Dec. 31, 1929. G H. CASE 1,742,056

BENDING MACHINE

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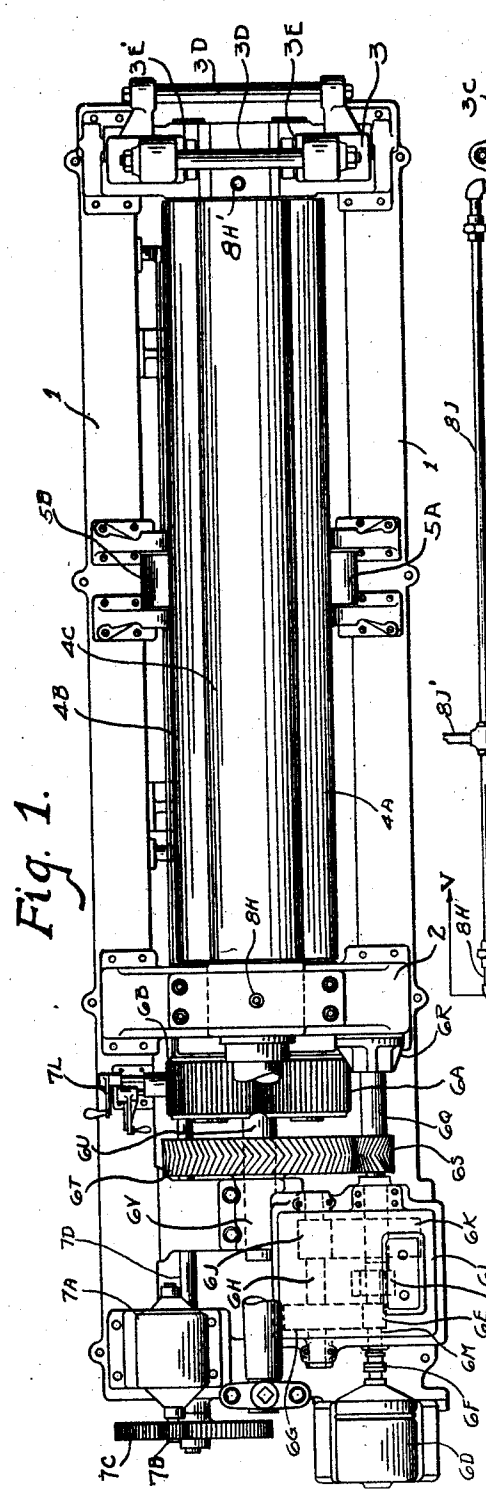


Fig. 1.

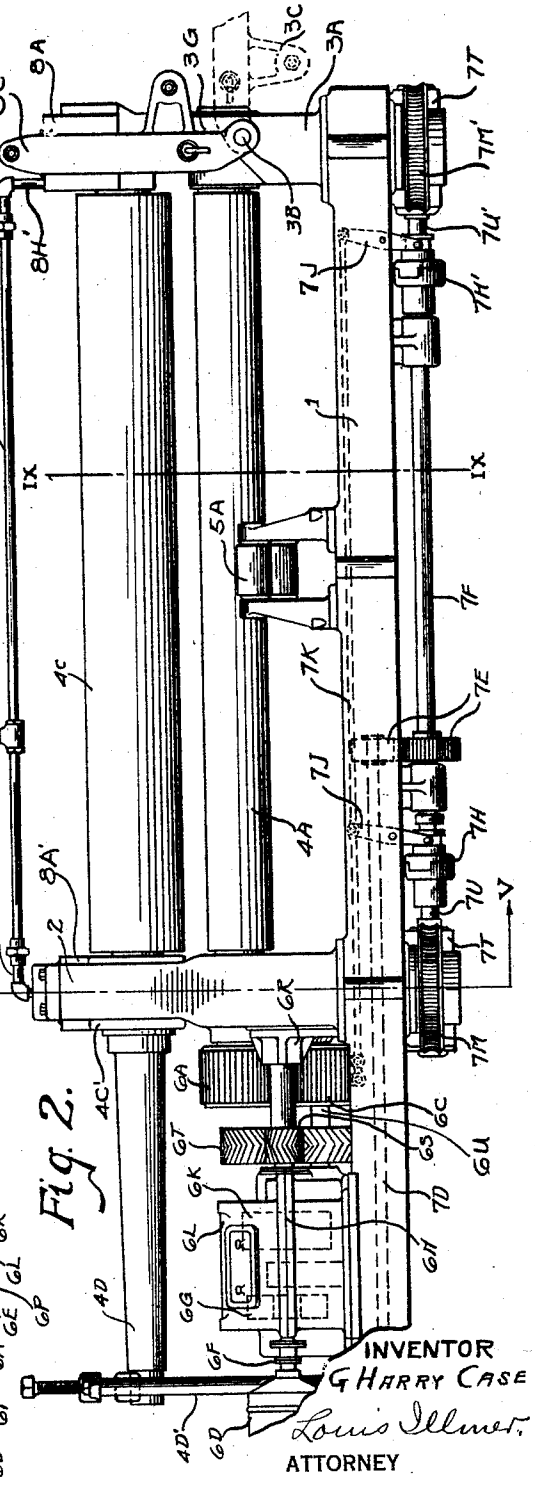


Fig. 2.

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Fig. 3.

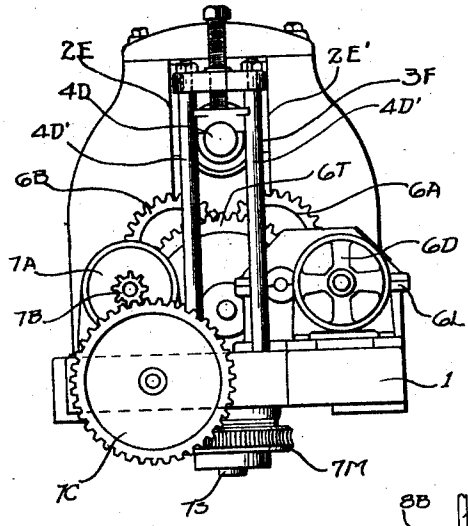


Fig. 4.

