Dec. 14, 1971 E. KRAFFT ETAL 3,626,732

STRAIGHTENING MACHINE FOR METALLIC BARS OR THE LIKE

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FIG. 1

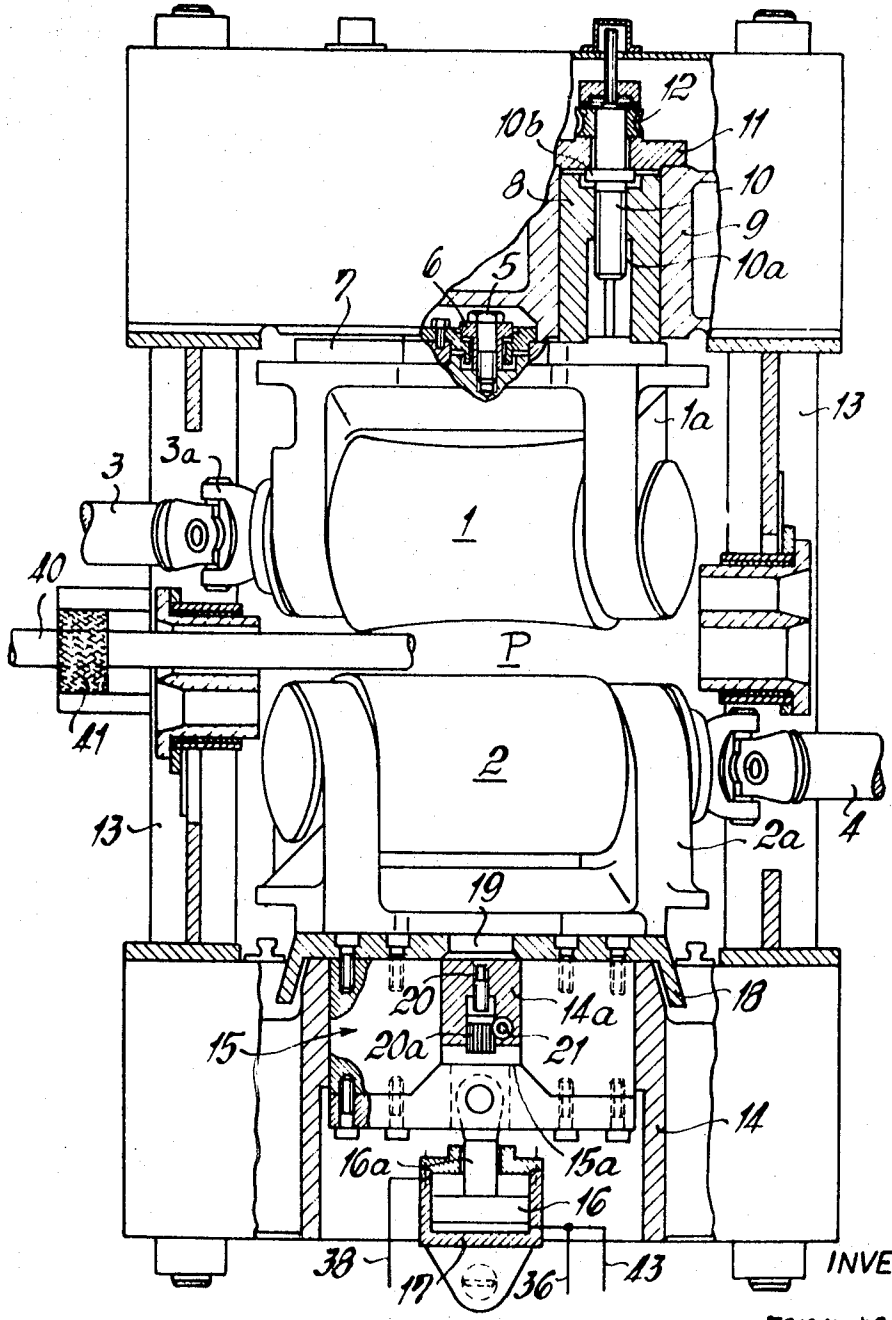

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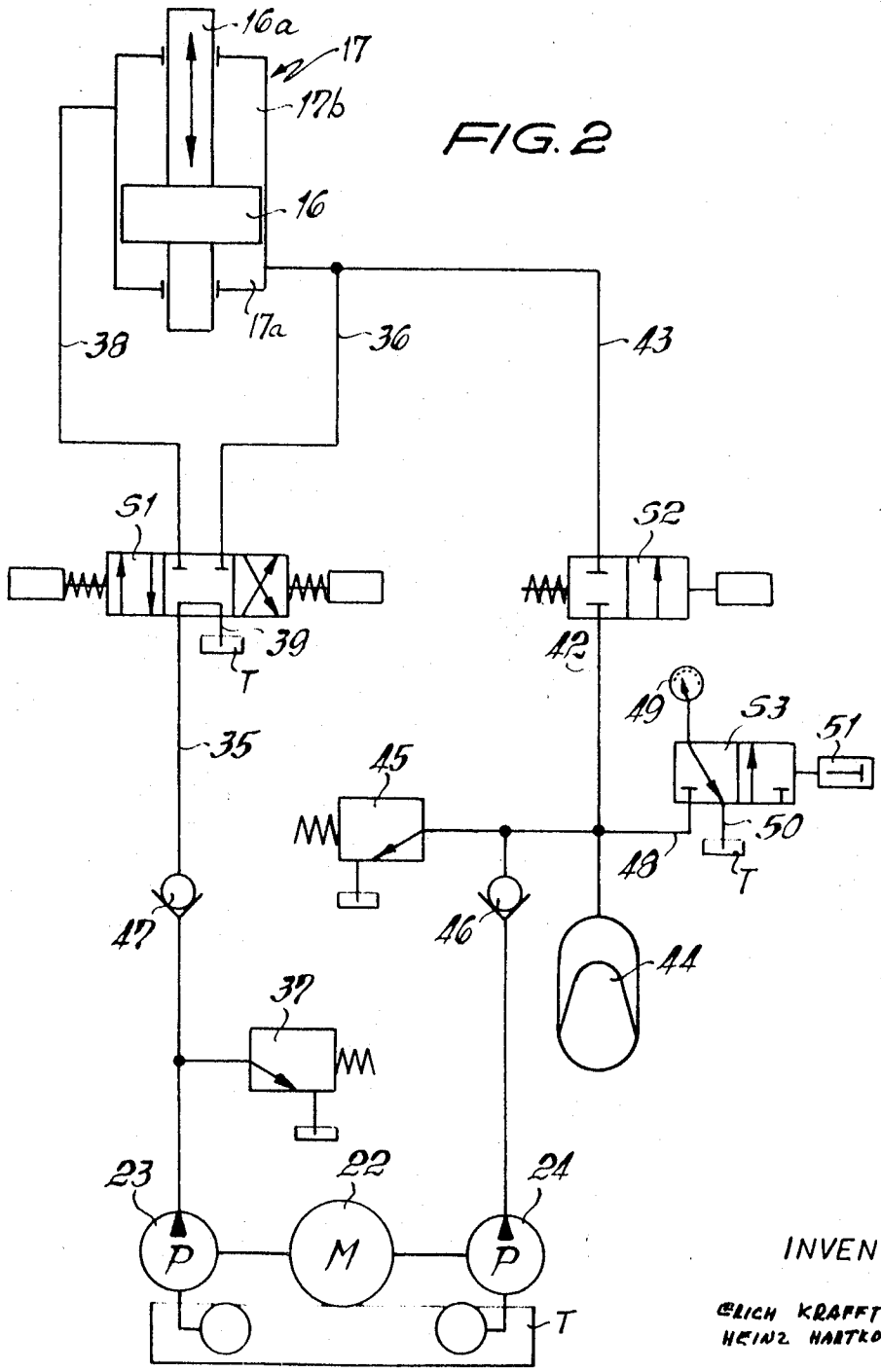
FIG. 2



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STRAIGHTENING MACHINE FOR METALLIC BARS OR THE LIKE

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Int. Cl. B21d 3/04
U.S. Cl. 72—99 8 Claims

ABSTRACT OF THE DISCLOSURE

A straightening machine for workpieces of circular or other than circular cross section wherein the lower roll of a pair of superimposed straightening rolls is movable to and from a retracted position in which its carrier abuts against the housing and cannot yield when the rolls treat workpieces of circular cross section. The carrier is mounted on the piston of a double-acting hydraulic cylinder which can move the lower roll from retracted position to bias it against a workpiece of other than circular cross section. The cylinder can receive pressurized oil from a pump by way of a first solenoid-operated valve which can effect rapid movements of the lower roll to and from retracted position, and from an accumulator by way of a second solenoid operated valve which can admit highly pressurized oil to urge the lower roll toward the upper roll during treatment of workpieces of other than circular cross section.

