April 6, 1965 M. D. JEPSON ETAL 3,176,411

PAPER DRYING HOOD

Filed Sept. 26, 1960 8 Sheets-Sheet 1

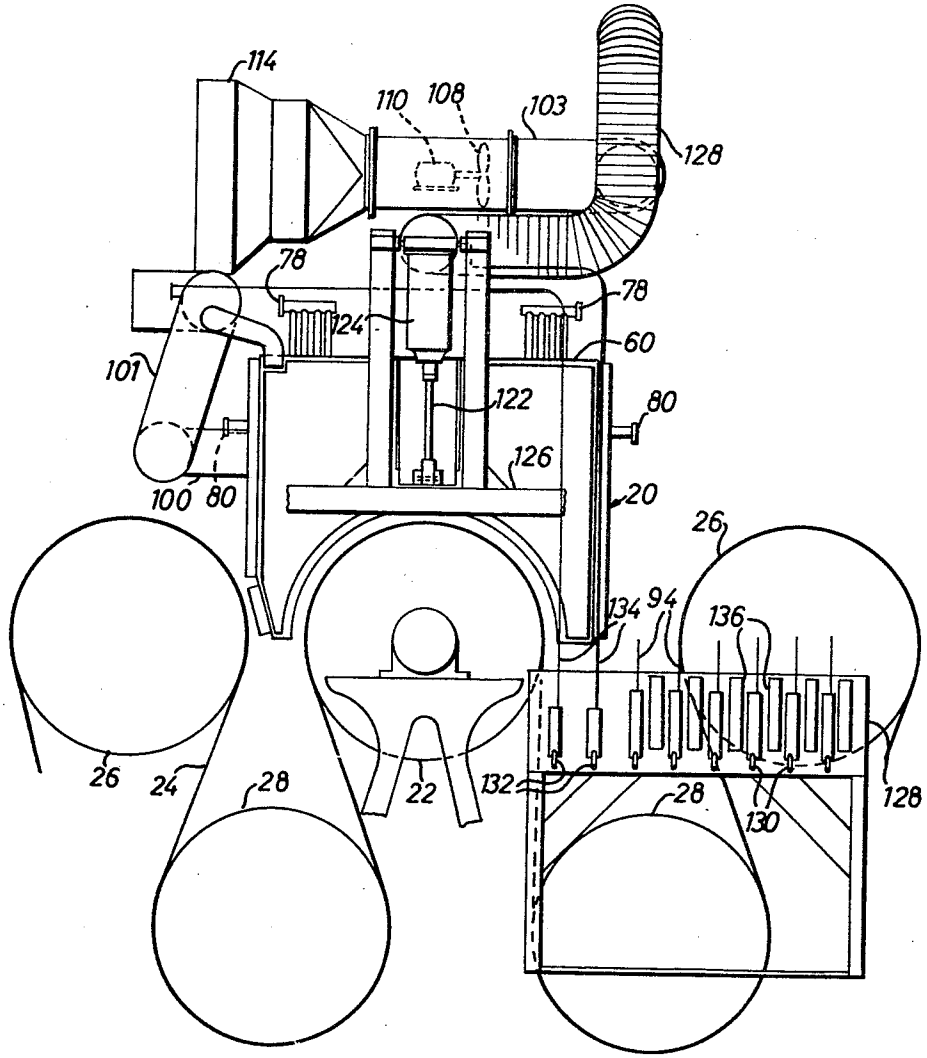


FIG. 1

INVENTORS

Michael Denis Jepson and
George Flatman Underhay
By Baldwin & Wight, Attorneys

April 6, 1965 M. D. JEPSON ETAL 3,176,411

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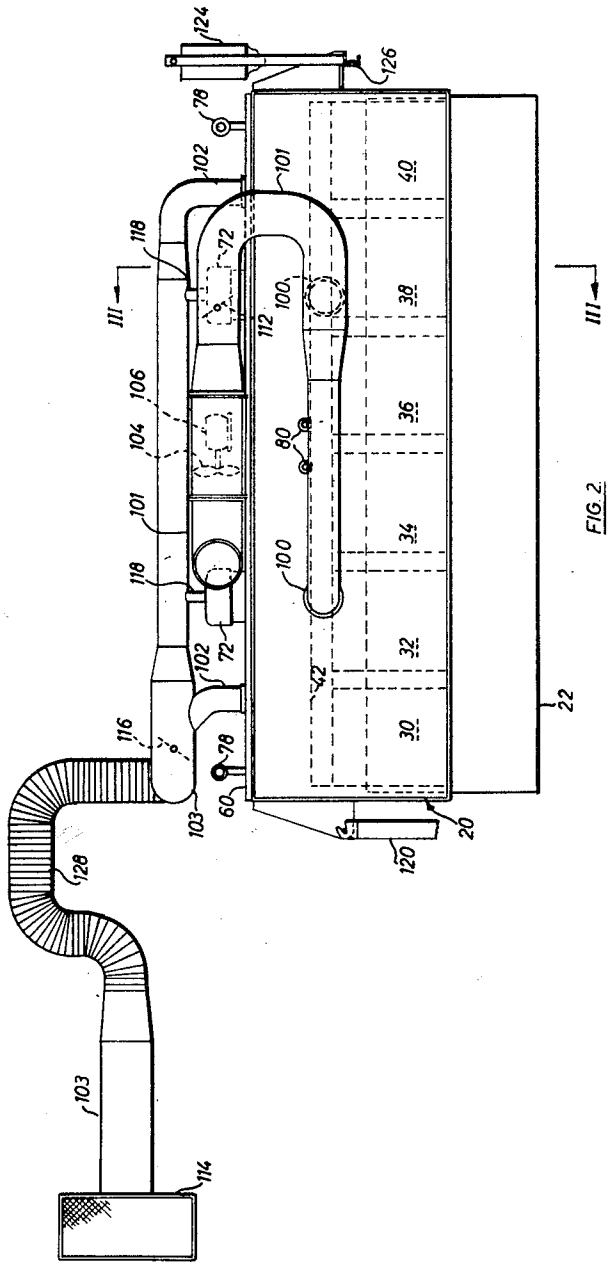


