Dec. 31, 1968 H. M. GRIERSON 3,419,068

DRYING CYLINDERS FOR PAPER MAKING AND TEXTILE MACHINES

Filed Sept. 30, 1966

Fig. 1.

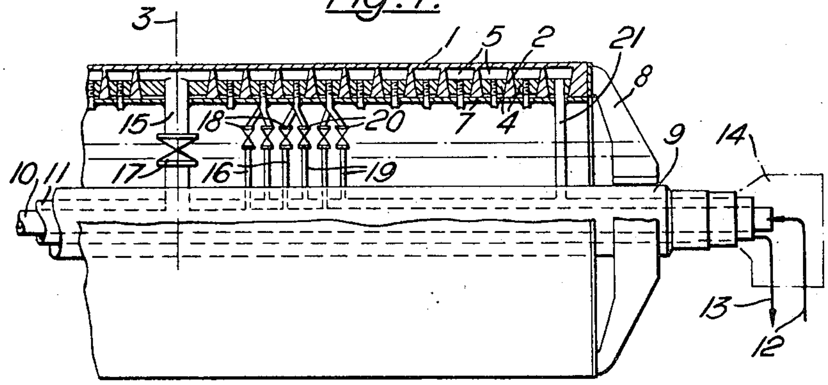


Fig. 2.

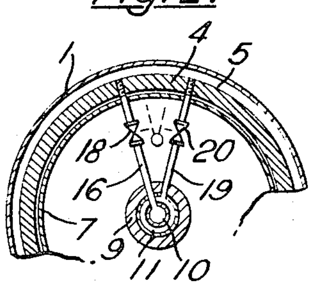
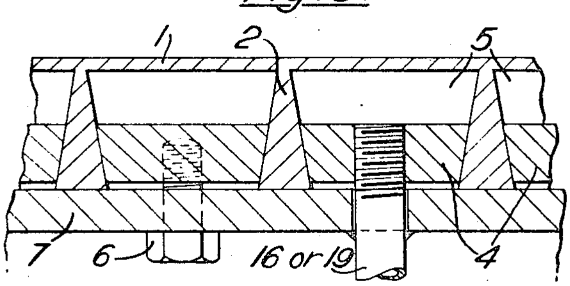


Fig. 3.



HEW McINNES GRIERSON
Inventor
By Imirie & Smiley
Attorneys

Fig. 4.

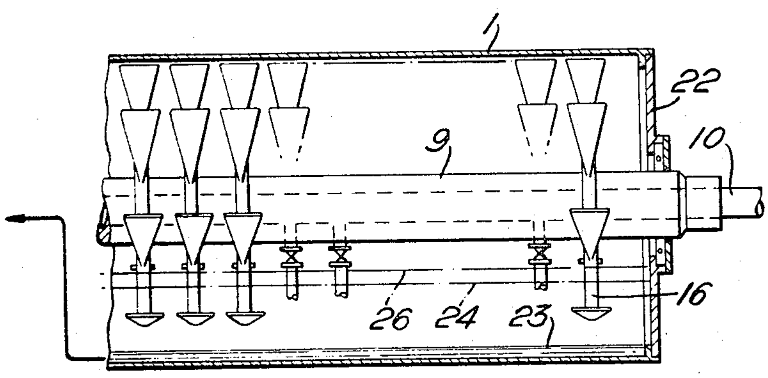
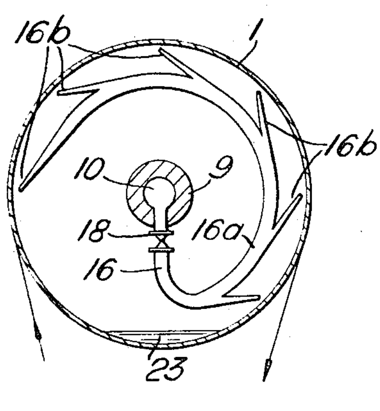


Fig. 5.



Inventor
HEW McINNES GRIERSON
By Imrie & Smiley
Attorneys

Fig. 6.

