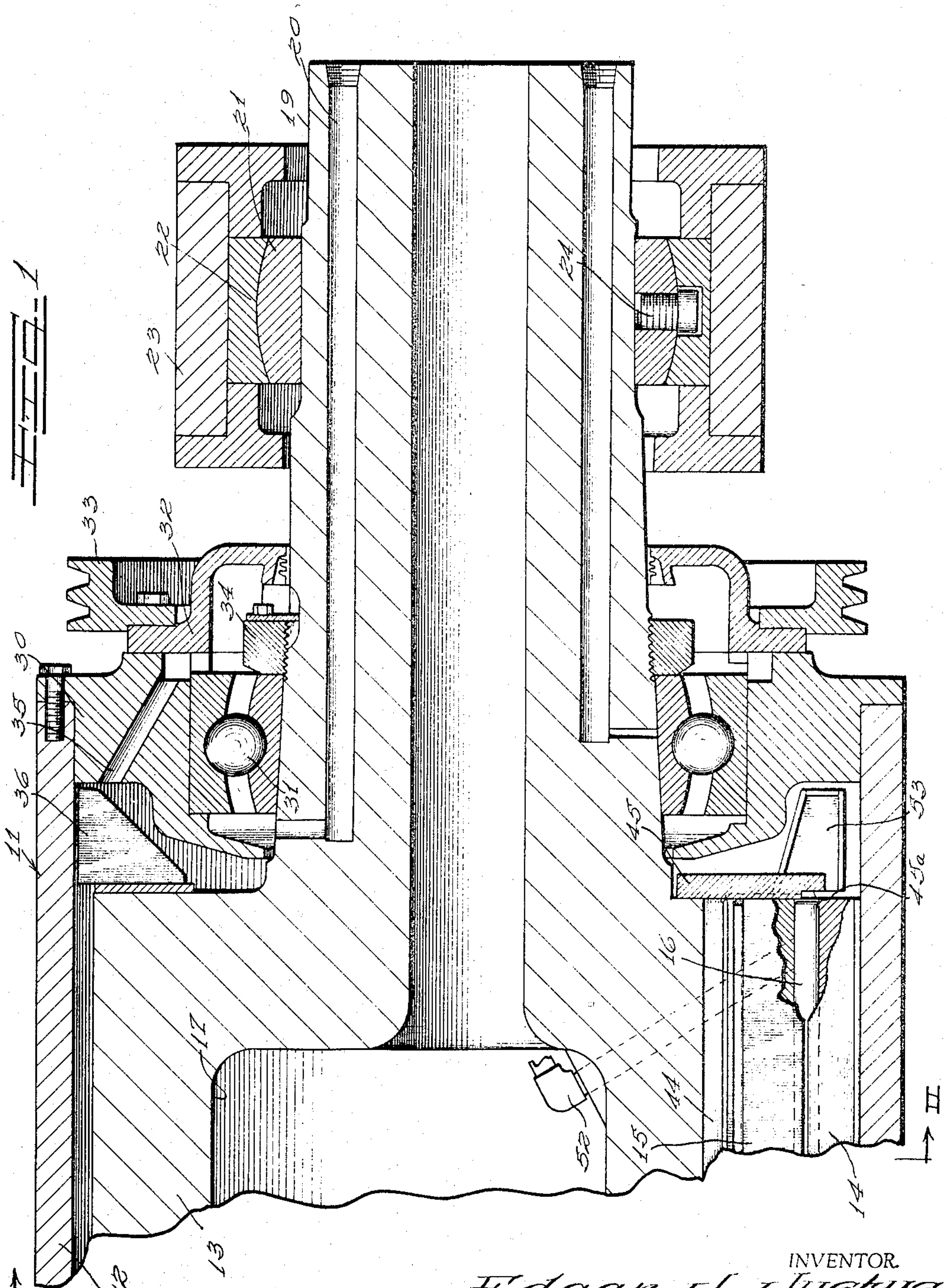
Oct. 4, 1966 E. J. JUSTUS 3,276,102

ADJUSTABLE CROWN ROLL

Filed Jan. 24, 1964 6 Sheets-Sheet 1



INVENTOR.

Edgar J. Justus

BY

Hill, Sherman, Meroni, Gross & Simpson

ATTORNEYS

Oct. 4, 1966

E. J. JUSTUS

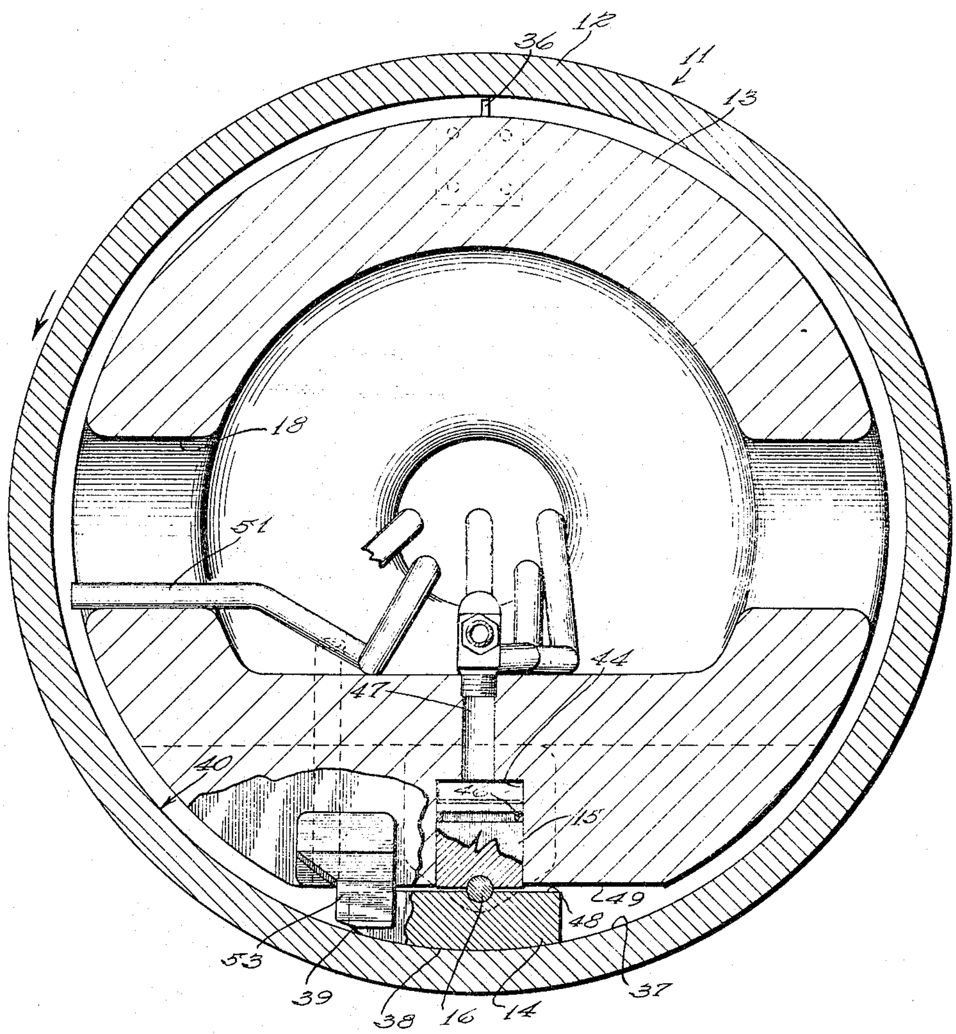
3,276,102

ADJUSTABLE CROWN ROLL

Filed Jan. 24, 1964

6 Sheets-Sheet 2

FIG. 2



INVENTOR.

