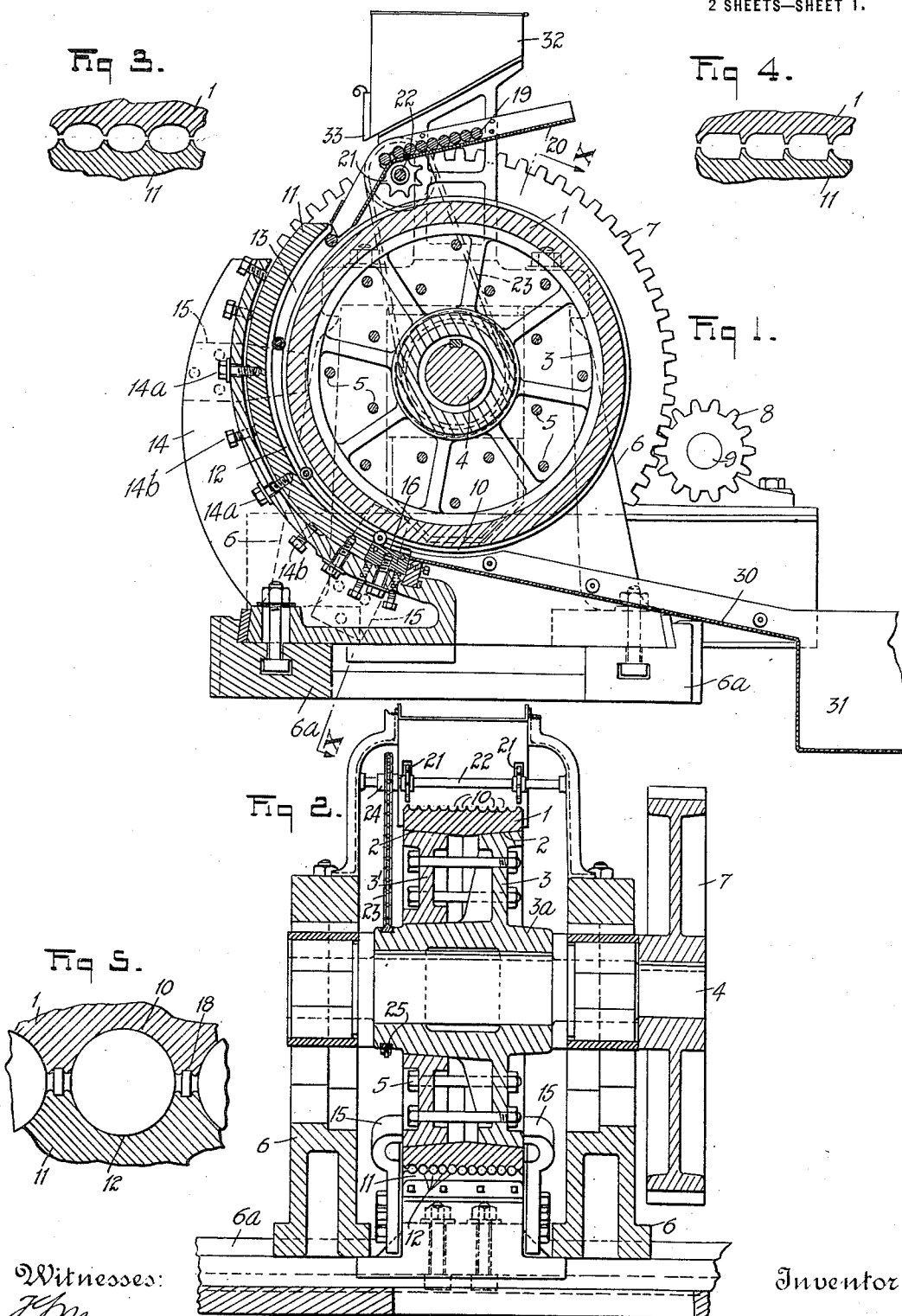


F. E. CANDA.
BALL ROLLING MACHINE.
APPLICATION FILED JUNE 10, 1915.

1,189,662.

