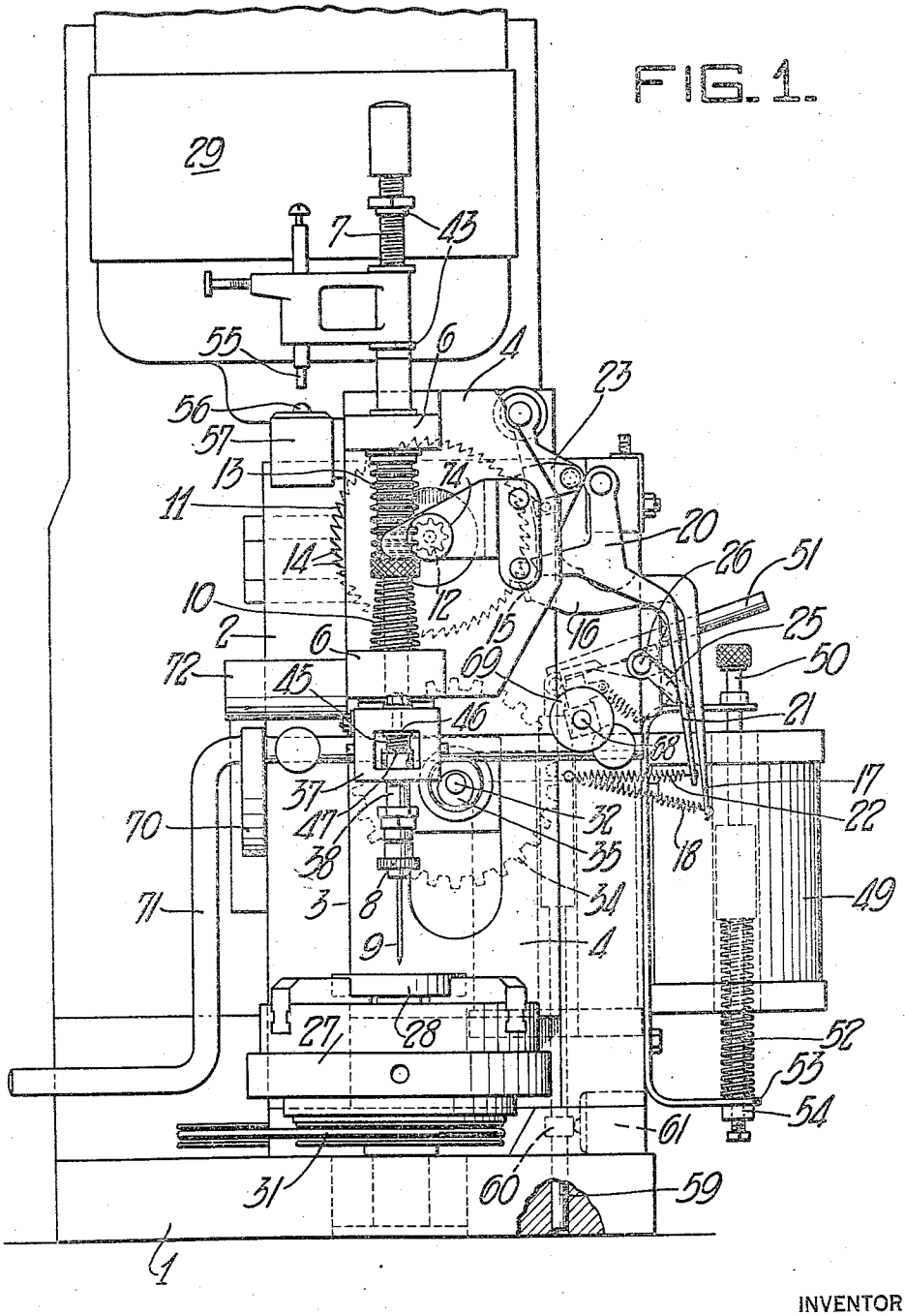
Jan. 1, 1946. A. D. KUTZLER 2,391,983

HOLE LAPPING MACHINE

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FIG. 1.



