

(No Model.)

2 Sheets—Sheet 1.

R. CONRADER.

MACHINE FOR GRINDING SPHERICAL OR OTHER SURFACES.

No. 513,631.

Patented Jan. 30, 1894.

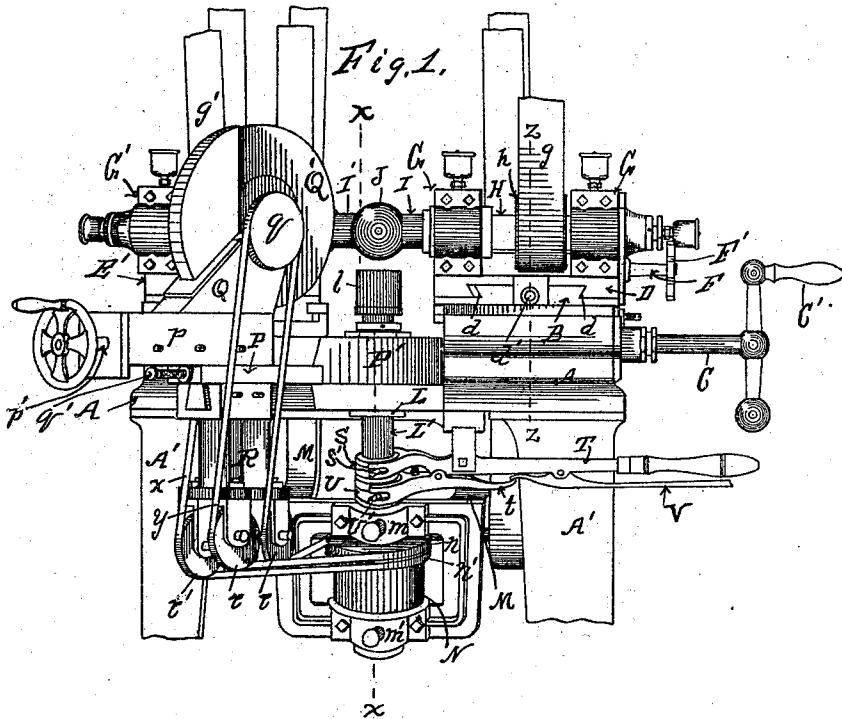
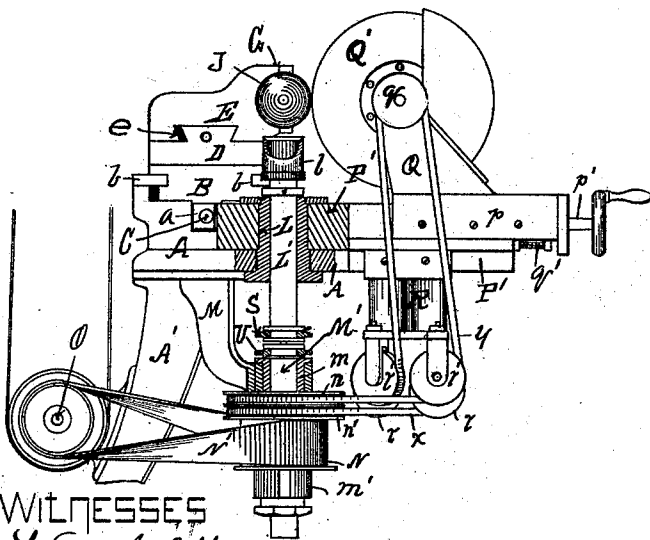


Fig. 2.

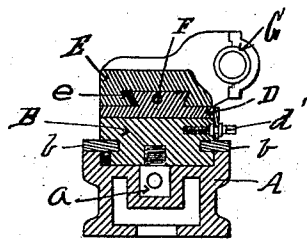


WITNESSES

F. Einfeldt.

A. L. Jackson

Fig. 6.



