No. 644,445. Patented Feb. 27, 1900.

F. NERZ.

GRINDING MACHINE.

(Application filed Dec. 29, 1897.)

(No Model.) 4 Sheets—Sheet 1.

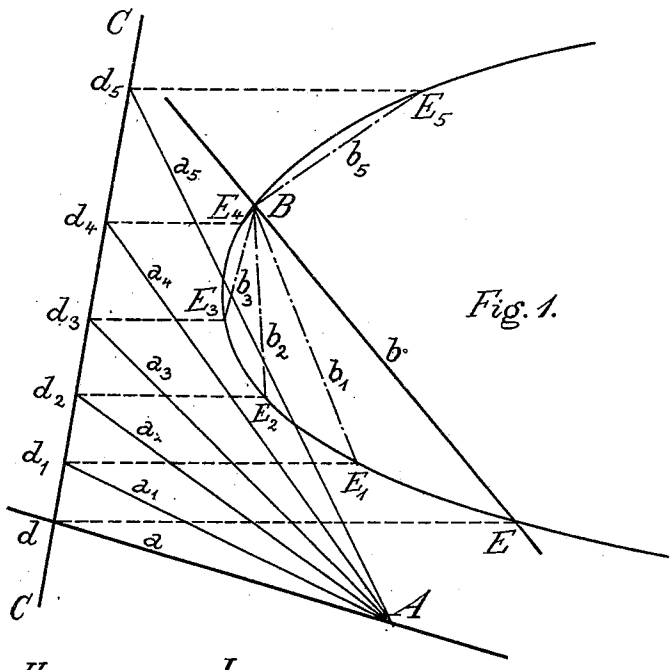


Fig. 1.

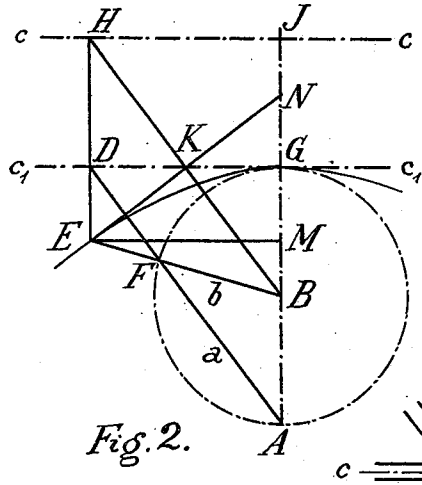
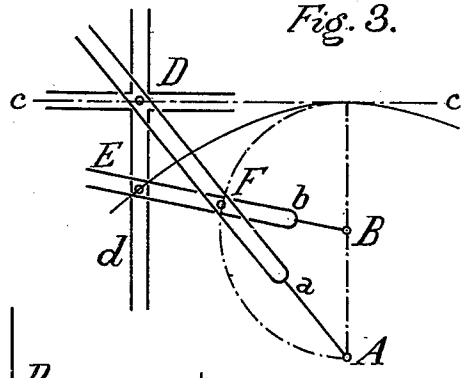


Fig. 2.

Fig. 3.



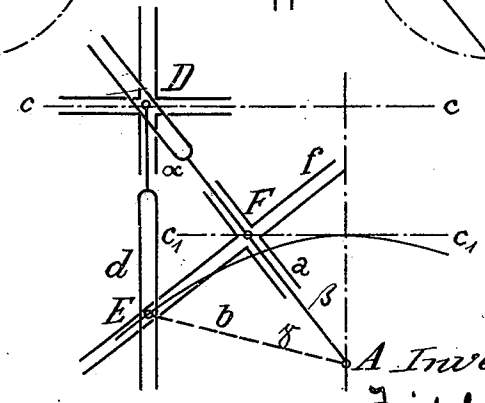


Fig. 4.

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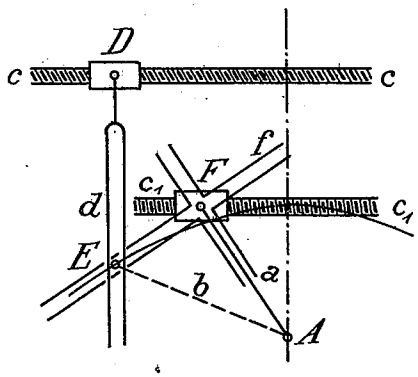


Fig. 5.

