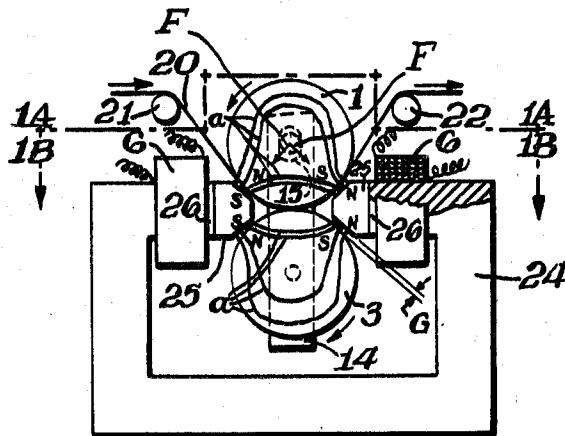


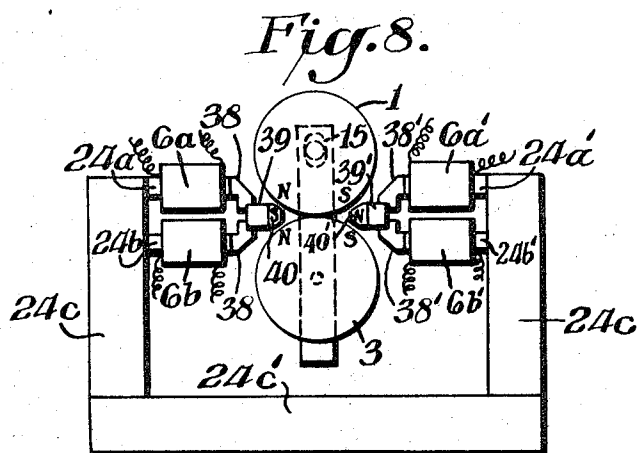
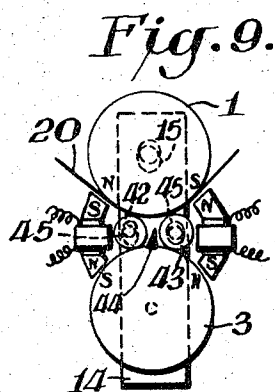
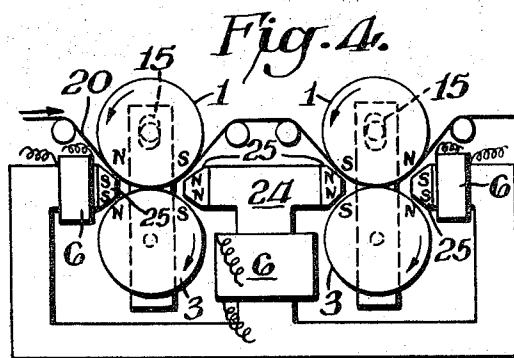
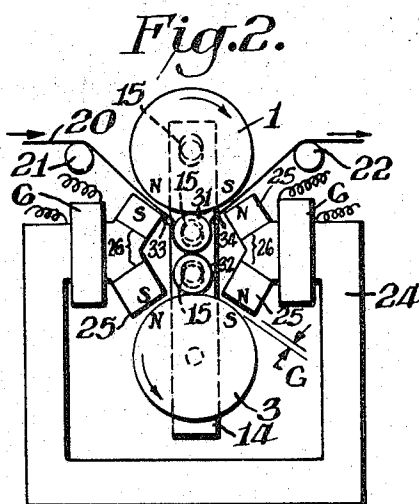
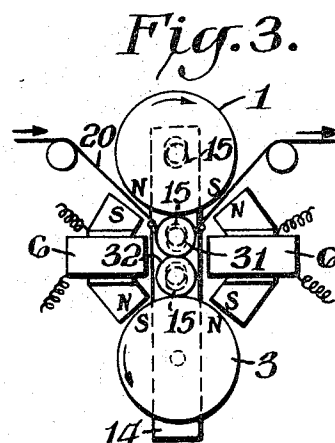
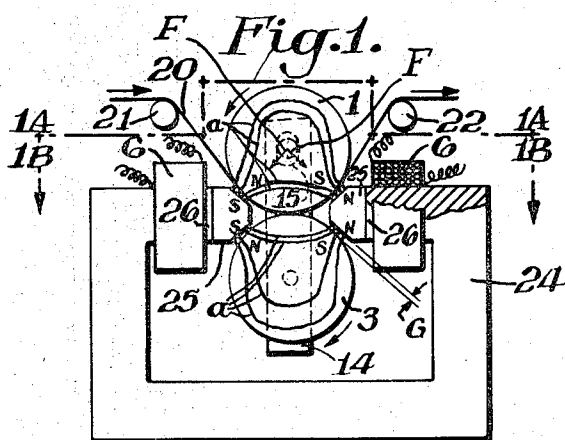
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 [21] Appl. No. **689,087**  
 [22] Filed **Dec. 8, 1967**  
 [45] Patented **Jan. 19, 1971**  
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**Continuation-in-part of application Ser. No.**  
**462,961, June 10, 1965, now Patent No.**  
**3,413,915, dated Dec. 3, 1968.**