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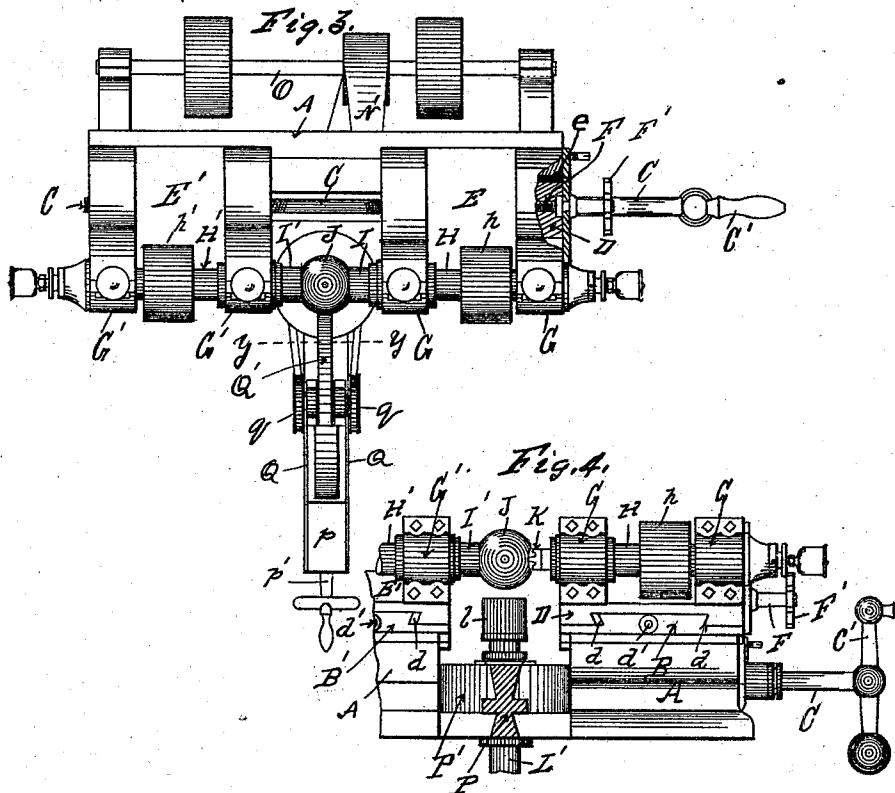


Fig. 7.

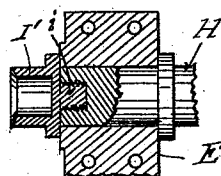
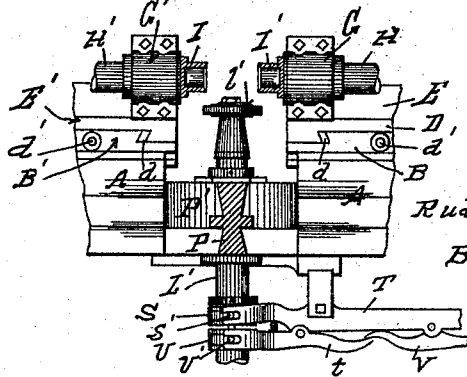


Fig. 5.



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# UNITED STATES PATENT OFFICE.

RUDOLPH CONRADER, OF ERIE, PENNSYLVANIA.

## MACHINE FOR GRINDING SPHERICAL OR OTHER SURFACES.

SPECIFICATION forming part of Letters Patent No. 513,631, dated January 30, 1894.

Application filed July 11, 1892. Serial No. 439,725. (No model.)

*To all whom it may concern:*

Be it known that I, RUDOLPH CONRADER, a citizen of the United States, residing at the city of Erie, in the county of Erie and State of Pennsylvania, have invented certain new and useful Improvements in Machines for Grinding Spherical or other curved Surfaces; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, forming part of this specification.

My invention consists in the improvements in machines for grinding spherical and other curved surfaces hereinafter set forth and explained, and illustrated in the accompanying drawings, in which—

Figure 1, is a perspective view of my improved machine for grinding spherical and other curved surfaces. Fig. 2, is a vertical transverse section of the same, on the line  $x, x$ , in Fig. 1. Fig. 3, is a top or plan view of the same. Fig. 4, is a longitudinal section of the same on the line  $y, y$ , in Fig. 3. Fig. 5, is a vertical longitudinal section of a portion of the machine, on a line coincident with the centers of the ball chucks thereof, showing an arrangement of mechanism for grinding the ball chucks to like centers. Fig. 6, shows a detail of a portion of the machine in section on the line  $z, z$ , in Fig. 1. Fig. 7, is a detail view of a portion of the machine in section.

The object of my invention, is to construct a machine, adapted primarily for grinding and polishing balls of ivory, wood and other non-metallic materials, though it can be utilized for turning and grinding balls of metal if desired.