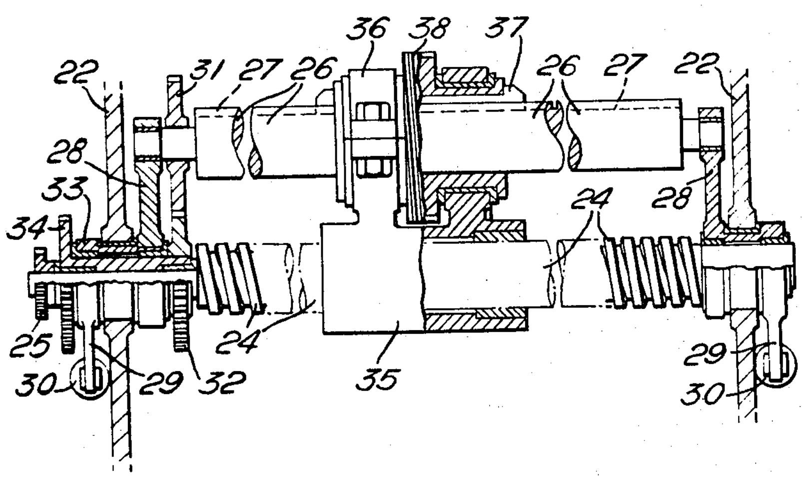
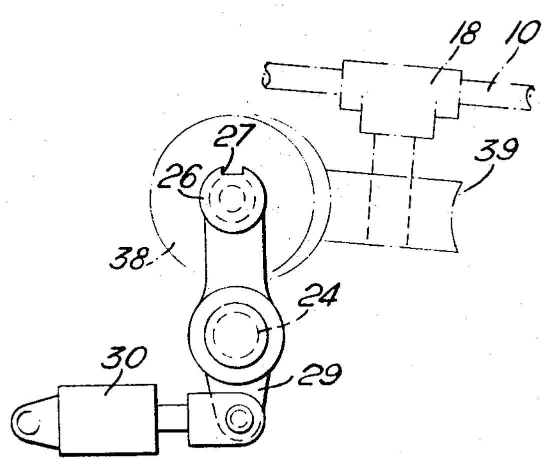


Fig. 7.



Inventor
HEW McINNES GRIERSON
By Emmie & Smiley
Attorneys

United States Patent Office 3,419,068
Patented Dec. 31, 1968

1

3,419,068
DRYING CYLINDERS FOR PAPER MAKING AND TEXTILE MACHINES

Hew McInnes Grierson, Beaconsfield, England, assignor to Wiggins Teape Research & Development Limited, London, England, a British company

Filed Sept. 30, 1966, Ser. No. 583,234
Claims priority, application Great Britain, Nov. 11, 1965, 47,953/65
10 Claims. (Cl. 165—89)

ABSTRACT OF THE DISCLOSURE

A drying cylinder for paper making and textile machines is cooled by the application of a heat exchange fluid to the interior of the periphery of the cylinder from a plurality of delivery conduits housed in the cylinder and each fitted with a valve to control the rate of fluid flow through the conduit. Valve-operating means movable lengthwise of the interior of the cylinder and actuated from one end of the cylinder is selectively engaged with, or disengaged from, any one of the conduit valves and effects operation of the valve.

Background of the invention

In a paper making machine it is usual to employ either a number of drying cylinders each of about four feet diameter, or a smaller number of drying cylinders each of about four feet diameter and one or more large drying cylinders, known as M.G. cylinders, of the order of fifteen feet diameter. It is also usual to heat each cylinder, which is normally made of cast iron, internally by steam at relatively low pressure. A high temperature on the periphery of the cylinder has an adverse effect on many papers, and this factor usually limits the permissible steam pressure for the cylinders of smaller diameter, while in the case of the M.G. cylinders the strength of construction thereof is usually the limiting factor. The heat is mainly obtained from the condensation of the steam, the condensate being removed by suitable devices internal of the cylinders.

