C. M. CONRADSON.

GRINDING MACHINE FEEDING MECHANISM.

APPLICATION FILED NOV. 18, 1907.

957,936. **Patented May 17, 1910.**

4 SHEETS—SHEET 1.

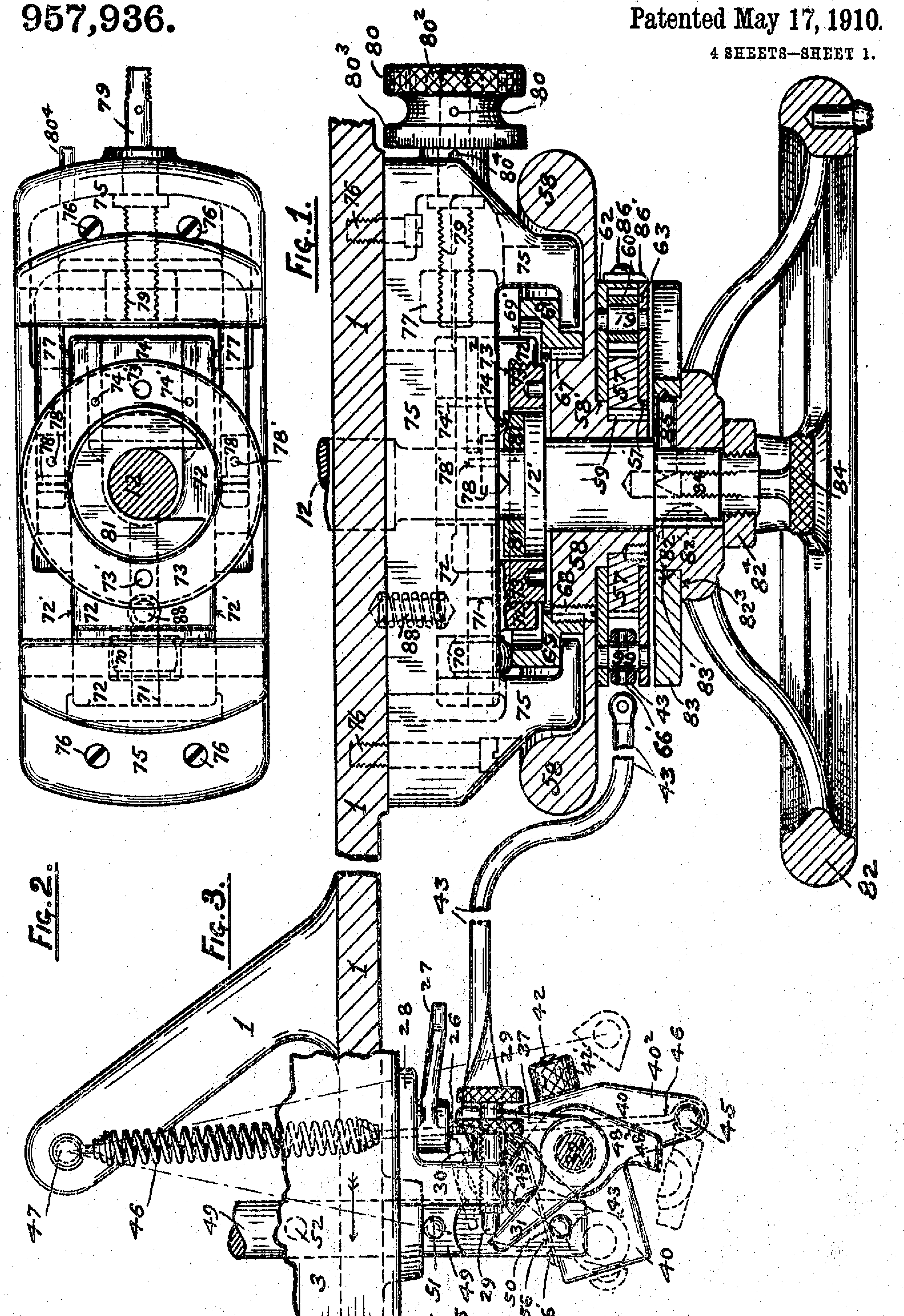


Fig. 1.

Fig. 2.

Fig. 3.

WITNESSES.

Frank L. Howard

Henry R. Kennedy.

INVENTOR.

Conrad M. Conradson

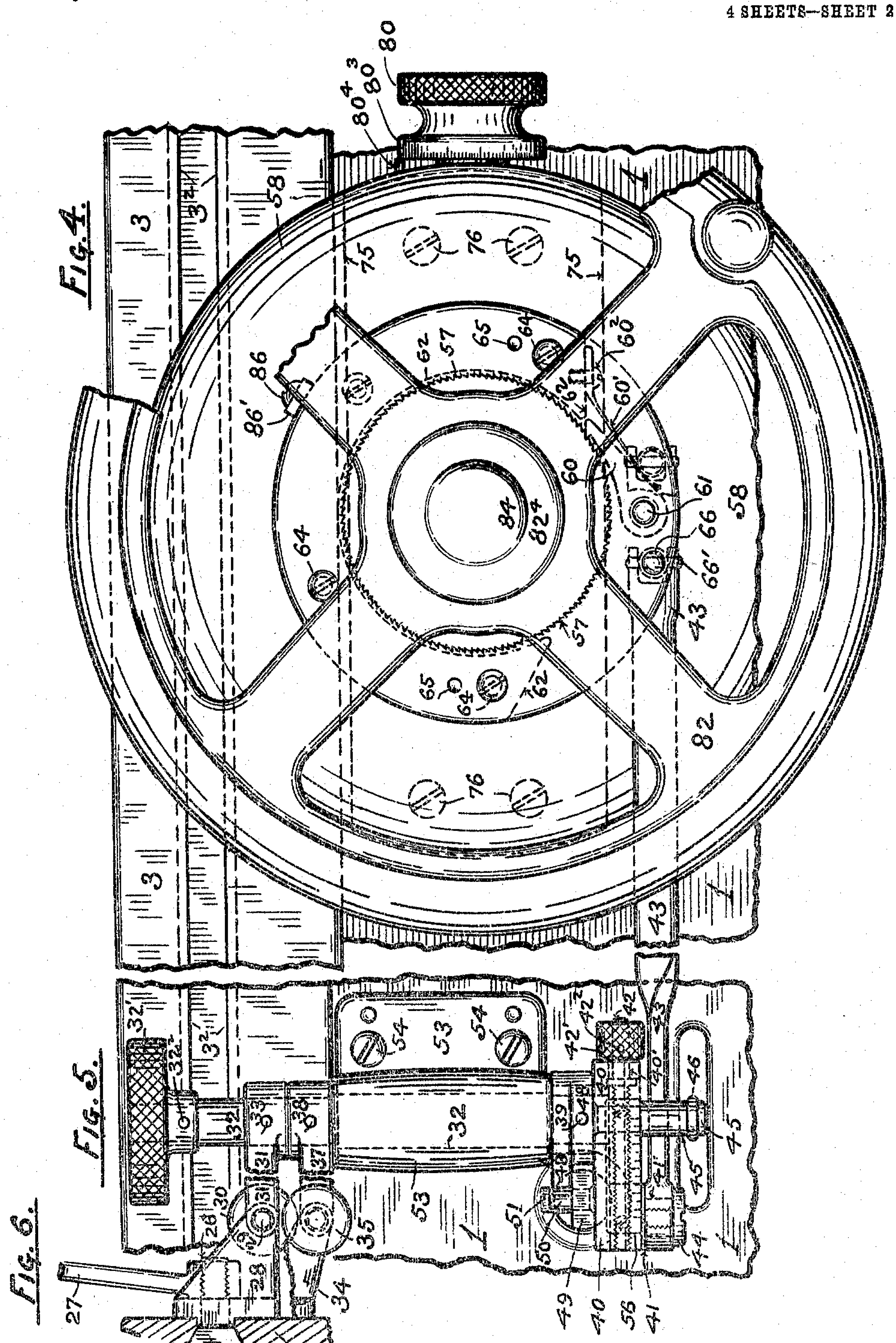
C. M. CONRADSON.