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[54] **MAGNETIC CALENDER**  
**7 Claims, 20 Drawing Figs.**  
 [52] U.S. Cl..... **100/169,**  
 18/2, 100/210, 226/181  
 [51] Int. Cl..... **B30b 3/04**  
 [50] Field of Search..... 18/2C;  
 100/163A, 169, 299M, 210; 226/94, 176, 181,  
 183; 19/272; 242/(Inquired); 317/(Inquired);  
 335/(Inquired)

**ABSTRACT:** A magnetic calender for sheet material incorporating a pair of ferromagnetic pressure applicators, at least one of which is a roll journaled for rotation about its longitudinal axis, defining between them a material-receiving nip, the applicators being mounted for free movement with respect to one another in a direction varying the opening of the nip, and paired magnetic means having pole faces of opposite polarity disposed symmetrically adjacent the peripheries of the pressure applicators in angularly offset locations from the nip developing components of force urging the pressure applicators towards one another.





INVENTOR

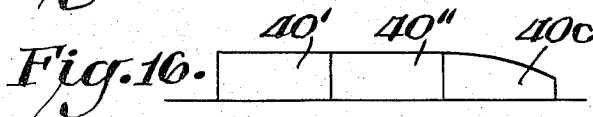
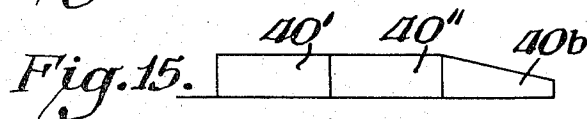
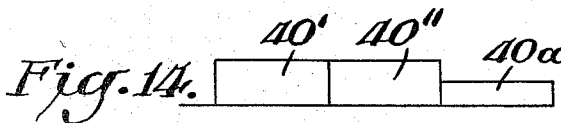
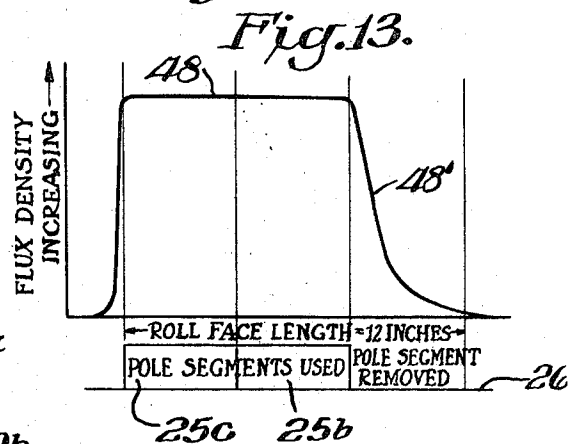
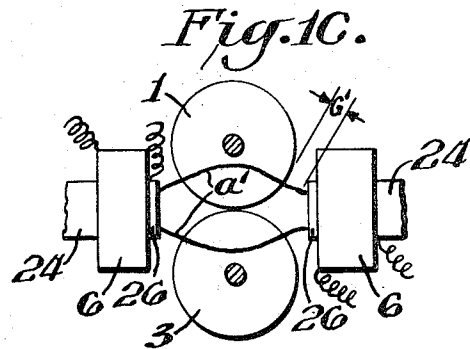
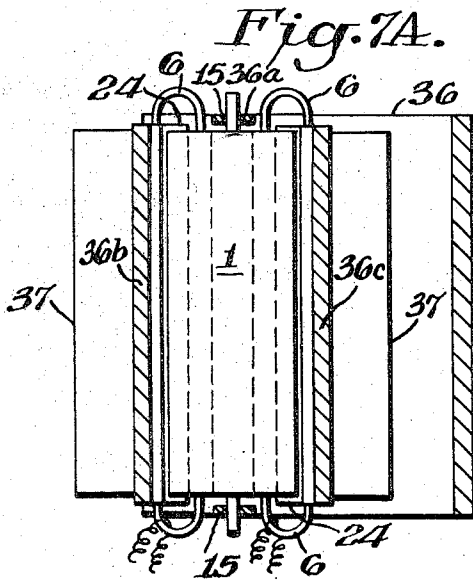
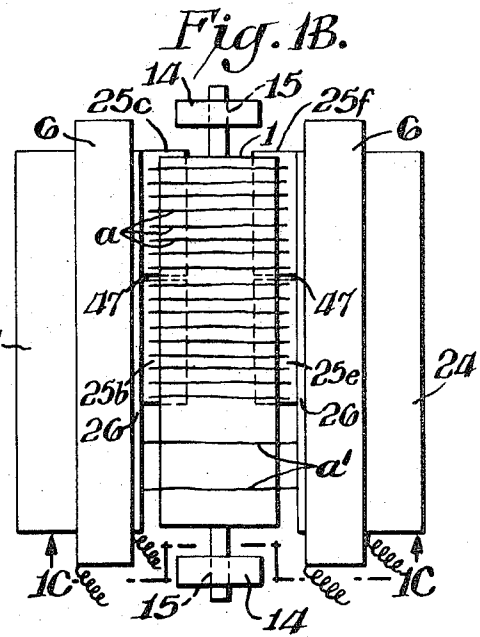
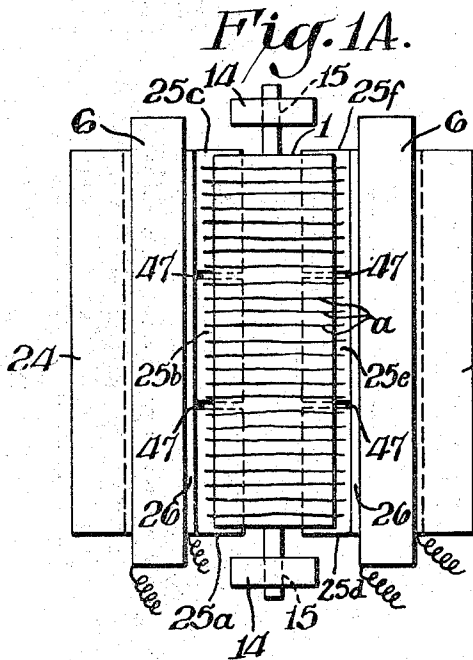
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Fig. 5.

