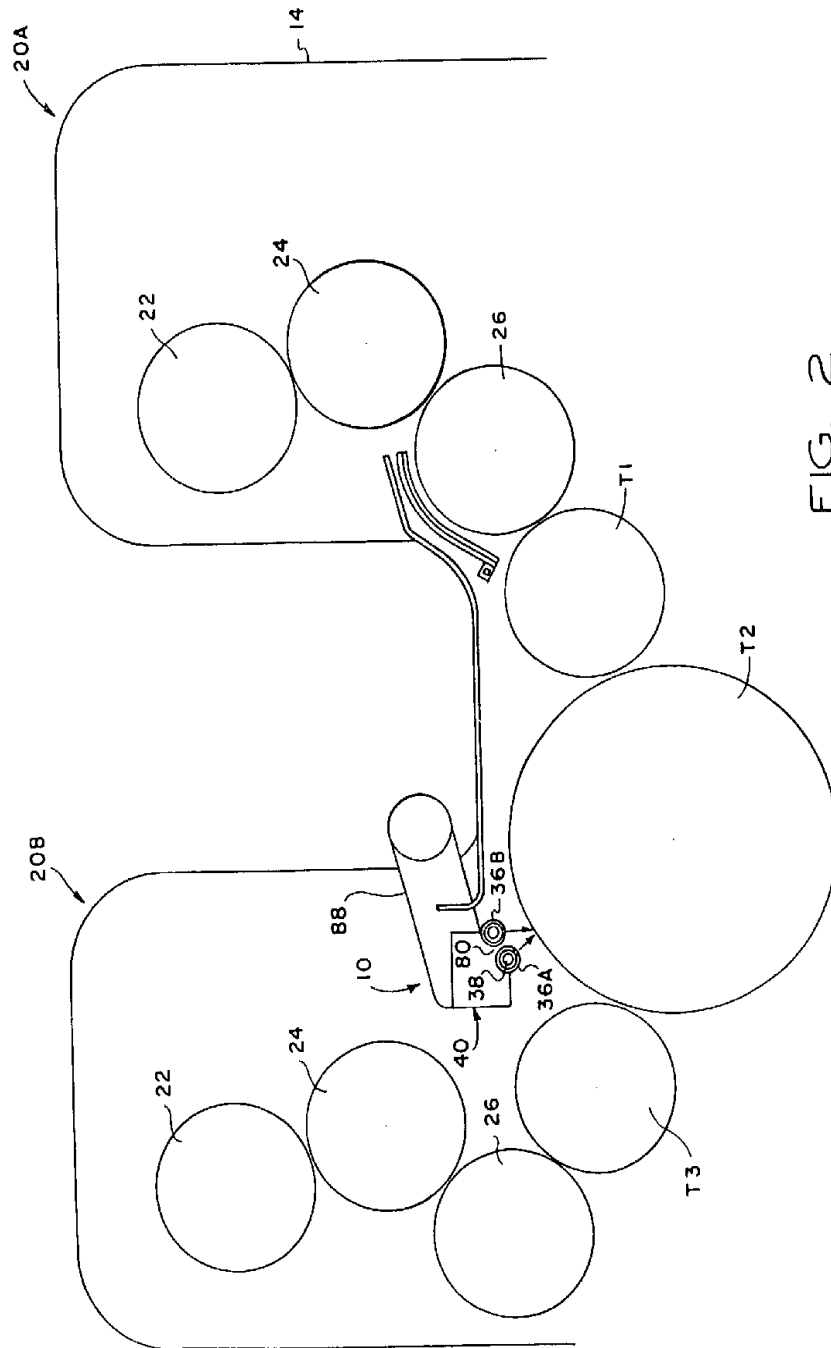
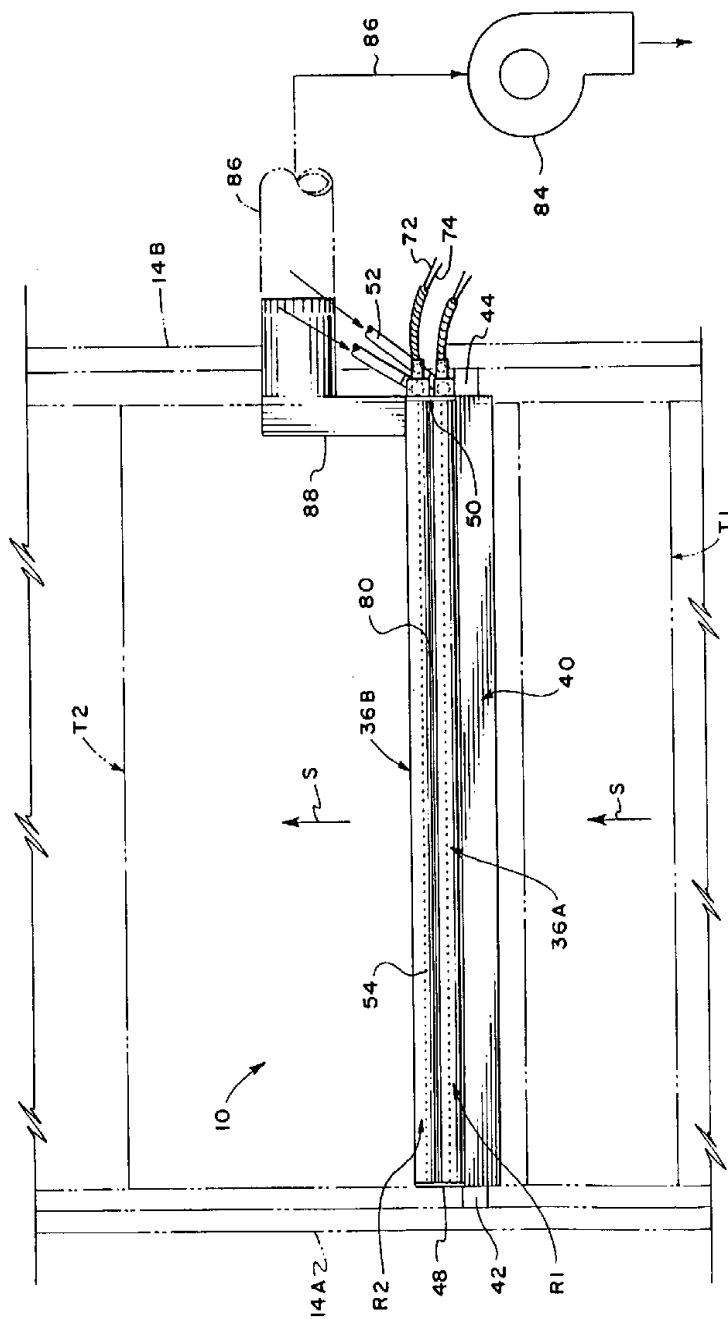
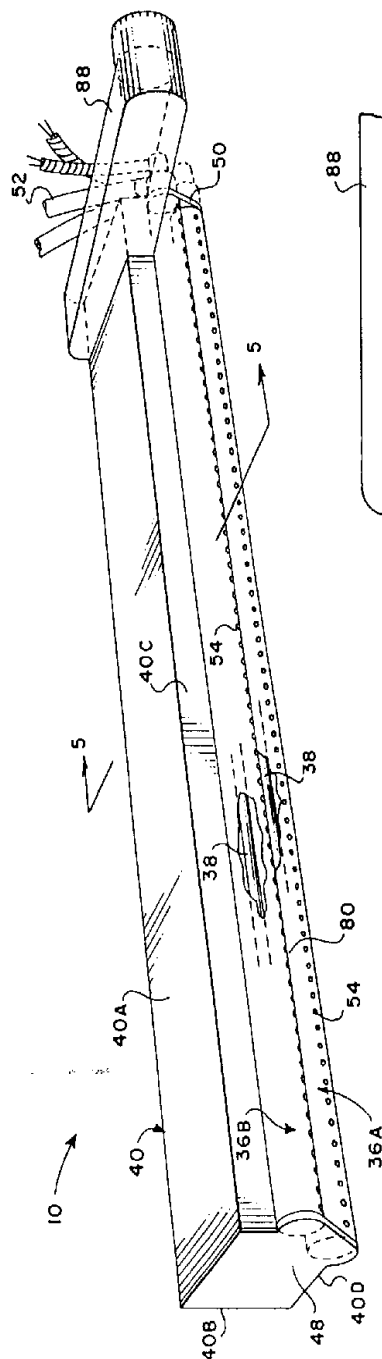


