Aug. 13, 1974 NISIKI HAYASI ET AL 3,829,338

DOUBLE FACER MACHINE HEAT CONTROL

Filed June 14, 1972 2 Sheets-Sheet 1

FIG. 1

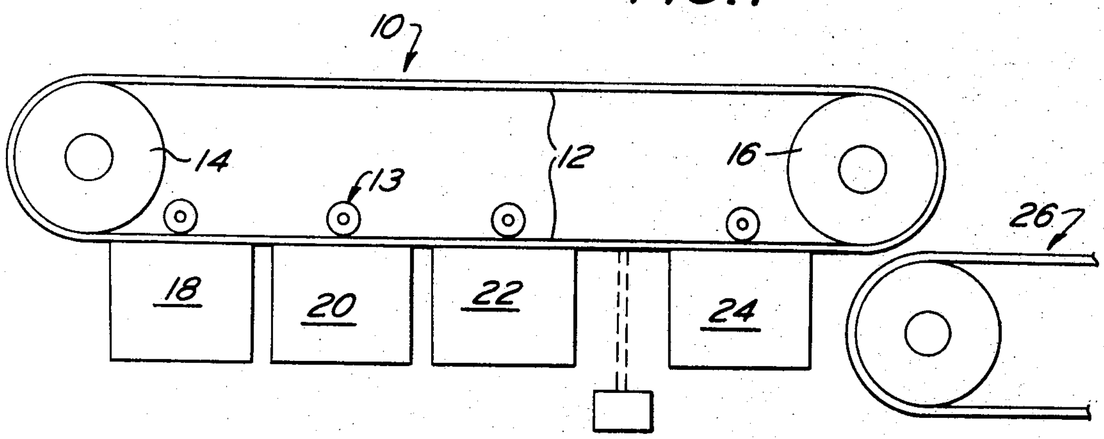
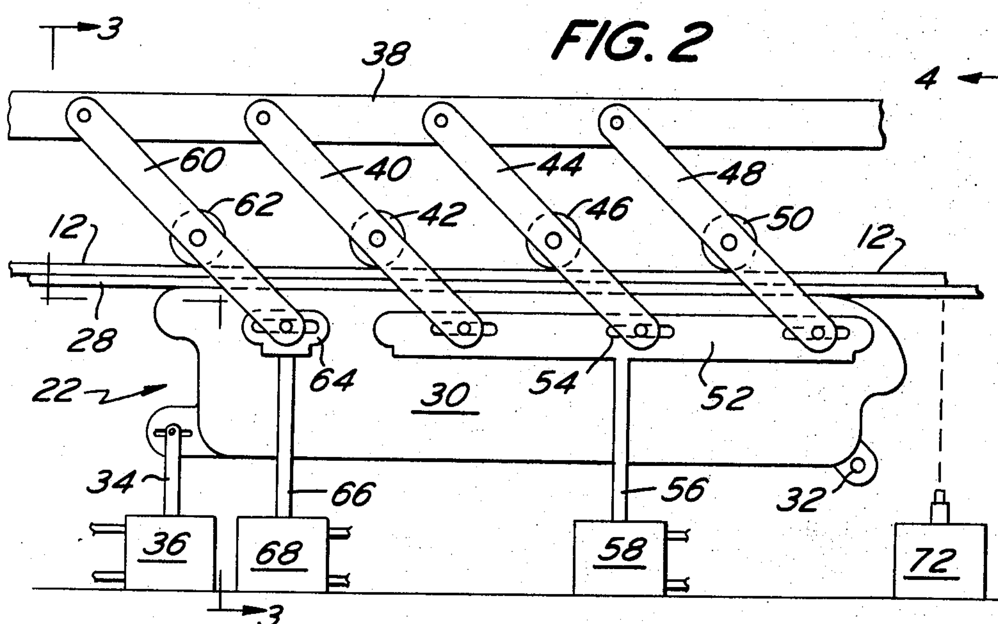


