2 Sheets—Sheet 1.

J. L. KNOWLTON.

MACHINE FOR ROUNDING AND POLISHING BALLS.

No. 49,122. Patented Aug. 1, 1865.

Fig. 6.

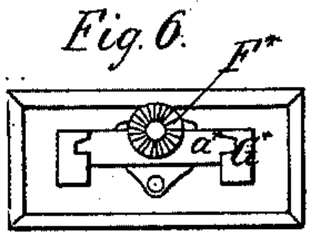


Fig. 4.

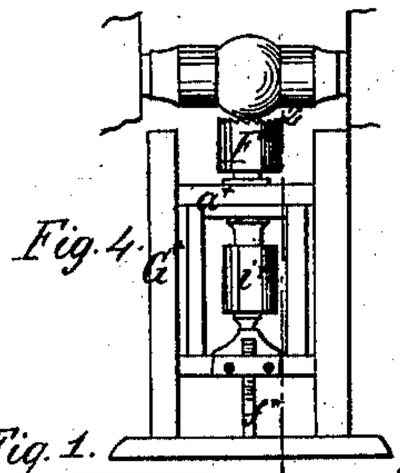


Fig. 5.

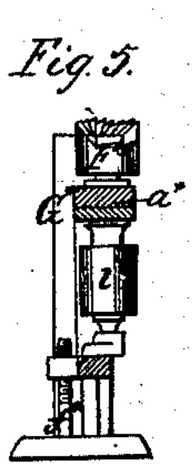
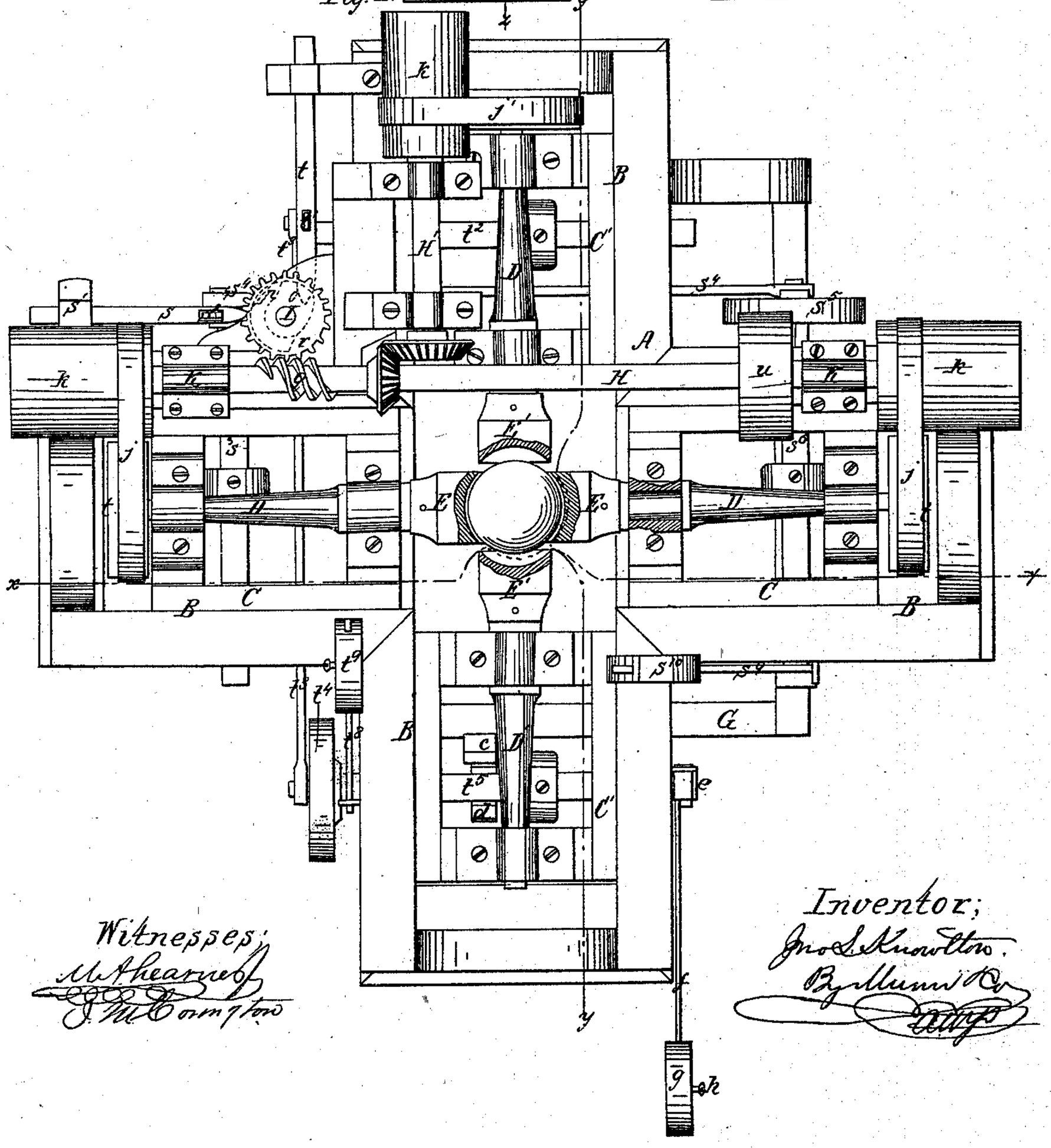


