Sept. 15, 1964 E. J. HUNTER 3,148,565

ROLLING MILL

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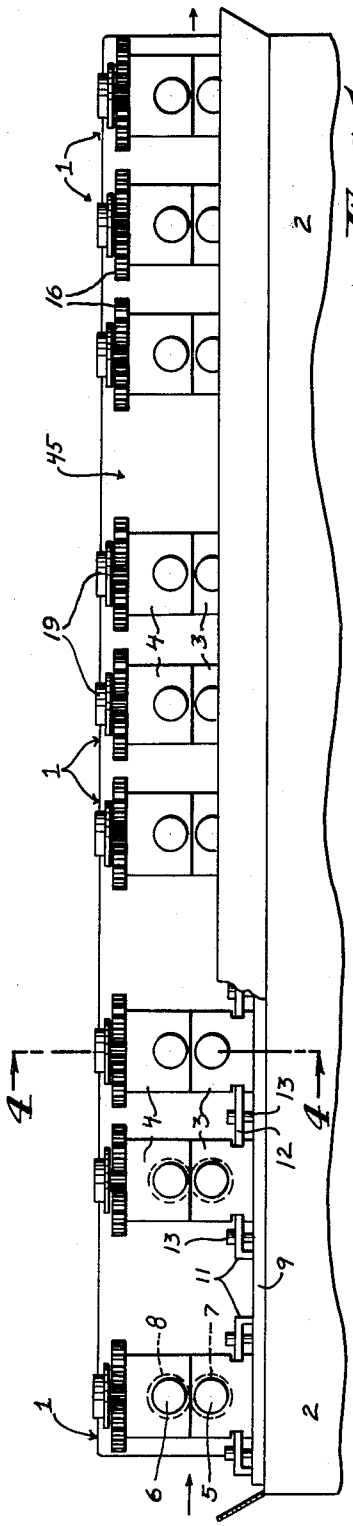


