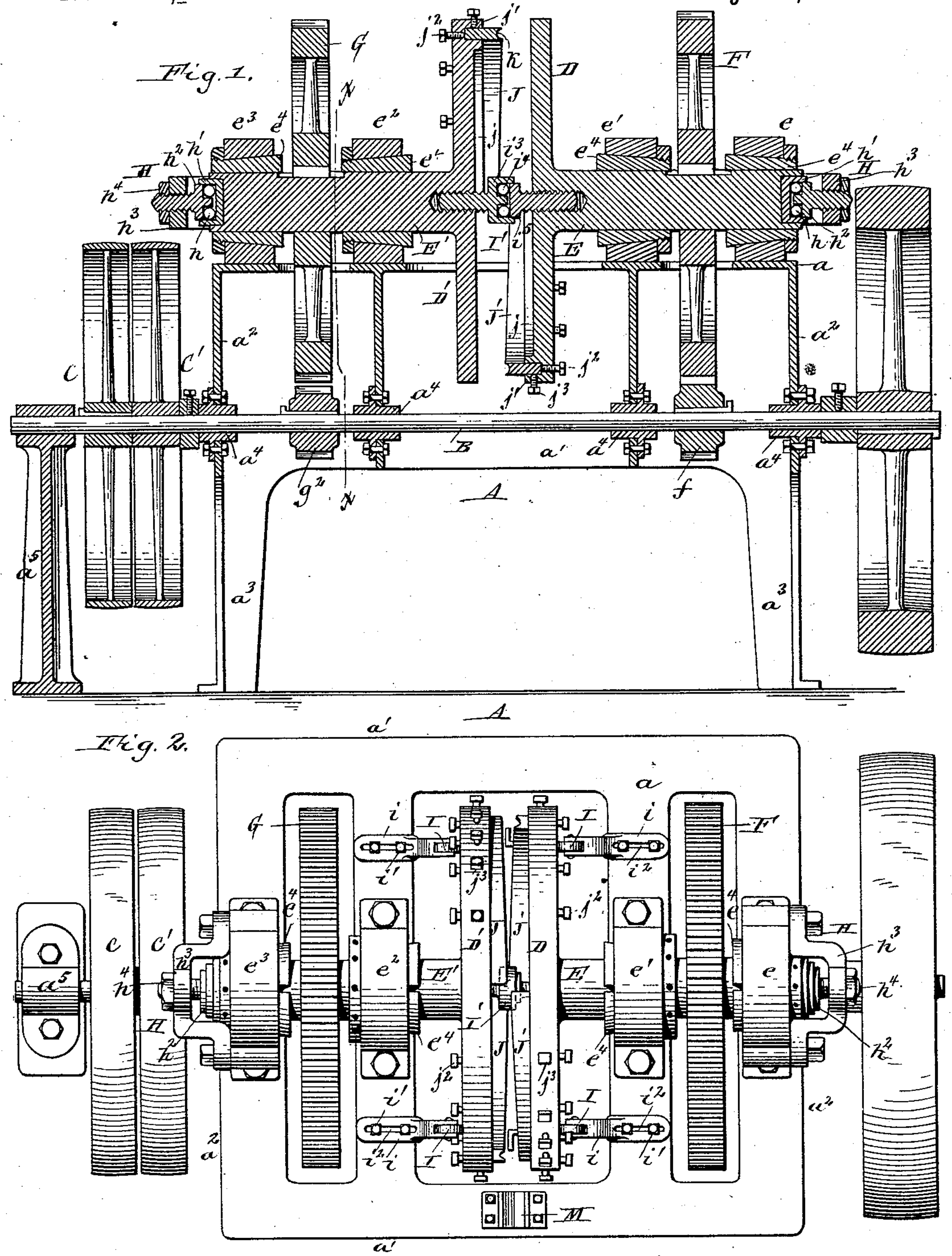
(No Model.) 3 Sheets—Sheet 1.

E. A. JONES.

MACHINE FOR MAKING METALLIC BALLS.

No. 455,880. Patented July 14, 1891.



Witnesses:
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Attorneys.

(No Model.)

3 Sheets—Sheet 2.

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Fig. 3.