FIG. 2

INVENTORS

Michael Denis Jepson and
George Flatman Underhay
BY Baldwin & Wight, Attorneys

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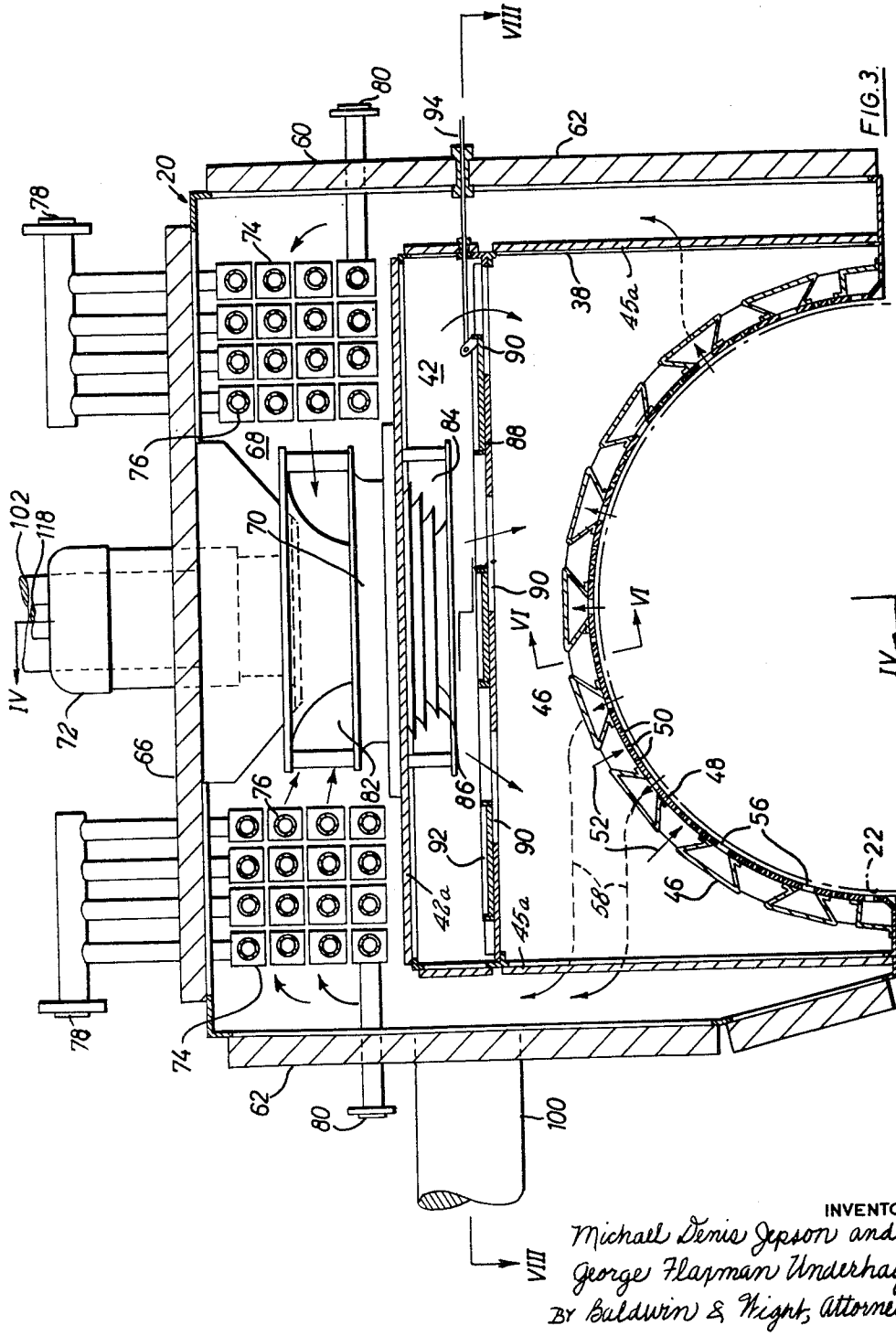


FIG. 3

INVENTORS

Michael Denis Jepson and

George Flapman Underhay

By Baldwin & Wright, Attorneys

April 6, 1965 M. D. JEPSON ETAL 3,176,411

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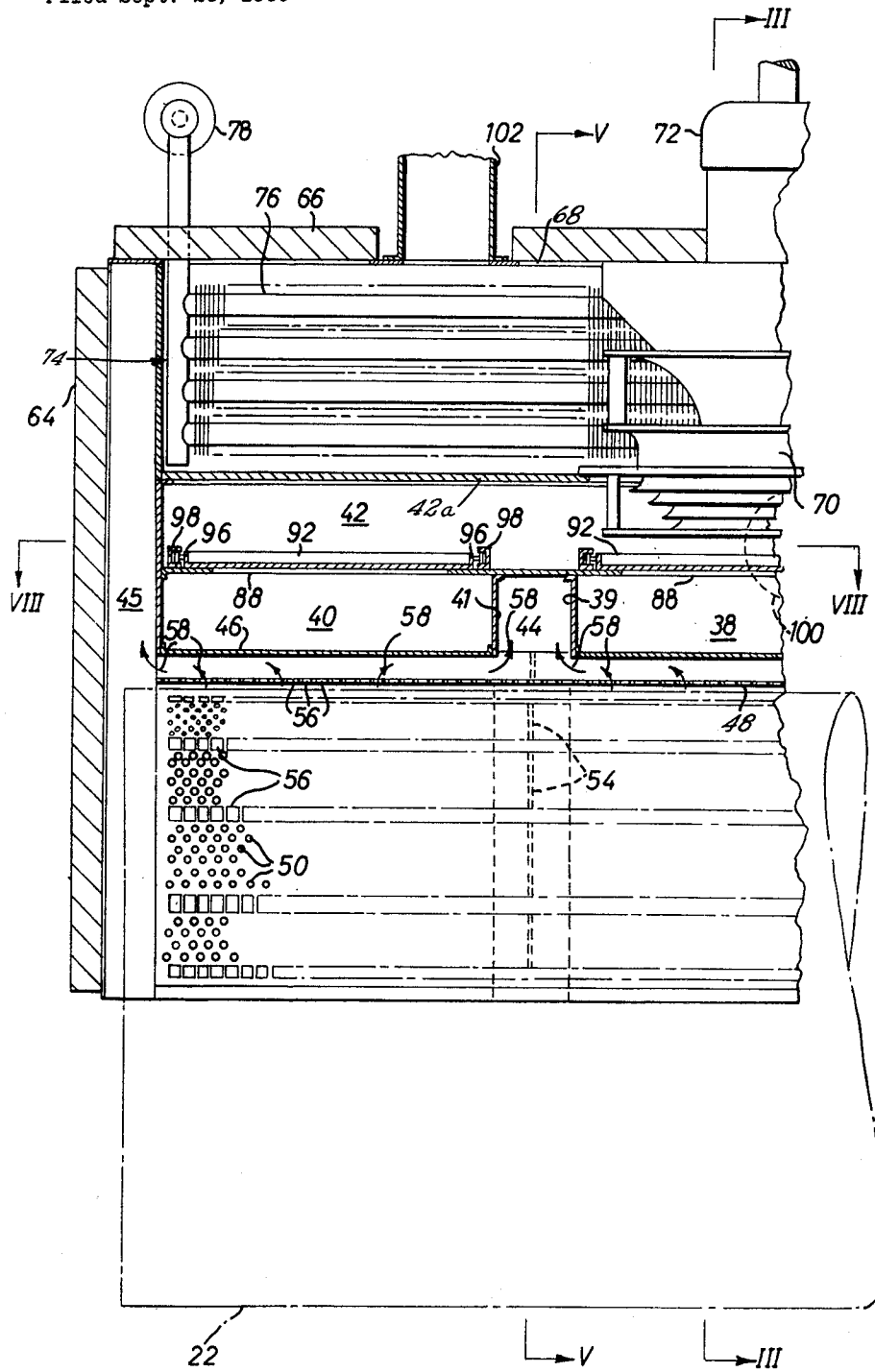


FIG. 4.

INVENTORS

Michael Denis Jepson and
George Flaxman Underhay
By Baldwin & Wight, attorneys

April 6, 1965 M. D. JEPSON ETAL 3,176,411

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Filed Sept. 26, 1960 8 Sheets-Sheet 5