In the construction of my improved machine for grinding spherical and other curved surfaces shown in the drawings, A, is the bed of the machine frame, and A', A', the legs thereof. On the ends of this frame are mounted carriages B, B', adapted to move longitudinally in gibs or ways  $b b$  on the frame A. On the carriages B and B' are downwardly projecting lugs or nuts  $a$  through which a screw shaft C passes provided with a right

hand thread on one end thereof, and a left hand thread on the other, which threads operate in the nuts  $a a$  on the carriages B and B' so that the rotation of the screw shaft C by means of the crank C' thereon operates to move the carriages B and B' simultaneously toward or away from each other an equal distance toward or from the center of the machine, according to the direction the screw shaft C is rotated. Upon the carriage B is mounted a plate D, adapted to move transversely on gibs  $d$  thereon, this transverse movement being adjusted by means of a screw  $d'$ . Upon the plate D on the carriage B is mounted a third section E of the carriage, which is adapted to be moved longitudinally on ways  $e$  on the plate D, by means of a screw F and hand wheel F' thereon, so that the section E of the carriage can be moved longitudinally on the plate D, as and for the purpose hereinafter set forth. In the construction of the carriage B' the section E' thereof operates by means of an adjusting screw  $d'$  directly on the transverse gibs  $d$  on the carriage B' without the intervention of an adjustable section or plate, like the section or plate D, upon which the carriage section E is mounted in the carriage B, so that the carriage section E' is not longitudinally adjustable on the carriage B'; these carriage sections E and E' are provided with shaft bearings G and G' G' in which are mounted longitudinal shafts H and H' having pulleys  $h$  and  $h'$  thereon, adapted to receive driving belts  $g$  and  $g'$ . On the inner ends of the shafts H and H', are placed removable chucks I I', adapted to clamp a ball J between them, or when desired, centers K can be used in place of the chucks I and I', as illustrated in Fig. 4. By means of this construction a ball J, may be clamped and held between the chucks I and I', or between centers in lieu thereof, exactly central. When, however, it is desired to cut out a chipped spot or other defect in one side of a ball, without cutting away so much of the ball, as to unduly reduce its size, I move back longitudinally the section E of the carriage B, by means of the adjusting screw F. The ball may then be clamped between the chucks or centers with the defective side thereof, within the chuck I, the center of the ball being then sufficiently to one

side of the center of rotation of the arm P, upon which the grinding carriage hereinafter described is supported to cut out the defect therein, and when the surface of the ball so mounted, is turned off between the chucks, it is removed and the section E of the carriage is moved back to its normal position, and the ball then again clamped by its opposite sides between the chucks, so that its center longitudinally coincides with the center of rotation of the arm P and the remainder thereof which was covered by the ball chucks during the first operation, is then turned off, completing it. When, however, the chip in the ball to be turned is so large that it interferes with the proper clamping of it between the chucks, a center K is used to hold the chipped end of the ball, until it is turned in one direction, when it is removed, and the ball chuck put in its place, so that the ball can be clamped between them.

Centrally between the ends of the frame bed A, is secured therein a sleeve bearing L, which projects over the top of the frame A. In this bearing a vertical shaft L' operates the upper end of which is adapted to receive a grinding or finishing tool *l*, or a chuck grinding tool *l'* as desired.

From the underside of the rear of the frame bed A are arms M which project downward and curve forward at each side of the lower end of the vertical shaft L' where they are connected together, and are provided with bearings *m*, *m'*, supporting a vertical shaft M' directly under the lower end of the shaft L'. A driving pulley N having pulleys *n*, *n'* secured thereto, is mounted on said shaft M' between the bearings *m*, *m'*, and connected therewith by means of an ordinary spline and groove (not shown), so that the shaft M' can be raised and lowered, as and for the purpose hereinafter set forth. Power is communicated to the driving pulley N by means of a belt N' from a counter shaft O at the rear of the machine.

On the top of the frame bed A is an arm P provided with a bearing P' which surrounds and swings on the outside of the sleeve shaft-bearing L. On this arm P is mounted a tool carriage *p* adapted to be moved in and out on ways (not shown) thereon, by means of a screw shaft *p'* in the usual manner. On this tool carriage *p* are arms Q in which is mounted a rotating grinding tool Q', having pulleys *q* on the ends of the shaft thereof. Adjustably secured to the arm P and projecting downward therefrom is an arm R having on the lower portion thereof idle pulleys *r*, *r'*, *n*, *n'* around which the belts *x* and *y*, from the pulleys *n* and *n'* run to the pulleys *q* on the shaft of the rotating grinding tool Q' and by means whereof it is driven. In the end of the arm P is an adjusting screw *q'* adapted to limit the inward movement of the carriage *p*.

