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3,456,582

CROWNLESS ELECTROMAGNETIC PRESS ROLL LOADING

Filed Sept. 29, 1966

2 Sheets-Sheet 1

Fig-1

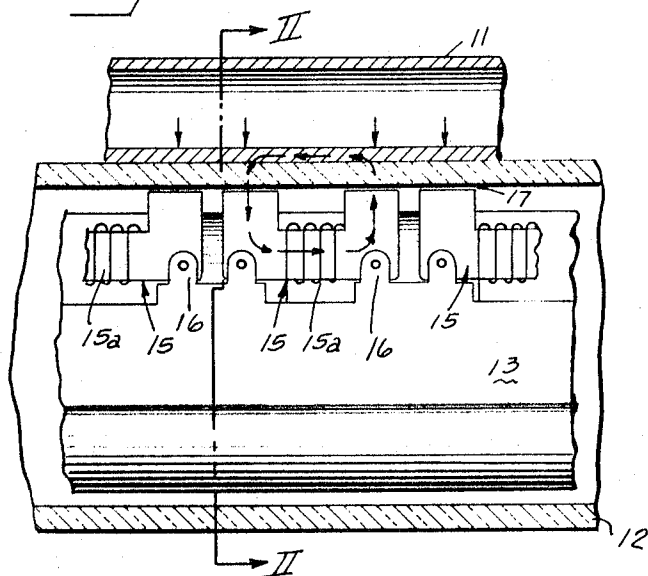


Fig-2

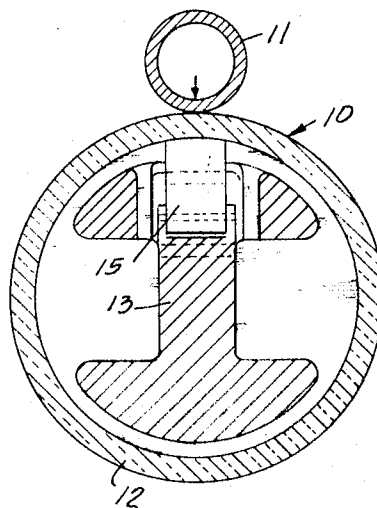


Fig-3

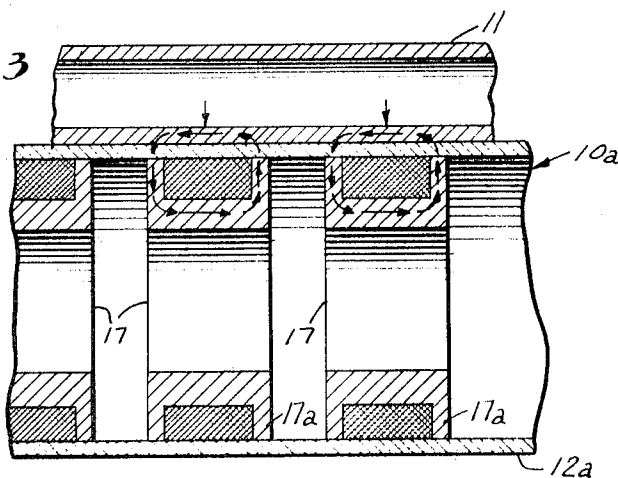
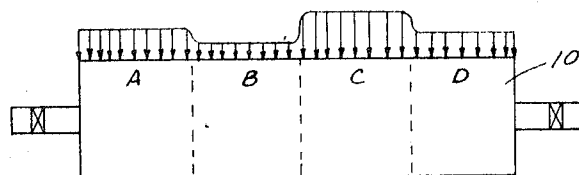