Fig. 1.



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By Munn & Co
Attys

2 Sheets—Sheet 2.

J. L. KNOWLTON.

MACHINE FOR ROUNDING AND POLISHING BALLS.

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Fig. 2.

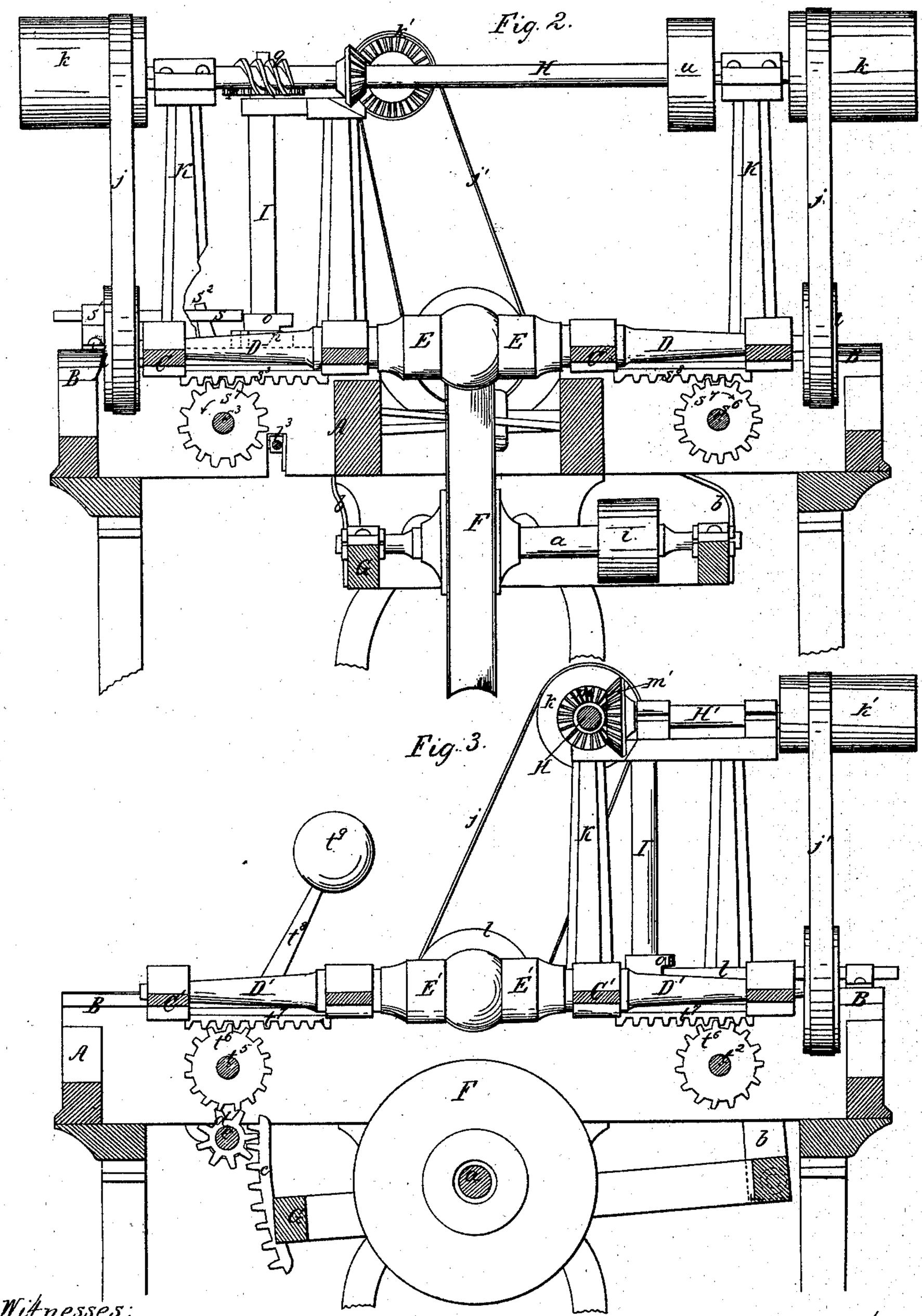

Fig. 3.

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UNITED STATES PATENT OFFICE.

JOHN LOPER KNOWLTON, OF PHILADELPHIA, PENNSYLVANIA.

IMPROVED MACHINE FOR ROUNDING AND POLISHING BALLS.

Specification forming part of Letters Patent No. **49,122**, dated August 1, 1865.

To all whom it may concern:

Be it known that I, JOHN LOPER KNOWLTON, of the city and county of Philadelphia, and State of Pennsylvania, have invented a new and Improved Machine for Rounding and Polishing Balls, &c.; and I do hereby declare that the following is a full, clear, and exact description thereof, which will enable others skilled in the art to make and use the same, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 represents a plan or top view of this invention. Fig. 2 is a transverse vertical section of the same, taken in the plane indicated by the line *x x*, Fig. 1. Fig. 3 is a similar section of the same, the plane of section being indicated by the line *y y*, Fig. 1. Fig. 4 is a detached front elevation of a milling-tool used in turning balls. Fig. 5 is a transverse vertical section, the line *z z*, Fig. 4, indicating the plane of section. Fig. 6 is a plan or top view of the same.

Similar letters of reference indicate like parts.