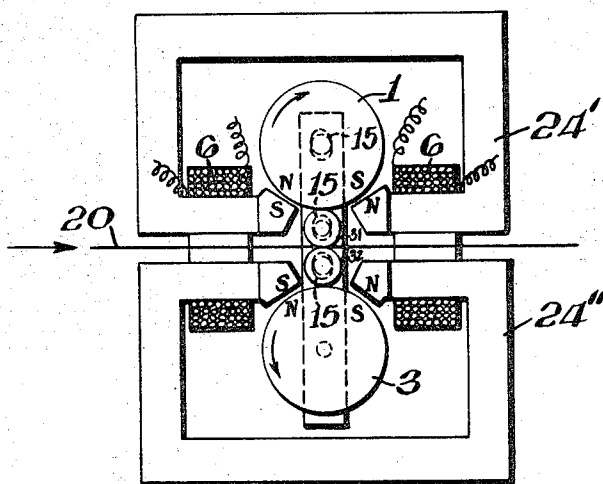


Fig. 6.

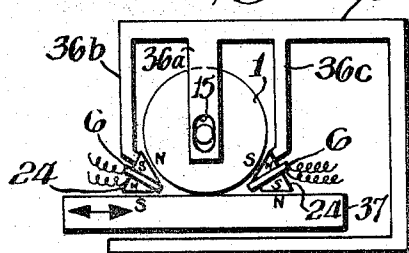


Fig. 7.

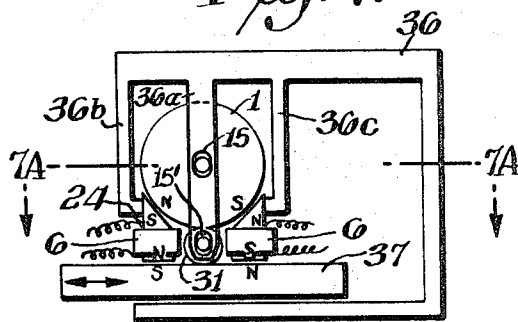


Fig. 10.

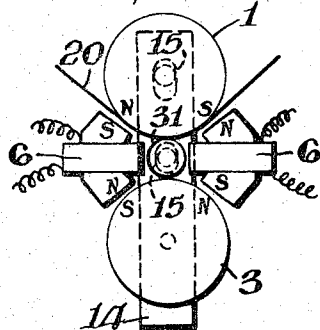


Fig. 11.

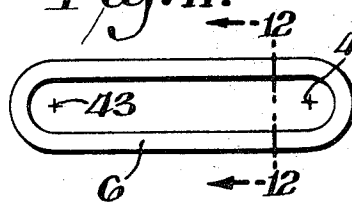
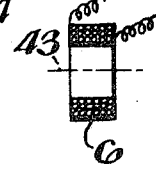


Fig. 12.



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## MAGNETIC CALENDER

## CROSS REFERENCE TO RELATED APPLICATIONS

This Application is a continuation-in-part of U.S. Application Serial No. 462,961, filed June 10, 1965, now issued as U.S. Pat. 3,413,915 dated Dec. 3, 1968.

## BRIEF SUMMARY OF THE INVENTION

Generally, this invention comprises a magnetic calender of the design taught in U.S. Pat. 3,413,915, dated Dec. 3, 1968, most commonly incorporating pressure applicators consisting of a pair of cylindrical rolls, but which may also take the form of a single cylindrical roll bearing against a planar companion member; which, between them, define a nip through which web-form material can be passed while being subjected to the compressive action of the pressure applicators, and paired magnetic means having pole faces of opposite polarity disposed symmetrically with reference to the nip adjacent the peripheries of each of the pressure applicators in subdiametral angularly offset locations from the nip developing components of force urging the pressure applicators towards one another.