BACKGROUND OF THE INVENTION

The present invention relates to straightening machines for metallic bars, tubes or analogous elongated workpieces. More particularly, the invention relates to improvements in straightening machines which can be used for treatment of workpieces having a circular or other than circular cross section.

At the present time, workpieces of other than circular cross section are straightened in machines which are not suited for straightening of solid or hollow circular cylindrical (bar or tubular) stock. This is due to the fact that the rolls of a machine for straightening of circular cylindrical stock must be mounted with a view to prevent any appreciable displacement in response to passage of treated material whereas a machine for straightening of non-cylindrical workpieces must permit a certain movement of at least one of each pair of cooperating rolls to account for non-circular cross section of workpieces. Thus, a machine for straightening of truly cylindrical workpieces in the form of bars or tubes normally comprises upper and lower straightening rolls which are fixed at a desired distance from each other and cannot yield when their peripheral surfaces engage and treat a travelling workpiece. Such workpieces normally include drawn or shaved tubes or bars. The rolls of a machine for straightening of rolled billets or other workpieces whose cross section is out of round are mounted in such a way that one roll of each pair of rolls can yield and to thus allow for changes in the width of the passage wherein the workpiece moves lengthwise while rotating about its own axis.

It was already proposed to provide a straightening machine with rolls which are capable of treating workpieces of circular or other than circular outline. This proposal includes such mounting of upper straightening rolls that they are movable toward and away from the lower rolls and the provision of pneumatic means for biasing the upper rolls toward the lower rolls. The carriers for the upper rolls constitute pistons which are movable in pneumatic cylinders. The just described machine is further provided with means for effecting rapid movement of upper rolls away from the lower rolls in order to permit penetration of the leading end of a workpiece between the foremost rolls. Once the leading end of a workpiece has entered the passage between the rolls, the upper rolls are lowered and their carriers are subjected to the action of a compressed gaseous fluid to hold the rollers in engagement with the workpiece.

A drawback of such machines is that they are not suited for straightening of relatively stiff cylindrical workpieces. This is due to the fact that the pneumatic force furnished by compressed gaseous fluid does not suffice to insure proper retention of upper rolls during straightening of a tube or bar having a circular cross section. The provision of pneumatically biased pistons as a means for carrying the upper rolls is actually a mere safety measure but the number of uses to which such a machine can be put with reasonable effectiveness is quite limited.

SUMMARY OF THE INVENTION

An object of the invention is to provide a versatile straightening machine which is equally suited for straightening of cylindrical and for straightening of non-cylindrical stock.

Another object of the invention is to provide a straightening machine which can be rapidly and conveniently converted from treatment of cylindrical stock to treatment of non-cylindrical stock or vice versa.

A further object of the invention is to provide a machine wherein the force with which the straightening rolls engage a workpiece of other than circular cross-section can be regulated in the course of a straightening operation.

An additional object of the invention is to provide a machine which is capable of straightening lightweight as well as heavy and rigid stock of circular or other than circular cross section.

Still another object of the invention is to provide novel and improved mounting means for the rolls of a straightening machine for cylindrical or non-cylindrical stock.

An ancillary object of the invention is to provide novel biasing means for applying pressure to movable rolls in a straightening machine.

The invention is embodied in a machine for straightening of elongated workpieces of circular and other than circular cross section. The machine comprises a rigid housing, at least one pair of driven rotary straightening members defining a passage for workpieces, first mounting means provided in the housing for one of the straightening members and arranged to normally hold the one member against movement away from the other member, and second mounting means provided in the housing for the other straightening member. The second mounting means includes a carrier which is movable with the other member relative to the one member to and from a retracted position in which the housing prevents further movement of the other member away from the one member so that the machine is ready to treat workpieces of circular cross section, and hydraulic biasing means operable to yieldably urge the carrier away from the retracted position so that the straightening members are then ready to treat workpieces of other than circular cross section.

