Sept. 13, 1960 R. F. HOLLIS 2,952,297

CORRUGATOR STEAM SYSTEM

Filed May 23, 1957 3 Sheets-Sheet 1

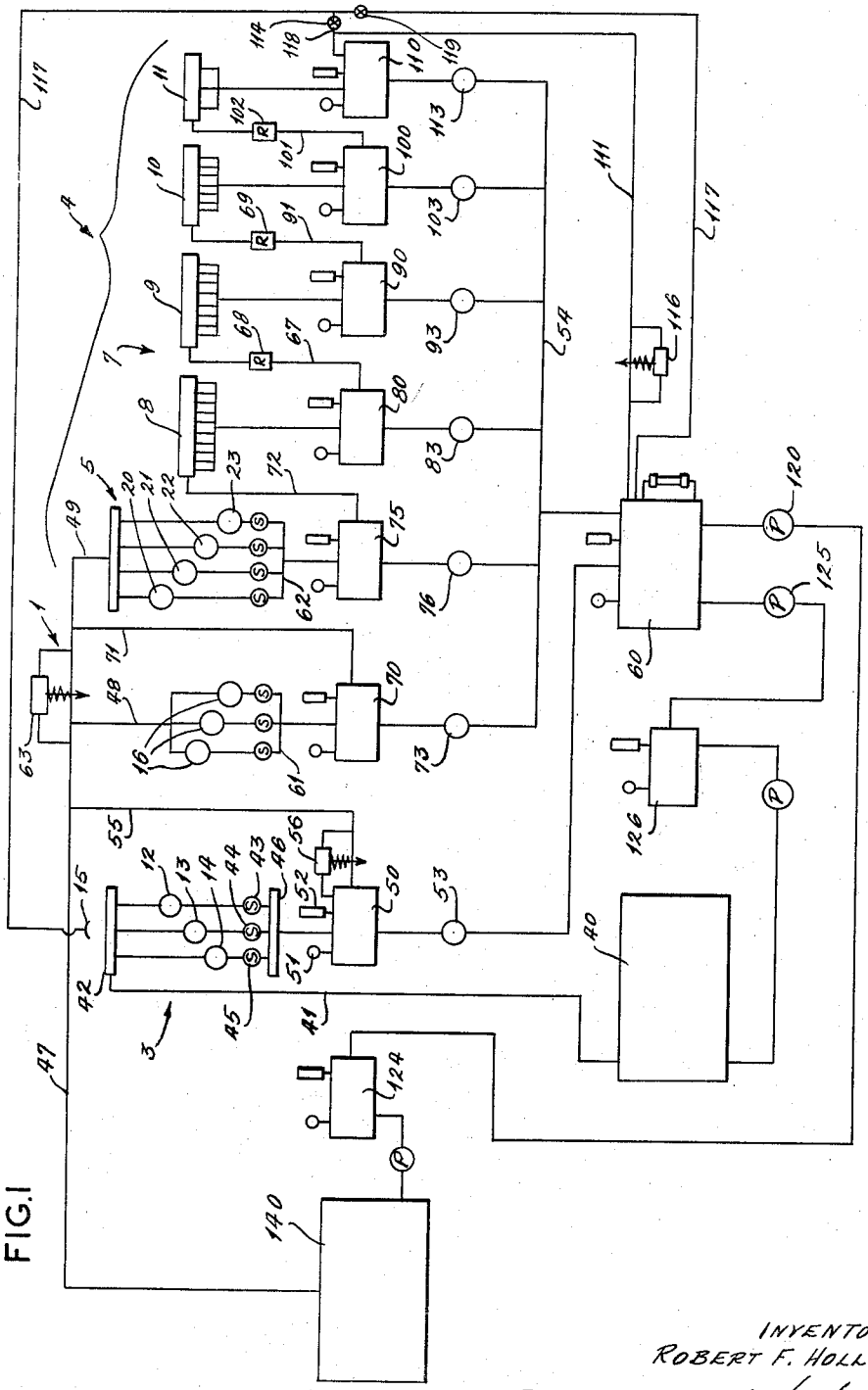