FIG. 2



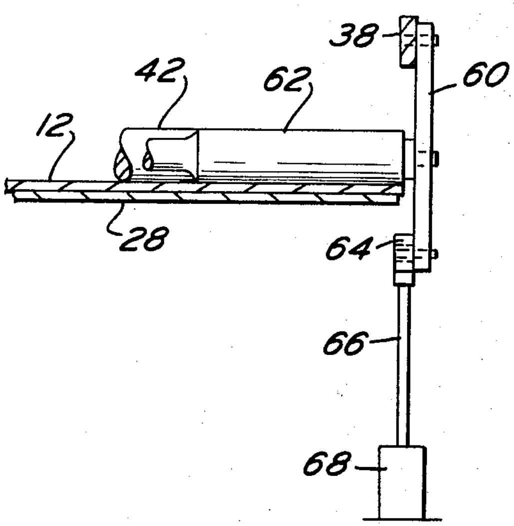


FIG. 3

DOUBLE FACER MACHINE HEAT CONTROL

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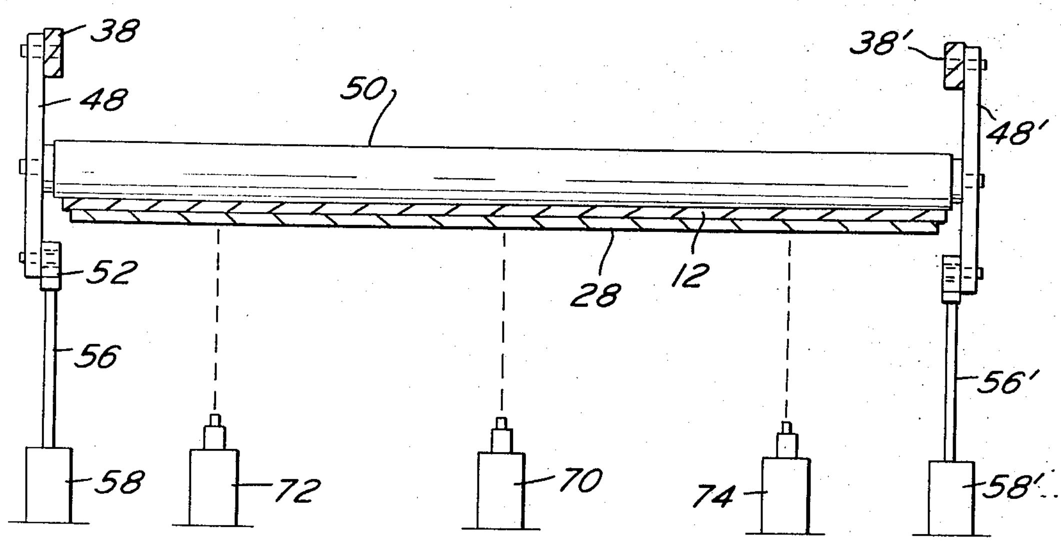
FIG. 4