FIG. 1

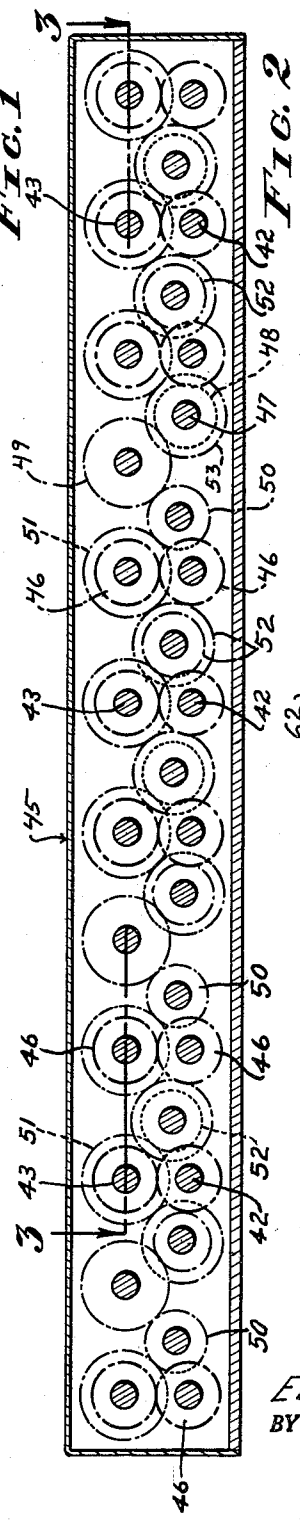


FIG. 2

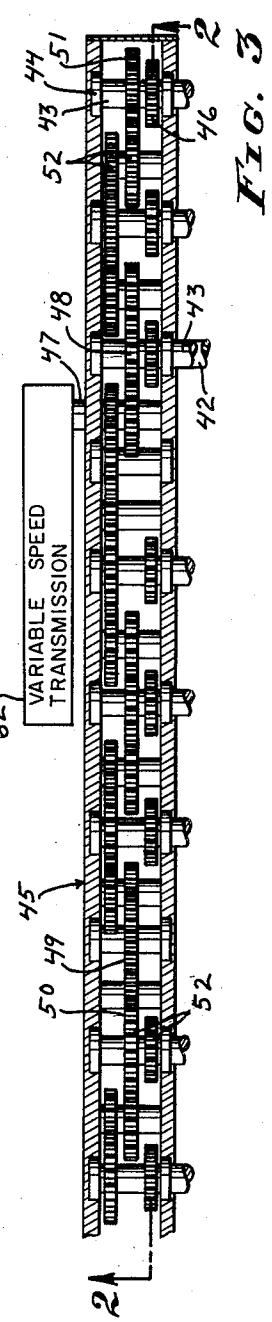


FIG. 3

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ROLLING MILL

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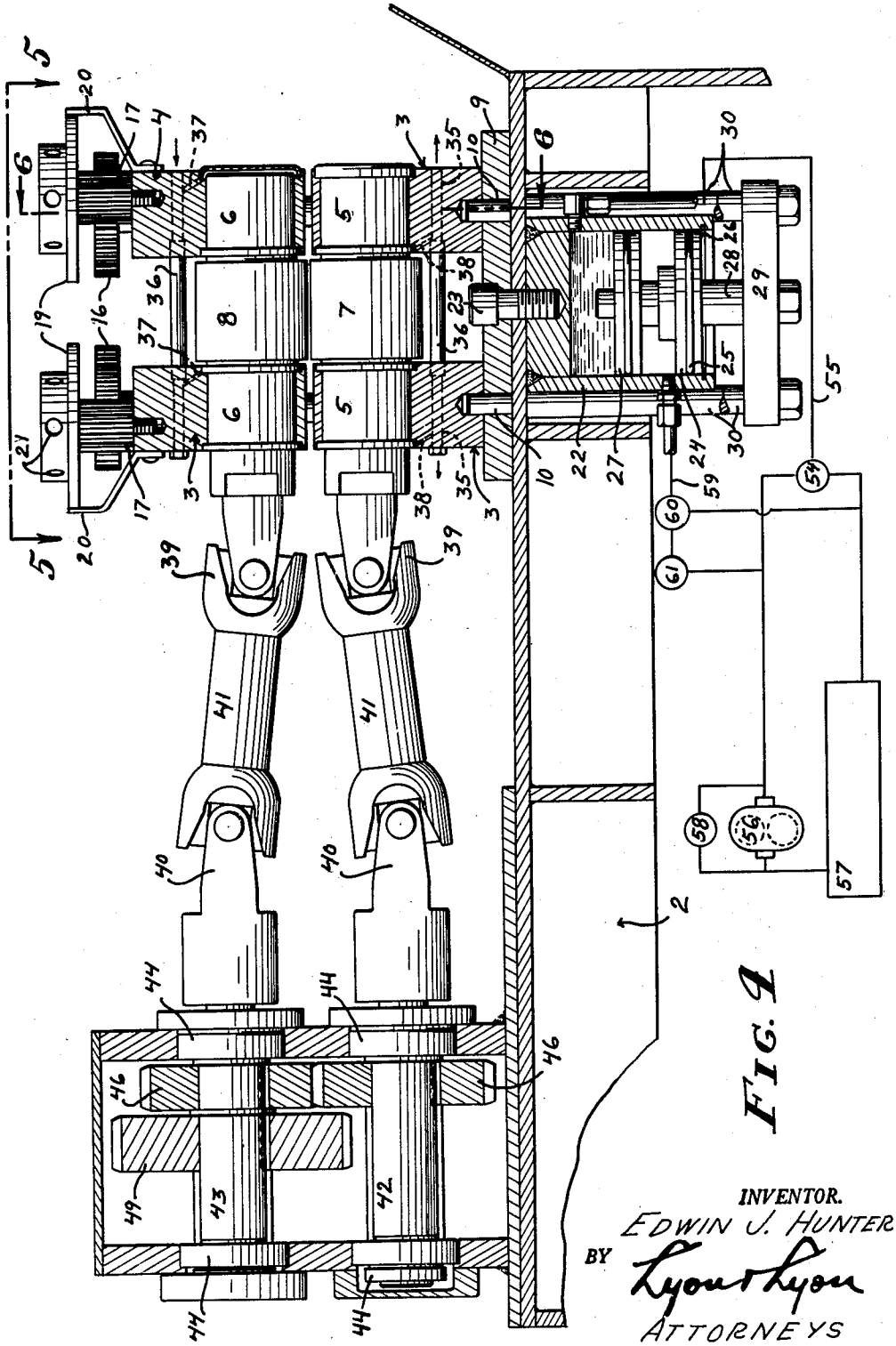


FIG. 4

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ROLLING MILL

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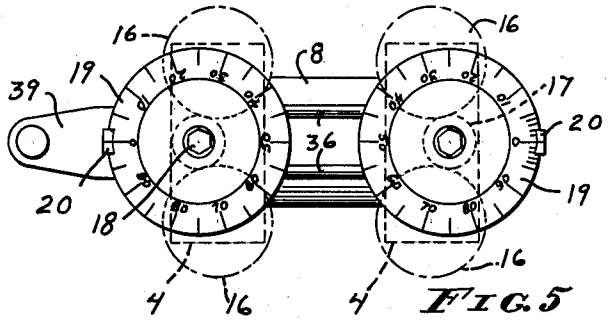