Patented July 4, 1916.

2 SHEETS—SHEET 1.



Witnesses:

J. Massy
Paul E. Franke

Inventor

By *his* Attorney *Fuchs and Canda*

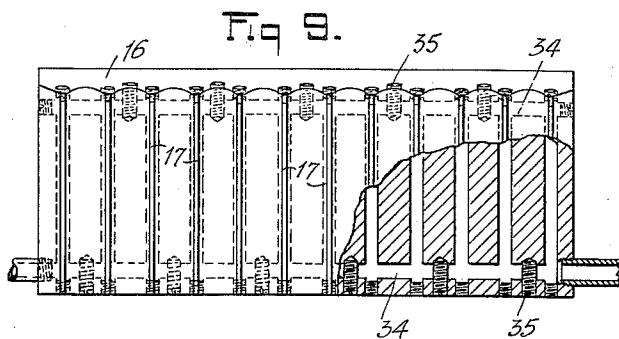
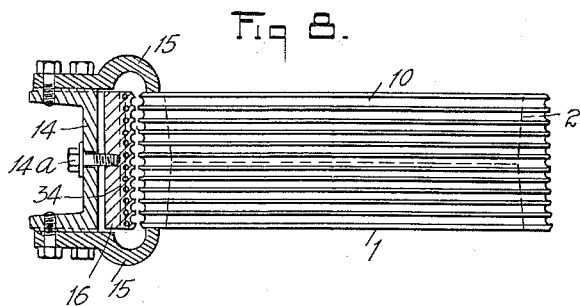
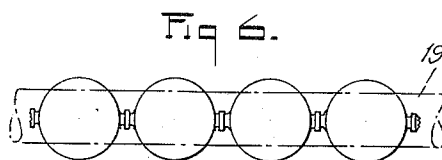
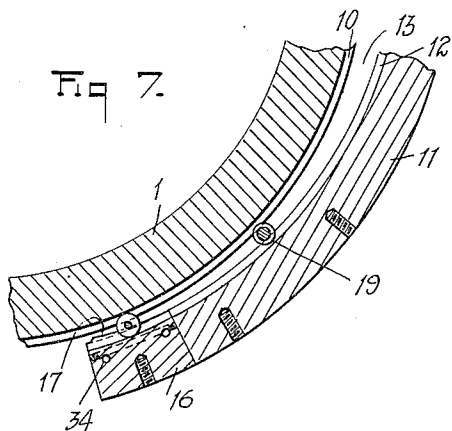
H. M. Marble

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2 SHEETS—SHEET 2.



Witnesses:
J. Massey
Paul C. Frank

Inventor
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H. M. Marble

UNITED STATES PATENT OFFICE.

FERDINAND E. CANDA, OF NEW YORK, N. Y.

BALL-ROLLING MACHINE.

1,189,662.

Specification of Letters Patent.

Patented July 4, 1916.

Application filed June 10, 1915. Serial No. 33,223.

To all whom it may concern:

Be it known that I, FERDINAND E. CANDA, a citizen of the United States of America, and a resident of New York, in the county of New York and State of New York, have invented a certain new and useful Ball-Rolling Machine, of which the following is a specification.

My invention relates to apparatus for forming balls and other bodies of rotation, and comprises novel die-means for forming balls from rod-stock by a rolling operation, feeding means for feeding the stock automatically into the machine, a tempering tank and means for delivering the formed material into such tank by gravity, and other features, all as hereinafter described and particularly pointed out in the appended claims.

The machine herein illustrated and described is adapted for carrying out the method of forming balls and other bodies of rotation, described and claimed in my prior application Serial No. 9,345, filed February 23, 1915, and this application is in part a continuation of such prior application, the machine herein illustrated and described comprising, however, certain improvements over that of my said former application.

The object of my invention is to provide improved means for forming balls and other objects of rotation with great rapidity and at low cost, and with apparatus of a simple character.

I will now proceed to describe my invention with reference to the accompanying drawings, and will then point out the novel features in claims.