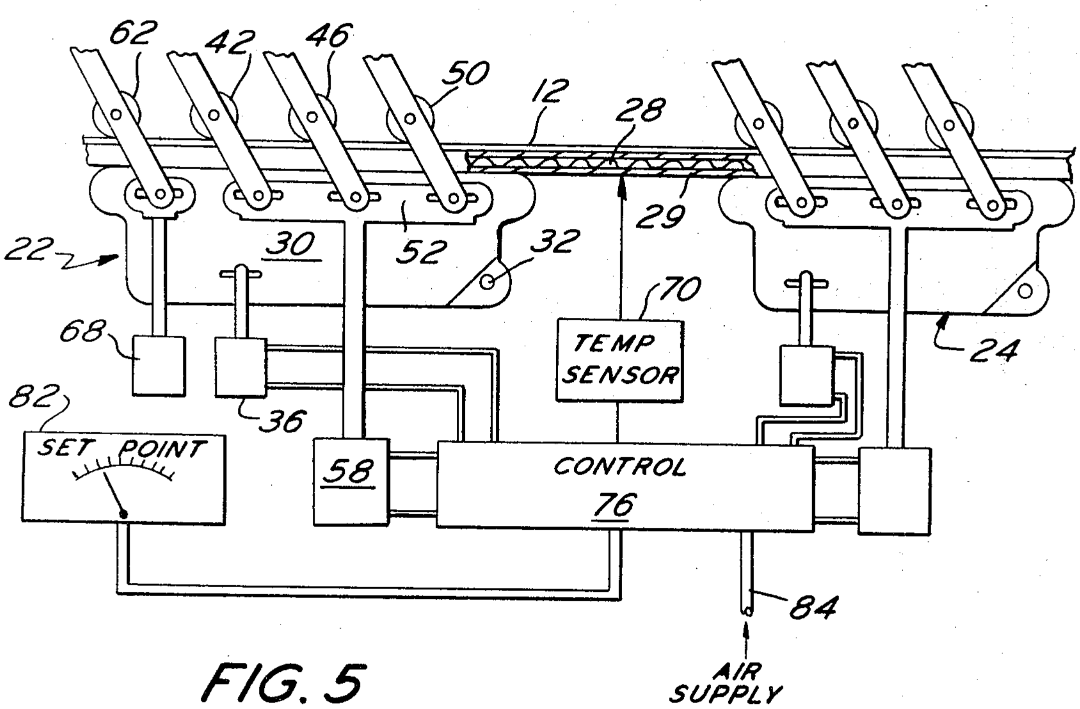


FIG. 5

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DOUBLE FACER MACHINE HEAT CONTROL

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U.S. Cl. 156—64 7 Claims

ABSTRACT OF THE DISCLOSURE

The temperature of the liner on double-face paperboard is measured after said paperboard has been heated in the double facer machine, without physically touching the liner with a calibrated sensor. The temperature signal is converted to a signal which is fed to a comparator to effect a variation of heat transfer from the heat source at the double facer machine when the measured temperature deviates from a selected normal range.

DISCLOSURE

It is old in the art of a corrugated paperboard combiner or double facer machine heat control to provide means for varying heat transfer to the components of double-face board in response to the speed of the board through the machine. For example, see U.S. Pat. 2,941,573 dated June 21, 1960, wherein the heat source is moved toward and away from the corrugated board. Also, see U.S. Pat. 3,472,158 dated Oct. 14, 1969 wherein heat control is effected by varying the number of roller weights on the dobule-facer belt as a function of speed of the double-face board. Another approach suggested heretofore for controlling heat transfer at the double-facer machine is disclosed in U.S. Pat. 3,175,300 dated Mar. 30, 1965. In that patent, the temperature of the surface of the board is detected and heat transfer is controlled by introducing high pressure air between the paperboard and the source of heat.

It is desirable when combining corrugated board, particularly with starch base adhesives, that no more heat than that required to gelatinized starch or effect an adhesive bond and evaporate excess moisture be applied. An excess of heat could diminish the strength of the bond and may cause the board to warp by affecting the moisture balance of the board components. Even if the passage of the board through the double-facer machine is interrupted, the total amount of heat the board is allowed to absorb should not exceed a predetermined quantity. Likewise, during high speed operation, the heat absorbed by the components of the board should be equal to the heat absorbed by said components during low speed operation.

In accordance with the present invention, a set point temperature is selected to be the desired temperature of the double-face paperboard after the bond has been effected. The set point temperature chosen will normally be in a range of temperature and will vary with the type of equipment involved, the characteristics of the liner, the flute, the amount of preheating of the liner and web of single-face board, the adhesive characteristics, etc.

At suitable stations along the length of the double facer heater section, the temperature of the bottom liner is measured at one or more locations without physically touching the liner with the heat sensor. The temperature

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signal is then amplified and fed to a comparator control device. The comparator control device compares the liner temperature signal with the set point signal and produces a signal which is utilized to regulate the effective weight of or the number of ballast rollers engaging the lower run of the double-facer belt. In this manner, the amount of heat transferred to the double-face board is controlled so as to attain the optimum temperature to complete the adhesive bond and dry the board regardless of the speed of the board as it travels through the double-facer machine.

It is an object of the present invention to provide a double-facer machine having means to increase or decrease the heat transfer rate to the double-face paperboard in response to measured characteristics of the board liner.

It is another object of the present invention to provide apparatus and method for making double-face paperboard wherein the length of the double-facer heater section for effective heat transfer to the board is controlled as a function of the temperature of the board liner.

It is another object of the present invention to provide a double-facer machine wherein heat transferred to double-face paperboard is varied transversely across the width of the board in response to a measured condition of the board liner.

Other objects will appear hereinafter.

For the purpose of illustrating the invention, there is shown in the drawings a form which is presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

FIG. 1 is a schematic side elevation view of a double facer machine.

FIG. 2 is a side elevation view of one heating unit shown schematically in FIG. 1.

FIG. 3 is a sectional view taken along the line **3—3** in FIG. 2.

FIG. 4 is a sectional view taken along the line **4—4** in FIG. 2.

FIG. 5 is a schematic diagram illustrating circuitry for effecting heat control.