GRINDING MACHINE FEEDING MECHANISM.

APPLICATION FILED NOV. 18, 1907.

957,936. Patented May 17, 1910.

4 SHEETS—SHEET 2.



WITNESSES.

Frank L. Howard

Henry R. Kennedy.

INVENTOR.

Conrad M. Conradson

C. M. CONRADSON.

GRINDING MACHINE FEEDING MECHANISM.

APPLICATION FILED NOV. 18, 1907.

957,936. Patented May 17, 1910.

4 SHEETS—SHEET 3.

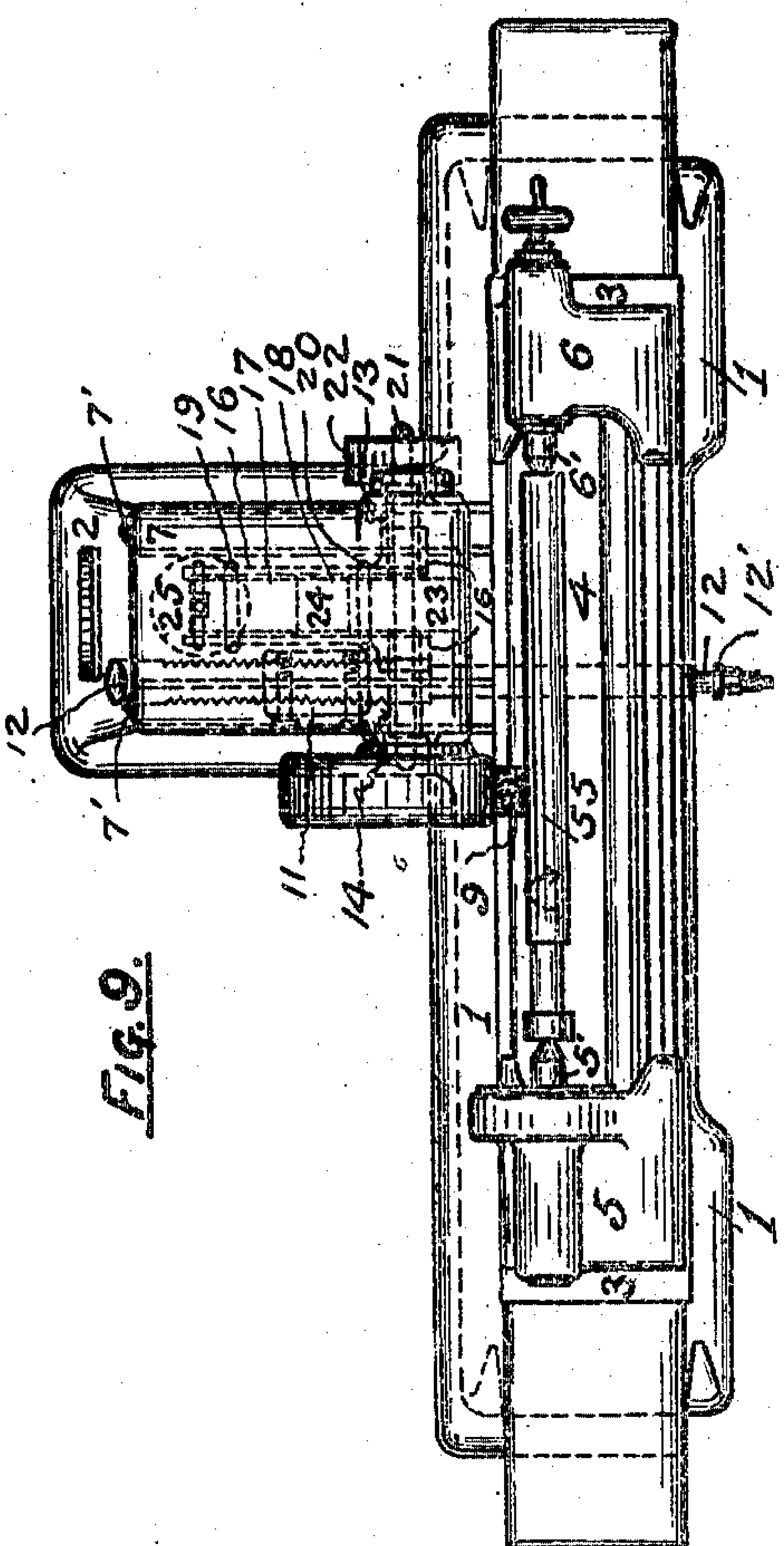


FIG. 9.