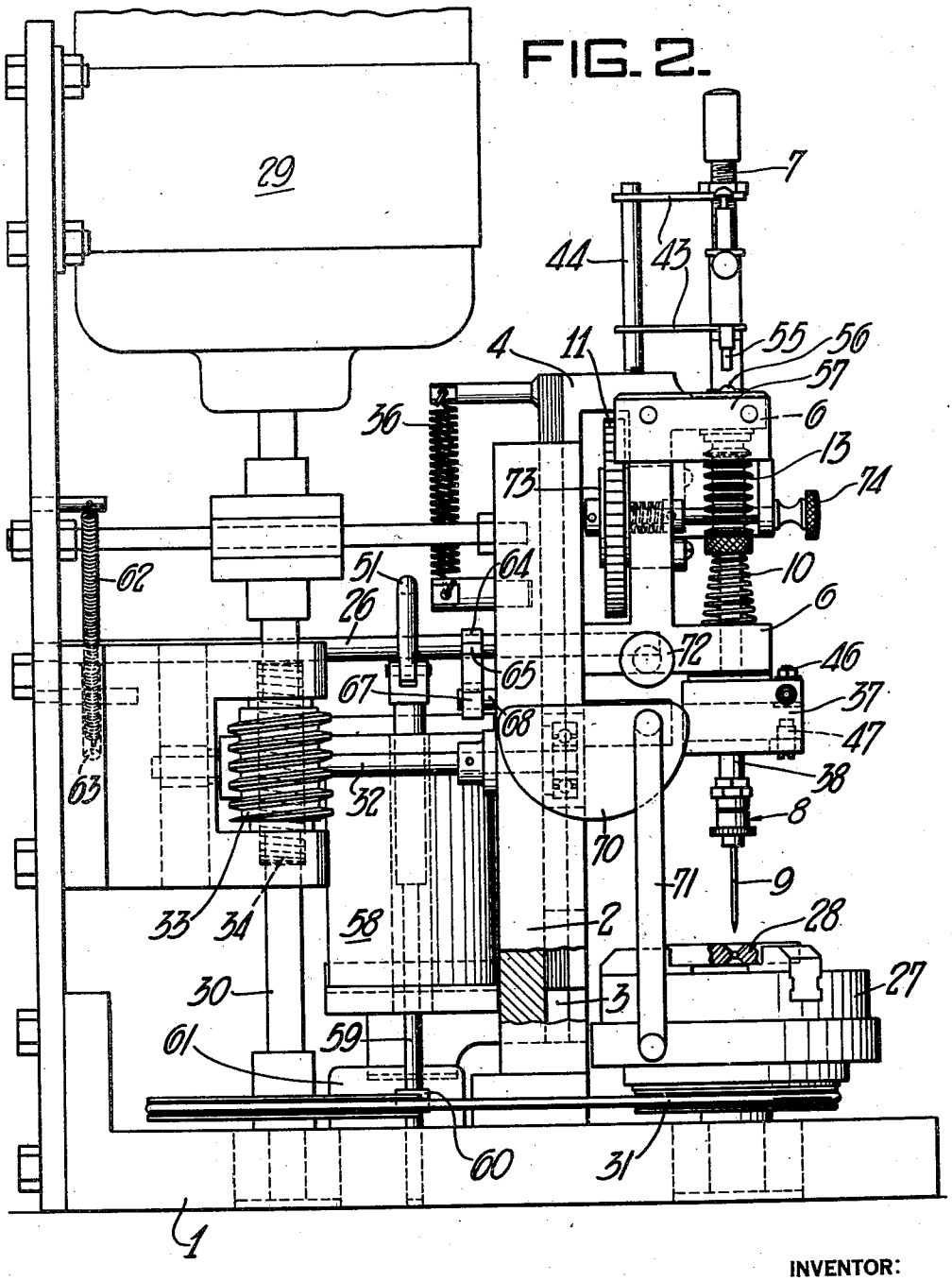
INVENTOR:
ADOLPH D. KUTZLER,
BY: John E. Jackson
HIS ATTORNEY.

Jan. 1, 1946. A. D. KUTZLER 2,391,983

HOLE LAPPING MACHINE

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FIG. 2.



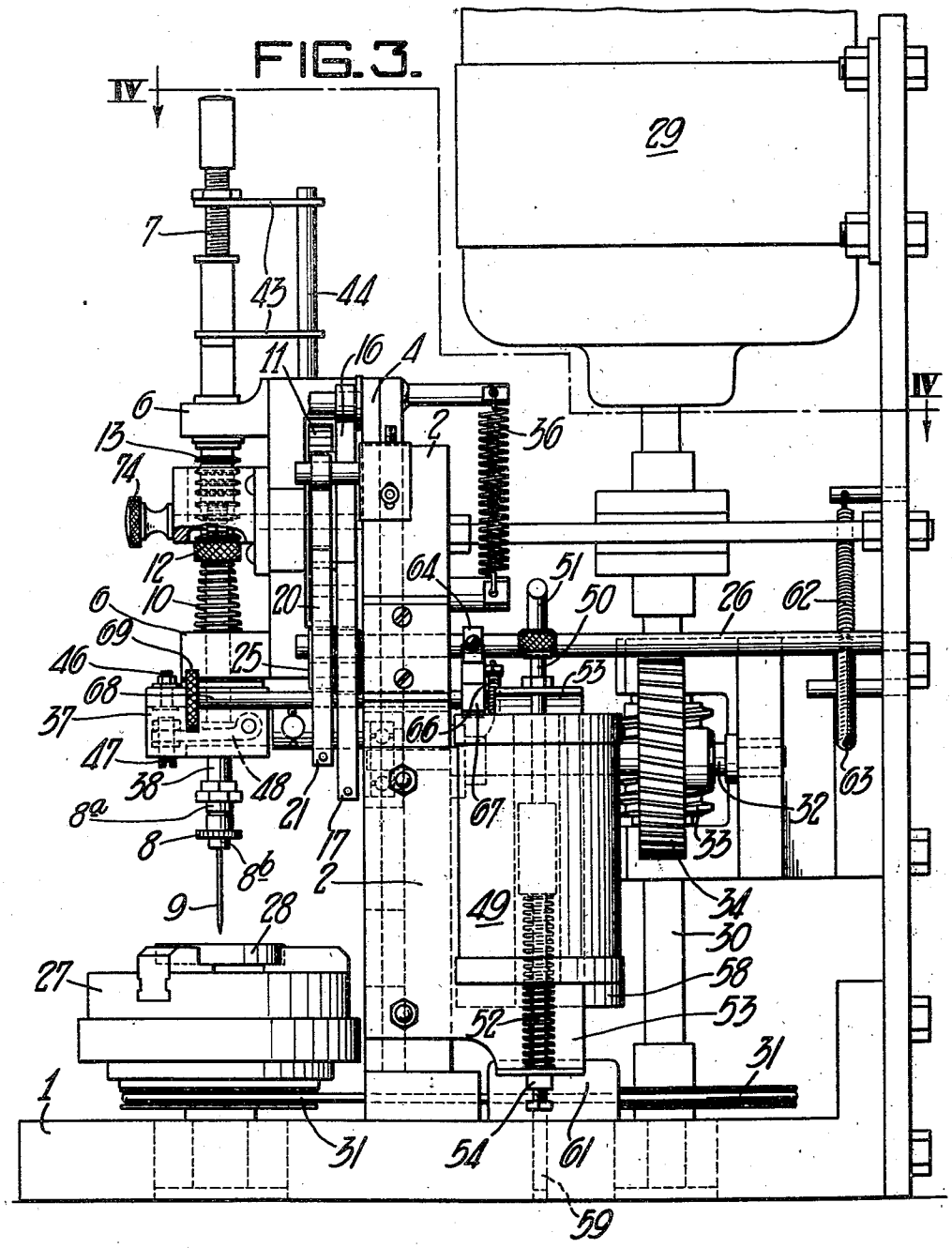
INVENTOR:
ADOLPH D. KUTZLER,
BY: John E. Jackson
HIS ATTORNEY.