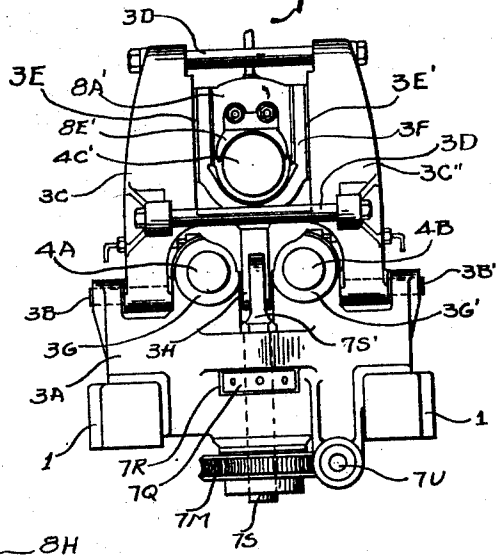
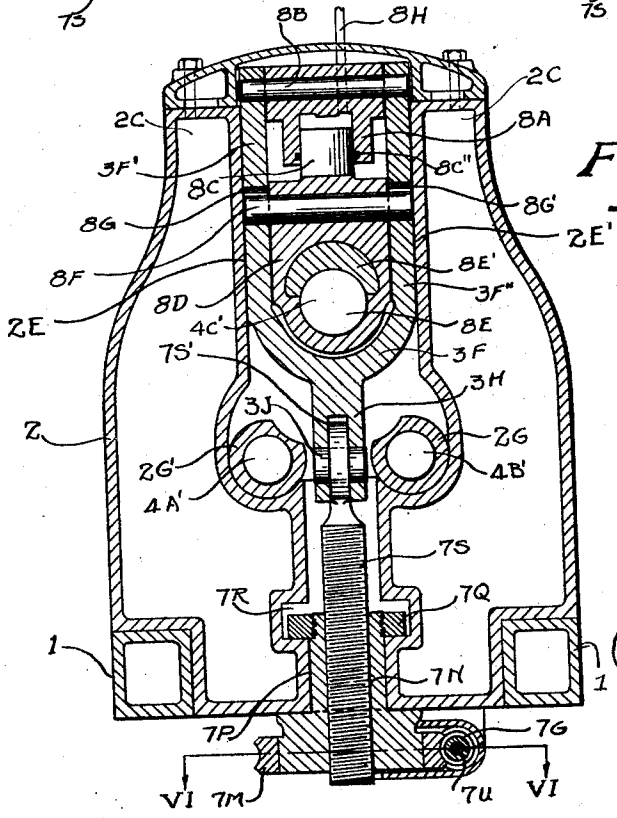


Fig. 5.



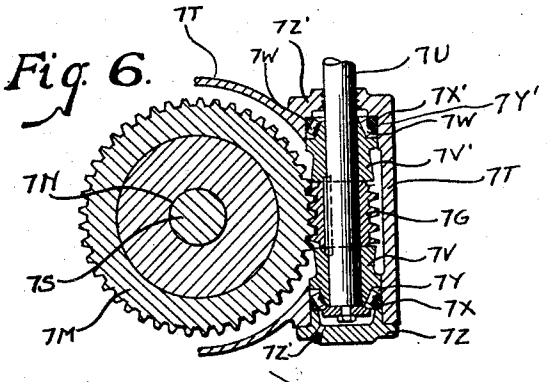
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Fig. 6.



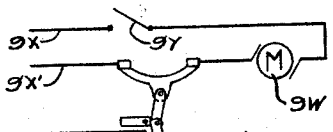


Fig. 8.

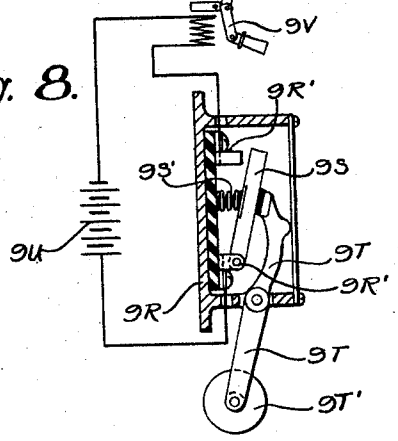


Fig. 7.

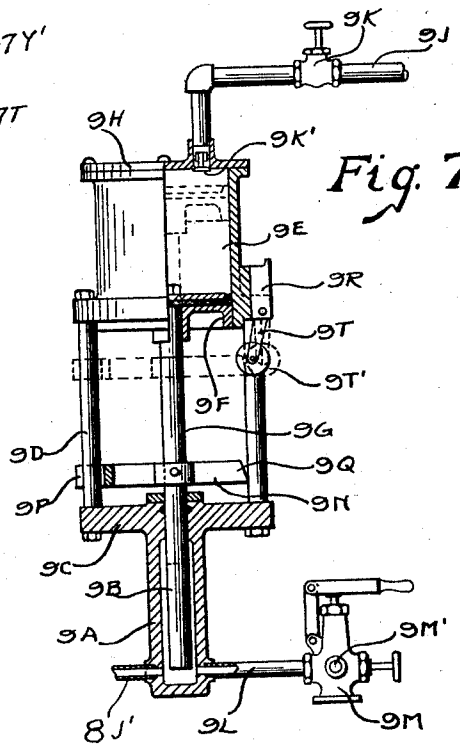
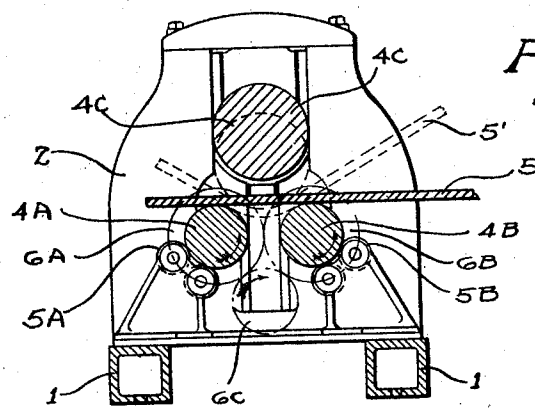


Fig. 9.



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Patented Dec. 31, 1929

1,742,056

UNITED STATES PATENT OFFICE

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BENDING MACHINE

Application filed December 15, 1927. Serial No. 240,145.

My invention relates to certain refinements in design of power-driven plate bending rolls, and more particularly to mills of the horizontal pyramid type embodying improved structural features together with advanced control devices adapted adequately to protect all of my roll and drive elements against breakdown from inordinate overloading.

Bending rolls are usually driven by high-speed electric motors which transmit through a long train of reduction gears in order to afford the desired slow speed and resulting high plate crimping pressures under which bending rolls are obliged to work; the point of power input in machines of this character is necessarily far removed from the location of the roll power offtake. Heretofore such electric motor drives have remained unprotected against destructive overloading, except for the unsatisfactory relief that may be afforded by ordinary fuses or circuit breakers as set to function under excessive current flow; this common expedient has however proven inadequate when applied to large bending roll equipment.

It is the aim of my invention to overcome and prevent ultimate motor burn-out which has in practice been found to be a not infrequent occurrence. Owing to improved type and gear disposition, I am enabled materially to reduce friction losses and this in itself makes any abnormal motor current flow a more nearly accurate measure of overloading that is actually being imposed between the mill rolls. In this connection, I have further provided for an independent auxiliary motor cut-out means adapted to automatically but positively trip the motor circuit breaker whenever the top roll of my machine is subjected to a predetermined journal overload and such supplementary alleviation is mechanically actuated and placed in immediate proximity to my rolls, that is to say ahead of the cited long train of roll drive gears.

