

Aug. 25, 1964

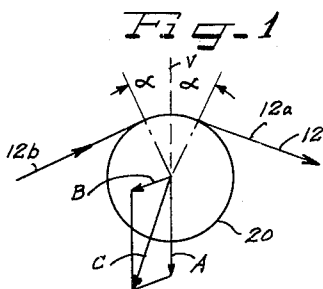
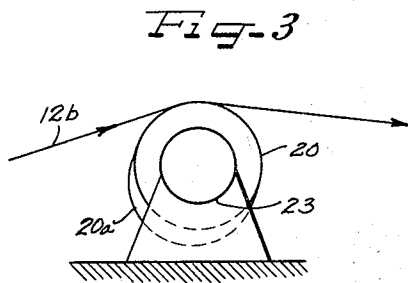
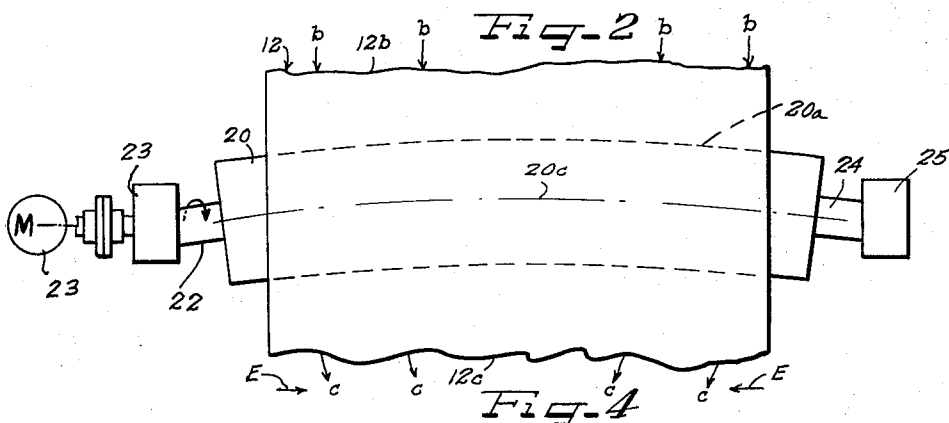
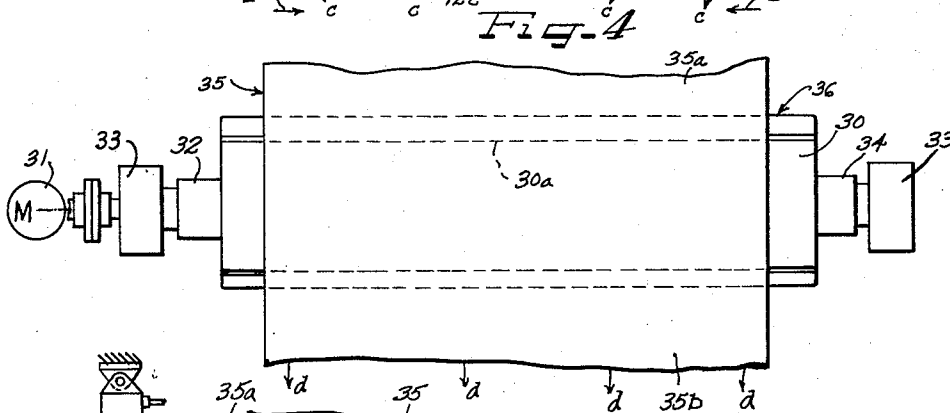
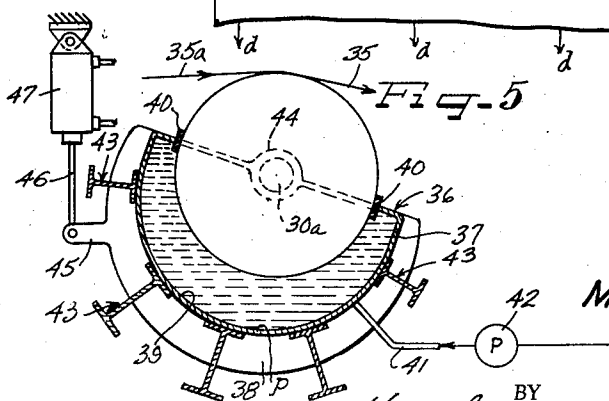
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3,146,160

ROLL WITH ADJUSTABLE DEFLECTION MEANS

Filed Aug. 1, 1960

3 Sheets-Sheet 1



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ROLL WITH ADJUSTABLE DEFLECTION MEANS

