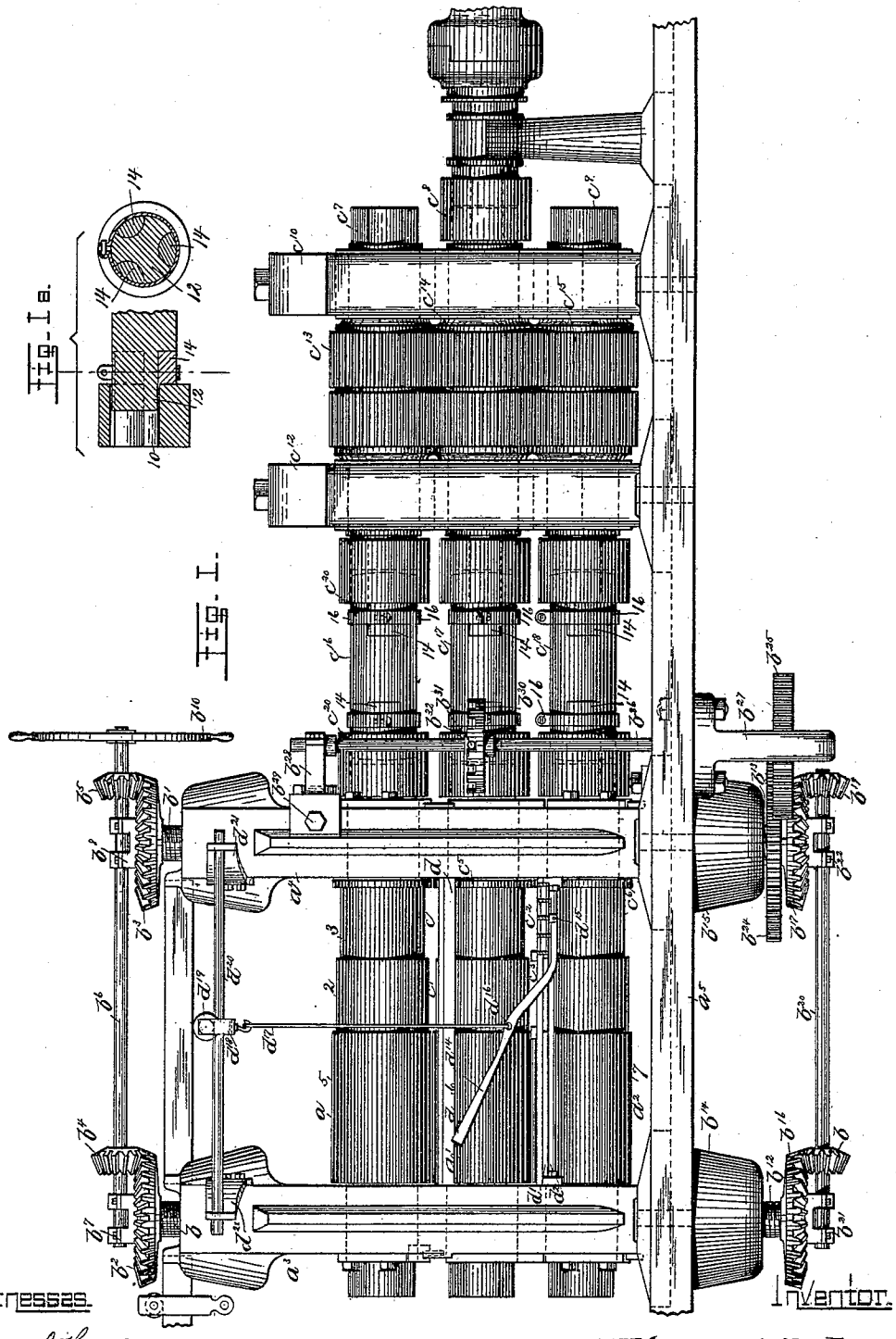
(No Model.) 4 Sheets—Sheet 1.

W. WAKELY.

METHOD OF AND APPARATUS FOR REDUCING METALS.

No. 449,145. Patented Mar. 31, 1891.



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(No Model.)

4 Sheets—Sheet 2.

W. WAKELY.

METHOD OF AND APPARATUS FOR REDUCING METALS.

