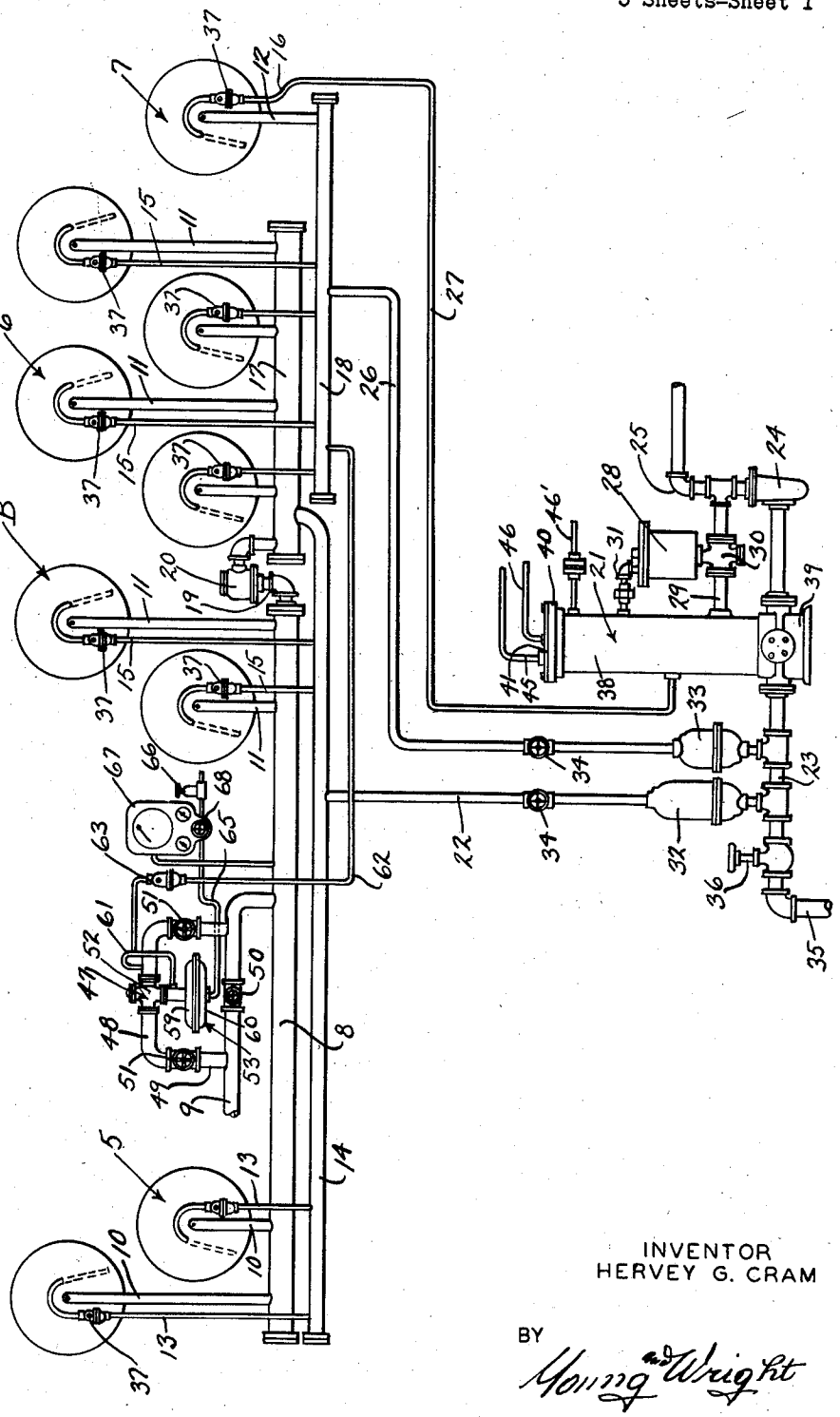
May 12, 1959 H. G. CRAM 2,885,790

DRAINAGE SYSTEM AND MOISTURE CONTROL

Filed May 24, 1957 3 Sheets-Sheet 1

Fig. 1.