Edgar J. Justus

BY

Hill, Sherman, Meroni, Gross & Simpson

ATTORNEYS

Oct. 4, 1966 E. J. JUSTUS 3,276,102

ADJUSTABLE CROWN ROLL

Filed Jan. 24, 1964 6 Sheets-Sheet 3

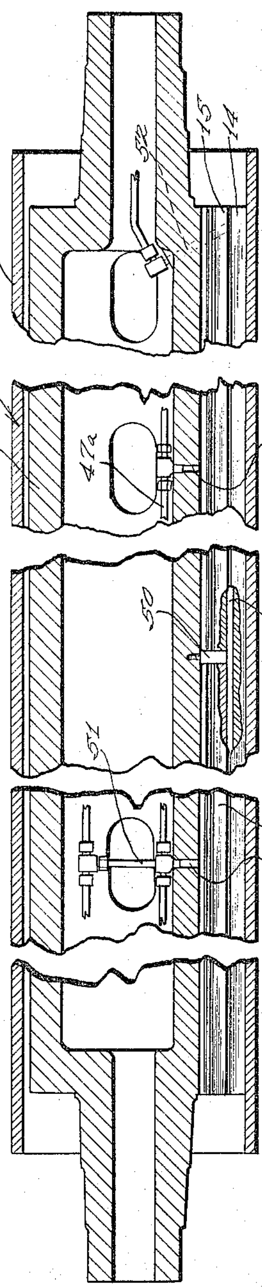


Fig. 3

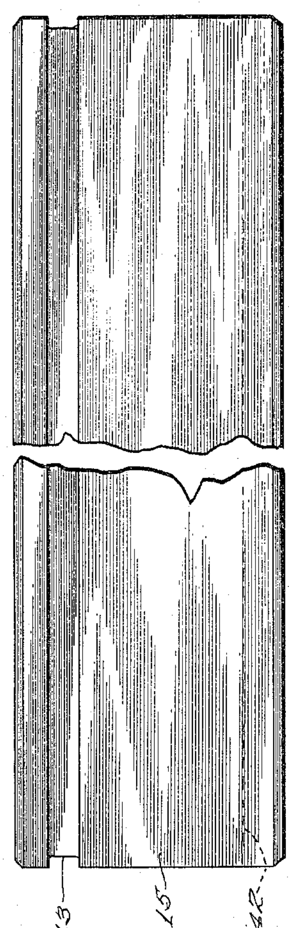


Fig. 6

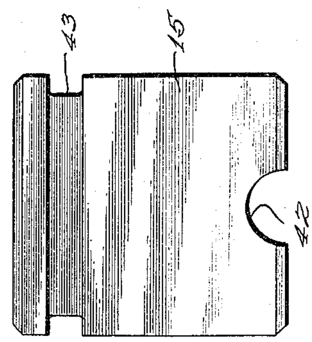


Fig. 7

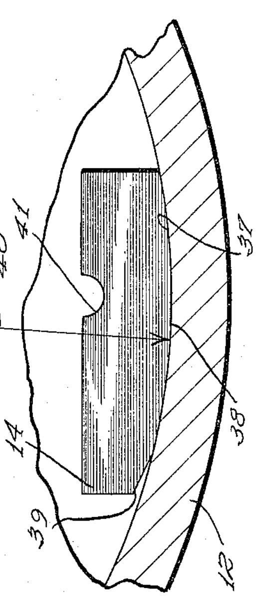


Fig. 5

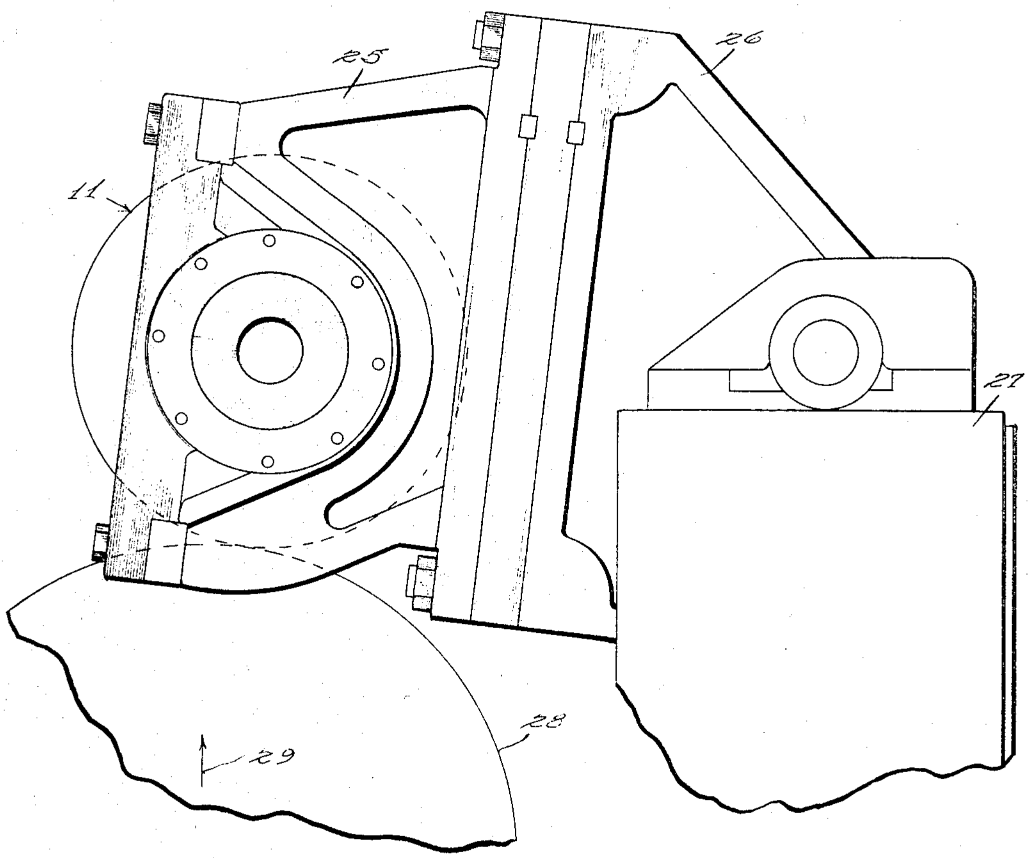
INVENTOR.
Edgar J. Justus
BY
Hill, Sherman, Meroni, Gross & Simpson
ATTORNEYS