FIG. 5

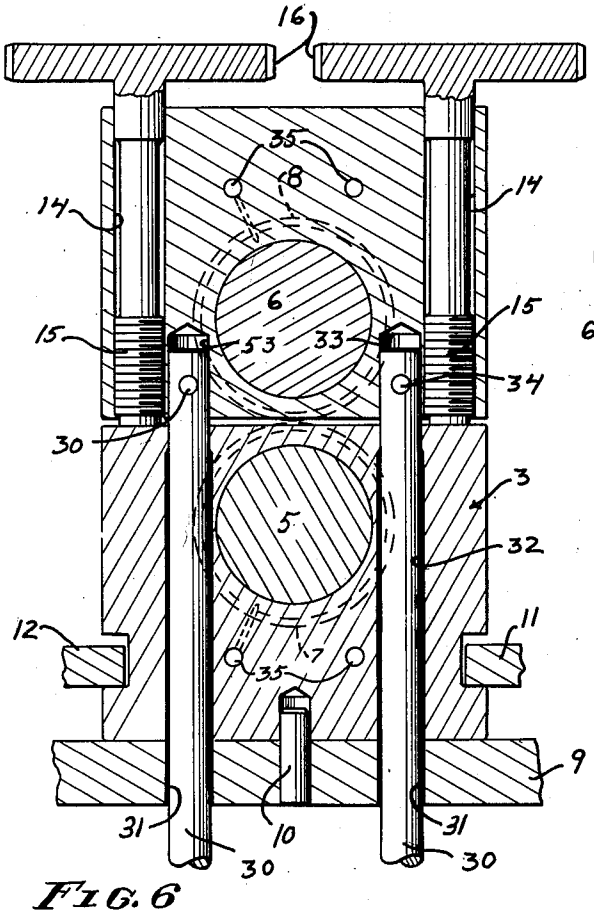


FIG. 6

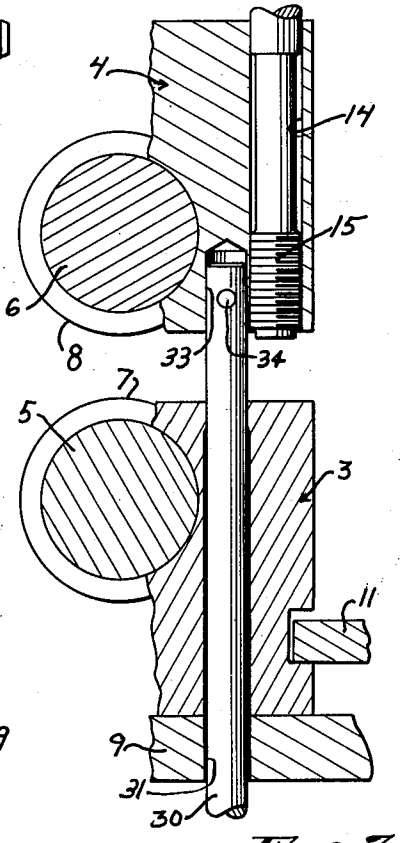


FIG. 7

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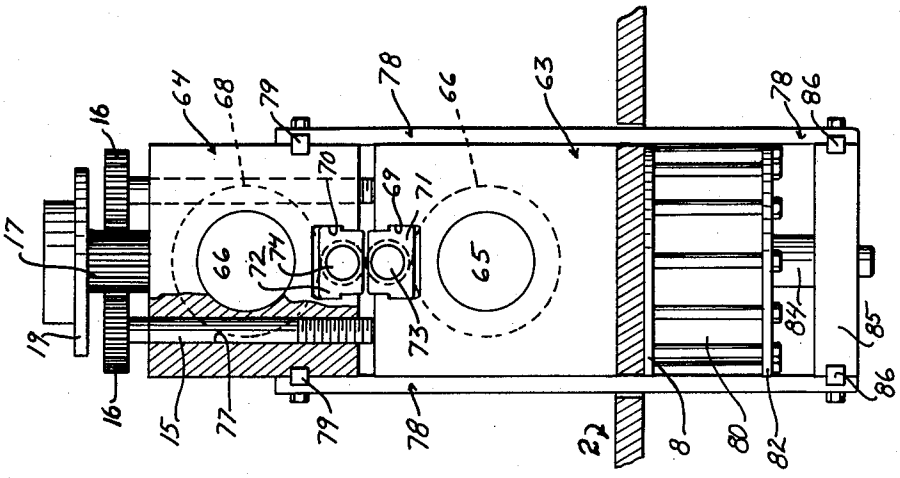


