April 28, 1953 F. S. SALTER 2,636,406

ROLLING MILL FOR RINGS

Filed Feb. 28, 1951 2 SHEETS—SHEET 1

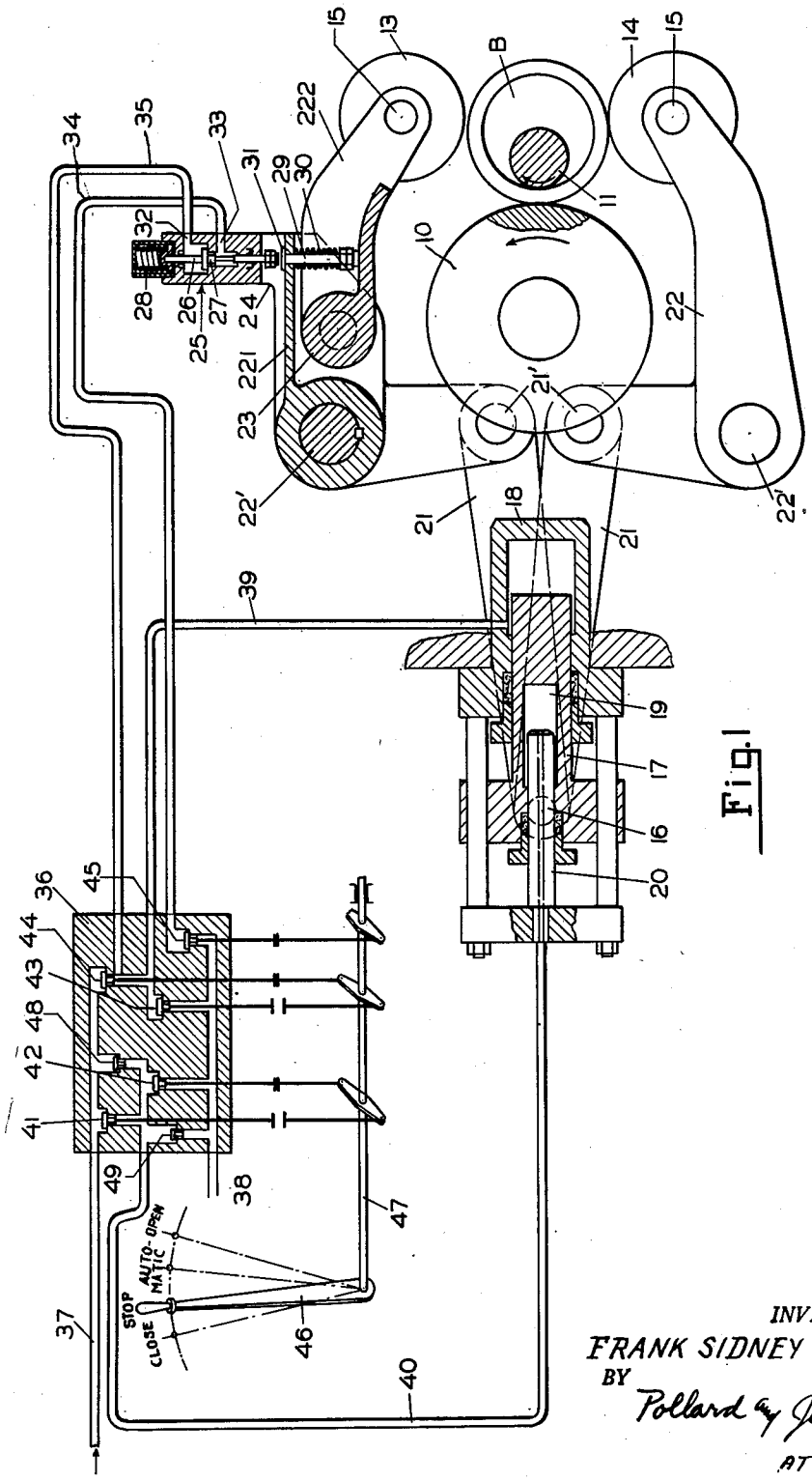


Fig. 1

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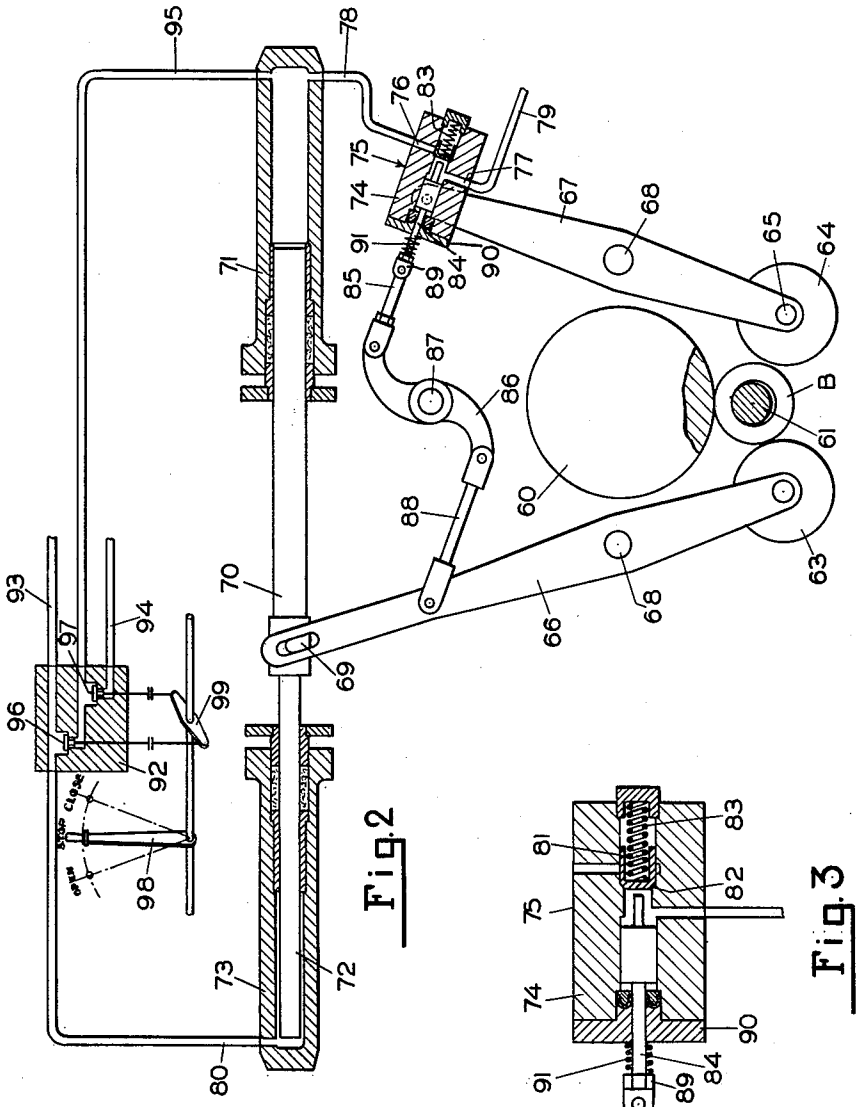


Fig. 2

Fig. 3

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ROLLING MILL FOR RINGS

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5 Claims. (Cl. 80—5)

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The invention relates to ring rolling mills in which the wall thickness of annular blanks is reduced and their diameter thereby increased by the combined action of an outer and an inner working roll. Mills of this type are frequently provided with means for guiding the blank during the rolling operation. These means usually comprise rolls which are caused to engage a blank under hydraulic or other pressure, and which have to be gradually retracted as the blank expands during the rolling operation.

Control of the receding movement of these guide rolls has so far been effected by hand and requires the constant and close attention of an operator.