Oct. 4, 1966 E. J. JUSTUS 3,276,102

ADJUSTABLE CROWN ROLL

Filed Jan. 24, 1964 6 Sheets-Sheet 4

FIG. 8



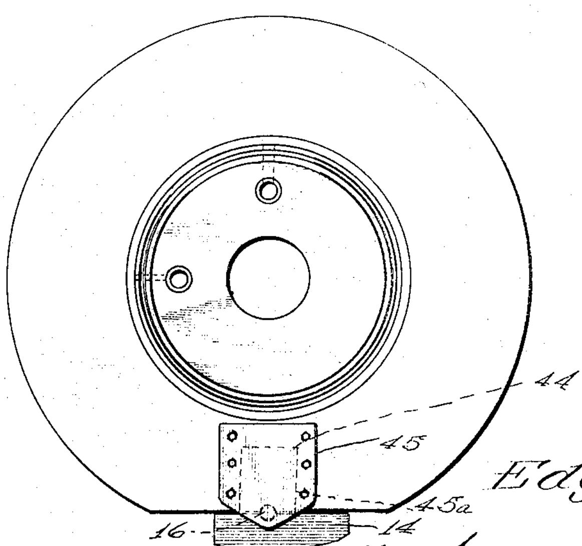


FIG. 4

INVENTOR.