Jan. 1, 1946. A. D. KUTZLER 2,391,983

HOLE LAPPING MACHINE

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FIG. 3.



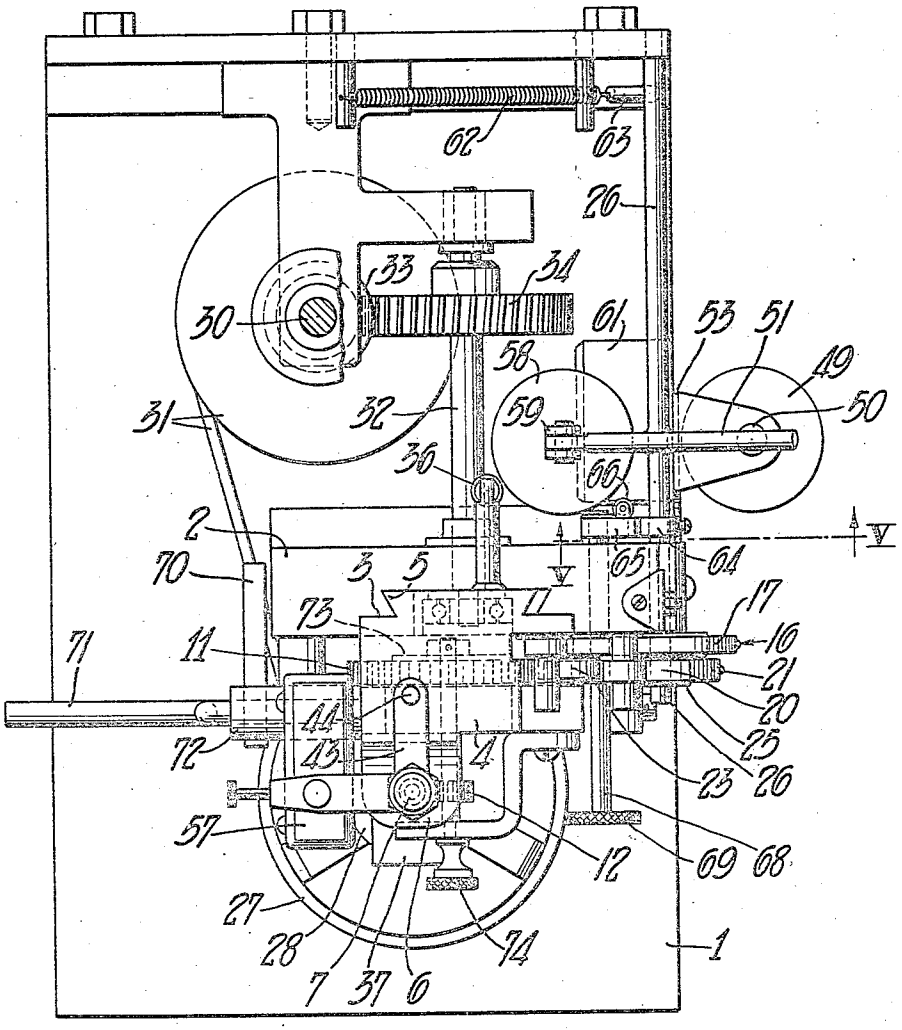
INVENTOR:
ADOLPH D. KUTZLER,
BY: John E. Jackson
HIS ATTORNEY.

Jan. 1, 1946. A. D. KUTZLER 2,391,983

HOLE LAPPING MACHINE

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FIG. 4.



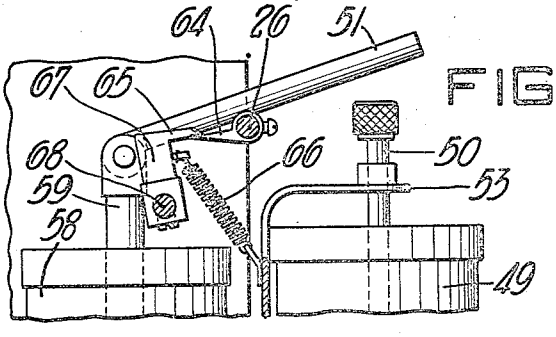


FIG. 5.

INVENTOR:
ADOLPH D. KUTZLER,
BY: John E. Jackson
HIS ATTORNEY.

Jan. 1, 1946. A. D. KUTZLER 2,391,983

HOLE LAPPING MACHINE

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FIG. 6.