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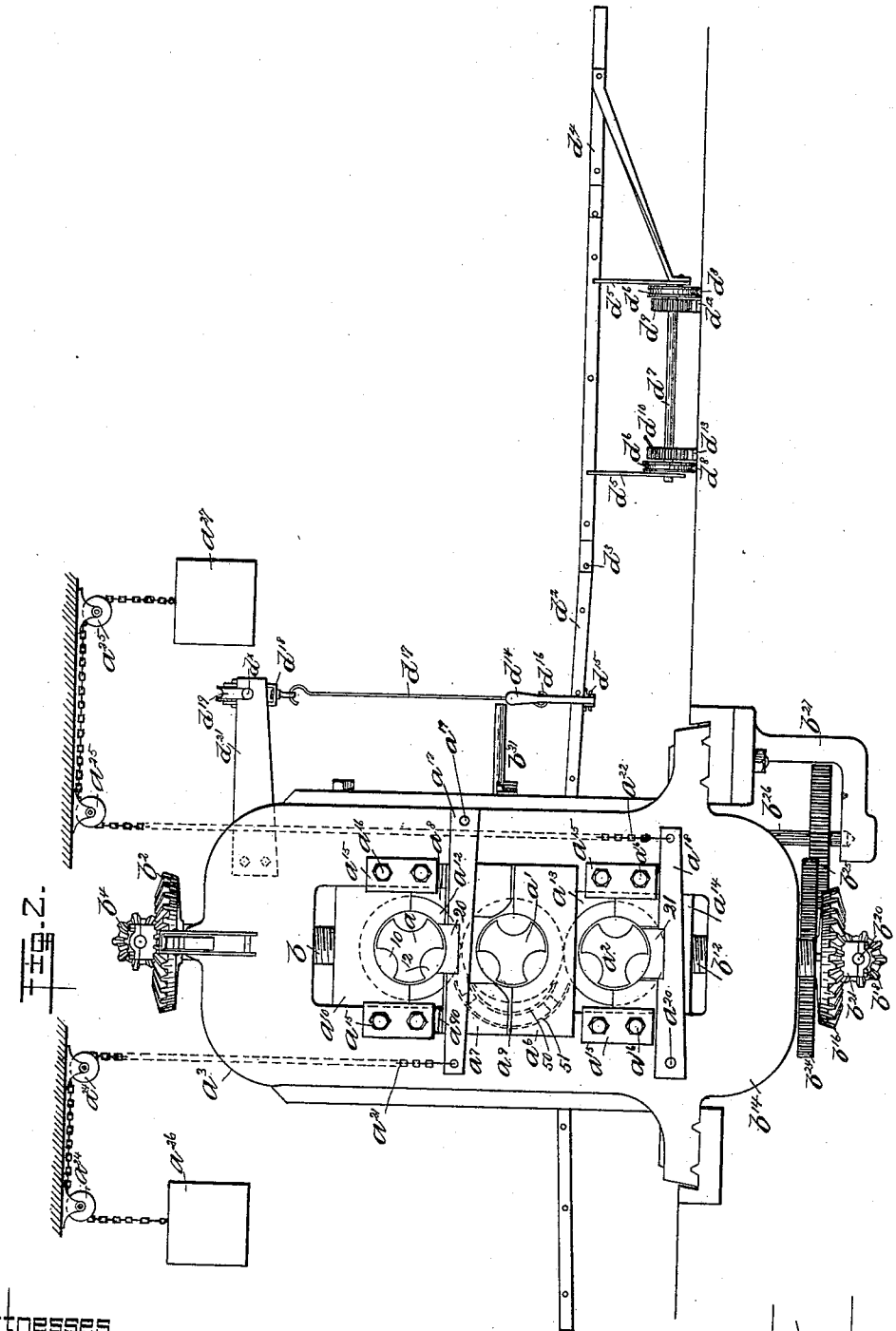

FIG. 2.

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(No Model.) 4 Sheets—Sheet 3.