## DRAWINGS

The construction of a number of embodiments of apparatus according to this invention and the manner in which these operate is detailed in the partially schematic drawings in which:

FIG. 1 is a partially broken, cross-sectional end view of a preferred embodiment of two roll calender apparatus with the section taken inboard of the nearest bearing support, details of roll frame support being omitted for purposes of simplicity in the showing;

FIGS. 1A and 1B are sections taken on line 1A-1B-1A1B, FIG. 1, showing, respectively, the general pattern of flux line distribution where all segments of the pole ends are in place and where two opposed segments are removed;

FIG. 1C is a section taken on line 1C-1C, FIG. 1B;

FIG. 2 is a view similar to FIG. 1 of a design of calender incorporating a pair of intermediate press rolls disposed between the main pressure applicator pair;

FIG. 3 is a view similar to FIG. 1 showing a modification of the design of FIG. 2, but provided with individual magnetic roll-biasing means instead of the common means of FIGS. 1 and 2;

FIG. 4 is a view similar to FIG. 1 showing two pressure applicator roll sets of the design shown in FIG. 1, arranged for tandem treatment of running web-form material wherein the electromagnetic biasing is provided by a unitary core incorporating an intermediate pole structure shared in common by the adjacent rolls of the two roll sets;

FIG. 5 is a view similar to FIG. 1 showing a design of apparatus according to FIG. 2 modified, however, to permit straight line throughput of web-form material via the intermediate press roll pair;

FIG. 6 is an end elevation view of a first embodiment of direct contact roll-reciprocatory plate web-pressing apparatus;

FIG. 7 is an end elevation view of a second embodiment of roll-reciprocatory plate web pressing apparatus incorporating another roll disposed between the main roll and the reciprocatory plate as the direct contact pressing agency;

FIG. 7A is a section taken on line 7A-7A, FIG. 7;

FIG. 8 is a view similar to FIG. 1 of an operating calendar having the general design of the embodiment of FIG. 1;

FIG. 9 is a view similar to FIG. 1 of an embodiment generally similar to those of FIGS. 2 and 3, but with the intermediate roll pair offset laterally one from another to define, collectively with the main pressure applicator rolls, a hermetically sealed space for the fluid treatment of web-form material in process;

FIG. 10 is a view similar to FIG. 1 of an embodiment of apparatus resembling that of FIG. 3 but incorporating a single intermediate roll rather than a roll pair;

FIG. 11 is a plan view of a preferred design of electromagnetic coil for use with the cores constituting components of this invention;

FIG. 12 is a section taken on line 12-12, FIG. 11;

FIG. 13 is a plot of flux densities between the pole end and the roll for the removed segment situation of FIGS. 1B and 1C, the locational relationship to the three pole end segments involved being represented by the parallel diagram underlying the plot; and

FIGS. 14, 15 and 16 are schematic portrayals in plan of three different multisegment pole end configurations adapted to obtain preselected flux density distributions between the pole end and the roll.

## DETAILED DESCRIPTION

When referring in this description and the claims to a "pair of ferromagnetic pressure applicators," which constitute indispensable components of this invention, the primary flux-conducting elements developing the biasing compressive action therebetween is intended, and these may constitute two cylindrical rolls, as shown in the embodiments of FIGS. 1-5 and 8-10, inclusive, or a single cylindrical roll cooperating with a reciprocator bed plate, as shown for the embodiments of FIGS. 6 and 7.

In the species of FIGS. 2, 3, 5, 7, 9 and 10 one or more passive rolls are disposed between the ferromagnetic pressure applicators, and these will be denoted simply as "pressure-transmitting" or "intermediate" rolls.

The term "nip" is intended to designate the roll-to-roll clearance space between a pair of cooperating ferromagnetic pressure applicators, without regard to whether pressure-transmitting intermediate rolls are, or are not, interposed therebetween.

The expression "paired magnetic means" is intended to mean the magnetic pole structures and their auxiliaries, such as electrical coil windings, regional flux guides and the like confronting given ferromagnetic pressure applicators on opposite sides of the nip, without regard to whether the flux guide is common to the paired magnetic means or individual to each.

By "symmetrically disposed" positional designation of the paired magnetic means pole faces with reference to the nip, substantially equal angular offset measured from the center of the center of the roll constituting one of the ferromagnetic pressure applicators with reference to the nip to the centroids of the pole faces and also substantially coextensive opposed pole face relationship on opposite sides of the nip is intended.

By "subdiametral angularly offset" disposition of the paired magnetic means pole faces with reference to the nip is meant the smallest included angle measured between the centroids of the pole faces, using the center of the roll constituting one of the ferromagnetic pressure applicators as scribing center, of less than diametral magnitude, i.e., less than 180°.

Referring now to FIG. 1, a preferred embodiment of the invention utilizes a pair of cylindrical roll-type pressure applicators 1 and 3, which, between them, define a web-receiving nip and which cooperatively apply compressive force to the web 20 by direct squeeze action contact therewith. Rolls 1 and 3 are provided with concentric shafts securely keyed thereto, journaled at the ends with their longitudinal axes horizontal and in a common vertical plane in pedestal supports 14, constituting uprights on the machine frame (not detailed). A conventional center drive (e.g., Hooke's or Cardan's couplings, provided with central splines for lengthwise accommodation), not detailed, is preferably employed to power-rotate the rolls; however, particularly in small-sized equipment, the web in process, if sufficiently strong to withstand the tensions required, can simply be dragged through the nip. To permit free vertical movement of roll 1 relative to roll 3, the former is shown, somewhat schematically, in that details of the conventional associated bearing are omitted, with its shaft end 75 mounted for free sliding movement within vertical slot 15,

whereas roll 3 is supported in conventional fixed bearings, not detailed. Under the circumstances, rolls 1 and 3 are in essentially line contact in their region of closest adjacency, thereby presenting the nip between which the running web 20 of material to be treated is passed from left to right as seen in FIG. 1, via free-rotating guide rolls 21 and 22 disposed on opposite sides of the nip.