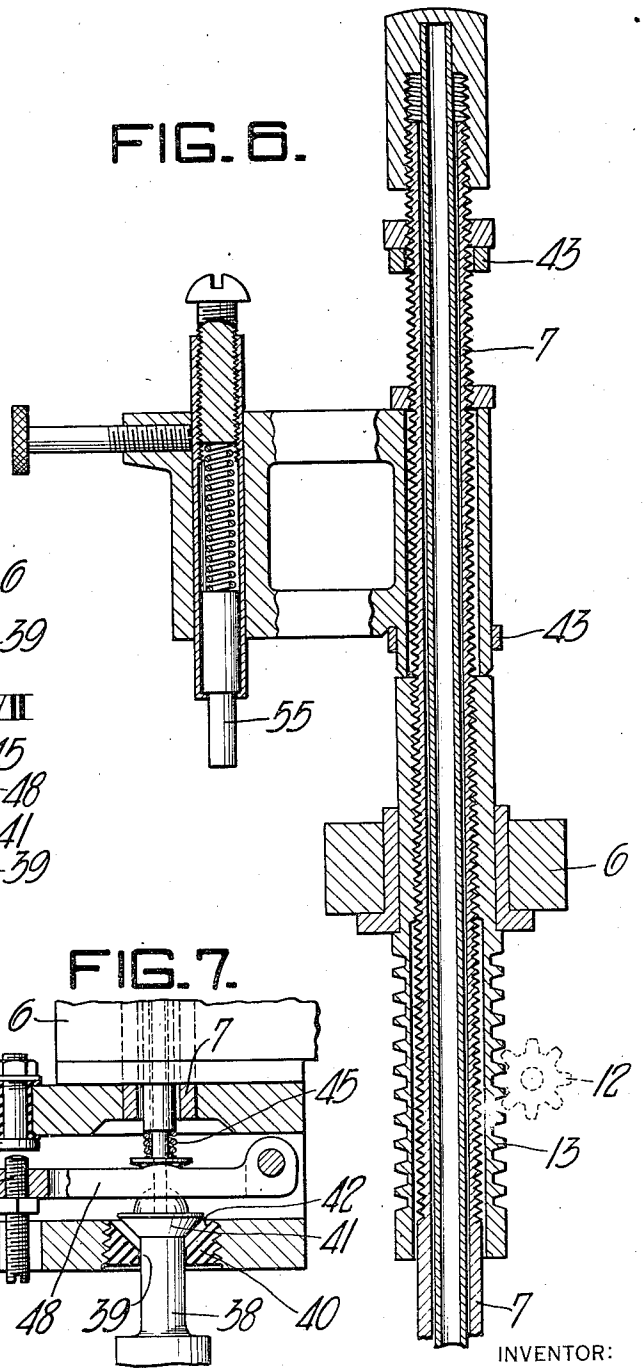


FIG. 6a.

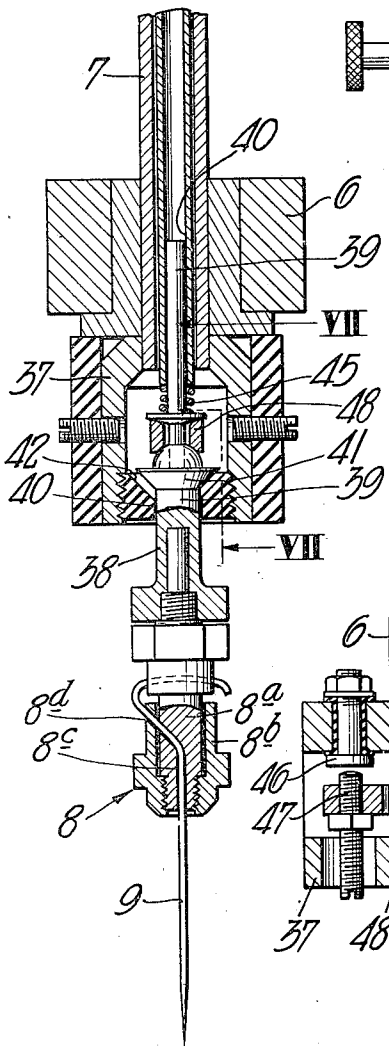


FIG. 7.

INVENTOR:
ADOLPH D. KUTZLER,
BY: John E. Jackson
HIS ATTORNEY.

Jan. 1, 1946. A. D. KUTZLER 2,391,983

HOLE LAPPING MACHINE

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FIG. 8.

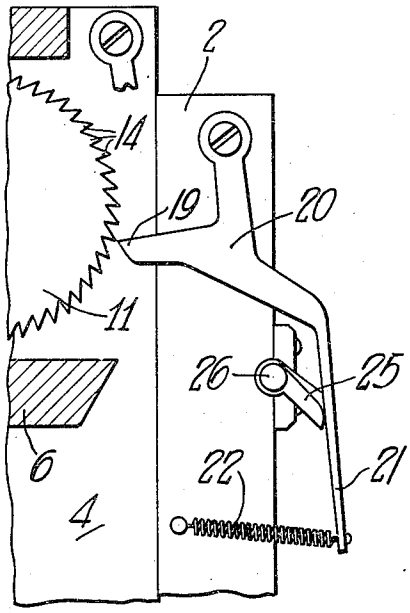


FIG. 10.

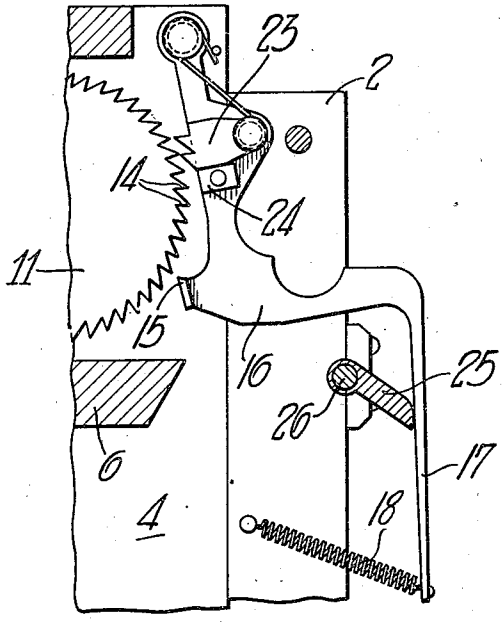


FIG. 9.