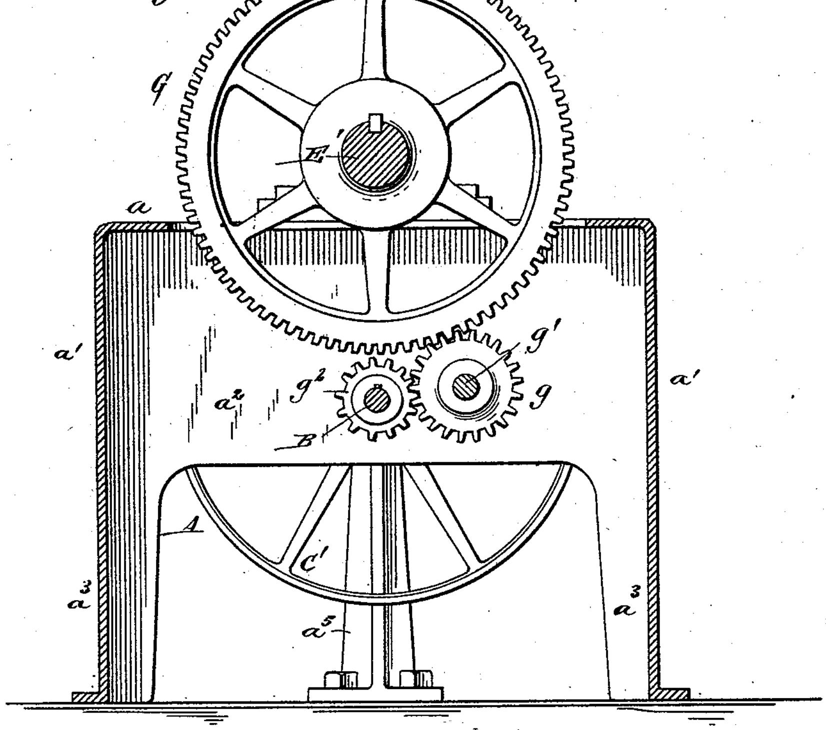


Fig. 5.

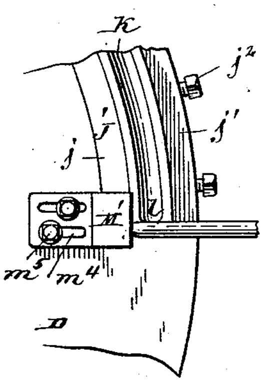


Fig. 4.

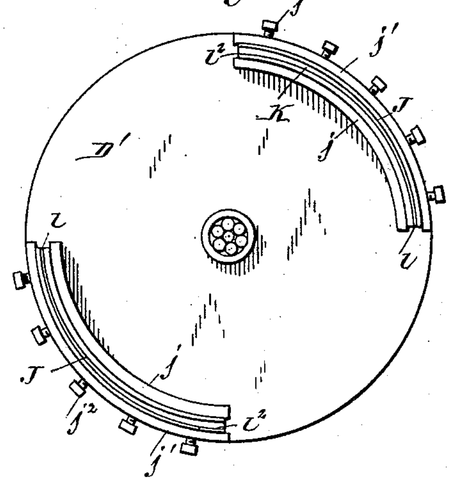
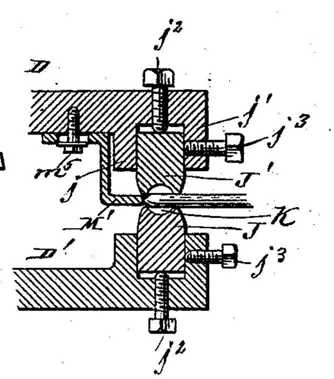


Fig. 6.