Referring to the drawing in detail, wherein like numerals indicate like elements, there is shown in FIG. 1 a double facer machine designated generally as **10.** The double facer machine **10** includes a conventional belt **12** extending around rollers **14** and **16.** The belt is weighted by ballast rollers schematically identified as **13.** The lower run of the belt **12** maintains a web of paperboard in intimate contact with a source of heat which is preferably a plurality of heat sources schematically identified by the numerals **18, 20, 22** and **24.** A typical double facer machine will have a greater number of discrete heat sources than shown. After being heated in the double facer machine **10,** the web of paperboard is directed to a conveyor **26** for subsequent operations including slitting, shearing, stacking, etc.

In FIG. 2, there is illustrated the details with respect to one of the heat sources illustrated in FIG. 1, namely the heat source **22.** All or some of the heat sources associated with the double-facer machine may be constructed as described hereinafter in conjunction with the heat source **22.**

The heat source **22** includes a source of heat such as a steam chest **30.** Steam chest **30** is adapted to be moved toward and away from the plane of the double-face paperboard **28** in a manner such as described in U.S. Pat. 2,941,573 dated June 21, 1960. Thus, in this regard, the steam chest **30** is mounted for pivotable movement about pin **32** at one end. The other end of the steam chest **30** is connected to one end of a piston rod **34** associated with a piston in cylinder **36**. The introduction of motive fluid such as pressurized air into the cylinder **36** causes the piston rod to move upwardly and downwardly to effect a pivotable movement of the steam chest **30**. If desired, the steam chest **30** may reciprocate vertically rather than pivot. In either event, the steam chest **30** is moved toward and away from the plane of the paperboard **28** to regulate heat transfer.

The frame of the double facer **10** includes a rail **38** along one side and a mating rail on the opposite side. The opposite sides of the double facer machine **10** are similiar. Hence, wherever applicable, only one side of the double facer machine **10** will be described in detail with the corresponding elements being illustrated in the drawing with corresponding primed numerals.

A lever arm **40** has one end pivotably connected to the rail **38**. Lever arm **40** rotatably supports a ballast roller **42** intermediate its ends. Lever arm **44** having ballast roller **46** and lever arm **48** having ballast roller **50** are similarly provided.

The lower end of the lever arms **40**, **44** and **48** are pivotably connected to a horizontally disposed manifold member **52** having elongated slots for receiving the pivot pin on the lever arms. Member **52** is connected to one end of a pison rod **56** which in turn is connected to a piston within cylinder **58**. The introduction of a motive fluid such as a pressurized air into the cylinder **58** causes member **52** to reciprocate vertically, exerting thereby greater or lesser perpendicular force on the lever arms **40**, **44** and **48**. Force applied to the lever arms **40**, **44** and **48** causes the rollers **42**, **46** and **50** to apply a greater or lesser pressure on the lower run of the belt **12**. A greater pressure on said belt lower run effects a higher heat transfer rate due to the more positive contact between the web of paperboard **28** and the steam chests or other heat sources, and vice versa. The rollers **42**, **46** and/or **50** may be raised completely out of contact with the belt lower run to further decrease heat transfer to the paperboard **28**.

In accordance with the present invention, the rollers **42**, **46** and **50** preferably have one of four different modes. In a first mode, the pressure applied to cylinder **58** maintains the member **52** at an elevation wherein the dead weight or weight of gravity of the rollers is applied to the belt **12**. In another mode of the rollers **42**, **46** and **50**, pressure is applied to cylinder **58** whereby the effective weight of the rollers is increased by an appropriate amount, such as approximately 50% to 200%, for the desired maximum heat transfer. In another mode of the rollers **42**, **46** and **50**, pressure is applied to the cylinder **58** to oppose some of the dead weight of the rollers such as 50% of their dead weight. In these three modes of the rollers **42**, **46** and **50**, they remain in contact with the belt **12**. In the fourth position, the rollers are lifted out of contact with the lower run of belt **12** for minimum heat transfer.

As the member **52** is moved upwardly or downwardly by the piston rod **56**, member **52** remains pivotably coupled to the lower ends of the lever arms **40**, **44** and **48**. In this regard, the pivot pin for each of said lever arms extends through a horizontally elongated slot **54** in member **52**. See FIG. 2.

The heat source **22** may have additional lever arms **60** pivotably connected at their upper end to the rail **38** on opposite sides of the double facer. A ballast roller **62** is supported in a central position on the lever arm **60**. See FIGS. 2 and 3. The periphery of roller **62** has one or more portions of reduced diameter so as to limit its effective length to a portion of the belt width such as one side edge portion thereof. The lower end of each lever arm **60** is pivotably connected to a coupling member **64** having an elongated horizontally disposed slot.