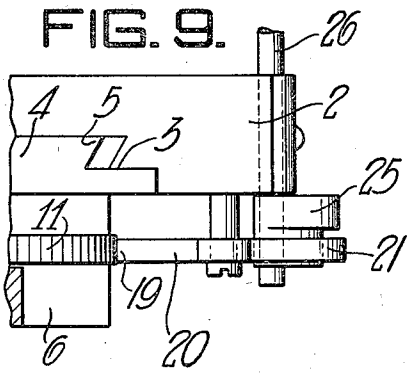
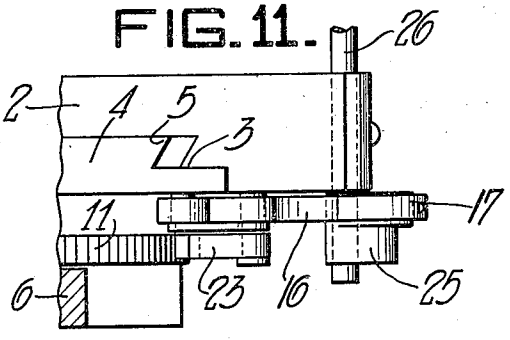


FIG. 11.



INVENTOR:
ADOLPH D. KUTZLER,
BY: John E. Jackson
HIS ATTORNEY.

Patented Jan. 1, 1946 2,391,983

UNITED STATES PATENT OFFICE

2,391,983

HOLE LAPPING MACHINE

Adolph D. Kutzler, Waukegan, Ill.

Application November 21, 1944, Serial No. 564,484

6 Claims. (Cl. 51—67)

This invention is exemplified by a machine especially designed to lap to finished size the bearing section of the die hole of a wire drawing die, but the principles may be applicable to the lapping of a hole in other objects. This exemplary machine has the advantages that it can lap a wire drawing die hole more precisely toward perfection, more accurately, and with less lapping tool breakage, than has heretofore been usual.

Having reference to the accompanying drawings illustrating this exemplary machine, the various figures are as follows:

Figure 1 is a front view;

Figure 2 is a left side view;

Figure 3 is a right side view opposite the view of Figure 2;

Figure 4 is a top view taken from the line IV—IV in Figure 3;

Figure 5 is a detail taken from the line V—V in Figure 4;

Figures 6 and 6a are longitudinal sections of details;

Figure 7 is a section taken from the line VII—VII in Figure 6a;

Figure 8 is a sectioned detail;

Figure 9 is a top view of Figure 8;

Figure 10 is a sectioned detail; and

Figure 11 is a top view of Figure 10.

More specifically, this illustrated machine has a base 1 rigidly carrying an upstanding support 2 providing a vertical guideway 3 vertically reciprocatively supporting a carriage 4 by way of a carriage tongue 5 riding the guideway 3. This carriage 4 has horizontal brackets 6 vertically reciprocatively mounting a rod 7 having a lower end carrying a chuck 8 for the die hole lapping tool 9, whereby the rod 7 functions as the mount for this chuck. This rod 7, or chuck mount, has a compression spring 10 arranged to provide a quick-acting force source continuously biasing the rod 7 to move relative the carriage 4 away from the pointing or working direction of the tool 9, which tool points away from the rod 7 parallel the reciprocating direction of all the various reciprocative parts, which all reciprocate relatively parallel. A ratchet wheel 11 is rotatively carried by the carriage 4 and is geared, through a pinion 12 and rack 13, to the rod 7 with its teeth 14 pointing counter the direction the rod 7 moves it when the rod moves relative the carriage under the bias of the spring 10. Such movement of the ratchet wheel 11 is prevented by a pawl 15 carried by the carriage 4 through a lever 16 swinging radially of the ratchet wheel 11 so that this pawl 15 releasably engages the teeth 14 of the ratchet wheel and prevents the described movement while permitting the ratchet wheel to oppositely turn in a direction feeding the rod 7 downwardly relative the carriage 4 against the bias of the spring 10. The lever 16 has a long depending arm 17 with a lower end tensioned radially toward the ratchet wheel by a spring 18 connecting with the support 2.

The rod 7 is fed downwardly relative the carriage 4 through the medium of a feeding pawl 19 carried by a lever 20 pivotally mounted by the support 2 so as to also swing radially respecting the ratchet wheel 11 and also having a lower depending arm 21 forced radially toward the ratchet wheel by a spring 22 connecting with the support 2. However, this pawl 19 and its mounting lever 20 do not reciprocate with the reciprocating carriage 4, since the lever 20 is pivoted to the non-moving support 2, and the pawl 19 lies in the reciprocative path of the ratchet wheel 11 so the latter is intermittently turned tooth-by-tooth during each of the downward reciprocative strokes, whereby to effect progressive downward feeding of the rod 7, functioning as a mount for the chuck 8, which feeding is in the tool pointing direction, against the bias of the spring 10, the pawl 15, which reciprocates with the carriage 4, preventing reverse rotation of the ratchet wheel 11 so long as this pawl is not released.

If this pawl 15 is released, then the spring 10 practically immediately jerks the rod 7 upwardly relative the reciprocating carriage 4, whereby to jerk upwardly the lapping tool 9, and it is now in order to note that the lever 16, which reciprocates with the carriage 4, also mounts a multiple-toothed pawl 23 which engages the teeth 14 and is closer to the swinging axis of the lever 16 so as to remain engaged with the teeth 14 upon partial swinging of the lever 16 sufficient to release the pawl 15 from the teeth 14, this swinging pawl then turning with the then reversing ratchet wheel until it swings into contact with a stop 24, these parts therefore providing an escapement permitting rotation of the ratchet wheel 11 a predetermined distance, which is shown as equalling two ratchet teeth, in a direction permitting the rod 7 to move upwardly away from the pointing direction of the tool 9 upon release of the pawl 15. To accomplish such action it is also necessary to release the feeding pawl 19, it being for this reason that the reciprocating lower lever arm end 17 and the similar but nonreciprocating end 21 are arranged closely together and approximately parallel so that they both can be worked by a cam 25 fixed to a horizontal shaft 26 journaled in the

support 2 and having cam ends bearing against both the lever ends, the reciprocating lever end being shaped appropriately to slide during the camming action of the cam 25. The arrangement is such that limited swinging of the cam 25 swings both the lower lever arm ends radially away from the ratchet wheel 11, the lever pivots and lever arm lengths being so related that this results in releasing both the pawls 15 and 19 from the ratchet wheel teeth 14 without freeing the escapement pawl 23.