This invention consists of a machine composed of four (more or less) different longitudinally-sliding rotary mandrels radiating from a common center and provided with chucks at their inner ends, in combination with suitable mechanism to force these chucks alternately up against the ball to be turned or ground and with a milling-tool or grinding-wheel in such a manner that two of the chucks will clamp the ball at a time, and the ball is thereby turned in either direction, while the grinding-wheel or milling-tool is held in contact with the surface of the ball by means of one or more screws, or by an adjustable weight. The force with which the grinding-wheel or tool is forced against the surface of the ball can thus be regulated at pleasure. The position of the revolving chucks and the time when the same grasp the ball are governed by a double cam and weights or springs, and said chucks are so shaped that they grasp the general surface of the ball, and that cavities and projections occurring on the surface of said ball will not be able to disturb the correct central position of the same.

A represents a frame, made of cast-iron or any other suitable material, in form of a cross, with four (more or less) guideways, B, radiating from a common center. These ways form the guides for carriages C C′, which form the bearings for mandrels D D′, as clearly shown in Fig. 1. Each of these mandrels carries on its inner end a chuck, E or E′, which is made in the form of a cup, to fit the surface of the ball to be turned, ground, or polished, and these chucks are connected to the mandrels so that they can be readily replaced by others made to fit balls of different diameters.