In said drawings: Figure 1 shows a vertical transverse section of a ball rolling machine embodying my invention, and Fig. 2 shows a vertical axial section of such machine. Figs. 3, 4 and 5 are fragmentary detail sections illustrating various profiles which the grooves of the roll and die may have, for forming objects of different shapes. Fig. 6 is an elevation of a portion of a ball group such as formed in the machine herein described, dotted lines indicating, in said figure, the size of the original rod-blank from which that ball group was formed, with reference to the size of the resulting balls. Fig. 7 is a fragmentary transverse section, on a larger scale than Figs. 1 and 2, of a portion of the grooved roll, the sta-

tionary die or breast, and the adjustable finishing die, provided with cutting-off means. Fig. 8 shows a transverse section through the finishing die or breast, its support, and the cheek plates, on line $x-x$ of Fig. 1, the roll being shown in elevation. Fig. 9 is a top view and partial section of the finishing die, showing means for water-cooling that die.

In the drawings, 1 designates a roll shell, shown in this instance as hollow, with reversely tapering interior surfaces 2, and mounted upon tapered disks 3 and 3', one of which has a hub 3^a keyed to the shaft 4, the other disk, 3' having a taper fit to that hub, the two disks being held together by bolts 5. The shaft 4 is mounted in suitable pedestals 6 themselves mounted upon a base 6^a and is driven by a gear 7 and a pinion 8, the latter mounted upon a driving shaft 9.

The roll 1 is provided with a number of grooves 10 of a profile corresponding to that of the object to be produced. If this object is to be spherical, the grooves 10 of the roll are of approximately semi-circular profile. Figs. 3 and 4 show other profiles which the grooves of the roll may have. Adjacent the roll 1 is a breast, or reducing-die, 11, provided with corresponding and registering grooves 12. The curvature of this breast or reducing die is a spiral, or an approximation to a spiral; or it may be circular but of larger radius than the roll 1 and eccentric to the roll 1; the construction being such that the space 13 between the breast and roll is relatively wide at the top and grows progressively narrower toward the bottom. For supporting this breast or reducing die, adjustably, I have indicated a shoe 14 mounted upon the base 6^a and provided with holding screws 14^a and thrust screws 14^b. It will be obvious that by adjustment of these screws the angle of the breast or reducing die with reference to the roll may be varied considerably, also the distance between the breast and roll may be varied considerably. It is important that this breast shall be held with its grooves in precise registry with the grooves of the roll, notwithstanding possible lateral motion of the roll; therefore, and as shown particularly in Figs. 2 and 8, I have provided cheek pieces 15 which bear lightly against the sides of the roll 1, and are bolted to the shoe 14. It will be understood that, by use of suitable thin shims between the shoe

14 and the cheek pieces, slight lateral adjustment of the breast 11 may be obtained, and therefore very accurate registry of the grooves of the breast and the grooves of the roll may be obtained; and such adjustment is independent of any slight lateral motion of the roll such as is apt to occur; for, since the cheek pieces bear against the sides of the roll, if the roll move laterally, so will the breast. I have found this to be a very important and necessary feature of the machine. As indicated particularly in Fig. 8, the cheek pieces are grooved opposite the space 13 between the roll and breast, so that if the rods from which the balls or other objects of rotation are formed, project beyond the side faces of the roll, they can nevertheless pass the cheek pieces.

