G. A. HATTERSLEY & L. KOENIG.

METHOD OF PRODUCING SCREW THREADS BY GRINDING.

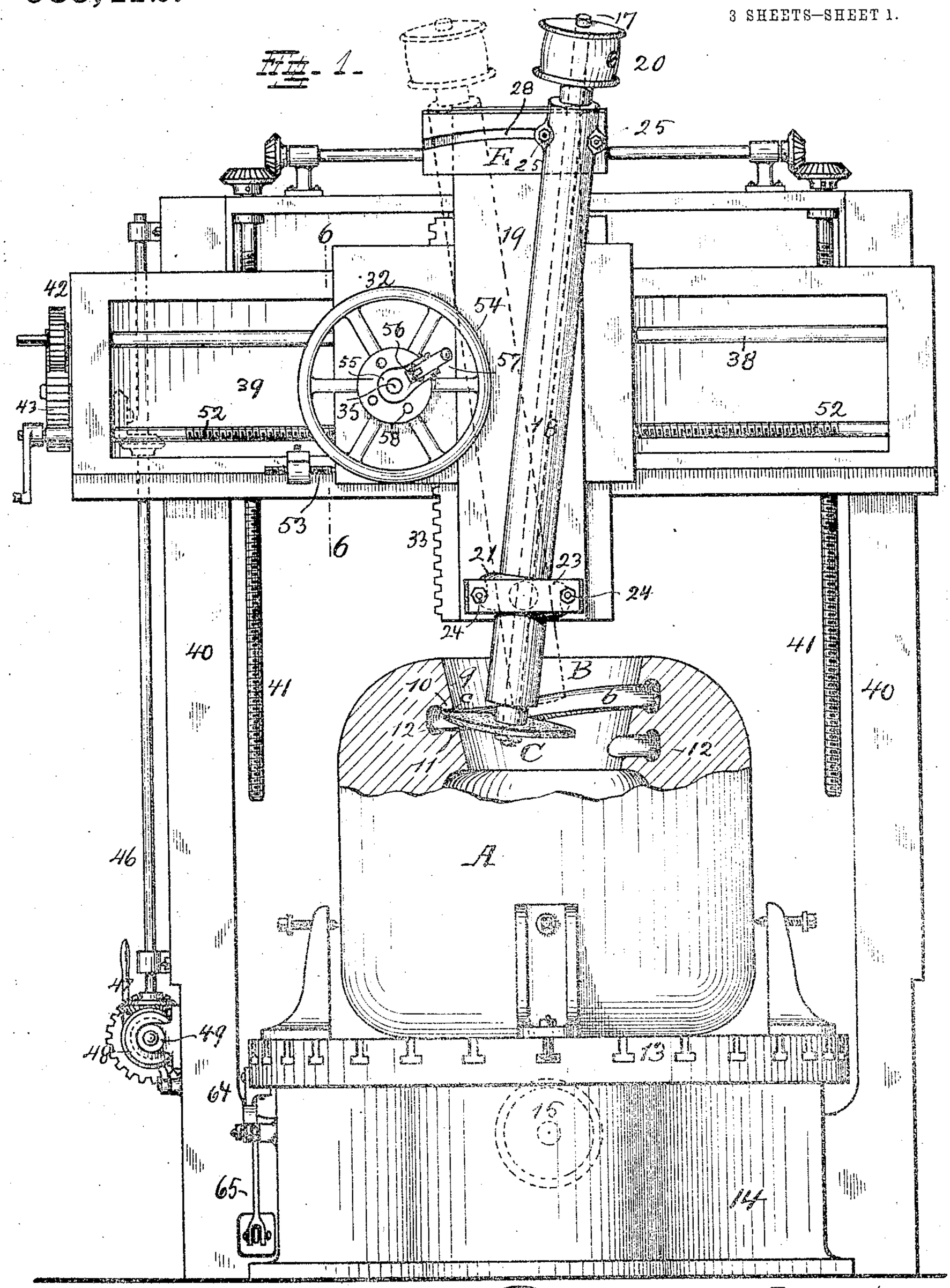
APPLICATION FILED AUG. 1, 1910.

985,412.

Patented Feb. 28, 1911.

3 SHEETS—SHEET 1.

Fig. 1.

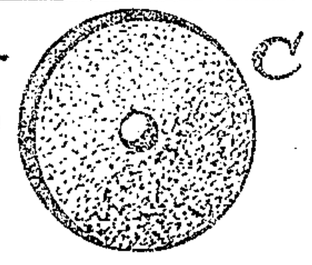


Witnesses.

A. R. Bothwell

T. LeBeau.

Fig. 2.



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3 SHEETS—SHEET 2.

Fig. 3.