It is one of the primary objects of the present invention to provide a ring rolling mill of the type described, in which the receding movement of the blank-guiding means during the rolling operation is automatically controlled so as to relieve the operator of his task of supervising the movement of the guiding means.

The invention relates in particular to ring rolling mills in which the guiding means are held in engagement with a blank by hydraulic pressure means, and it is characterised in the first place by the provision of means for automatically controlling the hydraulic pressure means in response to the expansion of a blank, in such a way that the guide means are caused to recede at the same rate as the expansion of the blank progresses.

According to a further feature of the invention, the aforesaid automatic control means comprise a relief valve for the pressure fluid in said hydraulic pressure means, said relief valve being opened in response to the expansion of a blank, whereby the recession of the guide means is effected and closed in response to the recession of the guide means upon release of the pressure fluid by the relief valve.

The relief valve and its automatic control means may be incorporated in a hydraulic pressure system having additional and selectively operable circuits for advancing or withdrawing the guide means without the relief valve becoming operative.

Further features of the invention will become apparent from the following specification, in which two embodiments of the invention are described by way of example, with reference to the accompanying drawings:

Fig. 1 is a diagrammatic plan view, partly in section, of a ring rolling mill according to the invention, showing only those parts of the mill

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which are essential to the understanding of the invention.

Fig. 2 is a similar view of another embodiment of the mill according to the invention.

Fig. 3 is a section through a valve forming part of the embodiment according to Fig. 2.

In Fig. 1, 10 is an outer and 11 an inner working roll of a ring rolling mill, both of which are adapted to act simultaneously on the outside and inside respectively of a blank B, so as to reduce its wall thickness and thereby increase its diameter. One or both of the rolls 10 and 11 are power-driven, and both rolls are constantly urged towards each other by separate pressure means, whereby the required rolling pressure is produced. The means for driving the roll or rolls and the pressure means are not shown or described here, as they are not part of the present invention.

Means are provided, comprising rolls 13 and 14, to guide a blank B during the rolling operation through the pass formed by the rolls 10 and 11. The rolls 13 and 14 are mounted on short axles 15 which are not driven and are connected by means presently to be described to a pin 16 on a ram 17.

Ram 17 is movable in a hydraulic cylinder 18 in a direction which causes both rolls 13 and 14 to approach the blank B and to make contact with its circumference. For movement of the rolls 13 and 14 in the opposite direction, ram 17 is hollow at one end, so as to form there a hydraulic return cylinder 19, which co-operates with a stationary ram 20.

The connection between the rolls 13 and 14 respectively and the pin 16 comprises pairs of oppositely arranged links 21 and bell-cranks 22, joined together by pins 21'. The bell-cranks 22 have pivot pins 22', and carry at their free ends the axles 15 on which the rolls 13 and 14 are mounted. The free arm of the bell-crank for roll 13 consists of two separate sections 221 and 222, hinged together at 23, while the free arm of the bell-crank for roll 14 is in one piece. Section 221 is formed with a boss 24 on to which a relief valve 25 for the release of pressure fluid from cylinder 18 is mounted. The valve has a closure member 26 which is normally held against a seat 27 by a spring 28, but can be lifted from the seat 27 by an actuating rod 29. The latter is normally held apart from member 26 by a spring 30 which is stronger than spring 28. Rod 29 has, further, a collar 31 which is normally held by spring 30 in engagement with a flange on bell-crank section 221. Bell-crank section 222 has also a flange which causes rod 29 to be displaced against the

action of spring 30, and thereby to lift closure member 26 from its seat 27, thus opening relief valve 25 as soon as section 222 is swung away from the blank B following the expansion of the latter during the rolling operation.

Closing of valve 25 can be effected without moving rod 29 back into its former position by the action of bell-crank section 221, which, when moved away from blank B, will cause valve seat 27 to approach closure member 26. This movement of section 221 takes place when the ram 17 is displaced to the right in Fig. 1 by the outward movement of roll 14, upon the release of pressure fluid from cylinder 18.