FIG. 1

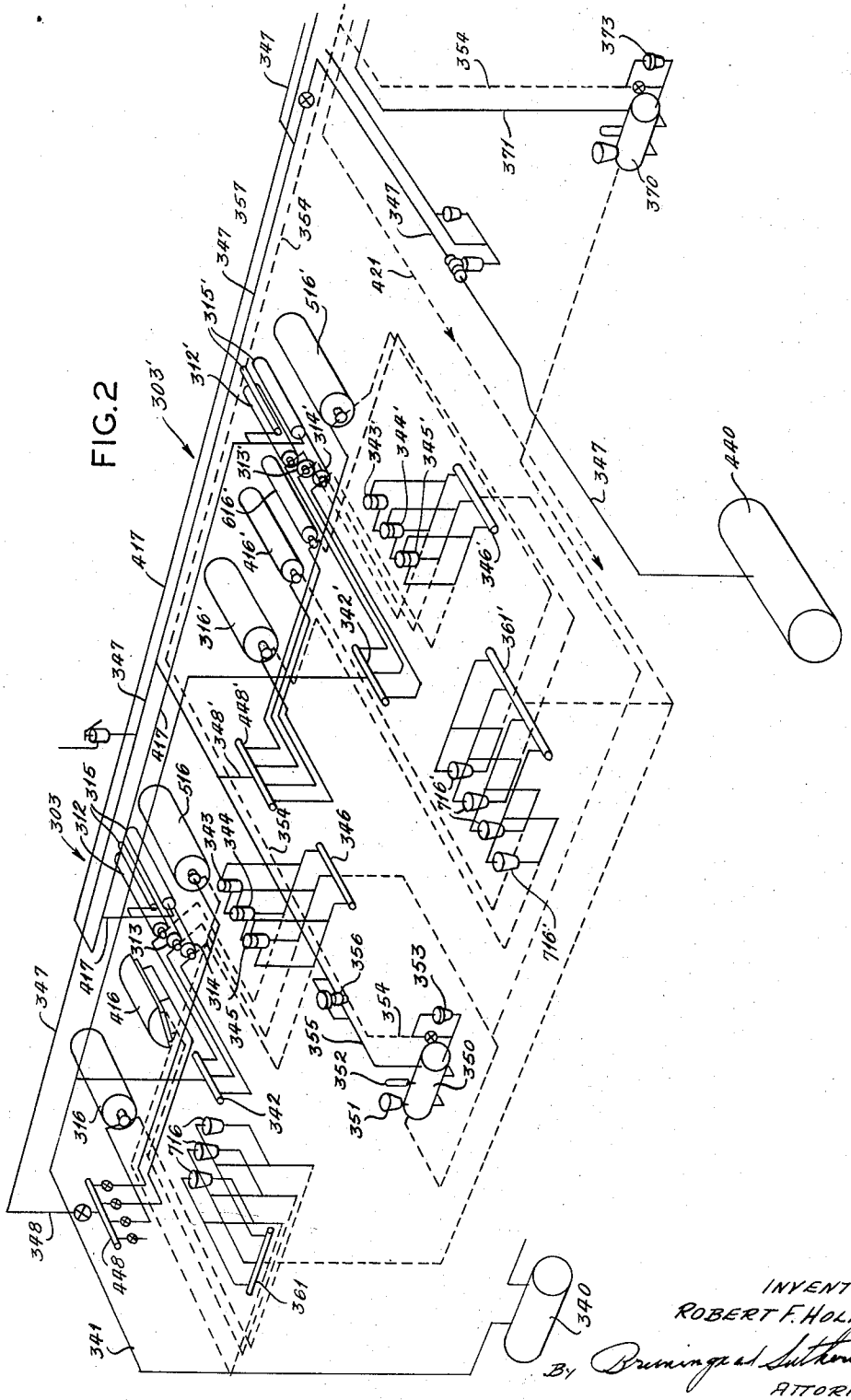
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CORRUGATOR STEAM SYSTEM