The biasing means preferably comprises a double-acting cylinder which is mounted in the housing, a piston which is reciprocable in the cylinder and is operatively connected with the carrier, a first source of pressurized hydraulic fluid, a first solenoid-operated valve which can connect the first source with the one or the other chamber of the cylinder to effect rapid movements of the carrier between the retracted position and a foremost position in which the other member is nearest to the one member, a

second source of pressurized fluid which preferably maintains the fluid at a pressure exceeding that of fluid which is supplied by the first source, and a second solenoid-operated valve which can admit fluid from the second source into that chamber of the cylinder wherein the fluid causes the carrier to move away from retracted position so that the other member is biased with great force against a workpiece of other than circular cross section.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved straightening machine itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a fragmentary schematic partly elevational and partly sectional view of a straightening machine which embodies one form of the invention; and

FIG. 2 is a diagrammatic view of the hydraulic biasing means in the machine of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The straightening machine of FIG. 1 comprises a housing or main support including an upper traverse **9**, a lower traverse **14** and upright columns **13** connecting the two traverses. The upper traverse **9** supports a first straightening member here shown as a roll **1** whose frame or holder **1***a* is turnable about the axis of a vertical pivot member **5** extending through a sleeve **6** which is mounted in a plate **7**. The roll **1** is connected with a drive shaft **3** by way of a universal joint **3***a* which permits the frame **1***a* to turn on the pivot member **5**. The latter is a screw which is in threaded engagement with the frame **1***a*. The motor which drives the shaft **3** is not shown in the drawing. The means for turning the frame **1***a* about the axis of the pivot member **5** is of known design and is not shown in FIG. 1. Such turning of the frame **1***a* is necessary to place the roll **1** into an optimum position with reference to the workpiece **40**. The plate **7** and the frame **1***a* constitute a mounting means for the roll **1**.

The plate **7** is movable up and down with reference to the upper traverse **9** by means of a displacing mechanism which includes several pushers or plungers **8** (only one shown) reciprocably guided in the traverse **9** and having internal threads mating with external threads **10***a* of spindles **10** which are rotatable in but cannot move axially of the traverse **9**. To this end, the traverse **9** includes a plate **11** through which the spindles **10** extend and which is flanked by flanges **10***b* of spindles **10** from below and by worm wheels **12** from above. These worm wheels are rigid with the respective spindles **10** and mesh with worms (not shown) which can be rotated by hand or by means of a motor to thereby move the plate **7** up or down and to thus select the width of the passage **P** between the roll **1** and a lower straightening roll **2** which is supported by the lower traverse **14**.

The roll **2** is driven by a shaft **4** and its frame or holder **2***a* is movable up and down, i.e., toward and away from the roll **1**. When the rolls **1**, **2** are used for straightening of tubular or bar stock of circular outline, the plate-like carrier **18** for the frame **2***a* assumes a retracted position and rests directly on the traverse **14** so that the roll **2** cannot yield and the workpiece must pass through a passage **P** of predetermined cross-sectional area. Such retracted position of the carrier **18** is shown in FIG. 1. The carrier **18** and frame **2***a* constitute a mounting means for the lower straightening roll **2**.

The carrier **18** is movable up and down with reference to the traverse **14** when the rolls **1**, **2** are replaced with rolls which serve to straighten elongated stock of other than circular cross section, for example, for straightening of rolled billets. The means for biasing the carrier **18** upwardly from its retracted position comprises a double-acting cylinder **17** which is pivotably mounted in the traverse **14** below the roll **2** and accommodates a piston **16** whose piston rod **16***a* carries a slide **15** which is movable up and down in suitable guide means provided therefor in the traverse **14**. The carrier **18** constitutes the cover of the slide **15** and is secured thereto by bolts, screws or other suitable fasteners.

The lower traverse **14** includes a transversely extending portion or beam **14***a* which also serves as a guide for the slide **15** and further supports a vertical centering pin **19** for the frame **2***a*. The pin **19** extends through a hole of the carrier **18**. The beam **14***a* further supports a vertically adjustable stop member **20** which meshes with the beam and has a worm wheel **20***a* meshing with a worm **21**. When the worm **21** is rotated to rotate the member **20**, the latter moves up or down and thus determines the maximum extent of upward movement of the slide **15**.

FIG. 2 illustrates the hydraulic circuit of the biasing means for the roll **2**. A reservoir or tank T for oil or other hydraulic fluid can supply fluid to two pumps **23**, **24** which are driven by an electric motor **22**. The pump **23** constitutes a first source of pressurized fluid and can force such fluid into a first supply conduit **35** provided with a check valve **47** and connected to a first adjustable solenoid-operated valve S1. The latter is connected to the chambers **17***a*, **17***b* of the double-acting cylinder **17** by conduits **36**, **38**. The valve S1 can seal the supply conduit **35** from the conduits **36**, **38** and then delivers fluid to a return line **39**. A pressure relief valve **37** can be actuated to adjust the fluid pressure in the supply conduit **35**.