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Fig. 6

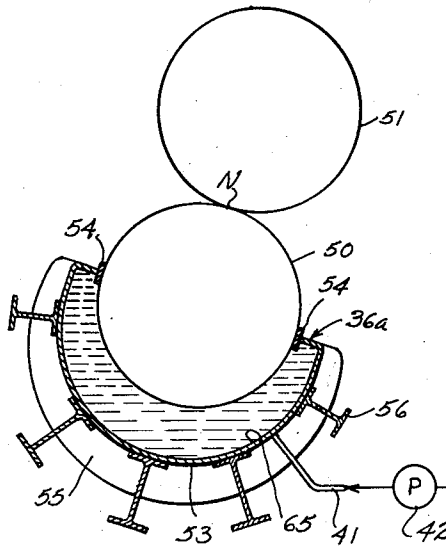


Fig. 8

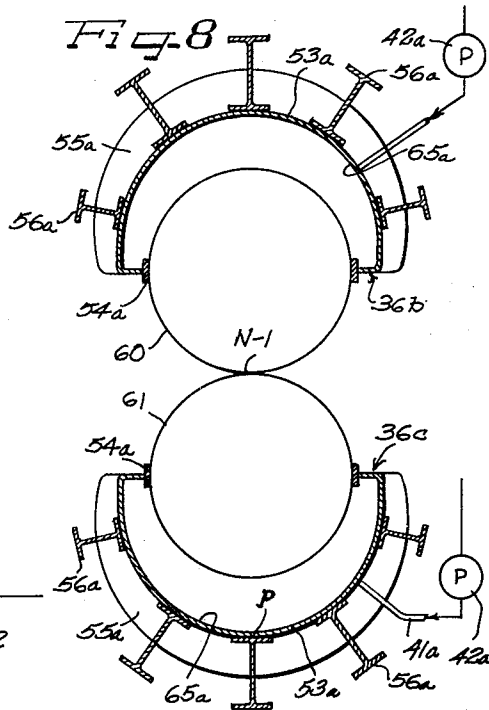


Fig. 7

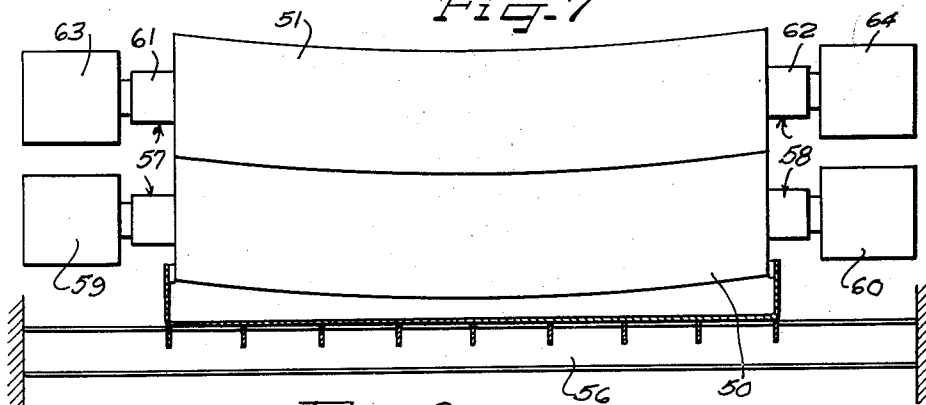
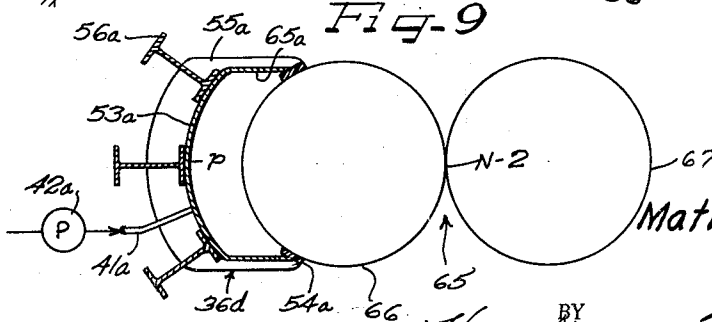


Fig. 9



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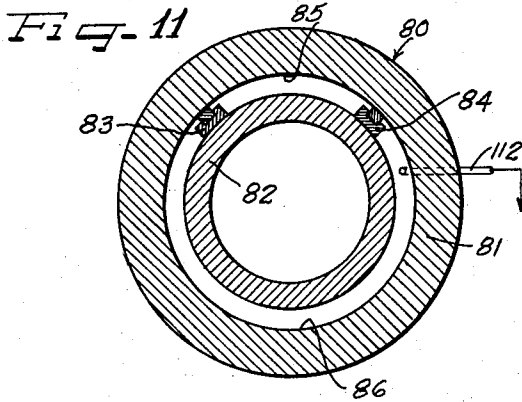
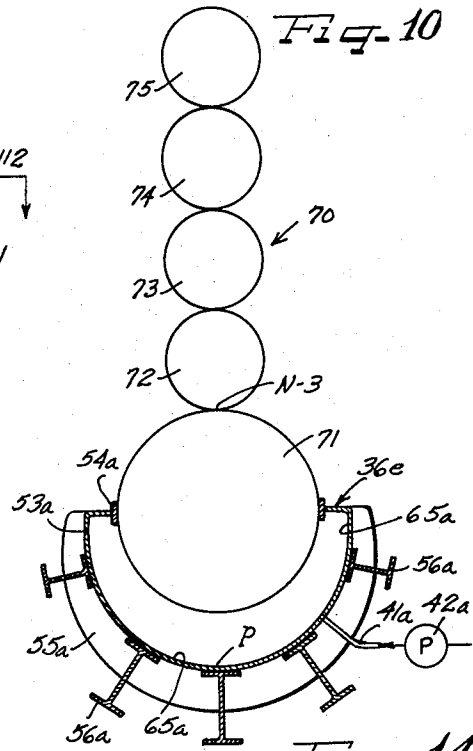
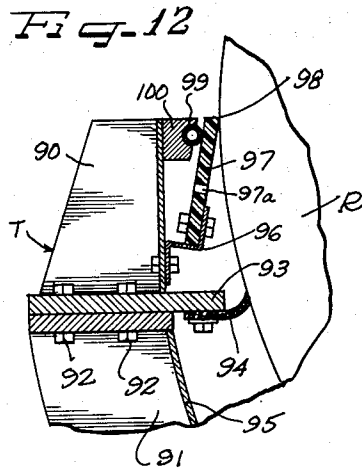
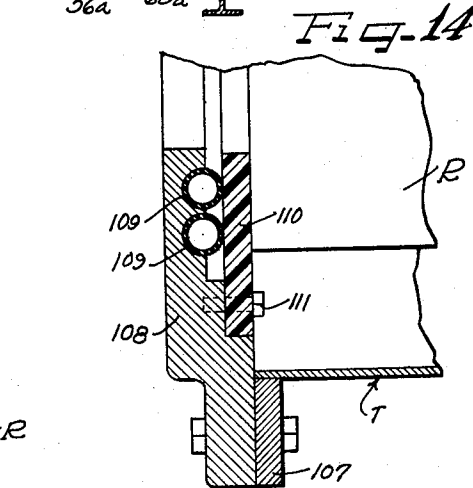
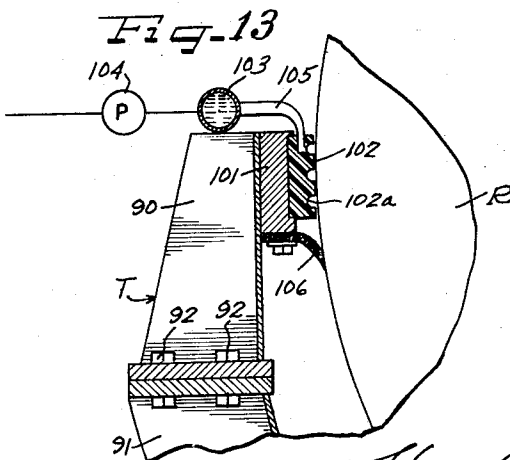
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ROLL WITH ADJUSTABLE DEFLECTION MEANS