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FIG. 2



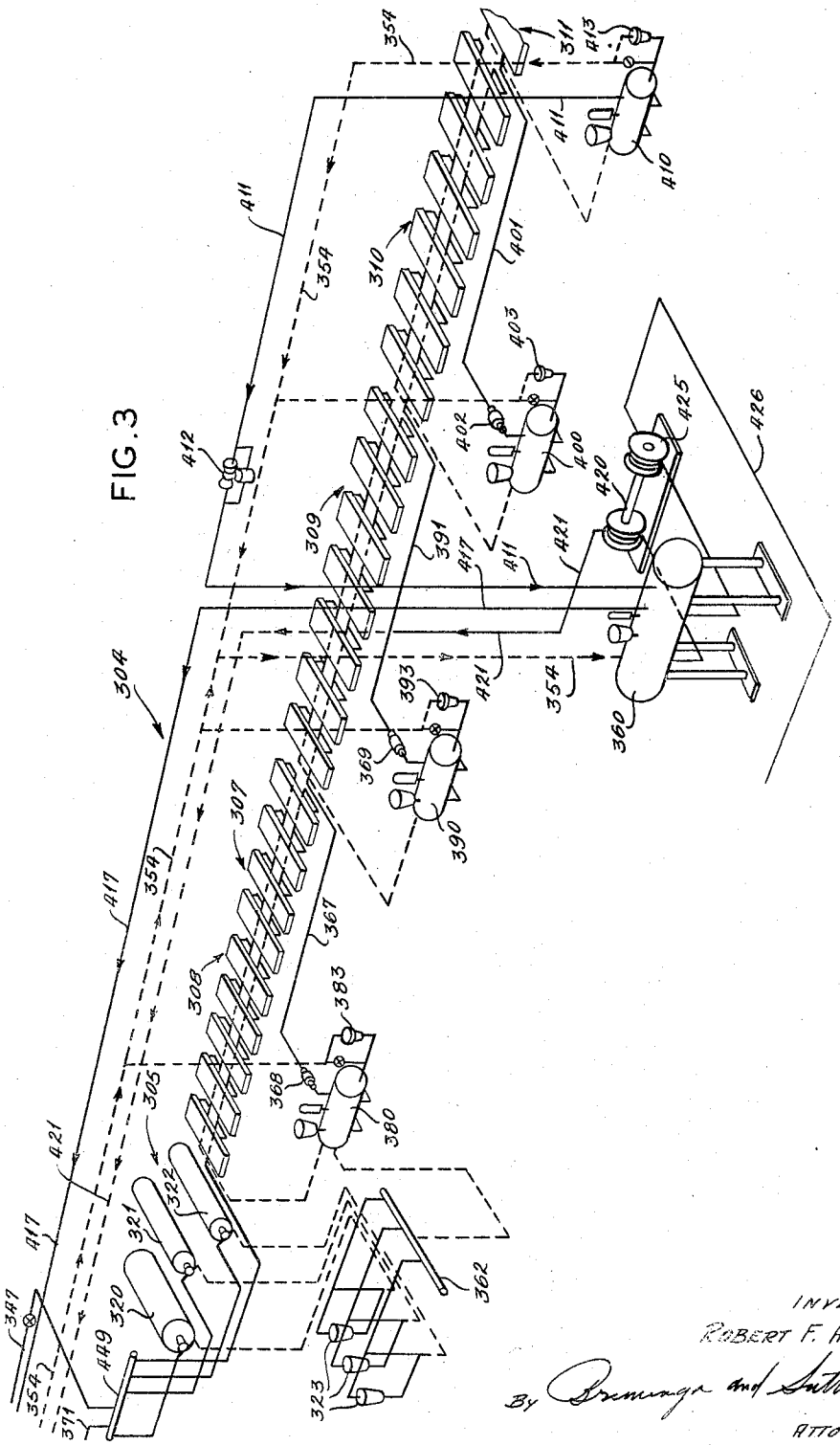
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CORRUGATOR STEAM SYSTEM

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FIG. 3



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2,952,297

CORRUGATOR STEAM SYSTEM

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Filed May 23, 1957, Ser. No. 661,076

4 Claims. (Cl. 154—33.05)

This invention relates to the corrugation of paperboard, and in particular to a steam system for a corrugating unit.

It has been common practice heretofore to supply steam direct to steam showers, preheaters, glue stations and double facers at pressures in the range of about 125 to 200 pounds per square inch gauge (p.s.i.g.), which produces a temperature of less than 400° F. in the corrugator rolls. At pressures less than 125 p.s.i.g., the double facer oven plates have functioned imperfectly or not at all, as a practical matter. It has also been considered desirable from the point of view of steam economy to use a minimum of steam in excess of the condensation load so as to prevent the return to the boiler through the condensate return line of uncondensed steam with consequential slamming and pounding of these lines. As corrugating speeds have increased, the problems of obtaining high heat efficiency and nicety of control have increased. To a large extent, the two problems have been antithetical.

One of the objects of this invention is to provide a steam system for a corrugating unit which admits of more exact control and which is more uniformly efficient than steam systems known heretofore.

Other objects will become apparent to those skilled in the art in the light of the following disclosure and accompanying drawing.