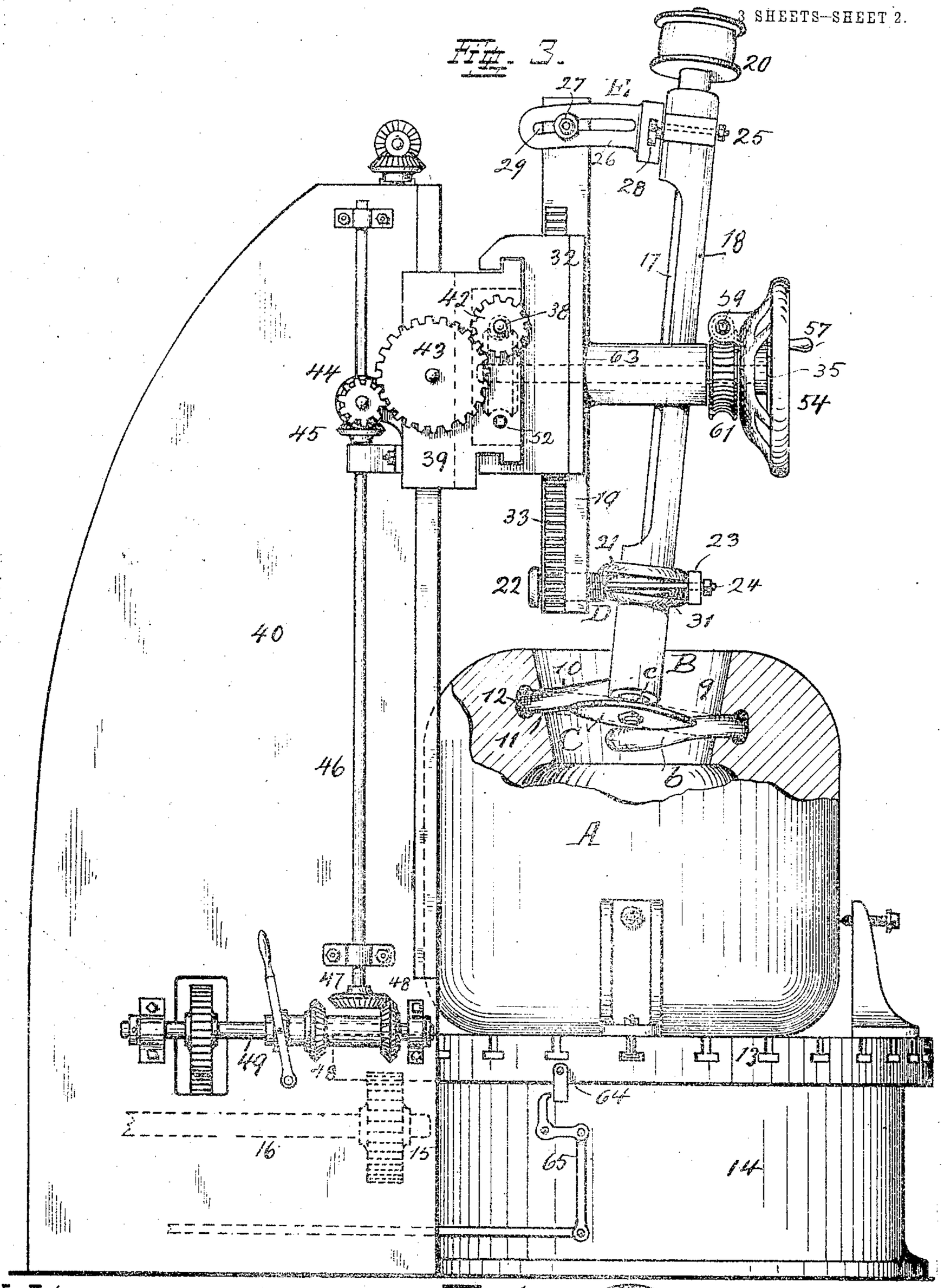

Fig. 4.

Witnesses.
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3 SHEETS—SHEET 3.

Fig. 5.