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DRAINAGE SYSTEM AND MOISTURE CONTROL

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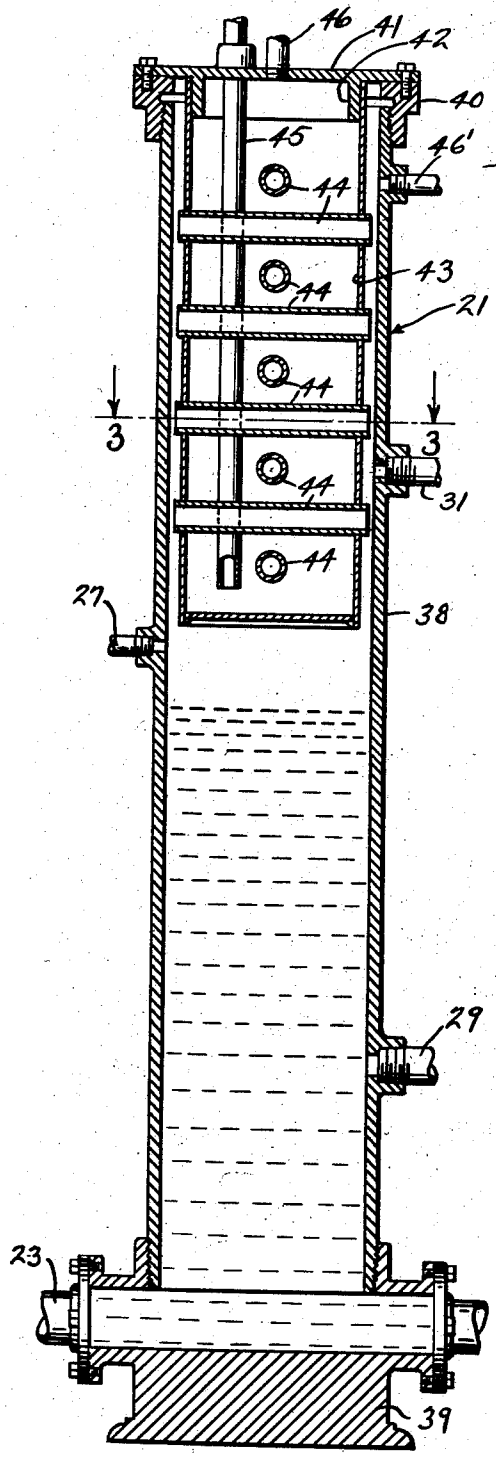
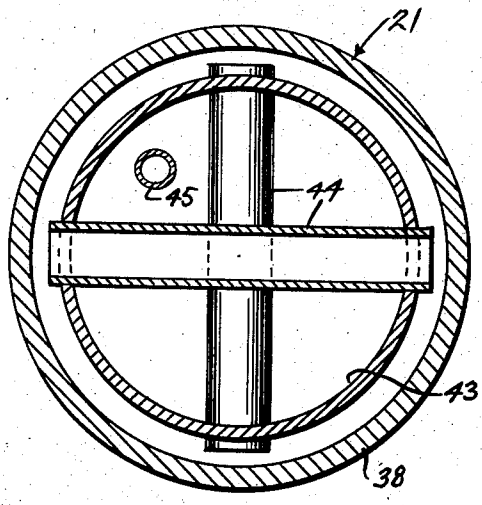


Fig. 2.

Fig. 3.



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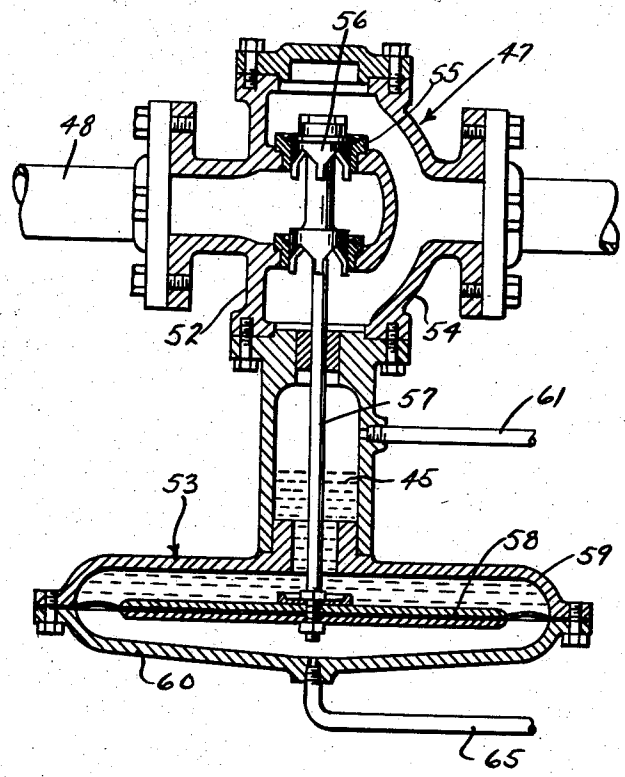
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DRAINAGE SYSTEM AND MOISTURE CONTROL