Valve 25 has two ports 32 and 33 which, by means of flexible pipes 34 and 35 respectively are connected to the cylinder 18 and to an exhaust line 36. In the position of Fig. 1, valve 25 is closed and the ports 32 and 33 have, therefore, no communication with each other. Ram 17 is thus hydraulically locked against movement to the right in Fig. 1, but will be caused to travel in that direction upon the expansion of the blank B, whereby rolls 13 and 14 are moved aside and the relief valve 25 operated as described before.

Relief valve 25 forms part of a hydraulic pressure system which includes circuits for supplying and discharging pressure fluid to and from the cylinders 18 and 19 respectively. These circuits are controlled from a valve block 36 connected to a pressure fluid supply line 37, an exhaust line 38, a line 39 leading to cylinder 18, and a line 40 leading to cylinder 19. The block 36 has a number of valves 41 to 45 which are operated by means of a lever 46 and rock-shaft 47 in a conventional manner, the different positions of lever 46, and thus of the valves controlled thereby, being apparent from the diagrammatic illustration of Fig. 1. The block 36 comprises, furthermore, a pressure limiting valve 48 and a suction valve 49, both in circuit with cylinder 19.

Before starting operations, the rolls 13 and 14 are moved aside, so that a blank B can be placed over the working roll 11. The valve actuating lever 46 is now moved into the "close" position, pressure water is thereby supplied to cylinder 18 and discharged from cylinder 19, so that ram 17 travels to the left in Fig. 1 and causes rolls 13 and 14 to move towards the blank B. It will be noted here that the two rolls 13 and 14 are not entirely symmetrically positioned relative to the centre line through the axes of the rolls 10 and 11 inasmuch as the roll 13 is slightly further away from that line than the roll 14, so that there will be a small clearance between roll 13 and blank B when the roll 14 touches the blank. After the roll 14 has made contact with the blank B, the lever 46 is moved into the "automatic" position, whereby all valves in block 36 are closed, excepting valve 45. Cylinder 18 is thus placed in communication with exhaust line 38 whenever the ports 32 and 33 are placed in communication with each other by the opening of the relief valve 25 in the afore-described manner.

The rolling operation proper is now carried out and the wall thickness of the blank B gradually reduced by the combined action of the rolls 10 and 11, the diameter of the blank B increasing at the same rate as its wall thickness decreases. The clearance between roll 13 and blank B permits the latter to expand freely first and to shift towards that roll while being in pressure contact with roll 14 due to the action of the pressure fluid in cylinder 18. On further expansion, blank B contacts roll 13 and moves it aside, whereby valve 25 is opened as described before, and pressure fluid is released from cylinder 18. This enables roll 14 to give way to the expanding blank, and at the same time displaces ram 17 to the right in Fig. 1 through the connection between roll 14 and ram 17 by parts 21 and 22. Displacement of ram 17 causes valve 25 to be closed again, as described before. Roll 14 is thus locked temporarily in position again, and the spreading of the blank takes place towards roll 13 which is moved aside, opens valve 25 and releases pressure fluid from cylinder 18, thereby permitting roll 14 to give way to the spreading blank, closing valve 25 again, and so on until the blank has been rolled to its desired thickness.

The movements of the rolls 13 and 14 which effect the opening and closing of valve 25 are very small, and follow each other continuously and in quick succession. It will also be observed that the chief function of roll 13 during the rolling process proper is to control the operation of valve 25, without transmitting any appreciable pressure to the blank B, the guiding action being applied mainly by roll 14.

The suction valve 49 serves to establish communication between cylinder 19 and exhaust line 38, while the ram 17 advances into cylinder 18, thus preventing the ingress of air into the cylinder 19.