In accordance with this invention, generally stated, I have discovered that by sweeping a large excess of steam, over and above that required by the condensation load, through the various elements, by equipping the corrugator rolls and preheaters with restricters and traps, by venting traps and flash tanks to vent non-condensible gases at each major station so as to ensure removal of such gases at every stage in the unit, by returning the condensate to the boiler or boilers under pressure and at a correspondingly elevated temperature, by putting a plurality of oven plate sections in tandem and maintaining a substantial pressure differential between the last unit of the tandem series and the first unit so as to ensure a steady sweep of steam through the system, by using differential pressure orifices in steam lines between oven plate sections to maintain predetermined ranges of differential pressure between oven plate sections, and by eliminating all restrictions in the discharge lines from the oven plates of the double facer to flash tanks, the difficulties with the steam systems known heretofore can be eliminated with a considerable economy of steam and very quick response to control settings. This is an unexpected result in that the increased flow of steam and the thorough venting of the system would appear to entail the use of more steam than has been used heretofore in conventional systems.

I have also discovered that in using the system of my invention, far higher boiler pressures may be used than have been contemplated heretofore. The preferred range of steam pressure used in my system at the corrugator rolls, is 300 to 600 pounds, with a steam temperature of between 420° and 490° F. and a roll tooth temperature between approximately 415° and 480° F. although lower pressures have been successfully used. The steam pressure on the oven plates, on the other hand, may be as low as 30 pounds when light board is being run, with an adequate sweep of steam being maintained, and condensate continuously removed.

The arrangement of traps, flash tanks and differential valves is such as to permit accurate control of the temperature of the various elements.

In the drawing,

Figure 1 is a diagrammatic view of a steam system in accordance with one illustrative embodiment of this invention;

Figure 2 is a somewhat diagrammatic isometric view of the single facer units and boilers of a corrugator steam system in accordance with another illustrative embodiment of this invention; and

Figure 3 is a somewhat diagrammatic isometric view of the double facer portion of the steam corrugator system shown in Figure 2.

Referring now to Figure 1 of the drawing, a diagrammatic view of one illustrative embodiment of this invention, reference number **1** indicates a corrugator made up of one single facer **3** and a double facer **4**. The double facer **4** has a glue station **5** and an oven **7**. The oven **7** is made up of a series of steam chest or plates which by way of illustration are divided into a first unit **8** of ten chests, a second unit **9** of eight chests, a third unit **10** of seven chests, and a fourth unit **11** of three chests.

The glue station **5** is provided with a single face board preheater **20**, and liner preheaters **21**, **22** and **23**.

The single facer **3** has an upper corrugator roll **12**, a lower corrugator roll **13**, a pressure roll **14** and an open shower **15**. The single facer **3** also has the usual preheaters, indicated at **16**.

In the illustrative embodiment shown, two boilers are used, a main boiler **140**, and a high pressure boiler **40**. The high pressure boiler **40** supplies steam through a line **41** to a first steam supply header **42**, at from 300 to 600 p.s.i.g. The first supply header **42** is connected by steam lines to the upper corrugator roll **12**, the lower corrugator roll **13**, and the pressure roll **14** of the single facer **3**. The steam is discharged from the rolls **12**, **13** and **14** through adjustable regulators ("Stickles" orifices) **43**, **44** and **45** respectively, thence to a first discharge header **46** connected through a pipe with a first flash tank **50**. The "flash tanks" referred to herein are in the nature of steam separators. The first flash tank **50** is equipped with a non-condensible gas vent **51**, and a thermometer **52**. The condensate in the flash tank **50** passes through a blast trap **53** into a condensate return pipe to a final receiver **60**. The steam from the flash tank **50** passes through a line **55**, through a differential controller **56**, to a main steam line **47** from the main boiler **140**. The pressure in the line **47** is normally not more than about 200 p.s.i.g.

From the main steam line **47**, the steam flows through a line **48** to the preheaters **16** and through a line **49** and header, to the preheaters **20**, **21**, **22** and **23**. A differential controller **63** is positioned in the line **47** between the lines **48** and **49**. Each of the preheaters is trapped individually with blast traps. From the blast traps, the steam and condensate from preheaters **16** pass, to a discharge header **61**, and from preheaters **20**, **21**, **22** and **23** to a discharge header **62**. From the discharge header **61** the steam and condensate pass to a second flash tank **70**, which is also equipped with a non-condensible gas vent and a thermometer. From the discharge header **62**, the steam and condensate pass to a third flash tank **75**.