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3 Sheets-Sheet 3

Fig. 4.



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2,885,790

DRAINAGE SYSTEM AND MOISTURE CONTROL

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Application May 24, 1957, Serial No. 661,457

6 Claims. (Cl. 34—48)

This invention relates to a drainage system for dryers of the rotary, cylindrical type and a moisture control for the sheet passing over the cylinders of the dryers; the invention being an advancement over the art as illustrated by my prior Patents No. 2,242,778 and No. 2,696,679 issued respectively on May 20, 1941 and December 14, 1954.

An object of my present invention is to provide maximum efficiency in the transfer of the latent heat in the steam, to and through the shell of each cylindrical dryer to the sheet of the paper in contact therewith.

In order to obtain maximum efficiency it is necessary to prevent the accumulation of air and other non-condensable gases within the cylindrical dryers during operation, in view of the fact such gases have an insulating effect rated at approximately 2000/1 with relation to the metal shell of the dryer and to maintain a fixed minimum accumulation of condensate within the cylindrical dryers during operation, in that such an accumulation of condensate in a dryer reduces the amount of shell surface in direct contact with the steam, the insulating effect of the condensate being approximately 85/1 with relation to the metal shell of the dryer, plus the fact that the amount of accumulated condensate in the dryers has a very definite effect upon the power required for the rotation thereof, and further to dry the sheet with the least possible steam consumption per ton of paper dried.

It is therefore a further object of my present invention to provide a continuous blow-through system in the cylindrical dryers so that there will be a fast and continuous circulation of steam through each dryer for the continuous removal of the condensate, air and other non-condensable gases, and, with a fixed pressure differential across each dryer sufficient to serve this purpose.

A further important object of my invention is to provide a dryer drainage system and moisture control that will be automatic in operation, and, with unnecessary troublesome and space consuming equipment.

A further salient object of my invention is to provide a novel means for maintaining a fixed required moisture content in the sheet of paper as the same leaves the cylindrical dryers so that the sheet will be satisfactory for use by the paper manufacturer and consumer. Maintenance of a fixed required moisture content in the sheet is of prime importance, in that, the cost of paper making is materially reduced relative to an increase in the moisture content in the sheet, i.e., an increase in the moisture content in the sheet of 1% with a machine or machines producing 100 tons of paper per day, means a reduction in cost of paper making material of 1% and an equivalent reduction in the steam requirement for drying, or in other words, an extra ton of paper per day without additional cost; also, a variation in the moisture content in the sheet is not only detrimental to the consumer requirement but it may also effect the operation of the paper drying machine, i.e., an excessively high or low mositure content in the sheet may cause difficulty at the calendar stack or, in passing the dryers.

It is obvious that the rate of condensation in a paper machine dryer is relative to the moisture content in the sheet of paper in contact with the cylindrical dryers during operation, therefore, an increase or decrease in the moisture content of the sheet effects a relative variation in the rate of condensation in the dryer; a relative steam demand, and a consequent variation in pressure in the steam headers supplying the dryers.

It is therefore, a still further object of my invention to maintain a required moisture content in the sheet by providing an extremely sensitive and accurate control of the rate of flow of the steam to the dryers relative to the demand.

Another, still further object of my invention is to provide a proportional reduction in pressure automatically when the sheet is temporarily off the drying cylinders so that the dryers will be at the proper drying rate to receive and accept the sheet when the sheet is again passed over the cylindrical dryers.