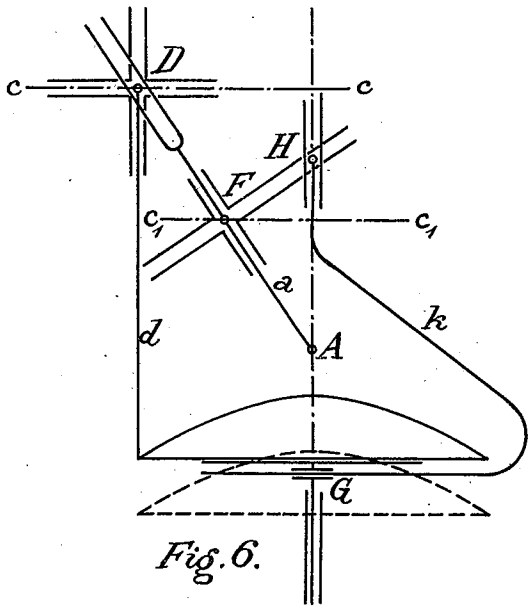


Fig. 6.

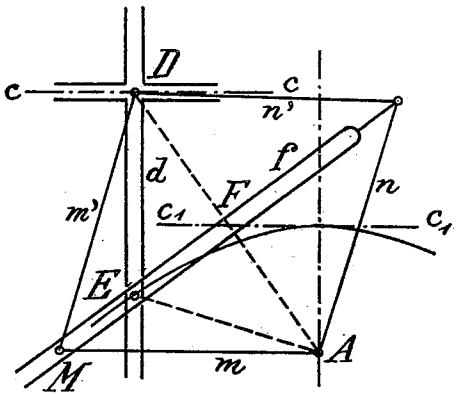
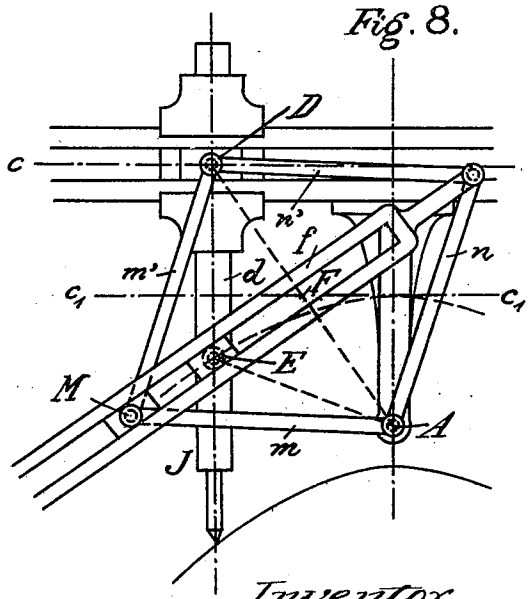


Fig. 7.

Fig. 8.



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(Application filed Dec. 29, 1897.)

(No Model.) 4 Sheets—Sheet 3.

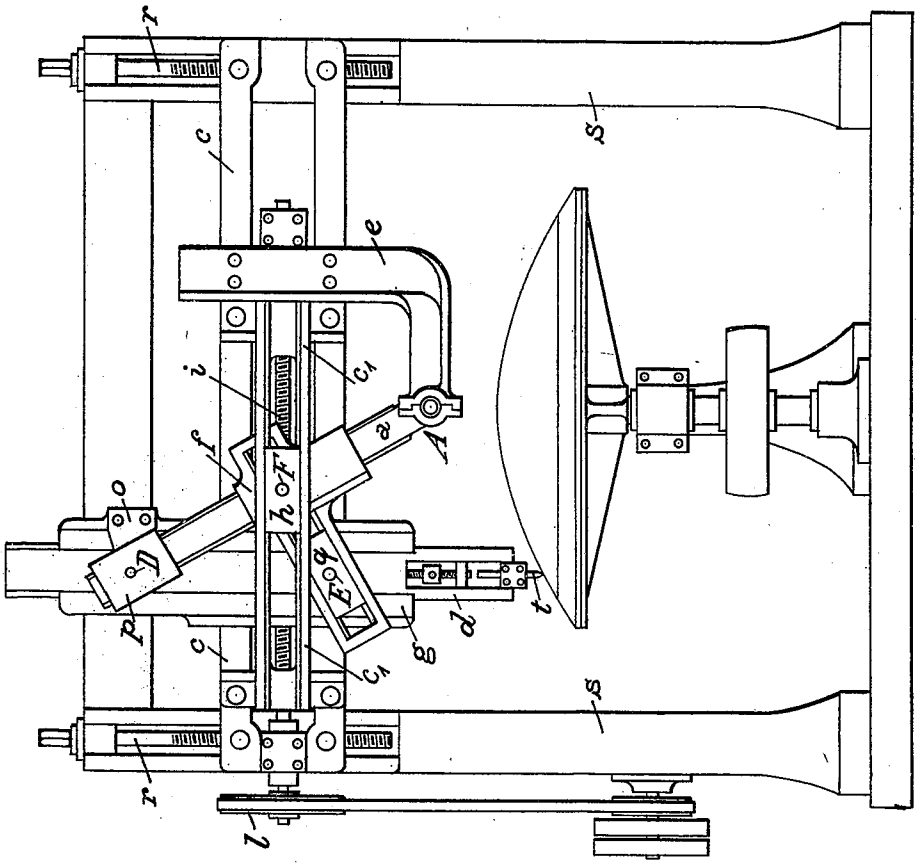


Fig. 9.