With cylinders of the kind just referred to, the heat flow is inhibited by:

(a) a film of condensate on the inner surface of the cylinder shell, the thickness of the film depending upon several factors which include surface finish, efficiency of condensate removal devices, and speed of rotation; and

(b) the cast-iron shell which has relatively low thermal conductivity properties, and which has a thickness of about ¾ inch for a cylinder of smaller diameter, and of about 2½ inches for an M.G. cylinder.

Externally, a prevalent fault, showing as temperature differences along the periphery of a cylinder, is caused by the paper carrying away heat from that part of the periphery of the cylinder with which it comes into contact, at a faster rate than the heat can radiate from the edges and end elements of the cylinder. This causes the edges of the cylinder to be excessively hot and the paper to be overdried at the edges relative to the centre of the web. Other conditions, such as draughts, and poor vapour removal installations, can also cause uneven drying across the width of the paper web.

Summary of the invention

According to the present invention, a heat exchange cylinder is so constructed as greatly to enhance the rate of heat flow from the heating medium inside the cylinder to the peripheral surface of the cylinder, or vice versa if cooling, and to provide for temperature control along the peripheral surface of the cylinder either by providing uniform temperature or by controlling the surface temperature so that moisture variations across a web prior to engagement thereof by the cylinder may be rectified.

2

According to the invention there is provided a hollow heat exchange cylinder the peripheral temperature of which is controlled by a circulating heat exchange fluid at least in part applied to the interior surface of the cylinder from a plurality of delivery conduits spaced apart axially of the cylinder and communicating with a supply conduit common thereto and extending axially of the cylinder, and in which the rate of fluid flow through the delivery conduits is controllable.

The cylinder may comprise inner and outer radially spaced concentric shells the space between which is closed at the opposite ends thereof and is divided into axially spaced communicating passages extending around the cylinder, and wherein the heat exchange fluid is arranged to pass into said passages from said delivery conduits and/or from a main duct communicating with the supply conduit at a position substantially midway between the opposite ends of the cylinder, said delivery conduits and main duct each including a valve operable to control the rate of fluid flow from the supply conduit to said passages. At least one fluid return duct may communicate with said passages and a main return conduit concentric with the supply conduit, a return conduit cooperate with each of said delivery conduits and communicate with a passage and with the main return conduit, and each return conduit include a valve operable to control the rate of fluid flow from the passage to the main return conduit. The passages may be of helical form and may be of opposite hand on opposite sides of the main duct and a return duct be located at each end of the cylinder to communicate one with each of the passages of opposite hand and with the main return conduit.

The supply conduit may be stationary, the cylinder rotatable about the supply conduit, and each delivery conduit terminate in a jet or nozzle disposed in close proximity with and directed towards the interior surface of the cylinder and include a valve operable to control the rate of fluid flow from the supply conduit to the jet or nozzle. A portion of each delivery conduit may be substantially concentric with the interior surface of the cylinder and a series of jets or nozzles emanate from said portion. Return fluid may be extracted from the interior of the cylinder through a stationary return conduit coaxial with the supply conduit.

In an alternative embodiment of the invention the supply conduit may be supported for rotation in, and for axial movement relative to, a stationary tube about which the cylinder is rotatable, the supply conduit and tube each be provided with radially extending ports spaced apart lengthwise thereof with each port of the supply conduit partly in register with one port of the tube, the stationary tube be located within and spaced from an outer tube concentric therewith and rotatable about the stationary tube, the ends of the space between the tubes is closed and impediments are provided therein to prevent the axial flow of fluid entering the space from the ports of the stationary tube, the delivery conduits be rotatable with the outer tube and communicating with said space at positions between the impediments, and the rate of fluid flow through the delivery conduits be controllable by axial movement of the supply conduit, by rotation of the supply conduit, or by axial movement and rotation of the supply conduit. The extent of register between said ports may be progressive from at least one end towards the centre of the cylinder or from one end to the other.

In order that the invention may be clearly understood some embodiments thereof will now be described, by way of example, with reference to the accompanying drawings, in which;

FIG. 1 is a side elevation, partly in section, of a portion of a heat exchange cylinder according to the invention,

FIG. 2 is a transverse section of a part of the cylinder,

FIG. 3 illustrates a portion of FIG. 1 to an enlarged scale,

FIG. 4 is a sectional elevation of a portion of an alternative form of heat exchange cylinder according to the invention,

FIG. 5 is a transverse section of FIG. 4,

FIG. 6 is a broken elevation, partly in section, of a traversing valve-operating gear which may be embodied in a cylinder according to the invention,

FIG. 7 is an end view of a part of the gear shown in FIG. 6.