It becomes apparent that while the carriage 4 reciprocates the rod 7 is progressively fed downwardly unless the cam 25 is partially swung, in which case the rod 7 immediately very quickly feeds, or is jerked, upwardly twice the distance it has been feeding downwardly, this being true in the case of the exemplary machine, or any multiple of the downward feeding distance, and that a return swinging of the cam 25 again permits the downward feeding to immediately restart. Also, complete swinging of the cam 25 swings both the levers 16 and 20 away from the ratchet wheel teeth so far that the ratchet wheel is completely free, whereupon the rod 7 very rapidly is jerked, or fed, upwardly to the full extent of its reciprocative limits.

The base 1 vertically journals a horizontal chuck 27, of the type capable of engaging and precisely centering a cylindrical object with its axis concentric the revolving axis of the chuck, this type of chuck being used because the machine under discussion is designed to handle tungsten carbide dies, such as the die 28 illustrated in the jaws of the chuck 27, these dies having a cylindrical steel shell and the die hole being formed in the tungsten carbide insert axially concentric with this shell. It is to be understood that the idea is to lap the bearing section of the die hole in this die, the die hole being already formed through the tungsten carbide insert but not having its bearing section lapped to give its exact diameter and polish, this being the function of the tool 9. Incidentally, this tool 9 may be a special tool, or may be simply a piece of pointed wire of the proper diameter, it being necessary to reciprocatively advance the tool through the hole with a suitable abrasive while relatively rotating the die and tool.

Relative rotation between the chuck 8 and the chuck 27, required to effect relative rotation between tool 9 and die 28, is effected by a vertical electric motor 29, of the rotary type, having its armature shaft directly coupled to a vertical drive shaft 30 which is rotatively geared to the chuck 27, through a belt drive 31. Power from this drive shaft 30 is also used to reciprocate the carriage 4, this being done by a horizontal cam shaft 32 to which the shaft 30 is geared, by a worm 33 and worm gear 34, with this cam shaft working a cam 35 working against the carriage 4, the cam being in the form of a ball bearing mounted eccentrically respecting the axis of the shaft 32, and the carriage being held against this cam either solely by its gravity, or, more positively, by gravity plus a coil tension spring 36 connecting the top of the carriage 4 with the support 2 so as to keep the carriage spring-biased downwardly. This illustrative machine is designed so the chuck 27 rotates at about 2000 R. P. M. while the carriage 4 reciprocates vertically at 120 cycles per minute with a total reciprocative stroke of about one-quarter of an inch.

With the motor 29 operating, the chuck 27 rotates, so as to rotate the die 28, and the carriage 4 reciprocates vertically with the rod 7, mounting the chuck 8, gradually feeding toward the die by reason of the rotation of the ratchet wheel 11 by the pawl 19 engaging its teeth so as to turn it a distance of one tooth for each of its downward reciprocative strokes. This causes the tool 9 to reciprocatively enter the die hole of the die 28 and progressively lap its bearing section to size and finish. If there is any binding the tool 9 may receive sufficient torque to break or deform it and it may also receive sufficient thrust to possibly damage it. What is more important, however, is that in the case of such binding the bearing section of the die may be damaged, perhaps in such an imperceptible manner that the damage is reflected only in poor wire drawing qualities, the reason for which is very difficult to detect. In addition, after the tool 9 has properly lapped the bearing section of the die hole it should be immediately withdrawn because its continued working results in an over-sized die hole.

With the above in mind, the rod 7 mounts the chuck 8 through a thrust connection 37 permitting the chuck 8 to reciprocate relative the rod 7 while maintaining it in axial alignment therewith, this being done by screwing the chuck into a spindle 38 having spaced journals 39 working rotatively and reciprocatively in appropriately spaced journal bearings 40 provided in the lower end of the rod 7 and in the connection 37. The spindle 38 has a conical part 41 that cooperates frictionally with a conical part 42 inside the connection 37, this connection being nonrotative respecting the rod 7 and the latter being non-rotative respecting the carriage 4 by being fixed to horizontal brackets 43 at its upper end which slide on a vertical pin 44 fixed to the carriage top parallel the rod 7 and offset therefrom. The conical parts 41 and 42 are biased together by a coil compression spring 45, which also functions to bias the chuck 8 downwardly away from the rod 7 in the pointing direction of the tool 9, whereby a friction drive is effected between the chuck 8 and the rod 7 which is automatically responsive to a predetermined amount of torque on the chuck 8, and its tool 9, with the amount determined by the frictional coefficients and areas of the conical parts 41 and 42 and the elastic force exerted by the spring 45, to automatically and practically immediately stop the relative rotation between the two chucks 8 and 27, and hence between the tool 9 and the die 28, by reason of this friction drive slipping when the torque becomes so great it is unable to carry it.

Therefore, should the tool 9 rotatively bind a bit in the bearing section of the die hole, the tool 9 immediately stops rotating relative the work, since it immediately rotates with the work so that it is relatively stationary respecting the same. Because of the reciprocation involved, the tool 9 is withdrawn and, since the clutch action is automatic, it immediately stops rotating, whereupon on the next feeding reciprocative stroke it again tries to work the part where binding occurred and, if it cannot, again begins to rotate with the work so as to avoid relative rotation, with the consequent dangers attendant thereto which have been explained. This action continues until ultimately the part causing binding wears to a degree permitting lapping operations to proceed normally.