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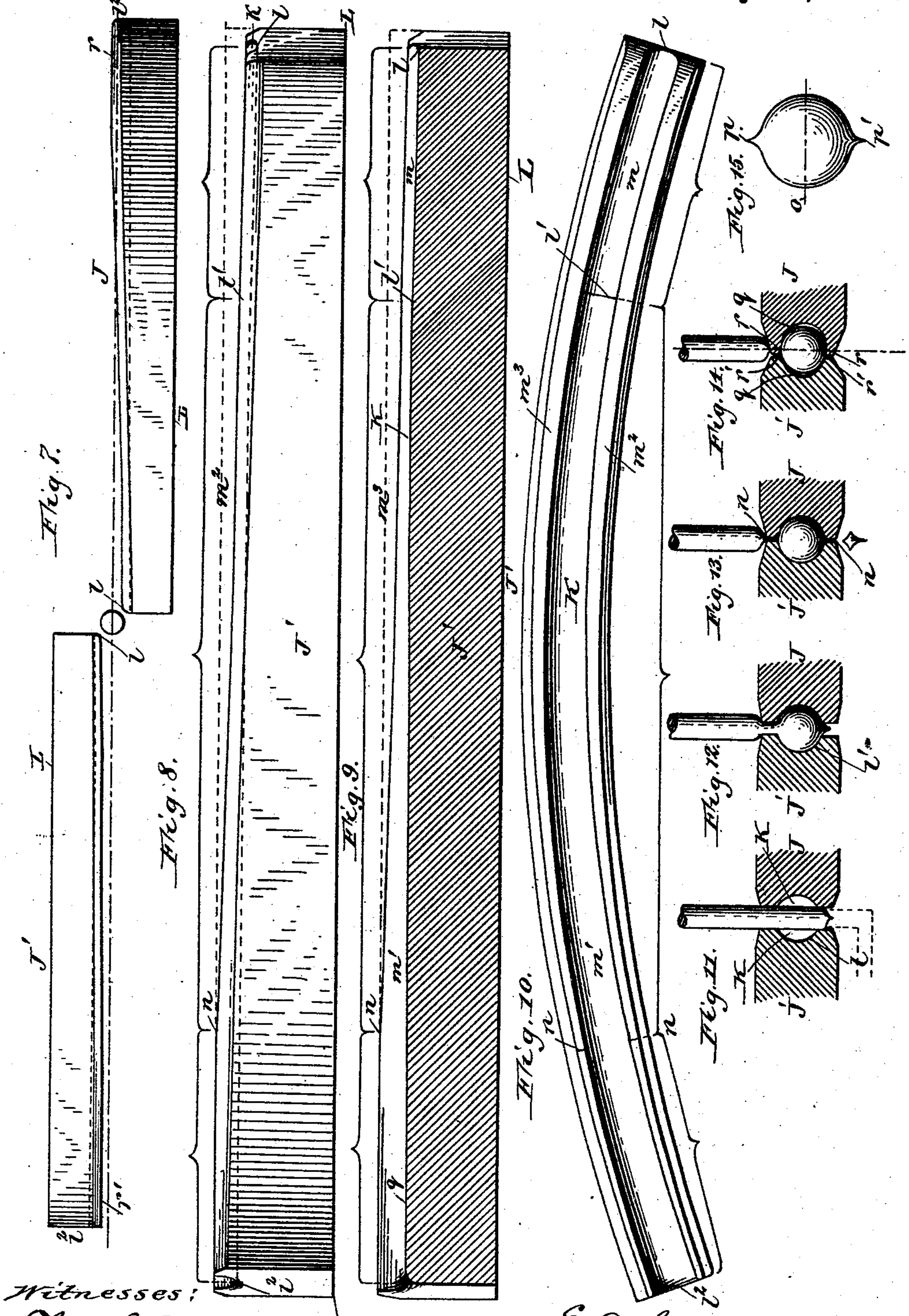

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By Wilhelm Bonner. Attorneys.

UNITED STATES PATENT OFFICE.

EDWARD A. JONES, OF TONAWANDA, NEW YORK.

MACHINE FOR MAKING METALLIC BALLS.

SPECIFICATION forming part of Letters Patent No. 455,880, dated July 14, 1891.

Application filed January 19, 1891. Serial No. 378,239. (No model.)

To all whom it may concern:

Be it known that I, EDWARD A. JONES, a subject of the Queen of Great Britain, residing at Tonawanda, in the county of Erie and State of New York, have invented a new and useful Improvement in Machines for Making Metal Balls, of which the following is a specification.