Edgar J. Justus

BY

Hill, Sherman, Meroni, Gross & Simpson

ATTORNEYS

Oct. 4, 1966 E. J. JUSTUS 3,276,102

ADJUSTABLE CROWN ROLL

Filed Jan. 24, 1964 6 Sheets-Sheet 5

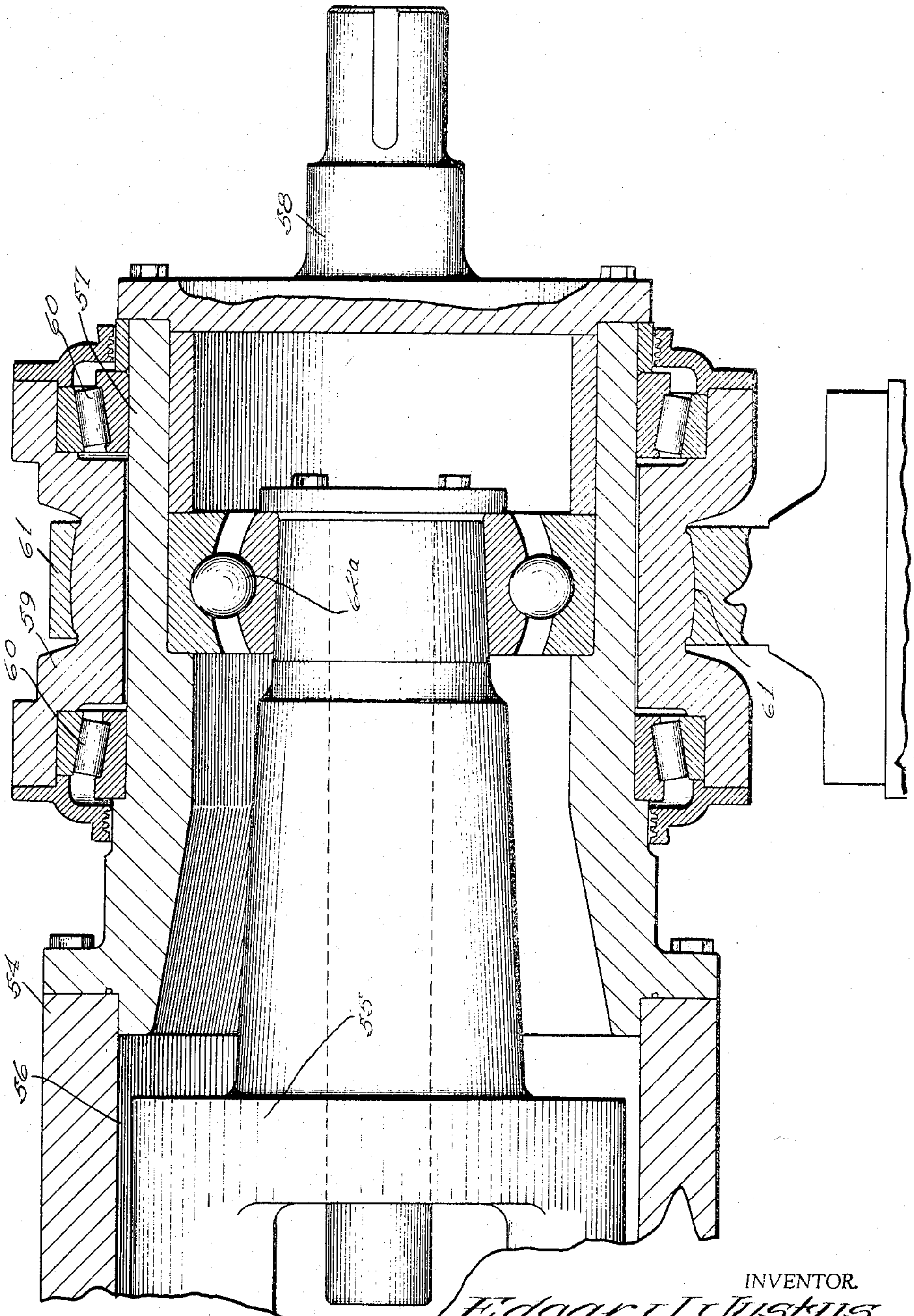


FIG. 9

INVENTOR.
Edgar J. Justus
BY
Hill, Sherman, Meroni, Gross & Simpson
ATTORNEYS

FIG. 10

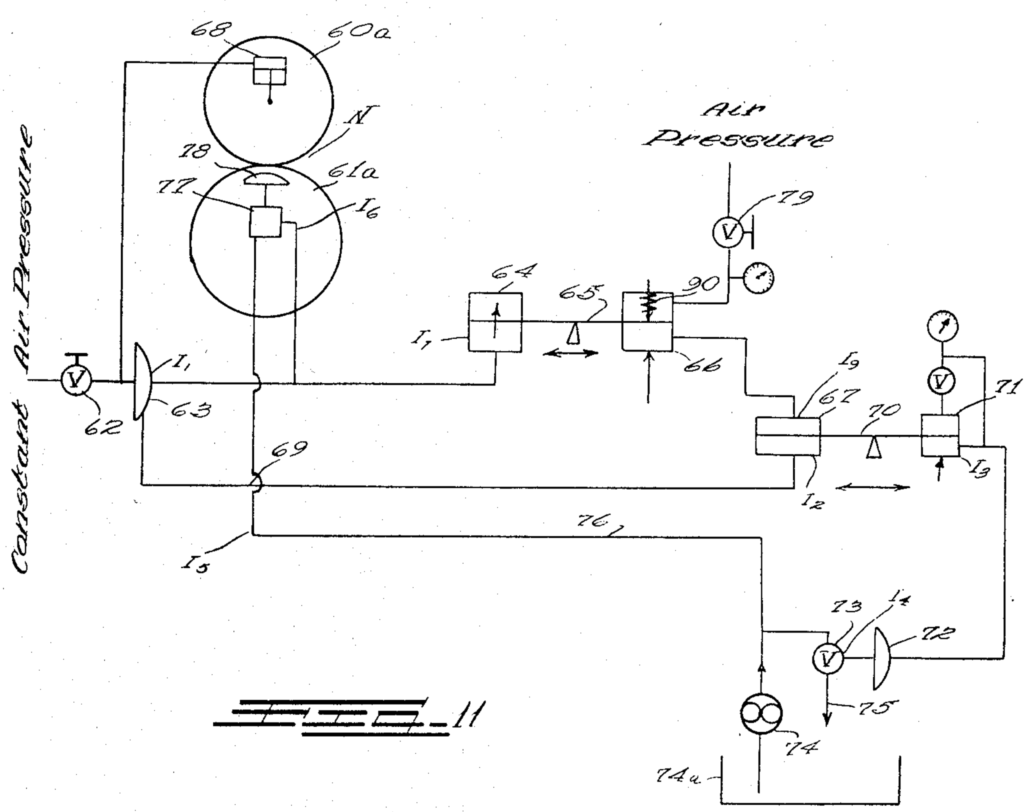
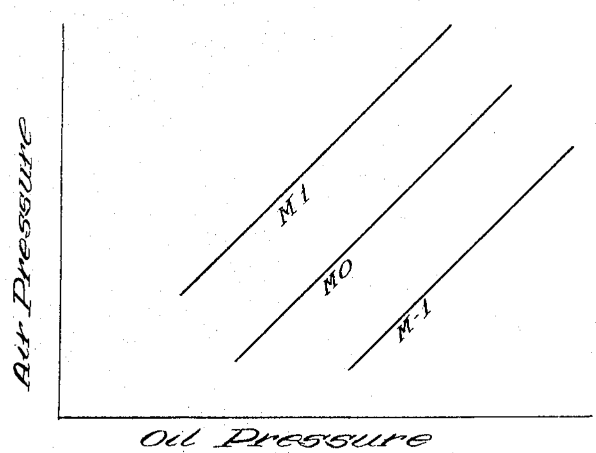


FIG. 11



INVENTOR.
Edgar J. Justus
BY
Hill, Sherman, Meroni, Gross & Simpson
ATTORNEYS

United States Patent Office

3,276,102
Patented Oct. 4, 1966

1

3,276,102
ADJUSTABLE CROWN ROLL

Edgar J. Justus, Beloit, Wis., assignor to Beloit Corporation, Beloit, Wis., a corporation of Wisconsin
Filed Jan. 24, 1964, Ser. No. 339,998
14 Claims. (Cl. 29—116)

This application is a continuation-in-part of application Serial No. 52,456, now Patent No. 3,119,324, filed August 29, 1960.

The present invention relates to improvements in rolls and particularly to an improved roll structure for obtaining controlled nip pressure between a roll couple.

In roll couples forming pressure nips therebetween roll deflection occurs when loads are applied to the rolls to obtain pressures in the nip. Various arrangements have been employed to obtain either a controlled or a uniform nip load along the length of the nip. Crowned rolls are usually satisfactory only for one predetermined nip load and other mechanical and hydraulic nip loading devices have not proven entirely satisfactory. The provision of uniform nip pressure is particularly important in papermaking machinery, for example, wherein the uniform treatment of a web of paper across its width is essential to obtaining a uniform and satisfactory product, and in a wet press, for example, uniform extraction of water is dependent upon uniform nip load, and in a satisfactory machine provisions must be made for varying the overall nip load.

An object of the present invention is to provide an improved roll structure which utilizes a cylindrical roll shell supported and loaded on its inner surface by a shoe means opposite the nip which is particularly satisfactory in obtaining uniform nip pressures over a range of overall nip loads and is capable of continuous high speed long operating life without rapid wear and without requiring frequent part replacement or servicing attention.

A further object of the invention is to provide an improved roll assembly capable of controlled deflection for obtaining a uniform nip load which is relatively inexpensive to construct and avoids disadvantages of the structures heretofore available.

A still further object of the invention is to provide an improved roll assembly having a roll shell with an inner supporting shoe means wherein superior lubrication is maintained between the shoe means and the shell, and the provision of extensive fluid seals or close manufacturing tolerances is avoided.

A still further object of the invention is to provide an improved control deflection roll having an outer roll shell supported on its inner surface opposite its nip area having features which make it particularly satisfactory for use in high speed papermaking machines at the nip loads required and which provides advances over structures heretofore available that make it practical for commercial use in such environments.

The mechanism contemplates providing a roll assembly including an outer elongate tubular cylindrical roll shell with a non-rotatable shaft means extending through the shell, means supporting the shaft means, bearing means between the roll shell and shaft means for positioning the roll shell, an elongate limber shoe means having an outer surface co-extensive with the length of the roll shell and being in axially continuous supporting engagement with the inner surface of the roll shell opposite a nip formed with another roll with said surface being rigidly shaped to build up a supporting film of lubricating fluid during relative rotation of the roll shell from fluid within the shell, a controlled fluid pressure loading means mounted on the shaft means applying radially outwardly directed forces to said shoe means along the length thereof so that a continuous nip loading force is maintained within the roll shell, and means pivotally supporting said shoe means for pivotal movement relative to the inner surface of the roll shell to conform to the pressure of the fluid lubricating film between the surface of the shoe means and roll shell.

2

Other objects, advantages and features of the invention will become more apparent with the teaching of the principles thereof in connection with the disclosure of the preferred embodiment in the specification, claims and drawings, in which:

FIGURE 1 is a vertical sectional view taken through the axis of a controlled deflection roll constructed and operating in accordance with the principles of the present invention, showing one end of the roll;

FIGURE 2 is a vertical sectional view taken substantially on line II—II of FIGURE 1;

FIGURE 3 is a smaller sectional view, similar to FIGURE 1, illustrating the arrangement along the length of the roll;

FIGURE 4 is an enlarged detailed fragmentary view showing the end plate at the end of the fluid pressure channel;

FIGURE 5 is a fragmentary sectional view illustrating the structure of the bearing shoe;

FIGURE 6 is a fragmentary side elevational view of the pivot bar;

FIGURE 7 is an end elevational view of the pivot bar;

FIGURE 8 is a fragmentary end elevational view showing an arrangement for two pressure rolls;

FIGURE 9 is a fragmentary vertical sectional view showing an arrangement whereby the controlled deflection roll is driven;

FIGURE 10 is a schematic showing of the fluid pressure circuits and control for the controlled deflection roll; and

FIGURE 11 is a graph showing pressure relationships for changing nip pressures and roll deflection.