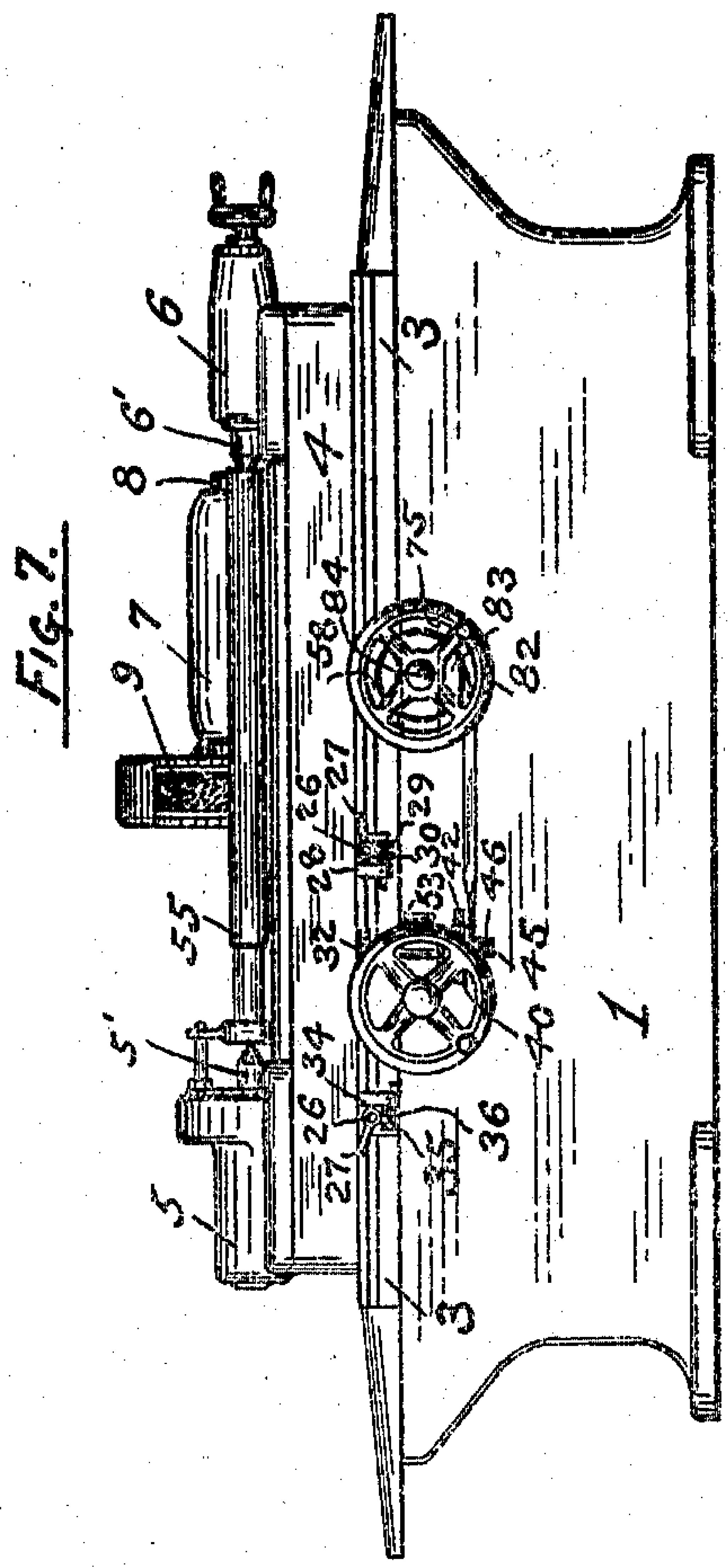


FIG. 7.