Member **64** is connected to the upper end of piston rod **66**. The lower end of piston rod **66** is connected to a piston within cylinder **68**. Motive fluid such as pressurized air may be introduced into cylinder **68** to raise or lower the roller **62** in the manner described above. However, the effective length of roller **62** is substantially less than that of the rollers **42**, **46** and **50** so that it only effects a portion such as a side edge portion of the paperboard **28**.

Referring to FIG. 4, is will be noted that a temperature sensing device **70** is positioned approximately intermediate the side edges of the paper board **28** for detecting the temperature of the liner **29** on the paperboard **28**. Similar temperature sensors **72** and **74** are provided for detecting the temperature of the liner adjacent the side edges of the paper board **28**. Each of the temperature sensors is of a non-contact type such as a commercially available infrared thermometer which generates an output voltage signal as a function of temperature.

Referring to the diagrammatic illustration in FIG. 5, it will be noted that the circuitry includes a comparator control device **76** connected to each of the temperature sensors. A set point device **82** is connected to the control device **76**. Pressurized air from a source such as a compressor is coupled to the control device **76** by way of conduit **84**. Control device **76** is a conventional comparator which balances voltages.

The control device **76** includes solenoid operated valves for controlling flow of pressurized air from conduit **84** to the various cylinders **36**, **58**, **68**, etc. Control device **76** separately compares the voltages from set point device **82** with the voltages from each of the temperature sensors. Actuation of the piston rod **66** in cylinder **68** to move roller **62** is responsive only to a comparison on the set point voltage and the voltage generated by temperature sensor **72**. Roller **62** controls heat transfer in a portion of the paperboard **28**. Sensor **74** is likewise coupled to device **76** for effecting operation of another cylinder comparable to cylinder **68** to raise or lower another roller like roller **62** which is effective only on another transverse portion of the paperboard **28**.

As the speed of the double-face paperboard **28** lessens, piston rod **34** associated with cylinder **36** must also be actuated to move the flat upper face of the steam chest **30** away from the plane of the double-face paperboard **28** to reduce heat transfer further. The signal for controlling the piston rod **34** in cylinder **36** is responsive to the comparison of the set point voltage and the voltage generated by temperature sensor **70**. As shown in FIG. 5, control device **76** may be coupled to the heat source **22** as well as the heat source **24** to effect similar action at the heat source **24**.

The set point device **82** must be manually adjusted by an operator to indicate the desired temperature on the paperboard **28**. Adjustment of device **82** may be effected merely by adjusting the length of a resistor in a Wheatstone bridge. A typical example of the present invention is as follows. Where a double-face paperboard **28** is a 26–26–26 weight board having a B-flute medium and is being combined on a Langston (trademark) double facer machine, the set point device **82** may be set at an appropriate temperature between 260° F. and 285° F. This automatically predetermines a deviation of about 10° F. Any time the temperature sensor detects a temperature of the liner **29** on the lower surface of the paperboard **28** which is outside the permissible range, the effective weight of the rollers will be increased or decreased and/or the steam chest will move away from the plane of the paperboard **28**. In this manner, the rate of heat transfer to the paperboard **28** will increase or decrease depending upon whether the measured temperature of the liner **29** is below or above the preset desired temperature range. As is well known, the temperature of the paperboard and its moisture content are interrelated. For example, a liner 29 was preheated prior to entering the double facer machine. If the liner 29 contains no free moisture, the liner 29 need only be subjected to heat along a small portion of the double facer machine 10. If the liner 29 has 3 percent moisture, it need only be subjected to heat for approximately one-half of the length of the heater section of the double facer machine 10. If the liner 29 has 6 percent moisture, it need be subjected to heat only during contact with approximately three-quarters of the length of the heater section of the double facer machine 10. If the liner 29 has 9 percent moisture, it need be subjected to heat for approximately the entire length of the heater section of the double facer machine 10.

This method of heat control is to be compared with prior art devices which attempt to effect a control of heat transfer as a function of speed or other relationships. By increasing the number of ballast rollers, such as that illustrated in FIG. 2, the effective heat transfer length of the double facer machine 10 may be decreased since the rate of heat transfer to the liner board 28 will be increased. On the basis of successful runs on a particular machine, and taking into consideration the variables described above, operating charts may be prepared for a particular production need whereby one or more heat sources can be out of service and at the same time uniform corrugated paperboard can be produced in the most efficient manner.