As shown on the drawings:

FIGURES 1–3 show a controlled deflection roll assembly **11** which operates in a roll couple with a second roll in the manner illustrated in FIGURE 8. The roll assembly includes an elongate cylindrical hollow roll shell **12** with a core or inner stationary shaft means **13** extending therethrough. The roll shell **12** is supported opposite the nip by a shoe means **14** which slidingly engages the inner surface of the roll shell **12**.

The shoe **14** is supported for applying a force to the roll shell by an elongate axially extending piston means or pivot bar **15**. The shoe **14** is pivotally supported so as to tiltably conform to the inner surface of the shell **12** and the film of supporting lubricating fluid which builds up between the shoe **14** and inner surface of the shell **12**. For providing the pivotal support an elongate pivot pin **16** is positioned between the pivot bar **15** and the shoe **14**.

The inner non-rotatable shaft **13** has a hollow center **17**, being substantially tubular in shape within the roll shell **12**, and has radial openings such as **18** for accommodating tubing. At the ends of the shaft are shaft ends **19** which are centrally hollow to accommodate tubing, and bearing lubricating passages **20** extend axially into the shaft ends **19**.

For supporting the roll assembly the shaft is supported at the ends on self-aligning bearings having parts **21** and **22** and a surrounding support **23** which is suitably mounted in a bracket such as shown in FIGURE 8. The bearing parts **21** and **22** are prevented from rotating relatively to thereby hold the shaft **13** against rotation by a threaded pin **24**.

In the roll mounting of FIGURE 8, the upper controlled deflection roll **11** is supported on a bracket **25** secured to a mounting bracket 26 on a machine frame 27. The controlled deflection roll 11 forms a nip with a lower roll 28 which is suitably supported and may be loaded at its ends by suitable mechanism such as that shown schematically by the arrowed line 29 to control the overall nip pressure. An arrangement of this type provides a press couple for a wet press of a paper machine and while the features of the invention are particularly well adapted to use in paper machinery for presses, calenders and the like it will be appreciated that they may be employed in other environments.

As shown in FIGURE 1, for holding the roll shell 12 in place and maintaining it in alignment with its mating roll, bearing rings 30 are bolted to the ends of the roll shell and are supported on bearings 31 on the ends 19 of the shaft. These may be Torrington type bearings secured by a threaded bearing ring 34. Bolted to the bearing ring 35 is an outer ring 32 carrying a sheave 33 for driving the roll shell 12 for finishing the outer surface thereof in preparation for use. The ring 32 has an inwardly extending flange for preventing the escape of lubricant from the bearing 31. The lubricant is supplied through the passage 20 and excess lubricant passes centrifugally out through the passages 35 into the interior of the roll shell and lubricant deflectors 36 bolted to the end of the shaft 13 clear the ends of the oil passages 35 within the shell so that the oil can escape and be returned through the return line as will be later described.

As shown in FIGURES 1–3, the inner surface 37 of the roll shell 12 is smooth and the outer surface 38, FIGURES 2 and 5 is formed to a radius 40 the same as the radius of the inner surface 37 of the shell 12. The leading end of the shoe 14 is removed to provide either a curved or, as shown, a flat surface 39 providing a lubricant collecting wedge shaped area which builds up a film of supporting fluid between the outer surface 38 of the shoe and the inner surface 37 of the shell. The pivotal support of the shoe 14 permits it to accommodate the building up of this supporting layer of fluid and permits the equalization of the pressure of the fluid over the outer surface 38 of the shoe. With this arrangement the sliding engagement between the shoe 14 and the shell 12 can occur at high speeds required by modern papermaking machinery without undue wear and without the generation of undue heat. Thus, because of the rigid outer shape of the shoe with its leading relieved nose surface 39, and because of the pivotal support of the shoe 14 successful high speed continued support can be achieved.

Another factor which contributes materially to the successful relationship between the shoe 14 and shell 12 is the provision of a shoe 14 with a continuous elongate outer surface 38 which is co-extensive with the length of the shell. By providing a continuous outer surface no concentrations of stress occur and no bending of the shell occurs at unsupported locations. Also there are no nonuniformities along the length of the shell with respect to the generation of heat due to the friction and uniform support is maintained along the entire length of the nip. The shoe 14 is relatively limber so that it can bend with bending of the roll while maintaining a uniform nip pressure and is preferably formed of a chilled casting cold worked 3–5% before machining. While a preferred arrangement is illustrated, it will be understood that the shoe could be formed in sections, with each section being independent but abutting each other so that the outer surface 38 would still provide a continuous support for the shell. Thus, reference herein to a continuous supporting surface in an axial direction encompasses the surface provided by a one-piece limber beam or by a beam formed in a number of pieces with the pieces closely abutting each other in an axial direction.

For providing the pivotal support for the shoe 14, an axially extending arcuate recess 41 is provided on the inner surface of the shoe, and a similar recess 42, shown in FIGURES 6 and 7, is provided in the pivot bar 15. These recesses 41 and 42 are formed to the radius of the

pin 16, which may be in sections along its length. The pivot pin is held at the recesses due to the forces between the pivot bar 15 and the shoe 16.

The pivot bar has a recess 43 extending on all surfaces near its base for receiving an O-ring to provide a seal for the liquid in an axially extending channel 44 in which the pivot bar 15 slides.

The channel 44 is rectangular in shape and is cut for the full length of the shaft 13. The channel can easily be milled and its ends are closed by end plates 45. The inner surfaces of the end plates are relieved at *45a* substantially in line with the surface 49 of the core with the relieved portion preventing the pin 16 from working axially out of the grooves. The end plates are conveniently bolted in place by bolts extending into tapped holes in the shaft.

The shaft 13 is formed with a planar surface 49 on each side of the channel 44, and the shoe 14 is wider than the width of the channel 44 so as to have surfaces 48 on each side of the channel which seat on the shaft surface 49 when pressure is relieved from the channel 44, but which clear the surface 49 during normal operation.

For delivering fluid under pressure to the channel pressure lines 47 lead to the channel from a main pressure line *47a*.