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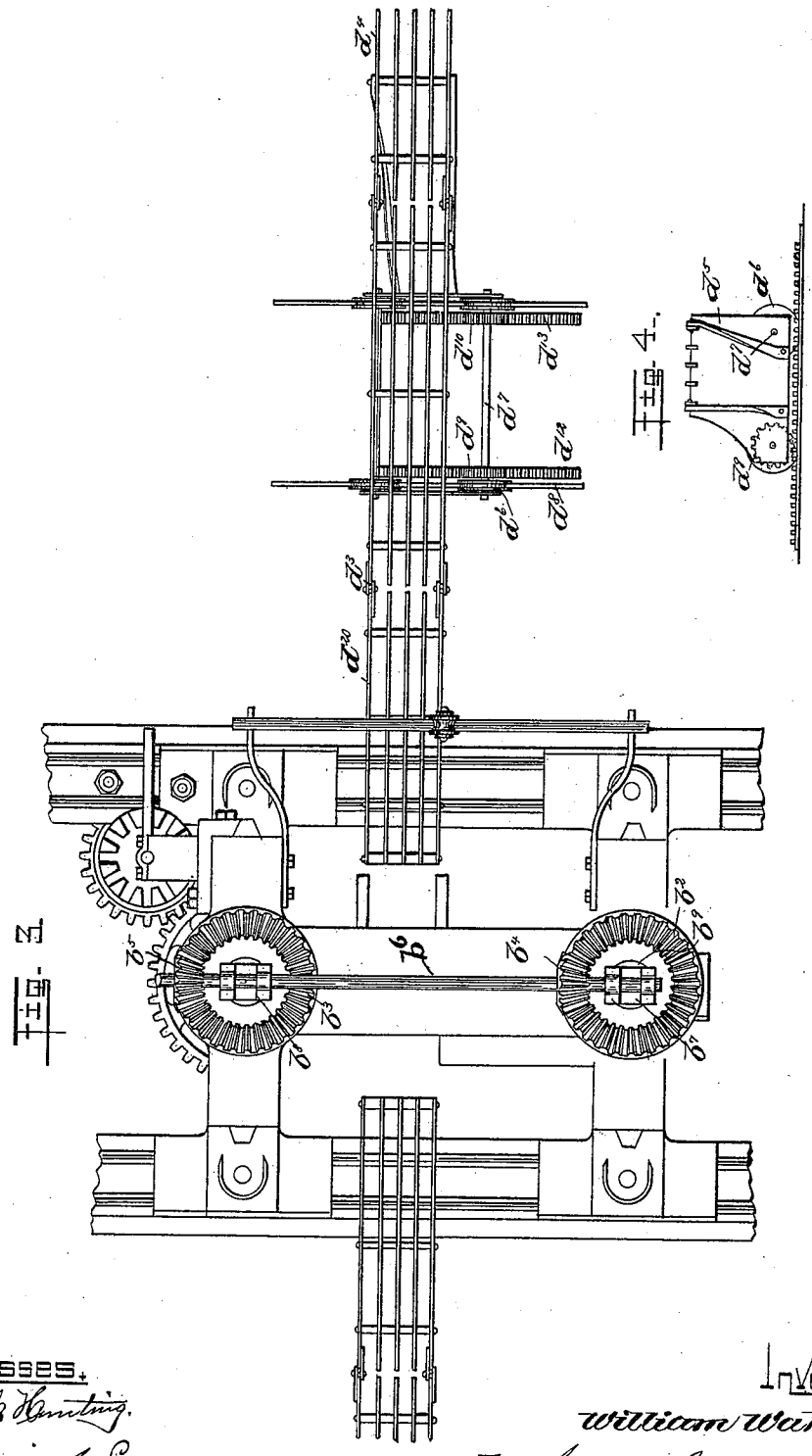

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(No Model.) 4 Sheets—Sheet 4.

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METHOD OF AND APPARATUS FOR REDUCING METALS.

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Fig. 5.