This invention relates to a machine by which metallic balls are made from rods or bars of metal by rolling or swaging portions of such rods or bars between movable dies. Heretofore these dies have been made straight and have had a rectilinear movement in opposite directions, or they have been made curved and mounted upon the cylindrical faces of disks rotating in opposite directions. A straight die moving in a rectilinear path has also been combined with a curved die moving in a circular path.

My invention has particular reference to a machine in which two curved dies are mounted upon rotating disks and has the object to improve the construction of such a machine, so as to compact or condense the metal more thoroughly and to produce balls of more true or exact spherical form.

In the accompanying drawings, consisting of three sheets, Figure 1 is a longitudinal sectional elevation of my improved ball-forming machine. Fig. 2 is a top plan view thereof. Fig. 3 is a cross-section thereof in line x x, Fig. 1. Fig. 4 is a face view of one of the die-carrying disks. Fig. 5 is a fragmentary elevation of one of the disks and the gage for the blank. Fig. 6 is a fragmentary section showing the blank between the opposing dies. Fig. 7 is a detached view of the swaging-dies, showing their position preparatory to seizing the blank. Fig. 8 is an elevation of one of said dies. Fig. 9 is a longitudinal section thereof. Fig. 10 is a face view thereof. Figs. 11, 12, 13, and 14 are transverse sections of the opposing dies, showing the progressive steps in forming the balls. Fig. 15 is a view of a ball before it is finished.

Like letters of reference refer to like parts in the several figures.

A represents the main frame of the machine, consisting, essentially, of a top plate a, side pieces a', cross-pieces a^2, and legs a^3.

B represents the main driving-shaft, arranged lengthwise in the frame underneath the top plate and journaled in bearings a^4, secured to the cross-pieces a^2, and a standard a^5, arranged adjacent to one end of the main frame.

C C′ represent tight and loose pulleys arranged on the shaft between the standard and the main frame.

D D′ represent two die-carrying disks arranged transversely in the main frame with their flat opposing faces separated a suitable distance. The disks are provided on their rear sides with stub-shafts E E′, journaled, respectively, in bearings e e' e^2 e^3, secured to the top plate of the main frame. These stub-shafts are arranged in line with each other and are surrounded by split conical sleeves e^4, which are adjustably arranged in the bearings to take up wear.

F represents a gear-wheel keyed to the shaft E of the disk D between its bearings e e' and meshing with a pinion f on the main driving-shaft, whereby the disk D is rotated directly from the driving-shaft.

G is a gear-wheel keyed to the shaft E′ of the disk D′ between its bearings e^2 e^3, and meshing with an idler gear-wheel g, mounted on a longitudinal shaft g', journaled in the main frame. This idler meshes with a pinion g^2 on the driving-shaft, whereby the disk D′ is rotated in a direction opposite to that of the disk D.

H represents thrust-bearings arranged on the outer ends of the disk-shafts, whereby the disks are held against backward movement. Each of these bearings is provided with an annular row of balls h, arranged in a cup or recess h' in the outer end of each shaft, and a follower h^2 bearing against said balls. Each follower is provided on its outer side with a screw-threaded shank arranged in a bracket h^3, secured to the adjacent bearing and provided with a jam-nut h^4, whereby the follower can be adjusted.

I represents thrust-rollers whereby the outer portions of the die-carrying disks are held against backward movement. These rollers are journaled in brackets i, secured to the top plate, and bear against the rear side of the disks on opposite sides of each shaft. These brackets are adjustably secured to the top plate by means of bolts i', passing through slots i^2, formed in said brackets.

I′ represents an intermediate ball-bearing arranged between the adjacent inner ends of the disk-shafts, whereby the disks are prevented from approaching each other. This bearing consists of a cup i^3, an annular row of balls i^4, arranged in said cup, and a follower i^5 bearing against the balls. The cup and the follower are each provided with a screw-threaded shank which engages in a screw-threaded opening in the adjoining disk-shaft. By means of these adjustable ball-bearings at the outer and inner ends of the disk-shafts the end-thrust of the disk-shafts is relieved and the disks can be easily adjusted longitudinally in the machine.