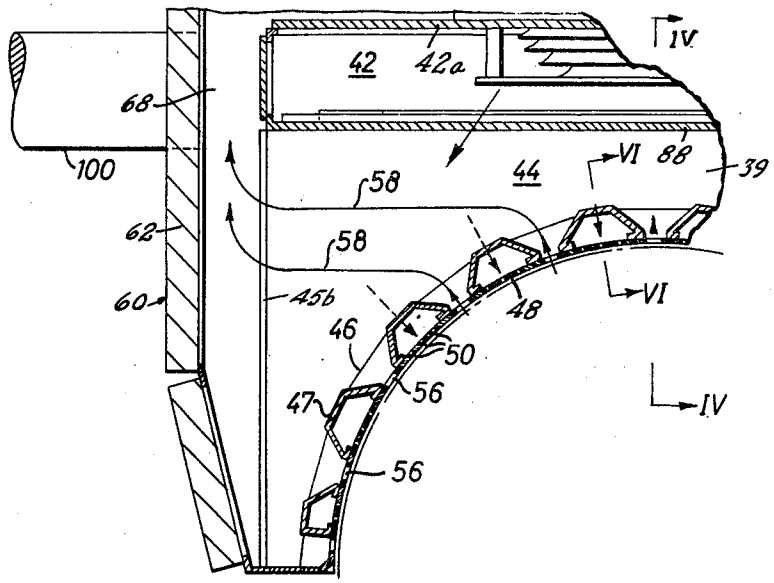


FIG.5

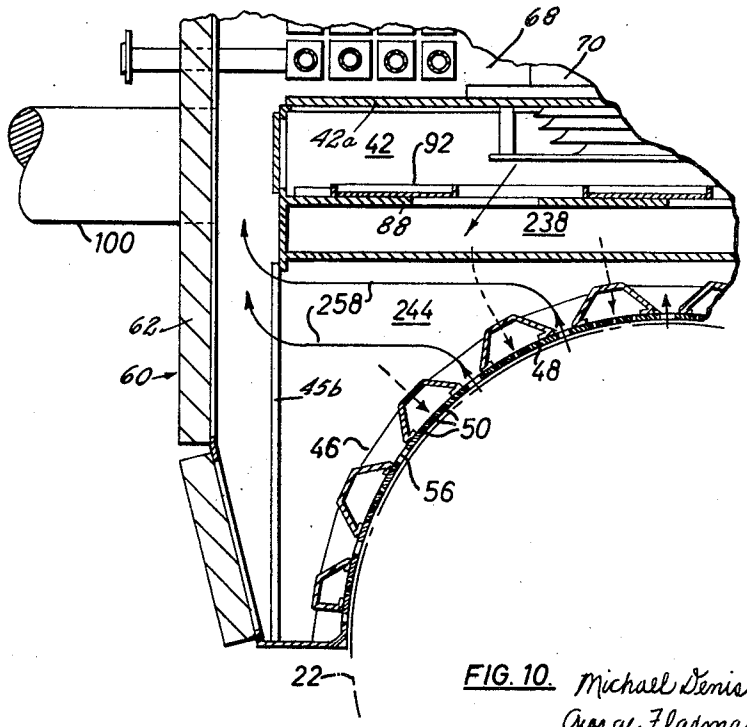


FIG. 10.

INVENTORS
Michael Denis Jepson and
George Flatman Underhay
BY Baldwin & Wight, Attorneys

April 6, 1965 M. D. JEPSON ETAL 3,176,411

PAPER DRYING HOOD

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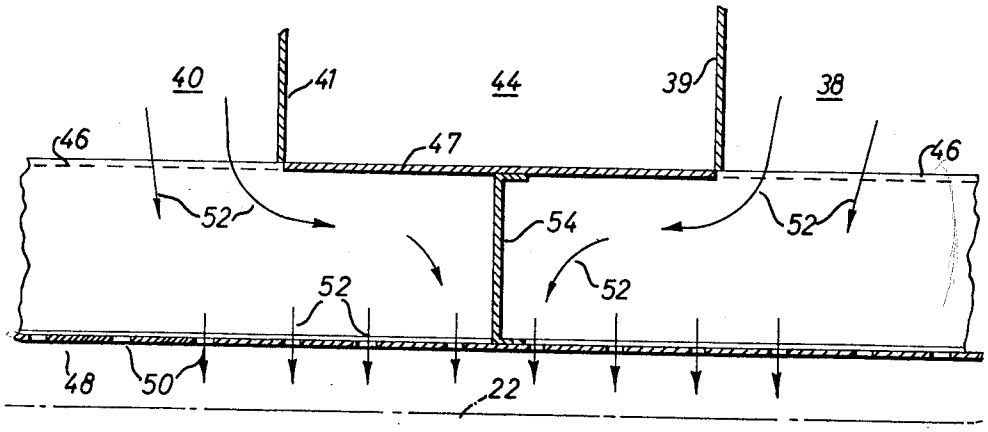


FIG. 6

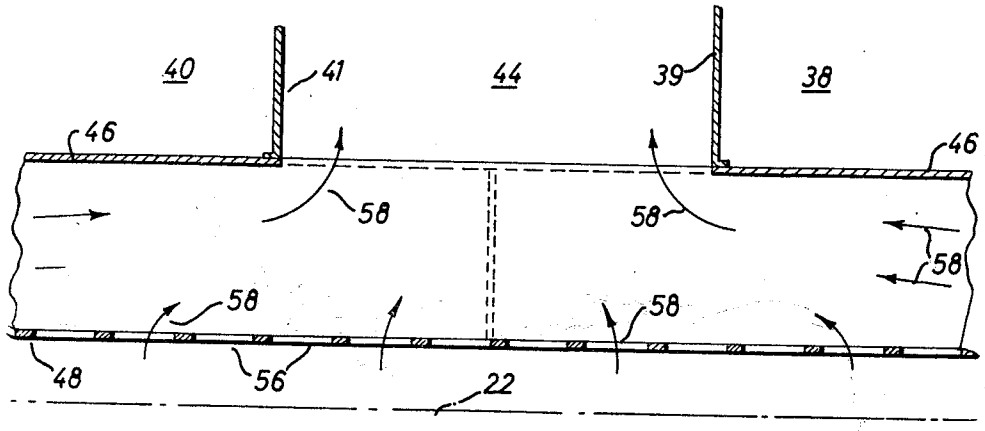


FIG. 7

INVENTORS

Michael Denis Jepson and
George Flaxman Underhay
By Baldwin & Wight, Attorneys

April 6, 1965 M. D. JEPSON ETAL 3,176,411

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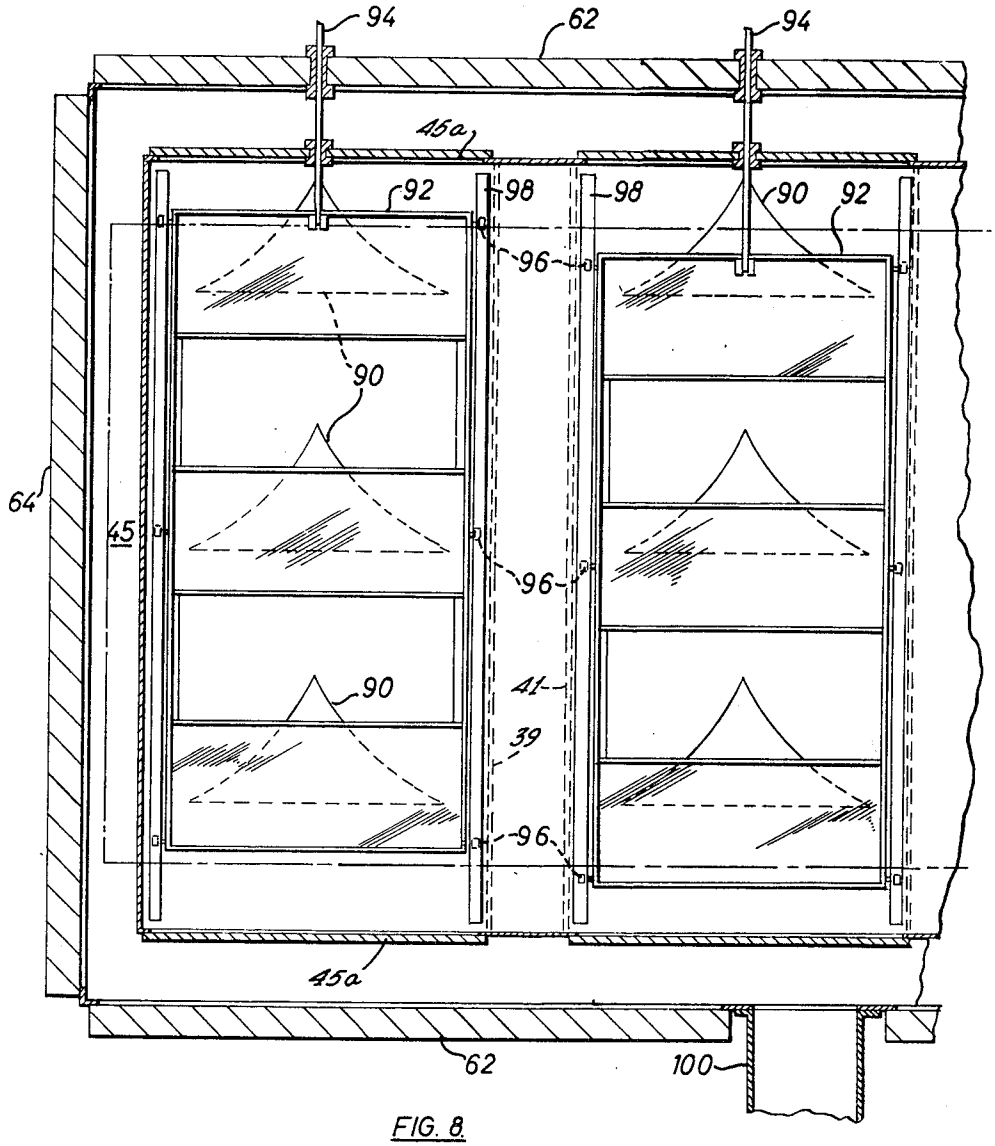


FIG. 8.