The channel is shown as formed in sections with dividers 50 between each of the sections and with the pivot bar 15 similarly formed in sections and the sections abutting the dividers 50. The dividers are conveniently formed by rectangular blocks which are set into the channel and held in place by bolts tapped into the top of the blocks with a sealing material around the edge of the blocks. With this arrangement fluid at different pressures can be directed to the different compartments into which the channel is divided by the dividers 50, although usually for maintaining uniform nip pressure the compartments will be interconnected as shown. Fluid pressure is preferably provided by hydraulic oil delivered from a controlled output pump.

For maintaining lubricating fluid such as oil within the inner surface of the shell 12 a lubricating line 51 directs a stream of oil against the inner surface of the shell ahead of the shoe 14. This oil spreads out and provides the built-up layer of lubricating film which forms between the shoe and the shell. Excess oil is returned through an oil return line 52, FIGURES 1 and 3; for aiding in returning the oil, scoops 53 are mounted at the ends of the shaft adjacent the ends of the shoe 14 at the leading edge thereof. These scoops gather up the excess oil that spreads out beyond the end of the shoe and feed it to the return lines 52.

Thus, in operation, lubricating fluid is continually supplied to the inner surface of the shell 12 through the lubricating supply line 51, and a film of lubricating oil builds up in the wedge shaped relieved leading edge 39 of the shoe 14 to build up a supporting film between the outer surface 38 of the shoe and the inner surface 37 of the roll shell 12. Excess oil is returned through the return lines 52. The shoe 14 provides the outer surface 38 which affords continuous support co-extensive with the roll shell 12.

FIGURE 9 shows an arrangement for continually driving a roll shell during operation. A roll shell 54 is provided with an axially extending annular end extension 57 that is carried in spaced bearings 60. The outer race of the bearings 60 is supported in a self-aligning bearing 61 which accommodates the bending which will occur without stress.

The bearings 60 also support the load on the inner shaft 55 supporting the shoe 56. The shaft 55 is supported at its ends on bearings *62a* which are carried in the annular extension 57 which is supported by the bearings 60. The extension is also provided with an end 58 to which a drive sheave is secured.

FIGURE 10 shows schematically a pressure control arrangement wherein an initial pressure change is made in the force applied to a roll mounted in fixed bearings, and an automatic change is made to the pressure applied to the inner surface of the roll shell. Forces may be applied to the end of an upper roll **60**a by air cylinders **68** at the ends of the roll to control roll bending with air being supplied from an adjustable air pressure valve **62**. The valve **62** may be manually operated or may be automatically controlled in response to other operational factors of the machine.

The air pressure signal is supplied to a responsive diaphragm **63** which supplies a pressure signal through lines **69** to a diaphragmed pressure balancing chamber **67**. The diaphragm of the chamber **67** is connected to a pivotal arm **70** which connects to a diaphragm of a chamber **71**. The arm **70** is mounted on an adjustable pivot point and the unit including chamber **67** and **71** is of the type which is available commercially, such as for example, a Hagen ratio totalizer. For convenience of reference, the pressure signals are referred to by the letter I, with the initial air pressure signal I_1 being supplied at the diaphragm **63**, and transmitted through the line **69** to register at I_2 and be converted into a signal I_3. The signal I_3 is supplied to a pressure responsive diaphragm **72** which provides a signal I_4 to control a by-pass valve **73** that regulates the pressure output of an oil pump **74** receiving oil from a tank **74**a.

The output of the pump **74** is supplied through an oil pressure line **76** to a chamber **77** operating on a piston beneath at loading shoe **78** within a roll shell **61**a. The shell **61**a forms a nip N with the upper roll **60**. In the arrangement of FIGURE 10 the loaded roll shell is shown below the mating roll **60**a and it will be understood that the roll shell may be either above or below the mating roll and is not limited to a particular position. The pressure supplied through the line **76** is shown as I_5, and a pressure indication signal I_6 is fed from the cylinder **77** to the diaphragm within a pressure chamber **64**. The diaphragm acts on a lever arm **65** with its pressure signal I_7, to be converted to a pressure signal I_8 by acting on a diaphragm within a pressure chamber **66**, connected to the lever arm **65**. The diaphragm is loaded by a spring **90** but the resistance pressure of the spring **90** can be altered by a modifying signal provided from a valve **79** from a constant air pressure line. By changing the air pressure supply through the valve **79**, the relationship between the air pressure and oil pressure can be changed to change the crown of the roll **60**a. FIGURE 11 shows three curves M_1, M_0, and M_{-1}, which result from three different settings of the valve **79**. The unit including chambers **64** and **66** can also be a Hagen ratio totalizer or equivalent mechanism.

The output signal I_7 is supplied to the upper portion of the chamber **15** as signal I_9. The signal I_9 will thus influence the position of the arm **70** and accordingly the pressure transmitted to the channel **77**. Changes in the slopes of the pressure relationships M_1, M_0, and M_{-1} can be varied by changing the location of the pivot point for either the lever arms **65** or **70**.

Thus is will be seen that I have provided an improved controlled deflection roll arrangement which meets the objectives and advantages above set forth, and which is capable of obtaining uniform or controlled nip pressure avoiding advantages encountered in devices heretofore available.

The drawings and specifications present a detailed disclosure of the preferred embodiments of the invention, and it is to be understood that the invention is not limited to the specific forms disclosed, but covers all modifications, changes and alternative constructions and methods falling within the scope of the principles taught by the invention.

I claim as my invention:

1. A roll assembly for forming a pressure nip with a second roll comprising:

an outer tubular cylindrical roll shell,

a non-rotatable shaft means extending through said shell,

means supporting said shaft means,

bearing means between the roll shell and shaft for positioning the roll shell and to maintain it in alignment with the second roll,

a rigid elongate limber shoe means bendable over its length having an outer surface substantially coextensive with the length of the roll shell and being in axially continuous supporting engagement with the inner surface of the shell opposite the nip with said surface being rigid and of substantially the same radius of curvature as the inner surface of the roll shell and having a leading nose surface spaced from and facing the oncoming roll shell inner surface to build up a supporting film of lubricating fluid during relative rotation of the roll shell from fluid within the shell,

and a controlled fluid pressure loading means mounted on said shaft means applying radially outwardly directed forces to said shoe means along the length thereof so that a continuous nip loading force is maintained within the roll shell independent of bending of the nip with load.

2. A roll assembly for forming a pressure nip with a second roll comprising:

an outer tubular cylindrical roll shell,

a non-rotatable shaft means extending through said shell,

means supporting said shaft means,

bearing means between the roll shell and shaft for positioning the roll shell and to maintain it in alignment with the second roll,

a shoe means having an outer surface axially substantially coextensive with the roll shell for continuous supporting engagement therewith and having a radial outer surface of substantially the same radius of curvature as the inner surface of the roll shell and having a leading nose surface spaced from and facing the oncoming roll shell inner surface to build up a supporting film of lubricating fluid during relative rotation of the roll shell from fluid within the shell,

means delivering lubricating fluid within the roll shell against the inner surface thereof in advance of said shoe means,

and a controlled fluid pressure loading means mounted on said shaft means applying radially outwardly directed forces to said shoe means along the length thereof so that a continuous nip loading force is maintained within the roll shell independent of bending of the nip with load.