Fig-7

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Fig-4

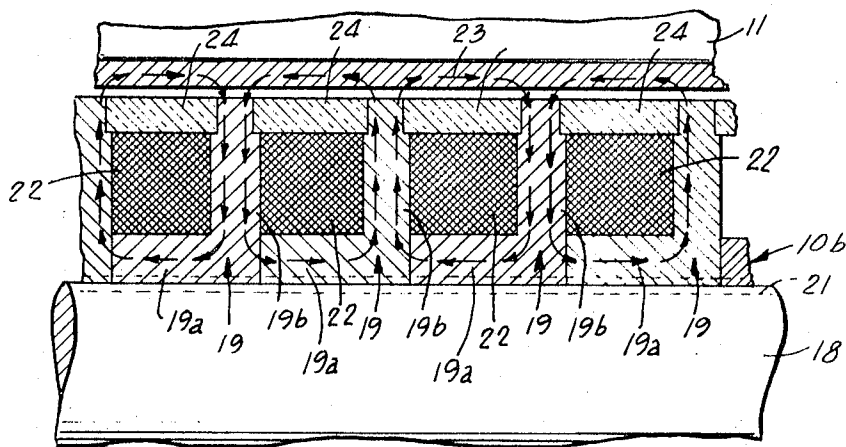


Fig-5

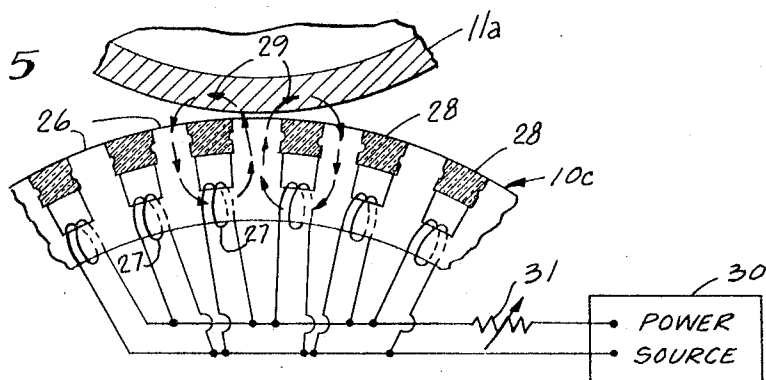
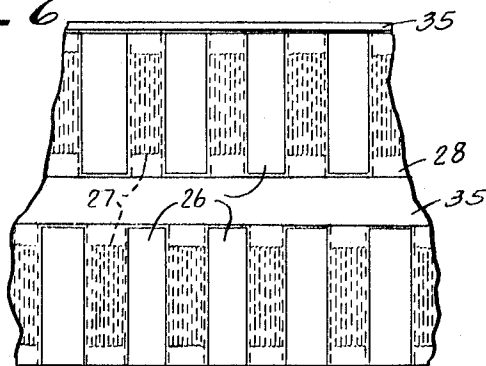


Fig-6



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CROWNLESS ELECTROMAGNETIC PRESS ROLL LOADING

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1 Claim

ABSTRACT OF THE DISCLOSURE

This invention is directed to a press roll having electromagnetic means, associated therewith to attract a second roll of magnetic material toward the press roll with a force proportional to the strength of the magnetic field. The electromagnetic coils within the press roll are so arranged so as to provide a variable force profile between the press roll and the roll of magnetic material.

This invention relates generally to pressure rollers and more particularly to pressure rollers of the type which can exert either a uniform pressure along the nip of the rollers or a continuously variable pressure along the nip of the rollers. The pressure rollers of the present invention have particular utility when used in conjunction with a paper making machine.

Many processing machines have rollers by means of which a relatively wide and flat portion of a web is advanced and simultaneously subjected in a continuous manner to a processing function which applies various degrees of pressure to the web. Depending upon the type of processing function to which the web is subjected, the rollers, henceforth will be designated as pressure rollers. Such pressure rollers may be in the form of a single roll which is in rotatable contact with a flat surface, or may be a pair of rollers which are urged together to press the web therebetween, as is the case with web squeezers of the paper making industry.

The arrangement of all such pressure rollers is primarily the same. In most instances both ends of each roller are journaled by pivots or shafts and are driven through one of the shafts or at a point on the outer circumference of the roll. With roller pairs, each roller may be driven individually or through the intervention of an intermediate transmission connected to the two rollers.

