Oct. 1, 1935. E. W. MIKAELSON ET AL 2,016,016

ROLLING MILL

Filed Feb. 15, 1934 6 Sheets-Sheet 1

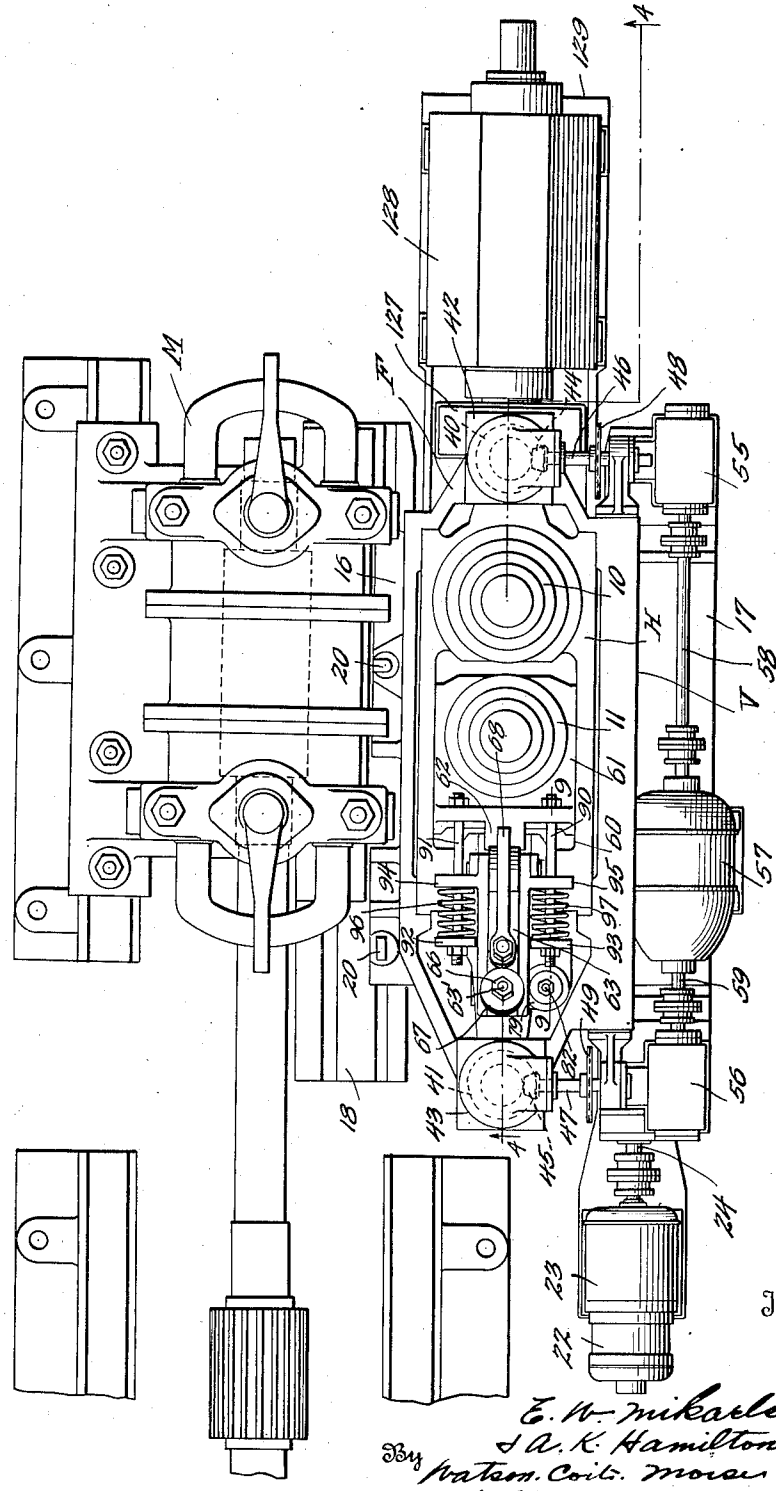

Fig. 1.

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ROLLING MILL

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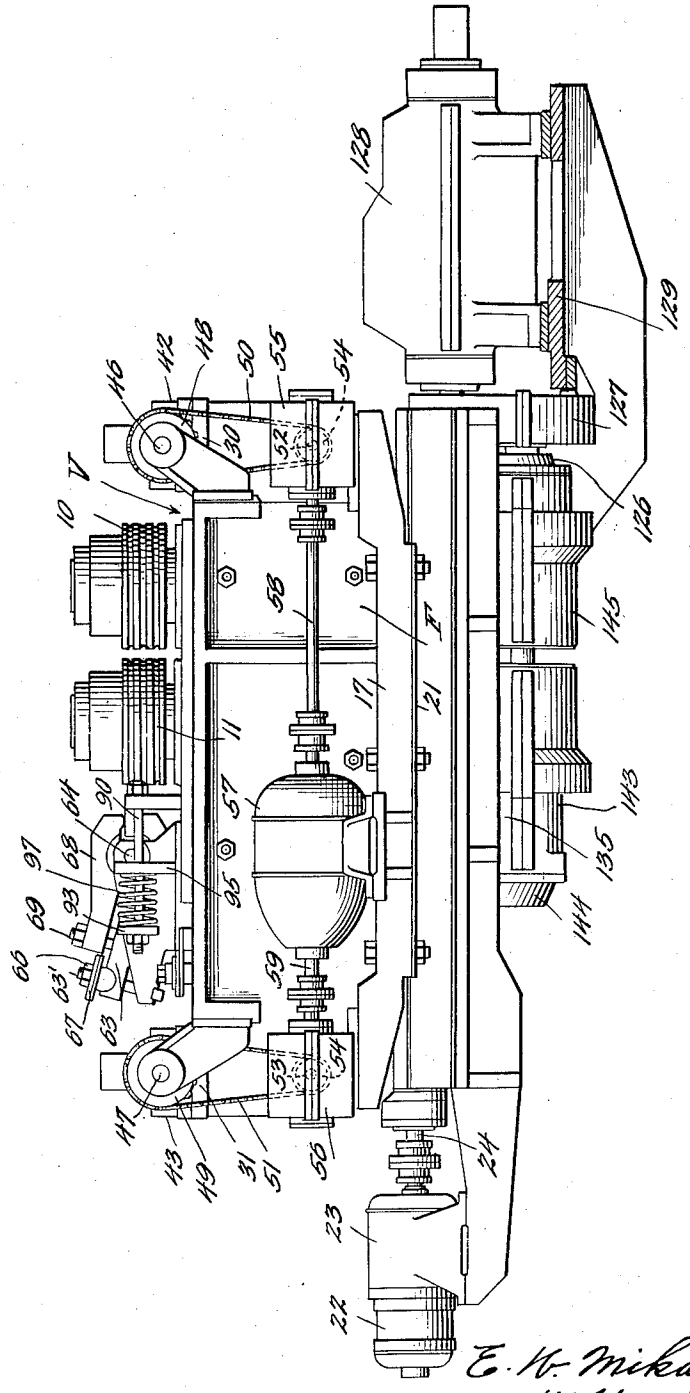
FIG. 2.