After the blank has been reduced to its desired thickness, it is often required to give the blank a few rounding-off passes in order to correct any deviations from a true circular shape. These passes are effecteed after the valve-actuating lever 46 has been moved to "stop," whereby all valves in control block 36 are closed, and relief valve 25 is put out of action. The rolls 13 and 14 are thereby locked in their respective positions and are both firmly held in contact with the blank during the rounding-off passes.

After rolling has been terminated, the lever 46 is moved into the "open" position. Valves 41, 43 and 45 are thereby opened and valves 42 and 44 closed. Pressure fluid is thereby admitted to cylinder 19 and discharged from cylinder 18. The rolls 13 and 14 are thereby caused to swing open to make room for the removal of the finished blank and for the insertion of a fresh one.

Fig. 2 shows another embodiment of a ring rolling mill according to the invention, in which the same principle as in the embodiment of Fig. 1 is used for automatically controlling the blank-guiding means. The mill according to Fig. 2 has outer and inner working rolls 60 and 61 respectively, corresponding to the rolls 10 and 11 of the embodiment of Fig. 1, and, further, rolls 63 and 64 corresponding to the rolls 13 and 14 of Fig. 1. The rolls 63 and 64 are both mounted on short axles 65 carried by levers 66 and 67 respectively which are pivoted intermediate their ends about pins 68. Lever 66 has, at the end opposite to that carrying roll 63, a pin-and-slot connection 69 with a double-acting ram 70 displaceable in a hydraulic cylinder 71, the rearward extension 72 of ram 70 being displaceable in a cylinder 73 of smaller diameter than cylinder 71. Pivoted to the lever 67 at the end opposite to that carrying roll 64 is a casing 74 of a relief valve 75 which has two ports 76 and 77 connected to cylinder 71 by a flexible pipe 78 and to an exhaust line, not shown, by a flexible pipe 79 respectively. Cylinder 73 is constantly connected to a line 80, and always supplied with hydraulic pressure fluid. In view of the greater

area of cylinder 71, however, the ram 70 is normally urged towards the left in Fig. 2.

Movement of the ram 70 in the opposite direction is effected by placing the ports 76 and 77 in communication with each other through opening relief valve 75 and thereby releasing pressure fluid from cylinder 71. The relief valve 75 has the same function to fulfil as the relief valve of Fig. 1, and is therefore similar to the latter in its essential features. It has a closure member 81 normally held against a seat 82 by a spring 83, but adapted to be lifted from the seat by an actuating rod 84 (see Fig. 3). Rod 84 is connected by a link 85 to an S-shaped lever 86 pivoted at its centre about a fixed pin 87 situated in the centre line of the axes of the rolls 60 and 61, the S-shaped lever being in turn connected by a link 88 to lever 66. Inserted between a nut 89 on rod 84 and a cover plate 90 of valve casing 74 is a spring 91 which normally keeps rod 84 out of engagement with closure member 81.

It will be apparent from the foregoing, and from an inspection of Fig. 2, that any outward movement of roll 64 will cause valve casing 74 to be displaced towards the left in Fig. 2 relative to rod 84, which remains stationary at this stage, with closure member 81 following the movement of the casing 74 due to the action of spring 83. In this way, closure member 81 is caused to abut against rod 84 and to be lifted from its seat 82, placing ports 76 and 77 in communication with each other, whereby pressure fluid is released from cylinder 71.

Without moving casing 74 back into its former position, relief valve 75 can be closed by displacing rod 84 to the left in Fig. 2 and thus allowing closure member 81 to return to its seat 82 under the action of spring 83. This is effected by the aforedescribed connection between rod 84 and lever 66, whereby displacement of rod 84 to the left of Fig. 2 takes place when the lever 66 is rocked about its pivot pin 68 in a clockwise direction upon the release of pressure fluid from cylinder 71.