The condensate from the second flash tank **70** passes through a blast trap **73**, through a condensate return pipe **54**, to the final receiver **60**. The steam flashing in flash tank **70**, and that uncondensed steam which passes through the preheaters **16** to the flash tank **70**, passes, through a line **71**, to the main steam line **47**, on the same side of the differential controller **63** as the line **49**.

The condensate from the third flash tank **75** passes through a blast trap **76** to the condensate line **54**, thence to the final receiver **60**. The steam flashing in flash tank **75**, and that uncondensed steam which passes through the preheaters **20**, **21**, **22** and **23**, passes, through a line **72**, to the first unit **8** of the oven **7**, which unit consists of ten steam chests connected in parallel. The chests are connected to discharge to a common line through which the steam and condensate pass to a fourth flash tank **80**. It is to be noted that there are no restrictors in the lines from the chests to the flash tank **80**. The condensate in the fourth flash tank **80** passes through a blast trap **83** to the common condensate return line **54**, thence to the final receiver **60**. The steam which flashes in the fourth flash tank **80** and the uncondensed steam which passes through the chests of the section **8**, pass through a line **67**, in which there is a restrictor **68**, from the flash tank **80** to the next section **9** of eight chests, which are also connected in parallel with one another. The steam and condensate from the chests of section **9** pass unrestrictedly through a common line to a fifth flash tank **90**. The condensate from the fifth flash tank **90** passes through a blast trap **93** to the common condensate return line **54**, thence to the final receiver **60**. The steam which flashes in the flash tank **90** and the uncondensed steam which passes through the chests of section **9** pass from the flash tank **90** through a line **91**, in which there is a restrictor **69**, to the third section **10** of seven chests connected in parallel. The steam and condensate from the chests of section **10** pass unrestrictedly through a common line to a sixth flash tank **100**. The condensate from the sixth flash tank **100** passes through a blast trap **103** to the common condensate return line **54**, thence to the final receiver **60**.

The steam which flashes in the flash tank **100** and the uncondensed steam which passes through the chests of section **10** passes through a line **101**, in which there is a restrictor **102**, to the fourth section **11** of three chests connected in parallel. The steam and condensate from the chests of section **11** pass unrestrictedly through a common line to a seventh flash tank **110**. The condensate from the seventh flash tank **110** passes through a blast trap **113** to the common condensate line **54**, thence to the final receiver **60**. The steam which flashes in the flash tank **110** and the uncondensed steam which passes through the chests of section **11** passes through a line **111** to the final receiver **60**. A differential controller **116** is positioned in the line **111**.

From the final receiver **60**, uncondensed steam from flash tank **110** and steam which flashes in the receiver is delivered to the shower **15** through a line **117**. A by-pass line **118** from the flash tank **110** to the line **117** is arranged, with valves **114** and **119**, to enable steam to be sent to the shower **15** directly from the flash tank **110**.

The condensate from the final receiver **60** is pumped to a feedwater tank for the two boilers, a pump **120** pumping to a feedwater tank **124** of the main boiler **140**, and a pump **125** pumping to a feedwater tank **126** of the high pressure boiler **40**.

Each of the blast traps **53**, **73**, **76**, **83**, **93**, **103** and **113** is provided with an internal check valve. Each of the flash tanks **50**, **70**, **75**, **80**, **90**, **100** and **110**, the final receiver **60**, and the feed water tanks **124** and **126**, is equipped with a non-condensible gas vent and a thermometer.

Each of the differential pressure controllers **56**, **63** and **116** should be precisely calibrated and regulatable, in order to realize the full benefit of the system of this invention. In steam systems known heretofore, the steam pressures have been practically unregulable within wide limits, and simple spring-loaded differential valves have been sufficient. With the present system, accurately regulated differential valves, controlled by air pressure or the like, can and must be used to give the nicety of control to which the system is capable of responding.

There are no traps or restrictors in any of the discharge lines from the chests in the sections **8**, **9**, **10** and **11**, the steam passing freely through the chest to the flash tanks.

In the operation of the embodiment of corrugating system shown in Figure 1, steam is supplied from the high pressure boiler **40** to the corrugator rolls **12**, **13** and **14** of the single facer **3**, at from 300 to 600 p.s.i.g., going in to the header. The flow of steam through the corrugator rolls of the single facer **3** is regulated by the adjustable orifices **43**, **44**, and **45**. Since the steam and condensate from the corrugator rolls goes to the flash tank **50**, and since the flash tank **50** is connected through the differential controller **55** to the steam line **47** in which the pressure is on the order of 200 p.s.i.g., and to the final receiver **60**, which is at even lower pressure than the steam line **47**, a copious flow of steam is maintained through the single facer rolls. The differential controller **63** in the main steam line **47** between the line **48**, leading to the preheaters for the single facer, and the line **49**, leading to the glue station preheaters, provides a sufficient differential to permit steady flow of steam from the flash tank **70** to the steam line **47** between the differential controller **63** and the line **49**.