If the thrust on the tool 9, resulting from binding of the tool in the bearing section of the die

hole, exceeds the elastic force exerted by the spring 45, then the chuck 8 moves upwardly slightly so as to completely separate the conical parts 41 and 42 and completely break the frictional connection between these parts, at which time the chuck 8 rotates completely freely with the chuck 27. When this occurs, an electric switch is operated, this switch being represented by a fixed electrical contact 46, carried by the connection 37, and a moving electrical contactor 47 carried by the long arm of a lever 48 pivoted for vertical swinging by the connection 37 and connecting with the spindle 38 so as to move the contactor 47 against the contact 46 by the upward reciprocation of this spindle, resulting when the rod 7 is reciprocating toward the chuck 27 and the spring 45 is unable to withstand the force exerted by the tool 9 working in the die hole. That is to say, the connection 37 also functions, through the working of the spring 45, to provide a device for measuring the thrust pressure exerted on the chuck 8 by the tool 9, and the contacts 46 and 47 automatically close when this thrust pressure exceeds a predetermined value set by the elasticity of the spring 45.

The contactors 46 and 47 are connected in an electrically powered circuit with an electric solenoid 49 which is energized when the contactors close and then thrusts an armature rod 50 upwardly so it engages one end of a two-armed lever 51 fixed to the shaft 26, the armature rod 50 which thrusts upwardly having a downwardly extending extension 52 passing through a bracket 53 and provided at its lower end with a stop 54 which engages this bracket 53 and limits upward movement of the thrusting end of the rod 50 to a distance causing the lever 51 to turn the shaft 26 just sufficiently to partially throw the cam 25 so it partially throws the levers 16 and 20, as required to release only the pawls 15 and 19 from the ratchet teeth 14 in the fashion already described. It becomes apparent that whenever the device measuring the thrust on the chuck 8 measures an amount that is predetermined, by the elasticity of the spring 45, as being the maximum that can be properly applied to the tool 9, during its forward reciprocation into the die hole, that the means described, automatically in immediate response to this measurement of this predetermined amount of thrust pressure, effects upward feeding of the rod 7, and because of the quick-acting nature of the spring 10 this upward movement is considerably more rapid than the downward movement of the reciprocating carriage 4, whereby the tool is jerked upwardly respecting the die so as to be immediately relieved of all pressure, this then resulting in the frictional drive parts 41 and 42 immediately reengaging so that the chuck 8, which is free to spin during the period of excess pressure, is again held against rotation, so relative rotation between the tool and work immediately is re-established unless the rotary binding should be too great. The escapement 23 is arranged so that this backward feeding, effected when the pressure becomes too great, is double the forward feeding stroke intermittently effected during each downward reciprocation of the carriage 4. Thus, the carriage 4 reciprocates downwardly, the ratchet wheel 11 is turned a distance equaling one of its teeth 14, and, if the undue pressure is encountered, both the pawls 15 and 19 are immediately released so that the ratchet wheel 11 immediately flies the other way a distance equaling two of its teeth, thus unfeeding the rod 7 twice the distance it was initially fed.

In operation, the tool 9 is reciprocated up and down in the bearing section of the die hole while the die rotates relative the tool, the tool carefully feeling its way along and being ready to start spinning with the die immediately when the resistance to the relative rotation becomes too great, and all the time carefully feeding through the bearing section, while likewise feeling its way, and, immediately upon meeting too much thrusting resistance, jerking itself backwardly a distance somewhat greater than it fed forwardly, yet not so great a distance as to completely remove it from the die hole. In connection with this last, resistance is usually encountered after the tool has penetrated the die hole some distance and it is undesirable to yank the tool completely free from the bearing section, since this is not conducive to a fine finish, so the machine is arranged so that the forward feeding is accomplished intermittently with very small distances of intermittent feeding motion, and so that the tool is jerked back just a little farther than it was fed when it encounters too much thrust. Of course, the tool again feeds to the place where binding occurred, and if the binding conditions have not been alleviated by the abrasive action, the tool will again be jerked back, and sometimes this may happen a number of times, but ultimately the tool gently feeds through the entire bearing section while effecting a very uniform and gentle lapping such as is required to finely and exactly finish the bearing section to size.

The top of the rod 7 carries a finger 55 which moves downwardly with the rod during the latter's feeding, this finger being vertically adjustable and being adjusted so that just after the tool passes completely through the bearing section of the die hole, so the lapping operation is completed, the finger 55 contacts the button 56 of a microlimit switch 57 which electrically connects a suitable powered electrical circuit to a second solenoid 58, this pulling down on an armature rod 59 connecting with the other end of the two-armed lever 51 and rocking the shaft 26 so as to fully throw the cam 25 far enough to move the ends of the levers 16 and 20 far enough in a radial direction away, from the ratchet wheel 11, to completely free all of the pawls 15, 19 and 23 from the ratchet teeth, this completely freeing the rod 7 from restraint so that the spring 10, which constantly biases the rod 7 to an upward position all the time, functions to jerk the rod 7 to its reciprocation limit relative the carriage 4, this jerking the tool 9 out of the die hole before the latter can be enlarged to an oversize.