Relief valve 75 forms part of a hydraulic pressure system which includes circuits for supplying and discharging pressure fluid to and from the cylinder 71. These circuits are controlled from a valve block 92 connected to a pressure fluid supply line 93, and exhaust line 94 and a line 95 leading to cylinder 71. The block 92 has valves 96 and 97 which are operated by means of a lever 98 and a rock-shaft 99 in a conventional manner, the different positions of lever 98, and thus of the valves controlled thereby, being apparent from the diagrammatic illustration of Fig. 2.

The operation of the blank-guiding means of Fig. 2 is substantially similar to that of the means shown in Fig. 1 which have been described before.

Before starting operation, the rolls 63 and 64 are moved aside so that a blank B can be placed over the inner working roll 61. The actuating lever 98 is then moved into the "close" position, whereby valve 96 is opened and valve 97 closed. Cylinder 71 is filled with pressure fluid from line 93, so that ram 70 can overcome the constant pressure in cylinder 73 and is displaced to the left in Fig. 2, swinging lever 66 about its pivot pin 68 in a counter-clockwise direction. At the same time, lever 67 is rocked in a clockwise direction through the afore-described link and lever connection comprising the parts 85 to 88 and through the action of spring 91 which moves casing 74 to the right when rod 84 is moved to the right. Thus, both rolls 63 and 64 are caused to move towards the blank B.

In the same way as in Fig. 1, the two rolls 63 and 64 are not entirely symmetrically positioned relative to the centre line of the axes of the rolls 60 and 61, inasmuch as the roll 64 is slightly further away from that line than the roll 63, so that there will be a small clearance between roll 64 and blank B when the roll 63 touches the blank.

After the rolls 63 and 64 have been so far approached to the blank B that the roll 63 makes contact therewith, the lever 98 is moved into the "stop" position whereby both valves 96 and 97 are closed and the supply of pressure fluid to cylinder 71 cut off.

The rolling operation proper is now carried out, and the wall thickness of blank B gradually reduced by the combined action of the rolls 60 and 61, the diameter of the blank increasing at the same rate as its wall thickness decreases. The clearance between the roll 64 and blank B permits the latter to expand freely first and to shift towards that roll while being in pressure contact with roll 63, due to the hydraulic force exerted on ram 70. On further expansion, blank B contacts roll 64 and moves it aside, whereby lever 67 is moved in a counter-clockwise direction in Fig. 2. Valve 75 is then opened as described before and pressure fluid released from cylinder 71. This enables roll 63 to give way to the expanding blank, thereby swinging lever 66 in a clockwise direction and closing valve 75 through the link connection 85—88. Roll 63 is thus locked temporarily in position again and the spreading of the blank takes place towards roll 64 which is moved aside, opens valve 75 and releases pressure fluid from cylinder 71, thereby permitting roll 63 to give way further to the spreading blank, closing valve 75 again and so on, until the blank has been rolled to its desired thickness.

Similar to the case of Fig. 1, the movements of the rolls 63 and 64 which effect the opening and closing of the valve 74 are very small and follow each other continuously and in quick succession. The chief function of roll 64 during the rolling process proper is to control the operation of valve 75 without transmitting any appreciable pressure to the blank B, the guiding action being applied mainly by roll 63.

After rolling has been terminated, the lever 98 is moved into the "open" position. Valve 96 is thereby closed, and valve 97 opened, whereby pressure fluid is discharged from cylinder 71 into line 94. This causes the ram 70 to travel to the right in Fig. 2, whereby both rolls 63 and 64 are swung open to make room for the removal of the finished blank, and for the insertion of a fresh one.