FIG. 9

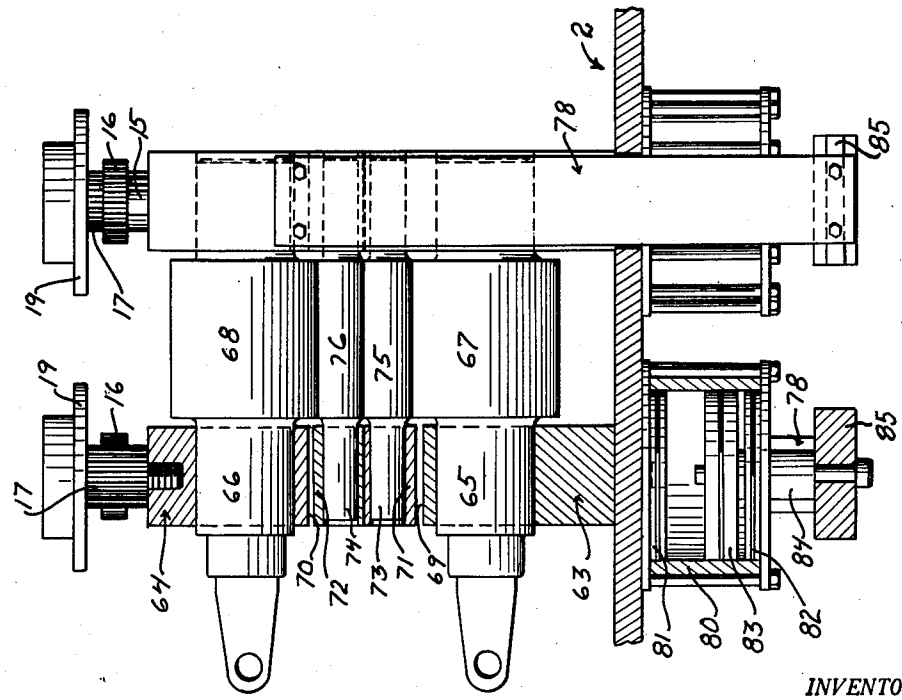


FIG. 8

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3,148,565

ROLLING MILL

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Filed Aug. 15, 1960, Ser. No. 49,682
7 Claims. (Cl. 80—35)

This invention relates to rolling mills, and included in the objects of this invention are:

First, to provide a rolling mill wherein framework structurally connecting the bearings for the upper and lower rolls is eliminated, thereby not only materially reducing the weight, but also substantially reducing the area occupied by the rolling mill, so that a series of rolling mills may be more closely grouped than has heretofore been possible.

Second, to provide a rolling mill wherein the upper roll and its bearings are urged toward the lower roll by tension members extending through and below the lower roll and its bearings, and connected to hydraulic means located under the mill.

Third, to provide a rolling mill wherein the minimum spacing between the rolls is accurately and positively determined by adjustable stops, and a predetermined hydraulic load is applied in a direction to force the rolls toward each other until limited by the stops; whereby in the event of overload the rolls may separate.

Fourth, to provide a rolling mill whereby the rolls may be quickly separated a substantial distance in an emergency so as to free the work, or as desired in the course of servicing the mill.

Fifth, to provide a rolling mill comprising a plurality of stations so interconnected that the rolls of each station rotate at a rate which is faster by a predetermined percentage than the rolls of the preceding station, and wherein the speed of the rolls of all stations may be altered simultaneously.

Sixth, to provide a rolling mill adapted to roll a continuous strip of material wherein the spacing between the rolls of each station may be readily adjusted, so that each station may reduce the thickness of the strip in proportion to the increase in its roll speed with respect to the preceding station, in order to maintain the correct tension on the strip as it passes from station-to-station of the mill.

Seventh, to provide a rolling mill which is so arranged that in the event the work strip "cobbles" or buckles between stations, or is parted by tension, or other emergency occurs, which requires separation of the rolls, the operating adjustments of the rolls are not disturbed. That is, the minimum spacing between the rolls determined by the adjustable stops is not altered, so that, on return of the rolls to their operating position, further adjustment is not required.

Eighth, to provide a rolling mill which may be adapted to various roll arrangements, such as a two roll arrangement used principally for relatively narrow stock, or the roll arrangements in which the work engaging roll is in turn engaged and supported by one or more backing rolls.

With the above and other objects in view, as may appear hereinafter, reference is directed to the accompanying drawings in which:

FIGURE 1 is a fragmentary side view of the rolling mill with a portion broken away and in section;

FIGURE 2 is a fragmentary sectional view of the gear housing taken through 2—2 of FIGURE 3, showing the gears in elevation;

FIGURE 3 is a fragmentary sectional view of the gear housing taken through 3—3 of FIGURE 2 with the gears shown in plan and with the projecting portions of the shaft shown fragmentarily;

FIGURE 4 is an enlarged, fragmentary, transverse, sectional view taken through 4—4 of FIGURE 1 with portions shown in elevation;

FIGURE 5 is a top view of one of the rolling stations taken substantially from the line 5—5 of FIGURE 4;

FIGURE 6 is a further enlarged, fragmentary, sectional view taken through 6—6 of FIGURE 4 showing one of the rolling stations with the rolls in their operating position;

FIGURE 7 is a fragmentary sectional view similar to FIGURE 6, showing the upper and lower rolls separated from each other for servicing the rolling station;

FIGURE 8 is partial sectional partial elevational view of a modified form of rolling mill taken through 8—8 of FIGURE 9;

FIGURE 9 is an end elevational view thereof with the mounting base and a portion of the upper roll block shown in section.