Filed Aug. 1, 1960

3 Sheets-Sheet 3



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3,146,160

ROLL WITH ADJUSTABLE DEFLECTION MEANS
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Filed Aug. 1, 1960, Ser. No. 46,450
2 Claims. (Cl. 162-305)

The present invention relates broadly to the paper making and related arts, and is more particularly concerned with a roll structure and deflection means for use there-
with featuring a substantially fluid-tight chamber located in partially encircling relation with respect to the roll structure for applying a controllable pressure to the roll to accurately counteract the forces tending to deflect the same.

It is known that at different stages during the course of paper manufacture roll structures of various types are employed for performance of diverse functions. Illustrative of such rolls are wire drive rolls, plain and suction press rolls, smoothing press rolls, pressure rolls, breaker-stacked rolls, size press rolls, pull rolls, calender rolls and the like. Each of the mentioned types of rolls has in common, for the purpose of the instant description, the use therewith of means normally contacting the roll and tending to deflect the centroidal axis thereof.

To illustrate, drive rolls mounted to engage the loop of the forming wire in a Fourdrinier type paper making machine engage the surface of the wire, and the weight of the roll coupled with an applied load arising from the resistance of the wire to being driven produce a force component which tends to deflect the drive roll in a direction downwardly and toward the oncoming forming wire. As well, in press roll couples and in other roll arrangements wherein at least a pair of rolls are in nip-defining relationship, the algebraic summation of the weight, the nip forces, the bending moments produced by the journal loading, and torque (if any) tends to produce in each of such rolls a curvature of its centroidal axis, in accordance with well known laws of flexure of materials. It is common to attempt to counter this effect by "crowning," i.e., by grinding the roll slightly barrel shape in an amount and curvature calculated to offset the curvature under operating conditions.

The normal deflection, when concave toward the wire wrap, on a wire drive roll, if not relieved, tends to cause the off-running portion of the forming wire to be compacted or squeezed laterally, which increases substantially the wear on the wire. The initial investment in a forming wire is very substantial, but even more important, the production loss during wire replacement is frequently enormous.

Specifically as to press rolls, a different problem exists. Production schedules for many paper machines require relatively frequent changes in the type and grade of product. Certain grades of paper demand that the pressing and other treatment not reduced significantly the thickness or caliper of the web, and this in turn requires that the nip loads in a press couple be relatively light. On the other hand, certain other paper products required from the same paper machine permit or even demand more severe pressing, and in order to achieve some measure of versatility with the same paper machine, one practice followed by the art to accomplish the noted changes is the removal of the press rolls for regrounding to a different amount of crowning. Obviously, this practice is also both expensive and time consuming. And as will be later noted, crowning of the roll causes differences in the surface speed of the roll between the central and end portions of the roll, which is often harmful to the function of the press.

It is accordingly an important aim of the instant invention to provide a roll assembly embodying therein novel means to counteract the forces tending to deflect the roll.

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Another object of this invention lies in the provision of an improved paper machine arrangement comprising a roll, means normally contacting the roll and tending to deflect the centroidal axis thereof, and means forming with the roll a substantially fluid-tight chamber for applying a controllable pressure to said roll to counteract the forces tending to deflect the roll.

A further object of the present invention is to provide improved apparatus for relieving deflection in a roll member, comprising means forming a substantially fluid-tight chamber located in partially encircling relation with respect to the roll member, and means for supplying a pressurized fluid to the chamber at a pressure calculated to compensate for the weight of the roll member and other forces causing said deflection.

Other objects and advantages of the invention will become more apparent during the course of the following description, particularly when taken in connection with the accompanying drawings.