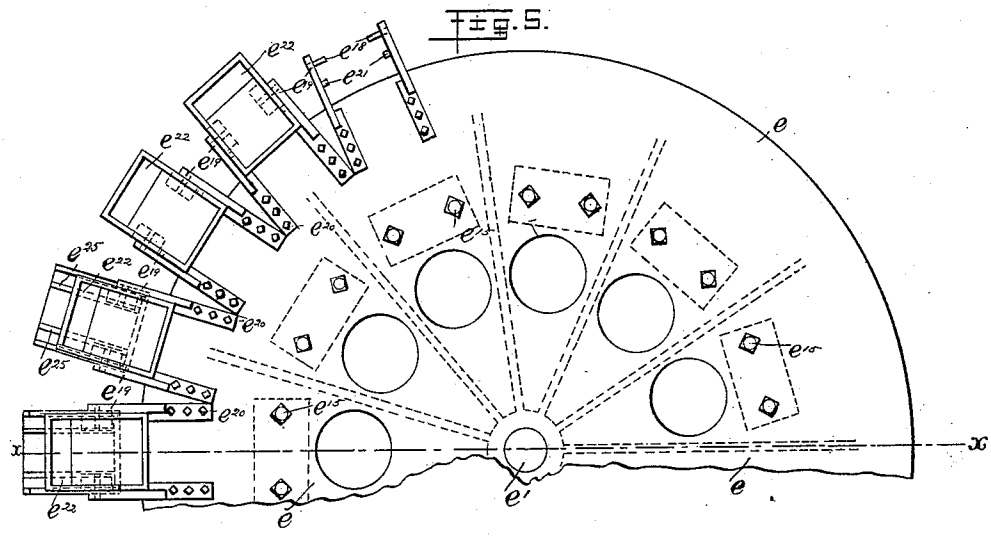
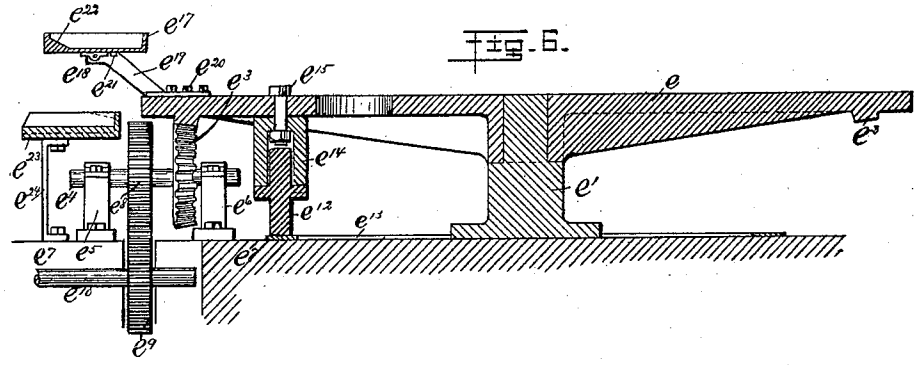


Fig. 6.



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UNITED STATES PATENT OFFICE.

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METHOD OF AND APPARATUS FOR REDUCING METALS.

SPECIFICATION forming part of Letters Patent No. 449,145, dated March 31, 1891.

Application filed April 26, 1890. Serial No. 349,616. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM WAKELY, a subject of the Queen of Great Britain, but now residing at Taunton, county of Bristol, State of Massachusetts, have invented an Improvement in Methods of and Apparatus for Reducing Metals, of which the following description, in connection with the accompanying drawings, is a specification, like letters and figures on the drawings representing like parts.

This invention relates to a novel process and apparatus by which metal may be cast into ingots or cakes and reduced and finished in one apparatus.

My invention, among other things, is especially applicable for the treatment of what is known as "yellow metal," now commonly employed as sheathing for the bottoms of ships.

Prior to my invention yellow metal has been manipulated in the following manner, viz:

First. The molten metal is first poured into a mold to form an ingot or cake, which is allowed to become cold or cooled below the degree of temperature at which the metal may be drawn or reduced.

Second. The ingot of metal is next reheated and reduced in a rolling-mill composed of two or more horizontal rolls, having the lower or lowest roll mounted in fixed or stationary bearings and the upper roll or rolls made adjustable with relation to the fixed lower roll by means of wedges. The ingot is reduced by this machine into the form of a slab.

Third. The slab thus formed is cut up into suitable lengths or pieces, and each piece is reheated to the necessary temperature for reduction and then passed through a second or finishing machine of like construction as the reducing-machine, but composed of two rolls.

With the machines or rolling-mills as now commonly constructed and known to me the ingot or cake cannot be reduced directly into the form of a slab, for when a two-height machine is used—that is, a machine composed of two rollers—the metal can only be reduced in one way—that is, it can be fed through the rolls from only one side of the machine—and consequently the said metal on its passage over the upper roll from the discharge to the feed side of the machine, becomes too cool to be worked—that is, it becomes too cool for the necessary amount of manipulation to produce a slab. So, also, when the machine is what is known as a "three-height" machine—that is, a machine composed of three rolls—the lowest one of which has fixed or stationary bearings, the slab cannot be reduced directly into sheet form of the desired thickness or size, for the rolls would not be sprung or forced apart by the thin piece of metal sufficiently to obtain a stationary bearing for the upper rolls to draw or take hold of the metal, even when the latter is of such temperature as to permit of its being drawn or rolled. Furthermore, the three-height machine as now constructed cannot be used as a finishing-machine, because the upper rolls cannot be forced apart sufficiently to allow of their being ground and polished to obtain a perfectly-finished sheet.

In accordance with my present invention the ingot or cake may be reduced and finished in a single three-height machine or rolling-mill in which the center roll is provided with fixed or stationary bearings and the upper and lower roll with adjustable bearings, the said rolls having suitable grooves to correspond to the thickness of metal being reduced when used for reducing yellow metal.