The rolling mill illustrated in the drawings is particularly adapted for rolling a narrow strip of metal, and therefore is of such dimension that a plurality of rolling stations 1 may be mounted on a common bed 2. In the construction illustrated, the rolling stations are arranged in groups, nine stations being shown. The first station is spaced from the next two stations, and the next three stations are arranged in a group and spaced from the preceding two stations and the last three stations as illustrated in FIGURE 1. The grouping of the stations permits the installation of conventional trimming devices (not shown). These stations, of course, may be arranged in other groups and fewer or greater in number, depending upon the desired reduction in thickness of the metal being rolled. Also any or several selected stations may be rendered inoperative to vary the thickness reduction of the material being rolled by raising the upper roll, as indicated by FIGURE 7 and described more fully hereinafter.

Each rolling station 1 includes a pair of lower blocks 3 and a pair of upper blocks 4. The upper and lower blocks are provided with bearing bores which receive the journals 5 and 6 of a lower roll 7 and an upper roll 8, respectively. The rolls may be identical, with their journals 5 and 6 somewhat smaller in diameter than their respective rolls 7 and 8. The bearing bores of the blocks 3 and 4 are disposed relatively close to the confronting ends of the blocks, so that clearance exists between the blocks when the rolls 7 and 8 are brought close together.

The lower pair of blocks 3 rest on a base plate 9 mounted on the bed 2 and are precisely located by pins 10. The lower blocks are provided with transverse slots which receive the ends of holddown clamps 11 and 12. The holddown clamps 11 are L-shaped and so arranged that one end bears against the base plate 9, whereas the holddown clamps 12 are in the form of flat bars extending between adjacent rolling stations. Bolts 13 extend downwardly through the clamps 11 and 12 and screw into the base plate 9.

As shown in FIGURES 6 and 7, each upper block 4 is is provided near its forward and rearward sides with a pair of vertical bores 14, each of which is provided with screw threads at its lower portion. Each bore 14 receives a roll-spacing screw 15, the lower end of which protrudes from the upper block 4 to engage the lower block 3. The upper end of each spacing screw 15 extends above the upper block 4 and is provided with a gear head 16. As shown in FIGURE 5, the gear heads of each pair of roll-spacing screws 15 engage a common pinion 17 journaled on a vertical shaft 18, the lower end of which is screw-threaded into the upper end of the corresponding upper block 4.

Secured to the upper end of each pinion 17 is a dial

wheel 19 having a flange graduated in appropriate divisions of a circle. A pointer 20 secured to the corresponding upper block 4 cooperates with the margin of the dial wheel 19 to aid in indicating the position of the dial wheel. The axial length of each pinion 17 is greater than the axial length of the gear heads 16 meshing therewith, so that as the pinion 17 is rotated the gear heads 16 and roll-spacing screws 15 may travel longitudinally with respect to the upper block 4, and thereby raise and lower the upper block with respect to the corresponding lower block 3. The dial wheels 19 may be provided with sockets 21 for engagement by a bar or spanner wrench, to facilitate manual adjustment of the dial wheels 19.

Disposed below each rolling station 1, underneath the bed 2 and base plate 9, is a hydraulic cylinder 22, as shown in FIGURES 4, 8, and 9. The hydraulic cylinder is closed at its upper end and held in place by a bolt 23. The lower end of each hydraulic cylinder is closed by a disk 24 having a seal ring 25 and retained in place by a retainer ring 26. Each hydraulic cylinder receives a piston 27 having a stem 28 extending downwardly through the disk 24. The lower extended end of the stem 28 is joined to a square plate 29 which in turn is joined at its corners to four tension bars 30.

The four tension bars 30—see FIG. 6— associated with each rolling station 1 extend upwardly through clearance holes 31 in the bed 2 and base plate 9, and continue upwardly through guide bores 32 provided in the lower blocks 3. The tension bars project above the lower blocks 3 into sockets 33 provided in the upper blocks 4. The guide bores 32 are constricted at their upper ends to provide close sliding fits with the tension bars 30, so as to align the upper blocks 4 accurately with respect to the lower blocks 3, or separate guide pins may be used. Indeed, the roll-spacing screws may extend into guide sockets in the lower journal blocks to accomplish this purpose. The essential feature is that the blocks are maintained in their vertical alignment by guide means without the need of external framework.

The tension bars 30 are anchored in the sockets 33 by means of cross pins 34. Pressure applied to the top of the piston 27 places the bars 30 under tension and forces the lower ends of the spacing screws 15 against the lower block 3, as shown in FIGURE 6. Pressure applied under the piston 27 places the bars under compression, consequently, the bars function normally as tension bars; but in an emergency, or when for any reason it is desirable to raise the upper blocks, the bars 30 function as thrust or push bars.