J J′ represent the dies whereby the blank is rolled and swaged into a spherical form. These dies are secured in pairs to the flat opposing sides of the disks, so that the working-faces of each pair of dies move past each other in opposite directions. Each of the dies consists of a steel bar curved concentric with the disk-shaft and arranged with its back between two concentric ribs j j', formed on the front side of the disk, as represented in Fig. 4.

j^2 represents adjusting-screws arranged horizontally in the die, between the ribs j j', and bearing against the back of the die, for adjusting the same horizontally toward and from the opposing die.

j^3 represents set-screws arranged radially in the outer rib j' and engaging against the outer side of the die, whereby the latter is clamped against the inner rib j and secured in position after adjustment.

The working-face of each die is arranged nearly in a plane at right angles to the axis of rotation and is constructed as follows: A semicircular groove K is first cut into the face of a curved steel bar having the same thickness throughout its length. This groove commences at the front end l of the bar and rises rearwardly with reference to the base-line or back L of the bar to the point l', which is located about one-fifth of the length of the bar from the front end, and then falls with reference to the base-line to the rear end l^2 of the bar, thereby forming a groove composed of an ascending front portion m and a descending rear portion m'. The inclination of the ascending front portion m of the groove is very slight and that of the descending rear portion is about the same. The projecting portions of the bar forming the inner curved face portion m^2 and the outer concentric face portion m^3 on opposite sides of the groove are next ground down, so that the face of the die gradually rises from the front end toward the rear end. The die-face is ground down to about one-half of the depth of the groove and parallel with the bottom of the latter from the front end of the die to the summit l' of the groove. Beyond this point the die-face is ground so that it rises gradually in a curve to the point n, which is located about one-fifth of the length of the die from the rear end, and from there the die-face continues to the end parallel with the base-line of the die.

M represents a V-shaped rest for supporting the blank as it is fed between the dies. This rest is secured upon the front portion of the top plate between the dies.

M′ represents a stop or gage whereby the inward movement of the blank is limited as the latter is fed between the dies. This gage is secured to the flat face of one of the disks opposite the front end of its die, and is made adjustable by means of slots m^4, through which the fastening-bolts m^5 pass. The front ends of the dies are rounded to permit the blank to enter between the dies, and the face of each die is of sufficient width on each side of the groove to enable the dies to firmly grasp the blank on opposite sides of the groove, as represented in Figs. 5 and 11.

The bar or blank is heated and placed on the rest. When the gage arrives opposite the rest, the blank is pushed against the gage and the dies then seize the blank. As the dies rotate past each other their faces gradually approach each other, and force the metal into the grooves of both dies. The flat faces outside of the groove seize the blank as soon as the front ends of the dies arrive opposite each other, and grasp the blank so firmly that they crowd the metal inwardly and force it into the groove from the beginning of the operation, instead of spreading the metal, which takes place when the front portions of the dies are narrow and have a rearwardly-diverging form. During the rotation of the dies the bar between them is rolled and twisted, but remains practically at the point where it was introduced between the dies until it is finished into a ball. When the dies are rotated so that the summits l' of both grooves stand opposite each other, the bar is pressed or swaged to such an extent that the metal is in contact with the bottom of the groove, as represented in Fig. 12, and completes the equator o of the ball. During the subsequent rotation of the dies the projecting die-faces continue to approach each other and the depth of the groove increases in proportion. This causes the dies to crowd the metal into the groove and increases the spherical form of the ball. When the dies have rotated so that the highest points n of the faces stand opposite each other, the ball is twisted or pinched off from the bar, as represented in Fig. 13, which leaves the ball with two projecting poles p p', as represented in Fig. 15. The preliminary formation of the ball is effected by the pressure of the dies against the equatorial side of the ball, which causes the ball to revolve or roll at right angles to the rotation of the dies. During the final operation of the dies from the point n to the end of the die the projecting poles of the ball are removed and the ball is delivered from the dies in a perfect spherical form, as follows: The die being curved concentric with the axis of rotation, the outer curved wall of its groove extends over a greater distance than its inner wall, which is arranged nearer the axis of the dies. The lineal difference between the outer and inner walls of the groove causes the ball to be rotated on an axis parallel with the axis of the dies, or at right angles to the axis on which the ball rotated before it was severed from the bar. The ball in being so rotated both by the opposing faces of the dies in one direction and in another direction by the difference in the length and speed of the groove-walls receives a spiral movement, which causes the ball to present all parts of its surface to the action of the dies, thereby enabling the latter to remove the poles or projections and producing a ball of perfectly-spherical form. This spiral movement is retarded when the ball is in contact with the bottom of the grooves, which produce a uniform pressure on all sides of the ball. To avoid this the grooves are cut sufficiently deep from the point n to the rear end of the dies to form a clear space q between the bottom of each die and the ball, as represented in Fig. 14, which enables the side walls to exert a greater influence in rotating the ball. In order to increase the spiral movement of the ball in finishing the same, the rear portion r of the face of one die projects beyond the center line of the groove toward the opposite die, and the rear portion r' of the face of the opposing die recedes to the same extent, as represented in Fig. 14. This produces a bearing for the outer and inner parts of the ball in the same die and in a line passing diametrically through the ball.