The bending machine herein contemplated may comprise one bottom roll or a pair of laterally spaced bottom rolls intermeshing at one end with a power-driven gear means Superimposed thereon is a top roll mounted in the customary relation and adapted to roll or bend a heavy plate therebetween. The top roll end journals are respectively mounted in longitudinally spaced bearing shells and these are preferably carried in vertically slidable yokes that may be raised or lowered by screw-down means with respect to the fixedly mounted bottom roll bearing shells.

An important feature of my improved mill structure resides in yieldably holding down the respective top roll journals preferably by hydraulic ram means adapted to afford proper relief in the event an unusually heavy plate should be run through the rolls or in case the screw-down feed should at any time prove too heavy for the rated capacity of any given bending machine. Failure on part of the inserted plate to crimp or bend readily, is compensated for by allowing the non-rigidly mounted top roll to lift away from said complementary bottom rolls, and this safety device in turn serves to partially relieve the motor drive members and likewise the rolls from excessive overloading.

In the event that the indicated floating top roll mounting should for any reason prove insufficient to meet aggravated instances of machine overloading, I have provided for still another emergency unloading means in that the resulting lift displacement of both my hydraulic relief rams is discharged into a regulator intensifier, which in turn is provided with a loaded plunger whose movement is made to respond to the combined ram displacements. Said plunger is equipped with adjustable counter loading means and after said plunger movement is allowed to reach a predetermined point, an electric circuit breaker switch commanding the power supply to the prime mover of my bending machine, is tripped for the purpose of automatically shutting down further roll operation. The hydraulic safety means herein afforded not only completely protect my machine against any detrimental overload but the adjustments permit of unloading the motor drive upon reaching any predeterminable limit of roll load.

An important object of my invention is to equip bending roll machines with the cited roll safeguards and emergency devices, pref-

erably in association with reduction gearing adapted to eliminate undue friction waste. To this end, both the type and arrangement of my roll reduction gear drive have been improved over conventional practice and roller bearings have been incorporated to take up the unusually heavy thrust loads likely to be imposed upon certain of the screw-down members. Embodied herein are also other features of structure and organization, all of which will be set forth in detail hereinafter. Reference is had to the accompanying three sheets of drawings which are illustrative of a specific embodiment of my invention; like characters of reference indicate like parts in the several views, and in which drawings:

Fig. 2 is an elevational side view of a bending roll assembly into which my improvements have been incorporated, while Fig. 1 represents a top view thereof.

Fig. 3 and 4 respectively show the motor drive end view and the rear end view of my assembled machine.

Fig. 5 is a sectional detail of my forward mill housing as taken through line V—V of Fig. 2, while Fig. 6 is a fragmental sectional view illustrating certain details of my screw-down worm gear drive as taken through line VI—VI of Fig. 5.

Fig. 7 shows a suitable structure of one style of intensifier regulator with which my hydraulic top roller rams may be made to cooperate for cutting off the power from the mill drive motors.

Fig. 8 indicates a breaker switch that may be used for motor shut-down purposes and said figure also diagrammatically represents suitable electric circuit connections controlled by said switch.

Fig. 9 represents in reduced scale, a transverse view as taken through my bending rolls along line IX—IX of Fig. 2.

Referring now in detail to said drawings, the more conventional features of my bending machine will first be described in order to lay proper foundation for the improvements that are comprised in the present invention. The disclosure herein exemplified is confined to a three-roll bending mill of the conventional pyramid type in which the numeral 1 indicates a double girder-like bed plate intermediate the ends of which is mounted the forward housing 2, while adjacent to one plate end is mounted the rear housing 3.

As shown in Figs. 2 and 4, the last named housing may comprise a base portion 3A carrying a set of spaced pintles 3B and 3B′ as shown in dotted lines, upon which is pivotally mounted the upper jaw portion 3C, said spaced jaws being rigidly interconnected into a unitary structure by heavy tie-bolts 3D. The inner transverse jaw faces constitute complementary guides 3E and 3E′ between which is slidably mounted the screw-down yoke 3F having spaced upturned strap ends 3F′ and 3F″ while the depending yoke shank carries a fork end coupling pin 3J. The housing base 3A may be further equipt with fixedly mounted lower bearing shells 3G and 3G′ which are here kept sufficiently spaced to clear said depending yoke shank when the latter is shifted into lowermost position.

As will be seen from Fig. 5, the forward housing 2 is similarly equipt except that this is preferably designed as a one-piece member adapted to likewise mount a set of lower bearing shells 2G and 2G′. Said housing is further provided with corresponding jaw portions 2C respectively equipt with spaced guide faces 2E and 2E′ between which is slidably carried a crotched yoke piece 3F substantially identical with that described in connection with the rear housing 3. These housing yokes are adapted to be raised or lowered in unison through screw-down adjusting means which will presently be described.

Between each set of spaced complementary lower bearing shells such as 2G and 3G or 2G′ and 3G′, are respectively mounted the relatively long twin lower journaled rolls 4A and 4B, and superimposed thereon preferably in pyramidal relation, is a somewhat larger top roll 4C of which the respective journal ends 4C′ are each mounted in a slide block 8D as movably carried between the yoke end straps 3F′ and 3F″. If desired, the forward roll journal portion may be projected into a balancing tail 4D and provided with suitable support means 4D′ adapted to hold the top roll against undue tilting whenever the rear journal block together with the pivoted housing portion 3C is swung rearwardly as indicated in dotted outline. As will be understood, these triple rolls are usually but not necessarily arranged in a cross-sectionally triangular relation as is indicated by Fig. 9, such that by raising the top roll, an initially flat plate may be freely interposed to span the spaced bottom rolls: the top roll is then forcibly brought down toward said bottom rolls for the purpose of imparting an initial curvature or flute-like bend adjacent to one longitudinal plate edge as indicated in dotted lines by 5′ in Fig. 9. The two bottom rolls are ordinarily reenforced against spreading by the guide rollers 5A and 5B, and upon imparting a rotary movement to the two bottom rolls, said plate 5′ will be drawn through said tensioned rolls, thus causing the entire plate to be bent up into cylindrical shape as will presently be more explicitly described.

The spaced twin bottom rolls 4A and 4B are each provided with suitable end journals and the forward motor ends thereof respectively extend through the bearing shells 2G and 2G′; each such projecting journal end is equipped with a separate roll end gear 6A and 6B respectively, and these in turn inter-

mesh with the intermediary drive gear 6C which rotates simultaneously both bottom rolls from below in one and the same direction as schematically represented in Fig. 9 by arrowed pitch lines. It will be apparent that the top roll 4C virtually operates in the manner of an idler since it is indirectly rotated through plate movement imparted thereto by means of the power driven twin bottom rolls. While rolling the plate, the drive gear 6C usually rotates at extremely slow speeds although operated by means of a high speed electric roll motor or main motive power means 6D. This motor is positively interconnected to said bottom rolls through a train of high ratio reduction gears, which in the present instance is accomplished in an improved manner as will be more fully pointed out hereinafter.