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ROLLING MILL

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FIG. 3.

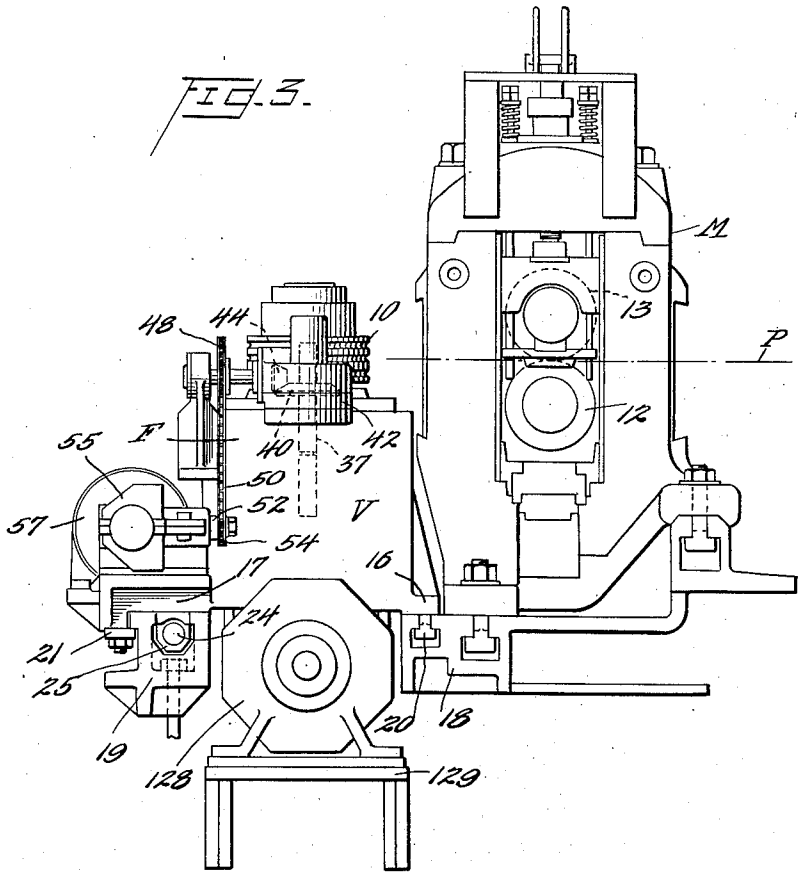
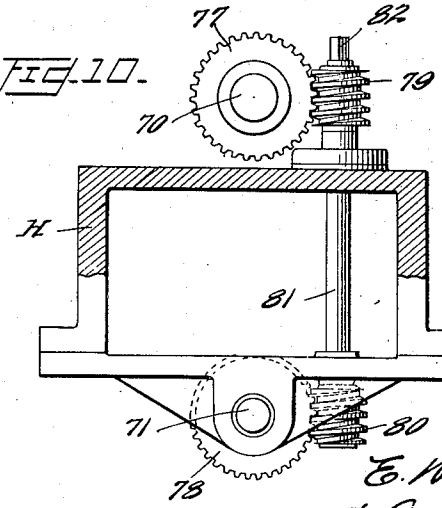


FIG. 10.