The particular features of my invention will be pointed out in the claims at the end of this specification.

Figure 1 is a front elevation of a machine or rolling-mill embodying my invention; Fig. 1ª, a detail to be referred to; Fig. 2, an end elevation of the machine shown in Fig. 1, looking toward the right; Fig. 3, a top or plan view of the machine shown in Fig. 2; Fig. 4, a detail of the carriage to be referred to; Fig. 5, a top or plan view of a sufficient portion of the turn-table portion of the apparatus to enable the operation of the said turn-table to be readily understood, and Fig. 6 a transverse section of the turn-table shown in Fig. 5 on line x x.

The rolling-mill portion of the apparatus, in accordance with my invention, is composed of three substantially horizontal rolls a a' a^2, arranged above each other to form what is technically known as a "three-height" machine. The rolls a a' a^2 have suitable bearings, as will be described, in uprights a^3 a^4, secured to or forming part of a base a^5. The

middle roll a' is supported at its opposite ends by lower bearing-blocks a^6, secured to or forming part of the uprights a^3 a^4, as clearly shown in Fig. 2, and the upper bearing block or box a^7 is made independent of the frame, but is prevented from being moved upward by lugs or projections a^8 on the inner side of the uprights a^3 a^4, the said upper box or bearing being made fixed or stationary by one or more shims a^9, interposed between the said bearing-blocks, the said upper box and shim being made stationary by suitable keys a^{90}, interposed between the said box and the lugs a^8. The upper roll a is supported in movable bearing-blocks a^{10} a^{12}, and the roll a^2 is supported in movable bearing-blocks a^{13} a^{14}, the said blocks being guided in their movement by guides (shown as plates or bearings) a^{15}, secured to the opposite sides of the uprights a^3 a^4, as by bolts a^{16}. The movable rolls a a^2 have their journals supported, as herein shown, by auxiliary bearing-blocks 20 21, which are slotted on the under side to embrace and slide upon levers a^{17} a^{18}, pivoted, as at a^{19} a^{20}, to the opposite sides of the upright a^3 a^4, the said levers having their free ends connected, as herein shown, to chains a^{21} a^{22}, passed about pulleys a^{24} a^{25}, located above the machine and having attached to their opposite ends weights a^{26} a^{27}. The upper bearing boxes or blocks of the movable roll a are adjusted in an upward direction, as herein shown, by means of screw-threaded rods b b', extended from above down through the uprights a^3 a^4. The screw-threaded rods b b' have secured to or forming part of them, as herein shown, bevel-gears b^2 b^3, with which mesh pinions b^4 b^5 on a shaft b^6, having bearings in suitable boxes b^7 b^8, herein shown as secured to or forming part of a spindle b^9, extended into a socket in and supported by the bevel-gears b^2 b^3, as clearly shown in Fig. 3, the said shaft at one side of the machine being provided, as herein shown, with a hand-wheel b^{10}, by which rotation may be imparted to the bevel-gears b^2 b^3 to raise and lower them to permit of the adjustment of the upper roll a', as will be described. The lower bearing-boxes a^{14} of the movable roll a^2 are normally supported, as shown, by threaded rods b^{12} b^{13}, herein shown as extended through bosses b^{14} b^{15} on the under side of the base or bed plate a^5, the said threaded rods having secured to or forming part of them bevel-gears b^{16} b^{17} in mesh with pinions b^{18} b^{19} on a shaft b^{20}, having bearings in boxes b^{21} b^{22}, secured to or forming