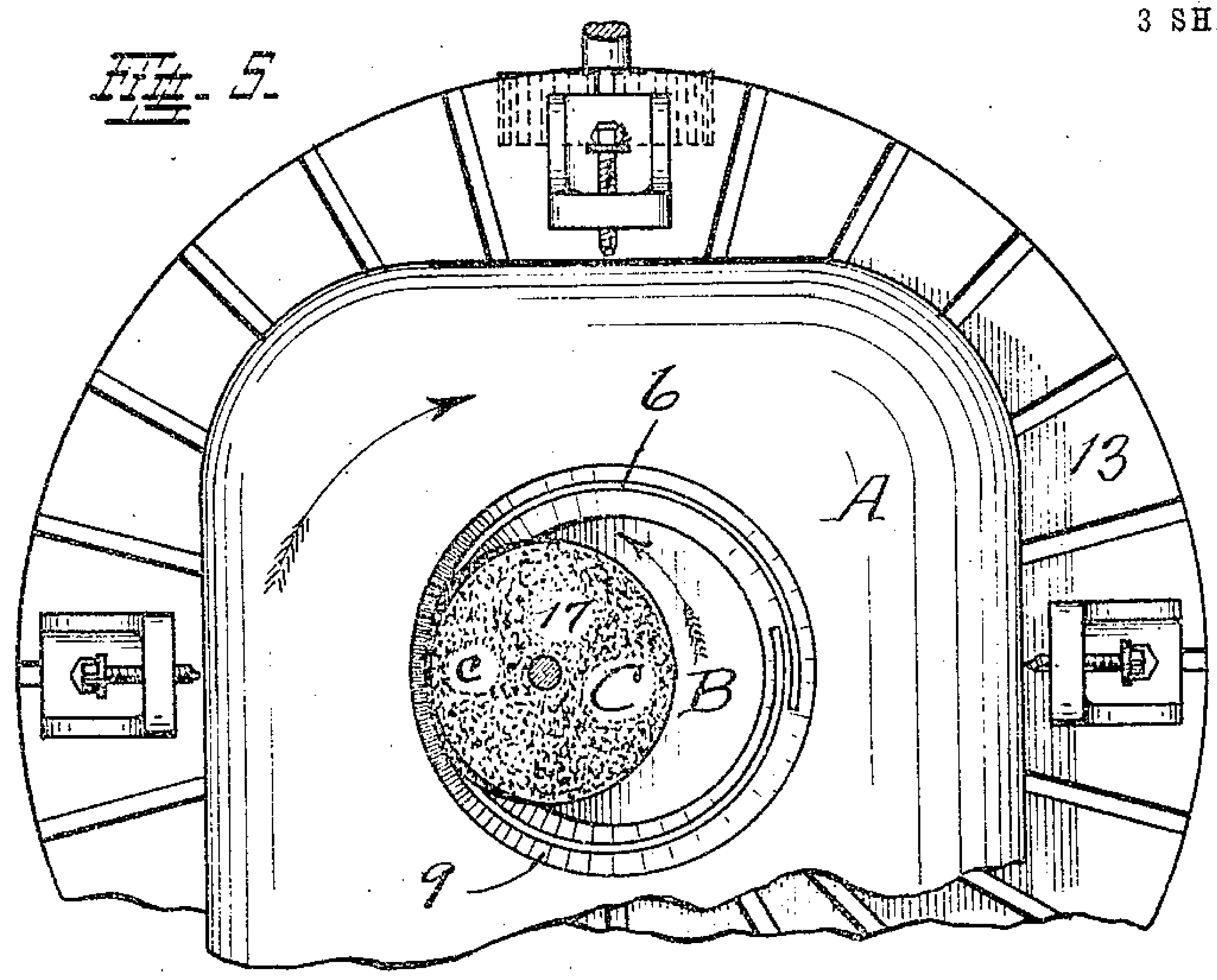


Fig. 6.

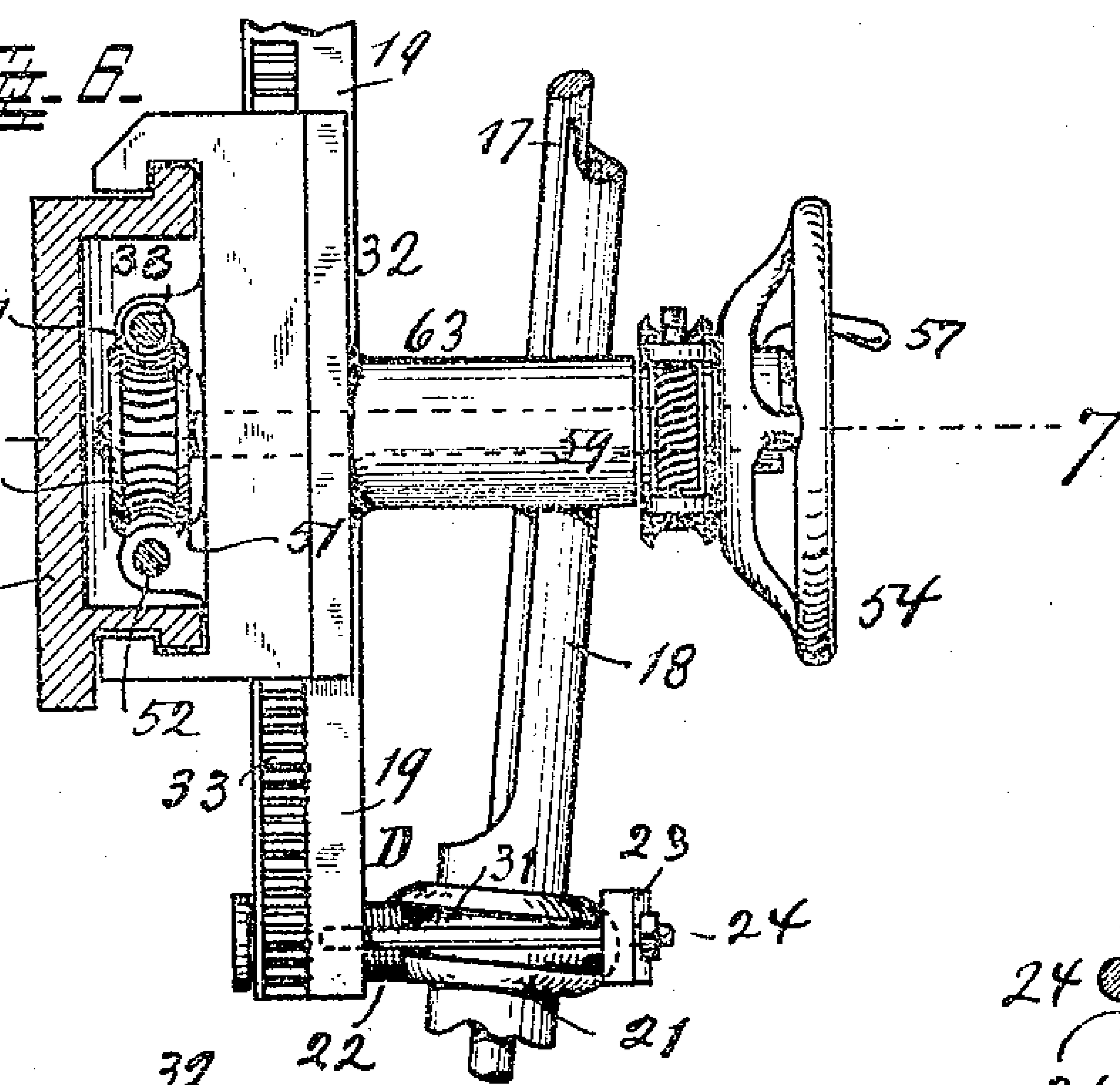


Fig. 8.