In the drawings, wherein like numerals designate like parts throughout the same:

FIGURE 1 is a diagrammatic view showing forces applied to a drive roll in a Fourdrinier type paper making machine;

FIGURE 2 is an exaggerated essentially diagrammatic top plan view of a drive roll mounting of the prior art;

FIGURE 3 is an essentially diagrammatic side elevational view of the device of FIGURE 2;

FIGURE 4 is a diagrammatic top plan view drawn along the lines of FIGURE 2, but showing an embodiment of the instant invention;

FIGURE 5 is a diagrammatic side elevational view, with parts taken in section, of the device of FIGURE 4;

FIGURE 6 is a view similar to FIGURE 5, but showing the deflection relieving means of this invention as applied to a press couple;

FIGURE 7 is a diagrammatic end elevational view, with parts in section, of the arrangement of FIGURE 6;

FIGURE 8 is a view similar to FIGURE 6, and illustrative of the use of this invention in association with both rolls of a press couple;

FIGURE 9 is an essentially diagrammatic side elevational view, with parts therein taken in section, of a further roll assembly embodying the novel concepts of this invention;

FIGURE 10 is a view like FIGURE 8, but illustrative of a calender stack with the king roll partially encircled by the pressure applying means of this invention;

FIGURE 11 is a vertical sectional view through a roll structure featuring pressure applying means located interiorly of the roll;

FIGURES 12 and 13 are detail sectional views to more fully illustrate exemplary forms of side seal arrangements which may be employed; and

FIGURE 14 is a detail sectional view of one form of end seal arrangement.

The description now to follow will be first directed to FIGURES 1 to 5, the latter two views being illustrative of a wire drive roll and the means of this invention forming a substantially fluid-tight chamber for applying a controllable uniformly distributed pressure to the wire drive roll to counteract the forces tending to deflect the roll. However, it will be apparent when reference is made to FIGURES 6 to 11 that the invention is not restricted to a wire drive roll. In fact, the invention is of important application to any roll structure, whether or not used on or off a paper machine, and it is within the contemplation of this invention that the deflection relieving means herein disclosed will produce substantial improvements on rolls used in steel mills and other industries.

As well, the invention is of important application in

combination with conventional loading applied at the journals of a mating roll and/or with a straight roll or a roll having conventional crown. By regulating the forces produced by the fluid chamber of this invention, in cooperation with journal loading, there is thus obtained a novel manner of altering the shape of the nip pressure profile.

It has earlier been the accepted practice in a Fourdrinier type paper making machine to drive the forming wire through the suction couch roll, however, recently it has been found advantageous to use the return rolls as drive rolls and to drive the wire with drive rolls mounted outside the loop of the wire and engaging the outer surface of the wire. In the case of such rolls the wire passes over the top of the drive rolls.

While these changes in the wire drive arrangement have resulted in a much longer wire life, it is apparent that many further improvements can be made. Specifically, it is known that the drive roll has a tendency to deflect from its own weight and forces applied thereto, and such deflection curvature causes at least a compacting together of the woven elements of the wire, and in some cases an overlapping or ridging of small portions of the wire. These conditions markedly increase wear on the wire and may destroy its usefulness.

This may be more fully understood when reference is made to FIGURE 1, which is a diagram showing some of the forces applied to a drive roll 20. The wire 12 (traveling in the direction indicated by the arrow) passes over the top of the roll 20 and wraps the roll 20 by a total angle of wrap of 2 alpha. As here shown the oncoming side 12b of the wire 12 wraps the roll 20 over the angle alpha and the off-running side 12c of the wire also wraps the roll over the angle alpha with the dividing line ν therebetween being a substantially vertical line passing through the center of the roll 20. The tension on the wire 12 thus applies a force in an essentially downward vertical direction indicated by the arrow A.

The weight of the roll 20 also applies a force in the direction of the arrow A. It will be appreciated that loading forces such as the weight of the roll and the tension on the wire 12 load the roll 20 as a beam. And the roll 20 has a substantial length compared to its diameter. For example, in a typical paper machine the roll 20 will be approximately 20 feet long and approximately 1½ feet in diameter.

It will further be appreciated that, when the roll 20 is rotated in the direction indicated by the arrow (on the roll 20) there is a load applied across the top of the roll in a direction generally tangential to the roll portion wrapped by the wire 12. The wire 12 resists being driven to this extent so as to apply this load to the roll 20 and this load applies generally in the direction of the line of force B. The resulting sum of all of the loads applied to the roll 20 may be indicated by the force line C and this generally is the direction in which the roll 20 tends to deflect the centroidal axis thereof. It will be noted that the roll tends to deflect in a direction downwardly and toward the oncoming wire (12b).