The magnetic bias for the calender of this invention is provided by the electromagnetic structure incorporating the unitary ferromagnetic C-shaped core indicated generally at 24, preferably extending the full length of rolls 1 and 3, the confronting ends of which are surrounded by symmetrically disposed DC coils 6 which supply the magnetization.

A preferred form of coil 6 is detailed in FIGS. 11 and 12, the coil, in plan, comprising straight run side lengths which are closed at each end by semicircular portions drawn on equal radii from centers 43 and 44, which, in the design of FIG. 1, lie in a common horizontal plane with the roll nip. The straight length expanses of the coils 6 run the full lengths of rolls 1 and 3, thereby providing uniform magnetic loading throughout the entire roll lengths. Typically, each coil 6 can have 400 turns of insulated 0.386 inch dia. copper wire, connected at the free end leads to a 150 amp. source of direct current, the coils being connected to give the polarization indicated by the conventional N-S designations on the pole ends 25 and the portions of rolls 1 and 3 confronting the pole faces.

Pole ends 25 are preferably made separable from core 24, against the inturned ends of which they are retained in tight abutment along lines 26, being held in place by suitable clamps, screws or the like not detailed. The portions of the pole ends confronting rolls 1 and 3 are contoured at angles of about 45°, thus presenting pole faces which are generally coparallel with tangent lines drawn symmetrically of the rolls but with the pole faces separated from the rolls by gaps G of approximately 0.10 inch to about 0.30 inch, depending upon the thickness of the web 20 in process. It is preferred to locate the pole end parting line 26 such that the point of nearest approach of rolls 1, 3 to flux guide 24 will be from about 20 to 100 times larger than the gap width G.

The construction and polarization described is essential in that it gives rise to a flux path indicated by lines *a* in a sense which is either generally chordal in the rolls 1, 3 nearest the nip, or partially circumferential elsewhere in the rolls, i.e., there is practically zero roll-to-roll flux passage, in contradistinction from the apparatus of said U.S. Pat. No. 3,413,915. Accordingly, the roll-to-roll biasing force is obtained exclusively as the vector sum of the respective roll-to-pole face attractive forces, the latter being designated by the arrows F, FIG. 1, directed towards the centroids of the pole faces.

The smallest included angle between arrows F, taking the axis of roll 1 as scribing center, should be subdiametral referred to this roll, i.e., less than 180° and, preferably, less than 100°. Thus, the preferred half-angle, measured from the axis of roll 1 as center between each pole face centroid and the nip is less than about 50°.

The design described not only makes it possible to interpose nonferromagnetic intermediary rolls between the ferromagnetic pressure applicators, where this may be desirable from the process standpoint, but it also enables the regulation of the across-nip compressive force by selective removal of pole end segments, all as hereinafter described. Another advantage, productive of enhanced strength roll-to-pole biasing forces, is the capability of placing the pole ends closer to the nip as compared with said U.S. Pat. No. 3,413,915. It is preferred to fabricate pole ends 25 from a ferromagnetic material of high saturation value, such as cobalt alloy steel, as an example.

The utilization of segmented pole ends is explained with particular reference to FIGS. 1A and 1B, which are plan views of the embodiment of FIG. 1, and FIG. 1C, which is an end sectional view thereof. For purposes of explanation solely, it is assumed that the pole ends are divided into three equal length, equal height segments, denoted 25a, 25b and 25c for the left-

hand side of flux guide 24, and 25d, 25e and 25f for the right-hand side, as viewed in FIGS. 1A and 1B. The adjoining edges of the pole end segments are denoted by separate lines 47, it being understood, however, that the abutting surfaces of the segments are, in practice, finished to a high degree of planarity to thereby essentially eliminate any space therebetween.

In order to more clearly distinguish adjacent elements one from another, the total lengths (measured axially with respect to rolls 1 and 3) of the flux guide 24 and the pole ends 25 as shown slightly greater than the lengths of the rolls 1 and 3, it being understood that, in practice, these elements are all of approximately equal length and coextensive one with another.

As shown in FIG. 1A, the distribution of magnetic flux lines *a* is uniform for the situation where all three pole end segments are in place adjacent flux guide 24; however, when a pair opposed pole end segments 25a and 25d are removed, as shown in FIG. 1B, the flux density over the lower third of the lengths of rolls 1 and 3 decreases very markedly, as indicated by the relative diminution in number of flux lines *a'* spanning the opposed ends of the flux guide. It is still true that these flux lines *a'* traverse the rolls 1 and 3 in a chordal sense, as shown in FIG. 1C (from the background of which the end faces of segments 25b, 25c, 25d and 25f have been omitted for clarity in the representation), but the magnetic biasing action is now considerably, and selectively, diminished over the apparatus of FIG. 1A.