From the above description, it should be apparent that the heat to be transferred to the paperboard must be applied over a longer portion of the double facer machine 10 when the liner 29 has a high moisture content as compared with a liner 29 having a low moisture content. It is desired to use the entire length of the heating section of double facer machine 10 to effect heat transfer to the paperboard, regardless of the moisture content of the liner 29 to obtain the best thermal efficiency and to keep the board temperature within the prescribed values. In order that this may be accomplished, the rate of temperature rise of the liner 29 is detected by having sets of said sensors 70, 72, 74 at spaced locations along the length of the double facer machine 10.

When the detected temperature of the liner 29 is higher than the prescribed upper limit of temperature, one or more heat sources and/or their associated rollers may be moved to reduce heat transfer to the liner 29. This will cause the temperature of the liner 29 to fall. In this manner, the liner temperature may "hunt" in the preset temperature range whereby all moisture (except for residual moisture) will have been removed at or just prior to exit from the heating section of the double facer machine 10. As pointed out above, the adjustment of heat transfer rate to the liner may be accomplished across the width of the paperboard 28 or only within a narrow range zone.

The apparatus and method of the present invention more accurately transmits heat to the paperboard 28, prevents overheating of the paperboard 28, and provides for selective heating of portions or zones of the paperboard 28. While the web of paperboard 28 has been referred to as being double-face, heat transfer to other webs of paperboard such as double wall and triple wall board may be controlled in the same manner.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification as indicating the scope of the invention.

We claim:

1. A method of combining the components of double-face corrugated paperboard wherein a liner is bonded to the crest of flutes of a single-face web as the liner and single-face web are moved through a double facer machine having a heat source by an endless belt, and wherein heat from the source is transmitted to said components through said liner to effect a bond comprising the steps of:

(a) applying a bonding agent to one of the components of the paperboard,
(b) feeding the single-face web and the liner into the double-facer machine with the liner on the bottom and with rollers in contact with the lower run of the belt,
(c) measuring the temperature of the liner with a heat sensor therebelow and without physically touching the liner with said heat sensor,
(d) performing said measuring step at a location which is between the ends of the heat source so that the liner and bonding agent have been heated by that portion of the heat source upstream therefrom,
(e) generating a signal indicative of the liner temperature as measured by said heat sensor,
(f) generating a signal indicative of the desired temperature for the liner,
(g) comparing said signals and generating an output signal, and
(h) regulating the heat transferred to the liner by the heat source downstream from said location of said heat sensor by using said output signal to vary the effective weight of at least some of said rollers above or below the gravitational weight of said rollers.

2. A method in accordance with claim 1 including performing said measuring step at two different locations on said liner.

3. A method in accordance with claim 1 wherein said regulating step includes pivoting at least one roller upwardly away from the lower run of the belt in response to an output signal above a predetermined value.

4. Apparatus for controlling the transfer of heat to effect bonding of a liner to the crests of a web of single-face corrugated paperboard comprising:

(a) a double facer machine having a heat source for transmitting heat through the liner and adapted to be in contact with the liner,
(b) an endless belt parallel to said heat source for causing the liner and web to move along the heat source,
(c) ballast rollers biasing the lower run of said belt towards said heat source,
(d) means for measuring the temperature of the liner at a location intermediate the ends of the heat source and for generating a signal indicative thereof,
(e) means for introducing a set point signal,
(f) control means for comparing the liner temperature signal and the set point signal, and for generating an output signal as a function thereof,
(g) means for selectively increasing and decreasing the effective weight of said ballast rollers downstream from said location as a function of the output signal,
(h) whereby the temperature of the liner may be increased or decreased downstream from said location so that it may be maintained within a predetermined range.

5. Apparatus in accordance with claim 4 wherein some of said rollers have an effective length which is shorter than the transverse width of said belt lower run.

6. Apparatus in accordance with claim 4 including means interconnecting at least two adjacent rollers for simultaneous adjustment with respect to their effective weight.

7. Apparatus in accordance with claim 4 wherein said means for increasing and decreasing the effective weight of said rollers is operable to change the effective weight of said rollers between 0 and 200% of the weight of the rollers.

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U.S. Cl. X.R.

156—205, 210, 358, 359, 378, 462, 470, 583