Referring now to FIGURES 2 and 3, it will be seen that the deflection is shown in exaggerated form. In FIGURE 2 the roll 20 is shown rotatably driven by drive means 23 (indicated diagrammatically) and both journals 23 and 24 rotatably mounted in bearing means 25. The wire 12 passes over the top of the roll 20; and it will be seen that the roll 20 is deflected in its central portion 20a backwardly or in the direction of the oncoming side 12b of the wire 12. Or as may be otherwise stated, the indicated centroidal axis 20c is deflected. As shown in FIGURE 3, the central portion 20a of the roll 20 is deflected off-center from the drive means 23 and the extreme edge of the roll, which is a full line marked 20. The central portion 20a is deflected toward the oncoming side 12b of the wire and also downwardly. The curvature of the roll surface, although not visible,

reorients the driving effort forces so that their lines of action tend to converge, resulting in the application to the wire of transverse forces in the directions indicated by the arrows E of FIGURE 2. Thus, although the oncoming side 12b of the wire 12 may have no transverse forces applied thereto and the wire 12 may be traveling in substantially a "straight line" in a plane generally tangential to the roll 20 (as indicated by the arrows b), as the wire 12 passes over the bowed or deflected roll 20, there is a tendency to narrow the wire at the off-running side 12c (as indicated by the arrows c). This transverse compression of the off-running wire side 12c tends to offer an opportunity for the wire to ridge, particularly if any slight forces may be applied normal to the plane of the wire (for example, by fibers or some dirt or impurity adhering to the roll 20 and passing between the roll 20 and the wire 12).

In FIGURES 4 and 5, there is shown one embodiment of the instant invention for relieving deflection in a roll member. A drive roll 30 is driven by suitable drive means 31 (shown diagrammatically). Bearing means 33 rotatably mount the journals 32 and 34 of the roll 30. A wire 35 passes over the roll 30 and is driven thereby in the direction indicated by the arrows in FIGURE 5.

To compensate for the curvature normally produced by the forces above described, there is provided adjustable deflection means generally designated by the numeral 36. In the form shown in FIGURE 5, the deflection means 36 comprises a generally semi-cylindrical tank portion 37 preferably extending substantially entirely along the length of the roll 30 and reinforced by a plurality of axially spaced strengthening ribs 38, only one of which is shown in FIGURE 5. The tank or gland 36 defines therewithin a substantially fluid-tight chamber 39 for containing a suitable pneumatic or hydraulic fluid, which may be air, gas, water, oil, liquid metal or other fluids, depending upon the intended application. The chamber 39 is sealed against substantial fluid leakage at the sides and ends of the roll 30, and side seal means 40 are shown in FIGURE 5, although specific reference will be later made to the details of exemplary forms of end and seal means. Although shown encompassing approximately one half of the roll periphery, chamber 39 may span a lesser part of the periphery.

Fluid is admitted under pressure to the deflection relieving chamber 39 by a connection 41 within which is located pump means 42 (shown diagrammatically). The fluid selected should be of the minimum viscosity consistent with low leakage losses at the pressures required to minimize the power required for rotation of the roll. Generally, air is found to be most advantageous.

The tank or gland 37 is supported along its length in any suitable manner, for example, by a plurality of beam members 43. The arcuate center or point p on the tank or gland 37 is ordinarily mounted on line with the sum of all the forces applied to the roll 30, this force line having been indicated as C in FIGURE 1. The precise radial direction of the force line may vary somewhat depending upon the wire tension load and the load imposed by driving of the wire 35, and accordingly, it is desirable that means be provided to circumferentially shift the deflection means 36. As for example, the tank or gland 37 may mount bearing means 44 at opposite ends received coaxial with shaft 30a of the roll 30. To then shift the gland 36 circumferentially to align the point p with the force line, one or more of the web members 38 may mount bracket means 45 to which is connected piston 46 of cylinder means 47, rigidly mounted as shown.

Thus by suitable regulation of the fluid pressure within and position of the gland 37, the deflection curvature of roll 30, normally resulting from the weight and the applied forces, may be exactly equalled or cancelled, or either an under or overcorrection may be applied as desired. Since the gland 37 contains a uniformly distributed pressure, its effect upon the roll may precisely correspond to the sub-

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stantially uniformly distributed forces, that is, the weight of the roll body, the wire tension, nip loading, and the like, without significant force couples which would introduce changes of shape in the flexure curve of the roll. As arrows, *d*, indicate in FIGURE 4, the wire thereby leaves the roll 30 in full width with the driving forces oriented non-convergently.

In addition to effectively counteract the normal roll deflection, the pressure applying means 36 of FIGURES 4 and 5, as well as the similar means in FIGURES 6 to 11, has further advantages. First, since the framework beam members 43 take part or all of the load, smaller rolls, lighter weight rolls and shells, and smaller, cheaper bearings may be used. Second, by the disclosed structure, no undesirable bending moments occur, but instead, there is provided an essentially true or straight roll. Third, and as is believed now apparent, the adjustable deflection means of this invention is well adapted for use with existing roll structures.

It was earlier noted that the adjustable deflection means of this invention is not restricted in use to paper machine drive rolls, but also produces highly advantageous results in any roll assembly comprised of two or more rolls between which a uniform nip pressure is required across the contacting faces thereof. Illustrative of such roll assemblies are paper machine plain press rolls, smoothing press rolls, pressure rolls, breaker stack rolls, size press rolls, pull rolls, calender rolls and the like. A few of the divers applications for the instant invention are shown in FIGURES 6 to 11, and with reference first to FIGURES 6 and 7, it will be observed that an adjustable deflection means 36a may be employed in connection with a bottom press roll 50 defining a nip N with a top press roll 51. The adjustable deflection means 36a in FIGURES 6 and 7 includes a gland portion 53 mounting seal means 54, and constructed of circumferential members 55 joined to beam members 56 secured at opposite ends to rigid structure, as shown in FIGURE 7, whereby the reactions of force applied to the roll body 50 are transferred to said structure. Of course, the tank or gland member 53 may be circumferentially shiftable as in FIGURE 5 for the same purpose, although in FIGURES 6 and 7 a rigid structure is shown, and in either case the beam and web members must be sized and arranged to resist the required fluid pressure within and the portions of the force transferred. The forces thus are transferred, not via the roll journal-bearing structure as now practiced in the art, but via the structures provided by beams and webs such as 56 and 55.