With these and other objects in view, the invention consists in the novel construction, arrangement and formation of parts, as will be hereinafter more specifically described and claimed, and illustrated in the accompanying drawings, in which drawings,

Figure 1 is a diagrammatic view in side elevation showing my improved drainage system and moisture control incorporated with a battery of dryers in a paper making machine;

Figure 2 is an enlarged central vertical sectional view taken through the novel condenser utilized in the system;

Figure 3 is a horizontal sectional view through the condenser taken on the line 3—3 of Figure 2, looking in the direction of the arrows, and

Figure 4 is an enlarged vertical sectional view through a pressure balanced diaphragm control valve of a type preferably used in my system.

Referring to the drawings in detail and more particularly to Figure 1, I have shown diagrammatically a battery B of dryers, of a paper making machine and these dryers are of the rotating, cylindrical type, over which and in contact with a continuous sheet of paper (not shown) is passing for the purpose of drying.

In accordance with my present invention, the battery B of dryers is divided into a primary section 5 of any number of cylindrical dryers; a section 6 of cylindrical dryers composed of a less number of dryers than the primary section 5 and a condensate section 7, composed of a less number of dryers than the secondary section 6. The primary section 5 can include, say 25 dryers, the secondary section 4 dryers (as illustrated) and the condensate or third section, a single dryer. It is to be noted that in the drawings I have only shown four dryers in the primary section in order that certain controls can be clearly illustrated, but it is again to be understood that the primary section 5 includes a greater number of dryers than the secondary section 6 and the condensate section 7.

Steam is supplied to the primary section 5 through the primary header 8 and this header is fed with steam from a supply line 9 leading from a suitable source (not shown). Each of the dryers of the primary section 5, the secondary section 6 and the condensate section 7 is provided with a hollow journal (see my above-mentioned patents), and coupled with the journals of the primary section 5 are feeder pipes 10 leading from the header 8. Connected with the coupling of the dryers of the secondary section 6 are feeder pipes 11, which will be later referred to. Connected with the coupling of the dryer of the condensate section 7 is a feeder pipe 12, which will also be later referred to.

Water of condensation, air and other non-condensable

gases and steam from the various dryers of the primary section 5 are removed by syphons 13 and these syphons extend through the hollow journals of these dryers and are connected with a primary condensate header 14 which extends along the primary steam header 8. Water of condensation, air and other non-condensable gases and steam from the various dryers of the secondary section 6 are removed by syphons 15 of the same character as the syphons 13 and these syphons extend through the journals of the dryers of the secondary section and these syphons 15 will be later referred to. Water of condensation, air and other non-condensable gases and any steam will be removed from the dryer of the condensate section by a syphon 16 which is the same as the syphons 13 and 15 and this syphon 16 will be later referred to. The syphons are well shown in my Patents Numbers 2,617,205 and 2,696,679 issued to me respectively on November 11, 1952 and December 14, 1954.

Extending along the dryers of the secondary section 6 is a secondary steam header 17 and the feeder pipes 11 of the dryers of this section communicate with the header 17. The primary condensate header 14 is coupled with and leads into the secondary steam header 17. Extending along the secondary steam header 17 is a secondary condensate header 18 and the syphons 15 of the section 6 are connected and communicate with the condensate header 18. The feeder pipe 12 for the dryer of the condensate section 7 is connected and communicates with the secondary condensate header 18.

Briefly, from the description so far, it can be seen, steam is supplied to the dryers of the primary section 5 from the header 8 and the condensate and gases are removed from these dryers to the condensate header 14 and this header, in turn, supplies the dryers of the secondary section 6 with steam for heating these dryers and that the condensate and gases from the dryers of the secondary section 6 are removed by the syphons 15 to the secondary header 18 for condensate and that steam from the condensate header 18 is supplied through the feeder 12 to the dryer of the condensate section 7 and that condensate and gases are removed from this dryer by the syphon 16.

If desired, additional live steam can be supplied from the primary steam header 8 to the secondary steam header 17 through a connection 19 having interposed therein a pressure differential unit or control 20. The control operating on a differential (in the present instance) of 2 pounds; the unit being in proportion to other controls, which will be now set forth.