For the purpose of forcibly lowering the top roll upon the plate 5 by power means, I preferably provide for an auxiliary electric motor or other screw-down prime-mover means 7A, equipt with the desired speed control and reversing devices as ordinarily used in such connection.

As shown in Fig. 1, such independent screw-down motor is preferably mounted at the forward extremity of the bed plate 1 and may be provided with an armature pinion 7B adapted to mesh with the first reduction gear 7C as carried upon the forward end of the lay shaft 7D that extends rearward and is geared at 7E (see Fig. 2) to drive the intermediate screw-down shaft 7F which latter is here disposed below the level of the bed plate 1. The end portions of this shaft 7F are each provided with a clutch 7H or 7H′, which respectively connect with the worm shafts 7U and 7U′. Said clutches may be individually thrown into or out of engagement by the actuating levers 7J which in turn are linked up by push rods such as 7K that run underneath the bed plate to a centralized control point 7L.

The aforesaid worm shafts are equipt with screw-down worms 7G and 7G′ which respectively mesh with the worm gears 7M and 7M′, the latter gears having their axes disposed vertically underneath the respective upright housings 2 and 3. As shown in Fig. 5, each such worm gear is provided with an internally threaded hub portion 7N which projects upwardly and is rotatably fitted into the housing bore 7P; the upper free end of said hub is shown equipt with a shouldered nut or collar 7Q which is received within the housing recess 7R and serves to positively retain the worm-gear in place against movement along its threaded hub axis when the nut is rotated in either direction. Said interial hub thread engages a non-rotatable adjusting screw 7S having an apertured head enlargement 7S′ adapted to connect with the aforesaid depending coupling pin 3J of the slidable yoke piece 3F. Since the screw part 75 is prevented from rotating, it will be apparent that any simultaneous turning on part of the described screw-down worm gears will serve to adjustably raise or lower the journal ends of the top roll 4C within desired limits such as are indicated in Fig. 9 by full and dotted lines. It will be observed that the described collar provision for retaining the nut-like threaded portion 7N against axial movement, keeps the gear 7M and its worm 7G in proper mesh alignment irrespective of the adjusted position that may be given to the slidable block 8D. To the end that my train of motor speed-reducing gears may afford a compact and efficient drive of the rolls without sacrifice of accessibility, my first speed reduction is obtained through the use of back gears of the double reduction herringbone type, preferably working with cut teeth and comprising a main motor pinion 6E as driven through a flexible coupling 6F carried by the motor extension shaft 6M. As shown in Fig. 1 by dotted outline, said pinion meshes with a relatively large motor driven gear 6G that is mounted upon the countershaft 6H. This last named shaft in turn carries an intermediate pinion 6J that meshes with a driven intermediate gear 6K is mounted upon a separate auxiliary lay shaft 6Q.

All of such back gearing members are arranged to be enclosed within the split casing or gear box 6L in order that said gears may be run in an oil bath and this box is shown as provided with spaced forward and rear side walls that are disposed transversely with reference to the longitudinal roll axes. The desired compact arrangement is in part attained by mounting the countershaft 6H alongside of the aligned shafts 6M and 6Q and thence extending the latter rearward to the bracket bearing 6R that is here shown as attached to the front housing 2. The described shafts are preferably mounted in split bearing shells that divide along the horizontal gear box part line 6N and are respectively carried by said forward and rear side walls of the gear casing. The interior of said box is provided with a pedestal bearing 6P as indicated in dotted outline and this is adapted to support the rear end of the motor extension shaft 6M and at the same time, may serve to lend support to the forward end of the lay shaft 6Q when this is disposed in substantial alignment with the motor shaft 6M as shown.

Intermediate the ends of the lay shaft 6Q, there is mounted a pinion 6S which is arranged to mesh with the large reduction gear 6T as carried upon the gear shaft 6U and which shaft in addition mounts the previously described roll drive gear 6C, all of which will be understood without detailed disclosure by reference to Figs. 1 and 2, where the forward journaled end of the shaft 6U is

supported by the pedestal 6V while the rear end of this shaft may be suitably mounted in the forward housing 2.

The roll gears 6A, 6B and 6C may be of the cast teeth spur gear type while the remaining gears which run at faster speeds are preferably of the cut teeth herringbone type. The allowable speed of my improved gear disposition may be further increased by the use of the cited oil bath provision, it being pointed out that large bending rolls ordinarily require considerable power of which the major portion has generally been spent in useless friction work. Any saving on this score naturally allows of using a smaller motor drive; at the same time, a reduction in friction losses makes my motor more directly responsive to the roll overloading and the resulting more prompt tripping of the conventional motor circuit breaker, better protects all my machine parts against breakdown.

Similar anti-friction innovations have been embodied in my screw-down devices; in Fig. 6 there is shown a recessed worm casing portion 7T adapted to mount a worm gear shaft such as 7U and which shaft is provided with elongated shouldered roller cones 7V and 7V′ respectively disposed against opposite ends of the worm 7G. Cooperating therewith are the thrust bearing rollers 7W respectively running upon the inner and outer pairs of races 7X and 7X′ as mounted within each of the bored casing recesses 7Y and 7Y′ and of which one such recess is closed by the removable cover plate 7Z and this is provided with a grease plug 7Z′. It will also be observed that said cones are each provided with a circumscribing flange portion that likewise centers in said bored recesses.

Turning now to the safety devices that in addition to the use of the conventional motor circuit breaker, serve to protect my bending roll members against abnormal overload, these are in part embodied in complementary roll relief cylinders designated 8A and 8A′ as respectively mounted in the upper portions of the front and rear mill housings. Such hydraulic members are respectively adapted to operate in conjunction with the spaced complementary top roll journals 4C′. A suitable assembly of one such cylinder is disclosed in Fig. 5 where it will be seen that the closed or head end of the cylinder 8A is preferably carried between the extremities of the spaced upturned yoke straps 3F′ and 3F″ which are here provided with aligned holes adapted to snugly receive a trunnion pin 8B in the fashion indicated.

Upon a medial pin portion may be pivotally hung the cylinder 8A to allow of self-alignment and also to provide for tilting of the forward top roll journal with respect to the bottom rolls when the upper rear housing part 3C is swung down as shown in dotted lines to free the rear top roll journal 4C′, this auxiliary feature being provided to facilitate removal from the rolls of a completely rolled boiler shell or the like.

The open depending cylinder bore is fitted with a ram 8C as sealed by the packing 8C″ and if desired, this ram may freely rest upon or be attached to the floating slide block 8D. The lowermost portion of said block is shown provided with a bearing bore 8E of the non-split type adapted to embrace and mount one of the upper roll journals 4C′ and this bore may be equipt with a removable crescent-shaped top journal box 8E′ adapted to be pulled out of place when the pivoted rear housing 3C is to be swung downwardly. Intermediate said bore 8E and the ram 8C, said block may be further provided with a transverse aperture through which the stop-pin 8F is snugly fitted with the pin ends extending laterally beyond the respective vertical faces of said block. The respective pin projections are intended to slide vertically in the elongated slots 8G and 8G′ as formed in the yoke end straps; in normal relation, said pin preferably rests upon the bottom of said slots with the ram drawn outwardly from the cylinder head in the fashion indicated by Fig. 5.