As appears in FIGURE 7, the lower press roll 50 is provided at opposite ends with journals 57 and 58 received in bearing means 59 and 60, respectively. Such bearing means may be fixedly mounted, or provided with means for permitting, when required, separations between the rolls. In either case either or both rolls may be provided with driving means. When one of the rolls is driven, it is desirable to provide also for the deflections due to torsional load produced by the driving effort.

The top press roll 51, likewise, mounts journals 61 and 62 rotatably received in bearing means 63 and 64, respectively, and preferably is fixed in location when roll 50 is movable or vice versa.

It was earlier pointed out that different grades of paper require different nip loads, and that the different grades may be produced on the same paper machine. Furthermore, it is often desirable to alter nip loading for other reasons. However, to accomplish this it has previously been required to remove the press rolls for regrounding to a different amount of crowning, crowning of course being practiced in an endeavor to obtain uniform nip loads across the contacting roll faces or to accept a degree of non-uniformity as expedient. To remove the press rolls and to effect regrounding is obviously a time consuming and expensive procedure. These difficulties are herein eliminated by the adjustable deflection means 36a which counteracts or relieves deflection of the press rolls 50 and 51

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to provide uniform nip pressures entirely along the roll contact line.

Referring again to FIGURE 7, it is now apparent that this invention may also be advantageously employed to over-correct the curvature due to the normal function by applying in the chamber 37 a pressure in excess of that required to balance the forces normally creating the deflection. The roll 50 would then, for example, be curved concave upward, the bearings 59 and 60 then exerting a net force downward on the journals 57 and 58 respectively. By then applying downward forces to the bearing housings 63 and 64, a graduated nip load distribution may be obtained having a maximum value substantially at the mid span of the nip and decreasing to a lesser value at the end points of the nip. It is likewise evident that by combining the conventional methods of applying loads to roll couples at their journals with the pressure gland 36 that some crown curvature may be advantageously combined. In this case by the simple manipulation of the pressure contained within the chamber 36, either an under-compensation or an over-compensation may be provided which permits the adjustment of the nip pressure distribution profile to provide a higher value at the ends with respect to the mid span or the lower pressure value at the ends as previously described.

It is noted that the adjustable deflection means 36a of FIGURES 6 and 7, while shown as stationary, could as well incorporate means for shifting the tank portion or gland 53 so as to locate its center in alignment with the loads to be relieved. As well, in all forms of the invention various pneumatic or hydraulic fluids can be employed, air or other gaseous materials being indicated in FIGURES 4 and 5, while in FIGURES 6 and 7 the pressure applying means is water, although other hydraulic media could as well be used.

In FIGURE 8 adjustable deflection means 36b and 36c are employed in partially encircling relation with respect to an upper press roll 60 and lower press roll 61, respectively. The structure of the deflection means 36b and 36c in FIGURE 8 is essentially identical to that shown in FIGURES 6 and 7, and accordingly like numerals have been applied thereto, with the suffix "a" attached.

As in FIGURES 6 and 7, the rolls 60 and 61 are plain press rolls. However, it is within the contemplation of this invention that the deflection means herein disclosed may be used in connection with a back-up roll, the latter roll being in contact with a suction press roll which in turn is in nip defining relation with a plain press roll.

The pressure applying fluid in FIGURES 7 and 8 may be any of the media earlier indicated, and as well, the deflection means 36b and 36c may be constructed to permit circumferential shifting, in the event it was desired to position the rolls 60 and 61 in non-vertical alignment.

In any event, in order to obtain uniform nip loads across the contacting faces of the rolls 60 and 61, the pressure applied by the lower fluid-tight chamber 36a is determined by the nip load at N-1 plus the weight of the bottom roll 61, while the pressure applied by the upper fluid-tight chamber 36a is determined by the nip load less the weight of the top roll 60. By so proceeding, the nip loading can be varied for effective pressing of various grades of paper, and yet uniform nip pressures obtained across the roll faces by controlling the relative pressures in the upper and lower fluid-tight chambers 36a in the manner indicated.

Certain press applications employ a roll couple wherein the roll parts thereof are generally horizontally aligned or in this approximate relationship. The instant invention also accomplishes highly advantageous results therewith, and an exemplary arrangement of this type structure is shown in FIGURE 9. A press couple generally designated at 65 and comprising press rolls 66 and 67 is shown as incorporating therewith adjustable deflection means 36d. The force counteracting means 36d is de-

sirably constructed in the manner of the structure 36a, and accordingly, as in FIGURE 8, like numerals with the suffix "a" have been appended to like parts.

The deflection means 36d in FIGURE 9 is indicated with its arcuate center *p* generally in horizontal alignment with the radial centers of the rolls 66 and 67. The relative position of the deflection means with respect to the roll 66 of course depends upon the weights of both rolls 66 and 67 and the nip load at *N*-2. As for example, if in a particular application the nip load was 25 pounds per lineal inch of each roll and the rolls weighed the same amount, it is readily apparent by summing the vectors the deflection means 36d would then be shifted approximately 45° counterclockwise. However, regardless of the relative position of the deflection means 36d with respect to the roll 66, the pressure applied by the gland 53a is equal to the nip loading, although of course, when the rolls 66 and 67 are generally horizontally aligned as shown, the roll weights would not exert any substantial forces needing to be relieved.