The pressing force which is exerted by the pressure rollers is exerted upon the end bearings which are displaced in lateral frame walls, for example by hydraulic fluid or by spring means, and is conveyed to the web through the nip region between the rollers. The transfer of pressure from the end support to the nip region of the rolls not only requires correspondingly large bearing supports due to the high occurring stresses, but also the rolls themselves must have a relatively large diameter in order to minimize deflection or bending at the center of the rolls. It is a well known fact that any deflection or bending will result in a nonuniform pressing of the web as it passes between the rolls. Such non-uniform pressure causes many difficulties and represents a problem well known in connection with pressure rollers of the paper making industry. In order to minimize deflection or bending of the pressure rolls, one solution is to make the rolls of solid material. This, however, requires a large amount of material which greatly increases the cost of such pressure rollers. Furthermore, it may be intended, by the use of the solid roll construction, to increase the weight of the roll in order to gain a more effective pressure.

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Furthermore, increasing the total weight of the roll will also increase the inertia thereof as well as increase the needed bearing capacity at the ends of the roll.

5 Crowning the roll surface will only provide a relatively narrow range of roll loading wherein uniform nip pressure is maintained across the roll face. With additional loading by magnetic means, as set forth in the present invention, the loading may be changed without changing the roll surface to maintain a uniform nip pressure across the roll face.

10 Therefore, one of the primary objects of the present invention is to provide pressure rolls which are relatively light weight and which rolls are capable of exerting a uniform pressure profile along the axial length thereof, and which rolls are relatively inexpensive to manufacture and highly efficient in operation.

Another object of the present invention is to provide a pair of pressure rolls especially for use in connection with the paper making industry, which will make it possible to considerably and safely reduce the weight of the pressure rolls and the end support means therefor.

Another object of the present invention is to provide pressure rolls, especially for the use in connection with the paper making industry, which will have a substantially reduced inertia.

25 Still another object of the invention is to provide pressure rolls having a variable pressure profile along the axial length of the nip, and the pressure exerted therebetween can be varied at different points along the length of the nip.

One of the primary advantages of the present invention is the use of a relatively small diameter nip roll which permits increased unit nip pressure without the use of heavy backing rolls, which are otherwise used to transmit loading forces through the pressure roll.

30 Still another object of the present invention is to provide pressure rollers which are heated as a function of their natural operation, to facilitate the removal of water from the web and thereby increase the efficiency of the paper making machine.

A feature of the present invention is the use of a variable magnetic field which passes from one roller into and through an adjacent roller which is constructed of material having magnetic properties.

45 Briefly, the present invention provides a roller having a plurality of electromagnets, and which magnets can rotate with the roller or remain stationary relative to an exterior rotatable shell. A second roller, of magnetic material, is positioned adjacent the roller having electromagnets and is attracted thereto by a magnetic field. The magnetic field generated within the roller can be varied along different axial points of the roller thereby applying a controllably variable pressure profile along the axial length of the roller. Not only can the nip pressure profile be variably controlled along the axial length of the roller, but the absolute magnitude of nip pressure may be controlled from "no" load to "maximum" load.

60 The invention, however, will be more fully realized by the novel structure of this invention and more fully understood from the following detailed description when taken in conjunction with the accompanying drawings in which like reference numerals throughout the various use of the drawings are intended to designate similar elements or components and wherein:

FIGURE 1 is an elevational sectional view of pressure rollers constructed in accordance with the principles of this invention;

70 FIGURE 2 is an elevational sectional view taken along the line II—II of FIGURE 1;

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FIGURE 3 is an elevational sectional view of an alternate embodiment of the present invention;

FIGURE 4 is still another alternate embodiment of the present invention;

FIGURE 5 is a further alternate embodiment of the present invention;

FIGURE 6 is a top plan view of the electromagnetic roller of FIGURE 5; and

FIGURE 7 is a diagrammatic representation of the electromagnetic pressure roller of the present invention showing a particular pressure profile.

As seen in FIGURE 1, a magnetic roller 10 is positioned for rotatable engagement with a second roller 11. The roller 11 is constructed of magnetic material, such as cast iron or steel. A rotatable hollow shell 12 forms the outer surface of the magnetic roller 10. A stationary core 13 is positioned within the shell 12 and concentric therewith. In this embodiment, the core 13 is preferably stationary and only the outer shell 12 is rotatable.