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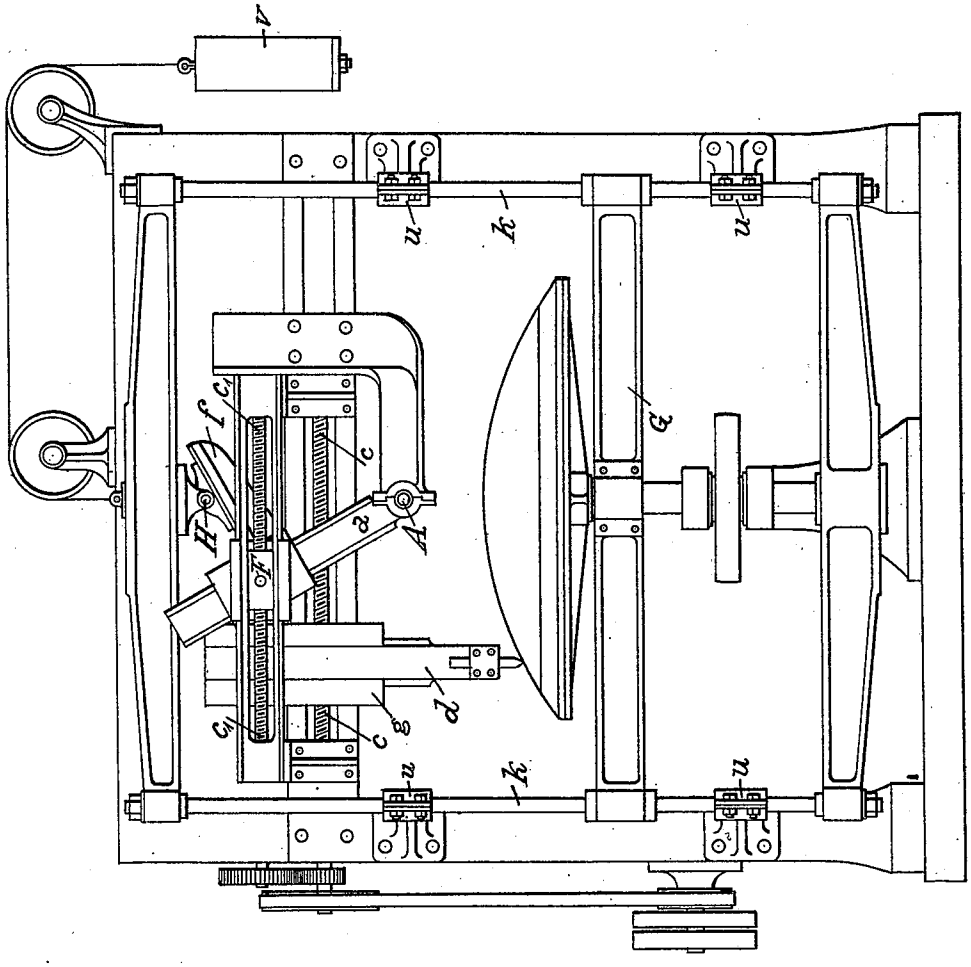


Fig. 10.

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UNITED STATES PATENT OFFICE.

FIDELIS NERZ, OF NUREMBERG, GERMANY.

GRINDING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 644,445, dated February 27, 1900.

Application filed December 29, 1897. Serial No. 664,311. (No model.)

To all whom it may concern:

Be it known that I, FIDELIS NERZ, engineer, a subject of the King of Bavaria, residing at Landgrafensstrasse, Nuremberg, in the Kingdom of Bavaria, German Empire, have invented a new and useful invention in Grinding-Machines for Parabolic Surfaces, of which the following is a specification.

The invention relates to apparatus for producing parabolic surfaces generated by the revolution of a parabola, and especially to that class of machines where the grinding-tool passes along the path of a parabola, while the material to be acted upon is rapidly rotated upon its own axis.

The invention particularly consists in arranging a sliding guide for the tool which whatever position the tool may assume is tangent to the surface to be generated, thus securing the most advantageous position thereof.