16 designates a so-called finishing die located at the lower end of the reducing die or breast 11, and separately adjustable both as to distance from the roll 1 and as to angle with respect to the roll 1. I have found this separate finishing die a very important feature in the machine. The main reducing die 11 is necessarily set, with respect to the roll 1, so as to cause very considerable reduction of the stock in passing between that roll and die; and it is practically necessary that the inner or working surface of this die 11 shall be a true curve; either a true segment of a circle, or a true segment of a spiral which can be readily generated. Therefore, it is not practicable to change the curvature of this breast or main reducing die 11, near the lower end, to provide for less reduction during the last portion of the travel of the material through the machine; yet unless provision be made for very little reducing only, during the last portion of the travel of the material through the machine, that material, as it emerges, will have a pronounced rib, which is quite objectionable. The separately adjustable finishing die 16 obviates this objection; for that die is formed separately from the main reducing die 11 and is set to give only such very slight reduction as is necessary to insure feeding of the material past that finishing die. Using this finishing die 16, the formation of a rib, in a plane parallel to the axis of rotation, on the material passing through the machine is obviated; and balls of very perfect contour are produced. Preferably, also, the finishing die is provided with raised ribs 17 for cutting, or at least for reducing to very small dimensions, the neck formed between adjacent balls by the rolling operation. It is impracticable to sever these necks by the action of the roll 1 and reducing die 11; but it is practicable to provide the finishing die 16 with ribs 17, rising somewhat sharply toward the corresponding ribs of the roll 1, and approaching to or very nearly to the central axis of the

balls passing through the machine, and sharpened if necessary, whereby the necks between successive balls will be severed, or reduced to such small dimensions that the balls are very easily separated by breaking them from these necks. Preferably, and as indicated in Fig. 7, the ribs 17, after reaching a point of greatest height, drop away sharply so as not to exert any dragging action on the balls as they emerge from between the rolls and the finishing die.

The finishing die should have a length, with reference to the direction of progress of the material through the machine, somewhat greater than the circumferential length of the finished ball.

As indicated in Figs. 5 and 6, the ribs intervening between the grooves of the die and breast may, with advantage be double; *i. e.*, there may be a groove 18 at or about the middle of each such rib. This construction permits the ribs of the roll and breast to approach nearer the axis of rotation of the material being acted upon, than would otherwise be the case, and also provides somewhat sharper edges for said ribs. The grooves 18 provide space to receive excess metal, if any. The scale of Figs. 2 and 8 is too small to permit the showing of the grooves 18 in those figures; and therefore Fig. 5 may be understood to show in detail and on a larger scale the cross-section of the ribs intervening between the grooves in Figs. 2 and 8. However, I do not limit myself to the use, on the roll and breast, of ribs having these recesses 18. When the ribs of the roll and breast are provided with grooves 18, as shown in Fig. 5, the ribs of the finishing die 16 will naturally have corresponding grooves.

The blanks supplied to this machine are customarily in the form of rods, which conveniently may be of circular section, such as the rods 19 shown in Fig. 1, though I do not limit myself to the use of blanks of circular cross section. When the material of these blanks is steel or other material which is very hard when cold, these blanks are preferably heated to a suitable forging or rolling temperature before they pass through the machine; and preferably suitable feed means is provided for feeding the blanks at regular intervals. For so feeding the blanks I have indicated the provision of a feed shelf 20, preferably slightly inclined toward the roll, and a sprocket feeding device 21 mounted upon a shaft 22 arranged to be driven from shaft 4 by a suitable drive chain 23 and sprocket wheels 24 and 25. It will be apparent that as the roll 1 rotates, the teeth of the sprocket feeding device 21, engaging the blanks 19 upon the feed shelf 20, will permit same to pass, one by one, into the space 13 between the roll 1 and breast.

Preferably, the space 13 is, at the top, of

just about sufficient width to receive the blanks 19; though it will do no harm if the width of the space 13 be slightly greater than the diameter of the blanks 19, at the top, in which latter case each blank, as soon as it drops into the space 19, will drop down until engaged on one side by the roll, and on the other side by the breast. The roll being in rotation, each blank 19 so engaged, will be caused to rotate, and as in its rotation it passes into the more contracted portion of the space 13, the blank will be grooved in correspondence with the ridges of the roll 1 and breast 11, and also the material of the blank, being forced aside by the ridges of the roll and breast, will be drawn into the grooves of the roll and breast so as to eventually fill such grooves, while on the other hand, the necks formed by the ridges of the roll and breast will be reduced, eventually, to very small dimensions.