The hydraulic cylinder 8A may be equipt with a flexibly fitted feed pipe 8H and the complementary cylinder 8A′ with a similar pipe 8H′, which pipes, as is schematically shown, may be interconnected by a common pipe line such as 8J adapted to communicate with the intensifier of my machine through the outlet 8J′. It is pointed out that while the described feed piping is here illustrated as rigidly connected, this in practice is intended to be provided with suitable slip connections of swivel joints to allow of proper freedom of movement between the working parts and at the same time to remove all cross-pipe obstruction from over the top roll so as to avoid any interference when manipulating the rolled plate.

The yoke piece 3F is slidably mounted between my housing guides and may be bodily lifted by screw-down means; such yoke movement will carry along the cylinder 8A, the relief ram 8C and the block 8D that mounts the top roll journal. Since both of my housings are similarly equipt, the described yieldable yoke structure constitutes a controllable hydraulic relief means commanding the top roll journal load whenever the screw-down yoke 3F progressively imposes a downward load upon either of the top roll ends. As a characteristic disposition of my relief cylinder 8A, it will be observed that as shown in Fig. 5, the slide block 8D is disposed intermediate the ram 8C and the screw 7S which latter element is preferably kept aligned with the axis of the cylinder.

As will appear presently, there are provided suitable intensifier means capable of main-

taining a predetermined hydraulic pressure behind both rams, and so long as this pressure is kept sufficiently high to more than counterbalance any normal upward lift on part of the top roll, such surplus pressure serves to hold the slide block 8D toward the crotch of the yoke 3F. In the event however that any abnormal overload should fall upon either of the top roll journals, the augmented upward reaction or thrust exerted upon the complementary relief rams will then partially press the hydraulic liquid out of the cylinders 8A and 8A′ and raise one or both slide blocks to a limited extent with respect to normal position. Such relative block movement will cause the projecting ends of the stop-pin 8F to slide upwardly in said guide slots and in turn allow the top roll journals to lift relative to the pair of non-yielding bottom rolls; this relief effect is capable of functioning in like amount irrespective of any particular screw-down yoke adjustment.

Having pointed out the more essential features embodied in my bending roll proper, there will now be described the hydraulic intensifier regulating means whereby I am enabled to maintain a predetermined pressure behind the aforesaid relief rams and to automatically shut off the motive power from my machine in case the rolls thereof should become dangerously overloaded.

For this purpose, I preferably employ an intensifier or regulating device of the accumulator type such for instance as shown in Fig. 7, which comprises a hydraulic cylinder 9A of relatively small bore into which is slidably mounted the packed plunger 9B. If desired, the upper end of the cylinder may be laterally flanged as at 9C to carry spaced columns or stanchions 9D and across the upper ends of which may be mounted the single-acting fluid cylinder 9E. The relatively large bore of said cylinder may be provided with a piston 9F having a rod 9G directly connected to reciprocate in unison with the aligned plunger 9B. Into the head 9H of said cylinder, there is shown a supply pipe 9J that is provided with a pressure reducing or control valve 9K as commanded by a non-return or check valve 9K′. Said supply pipe is preferably connected to a suitable source of gaseous fluid such as air or steam capable of mantaining a comparatively large total loading upon the piston rod 9G that will create a relatively high hydraulic unit pressure behind the plunger 9B, and this in turn is transmitted through the outlet pipe line 8J′ to the interconnected relief ram 8C and 8C′. It will be apparent that any suitable resilient loading of the plunger 9B might be made to accomplish the end in view and such spring-like modification is to be considered as the equivalent of the cited air or steam cylinder means.

The hydraulic cylinder 9A is further provided with an inlet pipe 9L that is fed by the supply or charging pump 9M and which pump may be either of the conventional hand operated or power driven type provided with the usual automatic suction and discharge valves. The port 9M′ serves to feed the hydraulic liquid to said pump and by its use, the interconnected ram piping system may be pumped up to any desired initial working pressure. After all the pipe lines and other chambers have been properly vented and filled with liquid, continued hand pumping will start lifting the plunger 9B against the counter pressure exerted thereon by the piston 9F. When the relief ram rests in its initial or normal stroke position shown in Fig. 5, the plunger 9B is intended to assume substantially its lowermost position as shown in Fig. 7 and thereupon the charging pump 9M need no longer be used except to occasionally compensate for hydraulic leakage.

If augmented air pressure is now thrown on top of the piston 9F by means of the reducing valve 9K, this will raise and maintain a relatively higher or intensified pressure within the hydraulic cylinder 9A and hence in turn may be adjusted so as to set up any desired initial pressure behind the two housing rams 8C and 8C′. Any abnormal upward loading imposed upon the adjusted top roll journals will exert a corresponding distributed gross pressure over the top of the equalized relief rams, and in the event that such pressure as measured per unit of area should rise to a value higher than that prevailing behind the intensifier plunger 9B, such augmented unit pressure will cause the intensifier piston 9F to be raised somewhat against the counter pressure then existing within the air cylinder 9E. The air or steam confined therein will allow of a lift on part of the plunger 9B and the point at which the rams are allowed to give way under abnormal roll journal loading, is largely dependent upon the initial pressure kept behind the piston 9F and this may readily be fixed by giving the desired setting to the reducing valve 9K.

So long as this initial pressure is maintained at a fixed value, it will always require substantially the same gross roll pressure to force the relief rams upward into their respective hydraulic cylinders. In case the ram pressure setting is not exceeded during normal operation of the rolls, said rams remain inactive and are merely held in reserve for emergency overload purposes. It will be apparent however that said initial hydraulic ram pressure is intended to be kept up within reasonable limits so as to insure of properly holding down the top roll journals against normal load expectations.

When said rams are brought into action, there will be displaced a certain volume of

hydraulic liquid which in turn results in a corresponding rise on part of the plunger 9B, but owing to the resistance offered by the counter-fluid pressure acting upon the piston 9F, there is here afforded a yieldable medium that is admirably adapted to relieve the top roll journals against overload when otherwise they would be rigidly confined for any fixed adjustment on part of the complementary yoke pieces 3F. Either one of my relief rams may independently move into their respective cylinder bores and the extent of this relief is made dependent upon the inequality or inordinancy of the respective top roll journal loads.