Referring to FIG. 2, there is shown an embodiment of apparatus according to this invention incorporating a pair of intermediate rolls, 31 and 32, as pressure-transmitting agencies in direct contact with the running web 20. These rolls are provided with shafts keyed securely thereto, with the ends journaled in slots 15 of pedestals 14 in the same manner as hereinbefore described for roll 1, FIG. 1, so as to permit free movement in the common vertical plane within which the longitudinal axes of all four of the rolls lie. The increased separation of pressure applicator rolls 1 and 3 thereby afforded, permits utilization of a substantially greater width of pole end 25, which is now provided as individual legs of a general Y configuration, one each confronting its associated pressure applicator periphery.

With the construction of FIG. 2, it is practicable to apply pressure to web 20 by constraining passage exclusively through the nip of rolls 31, 32, to which the web is led by small-diameter leading and trailing directional rollers 33 and 34, respectively, i.e., out of contact with roll 1, which can be very desirable where the web is corrosive per se, or contains corrosive impregnants, so that nonferromagnetic rolls fabricated from stainless steel, or protected with rubber exterior sleeves or the like, can be used without any diminution of magnetic biasing action. Moreover, the use of relatively small diameter intermediate rolls 31 and 32, as compared with the larger pressure applicator rolls 1 and 3, enables the imposition of substantially higher web loadings per unit area. Finally, this design permits the placement of pole ends 25 even closer to the roll 1, 3 nip than in the FIG. 1 embodiment, thereby increasing the vector sum of the forces effecting roll-to-roll biasing.

It should be mentioned that there is no inherent restriction on the material of fabrication of intermediate rolls 31, 32 in the FIG. 2 design, in that these rolls may both be ferromagnetic or nonferromagnetic, or one may be ferromagnetic and its mate nonferromagnetic, depending upon process requirements or the designer's choice, which broadens exceedingly the range of selection available.

Referring to FIG. 3, a third embodiment of apparatus is shown which is identical with that of FIG. 2 as regards the multiple roll arrangement, but which employs individual electromagnetic biasing means on opposite sides of the roll nip, thereby making it possible to reverse the relative pole face-roll polarity relationships for top pressure applicator roll 1 as compared with bottom pressure applicator roll 3. In addition, the FIG. 3 construction is more compact in that it dispenses with the relatively bulky, roll-encompassing FIG. 2 unitary core 24

while still, however, essentially eliminating roll 1-to-roll 3 flux passage, regardless of intermediate roll composition.

The embodiment of FIG. 4 constitutes an in tandem arrangement of pressure applicator roll sets constructed as hereinbefore described with respect to FIG. 1, except utilizing a common core 24 which, in this instance, has the general shape of a capital letter E laid on its side. Thus the middle leg of the E constitutes a common flux path for the pair of inside pole ends 25 confronting, on the left-hand side as seen in FIG. 4, the first roll set past which web 20 travels, and, on the right-hand side, the second roll set the web sequentially encounters.

Referring to FIG. 5, there is shown an embodiment incorporating intermediate rolls 31 and 32 as hereinbefore described with reference to FIGS. 2 and 3, but wherein there is provided straight-through feed of the web 20 in process, without necessity for any bending of the web, which can be highly desirable for relatively fragile or thick-coated webs which might be somewhat lacking in strength or resistance to cracking at this particular point in the processing. This is accomplished by providing a first separate upper flux guide 24' associated solely with pressure applicator roll 1, and a second separate lower flux guide 24'' associated solely with pressure applicator roll 3, the two, however, being served in common on opposite sides of the roll nip by a pair of coils 6 enclosing both of the flux guides adjacent their pole ends, thereby leaving the coil and core-to-core region completely open in line with the 31,32 roll nip, so that running passage of web 20 is unobstructed. In this construction, since adjacent portions of the flux guides are in close proximity, it is desirable to fabricate these in relatively stiff cross section to safeguard against distortion under magnetic loading.

In FIG. 6 there is shown an embodiment of apparatus employing as one pressure applicator of the pair a ferromagnetic cylindrical roll 1 provided with an integral concentric shaft which is journaled for free vertical movement within the slot 15 of a frame upright 36a, operating in conjunction with a reciprocatory ferromagnetic platen or bed plate 37, adapted to slide on ways machined in the horizontal frame 36 base, so as to permit ready insertion and withdrawal of web-form sheet material into or out of the roll-bed plate nip. Depending frame struts 36b and 36c support, on opposite sides of the roll-bed plate nip, individual electromagnetic biasing assemblies of the general design hereinbefore described with reference to FIG. 3, the coils of which are denoted at 6, in close adjacency to, but out of contact with, the pressure applicators. It is preferred that frame 36, and its depending arms 36a, 36b and 36c, be fabricated from nonferromagnetic material throughout.

FIGS. 7 and 7A show an embodiment of apparatus in all respects identical with that of FIG. 6 but having an intermediate roll 31 interposed between pressure applicator roll 1 and bed-plate 37, with longitudinal axis in the same vertical plane therewith. Freedom of vertical movement of roll 31 is provided by journaling the integral shaft ends in a vertical slot 15' cut in the middle depending arm 36a, which, with its neighbors 36b and 36c, must necessarily now be somewhat longer than for the apparatus of FIG. 6 in order to accommodate the added diameter of roll 31. As previously mentioned, the use of an intermediate roll 31 provides an enlarged nip, which is advantageous, in that larger electromagnetic biasing assemblies can be employed, as is clearly apparent from a visual comparison of FIGS. 6 and 7.