A second adjustable solenoid-operated valve S2 is installed in a second supply conduit **42** which is connected with the pump **24** through a check valve **46** and with a second source of pressurized fluid here shown as a diaphragm accumulator **44**. The valve S2 can admit pressurized fluid from the accumulator **44** to the cylinder chamber **17***a* by way of a conduit **43**. A pressure relief valve **45** can be actuated to adjust the fluid pressure in the supply conduit **42**, and a conduit **48** connects the supply conduit **42** with a third solenoid-operated valve S3 which is connected with the tank T by a return line **50** and can admit pressurized fluid to a pressure gauge **49** in response to actuation of a knob **51**. The parts S3 and **48**–**51** constitute a device which monitors the pressure of fluid in the accumulator **44**. The operation of valves S1 and S2 is regulated by a detector **41** (e.g., an inductor coil shown in FIG. 1) which produces signals in response to the presence or absence of a workpiece **40** in the adjacent portion of the path for workpieces.

The operation:

When the machine is used for straightening of tubular or bar stock of circular cross section, the frame **2***a* for the lower roll **2** is rigidly supported by the housing of the machine because the carrier **18** abuts directly against the adjacent portion of the lower traverse **14**.

If the machine is to be thereupon used for straightening of rolled billets or other workpieces of other than circular cross section, the rolls which were used for straightening of cylindrical workpieces are replaced with a different set of rolls for reasons which are well known to those skilled in the art. The motor **22** is thereupon started to drive the pumps **23**, **24** and the valve S1 is adjusted to connect the supply conduit **35** with the conduit **36** so that the piston **16** moves upwardly to the extent permitted by the stop pin **20**. The pressure of fluid in the supply conduit **35** is selected by the valve **37**; for example, such pressure may be in the range of 25 atmospheres super-atmospheric pressure. The upward movement of the piston **16** is terminated when the top face **15***a* of the slide **15** abuts against the portion **20***a* of the stop pin **20**. In the next step, the worm wheels **12** in the upper traverse **9** are rotated to move the carrier **7** up or down so as to place the upper straightening roll **1** at an optimum distance from the lower roll **2**. The distance is normally selected in such a way that the width of the passage P

between the rolls 1, 2 is slightly less than the minimum transverse dimension of the non-circular workpiece.

The valve S1 is thereupon adjusted to connect the supply conduit 35 with the conduit 38 whereby the piston 16 descends and the roll 2 moves downwardly and away from the roll 1. When the conduit 38 communicates with the supply conduit 35, the conduit 36 can discharge fluid into the return line 39. The downward movement of the piston 16 is terminated when the slide 15 returns to the retracted position shown in FIG. 1.

A workpiece 40 is thereupon fed toward the passage P between the rolls 1, 2 (in a direction from the left to the right, as viewed in FIG. 1) whereby its leading end reaches the detector coil 41. The advancing means which feeds the workpiece 40 toward the rolls 1, 2 preferably comprises pairs of driven advancing rollers (not shown) of any known design. The detector coil 41 thereupon automatically regulates the operation of valves S1, S2 in a manner as disclosed, for example, in German Utility Model No. 1,885,761. The electric circuit of the coil 41 and valves S1, S2 further includes suitable time delay relays. The coil 41 causes the valve S1 to connect the supply conduit 35 with the conduit 36 when the leading end of the workpiece 40 reaches or approaches the position shown in FIG. 1. The piston 16 then moves upwardly and the lower roll 2 is biased against the advancing workpiece. The coil 41 also adjusts the valve S2 substantially simultaneously with adjustment of the valve S1 so that the conduit 43 is connected with the second supply conduit 42 wherein the fluid pressure exceeds that in the supply conduit 35 because the pressure relief valve 45 is set in such a way that the fluid pressure in accumulator 44 exceeds the fluid pressure in the supply conduit 35. Thus, whereas the supply conduit 35 delivers fluid which is used to rapidly move the lower straightening roll 2 toward or away from the upper roll 1, the fluid in the accumulator 44 can supply such pressure which is to be maintained in the lower cylinder chamber 17*a* in the course of a straightening operation. The valve 45 is preferably of the type which can select an infinite number of fluid pressures in the accumulator 44 and supply conduit 42.