Figure 1 illustrates by a geometrical diagram the principle of the machine. Fig. 2 is another mathematical figure for special geometrical conditions. Figs. 3, 4, 5, and 6 show kinematical sketches of the mechanism used to produce a parabolic guide. Figs. 7 and 8 give a kinematical diagram and corresponding mechanism for a modification. Figs. 9 and 10 show complete machines corresponding to Figs. 4 and 5.

In order to have the invention fully understood, a few general geometrical principles may be explained, with reference to the accompanying drawings, before the apparatus which embodies the invention will be described.

When two straight lines a and b, Fig. 1 of the drawings, respectively turn upon points A and B in such a way that their angular velocities are in a constant proportion to each other—as, for instance, one is to two—and, further, a system of any number of parallel lines $d\ d_1\ d_2\ d_3\ d_4\ d_5$ are projected through the lines $a\ a_1\ a_2\ a_3\ a_4\ a_5$ upon their intersecting points with a fixed line C C, then the cutting points of this system with the corresponding lines $b\ b_1\ b_2\ b_3\ b_4\ b_5$ produce a parabola E E_1 E_2 E_3 E_4 E_5. Both the turning lines a and b are hereinafter termed "connecting-rods" a and b, respectively.

As the focus of the parabolic surface or shell to be ground must be known, the following suppositions are made for the geometrical construction which determine the position of the focus and the directrix—namely, first, that the third line $c\ c$, Fig. 2, is perpendicular to the connecting-line of both turning-points A and B, and, second, that at the beginning of the movement both connecting-rods and the connecting-line just mentioned cover each other. It results from well-known geometrical principles that when these suppositions are made, E, Fig. 2, is a point of the parabola, and E N a tangent thereof, as will be seen from the following explanations.

Referring to Fig. 2, the straight lines H J and D G are perpendicular to the connecting-line B G J, the lines G J = B G = A B = B F being equal to the radius r. By drawing a straight line B H through the center B and a perpendicular line H D from H, if the points A and D be united, it gives the point of intersection in F the circle described from center B, with the radius B G. The straight line B F E cuts off the point E on the perpendicular H D E. This point belongs to a parabola having its focus in B and its vertex in G. The angles A F B and D F E are equal, as well as the angles B A F and E D F. Therefore the triangles A B F and D E F must be similar to each other. Thence it follows that E F = D E, since A B = B F, and that B E = E H, as the line D H has been made equal to B F. It is obvious that the point E, because it is equidistant between the points B and H, belongs to a parabola having its directrix $c\ c$, its vertex G, and focus B. Supposing G M = x be the abscissa and E M = y the ordinate, if a perpendicular line is drawn through point E on the straight line B H—viz., E K N—the latter halves the line B H as well as D G, so that we have B K = H K and D K = G K. Owing to the fact that the triangles M E N and G K N are similar to each other, whence it follows that E M = D G = 2 G K, it is evident that the relation M N = 2 G M = 2 x must exist. M N is therefore the subtangent to the parabola-point E, and E N the tangent of the same, according to well-known geometrical principles.

In Figs. 3, 4, 5, 6, and 7 are shown the kinematic systems which result in producing the forms of mechanism involved in the machines shown in Figs. 9 and 10.

The reference-letters apply uniformly throughout.

Referring to Fig. 3, the points A and B are the turning-points of the connecting-rods a and b, shown as forked. D corresponds to the parallel system in Fig. 1, which is to be understood as a cross-piece capable of movement along a straight bed or rail parallel to itself. In order to obtain the desired proportion of the angular velocities—as, for instance, 1:2—a pin F is fixed in the connecting-rod b, so that it describes a circle, while the forked connecting-rod a slides upon this pin, as in Fig. 3. Under these conditions, as the one connecting-rod moves upon an angle drawn from the periphery and the other upon an angle drawn from the center of the same circle, then the proportion of the angular velocities must be constant—namely, in this case as one is to two—and consequently the point E describes a parabola.