part of spindles inserted into a socket in the bevel-gears b^{16} b^{17}. The threaded rod b^{13} has secured to it a gear-wheel b^{24} in mesh with a gear-wheel b^{25}, mounted on a vertical shaft or spindle b^{26}, supported at its lower end, as herein shown, by a bracket b^{27}, secured to the base-plate of the machine, and at its upper end by a bracket b^{28}, secured, as by bolt b^{29}, to the upright a^4. The shaft b^{26} has fast upon it, as herein shown, a turret-wheel b^{30}, which is adapted to be engaged and turned by a rod or handle b^{31}, secured to or forming part of a collar b^{32}, loosely mounted on the said shaft. By turning the shaft b^{26} by means of the handle or rod b^{31} the threaded shafts or rods b^{13} b^{12} through the system of gears above described may be adjusted vertically in the uprights a^3 a^4 of the frame-work of the machine, so as to remove the roll a^2 away from the fixed roll a' to obtain a wider passage between the said rolls, or to bring the roll a^2 nearer to the fixed roll a' to diminish the size of the passage or opening between the said rolls. The rolls a a' a^2 are herein shown as reduced in diameter, as at 2 3, to form between the rolls a a' passages c and c' and between the rolls a' and a^2 passages c^2 and c^3. The rolls a a' a^2 are provided at their end of smallest diameter with collars c^4 c^5 c^6, which are of the same or substantially the same diameter as the main or unreduced portions marked 5, 6, and 7, the said collars forming bearing-surfaces for the reduced ends of the rolls. The rolls a a' a^2 are connected, as will be described, to shafts c^7 c^8 c^9, supported in suitable uprights c^{10} c^{12}, and having mounted upon them, respectively, driving-gears c^{13} c^{14} c^{15}, the shaft c^8, as herein shown, forming the driving-shaft for the shafts c^7 c^9. The shafts of the rolls a a' a^2 are preferably detachably connected to the shafts c^7 c^8 c^9 by intermediate shafts c^{16} c^{17} c^{18}, which are secured to the journals of the co-operating shafts of the rolls and gears, preferably by thimbles or sleeves c^{20}. The ends of the rolls a a' a^2 and of the shafts c^7 c^8 c^9 and intermediate shafts c^{16} c^{17} c^{18} are preferably cut out in three places to form slots or grooves 10, as clearly shown in Figs. 1[a] and 2, and the thimbles c^{20} are provided on their inner circumference with projections 12, which fit into the grooves or slots 10, and the said thimbles are secured in place, as herein shown, by blocks 14, fitted into longitudinal grooves in the intermediate shafts, which grooves register with and receive the projections 12 of the thimbles c^{20} and the blocks 14, and the latter, abutting against the ends of the projections 12 of the thimbles, prevent longitudinal movement of the said thimbles on the intermediate shafts, the said blocks being secured in their grooves, as herein shown, by adjustably-detachable bands or straps 16. The thimbles c^{20} fit upon the ends of the intermediate shafts and the journals of the roll and gear-shafts somewhat loosely, so as to permit of a slight or limited vertical movement of the rolls a a^2. The uprights a^3 a^4 have secured to or forming part of them cross plates or bars d d', (see Fig. 1,) preferably inclined outwardly and having their inner ends contiguous to the top surface of the rolls a' a^2. The cross-plate d' has preferably secured to it an auxiliary cross-bar d^2 to form a rest for one end of a carrier or supporting-frame d^{20}, pivoted, as at d^3, to the main or stationary portion d^4 of the said frame, the said stationary portion being supported upon a carriage, herein shown as