FIG. 2

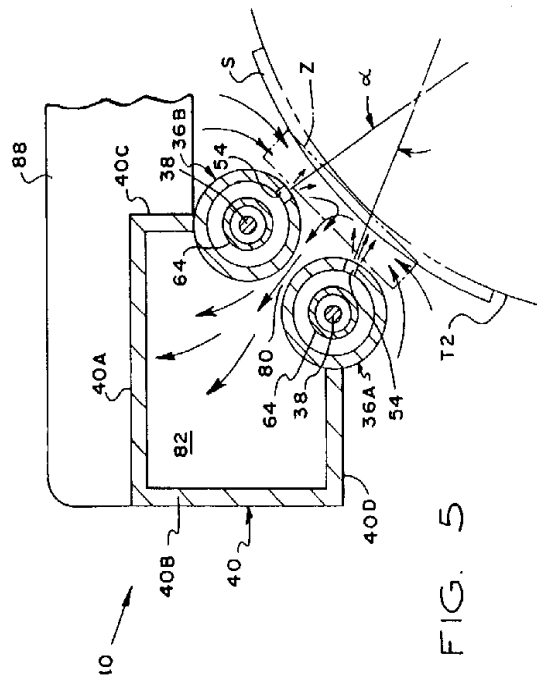
[illegible]

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FIG.