It is of course apparent that both of the rolls 66 and 67 could be partially encircled by an adjustable deflection means, and normally the roll 67 would be the drive roll, although this would depend somewhat upon the particular sheet being pressed.

Under certain circumstances the combination described or variations thereof are advantageously applied in a calender such as shown in FIGURE 10. This provides a great increase in the versatility of either a press couple or a calender stack, permitting the papermaker to quickly and conveniently compensate for inevitable variations in the paper web, which compensation has never previously been available to him.

Referring now to FIGURE 10, there is shown a calender stack generally designated by the numeral 70 and comprising a bottom or king roll 71 and a plurality of relatively smaller diameter rolls 72-75 in general vertical alignment therewith. As is the practice in the art, the calender stack 70 is supported by a suitable frame (not shown), and the king roll is mounted in fixed bearings while the rolls 72-75 thereabove are so mounted to permit a degree of vertical movement. Since the bearing structure is conventional and forms no part of the instant invention, specific showings thereof have been omitted.

It is also known that the king roll 71 carries the weight of the rolls 72-75 and the bearings therefor, and accordingly, it has been the prior art practice to crown the king roll 71 to compensate for its deflection and to thereby attain generally uniform nip pressures. However, crowning is a relatively expensive machining operation and eventually recrowning is necessary because of gradual wear on the king roll. In addition, as was noted, the different peripheral speeds along various portions of the roll is often disadvantageous in press applications, and of course, a particular crown is only satisfactory for a specific load condition.

These problems are herein avoided by provision of deflection means 36e constructed as shown in the same manner as the earlier described forms of the invention, and accordingly bearing like numerals with the suffix "a" appended thereto. To compensate for deflection in the bottom or king roll 71, pressure is applied by the chamber 53a in an amount essentially equal to the nip load at *N*-3 and the weight of the king roll 71.

It may be observed from the preceding description directed to FIGURES 4 to 10 that the force relieving pressure is applied against the outer diameter of one or more rolls. The forces tending to deflect a roll can also be counteracted by the relieving pressure being directed against the inside surface or diameter of a roll, and this is shown in FIGURE 11. As appears therein, a roll generally designated by the numeral 80 may comprise an outer annular shell 81 and a coaxially spaced inner annular shell 82, the shells 81 and 82 receiving there-

between seal means 83 and 84 to define a pair of substantially fluid-tight chambers 85 and 86. The inner shell 82 is of course stationary while the outer shell 81 rotates thereabout by connection with suitable drive means (not shown). This arrangement resembles the familiar suction roll, in that the internal member is stationary and surrounded by a rotatable shell.

The roll 80 may be employed in any one of the applications earlier listed, and in order to relieve the forces tending to deflect the roll 80 a positive pressure can be applied to the chamber 85, or alternatively, a negative pressure can be applied to the chamber 86. Thus, a pressurized fluid can be admitted to the chamber 85 and no fluid to the chamber 86, or no pressure applied in the chamber 85 and vacuum applied in the chamber 86. In either event, there exists a pressure difference between the chambers 85 and 86, and this is controlled to essentially equal the forces tending to deflect the roll, which are of course, the roll weight plus nip loads or the forces applied by the forming wire when the roll 80 is used in an application of the type illustrated in FIGURES 4 and 5.

It will of course be appreciated that the stationary roll member 82 may be of solid construction, rather than in the shell form shown, and that fluid can be admitted to either of the semi-circular chambers 85 or 86. The chambers are of course sealed at opposite ends of the rolls 81 and 82, and illustratively, oil may be pumped into one of the semi-circular chambers 85 or 86 between the non-rotating roll 82 and rotatable shell 81 to provide a roll structure which is completely floating on oil.

This described arrangement permits a smaller diameter roll to be employed, as contrasted with the conventional journal roller, and further, this smaller diameter roll produces a substantially higher specific pressure since the line of contact is smaller.

Seal means 40 and 54 have been somewhat diagrammatically illustrated in the preceding views as located in close running relation with the outer diameter of the roll to seal the chamber 39 or 53 and to reduce leakage of the pressure relieving fluid in the chamber. The particular construction of the seal means may be widely varied, and in FIGURES 12 and 13 two exemplary forms of side seals are illustrated. As appears in FIGURE 12, tank or gland T is provided with a pair of side wall portions 90 and 91 connected at 92 and mounting plate means 93 to which is attached a rubbing strip 94 to wipe from roll R fluid in chamber 95.

Located thereabove and attached to the tank side wall portion 90 is bracket means 96 supporting a sealing strip 97 of a suitable plastic composition, shown as angularly disposed and in sealing relation with the roll R at 98. As is illustrated, the strip 97 is passaged at 97a to equalize the pressures on opposite sides thereof. To urge the sealing strip 97 into the position shown, inflatable tubular means 99 supported by mounting means 100 may be employed. The fluid to inflate the tubular member 99 is desirably air, and it is believed now apparent that during rotation of the roll R partially submerged in pressure relieving fluid in the tank T, excess fluid is wiped from the roll by the flexible strip 94 and substantial leakage of fluid passing the wiping strip 94 is prevented by the effective seal provided by the strip member 97.