The removal of the condensate, air and other non-condensable gases from the dryers forms an important part of this invention and in conjunction with this removal, I utilize a novel condenser 21 which will be later described in detail. At the present moment, however, it can be seen that condensate is discharged from the primary condensate header 14, through a pipe 22 to and through a pipe 23 which leads and communicates with the lower end of the condenser 21. The condensate is removed from the condenser by a pump 24. The pump 24 can be of any desired character and operated in any desired way. In the present instance, the pump 24 is shown to be of the rotary type and its outlet has communicating therewith a riser pipe 25 which leads back to the boiler plant (not shown). Condensate and gases are discharged from the secondary condensate header 18 through a pipe 26 to the pipe 23 leading to the condenser and ultimately to the pump 24 and the boiler plant. Condensate and a minimum amount of steam is discharged from the dryer of the condensate section 7 to a pipe 27 that leads to and communicates directly with the condenser 21 at a point above the pipe 23 and at a point above the water or condensate level in the condenser. To maintain the water or condensate at a fixed level within the condenser, I employ a liqud level controller 28. A branch pipe 29 connects the condenser with the condensate return pipe 25 and the valve 30 of the liquid level controller 28 is interposed in the length of this branch pipe. It is to be noted that the branch pipe 29 is disposed at a point above the condensate feed pipe 23 and at a point materially below the condensate and steam return pipe 27. The level of condensate within the condenser 21 as communicated to the float chamber of the liquid level controller 28 provides the means to position the valve 30 to provide the required amount of condensate return from the discharge of the pump 24 to the condenser 21 to maintain a constant fixed level within the condenser 21. The purpose of the communicating pipe 31 top of liquid level controller 28 to the condenser 21 is to prevent any accumulation of air or other non-condensable gases at the top of the liquid level controller 28. The liquid level controller 28 is of a type commonly found on the open market.

The pipe 22 has interposed in the length thereof a pressure differential valve 32, which in the present application operates on a differential of five pounds. The condensate return pipe 26 has incorporated therein a pressure differential valve 33, which in the present instance operates on a differential of three pounds. It is to be noted that the pipe 27 is free of a pressure differential valve. Both the condensate pipes 22 and 26 also have preferably interposed in the lengths thereof a sight glass 34 so that an operator can see the flow of condensate. The pressure differential valves or units 32 and 33 are of the same type as shown in my Patent No. 2,696,679 heretofore mentioned.

The pipe 23 has also communicating therewith a pipe 35. Flow of water through the pipe 35 is controlled by a hand valve 36. The pipe 35 and the valve 36 are merely used as a clean out to a sewer, if such should ever be required.

All of the syphons 13, 15 and 16 have incorporated in their lengths pressure differential units or valves 37 and each of these pressure differential units, in the present instance, operates on a differential of two pounds and these units are exactly of the same type as shown in my Patent No. 2,696,679.

The condenser 21 includes a tubular casing shell 38 closed at its lower end by a head 39 to which is connected the pipe 23 for condensate and the outlet for the water to the pump 24. The upper end of the casing shell 38 has threaded thereon a collar 40 and bolted to this collar is a head 41. The head 41 in turn, carries a depending annular rib or sleeve 42. Securely welded or otherwise fastened to the rib or sleeve 42 is a depending interior cooling water chamber 43. This chamber 43 terminates well above the water level in the condenser. Extending entirely through the cooling water chamber 43 are open ended tubes 44, so that steam can flow freely therethrough and thus be expeditiously reduced to water of condensate. Extending into the chamber 43 is a water supply pipe 45 and communicating with the upper end of the chamber is a cooling water discharge pipe 46. The extreme upper end of the condenser has communicating therewith a discharge pipe 46' for air and other non-condensable gases and this pipe can discharge directly to the atmosphere if so desired.

The moisture control for the sheets includes a pressure balanced diaphragm control valve 47 interposed in the steam supply pipe 9. This valve 47 is specially designed to secure super-sensitivity, (see Fig. 4). The control valve 47 is carried by a by-pass line 48, the legs 49 of which communicate with the steam supply pipe 9 on opposite sides of a hand operated valve 50. The legs 49 also have incorporated therein hand operated valves 51. Normally, the valve 50 is closed and the valves 51 are open so that steam will flow through the by-pass pipe 48 and into the primary steam header 8 and be controlled by the valve 47. The control valve 47 includes the valve section 52 and the control diaphragm section 53. The valve section 52 includes the valve casing 54