The steam and condensate from the glue station preheater rolls **20**, **21**, **22** and **23** goes to the flash tank **75**. The steam from the flash tank **75** goes directly to the first section **8** of the oven **7**. The ten chests of the first section **8** are connected in parallel, and their discharge lines are connected to a common header from which the steam and condensate pass without restriction to the flash tank **80**. It is to be noted that there is no restriction in the steam line between the flash tank **75** and the flash tank **80**. The steam from the flash tank **75** thus sweeps through the first section **8** and into the flash tank **80** without restriction. In the line **67** between the flash tank **80** and the second section **9** of the oven **7**, in which there are eight chests, there is a restrictor **68**. This restrictor is preferably fixed. For example, if the line **67** is made up of 2½ inch pipe, the restrictor **68** may take the form of a short length of one inch pipe. Between the restrictor **68** and the flash tank **90** there are no restrictions in the system, so that the steam leaving the restrictor **68** makes an unrestricted sweep through the eight chests of the oven section **9**. The steam from the flash tank **90** passes through the line **91**, in which the second restrictor **69** is positioned, to the third section **10** of the oven **7**. The second restrictor **69** is also preferably fixed, and, if the line **91** is also of 2½ inch pipe, may take the form of a short length of ⅞ inch pipe. Between the restrictor **69** and the flash tank **100**, the steam sweeps unrestrictedly through the seven chests making up the third oven section. Another 2½ inch line **101** carries the steam which flashes from the flash tank **100** to the fourth section **11** of three chests. The restrictor **102** in the line **101** may take the form of a section of ¾ inch pipe. Between the restrictor **102** and the flash tank **110**, there is no other restriction. The restrictors **68**, **69** and **102** are designed to provide a differential between the chests of about four pounds, when no board is being processed. This differential arises from the flow of steam produced by the radiation losses from the chest and lines, even when the showers **15** are turned off. The restrictions produce a differential of 6 to 8 pounds when board is being processed.

The concept of placing restrictors in the steam lines

to the oven sections and no restriction in the discharge lines from the oven sections is a novel one, and the provision of such a system has several marked advantages. Since there is no restriction between the chests of a section and the flash tank associated with each chest section, the chests are swept clean of condensate. Since non-condensible gases are vented at each flash tank, the steam going to each successive section has been freshly purged of non-condensible gases and such gases are neither accumulated in the system nor blocked in the chests by restrictors in the discharge lines. An important consequence of putting restrictors in the steam supply lines immediately between the flash tanks and the chest sections, is a slight superheating of the steam immediately before it reaches the chests. This comes about because there is a drop in pressure at a constant total heat or enthalpy at this point. This superheating assists in preventing water logging, or slamming in the pipe system.

As a result of this system of restricting the discharge of the high pressure corrugator rolls, so that the supply of steam to the oven system is not totally uncontrolled, and the elimination of restriction on the discharge side of the oven sections and the restriction of the steam supply lines to oven sections, and of the venting of non-condensible gases at the discharge side of each major station, and each oven section, steam pressures as low as 30 p.s.i.g. at the last section have successfully been used with the system of this invention. This is to be compared with minimum pressures of around 125 p.s.i.g. in commercial systems known heretofore. In practice, the system of this invention has maintained the entire corrugator in ready condition, with the various rolls and chests in immediate condition to produce corrugated board, with the showers **15** cut off entirely. A further advantage lies in the rapidity with which the corrugator can be brought to operative condition after a shutdown. This is accomplished by the rapid flow of steam through the system and by the numerous non-condensible gas vents.

In Figures 2 and 3, a somewhat diagrammatic isometric view is shown of an embodiment of steam system of this invention which differs in some respects from the embodiment shown in Figure 1, but which operates in substantially the same way. In this embodiment, as far as possible, the elements corresponding to elements of the embodiment shown in Figure 1 will be given the same reference numbers increased by 300.

In the embodiment shown in Figures 2 and 3, two single facers **303** and **303'** are provided.

A double facer **304** has a glue station **305** and an oven **307**. The oven **307** is made up of a series of steam chests which, in this embodiment, are divided into a first unit **308** of nine chests, a second unit **309** of seven chests, a third unit **310** of six chests and a fourth unit **311** of three chests, only one of which, partly broken away, is shown.