A modification of the latter mechanism is shown in Fig. 4. The connecting-rod is removed and replaced by an equivalent element. Below the upper horizontal line $c\,c$ is arranged a second one $c_1\,c_1$, parallel thereto and equidistant between the upper line $c\,c$ and the central point A. A grinding cross-bar is movable on the line c_1 and also along the line of the connecting-rod a. It will be seen how this change is carried back to the first when it is considered that the right-angle triangles D F E and E F A are congruent, as D F is equal to F A and E F is equal to itself. Consequently angle $\alpha=\gamma$, but (as alternate angles are equal) also equal to β—that is, the connecting-rod a has to move half of the angle $\gamma+\beta$. This parabolic guide in Fig. 4 may also be directly produced, exactly as the former, if the continuation of the connecting-rod a is removed, as shown in Fig. 5, and the horizontal movement of both D and F is brought about by means of the two screw-spindles c and c_1 of equal pitch, c making twice the revolutions of c_1, or both screw-spindles having equal revolutions, but c having double the pitch, so that the nut and pin D would move twice the distance of the nut and pin F. The employment of the bed or rail f has a special advantage, inasmuch as f is a tangent to the parabola and grinding-tool. The latter works most advantageously in a normal or right-angle position to the surface to be ground and should be so placed.

When the grinding-machine is used for grinding small objects, such as lenses, it may be advantageous to raise or lower the material acted upon while the tool moves in a straight line. This leads to the construction shown in Fig. 6, wherein the raising and lowering are effected by a circular guide rod or arm k, attached to the point H and movable vertically. In this and all other arrangements shown it is to be understood that the parts indicated in the kinematic sketches must not interfere with each other in the planes of their respective motions, and the same remark applies to the more detailed arrangement shown.

A further modification is shown in Fig. 7. The links $m\,n$ and $m_1\,n_1$ here form a rhombus turnable upon the fixed point A, while the cross-piece is allowed to slide along the straight line $c\,c$, the diagonal f being forked, as before, to receive the pin E, which describes the parabola.

The form of the mechanism illustrated by Fig. 8 embodies the system indicated by Fig. 7. In either form the constructional elements of the apparatus are of a simple nature and quite intelligible from the figure, so that they need not be specified.

Fig. 9 shows a complete machine corresponding to Fig. 4.

Fig. 10 illustrates a modification corresponding to Figs. 5 and 6.

Referring to Fig. 9 of the drawings, on suitable standards $s\,s$ two beds $c\,c$ are arranged, capable of being vertically displaced by means of screw-spindles $r\,r$. The beds bear an arm e, ending in a pin A. The screw-spindle i, driven by a belt-pulley l, is connected to the guide g of the tool-holder d in such a manner that by a suitable rotation of the spindle i a horizontal displacement of the guide g takes place. Hereby a sliding piece p, connected to said guide g, is taken along by means of a suitable plate o, whereby a rotation of the arm a around the point A follows. The latter movement causes a horizontal displacement of the cross-piece f, sliding on the arm a, said cross-piece f being connected, by means of the pin F, to the slider h, movable horizontally within the guides $c_1\,c_1$. This movement further causes the slider q, movable in a slot of the cross-piece f, and which by means of the pin E is connected to the tool-holder d, to be guided in such a way that the point E respectively, the tool t, rigidly connected to said point describes a parabola, as has been explained withr eference to the diagram shown in Fig. 4.

In Fig. 10 of the drawings a modification of the machine is shown having two screw-spindles, according to the diagram of Fig. 5 combined with the disposition of Fig. 6, for raising the work-piece. The spindle $c\,c$ serves for the horizontal movement of the slider g, carrying the tool-holder d, while the spindle $c_1\,c_1$, by means of the levers a and f, causes the raising and lowering of the work-table G, supporting the work-piece. To this end the latter is movably arranged by means of rods k, sliding within lateral guides u and counterbalanced by means of a suitable counterweight v. The movement of the spindles $c\,c$ and $c_1\,c_1$ is regulated in such manner with respect to one another that if both spindles have an equal number of revolutions the one spindle has double the pitch of the other, but if both spindles are of equal pitch the number of revolutions is as one to two. The working of the machine described will be clearly understood without further explana-

tion, considering what has been explained with reference to Figs. 5 and 6.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. In a grinding-machine for parabolic surfaces, a rotating support for the surface sustained by a spindle and driven by a pulley, in combination with a grinding-tool operatively connected to a sliding arm and to a second pivoted arm, together with a screw-threaded shaft operatively connected to said arms and driven by a second pulley, all of said parts being so arranged that as the surface is rotated the tool is given advance movement thereover in such direction as to cut or grind a perfect paraboloidal surface, substantially as described.

2. In a grinding-machine for parabolic surfaces, a rotating support for the surface sustained by a spindle and driven by a pulley, in combination with a grinding-tool operatively connected to a sliding arm and to a second pivoted arm, together with means operatively connected to said arms and driven by a second pulley, all of said parts being so arranged that as the surface is rotated the tool is given advance movement thereover in such direction as to cut or grind a perfect paraboloidal surface, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

FIDELIS NERZ.

Witnesses:
ALOIS GOBANZ,
OSCAR BOCK.