In the drawings like reference numerals refer to like or similar parts.

Referring to FIGS. 1 to 3, the hollow heat exchange cylinder has open ends and comprises a shell **1** having internal webs **2** which are integral with or are secured to the shell **1**. The webs **2** form a helical path around the interior of the shell which path may be continuous from end-to-end of the shell or may, as shown in FIG. 1, be continuous from the opposite ends of the shell to the centre thereof and of opposite hand. Thus in FIG. 1 the path to the right-hand side of the centre line **3** is a left-hand helix and the path to the left-hand side of centre line **3** is a right-hand helix. Tapered helical pieces **4** cooperate with the webs **2** to form helical passages **5** arranged, as described below, to receive heat exchange fluid which may be either a liquid, a vapour, a gas, or liquid metal but which, for convenience, will hereinafter be referred to as oil. As shown in FIG. 3, the helical pieces **5** are clamped in position by screws **6** acting against a sleeve **7** concentric with the shell **1**. Brackets **8** are secured to the opposite ends of the cylinder.

The brackets **8** are mounted for rotation with a hollow shaft **9**, rotation of which is effected in any suitable manner not shown, which houses a supply conduit **10** and a main return conduit **11** which is concentric with the supply conduit **10**. Oil is fed into the supply conduit **10** through a pipe **12** and leaves the main return conduit through a pipe **13**. Connection between supply conduit **10** and pipe **12**, and between return conduit **11** and pipe **13**, is effected in known manner through a rotary union **14**.

The oil from supply conduit **10** passes therefrom to the passages **5** through a main duct **15** and delivery conduits **16**, the duct **15** being provided with a valve **17** and each delivery conduit with a valve **18**. The valves **17**, **18** are controlled manually through the open ends of the cylinder but if the cylinder has closed ends, for example as described below with reference to FIGS. 4 and 5 the valves **17** and **18** may be controlled externally of the cylinder by a traversing valve-operating gear. The valves **17**, **18** are operated, when necessary, to control the rate of oil flow from the supply conduit **10** to the passages **5**. The valve-operating gear may be operated by pneumatic, hydraulic, electrical, or mechanical means permitting adjustment of the valves during rotation of the cylinder, one form of such gear being described below.

Each delivery conduit **16** has a return conduit **19** cooperating therewith and each return conduit **19** includes a valve **20** which is operable manually or, if appropriate, by the traversing valve-operating gear. The return conduits **19** connect the passages **5** with the main return conduit **11**. In FIG. 2 the conduits **16** and **19** have, for clarity, been shown as being displaced angularly, the conduits, are, however, in line considered lengthwise of the cylinder.

Oil passing through the main duct **15** divides and progresses through the passages **5** to the right and left thereof and, if no oil is removed from the passage **5** through

conduits **19**, passes through return ducts **21** at the ends of the cylinder to the main return conduit **11**. It will be understood that, if desired, the pipe **13** may co-operate with a rotary union at the end of the conduit **11** opposite that shown in FIG. 1.

The shell **1** is a relatively thin shell, for example having a thickness of the order of ¼ inch to ½ inch for smaller cylinders or 1 inch to 2 inches for M.G. cylinders and is made of a material, such for example as copper, copper alloys, aluminium, or aluminium alloys, having a high thermal conductivity. This, as compared with the above-mentioned relatively thick cast-iron shells previously used, gives a greatly enhanced heat flow through the shell. By regulating the flow of oil to passages **5** through the delivery conduits **16**, and the rate of return through the return conduits **19**, it is possible to control the peripheral temperature of the cylinder along the length thereof and to arrange that the rate of flow is such that turbulent conditions occur in the passages so resulting in less restriction to heat flow in the boundary layer than is generally obtained with a condensate film of the kind referred to above.