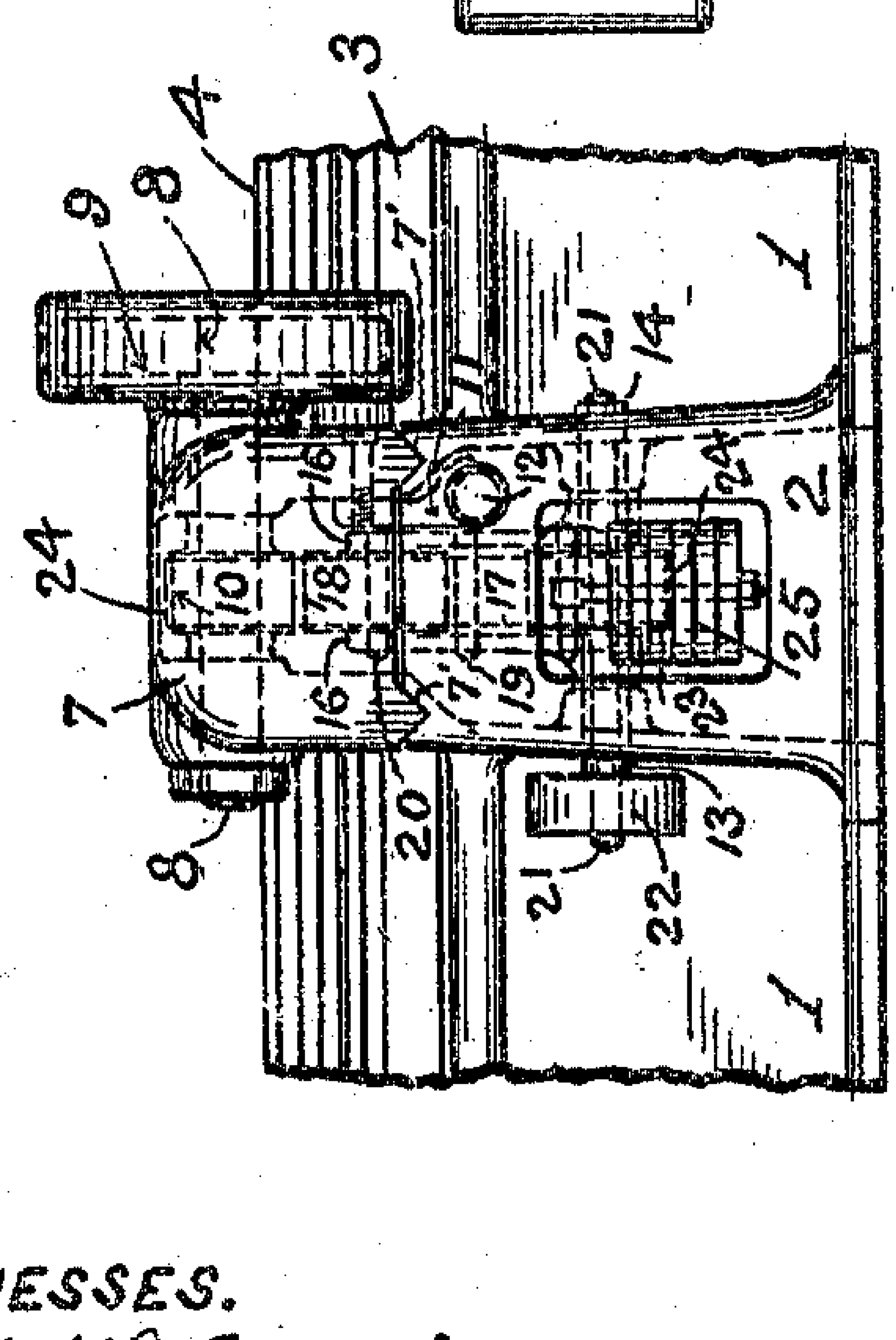


FIG. 10.

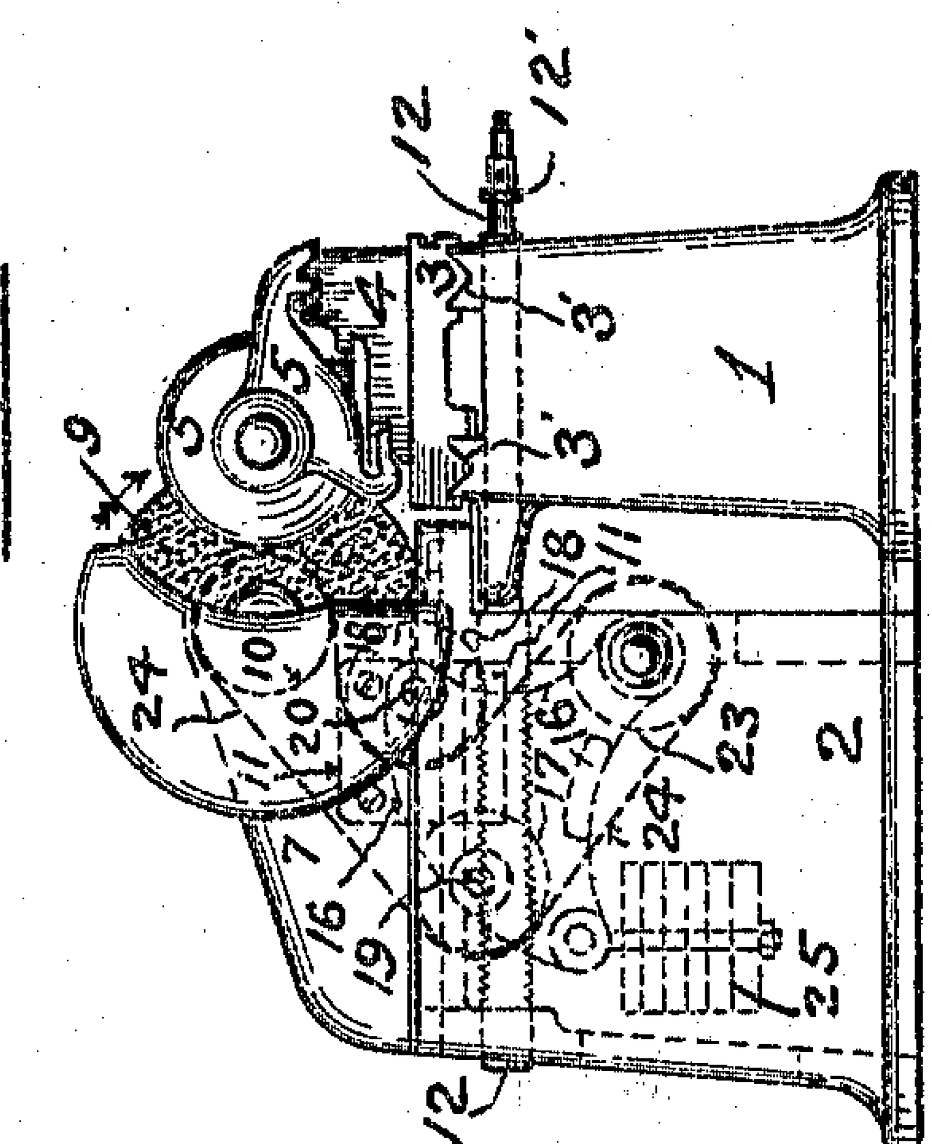


FIG. 8.

WITNESSES.

Frank L. Howard

Henry R. Kennedy.

INVENTOR.