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ROLLING MILL

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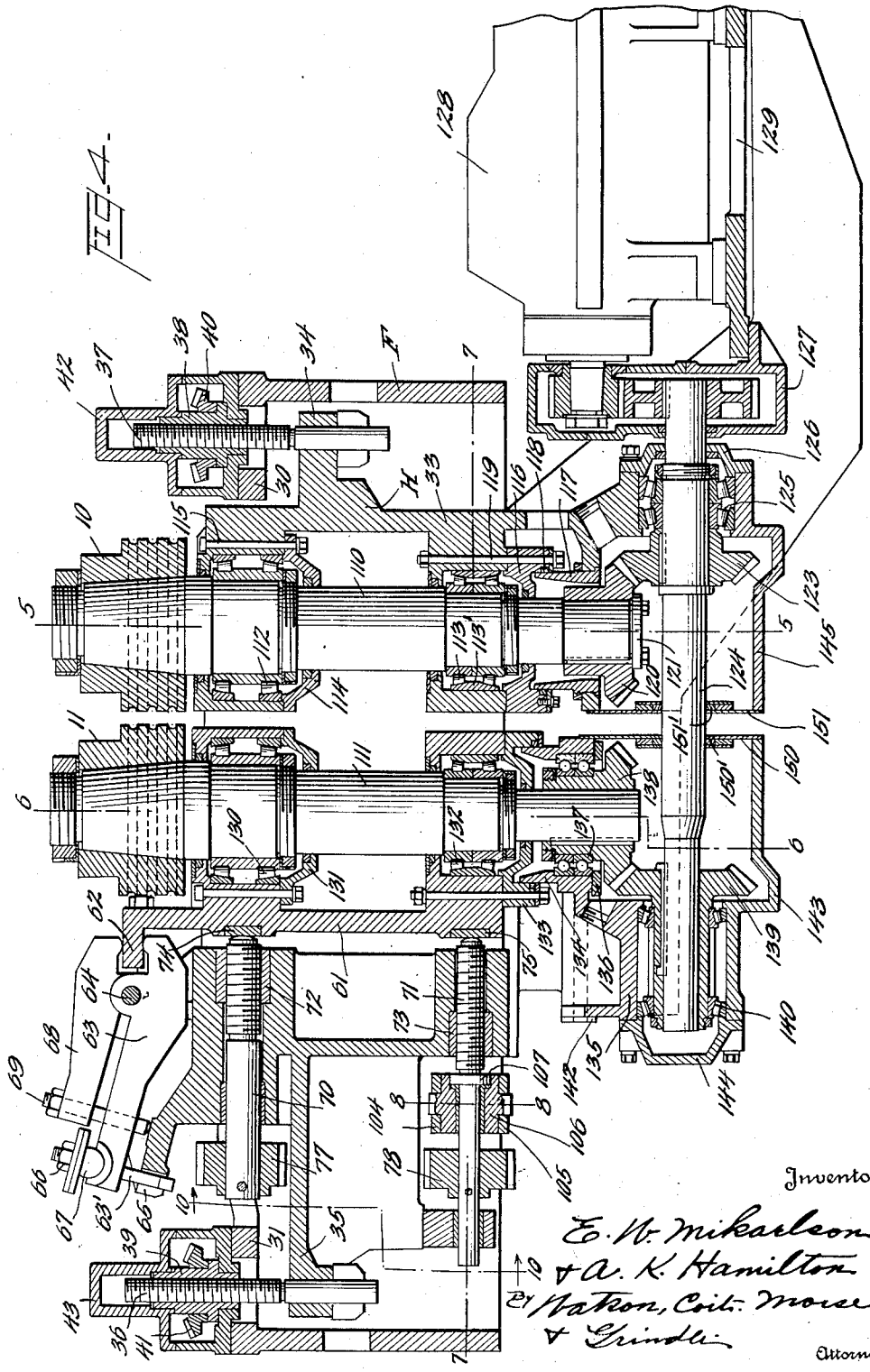
FIG. 4.



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ROLLING MILL

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Fig. 5.

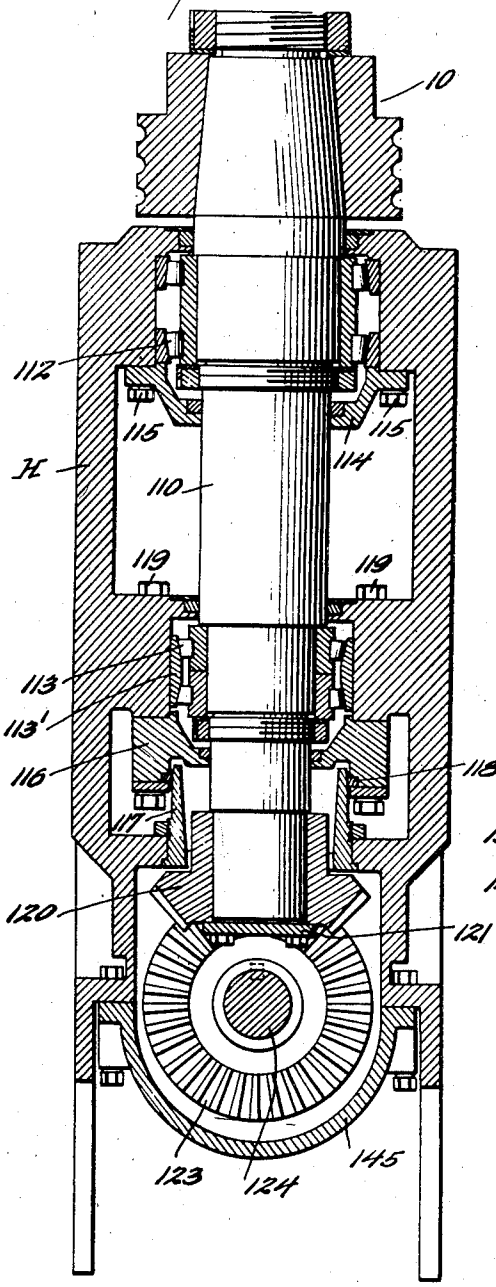
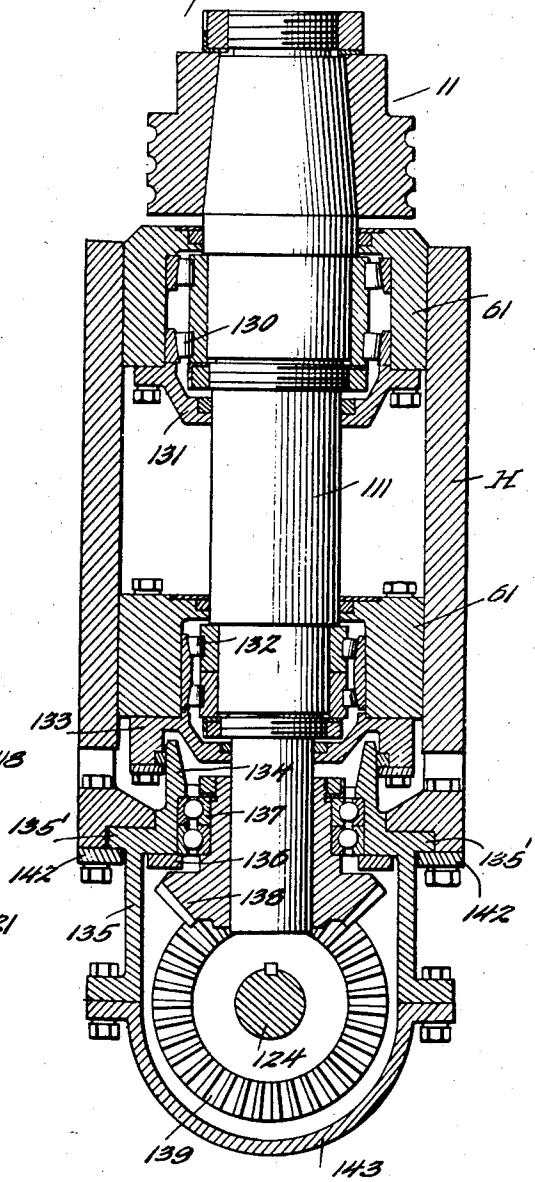


Fig. 6.