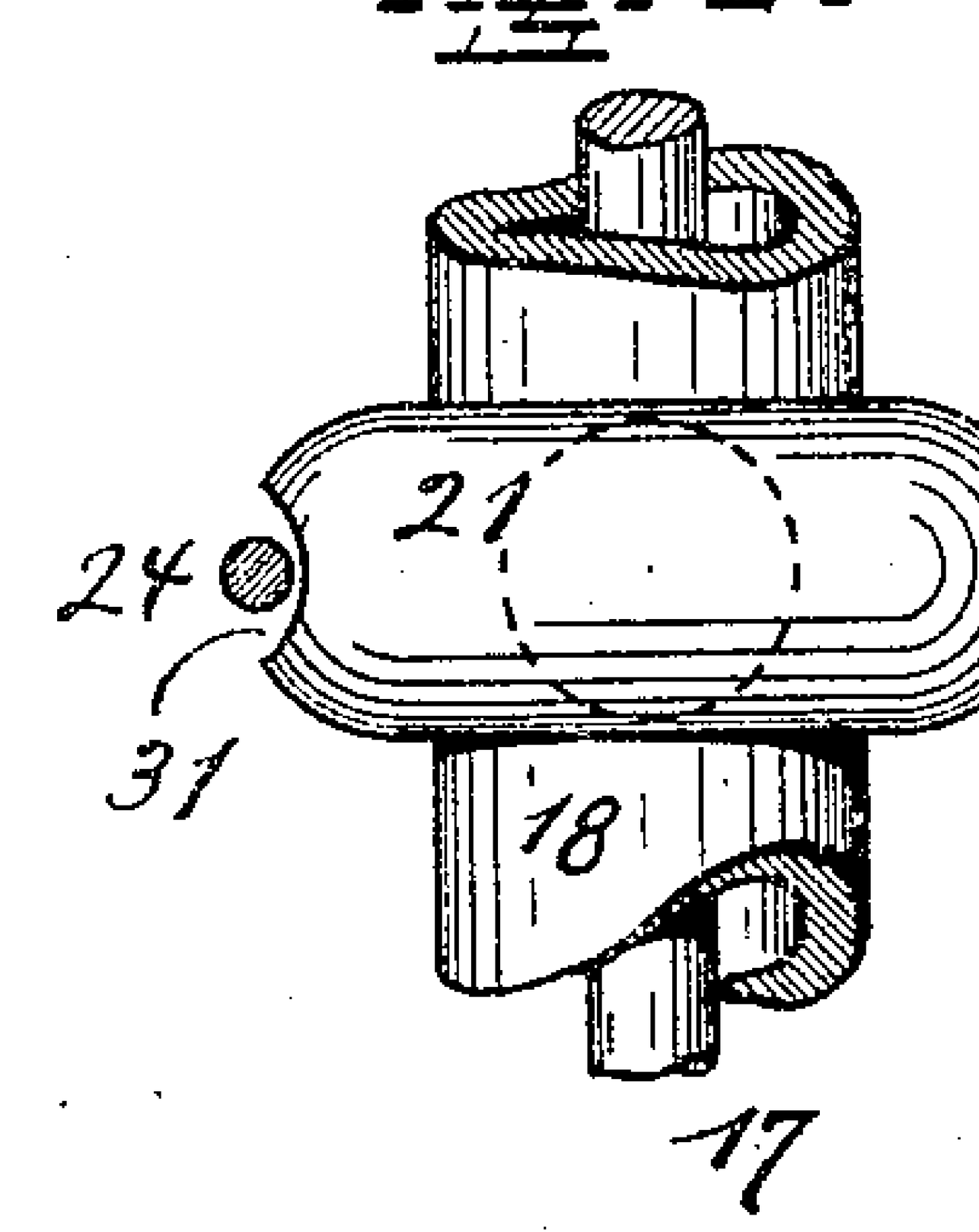
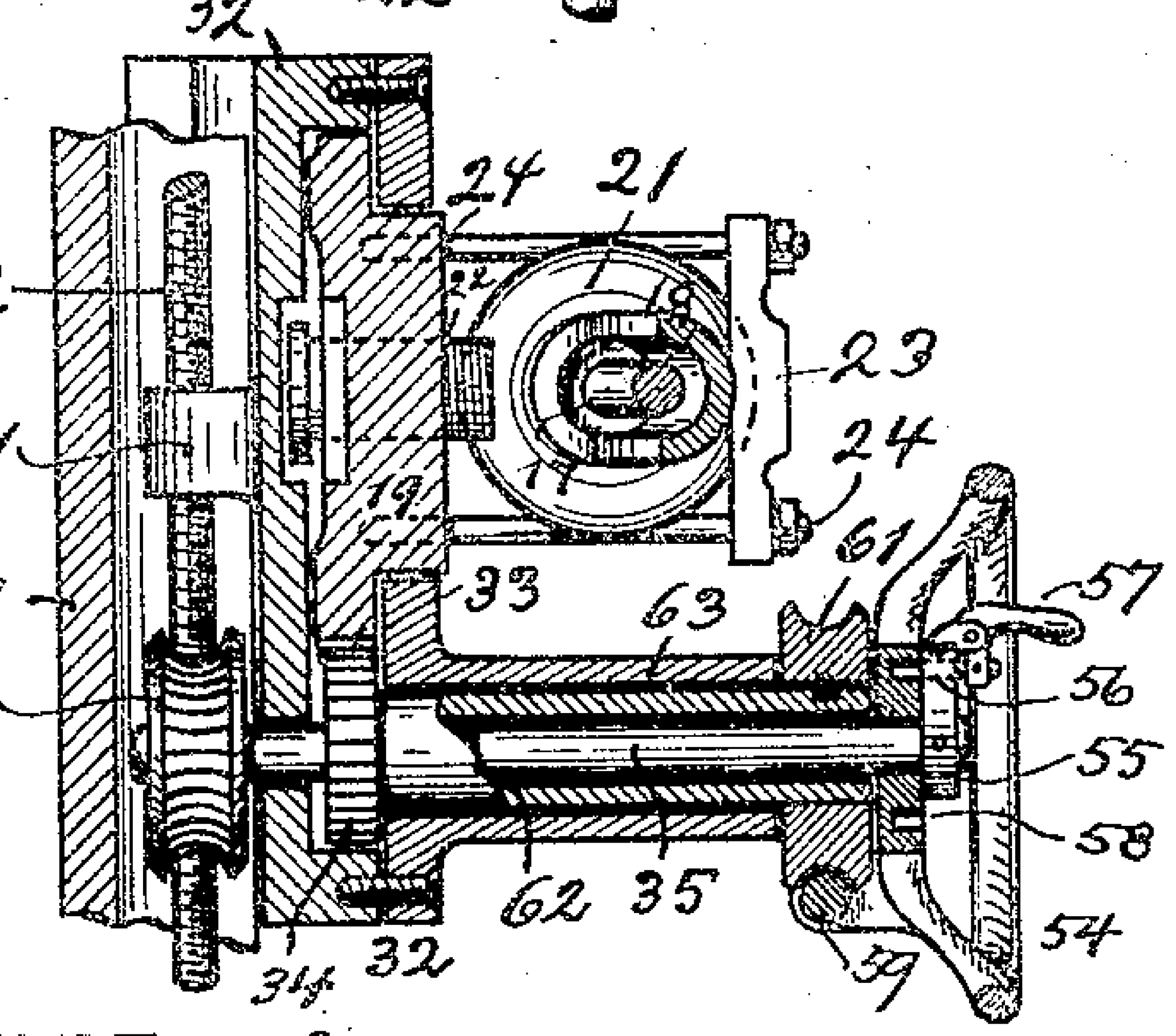