The tool which acts on the surface of the ball may either be a milling-tool, F*, such as shown in Figs. 4, 5, and 6, or it may be a grinding-wheel, F, such as shown in Figs. 2 and 3. The wheel F is mounted in a shaft, *a*, which has its bearings in a secondary frame, G, and this frame is hinged at one end to hangers *b*, suspended from the main frame A, as shown in Fig. 3, so that the front end of the same is free to swing up and down, and the grinding-surface of the wheel F can be forced up to the surface of the ball or removed therefrom at the pleasure of the operator.

The position of the swinging frame G is regulated by a toothed segment, *c*, which is secured to its loose end, and gears in a pinion, *d*, mounted on a shaft, *e*, which has its bearings in the lower part of the main frame A. One end of said shaft passes through the frame and bears a lever, *f*, to which a weight, *g*, is attached, by means of a set-screw, *h*, as shown in Fig. 1, so that it can be adjusted closer to or farther from the fulcrum of the lever *f*, and the power which forces the working-face of the wheel up against the ball is decreased or increased as circumstances may make it desirable.

The wheel F is used more particularly for grinding or polishing, and its working-face is hollowed out to correspond to the balls to be ground. It is attached to its shaft so that it can be readily replaced by another the face of which corresponds to balls of a larger or smaller diameter. The shaft *a* receives a rapid rotary motion by means of a belt stretched over a pulley mounted on the same, as shown in Fig. 2. If the milling-tool F* is to be used, the hinged frame G and the grinding-wheel are removed and the frame G*, Fig. 4, is adjusted under the ball in the proper position. This frame forms the guideways for the carriage C*, in which the vertical shaft *a** has its bearings, and attached to the top of this shaft is the milling-tool, as clearly shown in Figs.

4 and 5. A rotary motion is imparted to said shaft by a belt stretched round a pulley, i^*, and a set-screw, f^*, serves to set up the working-face of the milling-tool against the ball to be turned.

The secondary frame G* may either be made separate from the main frame A or it may be connected thereto, and it may be situated above or below said main frame.

The position of the ball in relation to the grinding or cutting tool is continually changed by the action of the chucks E E′. The mandrels D, on which the chucks E are mounted, receive a continuous rotary motion by means of belts j extending from the drums k on the driving-shaft H over pulleys l mounted on the ends of the mandrels D. Whenever the chucks E are brought to grasp the ball, therefore, said ball is compelled to revolve either in the direction in which the grinding-wheel revolves, but much slower than the same, or in the direction opposite to said grinding-wheel, as may be most desirable. At certain stated intervals the chucks E release the ball, and the chucks E′ are caused to grasp the same and turn it in a direction transversely to the working-face of the grinding-wheel or at right angles to the motion imparted to it by the chucks E. In order to effect this purpose a direct rotary motion is imparted to one or both of the mandrels D′ by a belt, j', extending from a drum, k', over a pulley mounted on the end of said mandrel, as shown particularly in Figs. 1, 2, and 3.

The drum k' is mounted on a shaft, H′, to which motion is imparted from the driving-shaft H by means of a bevel-gear, m m', or by any other equivalent means.

The motion of the chucks E E′ toward and from the surface of the ball is governed by two cams, o p, mounted on a vertical arbor, I, to which a slow rotary motion is imparted from the driving-shaft by means of an endless screw, q, and worm-wheel r. The cam o, which is situated close over the cam p on the shaft I, acts on a toe, s, and through it on the carriages C, which form the bearings for the mandrels D, and the cam p acts on a toe, t, and through it on the carriages C′, which form the bearings for the mandrels D′. The toe s slides back and forth toward and from the cam o in a bracket, s', secured to the main frame A, and it is pivoted to the upper end of a lever, s^2, which is mounted on the end of a rock-shaft, s^3, and connects by a rod, s^4, with an eccentric wrist-pin projecting from the face of a disk, s^5, which is mounted on a rock-shaft, s^6. These two rock-shafts have their bearings in the frame A under the carriages C, and each of them bear a pinion, s^7, which gears in a toothed rack, s^8, secured to the carriages C, as clearly shown in Fig. 2. The rock-shaft s^6 passes clear through the frame A and mounted on its end opposite to the disk s^5 in the lever s^9, to which an adjustable weight, s^{10}, is secured by a set-screw or any other suitable means. By the action of this weight the point of the toe s is held in contact with the surface of the cam o, and the chucks E are made to grasp the ball until the high portion of the cam comes opposite the end of the toe and causes the same to recede. As soon as this takes place the pinions s^7 rotate in the direction of the arrows marked thereon in Fig. 2, and the chucks E are caused to release the ball.