If, as mentioned above, the passage **5** is a single helix extending from one end of the cylinder to the other, the main duct **15** can be disposed at one end of the passage and a single return duct **21** at the other end thereof. It is also to be understood that the passage may be of a form other than helical, for example a plurality of parallel circular passages, each with a delivery conduit **16** and return conduit **19**, may be employed, and the passages may be intercommunicating through the medium of ports provided therebetween.

FIGS. 4 and 5 illustrate an alternative embodiment of the invention in which the cylinder has a thin shell **1** of high thermal conductivity closed by end plates **22**. The cylinder is rotatable about a stationary hollow shaft **9** which houses only the supply conduit **10**. Each delivery conduit **16** emanates from the supply conduit **10**, see FIG. 5, extends radially through the hollow shaft **9**, has a portion **16*a*** which is substantially concentric with the interior surface of the shell **1**, and which is provided with a series of jets or nozzles **16*b*** which is disposed in close proximity with and which is directed towards the interior surface of the shell **1**. The delivery conduits **16** include valves **18** operable, if required, as mentioned above, by traversing valve-operating gear. Return oil is collected in the bottom of the shell, as indicated at **23**, and is removed by a pump, not shown, either through a pipe co-axial with the supply conduit **10**, or through a main return duct concentric with the supply conduit after the manner described above with reference to FIGS. 1 to 3.

Temperature control of the periphery of the cylinder is effected by adjustment of the valves **18** and the jets or nozzles **16*b*** project oil on to the inner surface of the shell **1**, over all or part of the circumference. The oil is arranged to impinge against the interior surface of the shell **1** at a reasonably high velocity such as will tend to break down any boundary layer.

It will be understood that the arrangement of jets or nozzles may be other than that just described.

Referring to FIGS. 6 and 7, which diagrammatically illustrate one form of traversing valve-operating gear which may be employed, a screw **24** is rotatable in the end plates **22** and rotation of the screw is effected by a gear wheel **25** driven in any suitable manner, for example by a reversible motor not shown. A shaft **26** having a keyway **27** which extends the full length of the shaft is rotatable in arms **28** mounted for oscillation about the ends of screw **24** by levers **29** arranged for operation by air cylinders or by solenoids **30**. Rotation of shaft **26** is effected by meshing gears **31**, **32** of which gear **32** is secured to a sleeve **33** which also has a gear **34** secured thereto. The sleeve **33** is rotatable about the end of the screw **24** and gear **34** is driven in any suitable manner, for example by a reversible motor not shown. A bush **35** is screwed on to screw **24** and carries a bracket **36** which is provided with a key **37** slidable in the keyway **27**, and on which a worm **38** is mounted for rotation about shaft **26** and for co-operation with worm-wheels **39**, FIG. 7, arranged to control the valves **18** and, when provided, valve **19**.

When it is desired to adjust a valve the screw **24** is rotated to align the worm **38** with the appropriate worm-wheel **39**, following which the lever **29** is operated to rock shaft **26** so that the worm and worm-wheels mesh and then shaft **26** is rotated by gears **31, 32, 33** to effect the desired adjustment of the valve. After adjustment the worm is again disengaged from the worm-wheel.

The sleeve **53** is provided, between the delivery conduits **16**, with bleed orifices **56** having substantially constant flow characteristics and through which oil is returned into the sleeve **53** for extraction therefrom, for example by a pump not shown, through a stationary return conduit **11***a* coaxial with the supply conduit **10**.

Scoops **57** located at the ends of the sleeve **53** are rotatable therewith and are operable to pick up return oil from the open ends of the annular space **55** and to direct it into the sleeve for extraction therefrom.

By constructing drying cylinders as described herein with reference to the drawings the heated transfer medium can be so controlled in distribution and flow rate that temperature control of positions along the periphery of the cylinder may be effected. Further, the shell of the cylinder may be relatively thin and of a material having a high thermal conductivity and by effecting a turbulent flow or impingement of the heat exchange medium against the interior surface of the shell a reduction of boundary layer, as compared with previously known forms of drying cylinder, can be obtained. These two last mentioned features combine to give a substantially increased drying rate per unit area as compared with the steam-heated cast iron drying cylinders previously used in paper making machines.