INVENTORS

Michael Denis Jepson and
George Flafman Underhay
BY Baldwin & Wight, Attorneys

April 6, 1965 M. D. JEPSON ETAL 3,176,411

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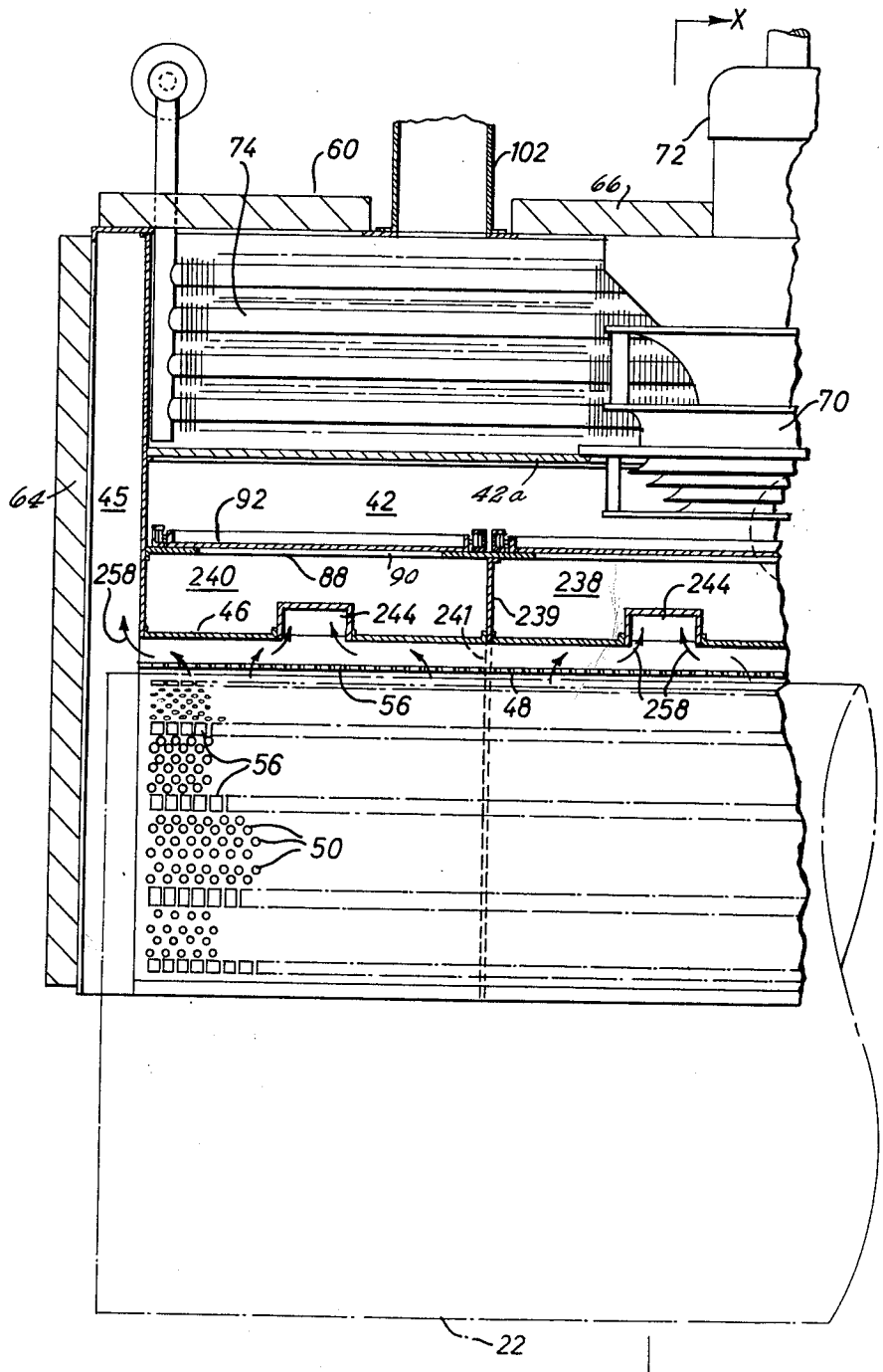


FIG. 9.

INVENTORS

Michael Denis Jepson and
George Fladman Underhay
BY Baldwin & Wight, Attorneys

United States Patent Office

3,176,411
Patented Apr. 6, 1965



3,176,411

# PAPER DRYING HOOD

Michael Denis Jepson, Ilkley, and George Flaxman Underhay, Weybridge, England, assignors to The Bowater Research and Development Company Limited, London, England, a company of the United Kingdom

Filed Sept. 26, 1960, Ser. No. 58,265
Claims priority, application Great Britain, Sept. 2, 1960, 30,426/60
7 Claims. ( Cl. 34—122)

The present invention relates to papermaking machinery and more particularly to drying sections of papermaking machines.

It is the principal object of the invention to provide an improved method and means for evaporating the moisture from the web and for increasing the rate of drying in papermaking machines.

In conventional machines the distribution of moisture in the web is somewhat uneven and in wide machines this may be very marked. For example, if paper is taken from the machine at an average moisture content of 6% it is not uncommon to find that the actual moisture content transversely of the web varies from 4% at one part to 8% at another part at the dry end of the drying section. Thus, if it were necessary not to have a moisture content of more than 6% at any part in the paper some of the paper would have to be overdried to reduce the moisture content of those parts of the paper having 8% of moisture down to 6% and the parts having 4% would be further over-dried. Moreover, the whole process of drying might have to be slowed up to allow the wetter portions to be dried down to the maximum permissible moisture content.

It is a further object of the present invention to provide a control of the moisture distribution across the paper web.

According to one aspect of the present invention, in a papermaking process wherein the web is dried by entrainment around one or more heated drying cylinders and by directing gaseous drying medium directly on to the outer surface of the web about the drying cylinder in such manner that evaporation of moisture from the web surface and transference of heat from the drying cylinder are enhanced at drying zones arranged transversely of the web, individual control of the drying rate in each zone is achieved by adjustment of the velocity of the drying medium directed onto the web at that zone or the temperature of the drying medium so directed or the humidity of the drying medium so directed or any combination of two or all of such adjustments, the gaseous medium, after flowing over and away from the outer surface of the web being caused to flow transversely of the web and then to flow in a direction away from the surface of the cylinder.

By the use of the invention it is possible to control the rate of drying transversely of the web to a degree sufficient to ensure that the web may be dried down to an overall pre-determined moisture content without any part of the paper being overdried or without any remoistening or conditioning of the paper after drying being necessary.

In order to avoid any tendency for the web to lift from the surface of the drying cylinder the velocity of the gaseous medium flowing away from the outer surface of the web is preferably substantially lower than the velocity of the gaseous drying medium directed onto the outer surface of the web.

The spent gaseous medium which flows away from the surface of the web is preferably recirculated after suitable treatment such as re-heating or the addition of make-up gaseous medium, or both, to restore its drying capacity before redirection onto the web.