As seen in FIGURE 2, the core 13 has a cross section similar to an I beam. Although this configuration has been found advantageous, it will be understood that other types of core members can be used. A plurality of electromagnets 15 are secured to a plurality of brackets 16 of the core 13. The electromagnets 15 have U-shaped cores 15A with leg portions extending upwardly toward the roller 11. In one embodiment of the present invention, a gap 17 is provided between the extremity of the legs of the core 15A and the interior surface of the shell 12. Therefore, the shell 12 must be sufficiently rigid to support the squeezing force from the roller 11. Another embodiment of the present invention is one in which the extended leg portions of the cores 15A are slidably engaged with the interior surface of the shell 12 in such a manner as to support the shell 12, as seen in FIGURE 2.

By way of example, the magnetic field which is generated by the electromagnet 15, passes from one leg of the magnet 15 through the non-magnetic shell 12 and into the surface of the magnetic roller 11 which is adjacent the electromagnet 15. The magnetic field then passes through the roller 11 in a line substantially parallel to the axis thereof and then through the non-magnetic shell 12 into the other extended legs of the electromagnet 15. Therefore, the complete magnetic circuit for each electromagnet includes a portion of the roll 11. By increasing the magnetic field which is generated by each electromagnet 15, the roll 11 is attracted toward the surface of the shell 12 with increased force. Furthermore, different ones of the electromagnets 15 can be energized at different levels thereby providing a variable pressure profile along the axial length of the nip between the rollers 10 and 11. The hysteresis losses, as well as frictional heat, may be used to increase the viscosity of water being removed by the press, thereby increasing the efficiency of the squeeze rollers 10 and 11.

As mentioned hereinabove, the extended leg portions of each of the electromagnets 15 may be in slidable contact with the interior surface of the shell 12. In this instance, a hydraulic lubricating system using oil or air or a combination of both may be used to reduce wear between the leg portions and the interior surface of the shell 12.

As seen in FIGURE 3, a magnetic roller 10a has a plurality of rotating magnets 17. The magnets 17 are contoured to fit firmly within the shell 12a and are rotatable therewith. The magnetic field which is generated by the magnets 17 passes through the shell 12a and into the roller 11. Therefore, the magnetic circuit of each of the electromagnets 17 is completed only in the nip region of the rollers 11 and 12a. The direction of the magnetic flux which is generated by each adjacent electromagnet 17 may be either aiding or opposing the magnetic flux which is generated by each adjacent electromagnet 17. However, it will be understood that as the electromagnets

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17 are moved closer together within the roll 10a it is preferable to have the magnetic flux passing through adjacent extended portions of the electromagnets in the aiding direction. That is, the arrowhead lines indicating the flux path will be in the same direction passing through the extended leg portions 17a of the electromagnets 17.

Although the embodiment shown in FIGURE 3 has only one magnetic roller 10a, it is not to be construed limited solely thereto. The roller 11 may be replaced by a roller which is constructed similar to the roller 10a. In this instance, the magnetic field generated by each roller would produce substantially twice the pressing force as compared to the roller 11 being merely of magnetic material.

As seen in FIGURE 4, a magnetic roller 10b has a center shaft 18 which, in turn, supports a plurality of electromagnets 19. The electromagnets 19 are maintained in a fixed position relative to the shaft 18 by a key 21. Each of the electromagnets 19 is provided with an annular ring 19a. As seen in FIGURE 4, the cross section of each of the rings 19a is somewhat L-shaped having an extended flange 19b extending radially outwardly of the shaft 18. The annular rings 19a are placed on the shaft, one next to the other, in such a manner as to cause the extended radial portion of each ring to provide a magnetic flux path for the electromagnetic coils 22. That is, the radially extended portion 19b of each ring 19a provides a flux path for the two electromagnetic coils on opposite sides thereof, as indicated by the arrowhead lines 23. A plurality of non-magnetic spacer rings 24 are positioned over each of the electromagnetic coils 22 and between adjacent radially extended portions. Suitable O-rings or other seal means may be provided between the radially extended portions of the rings 19a and the ring spacers 24 to prevent moisture or other foreign material from collecting on the electromagnetic coils 22.