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ROLLING MILL

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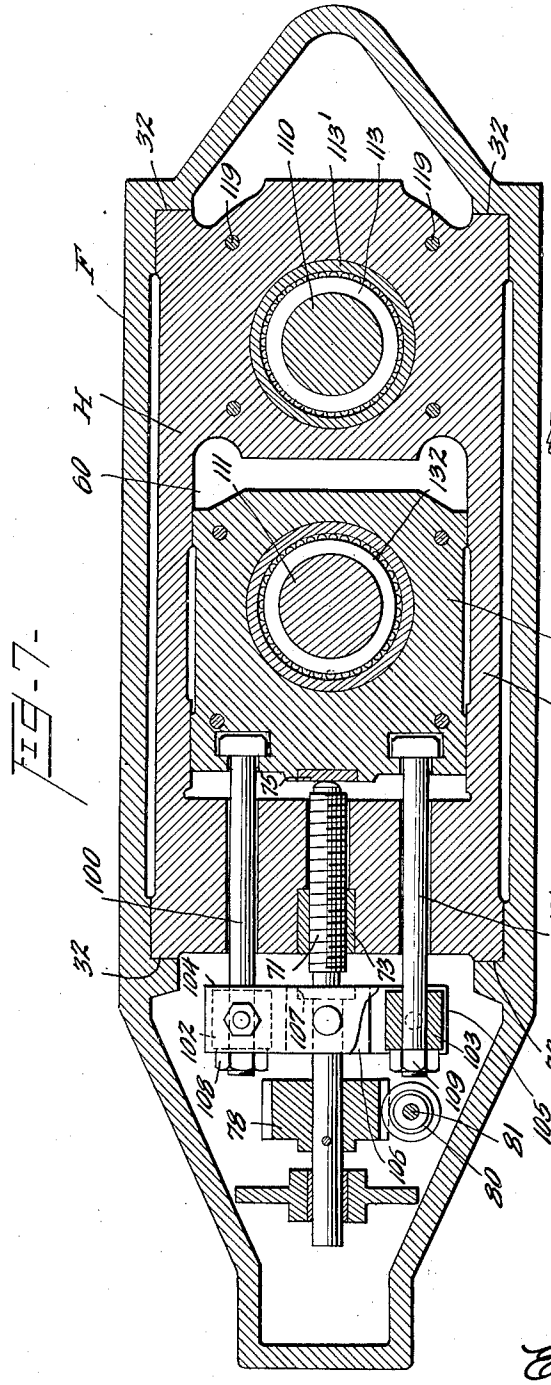

FIG. 7.

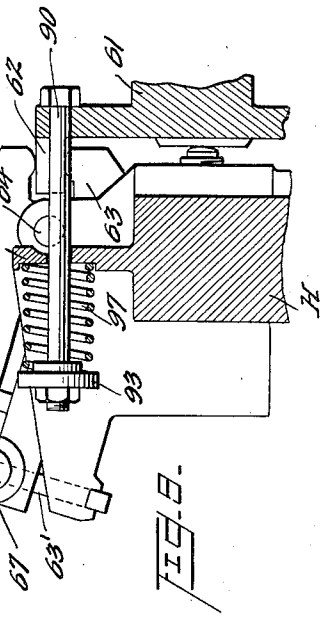

FIG. 8.

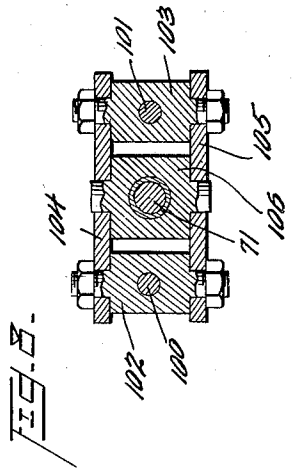

FIG. 9.

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Patented Oct. 1, 1935

2,016,016

UNITED STATES PATENT OFFICE

2,016,016

ROLLING MILL

Erik W. Mikaelson, Easton, Pa., and Alexander K. Hamilton, Chicago, Ill., assignors to Treadwell Engineering Company, Easton, Pa., a corporation of Pennsylvania

Application February 15, 1934, Serial No. 711,412

15 Claims. (Cl. 80—56)

This invention relates to rolling mills and particularly to rolling mills designed and intended for use in rolling at high speed and with great precision elongated metal members of relatively small cross section, for instance bars of circular cross section.

In the rolling of such members to precise shape and dimension it is generally customary to pass each through a series of stands which successively act upon the member and frequently one or more of the mills thus arranged to successively act upon a single member being processed are mills of the vertical type and others are mills of the horizontal type, thus insuring that the member being rolled is acted upon successively by sets of rolls having their axes angularly disposed. A superior product is produced, for instance, when a member is successively acted upon by vertical and horizontal mills, i. e., by mills in which the roll axes are vertically disposed and horizontally disposed respectively. The mill which comprises the subject matter of the present inventon is particularly adapted to be used in conjunction with other mills of either the same or different type but nevertheless is entirely suitable for use as a single unit arranged to perform a complete rolling operation by itself. Primarily also the invention relates to mills of the vertical type, i. e., in which the roll axes are vertically disposed, but certain of its features are applicable also to mills of the horizontal type, as will be apparent to one skilled in the art. The invention also particularly contemplates improvements in a mill of the vertical type with overhung rolls, that is, a mill in which the rolls are mounted upon the upper ends of the roll supporting arbors and are positioned above the supporting framework of the mill so as to be readily visible and accessible. Here again, however, certain novel features of the invention are readily applicable to mills in which the rolls are provided with axially extending necks at both ends thereof respectively, which roll necks are rotatably supported in bearings in a suitable housing.