According to another aspect of the present invention,



a drying hood for a drying cylinder of a paper-making machine comprises a plurality of pressure chambers disposed in side by side relationship transversely of the direction of paper travel, each pressure chamber having an arcuate face adapted to the periphery of the drying cylinder and containing nozzle orifices for the direction of gaseous drying medium onto a web of paper on the periphery of said drying cylinder, and means for supplying gaseous drying medium to said pressure chambers and for enabling the drying rate achieved by the drying medium directed from the nozzle orifices of each pressure chamber to be individually controlled, by adjustment of the humidity of the drying medium supplied to each pressure chamber, or the temperature of the drying medium supplied to each pressure chamber, or the rate of supply of drying medium to each pressure chamber, or any combination of two or all of such adjustments, and exhaust passageways spaced apart transversely of the direction of paper travel by which the gaseous medium after flowing over and away from the surface of the web can flow in a direction away from the periphery of the drying cylinder.

According to a further feature of the present invention, a drying hood for a drying cylinder of a drying section of a papermaking machine comprises a manifold, fan means for supplying gaseous medium to said manifold, heating means for heating the said gaseous medium, a plurality of pressure chambers disposed in side-by-side relationship transversely of the direction of paper travel, each pressure chamber communicating with said manifold for receiving heated gaseous medium therefrom and having an arcuate face adapted to the periphery of the drying cylinder and containing nozzle orifices for the direction of heated gaseous medium onto a web of paper on the periphery of said drying cylinder so as to hold the web in close non-adhesive contact with the cylinder, valve means for individually controlling the flow of gaseous medium from said manifold to each pressure chamber, and exhaust passageways spaced apart transversely of the direction of paper travel by which the gaseous medium after flowing over and away from the surface of the web can flow in a direction away from the periphery of the drying cylinder.

Preferably the pressure chambers are spaced-apart and the spaces between them provide at least some of the exhaust passageways.

Preferably the manifold lies directly adjacent said pressure chambers and on the opposite side thereof to their arcuate faces and said valve means conveniently comprises shutters controlling ports in a wall between the manifold and the pressure chambers.

Since the gaseous medium must be brought into direct contact with the web entrained around the cylinder no dryer felt is employed. The invention is applicable to any type of drying section and can be used with machines employing a number of small cylinders, a single large cylinder such as is generally used for the production of glazed or creped paper, or a combination of both large and small cylinders. In the case of a multi-cylinder drying section when the web is maintained in non-adhesive contact with the cylinders, the necessary pressure to maintain contact, and which, in conventional machines is produced by the dryer felts, is generated by the pressure of the gaseous medium directed onto the web or any longitudinal tension which may be applied to the web or both.

In a preferred arrangement the drying hood has an outer casing for collecting spent gaseous medium flowing away from the periphery of the drying cylinder, the fan means communicating by its inlet side with the interior of said casing whereby to re-supply spent gaseous medium to said manifold. The preferred drying medium is predominantly air, but it will be appreciated that in general a proportion of water vapour from the web is present and

to avoid saturation of the drying medium provision is generally made for exhausting some of the spent air from the casing and supplying fresh make-up air thereto. The pressure chambers, the manifold and the fan means can all be disposed within the outer casing with the heating means situated at the entry or entries to a supply chamber which is formed between the manifold and the wall of the casing opposite thereto. The inlet of the fan means can thus lie within the supply chamber and the outlet within the manifold. This is most conveniently achieved if the fan means comprises at least one axial flow fan driven by a motor which may be situated outside the casing. In the preferred arrangement the arcuate faces of the pressure chambers are contiguous and exhaust channels extending longitudinally of the drying cylinder but at the opposite side of the arcuate faces to the cylinder communicate with the exhaust passageways, said arcuate faces having exhaust openings to permit the spent air to flow into the exhaust channels.

The total area of the exhaust openings is preferably substantially greater than that of the nozzle orifices so that the velocity of the air flowing away from the cylinder is substantially less than the velocity of the drying air directed onto the web.

By maintaining a sufficient air velocity in the exhaust channels the pressure drop produced thereby can be utilised to maintain a slight positive pressure beneath the exhaust openings. Such a positive pressure is desirable when the web is weak so that close non-adhesive contact with the drying cylinder can be maintained when the web is beneath the exhaust openings. When the web is sufficiently strong to be held in close non-adhesive contact with the drying cylinder by its own tension, it may not be necessary that a positive pressure be maintained beneath the exhaust openings and even a slight negative pressure may not, in certain circumstances, be disadvantageous.

It is generally preferred however that the lowest pressure of the gaseous medium under the hood is sufficient to avoid the uncontrolled inflow of air at ambient conditions from outside the hood under its bottom edges.

The invention will be further described by way of example with reference to the accompanying drawings, in which:

FIG. 1 is a diagrammatic side elevation of part of a multi-cylinder drying section of a paper making machine incorporating a drying hood constructed according to the present invention;

FIG. 2 is a front elevation of the drying hood of FIG. 1;

FIG. 3 is a cross section on the line III—III of FIG. 2 to a larger scale, the section line III—III also being indicated in FIG. 4;

FIG. 4 is a section on the line IV—IV of FIG. 3, the section line IV—IV also being indicated in FIG. 5;

FIG. 5 is a detailed section on the line V—V of FIG. 4;

FIG. 6 is a detailed cross section on the line VI—VI of FIG. 3 to a still larger scale, the section line VI—VI also being indicated in FIG. 5;

FIG. 7 is an enlarged detail of the section shown in FIG. 4 for comparison with FIG. 6;

FIG. 8 is a section on the line VIII—VIII of FIG. 3, the section line VIII—VIII also being indicated in FIG. 4;

FIG. 9 is a cross section similar to that shown in FIG. 4, but of another embodiment of drying hood according to the invention; and

FIG. 10 is a detail section on the line X—X of FIG. 9.

Referring now to the drawings, and more particularly to FIGS. 1 and 2, a drying hood **20** constructed according to the present invention is disposed about an upper cylinder **22** of a multi-cylinder drying section of a paper making machine. A web of paper **24** to be dried passes alternately round cylinders in an upper row and cylinders in a lower row, those in the upper row, other than the cylinder **22**, being indicated by **26** and those in the lower row by **28** in FIG. **1**.

The drying hood **20** contains six pressure chambers **30**, **32**, **34**, **36**, **38** and **40** deployed axially of the cylinder in the positions indicated by dotted lines in FIG. 2. The pressure chambers are individually supplied with gaseous drying medium, which in the embodiment shown is air, from a common manifold **42**.

FIGS. 3 to 8 show the construction of the drying hood in more detail. Referring to FIG. 4, the pressure chambers **38** and **40** are spaced apart so that their longitudinal partition walls **39** and **41** define an exhaust passageway **44** by which spent air can flow in a direction away from the surface of the cylinder **22**. All the other pressure chambers are likewise spaced apart.

As can be seen from FIGS. 3 to 7, a series of flow passage means formed as channels **46** extend along the cylinder **22** behind a perforated arcuate bottom wall or face **48** of each pressure chamber, the arcuate faces substantially conforming to the periphery of the cylinder in radially outwardly spaced relation to the latter. Drying air in the pressure chamber **38** has access to nozzle orifices **50** in the form of holes arranged in the arcuate face **48** for the projection of air towards the web of paper on the surface of the cylinder **22**. This is indicated in FIGS. 3 and 6 by arrows **52**.

Although the following description refers for the most part to the pressure chambers **38** and **40**, it will be appreciated that all the pressure chambers **30**, **32**, **34**, **36**, **38** and **40** are of similar construction.

As can be seen in FIGS. 6 and 7, the arcuate faces of the pressure chambers are contiguous although the pressure chamber walls **39** and **41** are spaced apart. The channels **46** extend the full length of the contiguous arcuate faces **48** but are open to the exhaust passageway **44** at their faces opposite the arcuate faces **48**, as can be seen in FIG. 7. The gaps between the channels provide access to the nozzle orifices for the air in the pressure chambers and are isolated from the exhaust passageway **44** by plates **47** as can be seen in FIGS. 5 and 6. Intercommunication between the pressure chambers along the gaps between the channels **46** is prevented by plates **54** (see FIG. 6).