3. A roll assembly for forming a pressure nip with a second roll comprising:

an outer tubular cylindrical roll shell,

a non-rotatable shaft means extending through said shell,

means supporting said shaft means,

bearing means between the roll shell and shaft for positioning the roll shell and to maintain it in alignment with the second roll,

a shoe means having an outer surface substantially co-extensive with the length of the roll shell and being in axially continuous supporting engagement with the inner surface of the shell opposite the nip,

said surface being arcuate and convex and of substantially the same radius of curvature as the inner surface of the roll shell and having a leading nose surface spaced from and facing the oncoming roll shell inner surface for building up a supporting film of lubricating fluid between the roll shell and shoe means from fluid within the roll shell, and a controlled fluid pressure loading means mounted on said shaft means applying radially outwardly directed forces to said shoe means along the length thereof so that a continuous nip loading force is maintained within the roll shell independent of bending of the nip with load.

4. A roll assembly for forming a pressure nip with a second roll comprising:

an outer tubular cylindrical roll shell,

a non-rotatable shaft means extending through said shell,

means supporting said shaft means,

bearing means between the roll shell and shaft for positioning the roll shell and to maintain it in alignment with the second roll,

a shoe means having an outer surface axially substantially co-extensive with the roll shell for continuous supporting engagement therewith and having a rigid radial outer surface of substantially the same radius of curvature as the inner surface of the roll shell and having a leading nose surface spaced from and facing the oncoming roll shell inner surface to build up a supporting film of lubricating fluid during relative rotation of the roll shell from fluid within the shell,

a controlled fluid pressure loading means mounted on said shaft means applying radially outwardly directed forces to said shoe means along the length thereof so that a continuous nip loading force is maintained within the roll shell independent of bending of the nip with load,

means defining an axially elongate radially outwardly facing channel on said shaft means,

a fluid pressure line connected to said channel means,

and an elongate piston means supported by the fluid in said channel means supporting said shoe means for applying a radial nip loading force to said roll shell.

5. A roll assembly for forming a pressure nip with a second roll comprising:

an outer tubular cylindrical roll shell,

a non-rotatable shaft means extending through said shell,

means supporting said shaft means, bearing means between the roll shell and shaft for positioning the roll shell and to maintain it in alignment with the second roll,

a shoe means having an outer surface axially substantially co-extensive with the roll shell for continuous supporting engagement therewith and having a rigid radial outer surface of substantially the same radius of curvature as the inner surface of the roll shell and having a leading nose surface spaced from and facing the oncoming roll shell inner surface to build up a supporting film of lubricating fluid during relative rotation of the roll shell from fluid within the shell, a controlled fluid pressure loading means mounted on said shaft means applying radially outwardly directed forces to said shoe means along the length thereof so that a continuous nip loading force is maintained within the roll shell independent of bending of the nip with load,

means defining an axially elongate radially outwardly facing channel on said shaft means,

a fluid pressure line connected to said channel means,

an elongate piston means supported by the fluid in said channel means supporting said shoe means for applying a radial nip loading force to said roll shell,

and a pivotal connection between said piston means and shoe means supporting the shoe means on an axis parallel to the roll shell for accommodating the film of fluid built up between the inner surface of the roll shell and the shoe means.

6. A roll assembly for forming a pressure nip with a second roll comprising:

an outer tubular cylindrical roll shell,

a non-rotatable shaft means extending through said shell,

means supporting said shaft means,

bearing means between the roll shell and shaft for positioning the roll shell and to maintain it in alignment with the second roll,

a shoe means having an outer surface axially substantially co-extensive with the roll shell for continuous supporting engagement therewith and having a rigid radial outer surface of substantially the same radius of curvature as the inner surface of the roll shell and having a leading nose surface spaced from and facing the oncoming roll shell inner surface to build up a supporting film of lubricating fluid during relative rotation of the roll shell from fluid within the shell,

a controlled fluid pressure loading means mounted on said shaft means applying radially outwardly directed forces to said shoe means along the length thereof so that a continuous nip loading force is maintained within the roll shell independent of bending of the nip with load,

means defining an axially elongate radially outwardly facing channel on said shaft means,

a fluid pressure line connected to said channel means,

an elongate piston means supported by the fluid in said channel means supporting said shoe means for applying a radial nip loading force to said roll shell,

radially facing axially extending recesses in the shoe means and piston means,

and an axially extending pivot pin means in said recesses pivotally supporting the shoe means for accommodating the film of fluid built up between the inner surface of the roll shell and the shoe means.

7. A roll assembly for forming a pressure nip with a second roll comprising:

an outer tubular cylindrical roll shell,

a non-rotatable shaft means extending through said shell,

means supporting said shaft means,

bearing means between the roll shell and shaft for positioning the roll shell and to maintain it in alignment with the second roll,

a shoe means having an outer surface axially substantially co-extensive with the roll shell for continuous supporting engagement therewith and having a radial outer surface rigidly shaped to build up a supporting film of lubricating fluid during relative rotation of the roll shell from fluid within the shell,

a controlled fluid pressure loading means mounted on said shaft means applying radially outwardly directed forces to said shoe means along the length thereof so that a continuous nip loading force is maintained within the roll shell independent of bending of the nip with load,

means defining an axially elongate radially outwardly facing channel on said shaft means,

a fluid pressure line connected to said channel means,

an elongate piston means supported by the fluid in said channel means supporting said shoe means for applying a radial nip loading force to said roll shell,

and a radially outwardly facing shoe support surface on said shaft means beside said channel means,

said shoe means being circumferentially wider than the channel and resting on said surface with the collapse of pressure in said channel means.

8. A roll assembly for forming a pressure nip with a second roll comprising:

an outer tubular cylindrical roll shell,

a non-rotatable shaft means extending through said shell,

means supporting said shaft means, bearing means between the roll shell and shaft for positioning the roll shell and to maintain it in alignment with the second roll, a shoe means having an outer surface axially substantially co-extensive with the roll shell for continuous supporting engagement therewith and having a rigid radial outer surface of substantially the same radius of curvature as the inner surface of the roll shell and having a leading nose surface spaced from and facing the oncoming roll shell inner surface to build up a supporting film of lubricating fluid during relative rotation of the roll shell from fluid within the shell,

a controlled fluid pressure loading means mounted on said shaft means applying radially outwardly directed forces to said shoe means along the length thereof so that a continuous nip loading force is maintained within the roll shell independent of bending of the nip with load,

means defining an axially elongate radially outwardly facing channel on said shaft means,

a fluid pressure line connected to said channel means,

and a plurality of pistons located in said channel means each supported by the fluid in said channel means and each supporting said shoe means for applying a radial nip loading force to said roll shell.