The glue station **305** is provided with a single face board preheater **320** and linear preheaters **321** and **322**.

The single facers **303** and **303'**, are provided with upper corrugator rolls **312** and **312'**, lower corrugator rolls **313** and **313'** and pressure rolls **314** and **314'** respectively. The single facer **303** has a liner preheater **316**, a quadrant **416** and a medium preheater **516**. The single facer **303'** has a liner preheater **316'**, a second preheater **416'**, a third preheater **616'** and a medium preheater **516'**. The single facers **303** and **303'** are equipped with showers **315** and **315'** respectively.

Two boilers are used, a main boiler **440** and a high pressure boiler, which may be a so-called Bessler boiler, **340**. The high pressure boiler **340** supplies steam through a high pressure line **341** to the single facer rolls **312, 313, 314, 312', 313'**, and **314'** through high pressure headers **342** and **342'**, respectively. Discharge lines from the single facer rolls lead to Stickles orifices **343, 344** and **345, 343', 344'**, and **345'**, respectively, thence to discharge headers **346** and **346'**. From the discharge headers **346** and **346'** the steam and condensate are piped to a flash tank **350**. The flash tank **350** is equipped with a non-condensible gas vent **351** and a thermometer **352**. The condensate from the flash tank **350** passes through a blast trap **353** to a common return line **354** which leads to a final receiver **360**. The steam from the flash tank **350** passes through a line **355**, through a differential controller **356** to a main steam line **347**, leading from the main boiler **440**.

A line **348** leads from the main steam line **347** to a header **448**, from which steam is supplied to the preheater **316, 416** and **516** of the single facer station **303**. A line **348'** leads from the line **355**, between the differential controllers **356** and the main steam line **347**, to a header **448'**, from which steam is supplied to the preheaters **316', 416', 516'** and **616'** of the single facer station **303'**.

Steam and condensate from the preheaters **316, 416** and **516** pass through discharge lines to individual blast traps **716**. Steam and condensate from the preheaters **316', 416', 516'** and **616'** pass through discharge lines to individual blast traps **716'**. The separate blast traps **716** and **716'** discharge into common headers **361** and **361'**, respectively, which in turn are connected with a second flash tank **370**, which is also equipped with a non-condensible gas vent and a thermometer.

The condensate from the second flash tank **370** passes through a blast trap **373** to the common condensate return line **354**. The steam from flash tank **370** passes through a line **371** to a gluer header **449**, which is also connected to the main steam line **347**, in which there is a valve, so that the supplemental steam can be supplied from the main steam line **347**, and the system can be brought to operating condition more quickly after a shutdown. Steam lines from the header **449** supply the preheater rolls **320, 321** and **322**. In addition, a line from the header **449** runs directly to the first section **308** of the oven **307**. Discharge lines from the preheaters **320, 321** and **322** lead to blast traps **323**, which discharge into a common discharge header **362**.

As shown in Figure 3, the chests of each oven section are connected in parallel both to their steam supply lines and their discharge lines. The discharge line from the first oven section **308** leads to a third flash tank **380**. The header **362**, in this embodiment, also is connected to discharge to the flash tank **380**. The flash tank **380** is equipped with a non-condensible gas vent and a thermometer. The condensate from the flash tank **380** is discharged through a blast trap **383** to the common condensate line **354**. The steam from the flash tank **380** passes through a line **367** in which there is a restrictor **368**, to the second section **309** of the oven **307**. The chests of the section **309** discharge into a common line connected to a flash tank **390**. The condensate from the flash tank **390** passes through a blast trap **393** to the common condensate return line **354**. The steam from the flash tank **390** is conducted through a line **391**, in which there is a restrictor **369**, to the third oven section **310**. From the third oven section **310**, the steam and condensate pass through a discharge line to a fifth flash tank **400**. Condensate from the flash tank **400**, passes through a blast trap **403** to the common condensate return line **354**. The steam from the flash tank **400** is conducted through a line **401** in which there is a restrictor **402**, to the fourth oven section **311**. Steam and condensate from the fourth oven section **311** pass through a discharge pipe to a final flash tank **410**. Condensate from the flash tank **410** passes through a blast trap **413** to the condensate return line **354**. Steam from the flash tank **410** passes through a line **411** to the final receiver **360**. A differential controller **412** is in the line **411** between the final flash tank **410** and the final receiver **360**.