Fig. 7.



Witnesses.

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UNITED STATES PATENT OFFICE.

GEORGE A. HATTERSLEY, OF NORWOOD, AND LOUIS KOENIG, OF CINCINNATI, OHIO, ASSIGNORS TO THE VICTOR SAFE & LOCK CO., OF CINCINNATI, OHIO, A CORPORATION OF OHIO.

METHOD OF PRODUCING SCREW-THREADS BY GRINDING.

985,412. Specification of Letters Patent. Patented Feb. 28, 1911.

Application filed August 1, 1910. Serial No. 574,976.

To all whom it may concern:

Be it known that we, GEORGE A. HATTERSLEY and LOUIS KOENIG, citizens of the United States, the first residing at Norwood, the other in Cincinnati, both in Hamilton county, State of Ohio, have invented a certain new and useful Method for Producing Screw-Threads by Grinding; and we do declare the following to be a clear, full, and exact description thereof, attention being called to the three sheets of drawings which accompany this application and form a part thereof.

This invention relates to a method for applying grinding means which are particularly suitable for grinding screw-threads and may be used for forming, by grinding, a screw-thread complete, or for merely finishing one which has already been produced in the rough by a machine-tool for instance, or partly been formed in a casting.

A machine is shown and described as being used for grinding out and for finishing screw-threads formed in the rough in castings used in connection with safe-work of the screw-door type, in which type circular doors are held in closed position on the safe-body by means of a screw-connection. Patents No. 905,180 and No. 916,704, show safes of this type, each involving a safe-body having a circular door-opening and a door fitted to this opening, each being made of a casting of non-machineable metal, requiring grinding in the fitting and finishing of the work. The threads used in the screw-connection whereby these doors are held in place are produced in the rough in these castings and the machine here in consideration is used to finish these threads and to shape them so that complementary threads fit to each other. A related type of grinding machine is shown in Patent No. 810,903 which however is not constructed in a manner permitting also the grinding of screw-threads because of limited capacity of adjustment which prevents obtaining of certain positions of the grinding-wheel necessary for the purpose. The machine which is shown in connection with this invention and which is used according to our method is constructed to provide possibility of obtaining these various adjustments and particularly such necessary for the purpose of grinding screw-threads.