The flow passage channels **46** lead spent air flowing from the space between the arcuate faces **48** and the cylinder through larger size openings **56** to the exhaust passageway **44**, as can be seen from FIG. 4. Although only a few nozzle orifices **50** and exhaust openings **56** are shown, it will be appreciated that these extend over substantially the whole of the arcuate faces **48** of the pressure chambers. The path of the spent air is indicated by arrows **58** in FIGS. 3, 4, 5 and 7. As can be seen from these figures, the spent air, after issuing through the nozzle orifices **50**, flows only to a limited extent circumferentially of the cylinder before flowing away from the cylinder through the exhaust openings **56**. The spent air then flows transversely of the web along the channels **46** to the exhaust passageway **44** or one of the other exhaust passageways between the pressure chambers or to an end exhaust passageway **45** (FIG. 4), whereupon it can flow freely through gaps **45*b*** (FIGURE 5) in the transverse walls **45*a*** and away from the drying cylinder **22**. The exhaust passageways are circumferentially coextensive about the cylinder with the pressure chambers, and are spaced apart axially of the cylinder.

The drying hood **20** is provided with an outer casing **60** having side walls **62** transverse to the direction of movement of the web, end walls **64** longitudinal to the direction of movement of the web and a top wall **66** formed of heat insulating panelling (see FIGS. 3 and 4). Two spaced inner walls **45*a***, transverse to the direction of travel of the web, extend from the bottom wall **48** to the manifold **42**, one at each side of the arcuate part of the bottom wall **48**. The transverse walls **45*a*** are spaced from the respectively adjacent outer transverse walls **62** to define the end exhaust passageways **45**. A supply chamber **68** (FIG. 3) is formed between the manifold **42** and the top wall **66** of the casing, and main fans **70** are arranged be-

tween the supply chamber **68** and the manifold **42**. Spent air flowing away from the cylinder through the exhaust passageways **44** and **45** is collected in a collecting space within the casing above the intermediate wall **88** and flows into the supply chamber **68**, whereupon it is supplied to the manifold **42** by the main fans **70**, which are driven by motor **72**. The spent air flowing into the supply chamber **68**, passes through heaters **74** in the form of a plurality of finned steam pipes **76**, supplied with steam through inlets **78**, and having steam outlets **80**.

The main fans **70** are axial flow fans having their inlets **82** disposed directly in the supply chamber **68** and their outlets **84**, having a diffuser **86**, directly within the manifold **42**. This construction avoids the use of any ducting between the supply chamber and the manifold **42** and leads to a compact space-saving arrangement.

Each of the pressure chambers is individually supplied with air from the manifold **42**. As can be seen in FIGS. 3 and 4, the top wall **88** of each pressure chamber is intermediate each pressure chamber and a top inner wall **42***a*. The inner transverse walls **45***a*, together with the top inner wall **42***a* and the intermediate wall **88**, define the manifold **42**. The top wall **88**, which forms the bottom wall of the manifold **42**, is provided with ports **90** to permit the air to flow into the pressure chambers. The ports **90** are controlled by shutters **92**, each of which is individually slidable by means of a Bowden cable **94** to enable individual adjustment of the flow through the ports **90** to be made.

As can be seen more clearly in FIG. 8, each of the ports **90** is cusp shaped and in particular comes to a point at one end to enable a fine control of the quantity of air flowing from the manifold **42** to each pressure chamber to be obtained. For ease of manipulating the shutters, the shutters are provided with runners **96** which run in channels **98**, as can be seen in FIGS. 4 and 8.

It will be appreciated that the drying air is circulated along a substantially enclosed endless path, which comprises the manifold **42**, one of the pressure chambers, the nozzle orifices **50**, the exhaust openings **56**, the flow passage channels **46**, one of the exhaust passageways and the supply chamber **68** whence it is re-fed to the manifold **42** by the main fans **70**.

In order to prevent the drying air so circulated becoming saturated with water vapour, some of the air and evaporated water so circulated is withdrawn through exhaust ducts **100** and fresh air is supplied through ducts **102** (see FIGS. 1 to 5). As can be seen more clearly from FIGS. 1 and 2, there are two exhaust ducts **100** which are joined into a single duct **101**, within which is disposed an exhaust fan **104**, of the axial flow type, driven by a motor **106** (indicated diagrammatically in broken lines in FIG. 2). The exhaust fan **104** withdraws spent air from within the casing **60** and the spent air is discharged, for example, into a flue (not shown). The quantity of spent air withdrawn is controlled by a damper **112**. The make-up air ducts **102**, which are also two in number, are supplied from a common duct **103**, within which there is disposed a fresh-air fan **108**, also of the axial flow type, driven by a motor **110** (indicated diagrammatically in broken lines in FIG. 1). The fresh-air fan **108** draws fresh air in from the atmosphere through a filter **114** and supplies such fresh air to the supply chamber. The quantity of fresh or make-up air is controlled by a damper **116** (FIG. 2).

Cooling air for the motors **72** driving the main fans **70** is also supplied by the fresh-air fan **108**. For this purpose ducts **118** leading to the motors **72**, are also connected to the common duct **103**, as shown in FIG. 2. It can conveniently be arranged that cooling air after cooling the motors **72**, flows through the fan centres and is discharged just before the fan rotor blades of the main fans so as to mix with the drying air being circulated. If desired, the make-up air can be heated, for example by steam or electrical heaters (not shown). If the make-up air is also used to cool the motors **72** as shown, then the temperature to which such air is heated is limited by the temperature rating of the motors **72**. This temperature may, for example, be 160° F. If it is desired to heat the make-up air to a higher temperature, then a separate supply of cooling air for the motors **72** is preferred. It is not essential that the make-up air be heated before supplying to the supply chamber; the make-up air can obtain heat by admixture with the air being circulated through the heaters **74**.

The rate of supply of drying air to each of the pressure chambers can be individually controlled, thereby enabling the drying rate at six zones contiguously arranged transversely of the web to be separately controlled. The Bowden cables **94** attached to the shutters **92** (FIGS. 3 and 8) lead to a control panel **128** (FIG. 1) fitted with cranks or handles **130** for adjusting the shutters. The control panel **128** also has further handles **132** operating Bowden cables **134**, which control the dampers **112** and **116** in the exhaust air and make-up air ducts (FIG. 2).

The shutters are adjusted in order to obtain as even a moisture distribution, transversely of the finished web, as possible. Should the moisture profile transversely of the web vary during operation of the paper making machine, for example due to uneven wear of the calender or press rolls, then appropriate corrective action may be taken at the control panel **128**.

In order to provide access to the surface of the cylinder **22**, for example when threading the web through the machine, or when removing torn paper should a break occur in the web, the drying hood **20** is pivoted to a framework **120** situated at one end of the cylinder **22** and to a piston rod **122** of a pneumatic piston and cylinder mechanism **124** situated at the other end of the cylinder **22**, as can be seen in FIGS. 1 and 2. The upper end of the mechanism **124** is mounted on the framework **126**. The make-up air duct **103** is provided with a flexible portion **128** to avoid having to disconnect this duct when lifting the drying hood away from the surface of the cylinder.

The drying cylinders **22**, **26** and **28** are internally steam-heated in the conventional manner, the means for this purpose being omitted from the drawings for the sake of clarity.

More than one of the cylinders of the upper row may be provided with drying hoods according to the present invention, if so desired. Where adjacent cylinders in the same row have such drying hoods then the supply chambers, possibly the manifold and possibly also the pressure chambers, as well as the outer casing, may be arranged to be common to said adjacent cylinders. Moreover, drying hoods according to the present invention may also be adapted to the drying cylinders of the lower row. In order to increase the drying capacity of the drying section, a large number of drying hoods may be used. In this case it is not necesary that all the hoods be provided with shutters for individually controlling the drying rate transversely of the web, but it is desirable that they be so provided so that a substantially uniform moisture profile may be obtained through as large a part of the drying section as possible. Thus a uniform moisture profile transversely of the web may be obtained substantially throughout the drying section. This reduces the risk of wrinkles developing in the web.