An object of the invention is to provide a rolling mill of the type above generally described which includes a supporting frame and a roll carrying housing, the housing being adjustably mounted upon the frame in a novel and improved manner. It will be appreciated that where a rolling mill is only one of a number of mills which successively act upon a single member passing through all of the mills, it is highly essential that the " pass " of each mill be brought into exact alignment with the "pass" of the next succeeding mill. To this end the rolls must be adjustable in a vertical plane and the means for effecting the vertical adjustment must perform this operation with great precision. Another feature of the improved rolling mill resides in an improved means for effecting precise adjustment of one roll arbor longitudinally relatively to the other in order to bring the grooves of one roll into exact register with the corresponding grooves of the other roll. The invention also contemplates a mill in which the roll axes may be moved laterally, i. e., caused to approach or recede from each other, while remaining in exact parallelism at all times. Novel means is provided for effecting this lateral roll adjustment, and associated with this means is new and improved mechanism for rigidly holding the arbors of the two rolls in exact parallelism at all times despite the application of heavy forces by the rolls to the object passing between them, which forces tend to separate the rolls and effect relative tilting of the arbors.

Other features of the novelty of the invention consist in the means provided for maintaining the grooves of the opposed rolls in exact register with each other despite elongation and contraction of the supporting arbors by reason of changes in temperature; the driving means for imparting rotative forces to the arbors by means of mechanism positioned below the lower ends of the arbors and which maintains the driving connection to the prime mover at all times despite changes of position of one roll arbor relative to the other; the improved housings for certain of the driving gears whereby these gears are maintained in relatively adjustable grease tight casings, and further improvements in details of design and arrangement of conventional elements of rolling mills generally, which will be hereinafter more specifically pointed out.

One embodiment of the invention, selected for disclosure by way of example, is illustrated in the accompanying drawings in which:

Figure 1 is a plan view of the improved mill, shown in conjunction with a mill of the horizontal type, positioned closely adjacent thereto;

Figure 2 is a side elevation of the same;

Figure 3 is an end elevation;

Figure 4 is a section on line 4—4 of Figure 1;

Figures 5 and 6 are sections on lines 5—5 and 6—6 of Figure 4 respectively;

Figure 7 is a section on line 7—7 of Figure 4;

Figure 8 is a section on line 8—8 of Figure 4;

Figure 9 is a section on line 9—9 of Figure 1; and

Figure 10 is a section on line 10—10 of Figure 4.

In Figures 1 and 3 of the drawings the reference numeral V indicates generally the mill which comprises the subject matter of the present invention, and the reference numeral M indicates the horizontal mill with which the improved mill V is preferably closely associated, as shown in the drawings. The details of construction of the horizontal mill comprise no part of the present invention and will not be described. It need only be said that the work passes first between the rolls **10** and **11** of the vertical mill and thence directly between the rolls **12** and **13** of the horizontal mill, the approximate path of movement of work being indicated by the dotted line P in Figure 3.

The principal parts of the improved mill comprise the frame, generally indicated at F, the housing indicated at H, the mechanism for effecting the desired relative adjustment of the housing within the frame, the rolls and driving mechanism all associated with the housing, and the frame supports whereby the frame is rigidly supported upon the base in such manner that it may be moved longitudinally.

The frame comprises an elongated box-like structure having tapering ends and lateral flanges at its bottom, indicated at **16** and **17**, which flanges rest upon parallel shoe plates or trackways **18** and **19**. Suitable holding-down devices, such for instance as are indicated at **20** and **21** respectively, are provided for rigidly clamping the base of the frame to the shoe plates, these devices being releasable to permit movement of the frame longitudinally of the shoe plates for the purpose of bringing the pass of this vertical mill into line with the pass of the immediately succeeding machine M. In order that this longitudinal adjustment of the frame F may be conveniently carried out a motor **22** is provided which is connected to the frame F through speed reducing gearing enclosed within the casing **23** and the screw shaft **24**, this shaft extending into and having threaded engagement with a nut **25** integral with or rigidly secured to the frame F. The motor **22** is, of course, of the reversible type.

While the exact configuration of the frame is a matter of choice, it may be conveniently formed as shown in the drawings, having reduced tapering ends provided with interiorly overhanging portions **30** and **31** and accurately machined guiding surfaces **32** for the four corners of a housing, which is generally indicated at **33**, the housing being bodily slidable vertically within the frame but being constrained by the frame against all movement in a horizontal plane.

The housing in turn is a box like structure having extensions **34** and **35** at its ends which underlie the overhanging projecting portions **30** and **31** of the frame. The housing is adjustably suspended in the frame by means of screws **36** and **37**, the lower ends of these screws being non-rotatably secured to the housing extensions **34** and **35**, and the threaded upper portions of the screws having threaded engagement with nuts **38** and **39** rotatably supported upon overhanging portions **30** and **31** of the frame and carrying gears **40** and **41**. The nuts and gears affixed thereto are enclosed within suitable casings generally indicated at **42** and **43**.

Also located within these last mentioned casings are pinions **44** and **45** (Figure 1) mounted upon short shafts **46** and **47** respectively, which shafts are disposed in parallel relationship and extend outwardly, carrying upon their ends sprocket wheels **48** and **49**. Sprocket chains **50** and **51** passing over these sprocket wheels extend downwardly and also pass over sprocket wheels mounted upon the inner ends of short shafts **52** and **53**, one of these lower sprockets being indicated at **54** in Figure 3, and short shafts **52** and **53** entering speed reducers **55** and **56** mounted on the frame. Both of these speed reducers are also connected to a motor **57**, aligned shafts **58** and **59** being utilized for this purpose. Motor **57** is reversible and, when operated in either direction, causes simultaneous rotation of nuts **38** and **39** and simultaneous and equal vertical movements of screws **36** and **37** to effect vertical sliding movement of the housing within the frame. By proper operation and control of the motor **57** therefore the housing may be elevated or depressed to bring the rolls **10** and **11** into the desired horizontal relationship with the rolls **12** and **13** of the associated mill.