The lower and upper blocks 3 and 4 are provided with pairs of transversely extending lubrication bores 35, preferably in coaxial relation, and joined by connecting tubes 36 disposed between the pairs of lower and upper blocks as shown in FIGURE 6. The lubrication bores 35 are connected to lubrication supply and return lines (not shown). The lubrication bores connected with the lubrication supply lines communicate by passages 37 with one end of each bearing bore, whereas the lubrication bores connected with the lubrication return lines communicate by passages 38 to the opposite ends of the bearings so as to ensure lubrication and cooling of the journals 5 and 6. Suitable seal means are provided at the extremities of the journals to retain the lubricant therebetween.

The lower and upper rolls 7 and 8 of each rolling station are connected by a pair of universal joints 39 and 40 and an intermediate connecting link 41 to corresponding lower and upper drive shafts 42 and 43. The drive shafts are supported by bearings 44 between vertical walls forming the opposite sides of an elongated gear casing 45 mounted on the bed 2 behind the row of rolling stations 1. The lower and upper drive shafts 42 and 43 are connected by synchronizing gears 46 so that the lower and upper rolls 7 and 8 rotate at the same speed and in opposite directions.

At a suitable location, preferably intermediate the ends of the casing 45, there is provided a main drive shaft 47 extending therein from the side of the gear casing opposite from the rolling stations 1. The main drive shaft 47 is provided with a main drive gear 48 which is connected by a pair of idler gears 49 and 50 to an upper roll drive gear 51 nearest the main drive shaft 47 in the direction of the first of the rolling stations, that is, to the left as viewed in FIGURE 2.

Continuing in the direction toward the first of the stations, the upper drive shafts 42 of each group are connected by idler gear clusters 52, each cluster mounted on a common shaft, whereas the groups of stations are connected by additional sets of idler gears 49 and 50. Similarly, in the direction towards the last station, that is, toward the right as viewed in FIGURE 2, the different stations are interconnected by cluster gears 52, and the initial gear cluster is driven by a second main drive gear 53.

The gear ratio between the idler gears 49 and 50 are equal. The two gears of each gear cluster 52 are equal and so selected that beginning with the first rolling station, that is, the left-hand station as viewed in FIGURES 1 and 2, the rolls of succeeding stations rotate a predetermined percentage faster than the rolls of the preceding station.

The main drive shaft 47 is driven by a variable speed transmission 62 so that the speed of all the pairs of rolls may be changed in unison as desired. Because of the gear train drive between the roll pairs, the percentage of speed increase therebetween remains constant.

Control of the piston 27 may be by any conventional means whereby a predetermined high pressure may be applied to the top of the piston, or relieved; or, alternatively, a relatively low pressure may be applied to the underside of the piston. For example, as shown diagrammatically in FIGURE 4, the chamber joined above the piston 27 may be connected by a three-way valve 54 through a pressure line 55 to the high pressure side of a pump 56 or to a reservoir 57. A bypass valve 58 may be utilized to regulate the pressure in the pressure line 55 so that a predetermined force may be applied to the piston 27. A second pressure line 59, having a control valve 60 and a regulator valve 61, to limit the pressure therein, may be utilized to apply a force under the piston 27.

Operation of the rolling mill is as follows:

The strip to be rolled is supplied from a reel or drum (not shown) located to the left of the first station as viewed in FIGURE 1, and the rolled strip is wound upon a second reel or drum (not shown) located to the right as shown in FIGURE 1. Initially, the rolls of each station are closed to their adjusted positions. That is, the spacing screws 15 of the series of stations are preadjusted so that, with the screws bottomed, the spacing between succeeding pairs of rolls decreases in proportion to the increase in percentage of the increased rotational speed of the succeeding rolls. Pressure is applied above the pistons 27 to hold the rolls in their preadjusted positions. The rolls are initially rotated at reduced speeds, and the strip is fed from station to station.

If there appears to be an excess or a deficiency in tension on the strip being rolled as it passes between the stations, the spacing screws 15 may be adjusted by the dial wheels 19. Adjustment of the dial wheels is also utilized to bring the pairs of rolls into exact parallelism so that the material runs true through the rolling stations.

Coolant or a combination of coolant and lubricant is applied to the material being rolled in the conventional manner by means of nozzles located between the various stations.

In the course of rolling a strip of material, it is conventional practice to provide suitable trimming knives

along the sides of the material. The trimming knives, per se, do not form a part of the present invention and therefore are omitted.