having valve seats **55** on which are adapted to seat valve bodies **56** carried by a stem **57** attached to and operated by the diaphragm **58**. The diaphragm **58** is firmly clamped at its periphery by the sections **59** of the diaphragm housing **60**, forming a part of the diaphragm section **53**. Obviously, when the diaphragm **58** rises, the valve bodies **56** will be moved from their seats **55** allowing free flow of steam and when the diaphragm moves down the flow of steam will be regulated until the valve bodies **56** are firmly seated at which time the supply of steam will be entirely cut off. The diaphragm **58** is pressure balanced and operates as follows: steam flows into the upper end of the diaphragm housing through the medium of a supply line **61** which has direct communication with the steam by-pass line **48** down stream of the valve **47**. Attention is now directed to, and this forms an important part of the invention, the branch line **62** which communicates with and connects the line **61** with the secondary condensate header **18**. This line **62** has interposed in its length a pressure differential unit or valve **63** which is of the same type as the pressure differential valves or units **37**. However, in the present instance, the pressure differential valve **63** operates on a pressure differential of four pounds. In order to prevent direct contact of the steam with the diaphragm a column of water **64** is placed in the diaphragm housing directly between the upper face of the diaphragm **58** and the line **61**.

Communicating with the lower end of the diaphragm housing **60** is an air supply pipe **65**. Compressed air is supplied to line **65** from any suitable source and pressure is normally fixed by a pressure regulator valve **66**. Interposed in the line **65** is a pilot **67** of a conventional type and embodying a secording chart and air pressure adjusting knob **68**.

Compressed air is delivered to the bottom side of the diaphragm **58** of the pressure balanced diaphragm control valve **47** via the control knob **68** of the pilot **67** at the required pressure, as set up by the operator to effect a required moisture content in the sheet at the start of an operation. This pressure is equalized by means of the steam from the line **61** and the valve bodies **56** are positioned to effect the required steam pressure in the primary steam header **8**. The purpose of the by-pass line **62** with its four pound pressure differential unit **63** is to increase the sensitivity of the control of the steam supply with relation to the moisture content of the sheet and this functions as follows: an increase in the moisture content in the sheet effects a relative decrease in pressure in the steam header **8** which reacts relatively on the control valve **47** and the initial decrease in pressure in the secondary condensate header **18** effects a relative increase in the pressure differential across the four pound pressure differential unit or valve **63**, thereby increasing the amount of steam from the line **61**, and, thus decreasing the pressure on the upper side of the diaphragm **58** for a more rapid re-positioning of the valve bodies **56** in the readjustment of the drying rate.

The decrease in the moisture content in the sheet effects a relative increase in pressure in the steam header **8**, reacting relatively on the control valve **47**, and, the increase in pressure in the secondary condensate header **18** effects a relative decrease in the pressure differential across the four pound pressure differential unit or valve **63**; thereby decreasing the amount of steam by-passed from the line **61**. This increases the pressure on the upper side of the diaphragm **58** for a more rapid and accurate re-positioning of the valve bodies **56** for the readjustment thereof relative to the drying rate.

When the paper sheet is off the dryers temporarily, through a sheet break, the pressure will increase relatively in the secondary condensate header **18** effecting a decrease in pressure differential across the four pound pressure differential unit **63** and a relative increase in pressure in the line **61** and on the upper side of the diaphragm **58** to re-position the valve bodies **56** for a relative reduction in pressure in line with the dryer pressure requirement for the passing of the new sheet over the dryer cylinders.

It should be borne in mind, that, the four pound pressure differential unit **63** is the normal pressure differential between the primary steam header **8** and the secondary condensate header **18** at the required moisture content in the sheet.

Now referring back to the condenser **21**, with the liquid level pressure differential controls, it can be seen with a pressure differential of two pounds between the primary condensate header **14** and the secondary condensate header **18** and the discharge line or pipe **27** from the condensate section **7** and within the condenser **21** as fixed by the individual dryer two pound pressure differential units **37**: it will be obvious that, the established pressure differential between the primary condensate header **14** and the condenser **21** will be four pounds and between the secondary condensate header **18** and the condenser **21** will be two pounds.