When the trailing end of the workpiece 40 moves beyond the detector coil 41, the latter adjusts the valves S1 and S2 in the following way: The valve S1 connects the supply conduit 35 with the conduit 38 and the conduit 36 with the return line 39. Even prior to such adjustment of valve S1, the valve S2 is adjusted to assume the position shown in FIG. 2 in which the supply conduit 42 is sealed from the conduit 43 and cylinder chamber 17*a*. The pump 24 delivers to the accumulator 44 fresh fluid by way of the check valve 46 to replace the fluid which was fed into the chamber 17*a*. The pump 23 remains in operation and delivers fluid to the conduit 35; when the piston 16 returns to its lower end position, the fluid delivered by pump 23 opens the valve 37 and returns to the tank T.

The knob 51 can be actuated whenever the operator so desires to thereby connect the conduit 48 (and hence the accumulator 44) with pressure gauge 49. In this way, the operator can monitor the fluid pressure in the course of a straightening operation. When the knob 51 is released, the gauge 49 is connected with the return line 50 and is sealed from the supply conduit 42. If the pressure indicated by the gauge 49 is unsatisfactory, the operator changes the setting of the pressure relief valve 45.

A fresh cycle is started as soon as the leading end of the next-following workpiece enters or approaches the detector coil 41. It is clear that other types of detector means can be used with equal advantage as well as that the hydraulic circuit of FIG. 2 can have a single pump which delivers fluid to the supply conduit 35 and to the accumulator 44.

An advantage of the just described straightening machine (for example, over the machines disclosed in German Patent No. 835,825) is that both straightening rolls are rigidly supported by the housing of the machine when the latter is to treat workpieces of circular outline and that one of the straightening rolls can yield against fluid pressure when the workpieces are of other than circular outline. The provision of the accumulator 44 insures that the straightening action upon workpieces of other than circular outline is superior to that of presently known machines. When the lower cylinder chamber 17*a* receives fluid from the accumulator 44, the lower roll 2 invariably tends to assume a position in which the width of the passage P is less than the minimum transverse dimension of a workpiece of other than circular cross section. Moreover, the force with which the rolls act on workpieces of other than circular outline can be regulated in a very simple and time saving manner as well as within a very wide range. Still further, the magnitude of such force can be observed at all times so that any deviations from desirable magnitude can be eliminated without delay.

It is further clear that the machine can comprise two or more pairs of straightening rolls.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of our contribution to the art and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

1. In a machine for straightening of elongated workpieces of circular or other than circular cross section, a combination comprising a housing; at least one pair of exchangeable rotary straightening members defining a passage for workpieces; first mounting means provided in said housing for one of said members and arranged to normally hold said one member against movement away from the other member; and second mounting means provided in said housing for said other member, including a carrier movable with said other member relative to said one member to and from a retracted position in which the housing prevents further movement of said other member away from said one member so that said members are ready to treat workpieces of circular cross section, and hydraulic biasing means operable to yieldably urge said carrier away from said retracted position so that said members are ready to treat workpieces of other than circular cross section, said biasing means comprising a double acting cylinder mounted in said housing, a piston reciprocable in said cylinder, and a piston rod reciprocable with said piston and operative connected with said carrier, said cylinder including a first chamber arranged to receive a hydraulic fluid to effect movement of said carrier from said retracted position and a second chamber arranged to receive hydraulic fluid to effect movement of said carrier to said retracted position, said biasing means further comprising a circuit for effecting movements of said piston with reference to said cylinder and said circuit including a first source of pressurized hydraulic fluid, first adjustable valve means for connecting said first source to either one of said chambers, a second source of pressurized hydraulic fluid, and second adjustable valve means for connecting said second source with said first chamber.

2. A combination as defined in claim 1, wherein said other member is located below said one member.

3. A combination as defined in claim 1, wherein said second source is arranged to supply fluid at a pressure which exceeds the pressure of fluid supplied by said first source.

4. A combination as defined in claim 3, wherein said valves are solenoid-operated valves.

5. A combination as defined in claim 1, wherein said biasing means further comprises means for adjusting

the pressure of fluid supplied by at least one of said sources.

6. A combination as defined in claim 1, wherein said second source includes an accumulator.

7. A combination as defined in claim 1, further comprising means for monitoring the pressure of fluid in at least one of said sources.

8. A combination as defined in claim 1, further comprising detector means adjacent to the path of movement of workpieces toward and through said passage and operative to adjust said valves in response to movement of workpieces along said path.

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