In the following specification and particularly pointed out in the claims at the end thereof, will be found a full description of our invention, together with its operation, parts and construction, which latter is also illustrated in the accompanying three sheets of drawings, in which:—

Figure 1, shows a front-view of a machine, in connection with which our invention is explained certain parts being shown in section. Fig. 2, shows a top-view of the grinding-wheel as it appears in this view. Fig. 3, shows a side-elevation of the machine with certain parts shown in section. Fig. 4, shows a top-view of the grinding-wheel as it appears in this view. Fig. 5, is part of a top-view of the object upon which the grinding-wheel is operating. Fig. 6, is a vertical section on line 6—6 of Fig. 1. Fig. 7, is a horizontal section on line 7—7 of Fig. 6. Fig. 8, shows a detail of construction referred to hereinafter.

In the drawings, A indicates a cast-metal safe-body of which B is the door-opening and *b* a screw-thread provided in the jamb-surface 9 of this opening. A circular door, not shown, is fitted to this jamb and a complementary thread is provided to hold the door in place. The thread shown in the drawing is a female thread and in the position in which it appears 10 would be the upper side of it and 11 the lower one. This thread is roughly formed in the casting to be completed by a finishing tool and at its bottom it is enlarged as shown at 12 to provide clearance for the tool, which clearance, being beyond the finished and fitted part of the thread, is not considered in the finishing work. 13 is a table upon which this casting is held in a manner customary in machine-tools, said table being mounted for rotation in a lower frame-part 14. It is rotated by means of a pinion 15 shown in dotted lines which meshes into a toothed ring or crown-gear provided on the underside of this table and not visible in the drawings. 16 is a power-driven-shaft upon which this pinion is mounted. In view of the nature of the metal a grinding wheel C, supported for rotation is used for finishing the thread and for sizing it to a fit with reference to a complementary thread on the door. The thread is produced by a compound feed-motion participated in by the grinding-wheel and by the table, which latter serves to rotate the casting supported upon it in a horizontal

plane, while the grinding-wheel, without changing its position horizontally, moves at an angle to this plane. Thus by the motion of the table all parts of the rough thread are circumferentially subjected to the action of the grinding-wheel, while the same moves at the same time to follow the changing pitch-line of the thread. As will be noted, this compound motion, rotary of the safe-body, and vertical of the grinding-wheel, changes the position of the grinding-contact of this latter constantly and causes it to follow the line of a helical curve corresponding to the particular pitch of the screw-thread. That is to say, provided the grinding-wheel has been properly adjusted and the construction of the machine is according to permit such adjustment and causes the parts to move in the intended manner.

Compliance with these conditions is the object of our invention.

Since a line helically curved changes its formation and direction constantly as it progresses, no two points in it occupying the same plane, it follows that a grinding medium, in order to produce such a formation, must move accordingly and so as to maintain grinding contact with all points of this constantly changing line. This requires primarily that the grinding contact of the grinding medium be limited as much as possible, theoretically it should be limited to the geometrical point, because otherwise, if the wheel grinds at more than one point, that is if a considerable area of it is at once in grinding contact, flat places result which destroy the true line of the helical curve. For this reason the grinding-wheel is presented to the surface on which it is to grind in a tilted position and if grinding for instance the upper side 10 of the thread, it would be in a position as shown in Fig. 1, so that as to the wheel, grinding-contact takes place only with a point in the periphery of its upper edge, said point being indicated at *c* in Figs. 1, 2, 3, 4 and 5. This limited contact can however be had only when this point of grinding contact lies also at the same time in a plane which is radial to both the grinding-wheel and surface 9 which contains the screw-thread (observe Fig. 5) and provided further that this plane is vertical to the pitch line of the screw as shown in Fig. 3, (dotted lines) which shows the grinding-wheel in the same position as it is shown in Fig. 1, the parts of the safe shown there and on which it is grinding being removed. While heretofore the grinding contact has been spoken of as being confined to a point in the periphery of the wheel such a condition can be maintained in reality only for a limited time on account of the wear of the grinding-wheel which assumes a tapering edge. Therefore this point soon assumes the form of a line which extends from it inwardly and increases in length as the width of the zone of wear increases, said line lying within the radial plane above mentioned. Observe Figs. 2, 4 and 5. The particular positional relation between the point of grinding contact on the grinding-wheel and the pitch line of the screw is maintained by reason of the rotation of the safe-body in one plane and the simultaneously proceeding movement of the grinding-wheel in a direction at an angle to this plane, both motions proceeding in properly proportioned ratio and by means and mechanism to be presently described.

The grinding-spindle 17 is supported in two bearings, one at each of its ends, which bearings, in order to assure perfect alinement, are by preference contained in a substantially tubular frame-structure 18, which is supported on a carrier 19.