The housing H is in turn provided with a rectangular vertically extending recess **60** within which a cage **61** is positioned. This cage is so dimensioned that its side surfaces engage with a close sliding fit the side walls of the recess **60** in the housing while its length (measured longitudinally of the housing) is considerably less than that of the recess **60** so that it may be moved longitudinally in this recess. At its top the cage is provided with a laterally extending lug **62** having horizontally disposed upper and lower surfaces. The lower horizontal surface of lug **62** is engaged by one end of a lever **63** pivotally mounted upon a horizontally disposed pin **64**, the ends of which are supported in lugs projecting upwardly from the top of the housing. The opposite end of the lever **63** is tied to the housing by means of a bolt **63'**, the lower end of which is received in a suitable slot or recess **65** formed in the housing and the upper end of which is provided with an adjusting nut **66** and a swivel block **67** which fits within a correspondingly formed recess upon the upper side of lever **63**. Lever **63**, mounted on pin **64**, is the sole means for transferring the entire weight of the cage **61** to the housing, and by manipulating the nut **66**, the cage may be raised or lowered as desired in order to bring the grooves formed in roll **11** into exact register with the grooves of roll **10**. A second lever **68**, also rotatably supported upon the horizontal fulcrum pin **64**, has one end portion positioned in close proximity to the horizontal upper surface of lug **62**, as shown, and a set screw **69** at the opposite end of this lever has its lower end in contact with the upper surface of the housing, the set screw extending between the parallel arms of lever **63**. The lever **68** closely confines lug **62** and prevents any upward movement of the cage, but at the same time lug **62** is not positively gripped between the ends of levers **63** and **68** in order that there may be no opposition at this point to horizontal adjustment of the cage **61**.

This horizontal adjustment of the cage is effected by means of horizontally disposed screws **70** and **71**, screw **70** having threaded engagement with a block **72** fastened in the housing and screw **71** having a threaded engagement with a block or nut **73** also firmly secured in the housing. The inner ends of these screws have contact with hardened steel inserts **74** and **75** respectively, supported in the adjacent face of the cage and upon or adjacent their opposite ends are fixed the spiral gears **77** and **78**. By referring to Figure 10, it will be seen that the teeth of gear **77** mesh with the teeth of a worm **79** and that the teeth of gear **78** mesh with those of a worm **80**,

worms 79 and 80 being fixed upon a shaft 81 rotatably supported in the housing and having a polygonal upper end 82 by means of which this shaft may be manually rotated when a suitable tool is applied thereto. Manual rotation of shaft 81, of course, effects simultaneous rotation of screws 70 and 71 and equal horizontal and longitudinal movements of these screws so that cage 61 may be moved to the right or to the left (Figure 4) relatively to the housing without changing in the slightest its angular position relative to the housing. In order to maintain block 74 at all times in tight contact with the end of screw 70 a resilient retracting means is employed, this means including horizontally extending bolts 90 and 91, the inner ends of which are secured to the cage, as shown in Figure 1, and the outer ends of which are provided with spring abutments 92 and 93 respectively. Intermediate spring abutments 92 and 93 and webs or vertical flanges 94 and 95 of the housing are confined compression springs 96 and 97 which at all times tend to expand and the conjoint action of which is to draw the upper end of the housing toward the left (Figure 4), thus forcing the block 74 tightly against the inner end of screw 70, for all positions of adjustment of the cage in the housing.

Means is provided for preventing movement of the lower end of the cage toward the right (Figure 4) under the influence of heavy rolling forces developed between the rolls 10 and 11 during the operation of the mill. This means is most clearly indicated in Figures 7 and 8. Parallel horizontal rods 100 and 101 have enlarged inner ends which slidably fit within vertical T-slots formed in the cage, these rods lying in the horizontal plane of the lower adjusting screw 71 and extending outwardly through suitable apertures in the housing, to the exterior thereof. Slidably mounted on the outer end of each such rod is a block, these blocks being indicated at 102 and 103 respectively, and both such blocks having co-axial upwardly and downwardly extending cylindrical projections, most clearly shown in Figure 8. These cylindrical projections are received within cylindrical apertures formed in cross bars 104 and 105 respectively, and cross bars 104 and 105 are also provided with central cylindrical recesses to receive upwardly and downwardly coaxial projecting portions of a block 106 rotatably mounted upon the lower adjusting screw 71. An internal shoulder formed on block 106 rests against a flange 107 preferably formed integrally upon screw 71. When the nuts 108 and 109, which have threaded engagement with the extreme outer ends of rods 101, are tightened, rods 100 and 101 become tension members forcing the block 75, positioned at the lower end of the cage, tightly against the inner end of screw 71, and inasmuch as screw 71 has at all times threaded engagement with the nut 73 secured to the housing, the lower end of the cage is securely held by the means just described against horizontal movement despite the possible presence of very strong forces developed at the rolls tending to bring about such movement. By the cooperation of screw 71, rods 100, and the associated mechanism just described, however, the lower end of the cage may be very firmly anchored against horizontal movement for all possible adjustments of the cage.

It has been explained how the frame may be horizontally adjusted, the housing vertically adjusted within the frame, and the cage vertically and horizontally adjusted within the housing. All of these adjustments are for the purpose of bringing the corresponding grooves of two rolls into precise register and bringing the "pass" of the mill into exact register with the corresponding "pass" of the next adjacent mill. By the means just described, the most exact positioning of the "pass" of the mill may be brought about and maintained so that the actual rolling operation is accomplished with a very high degree of accuracy.