The rings 19a are wound with wire or small copper tubing in which a coolant may be circulated, if necessary. The thermal expansion of the non-magnetic rings 24 and of the magnetic rings 19a should be substantially the same to provide an even surface at elevated operating temperatures. As mentioned hereinabove, the roller 11 may be replaced by a roll which is constructed substantially the same as the magnetic roller 10b to provide an increased squeezing pressure at the nip region of the rollers.

As seen in FIGURES 5 and 6, the magnetic roller 10c has a plurality of fins 26 extending radially outwardly of the roller. Preferably, each of the fins 26 is discontinuous throughout the axial length of the roller 10c. Therefore, each pair of fins 26 constitutes a U-shaped core of an electromagnet. An electromagnetic coil 27 is wrapped about each of the cores of the magnetic roller 10c between each of the fins 26. Although the coils 27 are shown as being wrapped in the same direction about the core, it will be understood that each adjacent coil is wrapped in the opposite direction to produce flux paths which are opposing between successive coils. Furthermore, it will be understood that through the use of a commutator, only the coils which are in the immediate area of the nip roll 11a need be energized to complete the magnetic flux path. A non-magnetic spacer 28 is fashioned so as to fit within the open area between the extended finned portions 26, thereby providing a continuous roller surface for the magnetic roller 10c. Furthermore, a non-magnetic spacer or cover ring 35 is provided between each row of electromagnets associated with the roll 10c. That is, the spacer 35 is an annular ring which is placed between adjacent annular rows of electromagnets to prevent interaction between the magnets of one row with the electromagnets of the adjacent row. The non-magnetic spacer 35 also serves as a covering over the open end of each annular segment of the electromagnets of the roll 10c. Preferably, the roller 11a, of magnetic material, has a greater diameter than the roller 11 so as to be more effective when used with the embodiment disclosed by roller 10c.

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In operation, the magnetic field which is generated by each of the electromagnetic coils 27 passes through the extended fin portions 26 and into the roller 11a, as indicated by the arrowed lines 29. Therefore, the magnetic circuit for each of the electromagnetic coils 27 is closed only when a corresponding pair of finned portions 26 are adjacent the roller 11a. On the other hand, the magnetic circuits of the remaining finned portions, which are not adjacent the roller 11a, are substantially discontinuous, thereby offering a relatively high impedance to the electromagnetic coils 27. Since only the electromagnetic coils which have their extended fin portions adjacent the roller 11a offer maximum load to the current supply connected thereto, relatively little power is consumed on the coils which have their extended fin portion separated by a non-magnetic medium such as air. The coils 27 are electrically connected in parallel to a power source 30. A current control resistor 31 is connected between the coils 27 and the power source 30 to provide means for controlling the relative strength of the magnet field.

Seen in FIGURE 7 is a diagrammatic representation of one particular pressure profile which can be obtained by using the novel pressure rollers of the present invention. By way of example, the magnetic roller 10 may be divided into a plurality of magnetically controlled sections such as A, B, C, and D. The magnetic force generated by each section is variable independent of the other sections. Therefore, not only can the pressure rollers of the present invention provide a uniform pressure profile along the axial length of the nip, but also the pressure rollers of the present invention can provide a variable pressure profile along the axial length of the nip.

It will be understood that variations and modifications may be effected without departing from the spirit and scope of the novel concepts of this invention.

I claim as my invention:

1. An apparatus for applying pressure to a web comprising:

- a surface of magnetic material for receiving the web thereon;
- a cylindrical sleeve of non-magnetic material;
- a plurality of electromagnets positioned within said sleeve for creating a magnetic field through said sleeve and into said surface of magnetic material; and
- means connected to each of said electromagnets for supplying electric power thereto and providing means for varying the current to each of said electromagnets independent of one another thereby providing a variable force profile between said sleeve and said surface of magnetic material.

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PETER FELDMAN, Primary Examiner

U.S. Cl. X.R.

100—163, 299; 198—41