The yield range given to my rams is intended to compensate for all reasonable stop journal loads. However, whenever the safe predetermined limit in accordance with the foregoing devices has been exceeded, I further provide effective relay means for shutting down the power drive of my bending machine. To this end, the stanchions 9D preferably space the superimposed cylinders 9A and 9E sufficiently to allow of clearing the switch arm 9N as clamped to or otherwise carried by the reciprocating piston rod 9G. Said arm is provided with a forked extension 9P adapted to slidably straddle one of the stanchions for alignment purposes while the opposite arm end is provided with an inclined striker cam 9Q that travels in unison with the piston rod within the respective limits indicated by full and dotted arm lines. Cooperating with said cam is a relay switch box 9R of the open circuit type which as detailed in Fig. 8, is identical in operation to a conventional elevator limit switch and as such primarily comprises a pair of terminal posts such as 9R′ that may be interconnected by a knife element 9S, the latter being adapted to be thrown out of contact by the compression spring 9S′ or its equivalent. Said knife may be forcibly thrown into contact by the medially fulcrumed switch lever 9T, the free outer end of which carries a roller 9T′. As shown in full lines by Fig. 7, this roller is normally depressed inwardly toward the rod 9G by means of the spring 9S′ but whenever the switch arm 9N is allowed to reach its uppermost position, said inclined cam will push the roller 9T′ outwardly to close the circuit through the switch box 9R and this in intended to bring about a shut down of the power drive of my machine.

This automatic cut-out device may be applied to either or both the motors 7A and 6D but preferably to the former or screw down motor which may readily be accomplished through the wiring diagram represented in Fig. 8. In this instance, the switch box 9R is made to control a relay or pilot circuit of which 9U indicates an auxiliary source of current adapted to trip the circuit breaker 9V commanding the current flow to the motor 9W as fed by the power lines 9X and 9X′ under control of the starting switch or controller 9Y. While the box 9R is shown as of the open switch type, the circuit may if desired, be reversed to function on a closed circuit basis.

Referring now to the intended cooperation of the described working parts of my machine, this may be traced as follows: Firstly, it is pointed out that by the use of my improved devices, the top roll 4C may safely be brought down solidly upon the bottom rolls without harm to the motors notwithstanding that the auxiliary motor 7A is positively geared to the screw-down members. In case the top roll screw-down thrust should thereby become obstructed, the further turning of worm gears upon the complementary screws 7S will not be blocked as is a common occurrence when operating a conventional bending machine, but instead the relief cylinders 8A and 8A′ will merely be drawn down upon their respective floating rams 8C and 8C′. The combined resulting displacement will proportionally force the hydraulic medium out of said cylinders and through the interconnecting pipe 8J so as to register a corresponding lift displacement at the piston rod 9G. In case the running of the screw-down motor 7A should be prolonged under these conditions, the continued raising of the striker cam 9Q will ultimately engage the roller 9T′ and thereupon throw the switch box 9R. This in turn trips the circuit breaker 9V and shuts the power off of the screw-down motor before any serious damage can be done to any working parts of my machine. Upon reversing the rotation of my screw-down worm gears, the raising of the upper roll will return both relief rams and also the intensifier plunger back into their respective normal working positions.

As to the regular manner of operating my mill, this is made apparent by Fig. 9. Assuming the top roll 4C to be fully raised with respect to the bottom rolls by means of the screw-down motor into the position shown in full lines, then the rolls are ready to receive a substantially flat plate 5 therebetween. The screw-down motor may now be started and the clutch actuating levers thrown to cause an even descent on part of the top roll, which in turn gradually clamps the plate 5 in a spanning relation against the spaced bottom rolls. By virtue of the described large speed reduction, the slow moving screw members are capable of exerting an enormous localized pressure along the contacting roll faces and this causes the plate edge to be initially crimped or dented. The top roll is then held in such strained relation by the screw-down mechanism, and the main motor 6D is thereupon made to pass said plate through the rolls. When the en-

tire plate surface has thus been subjected to said initial crimping or bending action, the roll motor is ordinarily stopped and the screw-down imparts a further similar crimping increment to the plate edge which is in turn imparted to the entire plate by the roll motor, this process being kept up until any desired plate curvature is reached. My safety devices against overload are preferably incorporated to act upon the screw-down motor circuit for the reason that the more serious damage to the machine parts is more apt to occur while operating the screw-down members, although it is to be understood that my switch box 9R or its equivalent may in like manner be applied to cut out the main roll motor should this be deemed expedient.

The outstanding advantages of the described improvements are brought into play whenever attempt is made to initially crimp a heavy plate that is beyond the rated roll capacity to handle safely and is likely to lead to breakdown of machine parts or burn out the motor drive. My hydraulic safety devices afford full protection because the motor drive is automatically shut down whenever a predetermined roll loading is reached. It is emphasized, that by thus making the motor release directly responsive to the roll load, neither the motor nor the drive gearing need at any time be subjected to serious overload or injury resulting from destructive strain such as is far more likely to occur when having to rely solely upon fuses or the inadequate protection afforded by the conventional circuit breaker devices. Furthermore owing to the intermediary reduction gearing that must necessarily be interposed between bending rolls and their power drive, the current flow into such motors is not an accurate measure of the actual strain to which the rolls or housing parts may momentarily be subjected.

Large machines of the character to which my devices are especially suited, represent a very considerable investment, hence it is of utmost importance to reasonably safeguard these against undue fatigue or failure of the massive working parts. Careless or improper attendance is likely to allow the rolls to come together solidly without any cushioning plate therebetween and this is more likely to occur when placing dies across the bottom rolls in order to form up cone or V shapes instead of plain cylindrical curvatures. It will be understood that by virtue of my screw-down clutches, either of the housing yokes may be shifted independently of the other, also that after having made any desired adjustment, it is customary to shut down the screw-down motor while the roll motor is kept operative.

By the use of my floating roll journal relief means, all damage to the machine and gear parts may readily be avoided when given reasonable care, but should certain such parts become partially disabled due to unforeseen contingencies or careless attendance, my roll relief rams can thereupon be set to work at a reduced predetermined hydraulic pressure which correspondingly limits the roll load that can still be safely put thereon. Since my two ram cylinders are interconnected, this further provides for a certain roll "give" adapted to compensate for misalignment of the roll ends or unevenness in plate thickness. The further fact that bending rolls must of necessity be positively driven through reduction gears from powerful motors makes apparent the importance and need of applying thereto a more effective motor unloading device than is afforded by conventional methods.

A further distinctive feature resides in the described complementary bearing blocks as slidably mounted between their respective forked straps which structure allows the screw-down yoke to pass around each of the idler roll journals and in turn permits of locating my dual relief cylinders together with their respective rams above said movable roll journals, and these cylinder members through the medium of said yokes are adapted to be positively shifted toward or away from my fixedly mounted companion roll or rolls. As applied to the pyramid type of plate bending machine, the desired roll raising and lowering function is greatly facilitated by the use of depending threaded shank means attached to each of said unitary yokes and arranged to pass between the spaced bottom rolls, since this particular shank disposition allows of actuating the yieldably mounted idler roll from below by interconnected worm-gear means that may be effectively and compactly disposed underneath the respective roll housings.