As indicated on the drawing, each of the flash tanks

and final receiver is equipped with a non-condensible gas vent and thermometer.

A high pressure boiler condensate return pump **425** is connected in a line **426** between the final receiver **360** and a feed water tank for the high pressure boiler **340**. A main boiler condensate return pump **420** is in a line **421** between the final receiver **360** and a feed water tank for the main boiler **440**.

The operation of the embodiment shown in Figures 2 and 3 is substantially the same as that described in the system shown in Figure 1. The chief differences in the systems lie in the supplying of steam from the header **449**, in parallel to the glue station preheaters and the first chest section of the oven, and the discharge of the glue station preheater rolls to the flash tank from which steam is lead to the second oven section. There is, in this embodiment, no provision for sending steam from the final flash tank direct to the showers. The shower steam is supplied from the final receiver **360** through a shower line **417** from the final receiver **360**.

It can be seen that the system of this invention provides numerous advantages over the systems known heretofore. High corrugator roll temperatures can be maintained, but the flow of steam through these rolls to the main steam line can be accurately controlled by adjusting the orifices in their discharge lines. Relatively low pressure steam may be used on the oven sections with relatively high efficiencies, as compared with systems known heretofore, because of the purging of the non-condensible gases from the system at each station, the unrestricted sweeping of the steam through the chests to the flash tank associated with each section, and the super-heating of the steam by means of the restrictors in the steam supply lines.

While a two-boiler system is illustrated, a single boiler may be used, with suitable differential pressure valves. The system of this invention can be operated with low pressure steam at the single facer, but the use of high pressure steam permits high speed operation.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. In a corrugator steam system in which board passes successively through a single facer having corrugator rolls and a double facer having an oven made up of a multiplicity of team chests, wherein steam is supplied to the corrugator rolls and steam chests, the improvement comprising dividing the said steam chests into a multiplicity of sections, said sections being connected to a steam supply in series with one another, a discharge line from the first section of the series running directly, without intermediate restriction, to a flash tank, a steam line from said flash tank to the second section of the series, said steam line having a restrictor in it whereby a pressure drop is produced in the said steam line between the flash tank and the second section, said second section and each succeeding section having a discharge line running directly, without intermediate restriction, to a flash tank and each of said flash tanks except the final one having a steam line to the next succeeding section, each of said steam lines having a restriction in it.

2. In a corrugator steam system in which board passes successively through a single facer having preheaters and corrugator rolls and a double facer having preheaters and an oven made up of a multiplicity of steam chests, wherein steam is supplied to the corrugator and preheater rolls and steam chests through steam lines, and condensate and uncondensed steam is discharged from them through discharge lines, the improvement comprising dividing the steam chests into a multiplicity of sections, said sections being connected in series with one another to a steam supply, providing restriction in the discharge lines from the corrugator rolls and preheaters, said discharge lines being connected to flash tanks and said flash tanks being connected by steam lines to the steam supply to the oven steam chests; providing no restrictions in the discharge lines from the oven steam chest section to a flash tank associated with each section, and providing a restriction in the steam supply line between each successive chest section.

3. In the process of corrugating paperboard, wherein board is run successively through a single facer having preheaters and a double facer having preheaters and an oven having a multiplicity of steam chests divided into a multiplicity of sections connected in series, wherein steam is supplied to the preheaters and corrugator rolls and condensate and uncondensed steam is discharged from the preheaters and corrugator rolls to flash tanks, steam from said flash tanks is supplied to the oven sections and each oven section is connected to discharge to a flash tank, the improvement comprising restricting the discharge from the preheaters and corrugator rolls to the flash tanks, sweeping the steam unrestrictedly through the oven chests of each section to its flash tank, and restricting the flow of steam in the steam supply lines between successive oven sections.

4. In the process of corrugating paperboard, wherein board is run successively through a single facer having preheaters and a double facer having preheaters and an oven having a multiplicity of steam chests divided into a multiplicity of sections connected in series, wherein steam is supplied to the preheaters and corrugator rolls and condensate and uncondensed steam is discharged from the preheaters and corrugator rolls to flash tanks, steam from said flash tanks is supplied to the oven sections and each oven section is connected to discharge to a flash tank, the improvement comprising restricting the discharge from the preheaters and corrugator rolls to the flash tanks, sweeping the steam unrestrictedy through the oven chests of each section to its flash tank, restricting the flow of steam in the steam supply lines between successive oven sections, and venting non-condensible gases from each flash tank in the system.

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