The means for supporting and driving the rolls 10 and 11 will now be described. The roll 10 is mounted upon the upper end of an arbor 110 and the roll 11 upon the upper end of arbor 111. Arbor 110 is rotatably mounted upon the housing 33 by means of upper and lower antifriction bearings 112 and 113, respectively. The outer race of the upper bearing 112 is supported in fixed relationship to the housing by means of the bearing cap 114, secured to the housing by bolts 115, and it is this upper bearing which transmits the weight of the arbor and roll to the housing. The lower bearing 113 has its outer race 113' fitting closely within a cylindrical aperture in the housing formed to receive it, and there is likewise a lower bearing cap 116 secured to the housing. The outer race 113' of the lower bearing, however, is not confined against vertical movement but is free to slide axially within the recess in which it is contained as the arbor itself expands and contracts as the result of changes in temperature. A cylindrical recess, co-axial with arbor 110, is formed in the under-portion of the bearing cap 116, and this recess receives the upper portion of a cylindrical sleeve 117 secured to the housing, an annular packing ring 118 being provided to prevent the escape of grease between the outer surface of the sleeve and the inner cylindrical surface of the bearing cap. Cap 116 is detachably secured in position by means of bolts 119. Upon the lower end of arbor 110 is splined a bevel gear 120, the supporting plate 121 secured to the bottom of the shaft carrying the weight of this gear. The teeth of gear 120 mesh with the teeth of a companion gear 123 fixed on a drive shaft 124 extending horizontally and disposed in the plane of the axes of the arbors 110 and 111. One end of shaft 124 is suitably mounted in the housing by means of an anti-friction bearing 125 and at this end projects through the cap 126 and into the speed reduction gear box 127. Drive shaft 124 is in turn driven by means of an electric motor 128 mounted upon an extension 129 of the housing, through the gearing illustrated, whereby arbor 110 and roll 10 are rotated at the desired speed. As the driving motor moves with the housing at all times, its alignment with the shaft 124 and gearing is at all times perfectly maintained.

Arbor 111 is supported by means generally similar to that which has just been described in connection with arbor 110, but is, of course, carried by the cage 61 instead of directly by the housing. The upper anti-friction bearing 130 rotatably supports arbor 111 and transmits the weight of the arbor to the cage through the bearing cap 131. It will be understood that both bearings 112 and 130 are of the type having the capacity to take up end thrust due to the weight of the arbors and rolls mounted thereon. The lower anti-friction bearing 132 has its outer race likewise slidably mounted within a cylindrical recess formed in the cage so that this bearing does not take end thrust but permits longitudinal expansion and contraction of the arbor without opposition. The

lower bearing cap 133 is provided with a cylindrical recess co-axial with the arbor 111 into which is received the cylindrical upper end of a sleeve like projection 134 of the gear case 135 which is mounted upon the lower end of the housing. Mounted within the sleeve portion 134 of the gear case, and supported upon an annular ring 136, is an anti-friction bearing 137, the inner race of which carries a pinion 138 splined to the lower end of the arbor 111. The teeth of pinion 138 mesh with those of a mating pinion 139 splined upon the end of drive shaft 124 and rotatably supported within the gear case 135 by means of anti-friction bearings 140. The gear case 135 is supported upon the housing for horizontal sliding movement, having projecting flanges 135' received in trackways formed upon the housing in part by cutting away the housing and in part by securing the horizontally extending strips 142 thereto, to form grooves, receptive of flanges 135'. Gear case 135 may therefore move horizontally when the cage 61 is adjusted, the gear case being moved by reason of the interengagement of sleeve portion 134 thereof with the bearing cap 133 of the cage. In such movements gear 139 will simply slide along shaft 124, but the driving connection between the shaft and arbor will be maintained at all times. As clearly illustrated in Figure 6, the bottom of gear case 135 is closed by a cap 143, which may be removed when necessary, and an end closure cap 144 is also provided. A similar cap 145 is secured to the housing beneath arbor 110 to enclose gears 120 and 123. In order that both of these gear containing spaces may be grease-tight, closure plates 150 and 151 are provided. These plates are apertured for the passage of drive shaft 124, and packing means 150' and 151' is provided to prevent the escape of grease through the apertures provided for the drive shaft. In the vertical movements of the cage 61 the arbor 111 maintains its driving connection with gear 138, this gear as well as gear case 135 not being vertically movable, but arbor 111 sliding relatively to the gear and cap 133 sliding along projection 134.

It is thought that the operation of the driving mechanism will be clearly understood from the above description. Driving connection between the pairs of bevel gears is maintained at all times despite, in the case of arbor 111, both horizontal and vertical adjustments of the cage in which the arbor is supported.

Whenever desired, either or both of the arbors may be readily and easily removed. Thus removal of the gear case caps 143 and 145 permits removal of the drive shaft and associated pinions and gears 123 and 139, thus exposing to view pinions 120 and 138. To remove, arbor 110 supporting plate 121 will first be removed so that gear 120 may be dropped. Sleeve 117 may then be detached and immediately thereafter the bearing cap 116. Bearing 113, which is thus exposed, may then be freed from the arbor. By removal of bearing cap 114, bearing 112 may be freed from the arbor so that the latter may be drawn upwardly and out of the housing. In a generally similar manner, bearings 132 and 130 may be freed from arbor 111 and that arbor removed, it being understood, of course, that the cap 133 must be removed to make the bearing nut accessible.

The rolls of the improved mill, projecting as they do above the frame and housing, are readily accessible and visible, thus facilitating the operation, inspection, and repair. The mill as a whole is most compact and comparatively light in weight. The various adjustments provided make it possible for the operator to bring the rolls into the exact necessary relationship with each other and with the rolls of the next adjacent mill to perform work requiring the greatest precision.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A rolling mill comprising, in combination, a housing, a cage formed separately from the housing, two parallel roll arbors, one rotatably supported by the housing and the other by the cage, means for laterally adjusting the position of the cage with respect to the housing, and means for longitudinally adjusting the cage with respect to the housing, said last mentioned means permitting lateral movement of the housing at all times.

2. A vertical mill comprising a housing, a cage vertically and horizontally adjustable relatively to the housing and having a horizontal downwardly facing surface adjacent its top, parallel vertically disposed roll arbors, one rotatably supported by the housing and the other similarly supported by the cage, and a member mounted on the housing and having a portion engaging said horizontal surface of the cage, said member transmitting the entire weight of the cage to the housing and being operable to raise or lower the cage.