If it is desired to subject a web 20 to a relatively prolonged treatment with contained fluid or temperature treatment with steam or the like, or simply a pressure or vacuum treatment, the embodiment of FIG. 9 can be utilized, this incorporating laterally displaced intermediate rolls 42 and 43 journaled for free vertical movement within individual slots 45 machined in pedestal supports 14. Rolls 42 and 43, together with ferromagnetic pressure applicator rolls 1 and 3, constitute a cluster defining an interspace 44. If the ends of the rolls are provided with conventional pressure seals (not shown), interspace 44 can be made substantially leaktight to relatively high pres-

ures, the treating fluids then being introduced and removed through communicating supply lines (not shown), opening into the ends. In this design the electromagnetic biasing assemblies can be of design identical with that already described for FIG. 3. It should be recognized that lateral offsetting of the intermediate rolls as shown in FIG. 9 approximately halves the compressive forces applied to the web, which are now, however, applied twice in close sequence upon both entrance to, and exit from, interspace 44.

A test apparatus, detailed in FIG. 8, was constructed generally in accordance with the embodiment of FIG. 1 of this invention, except that two parallel flux guide legs 24a, 24b and 24a', 24b' were utilized on opposite sides of the roll nip in conjunction with inboard ferromagnetic L-shaped extensions 38,38 and 38', respectively, for reasons of economy, since these components were available from a previous test program. The individual flux guide portions were magnetized by the separate identical coils 6a, 6b on the left-hand side and 6a', 6b' on the right-hand side, as viewed in FIG. 8, to polarize (arbitrarily) the merged flux guide extension 39 and its beveled pole end 40 in the S (South) convention and the identical opposed extension 39' and its beveled pole end 40' in the N (North) convention. The remainder of the ferromagnetic flux guide was made up of two identical upstanding side pieces 24c,24c' abutting solidly upon base 24c', functionally duplicating the construction of FIGS. 1, 1A, 1B and 1C.

Pole ends 40 and 40' were each divided into three side-by-side segments of 4 inches individual length, the lengths of rolls 1 and 3 being 12 inches in this instance. The dimensional data, in inches, for the test apparatus was as follows:

1. Flux guide legs 24a, 24b, 24a' and 24b': Thickness 2.5 inches Width 9.0 inches Length coextensive with roll 1,3 length = 12 inches
2. L-shaped extensions 38,38' Thickness, Horizontal leg 2.5 inches Thickness vertical leg 2.5 inches. Length coextensive with roll 1,3 length = 12 inches.
3. Flux guide extensions 39,39' Thickness 3.31 inches Width 2.18 inches Length coextensive with roll 1,3 length = 12 inches.
4. Pole ends 40,40' Thickness 3.31 inches Width 2.25 inches Length coextensive with roll 1,3 length, three segments of 4 inches individual length, totaling 12.0 inches overall.
5. U-shaped flux guide 24c, 24c' Thickness, all members 5.0 inches. Height side pieces 24c, 24c'-29.5 inches, width base 24c'-50.0 inches, Length of all three components coextensive with roll 1,3 length = 12 inches.
6. Center-to-center bearing spacing endwise of rolls 1 and 3 = 20.0 inches.
7. Hollow cylindrical rolls 1 and 3 Inside dia. 9.75 inches Outside diameter 13.66 inches and face length 12.0 inches.

Coils 6a, 6b, 6a' and 6b' were identical in construction, each wound with 300 turns of 0.260 inches dia. copper wire insulated with two layers glass fiber, enabling safe operation at maximum current of 100 amps. DC, 150v., continuously at a maximum operating temperature of 180° C.

In tests of this experimental apparatus, using 120,000 ampere-turns of magnetic biasing, 100 yards per minute roll surface speed and rolls with a 0.005 inch nip gap (i.e., the compressed thickness of a web of material 20 passed therethrough), a roll 1-to-roll 3 loading of approximately 350 lbs./linear inch was attained.

Additional tests with the apparatus involved removing one opposed pole end segment from each pole confronting rolls 1 and 3, thus leaving 8 inches of pole end 40 (and 40') remaining. Shaft bearing reactions, measured by load cells at each end, with 120,000 ampere-turns of magnetic biasing and 100 yds/min. roll surface speed showed a bearing load of 1679 lbs. at the bearing nearest the site of the removed segments, whereas the loading was 2111 lbs. at the opposite bearing. When two opposed four-inch segments (including the middle segment) were removed in each side of the nip, the measured bearing reactions dropped to 1266 and 1774 lbs., respectively.

It will be understood that, to practice selective unloading of a portion of rolls 1 and 3, it is necessary to remove opposed pole segments symmetrically in both the horizontal and vertical senses. Thus, with the embodiments of FIGS. 2, 3, 5, 6, 7, 9 and 10, pole segments are removed in multiples of four, rather than two, as in FIGS. 1, 4 and 8. In all cases, the remaining pole segments must, of course, have substantially equal total lengths measured axially of rolls 1 and 3, and must also be mutually coextensive with opposed segments.