5 05 97 20025

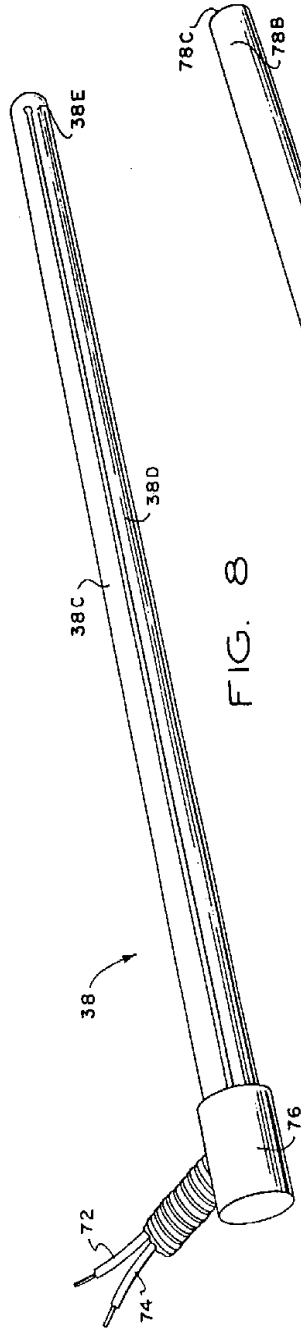


FIG. 8

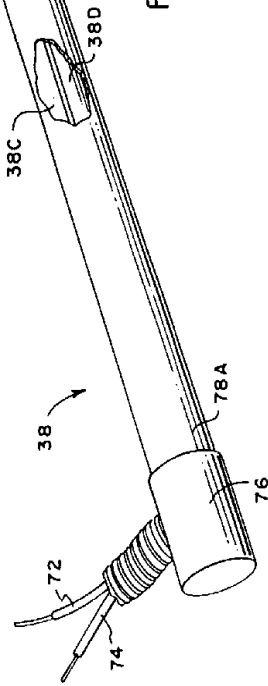


FIG. 9

5 05 97 20036

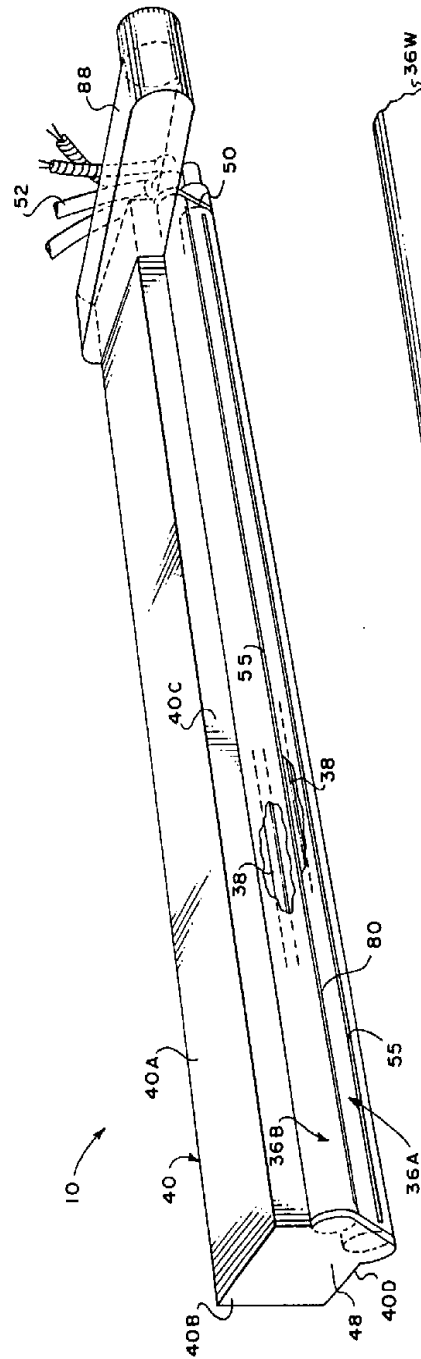


FIG. 10

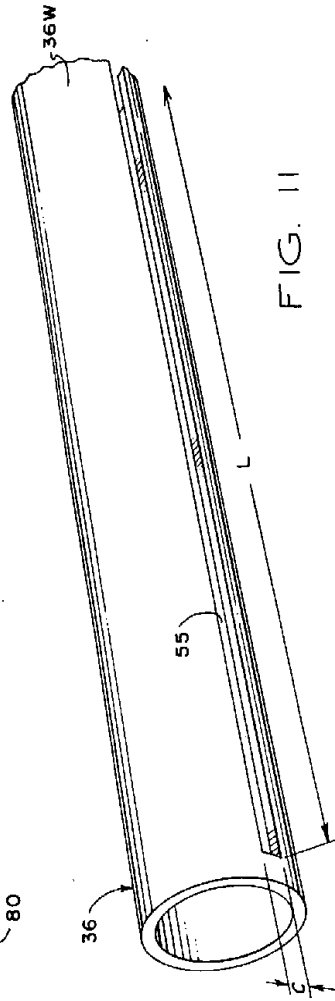


FIG. 11