In addition, I have devised a highly efficient and compact reduction gear drive to work in cooperation with the described emergency relief means, and this gearing not only reduces friction to a marked degree over common practice but runs with less vibration and far more quietly. My dust proof casing permits of running the gears in an oil bath and overcomes the usual neglect of proper lubrication in machines of this class. The end thrust of the worm gear, which has heretofore been a source of relatively large power waste and operating trouble, has herein been equipt with roller bearings that can be packed in grease and kept free from dirt and grit, so as to bring about a considerable reduction in avoidable friction over the ordinary mill. Finally, the saving in floor space attained by my compact disposition of gearing is a further significant factor as applied to bending rolls.

It will be obvious that my improvements are susceptible of rather wide modification

over the structural embodiment herein featured, it being apparent that my roll relief devices are equally applicable to mills of the two roll type, likewise it is not essential that my two drive motors be kept as separate entities since they may readily be combined by clutch means or the like to operate as a common prime mover, and that various similar changes may be made without departing from the spirit and scope of this invention as defined in the appended claims.

Claims:

1. In a plate bending machine of the pyramid type comprising three cooperating journaled rolls mounted between spaced housings, a power drive operatively connected to the complementary lower rolls, pivotally mounted bearing block means for each journal of the top roll, said blocks having their pivots disposed transversely to the longitudinal axis of said top roll to provide for tilting with respect to said driven bottom rolls, and means associated with said housings serving to yieldably retain the respective blocks and allow said top roll under abnormal journal load to lift away from the complementary bottom rolls.

2. The combination with a pair of cooperating journaled rolls, a prime mover adapted to drive one such roll, movable bearing block means for each journal of the companion roll, relief means yieldably retaining said blocks toward said one roll, and power cut-off means adapted to automatically unload the prime mover when one of said yieldable blocks is subjected to a predetermined degree of overload.

3. In a machine including a pair of cooperating journaled rolls mounted between spaced housings, a prime mover associated with said machine, movable bearing block means for each journal of one such roll, hydraulic relief means separately retaining the respective blocks toward the other roll, and unloading means adapted to automatically shut off said prime mover power whenever either of said relief means is subjected to a fixed degree of overload.

4. The combination with a pair of cooperating journaled rolls mounted between spaced housings, a prime mover associated with said machine adapted to drive one such roll, movable bearing block means for each journal of the companion roll, hydraulic relief means including a ram cylinder serving to independently retain each of the respective blocks toward said driven roll, said relief means being adapted to displace hydraulic medium when subjected to a predetermined roll load, means for bodily shifting said cylinders together with their respective movable blocks toward or away from said one driven roll, and conduit means interconnecting said cylinders.

5. In a plate bending machine comprising two cooperating journaled rolls mounted between spaced housings, a prime mover associated with said machine serving to drive one of said rolls, movable bearing block means for each journal of the other roll, hydraulic relief means for each of said blocks adapted to displace hydraulic medium when subjected to a predetermined roll load, means serving to register medium displacement, screw-down means including an adjusting screw and a rotatable nut adapted to shift one of the blocks, worm gear means actuating said nut, and retaining means for said nut serving to maintain the gear in alignment with its worm when the nut is rotated in either direction.

6. In a machine including a pair of cooperating journaled rolls mounted between spaced housings, a prime mover associated with said machine, movable bearing block means for each journal of one such roll, hydraulic relief means retaining said blocks toward the other roll, said means being adapted to displace hydraulic medium when subjected to predetermined abnormal roll load, accumulator plunger means serving to register medium displacement, and control means responsive to plunger movement and adapted to shut off prime mover power.

7. In a machine including a pair of cooperating journaled rolls mounted between spaced housings, an electric motor drive associated with said machine, movable bearing block means for each journal of one such roll, hydraulic relief means retaining said blocks toward the other roll, said means being adapted to displace hydraulic medium when subjected to a predetermined roll load, reciprocative plunger means serving to register medium displacement, and control means responsive to plunger movement, said means comprising a switch commanding current flow to said motor and which switch is adapted to be tripped in one extreme of plunger travel.

8. In a machine including a pair of cooperating journaled rolls mounted between spaced housings, a prime mover associated with said machine, movable bearing block means for each journal of one such roll, hydraulic relief means retaining said blocks toward the other roll said relief means being arranged to shift bodily with their respective blocks and adapted to displace hydraulic medium when subjected to a predetermined roll load, regulator means comprising a reciprocative plunger serving to register medium displacement, a fluid cylinder of the intensifier type provided with a piston operatively connected to oppose plunger movement, and means admitting fluid under pressure to said cylinder.

9. In a machine comprising a pair of cooperating journaled rolls mounted between spaced housings, a prime mover associated with said machine, movable bearing block

means for each journal of one such roll, hydraulic relief means retaining said blocks toward the other roll, said relief means being adapted to displace hydraulic medium when subjected to a predetermined roll load, regulator means comprising a reciprocative plunger serving to register medium displacement, and charging pump means adapted to replenish the hydraulic medium.

10. In a machine including a pair of cooperating journaled rolls mounted between spaced housings, a prime mover associated with said machine, movable bearing block means for each journal of one such roll, hydraulic relief means retaining the respective blocks toward the other roll, said relief means being shiftable with said blocks and adapted to displace hydraulic medium when subjected to predetermined roll load, and regulator means of the accumulator type comprising a plunger registering combined medium displacement and further comprising a fluid pressure cylinder having a counteractive piston.

11. In a machine comprising a pair of cooperating journaled rolls, a prime mover associated with said machine, movable bearing block means for each journal of one such roll, hydraulic relief means retaining the respective blocks toward the other roll, said relief means being shiftable with their respective blocks and adapted to displace hydraulic medium when subjected to predetermined roll load, and counterbalanced regulating means adapted to register medium displacement.

12. In a plate bending machine comprising a pair of cooperating journaled rolls mounted between forward and rear journal housings, said rear housing being provided with a lower base portion and an upper portion pivotally mounted thereon to swing outwardly and away from the forward housing into inoperative position, a prime mover operatively connected to drive one of said rolls, a movable bearing block means for each journal of the other roll of which one such block is carried by said swingable upper rear housing, and means for yieldably thrusting the respective blocks toward the respective journals of said driven roll when said upper rear housing portion is brought into operative position.

13. In a plate bending machine, a pair of journaled rolls parallelly mounted between spaced journal housings, means associated with said housings serving to yieldingly retain the respective journals of one such roll and allow the latter to automatically lift away relative to its companion roll when subjected to overload, a prime mover, a gear train positively connecting said mover with the companion roll, said gear train including an intermediary back gearing, and incasing means adapted to house said back gearing as a unit.

14. In a machine including a pair of cooperating journaled rolls mounted between spaced housings, a prime mover for said machine, a slidable yoke member for each of said housings, bearing block means for each of said yokes respectively adapted to carry the journals of one such roll, retaining means yieldingly mounting said blocks with respect to their respective yokes, and screw-down means for adjustably setting the respective positions of said slidable yokes and simultaneously shifting the retaining means therewith.