Conrad M. Conradson

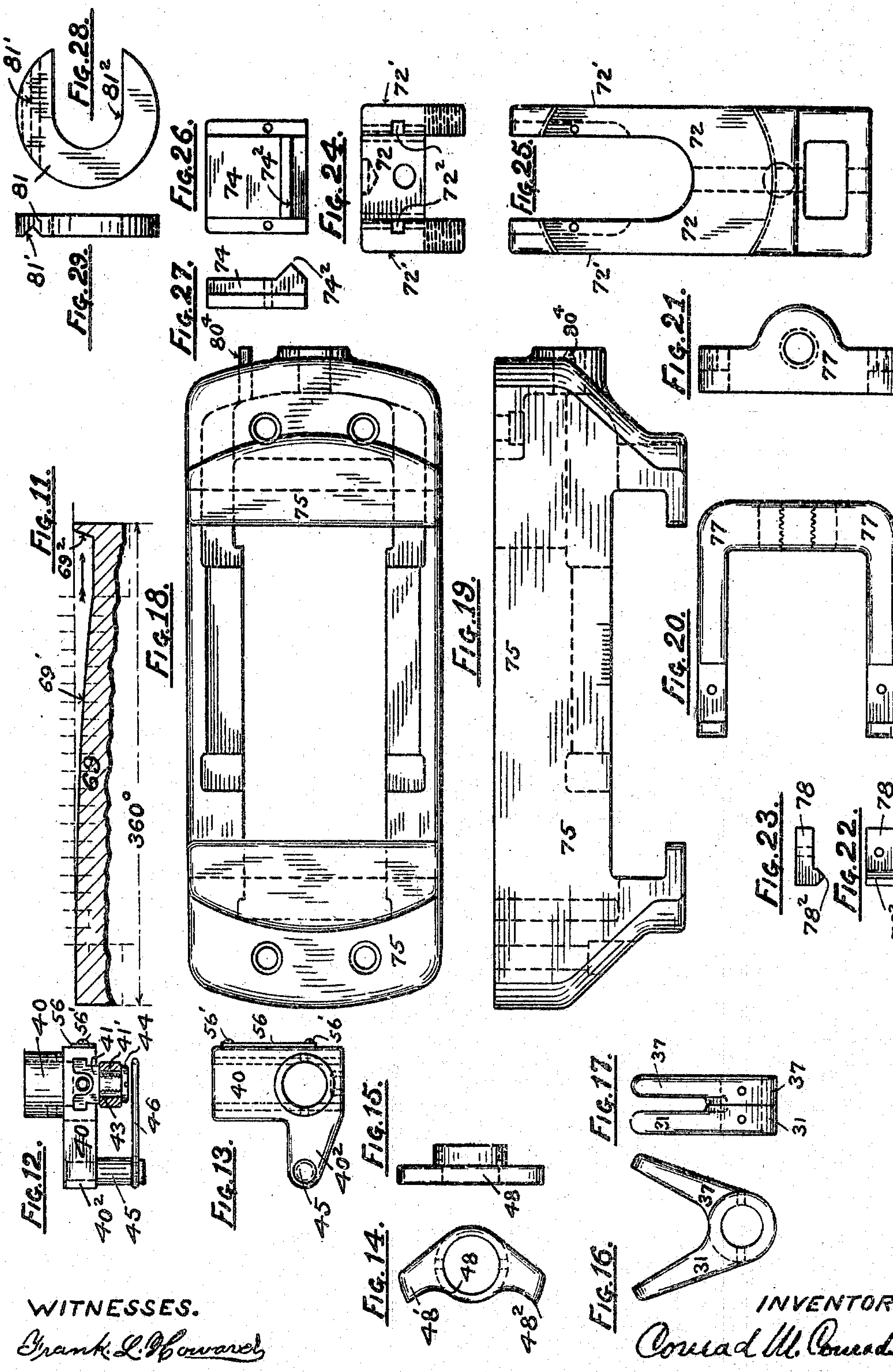
C. M. CONRADSON.

GRINDING MACHINE FEEDING MECHANISM.

APPLICATION FILED NOV. 18, 1907.

957,936. Patented May 17, 1910.

4 SHEETS—SHEET 4.



WITNESSES.

Frank L. Howard

Henry R. Kennedy.

INVENTOR.

Conrad M. Conradson

UNITED STATES PATENT OFFICE.

CONRAD M. CONRADSON, OF MADISON, WISCONSIN, ASSIGNOR TO VERNETTE E. PRENTICE, OF NEW YORK, N. Y.

GRINDING-MACHINE FEEDING MECHANISM.

957,936. Specification of Letters Patent. **Patented May 17, 1910.**

Application filed November 18, 1907. Serial No. 402,771.

To all whom it may concern:

Be it known that I, Conrad M. Conradson, a citizen of the United States, residing at Madison, in the county of Dane and State of Wisconsin, have invented a new and useful Grinding-Machine Feeding Mechanism, of which the following is a specification.

My invention relates to machines for grinding plane or cylindrical surfaces with a rotating emery or other abrasive tool.

One object of my invention is to obtain a more precise control of the abrasive tool relative to the work, in order to produce the work accurately and economically.

Another object is to have the feed operating mechanism convenient, and so that the abrasive wheel can be moved either to or from the work precisely.

Still another object is to provide means adapted to make the feed optionally variable or constant and also to have the machine automatically stop grinding when a predetermined size of work is reached.

I believe that I am the first to apply a variable feed to a grinding machine. On one well known make of grinding lathe there are two feeds so arranged that the operator can use a coarse feed at first for roughly grinding the work to approximately the required size, and then use a fine feed for finishing it to the exact size. But my new feeding mechanism for grinding machines can feed intermittently by a constant or varying increment, depending upon the predetermined shape of the cam face, and when the work is about the required size it can stop feeding and allow the work to make a predetermined number of passes before the machine automatically stops, or is stopped by hand. This ability to vary the feed and to use a cam of just the proper shape for the work in hand, is a valuable improvement, as for instance if the work is a casting or forging on which the surface to be ground has not previously been machined, as by a lathe, or a planer, then the surface will probably have uneven parts and small projections. Or if the work has previously been roughly machined leaving the tool marks, in either case, my new grinding machine feeding mechanism can be made to feed by large increments at first removing the high spots on the work, and then by gradually decreasing increments as the work approaches the finished dimensions and thus accomplish the same or better results in about one half of the time required by the old and non-sensitive constant increment feeding mechanisms now in use. I obtain these and other results by the use of a cam mechanism and a knife edge mechanism, both of the said mechanisms are shown but the knife edge mechanism only is claimed in this application. The cam mechanism is claimed in another application, Serial Number 402,770 filed November 18 1907.

The invention consists in the construction and combination of parts to be more fully described hereinafter and particularly set forth in the claims.