3. A vertical mill comprising a housing, a cage vertically and horizontally adjustable relatively to the housing and having a horizontal downwardly facing surface adjacent its top, parallel vertically disposed roll arbors, one rotatably supported by the housing and the other similarly supported by the cage, a lever pivotally mounted on the housing and having one end portion engaging said horizontal surface of the cage, said lever transmitting the entire weight of the cage to the housing, and means at the other end of said lever for rocking the same about its pivotal axis and locking it in any desired position of adjustment.

4. A vertical mill comprising a housing and a cage, each supporting a vertical rotatable roll arbor, the cage having a lug extending horizontally therefrom, said lug having horizontal upper and lower surfaces, two members adjustably mounted on the housing for engaging the horizontal surfaces of the lug respectively, whereby the cage is adjustably supported and guided.

5. In a vertical mill, in combination, a housing, a cage, a vertical arbor carried by the cage, a screw member having threaded engagement with the housing, the end of which bears against the cage, for thrusting the cage laterally with respect to the housing, a yoke rotatably mounted on said member without the housing, and means connecting the yoke and cage for preventing motion of the cage away from the end of the screw.

6. In a vertical mill, in combination, a housing, a cage, a vertical arbor carried by the cage, a screw member having threaded engagement with the housing, the end of which bears against the cage, for thrusting the cage laterally with respect to the housing, a yoke rotatably mounted on said member without the housing, and rods slidably extending through apertures in the housing and having their outer ends connected to the yoke and inner ends connected to the cage, said rods comprising tension members preventing motion of the cage away from the housing.

7. In a rolling mill, in combination, a frame having a vertically extending recess provided

with parallel vertically disposed guide surfaces, a roll supporting housing within said recess and having surfaces which slidably engage at all times the guide surfaces of the frame, said housing and frame having horizontally overlapping portions, and means for effecting vertical movement of the housing within the frame and maintaining the housing in any desired position of adjustment said means comprising adjustable members connecting the overlapping portions of the housing and frame, the housing being adjustably hung from the frame by said members.

8. In a rolling mill, in combination, a frame having a vertically extending recess provided with parallel vertically disposed guide surfaces, a roll supporting housing within said recess and having surfaces which slidably engage at all times the guide surfaces of the frame, said housing and frame having horizontally overlapping portions, and means for effecting vertical movement of the housing within the frame and maintaining the housing in any desired position of adjustment, said means comprising vertically extending adjustable tension members connecting the overlapping portions of the housing and frame, said members transmitting the entire weight of the housing and rolls to the frame.

9. In a rolling mill, in combination, a frame having a vertically extending recess provided with parallel vertically disposed guide surfaces, a roll supporting housing within said recess and having surfaces which slidably engage at all times the guide surfaces of the frame, said housing and frame having horizontally overlapping portions, and means for effecting vertical movement of the housing within the frame and maintaining the housing in any desired position of adjustment, said means comprising spaced vertically extending screws located at the ends of the housing and in the plane of the roll axes, said screws connecting the overlapping portions of the housing and frame, the housing being adjustably hung from the frame by said screws.

10. In a rolling mill, in combination, a housing, parallel roll arbors rotatably mounted in the housing, one of said arbors being adjustable relatively to the other in an axial direction, driving means for said arbors including gears mounted thereon so as to rotate therewith, a drive shaft beyond the ends of the arbors and extending transversely thereto, and gears fixed upon said drive shaft and meshing with said first mentioned gears respectively, the gear mounted on the adjustable arbor being slidable axially thereof so as to maintain meshing engagement with its mating gear when said arbor is adjusted.

11. In a rolling mill, in combination, a housing, a roll arbor having a roll thereon, spaced bearings rotatably supporting the arbor in the housing, one of the bearings being slidable at all times relatively to the housing independently of the other bearing, and the other bearing holding the arbor against axial movement bodily relatively to the housing.

12. In a rolling mill, in combination, a housing, a roll carrying arbor, and means comprising spaced bearings rotatably supporting said arbor in said housing, one of said bearings being slidably mounted in the housing to permit free longitudinal expansion and contraction of the arbor and the other bearing anchoring the arbor against bodily axial movement.

13. In a rolling mill, in combination, a frame, a roll arbor having a roll fixed upon one end and a driving gear upon the other, means supporting said arbor in the frame for lateral adjustment, a driving shaft extending transversely and beyond the end of said arbor, a gear slidably mounted upon said shaft and meshing with said first mentioned gear, and a casing enclosing said intermeshing gears, said casing being slidably carried by the frame and being formed separately from and detachably connected to the arbor supporting means, the casing and arbor supporting means being provided with mutually contacting cylindrical surfaces providing a telescoping joint permitting axial movement of the arbor and its supporting means relatively to the casing.

14. In a vertical mill, in combination, a housing, a cage carried by the housing and adjustable horizontally thereon, two parallel vertically disposed roll arbors, one rotatably supported in spaced bearings mounted in the housing and the other supported in spaced bearings mounted in the cage, the arbors projecting above the upper supporting bearings and having rolls mounted upon their upper ends, respectively, means for effecting horizontal adjustment of the cage relatively to the housing, and second means including a bolt having threaded connection to the housing and disposed substantially normally to the axis of the arbor mounted in the cage for connecting the lower adjacent portions of cage and housing and preventing tilting of the cage with respect to the housing during rolling operations, said second means being readily adjustable to permit bodily adjustment of the cage.

15. In a vertical mill, in combination, a housing, a cage carried by the housing and adjustable horizontally thereon, two parallel vertically disposed roll arbors, one rotatably supported in spaced bearings mounted in the housing and the other supported in spaced bearings mounted in the cage, the arbors projecting above the upper supporting bearings and having rolls mounted upon their upper ends, respectively, a horizontally disposed screw having threaded engagement with the housing and its end bearing against the cage, toward the upper end thereof, for horizontally adjusting the cage relatively to the housing, a second screw disposed parallel to said first mentioned screw and also having threaded engagement with the housing, one end of the last mentioned screw bearing against the same side of the cage as does the first screw but toward the lower end thereof, and a tension member connecting the body of said last mentioned screw and said cage, both of said screws lying substantially in the plane of the roll axes.

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