9. A roll assembly for forming a pressure nip with a second roll comprising:

an outer tubular cylindrical roll shell,

a non-rotatable shaft means extending through said shell,

means supporting said shaft means,

bearing means between the roll shell and shaft for positioning the roll shell and to maintain it in alignment with the second roll,

a shoe means having an outer surface axially substantially co-extensive with the roll shell for continuous supporting engagement therewith and having a rigid radial outer surface of substantially the same radius of curvature as the inner surface of the roll shell and having a leading nose surface spaced from and facing the oncoming roll shell inner surface to build up a supporting film of lubricating fluid during relative rotation of the roll shell from fluid within the shell,

a controlled fluid pressure loading means mounted on said shaft means applying radially outwardly directed forces to said shoe means along the length thereof so that a continuous nip loading force is maintained within the roll shell independent of bending of the nip with load,

means defining an axially elongate radially outwardly facing channel on said shaft means,

a plurality of pistons located in said channel means each supported by the fluid in said channel means and each supporting said shoe means for applying a radial nip loading force to said roll shell,

rigid dividers in said channel means between said pistons separating the channel means into a plurality of individual chambers,

and fluid pressure lines connected to the chambers.

10. A roll assembly for forming a pressure nip with a second roll comprising:

an outer tubular cylindrical roll shell,

a non-rotatable shaft means extending through said shell,

means supporting said shaft means,

bearing means between the roll and shaft for positioning the roll shell and to maintain it in alignment with the second roll,

a shoe means having an outer surface axially substantially co-extensive with the roll shell for continuous supporting engagement therewith and having a radial outer surface rigidly shaped to build up a supporting film of lubricating fluid during relative rotation of the roll shell from fluid within the shell,

a controlled fluid pressure loading means mounted on said shaft means applying radially outwardly directed forces to said shoe means along the length thereof so that a continuous nip loading force is maintained within the roll shell independent of bending of the nip with load,

and fluid scoops on the shaft means for removing excess fluid from the inner surface of the roll shell.

11. A roll assembly for forming a pressure nip with a second roll comprising:

an outer tubular cylindrical roll shell,

a non-rotatable shaft means extending through said shell,

means supporting said shaft means,

bearing means between the roll shell and shaft for positioning the roll shell and to maintain it in alignment with the second roll,

a shoe means having an outer surface axially substantially co-extensive with the roll shell for continuous supporting engagement therewith and having a radial outer surface rigidly shaped to build up a supporting film of lubricating fluid during relative rotation of the roll shell from fluid within the shell,

means delivering lubricating fluid within the roll shell against the inner surface thereof in advance of said shoe means,

a controlled fluid pressure loading means mounted on said shaft means applying radially outwardly directed forces to said shoe means along the length thereof so that a continuous nip loading force is maintained within the roll shell independent of bending of the nip with load,

and a fluid return passage means having an inlet immediately at the ends of said shoe means receiving excess fluid which does not form a film between the shoe means and roll shell.

12. A roll assembly for forming a pressure nip with a second roll comprising:

an outer tubular cylindrical roll shell,

a non-rotatable shaft means extending through said shell,

means supporting said shaft means,

end bearings between the ends of the roll shell and shaft means,

fluid end scoops on the shaft means projecting for moving fluid from the inner surface of the roll shell,

passages leading from the scoops to said end bearings for lubricating the bearings from the scoops,

a shoe means having an outer surface axially substantially co-extensive with the roll shell for continuous supporting engagement therewith and having a radial outer surface rigidly shaped to build up a supporting film of lubricating fluid during relative rotation of the roll shell from fluid within the shell,

a controlled fluid pressure loading means mounted on said shaft means applying radially outwardly directed forces to said shoe means along the length thereof so that a continuous nip loading force is maintained within the roll shell independent of bending of the nip with load,

and means pivotally supporting said shoe means about an axis parallel to the roll axis for pivotal movement relative to the inner surface of the roll to conform to the pressure of the fluid film between the shoe means and roll shell.

13. A roll assembly for forming a pressure nip with a second roll comprising:

an outer tubular cylindrical roll shell,

a non-rotatable shaft means extending through said shell,

self-aligning bearings supporting each end of the shaft means,

bearing means between the roll shell and shaft for positioning the roll shell and to maintain it in alignment with the second roll,

a shoe means having an outer surface axially substantially co-extensive with the roll shell for continuous supporting engagement therewith and having a rigid radial outer surface of substantially the same radius of curvature as the inner surface of the roll shell and having a leading nose surface spaced from and facing the oncoming roll shell inner surface to build up a supporting film of lubricating fluid during relative rotation of the roll shell from fluid within the shell,

a controlled fluid pressure loading means mounted on said shaft means applying radially outwardly directed forces to said shoe means along the length thereof so that a continuous nip loading force is maintained within the roll shell independent of bending of the nip with load,

and means pivotally supporting said shoe means about an axis parallel to the roll axis for pivotal movement relative to the inner surface of the roll to conform to the pressure of the fluid film between the shoe means and roll shell.

14. A roll assembly for forming a pressure nip with a second roll comprising:

an outer tubular cylindrical roll shell,

a non-rotatable shaft means extending through said shell,

means supporting said shaft means,

bearing means supporting said shaft means,

bearing means between the roll shell and shaft for positioning the roll shell and to maintain it in alignment with the second roll,

a shoe means having an outer surface axially substantially co-extensive with the roll shell for continuous supporting engagement therewtih and having a rigid radial outer surface of substantially the same radius of curvature as the inner surface of the roll shell and having a leading nose surface spaced from and facing the oncoming roll shell inner surface to build up a supporting film of lubricating fluid during relative rotation of the roll shell from fluid within the shell,

a controlled fluid pressure loading means mounted on said shaft means applying radially outwardly directed forces to said shoe means along the length thereof so that a continuous nip loading force is maintained within the roll shell independent of bending of the nip with load,

means defining an axially elongate radially outwardly facing continuous channel extending the full length of each shaft means and opening from the ends thereof,

plate means on the ends of said channel means,

a fluid pressure line connected to the channel means,

and an elongate piston means supported by the fluid in said channel means located between said plate means and supporting the shoe means for applying a radial nip loading force to said roll shell.

References Cited by the Examiner

UNITED STATES PATENTS

242,058	5/1881	Schurmann	29—116
1,868,860	7/1932	Von Reis.	
2,395,915	3/1946	Specht	29—116 X
2,854,700	11/1958	Caspari et al.	19—65
2,960,749	11/1960	Robertson et al.	29—116 X
3,106,153	10/1963	Westbrook	100—155
3,119,324	1/1964	Justus	100—170
3,131,625	5/1964	Kusters et al.	100—170

LOUIS O. MAASSEL, *Primary Examiner.*

WALTER A. SCHEEL, *Examiner.*