A drying hood according to the present invention can be fitted to an existing machine in order to improve the uniformity of the moisture content of the finished web and in order to increase the capacity of the drying section.

It is at present common practice to over-dry the web in the drying section of a paper making machine and then to subsequently re-moisten the web in a separate operation, so that the finished product will have a moisture content which is in keeping with the humidity of the sur-

rounding atmosphere, in order to obtain a moisture distribution which is as uniform as possible throughout the web. By providing a drying hood according to the invention over at least one of the cylinders of a multi-cylinder drying section, the web can be dried to a substantially uniform wetness in keeping with the humidity of the surrounding atmosphere, thus avoiding the necessity for over-drying and subsequent re-moistening.

In order to observe the degree of correction which is being provided by the drying hood **20**, the control panel **128** may be provided, as shown in FIG. 1, with pressure gauges **136** which are in communication with the pressure chambers, by means not shown. The pressure chambers may also be provided with thermometers, if desired. The humidity of the drying air being circulated is controlled by the dampers **112** and **116** (FIG. 2), and samples of the spent air flowing through the exhaust duct **101** may be taken for the purpose of assessing the moisture content of the drying air being circulated.

In operation, heat is transferred to the web on the drying cylinder **22** not only from the drying cylinder but also from the heated air directed on to the web. Moreover, the rate of heat transfer from the drying cylinder to the web is enhanced by blowing air on to the web for by taking away the evaporated moisture in the spent air the rate of evaporation is increased thereby increasing the temperature difference between the web and the drying cylinder.

Although a drying hood according to the present invention is illustrated in the drawings in its application to a multi-cylinder drying section of a paper-making machine it can also be applied to a paper-making machine having one large drying cylinder only, whether that cylinder is an M.G. cylinder or not. Where an M.G. cylinder is used the web is usually pressed into adhesive contact with the cylinder. Where an unpolished cylinder, whether of large or small diameter, is used the web is held in close but non-adhesive contact with the cylinder. In this latter case, the drying air issuing from the nozzle orifices of a drying hood according to the present invention creates a force acting on the outer surface of the web, thus at least assisting in maintaining the web in close but non-adhesive contact with the cylinder. Where a paper-making machine has a drying section with an M.G. cylinder and one or more pre-drying cylinders a drying hood according to the present invention may be applied to some or all of the pre-drying cylinders. It is envisaged furthermore that drying hoods according to the present invention can be applied to drying sections having few, large diameter drying cylinders compared with conventional multi-cylinder drying sections having a large number of small, e.g. 5 ft. diameter, drying cylinders.

In a multi-cylinder drying section, the web is maintained in close but non-adhesive contact with the drying cylinders, in order to permit a maximum rate of heat transfer from the cylinder to the web. If the web is sufficiently strong, then the tension in the web can be used to maintain such contact. However, if the web is very weak, then it is usual to provide felts in order to press the web into close non-adhesive contact with the drying cylinders. The felts, however, hinder the flow of moisture away from the web as it is dried. With the use of a drying hood according to the present invention the drying air issuing from the nozzle orifices creates a force acting on the outer surface of the web to hold the web in close non-adhesive contact with the drying cylinder as disclosed in United States Patent No. 2,919,495. Drying hoods according to the present invention obviate the necessity for felts, except possibly at the wettest part of the drying section. However, it is necessary that the risk of the web lifting from the surface of the cylinder when beneath the exhaust openings be reduced to a minimum. To this end the total cross-sectional area of the exhaust openings is made very much larger than the total cross-sectional area of the nozzle orifices, preferably at least sixteen times. In the embodiment of the drying hood shown, the total cross-sectional area of the exhaust openings is approximately twenty-eight times the total cross-sectional area of the nozzle orifices. Thus the velocity of the spent air flowing away from the web through the exhaust openings is very much lower than the velocity of the air flowing towards the web through the nozzle orifices. Moreover, there is some resistance to the flow of the spent air flowing through the exhaust channels and through the exhaust passageways, so that a slight positive pressure may be still maintained beneath the exhaust openings.

It will be appreciated that the provision of a large number of exhaust channels at fairly closely spaced intervals enables the spent air to be removed from the surface of the web without the surface of the web being presented to large openings extending transversely of the web. If the web were exposed to such large openings, then there would be a risk of the web being lifted from the surface of the drying cylinder beneath such openings, and being drawn into the machinery within the drying hood. In the drying hood of the present invention there are large exhaust openings, namely at the exhaust passageways, but these extend circumferentially of the drying cylinder, i.e. longitudinally of the web, and they communicate with the exhaust channels and not directly with the exposed surface of the web. Thus the risk of the web being broken and drawn into the exhaust passageways is reduced to a minimum.

The perforated arcuate faces of the pressure chambers present a substantially smooth surface to the web about the drying cylinder so that should a break occur in the web there is little risk of the broken web being caught up on the drying hood and damaging the hood.

It will be appreciated that although the drying hood is shown with six pressure chambers, a greater or lesser number may be employed, according to the length of the drying cylinder and the degree of uniformity of the moisture profile of the finished web which is required.

An alternative embodiment of drying hood according to the invention is shown in FIGS. 9 and 10 of the drawings. Principal parts which are like those of the embodiment of FIGS. 1 to 8 are indicated by like reference numerals. The embodiment of FIGS. 9 and 10 differ from that of the previous embodiment principally in that the pressure chambers, of which **238** and **240** are seen in the drawings, instead of being spaced apart, adjoin one another. Exhaust passageways **244**, which extend circumferentially of the drying cylinder **22**, are arranged within the pressure chambers themselves. The arrows **258** indicate the passage of spent air from the surface of the web through the exhaust openings **56**, and the flow passage channels **46** and exhaust passageways **45** and **244** through gaps **45***b* into the casing **60**. The pressure chambers **238** and **240** are in effect separated by a longitudinal partition **239**, which extends at **241** between the channels **46** to completely isolate the pressure chambers from one another.

It will be seen that, in the embodiment of FIGS. 9 and 10, the spent air, immediately after direction towards the surface of the web, first flows only to a limited extent circumferentially of the drying cylinder, then through the exhaust openings **56** into the channels **46** and subsequently transversely of the web into the exhaust passageways **244** and **45**, wherein it can flow in a direction away from the surface of the drying cylinder. The manner in which the spent air is led away from the surface of the cylinder is therefore substantially the same as that in the embodiment of FIGS. 1 to 8.

Although the embodiments of the invention shown in the drawings employ steam heaters, other forms of heating means could be employed, such as electrical heating elements and gas and oil burners which may heat the circulated air either indirectly or by admixture of their products of combustion with the circulated air.

In the embodiment of drying hood illustrated in FIGS. 1 and 2 of the drawings, access to the surface of the drying cylinder is obtained by pivoting the hood about one end. It may, however, be preferable, according to the design of the frame of the drying section to which the hood is applied, to arrange for the hood to be liftable vertically, for example by four hydraulic or pneumatic piston and cylinder mechanisms or screw jacks arranged at its corners. The pneumatic piston and cylinder mechanism illustrated in FIGS. 1 and 2 may be replaced by a hydraulic piston and cylinder mechanism if so desired.

In the illustrated embodiments of the invention, the shutters controlling the ports between the common manifold and the individual pressure chambers are manually operable using Bowden cables. However, the shutters could be operated by air or hydraulic cylinders or by screwed rods on each of which a nut is rotatable by means of an air or electric motor.

It is envisaged that the moisture profile transversely of the finished web may be controlled automatically. For this purpose moisture content sensing shoes, corresponding in number and transverse positions to the number and transverse positions of the pressure chambers, may be arranged to meter the moisture content of the web leaving the drying section, each of the moisture content sensing shoes being connected electrically or otherwise so as to control the shutter associated with the corresponding pressure chamber. Alternatively a single moisture content sensing shoe may be arranged to traverse the web continuously or intermittently, and to feed the metered moisture content to the appropriate shutter control mechanism according to the transverse position of the shoe at a particular moment.