20 is a belt-pulley at the upper end of the grinding-spindle whereby this latter is rotated. The lower connection of frame 18 to this carrier is by a universal joint D, which permits adjustment necessary to enable the grinding-wheel to assume the various tilted positions described. The principal movement for this adjustment is had at the upper end of the frame where it may be moved in or out with reference to carrier 19, or laterally with respect thereto, the lower part of the frame simply following by turning at the universal joint which acts as a pivot. This latter joint is substantially a ball and socket-joint, the ball being formed by a spherical projection 21, fitted to a socket which is formed at one end of a screw 22, seated in the lower end of carrier 19. The ball is held in this socket by a bar 23 extending across it on the outer side and held to the carrier by screws 24. At its upper end frame 18 is connected to a frame E by bolts 25, said frame being connected to the carrier by two rearwardly extending wings 26 and by screws 27. Bolts 25 are T-bolts and their heads occupy a T-slot 28 in frame E, said slot being curved on a radius which has its center in universal joint D. Screws 27 are seated in carrier 19 and extend into slots 29 in wings 26, said slots being also formed on a radius, the center of which is likewise in universal joint D. It will now be seen that the tilted position of the grinding-wheel shown in Fig. 1, required to cause it to grind on its edge, may be obtained by swinging the spindle-frame with the grinding-spindle to the right on frame E, after which bolts 25 are tightened in slot 28. If the wheel is grinding on the lower side 11 of the screw-thread, the spindle would be swung to the opposite side as shown in dotted lines. To obtain the tilted position shown in Fig. 3, to cause the grinding-wheel to meet the inclination of the pitch-line of the screw, frame E with

the upper end of spindle-frame 18, both forming now a rigidly connected structure, are swung with reference to the upper end of carrier 19, and after adjustment, secured thereto by the tightening of screws 27. While this adjustment is being had at the upper end of the spindle-frame, screws 24 at its lower end are sufficiently eased to permit a free movement of the members of the ball- and socket-joint. These screws although closely fitted against opposite sides of ball 21, do not interfere with this limited movement of the same, because round-bottomed notches 31 are provided in said ball. (See Fig. 8.) The adjustment had at the upper end of the spindle-frame may be aided and corrected if necessary, by moving screw 22 whereby the lower end of the spindle may be moved in or out with reference to carrier 19. After all adjustments are completed screws 24 are also tightened, so that the spindle-supporting-frame 18 and carrier 19 become now a rigidly connected structure which is supported to be movable to and from table 13 which carries the object A. For such purpose carrier 19 is slidably fitted to a cross-head 32 and provided with a rack 33 which is engaged by a pinion 34, whereby said carrier is caused to move either up or down to follow the inclination of the pitch of screw-thread *b*. The actuation of this pinion is obtained from a shaft 35 which carries a worm-wheel 36, rotated by a worm 37. This latter is connected to a shaft 38, mounted on a rail 39 which is supported on upright frame-members 40. This support may be one vertically adjustable by means of screws 41 in a manner customary in machine-tools. Shaft 38 is rotated by means of gears 42, 43 and 44, the latter rotated by a set of bevel-wheels 45 from an upright shaft 46. This latter carries a bevel-wheel 47 and may be rotated in either direction by either one of two bevel-wheels 48, 48, shiftably mounted upon a power-driven-shaft 49. By changing the direction of rotation of shaft 46, worm 37 is caused to rotate accordingly and carrier 19 may be directed to move either up or down. Cross-head 32 is slidably mounted on rail 39 and provided with a nut 51, engaged by a screw 52 mounted in rail 39, so that, when said screw is rotated, which may be by means of a crank, the head is is caused to move transversely on rail 39. Worm 37 follows the head so as to maintain engagement with worm-wheel 36, its engagement with shaft 38 being by a customary spline.

The parts for positioning are handled as follows: The grinding-wheel, having been raised by means of carrier 19, to permit placing of object A, and moved laterally by head 32 on rail 39 to be in proper position above the object, is lowered again by movement of the carrier until it is opposite one end of thread *b*. Next the two tilted positions of the grinding-wheel, shown respectively in Figs. 1 and 3, are obtained by adjusting the grinding-spindle on said carrier in the manner described. This adjustment having been determined, the grinding-wheel is moved into thread *b* as shown in Fig. 1, by moving cross-head 32, which is done by rotating screw 52. A cut circumferentially all around through the thread is taken, after which rotation of table 13 and angular movement of the grinding-wheel is stopped, and the latter is moved out of the thread by shifting cross-head 32. Since one cut is rarely sufficient to cover the surface to be ground, additional cuts are taken, the wheel for each subsequent cut and while maintaining its tilted position being set deeper into the thread, this being done after the wheel has each time been brought opposite one of the ends of the thread. We prefer to grind while the grinding-wheel follows the pitch-line with a downward movement and therefore, for each re-setting, the wheel is raised to be opposite the high end of the thread, after which it is set into the same and the compound feed-motion by table and carrier is caused to resume. A gage 53, adjustably mounted on the rail, aids the determination of the extent of these successive re-settings.

The upright movement of carrier 19 described before as proceeding from worm-wheel 36 and worm 37 and whereby the grinding-wheel is caused to follow the pitch of the screw, is rather slow and therefore means have been provided whereby, for setting the grinding-wheel and for moving it vertically with respect to the work, carrier 19 may be moved more quickly by hand and at which time worm-wheel 36 and worm 37 are not used for the purpose. These means consist of a hand-wheel 54, loosely mounted and of an arm 55 rigidly connected to shaft 35 which carries worm-wheel 36. This arm carries a locking-pin 56 which may be manipulated by means of a handle 57 to enter into any one of a number of holes 58 provided in the hub of the hand-wheel and whereby, when said pin occupies one of these holes, said hand-wheel is positively locked to shaft 35. On its rear side, the hand-wheel carries a worm 59, endwise confined, but free for rotation, said worm engaging a worm-wheel 61, rigidly mounted upon a hollow shaft 62 which carries pinion 34 and is sleeved upon shaft 35 and supported in a bearing 63 forming part of cross-head 32. It will now be seen that if hand-wheel 54 by means of pin 56 is locked to shaft 35 so as to be driven by it, and power-driven worm-shaft 38 is caused to rotate, machine-operated change of position of the grinding-wheel, whereby it is caused to follow the pitch-line, is had by means of carrier 19 which is moved by pinion 34 on