Referring to the accompanying drawings forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the views, Figure 1 is a partial plan view of my grinding machine feeding mechanism shown partly in section. Fig. 2 is a partial front view of the same with the hand wheels and cam removed. Fig. 3 is a plan view shown partly in section of the mechanism for actuating the feed through a connecting rod, by means of a reciprocating table. Fig. 4 is a broken front view of the feeding mechanism showing the hand wheel and ratchet wheel. Fig. 5 is a front view of the mechanism for actuating the ratchet wheel through a connecting rod. Fig. 6 is a broken sectional view of the reciprocating table showing the adjustable dogs for operating the ratchet connecting rod through intermediate mechanism. Fig. 7 is a front elevation of a grinding machine for cylindrical work equipped with my new feeding mechanism. Fig. 8 is a side view of the same with a part of the feeding mechanism removed. Fig. 9 is a top view of the same with a part of the feeding mechanism removed. Fig. 10 is a partial rear view showing the grinding wheel slide counterweight mechanism. Fig. 11 is a development of the feed cam; Fig. 12 is an elevation and Fig. 13 a plan of the feed-adjusting crank; Fig. 14 is a plan and Fig. 15 an elevation of the feed trip lever; Fig. 16 is a plan and Fig. 17 an elevation of the reverse clutch trip lever; Fig. 18 is a plan and Fig. 19 an elevation of a bracket supporting the feed works; Fig. 20 is a plan and Fig. 21 an elevation of the feed-adjusting yoke; Fig. 22 is a plan and Fig. 23 an elevation of the feed-adjusting lever fulcrum; Fig. 24 is an end elevation and Fig. 25 a plan of the feed-adjusting slide; Fig. 26 is a plan and Fig. 27 an elevation of a knife-edge fulcrum for the feed lever; Fig. 28 is a plan and Fig. 29 an elevation of the feed lever fulcrum abutment.

In Figs. 7, 8, 9, and 10, 1 is the main base of the machine, 2 is the wheel base securely bolted to the main base, 3 is the table adapted to reciprocate in the tracks 3′ 4 is the swivel rigidly clamped to the table 3 and upon which are mounted with longitudinal adjustment, the headstock 5 and tailstock 6, the headstock having means to rotate the work 55 on centers 5′ and 6′, 7 is the wheel slide mounted to slide at right angles to the table in the tracks 7′ in the wheel base 2, on this slide is rotatively mounted a spindle 8, Fig. 10 having its axis preferably parallel to the track 3′; fastened to the spindle 8, is an abrasive wheel 9, of emery or other material. Also fastened to the spindle 8 is a pulley 10. Fastened to the wheel slide 7 is a half nut 11 engaging the threaded portion of screw 12, the latter being journaled in the base 1 and wheel base 2, Fig. 8 and also adapted to slide longitudinally therein. Pivoted on the bushings 13 and 14 and located inside of the wheel base 2 is a bell crank 16 in which are mounted two rotatable idler pulleys 17 and 18 respectively on studs 19 and 20.

The bushings 13 and 14 are fastened in the wheel base 2 and have journaled in them the driving shaft 21 with its axis parallel to the axis of the spindle 8. This shaft can be rotated by several well known means as by a moving belt on the pulley 22. The said pulley being keyed or otherwise fastened to the shaft 21. Fastened to the shaft 21 inside of the wheel base 2 and between the bushings 13 and 14 and also between the two sides of the bell crank 16 is a driving pulley 23 Fig. 8. An endless belt 24 operatively connects the driving pulley 23 and spindle pulley 10 and passes in contact with the idler pulleys 17 and 18 and thus causes the rotation of the abrasive wheel 9 actuated primarily by the said moving belt on the pulley 22. Pivotally attached to the bell crank 16 is a counter weight 25 formed of several separate plates partly so as to admit adjustment of the tension in the belt 24. This counter weight 25 also through the bell crank 16, belt 24 and wheel slide 7 holds the nut 11 tightly and without play against the thread of the screw 12. The thrust thus caused on the screw 12 is taken by a knife edge which will be hereinafter fully explained.

Adjustably fastened to the reciprocating table 3 Fig. 6 in the slot 3^2 by the screw 26 and nuts 27 is the dog 28. Threaded into the dog 28 Fig. 3 is an adjustable knurled screw 29 having a knurled nut 30. The office of this screw is to actuate the lever 31 Fig. 5 fastened to the shaft 32 by means of the pin 33. Similarly another dog 34 Fig. 6 and Fig. 7 is adjustably fastened in the slot 3^2 and has threaded into it a knurled screw 35 having a knurled nut 36, this screw points in a direction opposite to the direction of the screw 29 and is located in the dog 34 so that it can actuate the lever 37, Fig. 5. This lever is fastened to the shaft 32 by means of a pin 38. Figs. 16 and 17 are detailed views of the levers 33 and 38.

Fastened to the lower end of the shaft 32 by means of the pin 39 is a feed plate 40 shown in detail views by Figs. 12 and 13; this plate is slotted and has fitted therein a block 41 adapted to be adjusted by the screw 42. The screw 42 taps into the block 41 and shoulders in the bearing 40′ Fig. 5 of the feed plate 40 and has a knurled knob 42′ pinned to it by the pin 42^2 Fig. 5 by which the block 41 can be adjusted from the maximum throw to zero. The block 41 has a cylindrical portion 41′ Fig. 12 forming a bearing for the connecting rod 43 and tapped into this turned portion 41′ is a screw 44 with a sufficiently large head to prevent the said rod 43 from dropping off. The feed plate 40 has an arm 40^2 into which is riveted a stud 45 at the lower end of this stud is pivotally connected a spring 46 in tension Fig. 3; the other end of this spring is similarly fastened to a stud 47 fixed in the base 1.

Fastened to the feed plate 40 Fig. 5 and thus to the shaft 32 by the pin 39 is a double armed lever 48 shown in detail by views Figs. 14 and 15; this lever is adapted to actuate the rod 49 through the stud 50 Fig. 3 and this rod is limited in a reciprocating motion by the studs 51 and 52 striking the base 1. The office of the rod 49 is to control the mechanism that reverses the direction of the motion of the table 3, and by means of the said studs 51 and 52 and the double lever 48 the intermittent oscillatory motion of the shaft 32 is limited in both directions being preferably approximately one half of a turn. The shaft 32 is journaled in a bracket 53 fastened to the base 1 by screws 54. The operation of this part of my grinding machine feeding mechanism is as follows; Fig. 3 the table 3 upon which the dogs 28 and 34 have respectively previously been adjusted by means of the said clamping screws 26, and then the screws 29 and 35 respectively adjusted so that the work 55 which rotates preferably in the direction of the arrow Fig. 9 will properly traverse the face of the wheel 9 which rotates in the direction of the arrow Fig. 8. As the reciprocating table 3 moves in the direction of the arrow Fig. 3 the rounded end of the screw 29 strikes the end of the lever 31 and has carried it and the shaft 32 with the members attached thereto into the position shown which is slightly more than one half of their total motion and also so that the spring 46 has sufficiently passed the dead center, and so that the tensions of the said spring is ample to complete the total oscillation of the shaft 32 and the members attached thereto. In this extreme position the end 48′ Fig. 3 and Fig. 14 of the lever 48 will come in contact with the stud 50 and move the rod 49 until the stud 52 strikes the base 1. Similarly when the table 3 moves in the direction opposite to the arrow Fig. 3 the rounded end of the screw 35 in the dog 34 strikes the lever 37 and by means of it and the spring 46 the end 48^2 of the double armed lever 48 will come in contact with the stud 50 and move the rod 49 until the stud 51 strikes the base 1 thus completing the oscillation of the shaft 32 in this direction. It will be noticed that the first part of the action of the shaft 32 in either direction is always positive being actuated respectively by the dogs fastened to the reciprocating table 3 and that the latter part is always by the power of the tension spring 46. This positive motion of the connecting rod 43 actuates a ratchet wheel 57 while the motion due to the spring 46 merely returns the ratchet pawl 60 for a new grip on the ratchet wheel 57. It will further be noticed that the positive motion of the rod 43 is always in the same direction, and that the spring motion is always in the opposite direction.