Where a large number of pressure chambers transverse of the web is employed a comparatively few exhaust passages are preferred. For example, eighteen pressure chambers may be arranged transversely of the web in six groups of three, the groups being spaced from one another to provide five exhaust passageways between adjacent pressure chambers. Such a structure is achieved by dividing each pressure chamber of the drying hood illustrated in FIGS. 1 to 8 into three, each one of which has its own shutter controlling the supply of heated air thereto from the common manifold. It is desirable that the spent air should flow through the exhaust channels with a significant velocity, the consequent pressure drop in the exhaust channels being used to maintain a slight positive pressure beneath the exhaust openings in the arcuate faces of the pressure chambers. If too many exhaust passageways were provided they would be a comparatively short distance apart so that the air velocity in the exhaust channels, which would be correspondingly shorter, would be negligible, leading to a negligible pressure drop in the exhaust channels which could not be used to maintain a positive pressure beneath the exhaust openings. Moreover, the provision of a comparatively few exhaust passageways transverse of the web when a large number of pressure chambers is employed leads to a simplification in construction.

It is possible to obtain pressures ranging from 4 ins. to 16 ins. water gauge (measured at 60° F.) in the manifolds of the illustrated embodiments of the invention. Thus the pressure in each of the pressure chambers may be varied from zero to 16 ins. water gauge. By using more powerful fans or a greater number of fans higher pressures are, of course, possible. A static positive pressure (with respect to atmosphere) of from 0.1 in to 1 in. water gauge (measured at 60° F.) is obtainable immediately beneath the exhaust openings in the perforated arcuate faces of the pressure chambers.

What is claimed is:

1. A drying hood for a drying cylinder of a machine for drying sheet material in continuous lengths to be entrained about said cylinder, comprising a casing having longitudinal walls, transverse walls, a top wall and a bottom wall, said bottom wall being at least in part of exteriorly concave arcuate shape adapted to the periphery of the drying cylinder and having its axis substantially parallel to said transverse walls; a manifold within said casing, a supply chamber being defined between said top wall and said manifold; heating means disposed in said supply chamber for heating gaseous medium therein; fan means housed within said casing and having its inlet in said supply chamber and its outlet within said manifold for supplying heated gaseous medium from said supply chamber to within said manifold; two transverse partitions parallel respectively to the transverse walls and extending from said bottom wall to said manifold one at each side of said arcuate part of said bottom wall defining a path for return flow of exhaust gas to the supply chamber; longitudinal partitions extending between said transverse partitions to define a plurality of pressure chambers between the bottom of the manifold and the arcuate surface, and a plurality of exhaust passageways coextensive with the pressure chambers about the periphery of the cylinder, the face of said manifold facing said bottom wall being provided with ports for the flow of heated gaseous medium from the interior of said manifold to each of said pressure chambers; shutters for closing said ports to a variable extent, each of said shutters being individual to one of said pressure chambers; and means for individually adjusting said shutters from without said casing, said arcuate part of said bottom wall being apertured for the direction of gaseous medium from said pressure chambers on to a web of paper on said drying cylinder and further apertured to provde access to said exhaust passageways for gaseous medium flowing over and away from the outer surface of said web on said cylinder and said exhaust passageways communicating through said transverse partitions with said supply chamber for the return to said supply chamber of gaseous medium received in said exhaust passageways.

2. In drying apparatus including a drying cylinder about which sheet material in continuous lengths to be dried is entrained, the combination comprising a plurality of pressure chambers deployed axially of the cylinder, said pressure chambers having axially aligned arcuate faces substantially conforming to the periphery of the cylinder in radially outwardly spaced relation thereto and having nozzle orifices for directing gaseous drying medium from the pressure chambers onto sheet material entrained about said cylinder; exhaust passageways circumferentially coextensive about said cylinder with said pressure chambers and spaced apart axially of said cylinder, each exhaust passageway being separated from the next thereto by at least one of said pressure chambers; means communicating through said arcuate faces for directing said gaseous medium axially of said cylinder to said exhaust passageways after said gaseous medium has flowed over and away from the surface of said sheet material; means for supplying gaseous drying medium to said pressure chambers; and means for enabling the drying rate of the sheet material achieved by said gaseous drying medium directed from each said pressure chamber to be independently controlled.

3. In drying apparatus including a drying cylinder about which sheet material in continuous lengths to be dried is entrained, the combination comprising a plurality of pressure chambers deployed axially of the cylinder, said pressure chambers having axially aligned arcuate faces substantially conforming to the periphery of the cylinder in radially outwardly spaced relation thereto and having nozzle orifices for directing gaseous drying medium from the pressure chambers onto sheet material entrained about said cylinder; exhaust passageways circumferentially coextensive about said cylinder with said pressure chambers and spaced apart axially of said cylinder; flow passage means radially outwardly beyond said arcuate faces extending axially of said cylinder and com-

municating with said exhaust passageways, said flow passage means also communicating through said arcuate faces with the spaces between said arcuate faces and said cylinder whereby gaseous medium which has flowed over and away from the surface of said sheet material will flow outwardly through said arcuate faces into said flow passage means and will then flow axially of said cylinder within said flow passage means to said exhaust passageways; means for supplying gaseous drying medium to said pressure chambers; and means for enabling the drying rate of the sheet material achieved by said gaseous drying medium directed from each said pressure chamber to be independently controlled.

4. Drying apparatus according to claim 3 in which said exhaust passageways are within said pressure chambers.

5. Drying apparatus according to claim 3 comprising an enclosing casing having a bottom wall which provides said pressure chamber arcuate faces; an intermediate wall spaced from said bottom wall; two spaced apart transverse walls parallel to the cylinder axis on opposite sides thereof and extending between said intermediate and bottom walls, said intermediate wall dividing the casing interior into a lower space bounded by said bottom wall, said transverse walls, and said intermediate wall, and a collecting space; a plurality of spaced apart partitions respectively extending from one of said transverse walls to the other in the direction of motion of sheet material entrained about said cylinder, said transverse walls, said bottom wall, said intermediate wall and said partitions defining said pressure chambers and said exhaust passageways, one of said intermediate and transverse walls having a plurality of ports separately providing communication between said collecting space and the respective pressure chambers and at least one other of said intermediate and transverse walls having gaps providing communication between said exhaust passageways and said collecting space, said means for supplying gaseous drying medium to said pressure chambers including a heater within said casing, and said means for enabling the drying rate of the sheet material to be controlled comprising means within said casing but operable from the exterior thereof for controlling the flow of drying medium from said collecting space through said ports individually to different ones of said pressure chambers.

6. Drying apparatus according to claim 3 comprising an enclosing casing having a bottom wall which provides said pressure chamber arcuate faces; two spaced apart inner transverse walls parallel to the cylinder axis and on opposite sides thereof; an intermediate wall spaced from said bottom wall and extending from one of said transverse walls to the other; a plurality of spaced apart partitions between said transverse walls extending parallel to the direction of motion of sheet material entrained about said cylinder, said inner transverse walls, said bottom wall, said intermediate wall and said partitions defining said pressure chambers and said exhaust passageways, and said exhaust passageway opening through at leat one of said inner transverse walls; and a top inner wall defining, with said intermediate wall and said inner transverse walls, a manifold which is included in said means for supplying gaseous drying medium to said pressure chambers, said means for supplying gaseous drying medium to said pressure chambers further including a heater within said casing, and means within said casing for delivering gaseous drying medium from said heater to said manifold, said means for enabling the drying rate of the sheet material to be independently controlled comprising separate independently operable inlet means between said manifold and the respective pressure chambers.

7. Drying apparatus according to claim 6 in which independently operable inlet means comprises cusp shaped ports in said intermediate wall between said manifold and respective pressure chambers; movable shutters respectively associated with said ports; and means connected to said shutters respectively and being operable from the exterior of said enclosing casing.

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NORMAN YUDKOFF, *Primary Examiner.*

GEORGE D. MITCHELL, CHARLES O'CONNELL, BENJAMIN BENDETT, *Examiners.*