I particularly intend to form, by the machine and method above described, steel or other iron balls adapted for use in crusher mills and the like. It is desirable that such balls shall be formed of very hard steel, and that the balls shall be properly and uniformly tempered; consequently I provide at the lower end of the passage 13, between the roll and breast, a shelf 30, down which each complete ball or ball-group will roll, as it emerges from such passage, into a tempering tank 31, which tank may contain oil or any other suitable tempering liquid. It will be noted that the blanks 19, placed at a proper rolling temperature upon the feed shelf 20, will pass through the machine at a uniform rate, and so quickly that they will still be at a temperature high enough for tempering when they escape from the passage 13 and reach the tempering tank 31. The temperature at which they reach the tempering tank may be regulated by the initial heat of the blank, and, if necessary, by making the shelf 30 of greater or less length as conditions may dictate; also, of course, by regulating the speed of rotation of the roll 1; though in general it will be desirable to rotate that roll 1 at as high a speed as is consistent with proper rolling of the blanks, so that the capacity of the machine may be as great as possible. The diameter of the roll 1, and therefore the curvature of the breast 11, will be regulated in design so as to secure the necessary gradual change of section of the blanks; for, as is well known, time must be provided for the flow of the metal. It is intended that the roll 1 shall be rotated at a speed of about ten revolutions per minute, though this speed may be varied, and naturally will be varied somewhat, in accordance with the diameter of the roll. For the treatment of chrome steel and other hard steels, the diameter of the roll 1 should preferably be such with reference to the dia-

meter of the balls to be formed, that the blanks shall rotate at least ten times during their passage through the space 13.

To secure ample traction between the roll 1 and the blanks, I may spread quartz sand or other suitable material over the surface of the roll 1, so as to cause such roll to "bite" the material of the blanks. For this purpose I have shown a sand reservoir 32 provided with a delivery spout 33 whereby sand or other gritty material may be fed to the exterior of the roll.

Because of the uniformity in time occupied during the passage of the blanks through the machine, it is evident that blanks which are delivered to the machine at a uniform temperature, will reach the tempering tank 31 at uniform or nearly uniform temperature; a very uniform tempering of the product being thereby insured.

My invention is not limited to the formation of crusher balls by the method and apparatus above described. It is equally applicable to the formation of balls of other materials, for example, of copper, or lead, or even plastic materials, such for example as the plastic compositions of which coal briquets or briquets of various ores are formed. When the machine is acting upon readily ductile material such as copper or lead, or briquet compositions, such material may often be rolled cold or nearly so. Bearing balls may also be formed by the method and machine above described, since such balls require grinding in any case, and in the process of grinding the balls will be brought to true spherical form.

While it appears at present that the principal utility of the method and machine described will be for the formation of spherical or approximately spherical bodies, still my invention is by no means confined to the formation of spherical or approximately spherical bodies, but is applied to the formation of various bodies of rotation. In Fig. 3 I have indicated the provision of the roll and breast with grooves adapted for the formation of ellipsoid bodies; and in Fig. 4 I have indicated the provision of the roll and breast with grooves adapted for the formation of bodies of still another profile.

In some cases it may be desirable to provide means for cooling the finishing die 16. In Fig. 9 I have illustrated the finishing die, as provided with passages 34 for the flow of a cooling fluid, such as water; such passages being formed, most conveniently, by boring intersecting holes, longitudinally and transversely, in the die near the surface thereof, plugging the ends of the holes so formed, except one inlet and one outlet hole, and inserting suitable plugs 35 at intervals in such arrangement as will convert the intersecting transverse and longitudinal bore

holes into a zigzag passage for the flow of cooling water or other cooling fluid through the die.