The pressure fluid is applied above the pistons 27 at a predetermined pressure calculated to apply sufficient forcing between the corresponding pair of rolls to effect a reduction in thickness of the material proportional to the increased speed of the corresponding rolls in relation to the preceding pair of rolls. Should the resistance of the material exceed the rolling force as determined by the pressure of the pressure fluid, the upper blocks 4 are permitted to raise, rather than cause damage to the rolls. By reason of the fact that the upper blocks are urged toward the lower blocks 3 by a predetermined force and are limited in their movement toward the lower blocks by the spacing screws 15, the rolls and their bearings cannot be overloaded.

The pressure of the fluid applied to the top of the pistons for the application of rolling pressure on the material being rolled may be relatively high, as compared to the pressure of fluid applied under the pistons to raise the upper blocks. In the event of malfunctioning of any station of the mill, or breakage of the material being rolled or other emergency, it is merely necessary to shut off the supply of pressure fluid above the pistons and permit it to bleed into a return line, and simultaneously apply pressure fluid to the undersides of the pistons only at sufficient pressure to lift the weights of the upper blocks 4 and associated mechanism.

It will be observed that, by reason of the location of a hydraulic loading system below the rolling mill and the use of tension bars to urge the upper bearing blocks toward the lower bearing blocks, there is no need for framework joining the upper and lower bearing blocks. This arrangement has several advantages which are not limited to the small scale rolling mill illustrated herein, but are equally or even more advantageous when utilized in the construction of large scale rolling mills.

Elimination of the connecting framework, which becomes quite massive in the construction of large scale mills, materially reduces the cost of manufacture. Elimination of the connecting framework also materially reduces the floor area required. This in turn means that the rolling mill stations may be closely grouped, so that floor space reduction is cumulative as the number of stations are increased. The close coupling makes feasible a gear train drive even in the construction of large mills. The gear train drive ensures proper speed relationship between the rolls of succeeding stations without complex, expensive electrical or electronic controls, which are subject to failure.

Still further, it is highly desirable to separate the rolls a substantial distance in case of emergency or for servicing. If the roll journals are supported from a framework, such framework must be excessively heavy to permit any substantial separation of the rolls.

It will be observed that such separation of the rolls in emergency or for servicing does not change the adjustment of the roll-spacing screws. Thus, on return to operating position, the previous adjustment is not disturbed. Individual adjustment of the rolls in a series of stations or stands is an exacting, time-consuming operation.

Initially, that is before a run, when the series of rolls is cold, the adjustments can only be approximate. During the warming-up period, additional adjustments must be made; and the adjustment of any station usually requires compensating adjustments of other stations. If these adjustments are disturbed when the rolls are separated in an emergency, then the time required to readjust the rolls greatly exceeds the time required to clear the mill of the resutls of the emergency. The dimensional changes caused by the cooling of the rolls during this delay requires an expensive repetition of the warming-up period.

With the construction herein shown and described, the downtime caused by the emergency is so greatly reduced that the mill can be placed back into operation before any appreciable cooling of the rolls or other parts has occurred; and readjustment is at least minimized and often not required.

It will also be observed that, while a single hydraulic cylinder is feasible for each station of the small scale rolling mill illustrated, in the construction of larger size mills a hydraulic cylinder may be employed for each tension bar.

Reference is now directed to FIGURES 8 and 9. The rolling mill station here shown incorporates all of the features of the first described structure, into the type of mill wherein the work engaging rolls are supported by backing rolls. This type of mill being suited to the rolling metal having greater width that is usually rolled by two roll mills.

As in the first described structure the rolling mill station illustrated in FIGURES 8 and 9 includes a pair of lower blocks 63 and a pair of upper blocks 64. These blocks have bearing bores which receive the journals 65 and 66 of a lower backing roll 67 and an upper backing roll 68, which may be identical. These rolls may be driven in the manner of the rolls 7 and 8 of the first described structure or other means, depending upon the size of the mill.

The confronting ends of the blocks 63 and 64 are provided with slots 69 and 70 which receive the journal blocks 71 and 72. The journal blocks 71 and 72 receive the journals 73 and 74 of working rolls 75 and 76 respectively which may also be identical. The working rolls are much smaller than the backing rolls and are supported throughout their lengths and thus prevented from bending under work loads by the backing rolls.

As in the first described structure, the upper blocks 64 are provided with vertical bores 77 having screwthreads at their lower ends, and adapted to receive roll-spacing screws 15 the lower ends of which bear against the lower blocks 63. The upper ends of the screws 15 are provided with gear heads 16, and the gear heads of the pair of screws in each block engage a common pinion 17 having a dial wheel 19 as previously described in connection with the first described structure.

In place of the tension rods 30, the modified structure is shown as provided with tension bars 78 disposed at opposite ends of the blocks 63 and 64 and anchored to the upper blocks 63 by keys 79. The tension bars extend below the lower blocks 64 and bed 2 or other supporting structure. Below each block 64 is a hydraulic cylinder 80 corresponding to the hydraulic cylinder 22, but in this case a pair of such cylinders is illustrated.