consisting of sides d^5, supporting axles d^7, having wheels d^6, the said wheels being adapted to run on a railway-track d^8, extended in the direction of the length of the rolls, the said shafts being provided, as herein shown, with gear-wheels d^9 d^{10}, which mesh with rack-bars d^{12} d^{13}, located within the track and acting to keep the carriage square or true, for a purpose to be herein described. The pivoted portion d^{20} of the carrier-frame is adapted to be moved on its pivots, as herein shown, by means of a lever d^{14}, having one end pivoted, as at d^{15}, to the under side of the movable portion d^{20}, and itself pivotally connected, as at d^{16}, to a link or rod d^{17}, secured to a pulley-block d^{18}, provided with a pulley d^{19}, adapted to be run on a rod $d^{\times}$, extended across the face of the machine and supported by brackets d^{21}, secured to the uprights a^3 a^4.

The apparatus as thus far described constitutes the reducing and finishing machine or rolling-mill, and the said apparatus has co-operating with it a revolving table or platform e, (see Figs. 5 and 6,) herein shown as pivotally mounted upon a central post or support e', and provided on its under side with a circumferential beveled rack-bar or gear-teeth e^2, with which meshes a beveled gear e^3 on a shaft e^4, having bearings in suitable uprights e^5 e^6, supported upon a suitable foundation e^7, which may be the floor of the room in which the apparatus is located. The shaft e^4 has mounted upon it a gear e^8, with which meshes a gear e^9 on a shaft e^{10}, constituting the driving-shaft for the revolving table, the said shaft being rotated in any usual or well-known manner. The table e is supported near its circumference by means of wheels e^{12}, adapted to run on a track or rail e^{13}, the said wheels having bearings in housings e^{14}, herein shown as secured to the table e by bolts e^{15}. The revolving table e has arranged about its circumference a number of molds e^{17}, pivotally mounted on their under side, as at e^{18}, to arms or braces e^{19}, firmly secured, as by bolts c^{20}, to the said table, the said mold being supported in a substantially horizontal position by a cross-bar e^{21}, connecting the co-operating arms or braces e^{19}. The mold e^{17} is preferably thickened at one end, as at e^{22}, so as to form an ingot or cake having a beveled end. One or more of the molds e^{17} will have located below it a receiving pan or frame e^{23}, supported at a suitable distance below the mold e^{17} to permit the latter to be turned over, so as to discharge the ingot from the mold into the receiving pan or frame. The pan or frame e^{23} is herein shown as supported upon an upright e^{24}, and is provided in its bottom, as shown in Fig. 5, with two longitudinal grooves or channels e^{25}, into which a forked tool or rod may enter to take the ingot from the receiving-pan and by means of a suitable overhead railway (not shown) place it upon the supporting-frame d^4. The molds e^{17} are filled with the yellow metal, which may be taken in a molten state directly from a suitable furnace arranged in close proximity to the revolving table, and after being filled with the metal the mold is carried around until it is above the receiving-pan e^{23}, and when in this position the operator turns the mold over and dumps the ingot into the receiving-pan, the table being revolved at a suitable speed to enable the molten metal to have become sufficiently set or solidified to enable it to be dumped as an ingot or cake. The ingot, as above described, is then taken and placed upon the supporting-frame d^4 and is carried or pushed forward and caused to enter the passage c^2 between the rolls a' a^2, the said passage being of sufficient width to enable the beveled end of the ingot to be inserted therein. The ingot on its way through the passage c^2 is reduced somewhat and is received upon a second supporting-frame d^4, located on the opposite side of the machine and not herein shown, and the pivoted portion of the said frame is raised to return the partially-reduced ingot from the rear side of the machine through the passage c between the rolls a and a', and as the reduced ingot issues from the passage c on the front side of the machine the operator, by means of the lever d^{14}, raises the movable portion of the stationary frame d^4 and receives the partially-reduced ingot, and as soon as the partially-reduced ingot has cleared the rolls a a' the operator drops the movable portion d^{20} of the frame, and at the same time the carriage is moved so as to bring the end of the frame supported by it in line with the passage c^3, which is smaller than the passage c^2. The ingot is still further reduced on its way through the passage c^3 and is returned through the passage c', which is still smaller than the passage c^3, and after the metal has left the passage c', it being received upon the stationary frame, the ingot has been reduced to the form of a slab of a suitable length, which may then be cut up into pieces of suitable length. To obtain the necessary or required amount or weight of metal to the square foot and yet have the sheets to be finished from the said pieces of uniform thickness, after the sheets have been cut up they are then reheated and passed between the portions 6 7 of the rolls a' a^2 and are carried back between the portions 5 6 of the rolls a a' by a guide, shown as two metal plates or bars 50 51, secured to the cross-bar d^2 on the rear side of the machine, and between which the metal sheet passes, and issues from between the portions 5 6 of the rolls as a sheet of the desired thickness, size, and weight. The width of the passages between the rollers a and a' may be varied—as, for instance, it may be increased by revolving the wheel b^9, so as to withdraw the threaded rods b b' away from the upper boxes a^{10} and permit the weight a^{26} to lift the roll a bodily upward until the upper blocks a^{10} are again brought in contact with the end of the adjusting-rods b. As the lever a^{17} is raised by the weight a^{26}, the auxiliary box a^{20}

slides down the said lever and finds its true or central bearing position. The lower roll a^2 may be moved away from the fixed roll a' by turning the shaft b^{26}, and as the threaded rods b^{12} b^{13} are lowered away from the lower boxes a^{14} of the said roll the said boxes and roll descend by gravity until again uniformly seated in contact with the adjusting-rods. The middle roll a' always remains fixed or stationary with respect to the top and bottom rolls, and in this way and by means of the adjusting devices above described I am enabled at all times to obtain a firm and solid bearing for the movable rolls a a^2, so that when the metal is passed through or between the said rolls and the roll a' the said rolls will bite and take hold of and reduce the same.

In finishing the sheets the finishing-rolls become worn after use and it is necessary to frequently true up the rolls, which is accomplished in a two-height machine by lifting the upper roll and inserting a polishing or grinding tool, usually a board covered with emery. In a three-height machine, wherein the lowest roll is fixed and the upper and middle rolls are adjustable by wedges, it is impossible to lift the said middle roll away from the lower roll, and consequently a polishing-tool could not be inserted between the said lower and middle rolls, and therefore a three-height machine cannot be used for finishing the sheets; but by making the middle roll stationary or fixed and the lower roll adjustable, as described, the polishing-tool may be inserted between them and the rolls rendered true.