Fastened to the feed plate 40 is a scale 56 Figs. 5 and 13 graduated and figured so that each graduation respectively indicates a total number of table reciprocations necessary to complete one revolution of the ratchet wheel 57 when the block 41 is adjusted to that particular graduation by the screw 42; for instance, if the ratchet wheel 57 contained 120 teeth and the feed plate had twelve graduations they would respectively indicate 120, 60, 40 , 30, 20, 17, 15, 13, 12, 11, 10 and 9 passes of the table 3 to complete one revolution of the ratchet wheel 57 (17, 13, 11 and 9 are approximate). That is the pawl 60 could optionally be made to take either 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, or 13 teeth of the ratchet wheel 57 at each pass of the table 3. The usefulness of this possibility will be hereinafter fully set forth.

The ratchet wheel 57 is keyed to the cam hand wheel 58 by the key 59 Fig. 1 and the pawl 60 is pivoted on a stud 61 held by a plate 62 and a cover plate 63; the plate 62 being sufficiently cut away to allow proper action of the pawl ratchet wheel and connecting rod as shown by dotted lines in Fig. 4. These plates 62 and 63 are fastened together by the screws 64 and pins 65 and are adapted to oscillate one on a shoulder 58′ on the hub of the cam hand wheel 58, and the other on the shoulder 57′ of the ratchet wheel 57, by means of the connecting rod 43 which is pivotally connected to the said plates through the stud 66; this stud 66 is shown in its preferred relation to stud 61 in Fig. 4.

Fastened to the inside of the cam hand wheel 58 by means of the key 67 and screw 68 is a cam 69; the cam surface 69′ can be various shapes to suit the various kinds of work being ground. It is intended that the operator shall have several cams on hand to select from. Fig. 11 is a development suggesting one form the cam surface 69^1 may take. Beginning at the point near the arrow the cam has a rapidly rising surface increasing by variable increments until at the extreme left it terminates in a straight line. The cam surface 69^1 is adapted to actuate a roller 70 Fig. 1 with a preferably crowned periphery; this roller is supported by a stud 71 fastened into one end of the lever 72; this lever 72 which is shown by detail views Fig. 24 and Fig. 25 is slotted and straddles the screw 12 with sufficient clearance to perform its function without touching the screw; into portions of the lever 72 is threaded a ring 73 having a spanner hole 73^1 and having the inner surface 73^2 adapted for a knife edge bearing. The slotted end of the lever 72 has grooves 72^2 Fig. 24 adapted to receive the knife edge 74 shown by detail views Figs. 26 and 27; this knife edge is held in position on the lever 72 by pins 74′; the sides 72′ of the lever 72 are adjustably fitted in the cam block 75 shown in detail views Figs. 18 and 19; this block is fastened to the base 1 by the screws 76. Adjustably mounted in the cam block 75 is a slide 77 adapted to straddle the lever 72 and screw 12; this slide has mounted on it two knife edges 78 shown by detail views Figs. 22 and 23; these are tongued into the slide 77 and also pinned thereto by the pins 78^1; the slide is adjusted by means of the screw 79 and graduated knob 80, the screw 79 being shouldered in the cam block 75. On the screw 12 is a shoulder collar 12^1 and against this is located without play a split washer and knife edge bearing 81 shown also by detail views Figs. 28 and 29.

The operation is as follows: The screw 12 has a continual pull due to the counterweight 25 Fig. 8, thus forcing the knife edge bearing 81 against the knife edge 74 mounted on the lever 72, and this lever in turn through the ring 73 which is threaded into it forces the surface 73^2 of the said ring against the two knife edges 78 fastened on the slide 77, thus forcing the roller 70 against the cam surface 69^1 of the cam 69. Now assuming that the cam surface 69^1 approximates the developed surface shown in Fig. 11, then by turning the cam hand wheel

58 in the direction that the hands of a clock revolve, the said cam surface will cause the lever 72 to move the screw 12 and hence the wheel slide 7 and wheel 9 toward the axis of the work 55. If the total throw of the cam 68 is .18 of an inch and the adjustment of the slide 77 by means of the screw 79 is sufficient to allow the relation of the distance from the bearing point of the roll 70 to the bearing edge of the knife edge 78 and the distance of the bearing of the knife edge 78 to the bearing of the knife edge 74 to be respectively as 3 to 1 as a maximum or 3 to 0 as a minimum, then the maximum throw of the screw will be one third of .18 or .06 of an inch, then if the threads of the adjusting screw 79 are 20 per inch, and the number of graduations on the knob 80 are 60 then one graduation would indicate

$$\frac{1}{60}\times\frac{1}{20}\times .06 = .00005$$

of an inch movement of the screw 12 or .0001 of an inch change in the diameter of the work, and one turn of the knob 80 would indicate .006 of an inch change in the diameter of the work 55, and 20 turns would give the maximum or .12 of an inch variation.