Each cylinder 80 is closed at its ends by end plates 81 and 82 and receives a piston 83. A stem 84 extends downwardly from the piston 83 through the lower end plate 82 and is provided at its extended lower end with a cross bar 85 the ends of which are connected by keys 86 to the lower ends of the corresponding tension bars 78.

The cylinders 80 are provided with pressure fluid and connected with a hydraulic system in the same manner as the first described structure, and the modified rolling mill operates in the same manner as the first described structure.

The straps or bars 78 may serve to retain the blocks 63 and 64 in alignment or guide pins located similarly to the tension rods 30 may be provided. Or for larger sizes of rolling mills more elaborate guide means may be utilized. The bars 78, like the bars 30, function both as tension and thrust bars, depending upon whether the roll station is in operation or is deactivated.

While particular embodiments of this invention have been shown and described, it is not intended to limit the same to the exact details of the constructions set forth, and it embraces such changes, modifications, and equivalents of the parts and their formation and arrangement as come within the purview of the appended claims.

What is claimed is:

1. A rolling mill, comprising:
a series of rolling mill stations;
each station including upper and lower rolls and sets of journals therefor;
stop means limiting approach of said rolls toward each other whereby said rolls define a predetermined minimum gap therebetween;
tension bars attached to one set of journals and traversing the other set of journals;
tension-applying means connected to said bars at the distal side of the set of journals traversed by said tension bars;
and means for simultaneously operating the tension-applying means of said series of rolling mill stations to effect application of predetermined tension on said tension bars, said operating means being responsive to a greater force tending to separate said rolls.

2. A rolling mill, comprising:
a series of rolling mill stations;
each station including upper and lower rolls and sets of journals therefor;
stop means for limiting approach of said rolls toward each other whereby said rolls define a predetermined minimum gap therebetween;
tension bars attached to one set of journals and traversing the other set of journals;
tension-applying means connected to said bars at the distal side of the set of journals traversed by said tension bars;
means for simultaneously operating the tension-applying means of said series of rolling mill stations to effect application of predetermined tension on said tension bars, said operating means being responsive to a greater force tending to separate said rolls;
and means for releasing tension at said tension bars and applying a force thereon in a direction to effect simultaneous separation of the sets of journals at said series of stations.

3. A rolling mill, comprising: a pair of lower roll journal blocks; a pair of upper roll journal blocks; an upper roll journaled between said upper journal blocks; a lower roll journaled between said lower journal blocks; tension-thrust members slidable in said lower journal blocks and secured to said upper journal blocks; means for applying tension loads to said members to force said upper roll toward said lower roll or thrust loads to raise said upper roll from said lower roll; stop means extending between said upper and lower journal blocks adapted to resist tension loads on said members to determine the minimum spacing between said rolls; and means for adjusting said stop means, said adjustment means and stop means being operable irrespective of tension loads imposed on said members to change the minimum spacing between said rolls.

4. A rolling mill, comprising: a pair of lower roll journal blocks; a pair of upper roll journal blocks; an upper roll journaled between said upper journal blocks; a lower roll journaled between said lower journal blocks; tension-thrust members slidable in said lower journal blocks and secured in said upper journal blocks; guide means for maintaining said upper journal blocks in alignment with said lower journal blocks; means for applying tension loads to said members to force said upper roll toward said lower roll or thrust loads to raise said upper roll from said lower roll; stop screws extending through said upper journal blocks and between said journal blocks to engage the lower journal blocks thereby to regulate the minimum spacing between said rolls; said screws adapted to exert a force in excess of said tension-applying load whereby the minimum distance between said rolls may be increased while tension is applied to said tension members.

5. A rolling mill, comprising:
an upper roll;
a lower roll;
an upper and a lower set of journaling means for said rolls;
tension bars secured to one set of journaling means and traversing the other set of journaling means;
guide means incorporating said tension bars for maintaining the axes of said rolls in a common plane;
adjustable spacer means movable between said journaling means to limit movement of said rolls toward each other;
and means disposed at the distal side of the journaling means traversed by said tension bars for applying a predetermined tensile force to said tension bars, said means being yieldable to a greater force tending to separate said rolls.

6. A rolling mill, comprising: an upper and a lower roll; an upper and a lower set of journaling means for said respective rolls; adjustable spacer means movable between said journaling means to limit movement of said rolls toward each other, thereby to establish a predetermined minimum space therebetween; tension bars secured to said upper set of journaling means and extending below said lower set of journaling means; and means connected with the lower ends of said tension bars for applying a predetermined tensional force on said tension bars, said means being yieldable to a greater force tending to separate said rolls.

7. A rolling mill as set forth in claim 6, wherein said upper and lower rolls are backing rolls and which further includes work engaging rolls disposed between said backing rolls.

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