The seal means may also take the form shown in FIGURE 13, wherein like numerals have been employed to designate like parts in FIGURE 12. As appears therein, mounting means 101 supports a seal member 102 having a plurality of grooves 102a formed therein. A fluid such as water is supplied from a conduit 103 by a pump means 104 through a connection 105 to the groove pattern to not only effectively seal the roll structure against excessive leakage, but to provide a lubricative effect. As in FIGURE 12, a wiping strip 105 may be employed, and this is conveniently mounted by the block member 101.

It is further desirable that the roll structure be sealed

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at opposite ends, and for this purpose the arrangement in FIGURE 14 may be employed. Tank or gland T located as earlier indicated with respect to roll R may mount at opposite ends web or rib members 107 to which is bolted or otherwise secured a semi-annular cap member 108. The cap member is suitably grooved to receive a plurality of inflatable tubular members 109 bearing against a semi-annular seal member 110 located in close running relation with opposite ends of the roll R. If desired, the seal means 110 may be secured to the cap member 108 at 111, and to achieve the desired lubricity between the seal means and the roll R, water or other fluid media may be directed between the roll ends and inner face of the seal means 110. As in FIGURE 12, the inflatable members 109 may carry air to force the seal means 110 into good sealing relation with the roll R, to prevent excessive fluid leakage from the tank T.

It has been noted hereinabove that the pressure relieving fluid used in the gland or tank chamber is susceptible of wide variation, and a number of pneumatic and hydraulic fluids were mentioned. It is desired if a liquid is employed to utilize a relatively low viscosity fluid in order to not introduce substantial fluid friction forces, which would have the effect of increasing the power requirements to drive the roll structures disclosed. It has further been stated hereinabove that the pressure relieving fluid is controlled in pressure to the desired level to compensate properly for the forces tending to cause roll deflection, and this can be attained either by control of the pump means 42, or by use of a conventional pressure regulator.

In this connection, the relieving pressure is actually relatively small since the area against which the relieving pressure acts is relatively large, and in the ultimate case, the area is the product of the roll outer diameter and roll face in contact with the pressure relieving fluid. As a specific example, assuming a maximum nip pressure in a press couple application of 300 pounds per lineal inch, a roll weight of 170 pounds per lineal inch, a roll diameter of 44 inches, and a roll face of "1" inch in contact with the pressure relieving fluid. Assuming that the roll to be relieved is in the bottom position and the outside loads operating thereon are essentially vertical, the pressure required in the pressure relieving chamber can readily be calculated to be 10.8 pounds per square inch. As is apparent, this value can be readily attained with many fluids by conventional pressure control systems.

It is of course appreciated that some fluid leakage will occur, even though seal means are employed as described. If air is employed as the pressure relieving fluid, illustratively it can be assumed that the total leakage area would be equivalent to about a one-half inch diameter orifice. Assuming a gauge pressure within the pressure relieving chamber of 15 p.s.i.g., the leakage air flow is about 108 cubic feet of free air per minute. The theoretical horsepower required to compress this air volume from atmospheric pressure to 15 p.s.i.g., using single stage adiabatic compression, is approximately 5.4 horsepower.

As is further appreciated, the pump means 42 are ef-

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fective to direct to the pressure relieving chamber defined by the tank or gland sufficient fluid to replace the small amount of fluid lost by leakage. In this connection, suitable trap means would be employed to collect the fluid leakage and any overflow into the nonpressured, or low pressure chamber, and in the roll structure of FIGURE 11 it may be desirable to provide a drain connection diagrammatically indicated at 112 and communicating with the chamber 86 to drain excess fluid therefrom through an end of the roll structure 82.

The numerous applications for the instant invention, in the paper machine art and in other industries wherein roll deflection problems are presented, have been pointed out hereinabove, and as well the different fluids which could be used for pressure relieving purposes have been stated. Numerous structural embodiments of the invention have been illustrated and described, and it is accordingly believed quite apparent that numerous other changes and modifications can be effected without departing from the novel concepts of this invention.

I claim as my invention:

1. Apparatus for controlling the deflection in a roll member, comprising means forming a substantially fluid-tight chamber located in partially encircling relation with respect to the roll member, means for supplying a pressurized fluid to said chamber at pressure calculated to oppose the forces tending to cause said deflection, and means for shifting the chamber circumferentially with respect to the roll member to locate generally the center of said chamber in alignment with the sum of all forces tending to cause the deflection.

2. Apparatus for controlling the deflection in an imperforate roll member, comprising a tank wrapping a portion of the circumference of the roll member and spaced radially therefrom to provide with said roll member a force relieving chamber, seal means between said tank and roll member to prevent excessive leakage of fluid, and means for supplying a pressurized fluid to said chamber at a pressure calculated to balance the forces tending to cause said deflection, and means for shifting the chamber circumferentially with respect to the roll member to locate generally the center of said chamber in alignment with the sum of all forces tending to cause the deflection.

References Cited in the file of this patent

UNITED STATES PATENTS

705,071	Graham	July 22, 1902
1,563,130	Weston	Nov. 24, 1925
1,870,971	Sundstrom	Aug. 9, 1932
2,395,915	Specht	Mar. 5, 1946
2,648,122	Hornbostel	Aug. 11, 1953
2,877,694	Thiessen	Mar. 17, 1959
2,908,964	Appenzeller	Oct. 20, 1959
2,911,040	Hornbostel	Nov. 3, 1959
3,031,872	Kusters	May 1, 1962

FOREIGN PATENTS

1,037,397	Germany	Aug. 28, 1958
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