It is to be understood that the invention is capable of other embodiments than those shown and described here. It is, for instance, within the scope of the invention to substitute the mechanical control of the opening and closing movements of the relief valve by an electrical control. In this case, the relief valve 25 or 75 could be arranged at a point distant from the mechanical connection between the hydraulic ram 17 or 70 and the rolls 13 and 14 or 63 and 64 respectively and remain stationary, so that flexible pipes for the supply and discharge of pressure fluid would no longer be required. The mechanical connection between the hydraulic ram 17 or 70 and the rolls 13 and 14 or 63 and 64 respectively would be provided with electrical contact means which would be opened and closed for energising or de-

energising a solenoid controlling the relief valve, the opening and closing of the contact means being effected by means similar to those effecting the opening and closing of the relief valve 25 and 75 respectively in the embodiments described before.

What I claim is:

1. A ring rolling mill having an inner and an outer working roll adapted to reduce the wall thickness of annular blanks while allowing the blanks to increase in diameter at the same time, guide rolls adapted to engage the outer periphery of a blank during a rolling operation, a hydraulic cylinder and ram unit for moving said guide rolls into engagement with a blank, automatically operated control means for alternatively reducing and re-establishing in quick succession the fluid pressure in said hydraulic cylinder while said guide rolls are in contact with a blank, and means connected to said control means movable by change in diameter of said blank to operate said control means.

2. A ring rolling mill having an inner and an outer working roll adapted to reduce the wall thickness of annular blanks while allowing the blanks to increase in diameter at the same time, guide rolls adapted to engage the outer periphery of a blank during a rolling operation, a hydraulic cylinder and ram unit for moving said guide rolls into engagement with a blank, an automatically operated relief valve for alternately reducing and re-establishing in quick succession the fluid pressure in said hydraulic cylinder while said guide rolls are in contact with a blank, and means operating said relief valve in response to blank diameter change.

3. A ring rolling mill having an inner and an outer working roll adapted to reduce the wall thickness of annular blanks while allowing the blanks to increase in diameter at the same time, guide rolls adapted to engage the outer periphery of a blank during a rolling operation, a hydraulic cylinder and ram unit for moving said guide rolls into engagement with a blank, a resilient mechanical connection between said ram and one of said guide rolls permitting a short displacement of one guide roll away from the centre of a blank independently of the other guide roll, an automatically operated relief valve for alternately reducing and re-establishing in quick succession the fluid pressure in said hydraulic cylinder while said guide rolls are in contact with a blank, and actuating means for opening said relief valve in response to a displacement of said guide roll away from the centre of a blank.

4. A ring rolling mill having an inner and an outer working roll adapted to reduce the wall thickness of annular blanks while allowing the blanks to increase in diameter at the same time, guide rolls adapted to engage the outer periphery of a blank during a rolling operation, a hydraulic cylinder and ram unit for moving said guide rolls into engagement with a blank, a resilient mechanical connection between said ram and one of said guide rolls permitting a short displacement of a guide roll away from the centre of a blank independently of the other guide roll, said connection comprising two elements pivoted to each other, and spring means normally urging one of said elements away from the other, an automatically operated relief valve for alternately reducing and re-establishing in quick succession the fluid pressure in said hydraulic cylinder while said guide rolls are in contact with a blank, and actuating means for opening said relief valve in response to a displacement of said guide roll away from the centre of a blank.

5. A ring rolling mill having an inner and an outer working roll adapted to reduce the wall thickness of annular blanks while allowing the blanks to increase in diameter at the same time, a pair of guide rolls adapted to engage the outer periphery of a blank during a rolling operation, a hydraulic cylinder and ram unit for moving said guide rolls into engagement with a blank, a resilient mechanical connection between said ram and one of said guide rolls permitting a short displacement of a guide roll away from the centre of a blank independently of the other guide roll, a rigid mechanical connection between the other of said guide rolls and said ram, an automatically operated relief valve for alternately reducing and re-establishing in quick succession the fluid pressure in said hydraulic cylinder while said guide rolls are in contact with a blank, and actuating means for opening said relief valve in response to a displacement of said guide roll away from the centre of a blank and for closing said relief valve in response to a displacement of said ram following the release of pressure fluid from said cylinder.

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