On the lower end of the vertical shaft L' is a collar S, provided with trunnions S' which engage with the forked ends of a lever T piv-

oted to the machine frame, and on the upper end of the vertical shaft M' is a like collar U provided with trunnions U' which engage with the forked end of a lever *t* pivoted to the lever T. A second lever V is also pivoted to the lever T the inner end of which engages with the outer end of the lever *t*, so that the ends of the shaft L' and M' can be forced together and at the same time raised up so that the grinding or finishing tool *l* on the upper end of the shaft L' will contact with a ball J, held between the chucks I, I', the upper shaft L' being driven by the frictional contact of its lower end, with the upper end of the shaft M', but when lowered away from the ball to its normal position the ends of the shafts are far enough apart to be out of contact with each other.

In operation the rough ball is first clamped between the chucks I and I'. The rotating grinding tool Q' is then set up into contact with the ball and moved around radially until the portion of the ball outside of the chucks is removed. The ball is then taken out and clamped between the chucks by its opposite sides and the portion first covered by the chucks is in like manner removed. The finishing tool *l* is then raised up against the ball and it is polished or otherwise finished thereby as desired.

Having thus fully described my invention, so as to enable others to construct and operate the same, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. The combination in a machine for grinding spherical and other curved surfaces, of two shafts having chucks thereon, one of which shafts is capable of longitudinal adjustment to and from the common and fixed center between the ends of the same, with a grinding wheel mounted on a carriage adapted to travel in a semi-circular path around a ball held between the chucks on, and rotated by said shafts and pulley and belt mechanism on said carriage for driving said wheel and a driving pulley axially centered with relation to the vertical axis of motion of the grinding wheel carriage, so as to maintain said belts in driving connection in all positions, substantially as and for the purpose set forth.

2. The combination in a machine for grinding spherical and other curved surfaces, of a shaft operating in bearings on a laterally adjustable support mounted on a longitudinally movable carriage, with a shaft operating in bearings on a laterally and longitudinally adjustable support, mounted on a longitudinally movable carriage, ball chucks on the inner ends of said shafts, and means substantially as shown for simultaneously moving said carriages toward and away from each other, substantially as and for the purpose set forth.

3. The combination in a machine for grinding spherical and other curved surfaces, of two shafts having chucks thereon adapted to clamp and hold a ball between them, and a

grinding wheel traveling in a semi-circular path around a center coinciding with the center of the ball held between said chucks, with a vertical shaft having a rotating ball finishing tool on the upper end thereof central with and adapted to be brought into contact with a ball held between said chucks, substantially as and for the purpose set forth.

4. The combination in a machine for grinding spherical and other curved surfaces, of two horizontal shafts having chucks thereon adapted to clamp and hold a ball between them, with a vertical shaft mounted in the frame of the machine and having a grinding or finishing tool on the upper end thereof, and mechanism for driving, and lever mechanism for raising said shaft so as to bring the tool thereon into contact with a ball held between said chucks, substantially as and for the purpose set forth.

5. The combination in a machine for grinding spherical and other curved surfaces, of a vertical shaft consisting of sections L' and M' the upper section L' having a grinding or polishing tool on the upper end thereof, and the lower section having a driving pulley connected therewith, so that it will move longi-

tudinally therein, with levers connected with said shafts adapted to force the adjacent ends of the sections together so that motion is communicated by the lower section M' to the upper section L' and also to raise said shafts up so as to bring the tool on the upper section thereof into contact with the article to be ground, substantially as and for the purpose set forth.

6. The combination in one of the longitudinally moving carriages of a machine for grinding spherical and other curved surfaces, of a lower section B operating longitudinally in gibs or ways on the machine frame, a section as D operating transversely in gibs on the section B, with a section as E operating longitudinally on gibs on the section D, and a screw mechanism for adjusting said sections upon each other, substantially as and for the purpose set forth.

In testimony whereof I affix my signature in presence of two witnesses.

RUDOLPH CONRADER.

Witnesses:

F. EINFELDT,  
WM. P. HAYES.