The toe t is arranged precisely like the toe s, and it is connected to a lever, t', which is mounted on a rock-shaft, t^2, and connects by a rod, t^3, with an eccentric wrist-pin secured in a disk, t^4, which is mounted on the end of a rock-shaft, t^5. The rock-shafts t^2 and t^5 extend through the frame A under the carriages C′, and pinions t^6, mounted on them, gear into toothed-racks t^7, which are secured to the carriages C′, as clearly shown in Fig. 3. A lever, t^8, which is mounted on the rock-shaft t^5, bears an adjustable weight, t^9, which holds the point of the toe t in contact with the cam p. When the high portion of this cam is opposite the point of the toe the chucks E′ are forced back from the surface of the ball, but when the low portion of said cam comes opposite the point of the toe the weight t^9 forces the chucks E up against the ball and causes them to grasp the same.

The cams o and p are so situated in relation to each other that when the high portion of the cam o is opposite the point of the toe s the low portion of the cam p is opposite the toe t, and vice versa, and it will be noticed, by referring to Fig. 1, where the said cams are shown in dotted lines, that the high portion of the cam p extends nearly two-thirds round, whereas the high portion of the cam o is very short. From this it follows that the chucks E hold the ball for the largest portion of the revolution of the shaft I, whereas the chucks E′ are allowed to grasp the same for a short time only, when it is released by the chucks E. The object of this arrangement is to impart to the ball a nearly continuous rotary motion in the plane in which the grinding-wheel revolves by the action of the chucks E, and to change the position of said ball occasionally in a direction at right angles with the plane in which the grinding-wheel rotates by the action of the chucks E′.

By the combined action of the chucks E E′ the position of the ball in relation to the grinding-surface of the wheel or to the cutting-surface of the milling-tool is continually changed, and a perfectly round and true ball is produced. The chucks grasp the general surface of the ball and keep the same in the center without reference to small projections or cavities which may occur in the rough ball. The weights g, s^{10}, and t^9 may be replaced by springs, and the mechanism may be changed in various minor details without changing the result. The driving-shaft has its bearings in standards K, rising from the frame A, and motion is imparted to it by a belt running on the pulley u, or in any other suitable manner.

This machine is particularly intended for

grinding shot and shell, and it can be used with great advantage for turning, grinding, and polishing balls of any other description.

I claim as new and desire to secure by Letters Patent—

1. The method herein described of imparting to the ball while being ground or turned an intermittent rotary motion in two or more directions by means of four (more or less) longitudinally-sliding rotary mandrels, D D′, radiating from a common center, and provided with chucks at their inner ends, or any other equivalent means, constructed and operating substantially as and for the purpose set forth.

2. The combination of four (more or less) chucks, E E′, made to grasp the work at stated intervals, with a grinding-wheel or milling-tool applied and operating substantially as and for the purpose described.

3. The combination of the segmental rack *c*, pinion *d*, shaft *e*, and weighted lever *f g*, arranged and operating, in connection with the pivoted frame G and polishing-wheel F, in the manner described, to regulate the pressure of the said wheel against the ball to be polished.

4. The cams $\overline{o}$ *p* and toes *s t*, in combination with the carriages C C′, chucks E E′, and weighted levers s^9 t^8, or their equivalents, constructed and operating substantially as and for the purpose described.

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