The rear end of the groove in each die is rounded off, so as to avoid marking or indenting the balls as they issue from the dies.

As represented in Fig. 4, each disk is provided with two dies, forming two pairs of dies. By increasing the size of the disks a larger number of dies may be employed and the product of the machine be correspondingly multiplied.

I claim as my invention—

1. The combination, with two disks arranged in line and rotating in opposite directions, of ball-forming dies secured to the opposing sides of the disks and provided with curved grooves formed in the opposing flat sides of the dies, substantially as set forth.

2. A ball-forming die having a curved groove in which the outer side of the groove has a longer radius than the inner side, and flat faces beginning at the front end of the die on both sides of the groove and extending to the rear end of the die, substantially as set forth.

3. A ball-forming die having a groove which ascends from the front end of the die to a summit point and descends from said point to the rear end of the die, substantially as set forth.

4. The combination of two curved dies rotating about the same axis and each provided with a curved groove in its flat side, one of said dies being provided in its rear portion with side faces which project toward the other die beyond the center line of the groove and the other die being provided in its rear portion with correspondingly-receding side faces, substantially as set forth.

5. In a ball-forming machine, the combination, with two revolving disks arranged axially in line, of opposing dies secured to the faces of said disks, substantially as set forth.

6. In a ball-forming machine, the combination, with two revolving disks arranged axially in line, of curved dies secured to said disks and having their working-faces arranged about at right angles to the axis of the disks, substantially as set forth.

7. In a ball-forming machine, the combination, with two revolving disks arranged axially in line, of dies secured to the faces of said disks, and a gage whereby the inward movement of the blank between the dies is limited, substantially as set forth.

8. In a ball-forming machine, the combination, with the two revolving disks arranged axially in line, of dies secured to the faces of said disks, and a gage secured to the face of one of said disks opposite the front end of the die, substantially as set forth.

9. In a ball-forming machine, the combination, with the main frame, of two revolving disks arranged axially in line and journaled in bearings on the main frame, dies secured to the faces of the disks, and thrust-rollers bearing against the rear sides of said disks, substantially as set forth.

10. In a ball-forming machine, the combination, with two revolving disks arranged axially in line, of dies secured to the faces of the disks, and a thrust-bearing interposed between the faces of the disks, substantially as set forth.

11. In a ball-forming machine, the combination, with two revolving disks arranged axially in line, and dies secured to their flat faces, of a cup provided with a threaded shank which enters one of said disks, a follower provided with a threaded shank which enters the other disk, and balls interposed between the follower and the cup, substantially as set forth.

12. In a ball-forming machine, the combination, with the main frame, of two revolving disks arranged axially in line and provided with shafts journaled on the main frame, and thrust-bearings engaging with the ends of the shafts, whereby the end-thrust of the disks is relieved, substantially as set forth.

13. In a ball-forming machine, the combination, with two revolving disks mounted upon shafts arranged axially in line and having dies secured to their flat faces, of a main

frame in which said shafts are journaled, and thrust-bearings composed of brackets extending over the ends of the shafts, screw-followers working in said brackets, and balls interposed between said followers and recessed rests in the ends of the shafts, substantially as set forth.

Witness my hand this 12th day of January, 1891.

EDWARD A. JONES.

Witnesses:
F. C. GEYER,
ALICE G. CONNELLY.