The purpose of the five pound pressure differential unit or valve **32** is to equalize the discharge from the primary condensate header **14** to the pressure within the water line **23** and within the condenser **21** and at the same time, provide a column of condensate of approximately (in the present instance) two and one-half feet to prevent the possibility of steam passage through the pipe **23** and the condenser **21**.

The purpose of the three pound pressure differential unit or valve **33** is identical with that of the five pound pressure differential unit **32**, as per the above description.

This arrangement allows for gaseous discharge to the condenser **21** along with the condensate only from the condensate section **7**, such gaseous discharge consisting of the air and other non-condensable gases as discharged from all of the drying cylinders and a minimum amount of steam to contact the condensing unit or chamber **43** within the condenser **21** for the separation and discharge of the non-condensable gases through the discharge pipe **46**.

Various other changes in details may be made without departing from the spirit or the scope of this invention, but what I claim as new is:

1. In a paper making machine, a battery of cylindrical dryers over which a paper web is fed including a primary section, a secondary section and a condensate section, means for circulating steam through the dryers of the primary section including a header for steam and means connecting all of the dryers of the primary section with the header, a primary header for condensate and returning steam for all of the dryers of the primary section, a syphon for each of the dryers of the primary section connected with the primary condensate header, means for circulating steam through the secondary section of dryers including a secondary steam header and means connecting all of the dryers of the secondary section with the secondary steam header, means connecting the primary condensate header with the secondary steam header, a secondary condensate header, means including a syphon for each dryer of the secondary section connected with the secondary condensate header for removing condensate and steam from the dryers of the secondary section, means connecting the secondary condensate header with the dryer of the condensate section, means including a siphon for the condensate section for removing condensate from said section automatic means in the syphons of the dryers for the primary, secondary and condensate section for maintaining a fixed predetermined pressure across each dryer, a condenser for receiving condensate and steam from the dryers of all of the sections, means for removing water of condensate from the condenser including a pump, means for maintaining a fixed water level in the condenser, an inlet pipe communicating with the con-

denser below the water level, independent return pipes connecting the primary and secondary condensate headers with the inlet pipe, means for connecting the syphon of the dryer of the condensate section with the condenser above the water level in the condenser, and automatic pressure differential valves in the pipes for connecting the primary and secondary condenser headers with the condenser.

2. In a paper making machine as defined in claim 1, and said pressure differential valve for the primary condenser header being of a higher pressure differential than the pressure differential valve for the secondary condensate header.

3. In a paper making machine as defined in claim 1, and said condenser having an outlet for air and non-condensable gases adjacent to the top of the condenser and above the water level in the condenser.

4. In a paper making machine as defined in claim 1, and said condenser including an interior chamber for cooling water, feed and return pipes for cooling water communicating with the chamber and said chamber having extending therethrough flues for the circulation of steam therethrough for cooling and condensing said steam.

5. In a paper making machine as defined in claim 2, and means connecting the primary steam header with the secondary steam header and said connection having interposed therein a pressure differential unit of the same value as the pressure differential units in the syphons.

6. In a paper making machine, a battery of cylindrical dryers over which a paper web is fed, including a primary section and a secondary section means for circulating steam through the dryers of the primary section including a header for steam, means connecting all of the dryers of the primary section with the header, and a steam supply

pipe for the primary header, a primary condensate header, means connecting all of the dryers of the primary section with the condensate header including a syphon for each dryer having communication with the condensate header, a secondary steam header for the secondary section having direct communication with the primary condensate header, means connecting the secondary steam header with the dryers of the secondary section, a secondary condensate header, a syphon for each dryer of the secondary section having communication with the secondary condensate header, pressure differential valves in said syphons for the primary and secondary sections of the same value for maintaining a fixed predetermined pressure across each dryer, means for removing condensate from the primary and secondary headers and means for controlling the rate of flow of steam to the dryers relative to the demand including a pressure balanced diaphragm control valve in the steam supply pipe, means connecting the steam supply pipe with the control valve on one side of its diaphragm, a conduit for compressed air having communication with the control valve below the lower face of its diaphragm, a pilot including a recording chart and pressure adjusting valve in said conduit, and a by-pass line connecting the secondary condensate header with the connection of the steam line with the control valve and said by-pass line having incorporated therein a pressure differential unit of a predetermined value.

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