hollow shaft 62, said shaft being driven by hand-wheel 54 to which it is held by worm-wheel 61 and worm 59. If the quicker, hand-operated movement of carrier 19 is desired for the purpose of setting the grinding-wheel and for adjusting its position above table 13, hand-wheel 54 is disconnected from power-driven shaft 35 by manipulation of locking-pin 56 by means of its handle 57, after which the grinding-wheel may be quickly raised or lowered. When the hand-wheel is used in this manner for setting the grinding-wheel, power-operation of shaft 35 is preferably stopped by use of a conveniently located clutch and shaft 62 is manipulated directly by the hand-wheel until the grinding-wheel approaches the desired position after which locking-pin 56 is turned into the nearest one of holes 58. This manipulation is sufficient for merely raising or lowering the grinding-wheel with respect to the work. Closer adjustment necessary to set the wheel exactly to the cut is had by further rotation of shaft 62 obtained by manipulation of worm 59, by means of a suitable wrench, whereby, by means of worm-wheel 61 on said shaft 62, additional movement of carrier 19 is had until the grinding-wheel is in the exact position desired for grinding.

When as in the case shown, the screw-thread to be ground does not run out in the open, that is extend to the edges of surface 9 in which it is contained, rotation of table 13 as well as the movement of carrier 19 must stop each time as soon as the end of the thread and the grinding-wheel come together. This is preferably done automatically and by means of a stop 64 adjusted to proper position on table 13 and which by means of a trip-lever mechanism 65 acts upon a clutch adapted to control operation of a general driving-shaft from which the operation of shafts 16 and 49 proceeds.

The use of customary means for changing speeds and for reversing motions, analogous to similar constructions in machine-tools is presumed, but since such means may be applied in various ways they are not shown in detail.

The complementary thread on the door which is fitted to the opening in the safe-body A, is ground in a similar way. However since the door is not so heavy, a lighter machine-tool of the lathe-type may be used, by the chuck of which the door is held. The grinding-wheel is supported in an analogous manner, that is in one which permits the grinding-spindle to be adjusted in the directions here described, so as to obtain the limited grinding-contact and to fit the pitch of the screw-thread. The method would however be substantially the same when used under the arrangement and with the means alluded to and would produce the same results as contemplated by our invention.

While as shown the thread to be finished is located in an annular surface, tapering inwardly, that is conical, disposed, the same procedure is followed if the thread were to be ground in a cylindrical surface. In other words, the thread is ground as if it were contained in a cylindrical surface and taper is not considered. A true screw-line results nevertheless, with this difference however, that the thread becomes deeper as it approaches the inner edge of surface 9, which however is not objectionable, provided the thread is started deep enough at the largest diameter of the taper.

Having described our invention, we claim as new:

1. The method of grinding screw-pitched surfaces which consists of carrying such a surface around a rotating grinding-wheel, of moving this latter in a ratio corresponding to the pitch of the surface and in a direction at an angle to the plane in which the surface moves and of maintaining grinding contact while these movements of grinding-wheel and of surface proceed.

2. The method of grinding a screw-thread which consists of moving the surface which contains the thread past a rotary grinding-wheel which is tilted with its flat side at an angle to the surface on which the wheel grinds and with the axis of its rotation located in a plane disposed at right angles to the pitch of the screw-thread.

3. The method of grinding screw-threads which consists of carrying the surface which is to contain the thread around a rotating grinding-wheel, of moving this latter in a ratio corresponding to the pitch of the thread past this surface and in a direction at right angles to the plane in which the surface moves and of maintaining grinding contact while these movements of grinding wheel and of surface proceed, said grinding contact being limited and lying at the end of a radius of the grinding-wheel which when extended intersects with the axis about which the surface which receives the thread rotates and which also lies in a plane disposed at right angles to the pitch-line of the screw-thread.

4. The method of producing by grinding a screw-thread in an annular, tapering surface, which consists of carrying this surface around a rotating grinding-wheel while this latter moves past this surface in a direction parallel to the axis of rotation of this surface and in a ratio corresponding to the pitch of the thread.

5. The method of producing a screw-thread by the compound feed motions of an object-supporting carrier which has a rotary motion and of a rotating grinding-wheel which moves in a linear direction, the mo-

tion of the carrier producing the thread circumferentially while the linear motion of the grinding-wheel produces the pitch-line.

6. The method of producing by grinding a screw-thread in an annular surface and which consists of supporting a rotary grinding wheel so as to produce a grinding contact limited to a point in the periphery or to a line on the wheel extending inwardly from said point, of moving the annular surface about this grinding contact, and of moving the grinding wheel in a direction at an angle to the plane in which the annular surface moves, both these movements being so speeded with relation to each other as to cause the limited grinding contact mentioned to remain in the pitch line of the screw-thread to be produced.

In testimony whereof, we hereunto affix our signatures in the presence of two witnesses.

GEORGE A. HATTERSLEY.
LOUIS KOENIG.

Witnesses:
C. SEENEY,
T. LE BEAU.