It will be seen that the ingots or cakes are reduced or finished on one machine, thereby effecting a saving not only of the cost of one machine, but also of the cost of heating the ingots or cakes before being manipulated and while being reduced in slab form, and also of the labor employed to manipulate the metal, and at the same time effecting a very considerable saving in time.

I have described my improved machine or rolling-mill as employed for reducing yellow metal; but I do not desire to limit myself in this respect, as the apparatus may be used in reducing and finishing other metals, such as copper, zinc, and iron. So, also, I have shown the rolls as made to form grooves of varying thickness for producing sheets of yellow metal; but I do not desire to limit my invention in this respect, as the rolls may be of any desired form, according to the kind of work required.

I claim—

1. The herein-described process of forming sheets of yellow and like metal, which consists in casting the metal into a mold to form an ingot or cake, passing the said cake or ingot while in a heated condition between reducing-rolls to reduce the said ingot or cake directly into the form of a slab without reheating of the ingot, dividing the said slab into pieces of suitable size to produce a finished sheet, and passing the said pieces between rolls to reduce the said pieces directly into sheets of the required thickness, size, and weight, substantially as described.

2. In a three-height rolling mill or apparatus, the combination, with a middle roll a', provided with a reduced portion and with a collar c^5 of substantially the same diameter as the unreduced portion of the said roll, and fixed or stationary bearings for the said roll, of a movable upper roll a, provided with a reduced portion and with a collar c^4 of substantially the same diameter as the unreduced portion of the said roll, movable bearings for said roll, a lower roll a^2, provided with a reduced portion and with a collar c^6 of substantially the same diameter as the unreduced portion, and movable bearings for said lower roll, substantially as described.

3. In a three-height rolling mill or apparatus, the combination, with a middle roll a', provided with a series of reduced portions of varying diameter and with a collar c^5 of substantially the same diameter as the unreduced portion of the said roll, and fixed or stationary bearings for the said roll, of a movable upper roll a, provided with a series of reduced portions co-operating with the reduced portions of the roll a' and having a collar c^4 of substantially the same diameter as the unreduced portion of the said roll, movable bearings for the roll a, a lower roll a^2, provided with a series of reduced portions co-operating with the reduced portions of the roll a' and having a collar c^6 of substantially the same diameter as the unreduced portion of the roll, movable bearings for the said roll, and means to move the bearings of the upper and lower rolls, substantially as described.

4. In a three-height rolling-mill, the combination, with a middle roll having fixed or stationary bearings, of an upper and lower roll provided with movable bearings, auxiliary bearings for the upper and lower rolls, levers to support said auxiliary bearings, and means connected to said levers to keep the auxiliary bearings in contact with said rolls, substantially as described.

5. In a three-height rolling-mill, the combination, with a middle roll having fixed or stationary bearings a^6 a^7, of an upper roll provided with movable bearings a^{10} a^{12} and a lower roll provided with movable bearings a^{13} a^{14}, threaded rods b b' to move the upper and lower rolls toward the middle roll, counterbalanced levers pivoted to the frame of the mill, and auxiliary bearings for said upper and lower rolls adjustable on the said levers, substantially as described.

6. The combination, with a three-height rolling-mill having its middle roll provided with fixed or stationary bearings and its upper and lower roll provided with movable bearings, of a carrier or supporting-frame provided with a pivoted portion d^{20}, an elevated rod or track supported by the frame of the rolling-mill, and means movable on said track

to which the pivoted portion d^{30} is connected, substantially as described.

7. The combination, with a three-height rolling-mill having its middle roll provided with fixed or stationary bearings and its upper and lower roll provided with movable bearings, of a carrier or supporting-frame provided with a pivoted portion d^{30} and a stationary portion d^4, a movable carriage to support the stationary portion of the carrier, a rod or track d^x, extended across the face of the machine, a pulley movable on said track, and means to connect the movable portion of the carrier or supporting-frame with the pulley, to operate substantially as described.

8. The combination, with a three-height rolling-mill having its middle roll provided with fixed or stationary bearings and its upper and lower roll provided with movable bearings, of a carrier or supporting-frame provided with a pivoted portion d^{30}, an elevated rod or track supported by the frame of the rolling-mill, means movable on said track to which the pivoted portion d^{30} is connected, and a turn-table provided with a series of pivoted molds, to operate substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM WAKELY.

Witnesses:

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EMMA J. BENNETT.