15. In a machine equipt with a pair of cooperating rolls, a prime mover for said machine, a movable yoke member for the respective housings each comprising a pair of straps interconnected by a crotch, bearing block means slidably embraced between each pair of straps and respectively mounting the journals of one such roll, yieldable retaining means for each of the blocks serving to thrust said blocks toward the crotch of the respective yokes, and screw-down means for adjustably setting said movable yokes.

16. In a machine equipt with a driven and a cooperating idler roll mounted between spaced housings, a prime mover operatively connected with the driven roll, a movable yoke member for the respective housings each comprising a pair of spaced straps, bearing block means slidably mounted between each pair of yoke straps and respectively carrying the journals of the idler roll, a trunnion pin extending between each pair of yoke straps, a hydraulic relief cylinder pivotally mounted upon each of said pins, a ram for each of the cylinders, respectively adapted to yieldingly thrust the idler roll blocks toward said driven roll, and screw-down means for adjustably setting yoke positions.

17. In a machine comprising three cooperating journaled rolls mounted in pyramidal relation between housings of which two lower rolls operate in shells respectively associated with said housings, a movable yoke member for each of said housings, yieldably retained block means for each of said yokes adapted to mount the respective journals of the top roll and allow the latter to automatically lift away from said lower rolls when subjected to a predetermined loading, screw-down means including a depending adjusting screw for each of said movable yokes disposed between the respective pairs of housing shells, interconnected worm gear means for actuating the respective screws, and power means serving to drive said worm gear means.

18. In a machine including a pair of cooperating journaled rolls mounted between housings, a movable yoke member for each housing, yieldably retained block means for

each of said yokes adapted to mount the respective journals of one such roll, screw-down means including an adjusting screw and nut means for each of said yokes, worm gear means including a worm shaft serving to actuate one of said screw and nut means, and casing means adapted to mount said shaft and its worm, said casing being provided with recesses adjacent to each end of the worm respectively equipt with thrust bearings of the roll type.

19. In a machine comprising a pair of cooperating journaled rolls mounted between forward and rear housings, said rear housing being provided with a lower base portion and an upper portion pivotally mounted thereon to swing outwardly away from the forward housing into inoperative position and which upper portion is further equipt with guide means, a movable yoke member slidably mounted upon said guide and comprising a pair of straps interconnected by a crotch having a depending shank, bearing block means for each journal of one such roll of which blocks one is carried by said swingable upper housing and slidably mounted between the yoke straps thereof, yieldable retaining means serving to thrust said one block toward its yoke crotch, and screw-down means for adjusting the movable yoke of said supper rear housing portion, said screw-down means including a non-rotatable adjusting screw member mounted in the lower base portion and attached to said shank through knuckle joint means adapted to permit of swinging said upper housing into inoperative position.

20. In a machine including a pair of complementary journaled rolls mounted between housings, a shiftable yoke member for each of said housings, yieldably retained block means for each of said yokes respectively mounting the journals of one such roll, each such block being adapted to allow the respective end portions of said one roll to automatically lift away when said rolls are subjected to predetermined loading therebetween, screw-down means for shifting said yokes, a prime mover adapted to drive said screw-down means, and power cut-off means serving to unload the prime mover whenever one of the aforesaid yieldable blocks is subjected to a fixed degree of overload.

21. In a machine including a pair of complementary journaled rolls mounted between housings, a shiftable yoke member for each of said housings, block means movably associated with each of said yokes and respectively mounting the journals of one such roll, relief means adapted to yieldably hold in place the respective block means, screw-down means for shifting said yokes, a prime mover adapted to drive said screw-down means, and unloading means serving to bring the prime mover to rest when said relief means is subjected to a predetermined degree of overload.

22. In a bending machine of the pyramid type comprising three complementary journaled rolls mounted between housings of which two such rolls operate in oppositely disposed shells respectively carried by the housings, block means movably associated with each of said housings and respectively mounting the journals of the other roll, a shiftable yoke member cooperating with each of said blocks, hydraulic relief means for each of said blocks, said means being bodily shiftable with the respective yokes and adapted to displace hydraulic medium when subjected to a predetermined loading, regulator means for said relief means, and adjusting means associated with said regulator adapted to alter the aforesaid predetermined loading.

23. In a bending machine comprising journaled rolls parallelly mounted between forward and rear housings, a gear shaft mounted forwardly of the first named housing, a roll drive gear carried upon said shaft, a reduction gear also carried by said shaft, a secondary shaft, a pinion mounted on the last named shaft and adapted to mesh with said reduction gear, a prime mover for the rolls disposed forwardly of the first named housing, a motor pinion direct-connected to said prime mover, a back-gear shaft, a driven gear assembled thereon and meshing with said motor pinion, an intermediate pinion also carried by said back-gear shaft, a driven intermediate gear carried by said secondary shaft and adapted to mesh with said intermediate pinion, and a gear-box means adapted to mount therein said back-gear shaft together with the cited gears assembled thereon and including the respective gear stipulated as meshing therewith, all of the aforesaid gear shafts being disposed in a substantionally parallel relation with respect to the axes of said rolls.

24. The combination with a pair of cooperating journaled rolls of spaced housings, means for driving one of said rolls, block means of the floating type associated with each of said housings and respectively adapted to yieldingly mount the journals of the other roll, an adjusting screw including a rotatable nut for each such block serving to positively shift the respective blocks toward or away from said one roll, gear means actuating said nuts, and collar means associated with the respective housings serving to retain said nuts against axial displacement irrespective of the direction of nut rotation.

25. The combination with a pair of cooperating journaled rolls of spaced housings, bearing block means movably associated with each of the housings and respectively adapted to mount the journals of one such roll, screw-down means including an adjusting

screw having its axis directed laterally away from the axis of said one roll and adapted to actuate one of said blocks, and hydraulic relief means for the last named block, said relief means as measured with respect to the aforesaid roll axis being oppositely disposed relatively to the stipulated screw disposition.

26. The combination with a pair of cooperating horizontally mounted journaled rolls of spaced housings, bearing block means for each such housing and respectively mounting the journals of one such rolls, a yoke member slidably associated with one of said housings and which yoke comprises a pair of complementary strap extensions adapted to straddle the block of said one housing, hydraulic relief means mounted across the upper end portions of said straps and adapted to thrust the last named block downwardly toward the crotch of said yoke member, and screw means for setting the yoke, said screw being operatively connected to the yoke crotch from below the axis of the said one roll.

27. The combination with a pair of cooperating journaled rolls of spaced housings, floating block means for each housing which respectively mount the journals of one such roll, a yoke member slidably associated with one of the housings and adapted to cooperate with the block thereof, screw-down means for adjustably setting said yoke, and roll relief means for the last named block, said means being uniformly operative irrespective of the setting given to said yoke.

In testimony whereof, I have herewith set my hand this 9th day of December, 1927.

G HARRY CASE.