The foregoing experimental operation demonstrates that large gradients in pressure applicator loadings are attainable by removal of relatively massive segments from the pole ends. Thus, referring to FIG. 13 for the FIGS. 1B and 1C embodiment, where an abrupt interface is left by removal of opposed segments 25a and 25d, a nearly equally abrupt gradient in magnetic flux density occurs, as depicted generally in FIG. 13 giving (at 48) an actual plot of flux density measured across the gap G with segments 25b, 25c, 25e and 25f in place as compared (plot 48') with that existing across the gap g' constituting the closest approach of parting line 26 to rolls 1 or 3. Here the actual dimensional ratio of gap G to gap G' was about 1 to 10, resulting in the very sharp drop in flux density represented by curve 48'.

Obviously, it is practicable, if desired, to modify the patterns of magnetic flux distribution in a practically unlimited number of ways in order to produce tapered roll force loadings of various types, three designs of which are shown in FIGS. 14-16. Thus, in FIG. 14, the ratio of gap G to the effective gap for segment 40a is, typically, 1 to 5, still however maintaining parallelism between the pole 40a end and its confronting pressure applicator (not shown). On the other hand, the segment can be linearly tapered, as shown for segment 40b, FIG. 15, or convexly curved, as shown for segment c, FIG. 16. Yet other configurations can include concave curving, or combinations of various steps and shapes to give more complex patterns of flux distribution, should this be advantageous.

As described at length in said U.S. Pat. No. 3,413,915, permanent magnets can be substituted for one or all of the electromagnetic biasing means hereinbefore taught, or combinations of permanent magnet and electromagnetic means can be utilized conjointly, if desired.

Moreover, the segments making up the pole ends of the magnetic biasing means can, of course, be made as modules of common length, permitting interchangeable substitution within a single magnetic calender apparatus to thereby adapt the apparatus to a wide variety of different preselected pressure impositions.

It is sometimes desirable to power-drive intermediate rolls 31, 32 (or 42, 43), especially when a relatively thick, high-friction web is being processed, such driving being then effected by the same type couplings hereinbefore described for the driving of rolls 1 and 3. On the other hand, where a thin web is being calendered, the intermediate rolls can be idler rolls turned by frictional contact with rolls 1 (or 1 and 3) and the tensioned web itself.

From the foregoing, it will be apparent that this invention can be modified extensively within the skill of the art without departure from its essential spirit, and it is accordingly intended to be limited only within the scope of the appended claims.

We claim:

1. A magnetically-biased, pressure-applying apparatus for

processing web-form materials comprising, in combination, a pair of roll-form ferromagnetic pressure applicators journaled for rotation about their longitudinal axes defining between them a material-receiving nip, said applicators being mounted for free movement with respect to one another in a direction varying the opening of said nip, and paired magnetic means having pole faces of opposite polarity disposed symmetrically with respect to said nip adjacent the peripheries of each of said ferromagnetic applicators in subdiametral angularly offset locations developing components of force urging said pressure applicators towards one another.

2. A magnetically-biased, pressure-applying apparatus for processing web-form materials according to claim 1 wherein said pole faces of said paired magnetic means constitute removable segments.

3. A magnetically-biased, pressure-applying apparatus for processing web-form materials according to claim 1 wherein said pole faces are formed longitudinally with a preselected contour on their surfaces in confrontation with the peripheries of said ferromagnetic pressure applicators, thereby maintaining a preselected flux gradient across the pole face-ferromagnetic pressure applicator gap in a direction axial of said pressure applicators.

4. A magnetically-biased, pressure-applying apparatus for processing web-form materials according to claim 1 wherein an intermediate pressure-transmitting roll is interposed in the nip between said ferromagnetic pressure applicators with axis lying in the general plane of said nip and the axes of said pressure applicators, said intermediate roll being mounted for free movement with respect to said pressure applicators in the plane of said axes of said pressure applicators and said nip.

5. A magnetically-biased, pressure-applying apparatus for processing web-form materials according to claim 1 wherein a plurality of intermediate pressure-transmitting rolls are interposed in the nip between said ferromagnetic pressure applicators with axes lying in the general plane of said nip and the axes of said pressure applicators, said intermediate rolls being mounted for free movement with respect to said pressure applicators in the plane of said pressure applicators and said nip.

6. A magnetically-biased, pressure-applying apparatus for processing web-form materials according to claim 1 wherein a pair of intermediate pressure-transmitting rolls mounted for free movement with respect to said pressure pressure applicators are interposed in the nip between said pressure applicators with axes laterally offset one from another to thereby define, together with said pressure applicators, a web-receiving enclosure.

7. A magnetically-biased, pressure-applying apparatus for processing web-form materials comprising, in combination, a pair of ferromagnetic pressure applicators defining between them a material-receiving nip, one of said applicators being a roll journaled for rotation about its longitudinal axis and the other of said applicators being a planar member adapted to reciprocatory displacement with respect to said roll in a plane generally tangent to said roll at the site of said nip, said applicators being mounted for free movement with respect to one another in a direction varying the opening of said nip, and paired magnetic means having pole faces of opposite polarity disposed symmetrically with respect to said nip adjacent the peripheries of each of said ferromagnetic applicators in subdiametral angularly offset locations developing components of force urging said pressure applicators towards one another.