I claim:

1. A hollow heat exchange cylinder the peripheral temperature of which is controlled by a circulating heat exchange fluid, comprising a plurality of delivery conduits spaced apart axially of the cylinder and arranged at least in part to apply the heat exchange fluid to the interior surface of the cylinder, a supply conduit communicating with and common to all said delivery conduits and extending axially within the cylinder, a valve included in each delivery conduit to control the rate of fluid flow through each such delivery conduit, valve-operating means supported for movement lengthwise of the interior of the cylinder, and actuating means located at one end of the cylinder for moving said valve-operating means lengthwise of the cylinder into registry with any one of said valves, and including mechanism for adjusting the valve with which the valve-operating means is registered.

2. A heat exchange cylinder according to claim **1** wherein the cylinder comprises inner and outer radially spaced concentric shells, the space between which is closed at the opposite ends thereof and is divided into axially spaced passages extending around the cylinder, said delivery conduits connecting said supply conduit to individual ones of said passages, a main duct connecting said supply conduit with the centrally located passage, said main duct including a valve operable by said valve-operating means.

3. A heat exchange cylinder according to claim **2**, wherein at least one fluid return duct communicates with said passages and a main return conduit concentric with the supply conduit, a return conduit co-operates with each of said delivery conduits and communicates with a passage and with the main return conduit, and each return conduit includes a valve operable by said valve-operating means to control the rate of fluid flow from the passage to the main return conduit.

4. A heat exchange cylinder according to claim **3**, wherein the passages are of helical form.

5. A heat exchange cylinder according to claim **4**, wherein the passages are of opposite hand on opposite sides of the main duct and a return duct is located at each end of the cylinder to communicate one with each of the passages of opposite hand and with the main return conduit.

6. A heat exchange cylinder according to claim **1**, wherein the supply conduit is stationary and the cylinder is rotatable about the supply conduit, and wherein each delivery conduit terminates in a jet or nozzle disposed in close proximity with and directed towards the interior surface of the cylinder and includes a valve operable externally of the cylinder to control the rate of fluid flow from the supply conduit to the jet or nozzle.

7. A heat exchange cylinder according to claim **6**, wherein a portion of each delivery conduit is substantially concentric with the interior surface of the cylinder and a series of jets or nozzles emanate from said portion.

8. A heat exchanger according to claim **7**, wherein return fluid is extracted from the interior of the cylinder through a stationary return conduit co-axial with the supply conduit.

9. A heat exchange cylinder according to claim **1**, wherein each valve is fitted with a rotatable worm wheel rotation of which opens and closes the valve, and wherein the valve-operating means and the actuating means therefor comprises a shaft located in the cylinder and extending lengthwise thereof, a bracket carried by a bush screwed on to a rotatable screw parallel to said shaft and extending through the cylinder, said bracket being slidable axially of the shaft, a worm arranged for meshing engagement with any one of said worm wheels and supported for rotation about the axis of said shaft and for axial movement with said bracket, arms supporting said shaft for rotation about its axis and for rocking movement about the axis of said screw to move the worm into and out of meshing relation with the worm wheels, and meshing gear wheels one of which is rotatable with said shaft and another of which is rotatable about the axis of said screw to effect rotation of said shaft following meshing of the worm with a worm wheel.

10. The heat exchange cylinder according to claim **1** wherein said valves are aligned with each other parallel to the axis of said cylinder, said valve-operating means being supported for movement along a path parallel and adjacent to the aligned valves.

References Cited

UNITED STATES PATENTS

2,599,346	6/1952	Offen	165—89
2,603,457	7/1952	Bishop	165—89
3,006,610	10/1961	Siegel	165—89
3,169,050	2/1965	Kroon	165—90
3,325,910	6/1967	Toivonen	165—89

FOREIGN PATENTS

944,436	11/1948	France.

ROBERT A. O'LEARY, *Primary Examiner.*

CHARLES SUKALO, *Assistant Examiner.*

U.S. Cl. X.R.

165—101