What I claim is:—

- 5 1. A machine for forming balls and other objects of rotation, comprising a grooved roll and a correspondingly grooved breast located in proximity to the roll, but with a space between the roll and breast which
10 gradually decreases in width in the direction of rotation of the roll, the depth of each such groove being greater than half the distance between the ribs of the roll and breast at the point at which the material to be acted
15 upon enters the space between the roll and breast, whereby objects of rotation are formed of a diameter greater than the initial diameter of the stock from which such objects are formed.
- 20 2. A machine for forming balls and other objects of rotation, comprising a grooved roll and a correspondingly grooved breast located in proximity to the roll, but with a space between the roll and breast which
25 gradually decreases in width in the direction of rotation of the roll, said breast provided with means engaging the roll and serving to cause the breast to follow lateral motions of the roll.
- 30 3. A machine for forming balls and other objects of rotation, comprising a grooved roll and a correspondingly grooved breast located in proximity to the roll, but with a space between the roll and breast which
35 gradually decreases in width in the direction of rotation of the roll, and a finishing die grooved in correspondence with the grooving of the breast and forming a continuation of the breast, and set to cause less reduction
40 of the material rolled, during passage between the roll and such finishing die, than occurs during the passage of such material between the roll and the breast.
- 45 4. A machine for forming balls and other objects of rotation, comprising a grooved roll and a correspondingly grooved breast located in proximity to the roll, but with a space between the roll and breast which
50 gradually decreases in width in the direction of rotation of the roll, and a finishing die grooved in correspondence with the grooving of the breast and forming a continuation of the breast and adjustable
55 separately from said breast, with respect to said roll, whereby said finishing die may be set to cause less reduction of the material passing between it and the roll than occurs during the passage of such material between the roll and breast.
- 60 5. A machine for forming balls and other objects of rotation, comprising a grooved roll and a correspondingly grooved breast located in proximity to the roll, but with a space between the roll and breast which
65 gradually decreases in width in the direction of rotation of the roll, said breast provided with means engaging the roll and serving to cause the breast to follow lateral motions of the roll, and a finishing die provided with ribs adapted to reduce the necks between adjacent balls to an extent greater than such balls are reduced during their passage past such finishing die.
- 70 6. A machine for forming balls and other objects of rotation, comprising a grooved roll and a correspondingly grooved breast located in proximity to the roll, but with a space between the roll and breast which gradually decreases in width in the direction of rotation of the roll, and a
75 finishing die forming a continuation of the breast but adjustable separately from said breast, with respect to the roll.
- 80 7. A machine for forming balls and other objects of rotation, comprising a grooved roll and a correspondingly grooved breast located in proximity to the roll, but with a space between the roll and breast which gradually decreases in width in the direction of rotation of the roll, and a finishing
85 die forming a continuation of the breast but adjustable separately from said breast, with respect to the roll, said finishing die provided with ribs adapted to reduce the necks between adjacent balls to an extent
90 greater than such balls are reduced during their passage past such finishing die.
- 95 8. A machine for forming balls or other objects of rotation, comprising grooved ball-rolling members, one movable with respect to the other, and with a space between them which gradually decreases in width in the direction of progress of the material acted upon between said members, and a finishing die forming a continuation of one
100 of said members but separately adjustable with respect to the other said member.
- 105 9. A machine for forming balls or other objects of rotation, comprising grooved ball-rolling members, one movable with respect to the other, and with a space between them which gradually decreases in width in the direction of progress of the material acted upon between said members, and a finishing die forming a continuation
110 of one of said members but separately adjustable with respect to the other said member, said finishing die provided with ribs adapted to reduce the necks between adjacent balls to an extent greater than such
115 balls are reduced during their passage between the said ball forming members.
- 120 10. A machine for forming balls and other objects of rotation, comprising a grooved roll and a correspondingly grooved breast located in proximity to the roll, but with a space between the roll and breast which gradually decreases in width in the direction of rotation of the roll, a support for said breast, and means carried by said
125 support for causing the breast to follow lateral motions of the roll, and a finishing die provided with ribs adapted to reduce the necks between adjacent balls to an extent greater than such balls are reduced during their passage past such finishing die.
- 130

support and engaging the roll, whereby said support and the breast carried thereby follow lateral motions of the roll.

11. A machine for forming balls and other objects of rotation, comprising a grooved roll and a correspondingly grooved breast located in proximity to the roll, but with a space between the roll and breast which gradually decreases in width in the direction of rotation of the roll, a support for said breast, and means carried by said support and engaging the roll, whereby said support and the breast carried thereby follow lateral motions of the roll, said roll-engaging means grooved opposite the space between the roll and breast, to permit passage of material acted upon which projects beyond the sides of the roll or breast.