The abrupt portion 69^2 of the cam 69 Fig. 11 is intended to allow the wheel slide 7 and wheel 9 to move sufficiently far back from the axis of the work 55 to allow the easy removal of the same and the inserting of another piece; when this new piece of work is in place on the centers 5^1 and 6^1 of the grinding machine and the machine has been started it is not necessary for the operator to wait until the wheel 9 due to the action of the cam 69 reaches the work 55, he can turn the cam hand wheel 58 in the proper direction by hand until the emery wheel 9 starts grinding and then allow it to continue automatically until it "knocks off" or stops itself, by means of the above said abrupt portion 69^2 of the surface of the cam 69 Fig. 11, which allows the counterweight 25 to pull the wheel 9 away from the work 55, because of the roll 70 dropping over the aforesaid abrupt portion 69^2 of the cam 69.

The hand wheel 82 is fastened to the screw 12 by the key 82^1 and has rotatively mounted on its hub 82^2 a disk 83, this disk can be clamped to the said hub by means of the knurled screw 84 threaded into the end of screw 12, the point of which 84^1 engages one end of a conically pointed pin 85 and is adapted to force the other end of the said pin into one side of the annular groove 83^1 in the disk 83 and thus clamp the disk 83 and hold it firmly against the surface 82^3 of the hand wheel 82. When it is desired to adjust the disk 83 the knurled screw 84 is slightly unscrewed. If the screw 12 is right handed and threaded into the half nut 11 and has 5 threads per one inch, so that one turn of the hand wheel moves the wheel slide 7 and wheel 9, .2 of an inch and if the disk 83 on its periphery is graduated into 400 divisions then one division would indicate

$$\frac{.2}{400} = .0005$$

of an inch movement of the abrasive wheel 9 or .001 of an inch in the diameter of the work 55.

Fastened to the plate 62 by a screw 86 is a plate 86^1 Fig. 3 having an index line thereon by which the amount of adjustment of the disk 83 can be ascertained. The hand wheel 82 and disk 83 are used to adjust the wheel 9 relative to the work 55. The cam mechanism hereinbefore described will always knock off or stop grinding the work as soon as the said wheel 9 has reached a limit fixed by the cam 69; now that limit can be changed as hereinbefore explained by turning the knob 80. It can also be changed a fraction of one thousandth of an inch or more by turning the hand wheel 82. By making note of the particular graduation the emery wheel 9 can be easily returned to the same point after grinding a number of other sizes or shoulders on the same or different pieces of work, for instance if another diameter on the work is .200 of an inch larger or smaller, one turn of the hand wheel in the proper direction will properly locate the wheel 9 for grinding the said shoulder. That is any number of diameters can readily be reproduced by returning the hand wheel 82 and disk 83 to their proper graduated point. Any change due to the wear of the abrasive wheel can when necessary be corrected by the fine adjustment provided by the screw 79 and knob 80 as hereinbefore described.

Having described my new grinding machine feeding mechanism I will now give a general description of the operation.

The abrasive wheel 9 being of the proper grade and revolving at the correct speed in the direction of the arrow Fig. 8 and the work 55 or piece to be ground being snugly located on the centers 5^1 and 6^1, and rotated thereon by means in the head 5 in the direction of the arrow Fig. 9, and the table 3 reciprocating through a proper distance in the tracks 3^1 determined by the dogs 28 and 34 Fig. 7, the operator knowing the approximate amount of material to be received from the work optionally turns the knob 80 on the screw 79 and moves the knife edges 78 until the graduation on the cam block 75 Fig. 19 indicates a maximum total longitudinal movement of the screw 12, as for instance .04 of an inch. Then the operator optionally determines about the number of passes or reciprocations the work must make. That is if the work is to be reduced in diameter .08 of an inch that is .04 of an inch on a side, and the feed of the wheel 9 toward the axis of the work 55 is to be actuated by a cam feeding by constant increments, the feeding taking place at each end of the work when the respective dog actuates the feeding mechanism, then if the block 41 is set at the graduation for ten passes on the scale 56 each pass of the wheel will remove .004 of an inch of material from the work 55 and after ten passes the cam 69 will have made about one revolution and the abrasive wheel 9 and slide 7 will have moved back from the work 5 5 and the work can then be removed and a new piece inserted.

In the above case if the block 41 had been set for twenty passes then .002 of an inch of material would have been removed at each pass providing that the cam face 69^1 was shaped to give constant increments of feed. But if the operator has used a cam with a surface approximately that shown by 69^1 Fig. 11 then the feeding increments would vary. The first increments being greater than the last for the purposes set forth and obviously the work would be done much more quickly and with a better finish than with the constant feed cam, but for facing a shoulder the constant increment feed would perhaps be best. After the grinding machine has automatically ground one piece exactly to the required dimensions, it will duplicate any number of pieces the only element of change being the wear of the grinding surface of the wheel 9, this is known to be very little ordinarily and the error in the work can when necessary be corrected by turning the knob 80.

Work having a number of diameters can easily be duplicated as hereinbefore explained by noting the respective graduation on the disk 83.

I claim:

1. The combination of a stroke-regulating means for finishing the work; a cam for regulating amount of stock to be removed; means for gradually reducing the amount of feed; means for stopping the feed at a predetermined point and making a number of traverses of the work past the wheel without feeding; means for compensating for wear of the wheel; means for grinding different diameters of work with the same initial adjustment; and means for measuring differences in the diameter of the work.

2. In a grinding machine, the combination of stroke-regulating means for finishing the work with means for regulating the amount of stock to be removed and including a movable cam.

3. In a grinding machine, the combination of a cam for gradually reducing the amount of feed with means for stopping the feed at a predetermined point and making a number of traverses of the work past the wheel without feeding.

4. The combination of means for stopping the feed at a predetermined point; means for making a number of traverses of work past the wheel without feeding; and means for compensating for the wear of the wheel, said means for stopping the feed at a predetermined point including a cam feed mechanism and also a cam limiting the movement of the grinding mechanism.

5. In a grinding machine feeding mechanism, the combination of a lever with a fixed knife edge adapted to engage a wheel support; a wheel support; a roller adapted to be actuated by a cam; a cam; a fulcrum plate adapted to co-act with the knife edge to form the fulcrum for said lever, the said fulcrum knife edge being adjustable relatively to said fixed knife edge.

6. The combination in a grinding machine of a feeding mechanism; a bracket for supporting the feed works; a reciprocating table, and mechanism for actuating the feed through a feed-rod by means of a reciprocating table.

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

CONRAD M. CONRADSON.

Witnesses:

FREDERICK D. STANTON,

ALBERT E. MOIR.