12. A machine for forming balls and other objects of rotation, comprising a grooved roll and a corresponding grooved breast located in proximity to the roll, but with a space between the roll and breast which gradually decreases in width in the direction of rotation of the roll, a support for said breast and means carried by said support for adjusting the position of the breast with respect to said roll.

13. A machine for forming balls and other objects of rotation, comprising grooved ball-forming members, one of which is movable with respect to the other, one of said members provided with interior passages for the flow of cooling fluid.

14. A machine for forming balls and other objects of rotation comprising a grooved roll and a correspondingly grooved breast located in proximity to the roll, but with a space between the roll and breast which gradually decreases in width in the direction of rotation of the roll, and rod feeding means arranged to deliver rods in succession and sidewise to the wider portion of the space between said roll and breast.

15. A machine for forming balls and other objects of rotation comprising a grooved roll and a correspondingly grooved breast located in proximity to the roll, but with a space between the roll and breast which gradually decreases in width in the direction of rotation of the roll, an inclined feed shelf in proximity to the wider portion of such space between the roll and the breast, and feeding means arranged to deliver rods sidewise from such shelf into said space, successively.

16. A machine for forming balls and other objects of rotation comprising a grooved roll and a correspondingly grooved breast located in proximity to the roll, but with a space between the roll and breast which gradually decreases in width in the direction of rotation of the roll, an inclined feed shelf in proximity to the wider portion

of such space between the roll and the breast, and feeding means arranged to deliver rods sidewise from such shelf into said space, successively, said feeding means comprising sprocket means having teeth arranged to engage said rods successively and thereby, first to retain said rods upon the shelf, and thereafter to feed them, one by one, into the space between the roll and breast.

17. A machine for forming balls and other objects of rotation, comprising a grooved roll and a correspondingly grooved breast adjacent said roll, the space between said roll and breast gradually contracting in width, in the direction of rotation of the roll, the grooves of the roll and breast registering, and the ribs intervening between the grooves of such roll and breast having projecting lips adapted to roll grooves in the necks of the bodies of rotation formed by coaction of said roll and breast.

18. A machine for forming balls and other objects of rotation, comprising a grooved roll and a correspondingly grooved breast adjacent said roll, the space between said roll and breast gradually contracting in width in the direction of rotation of the roll, the grooves of the roll and breast registering, and the ribs intervening between the grooves of such roll and breast having projecting lips with intervening depressions, such lips adapted to roll grooves in the necks of the bodies of rotation formed by coaction of such roll and breast, the spaces between adjacent lips constituting spaces for the reception of excess metal.

19. Means for rolling and tempering balls and the like comprising a grooved roll and a correspondingly grooved breast adapted to receive a rod sidewise between them, and to form same into ball groups, a tempering tank and means for delivering such ball-groups by gravity into such tempering tank.

20. A machine for forming balls and other objects of rotation, comprising a grooved roll and a correspondingly grooved breast located in proximity to the roll, but with a space between the roll and breast which gradually decreases in width in the direction of rotation of the roll, and a finishing die forming a continuation of the breast and located at a less angle with respect to the roll, than is the said breast.

21. A machine for forming balls and other objects of rotation, comprising a grooved roll and coacting grooved die means located in proximity to the roll but with a space between the roll and die means which gradually decreases in width in the direction of rotation of the roll, the terminal portion of such die means being at a less angle with respect to the roll, than is the major portion of such die means.

22. A machine for forming balls and other objects of rotation, comprising grooved

ball-rolling members, one movable with respect to the other, and with a space between them which gradually decreases in width in the direction of progress of the material acted upon between said members, one of said die means having a terminal portion which is at a less angle with respect to the other die means, than is the major portion of such first mentioned die means, such ter-

minal portion of a length approximating the 10 circumferential length of the finished object.

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

FERDINAND E. CANDA.

Witnesses:

H. M. MARBLE,

PAUL H. FRANKE.