This armature rod 59 of the solenoid 58 carries a cam 60 which presses on the button of a limit switch 61 in the electrical circuit through which the motor 29 is powered so as to automatically stop the motor and stop reciprocation of the carriage 4 and rotation of the chuck 27, all automatically upon completion of the die hole lapping operation. A tension coil spring 62 pulls on a lever arm 63 fixed to the shaft 26 in such a fashion that the shaft is always biased to turn in a direction lifting the armature rod 59, of the solenoid 58, so that the cam 60, on the bottom end of this armature rod, continuously tends to move away from the button of the swtich 61, the release of which would result in restarting of the motor 29. To lock the shaft 26, against such rotation under the bias of the spring 62, it is provided with a catch 64 which cams by a sear

65, against the resistance of a spring 66, and which sear 65 is carried by a lever 67 which can be thrown by a shaft 68, externally of the machine, through the medium of a convenient turn knob 69.

The action is such that when the solenoid 58 is energized, the machine stops operating, the lock 64 camming past the sear 65 and preventing reverse turning of the shaft 26. The workman then removes the finished die 28 and substitutes another, to have its die hole lapped, and he can then restart the machine simply by turning the knob 69 far enough so the sear 65 releases the lock 64, the spring 62 then jerking the shaft 26 around and this raising the armature rod 59 of the solenoid 58 so that the cam 60 on the lower end of this rod clears clears the button on the switch 61, the motor 29 then immediately starting.

During die changing, the reciprocative carriage 4 may be raised quite well up, to provide safe clearance between the tool 9 and the die, by means of a cam 70, which can be thrown by a handy crank 71, which engages a stud 72 fixed to the carriage so as to lift the latter and hold it up. The handle 71 is thrown back downwardly after the die 28 is held in the chuck 27. To avoid the inconvenience of waiting for the relatively slow feeding of the rod 7 downwardly to a point where the tool 9 starts working, the ratchet 11 connects with the pinion 12 through a friction clutch 73 and the pinion shaft extends outwardly and is provided with a knob 74 which may be turned, against the frictional resistance of the friction drive 73, to lower the rod 7 an appropriate amount, care being taken not to jam the tool 9 into the die hole. This friction drive also provides a safety feature should the motor 29 continue to operate, through failure of the switch 57 or the ordinary electrical apparatus required to make this arrangement work, because when the rod 7 reaches the limits of its downward reciprocation relative the reciprocating carriage 4, the friction drive 73 slips.

Before concluding, it is appropriate to note the details of the chuck 8 which is remarkable for its simplicity and effectiveness. It has been mentioned that the tool 9 may consist of an appropriately pointed piece of wire having the same size as that to which it is desired to finish the die hole bearing section, and the chuck 8 merely consists of two parts 8^a and 8^b screwed concentrically together with the part 8^a having a bore 8^c that is partially in axial alignment with the chuck and which partially deviates so as to extend laterally, the part 8^b which screws on the part 8^a having a bore 8^d which may be registered with this laterally or radially extending portion of the bore 8^c. With this arrangement, the pointed wire is simply fed up through the bore 8^c so as to come out through the bore 8^d in the part 8^b, the two bores having been registered, whereupon by forcibly turning the part 8^b relative the part 8^a, the portion of the wire extending through both bores is jammed so as to lock the wire in the chuck. If desired, a relatively long curlicue of wire may be left projecting beyond the bore 8^d so that when the working end, which is functioning as the tool 9, becomes too short through wear, the part 8^b can be turned slightly, to loosen the wire, the wire then pulled through somewhat farther, the part 8^b being then again turned to jam the wire and the tool being again ready for use while having the appropriate length.

I claim:

1. A machine including a holder for an object having a hole to be lapped, a chuck for holding a lapping tool for this hole in axial alignment therewith when the object is held by the holder, means for causing relative axial reciprocation of the chuck and holder while progressively feeding them together, means for causing relative rotation of the chuck and holder, and means automatically responsive to torque on the chuck for stopping said rotation whenever said torque attains a predetermined value.

2. A machine including a holder for an object having a hole to be lapped, a chuck for holding a lapping tool for this hole in axial alignment therewith when the object is held by the holder, means for causing relative axial reciprocation of the chuck and holder while progressively feeding them together, means for causing relative rotation of the chuck and holder, and means automatically responsive to feeding of the chuck and holder together a predetermined distance for quickly feeding them apart far enough so the tool held in the chuck is pulled free from the hole of the object held by the holder.

3. A machine including a holder for an object having a hole to be lapped, a chuck for holding a lapping tool for this hole in axial alignment therewith when the object is held by the holder, means for causing relative axial reciprocation of the chuck and holder while progressively feeding them together, a device for measuring the axial thrust pressure on the chuck during relative reciprocative strokes of the chuck and holder together, and means automatically responsive to the device measuring a predetermined pressure for momentarily interrupting said feeding and reversely feeding the chuck and holder at a speed exceeding that of said strokes for a predetermined distance.

4. A machine including a holder for an object having a hole to be lapped, a carriage linearly reciprocating parallel to the axis of this hole when the object is held by the holder, a chuck for holding a lapping tool for this hole in axial alignment therewith and which is carried by the carriage for linear movement relative thereto and parallel to said axis, a quick-acting force source continuously biasing the chuck to move relative the carriage away from the holder, releasable means for progressively moving the chuck relative the carriage toward the holder against the bias of this force source, an escapement for limiting movement of the chuck relative the carriage away from the holder by the bias of the force source to a predetermined distance, means for measuring the thrust force on the chuck and means for quickly releasing the releasable means automatically in response to the measuring means measuring a predetermined amount of thrust on the chuck.

5. A machine subcombination including a chuck for a lapping tool for reciprocation and relative rotation in a hole in an object, a mount for the chuck, means for connecting the chuck to the mount for reciprocation relative thereto axially of a tool held by the chuck, a spring biasing the chuck to move relative the mount toward the working direction of such a tool and taking the thrust during working of the tool, a carriage carrying the mount for reciprocation relative thereto in a direction axially of a tool held by the chuck and which reciprocates in a direction parallel to this direction, a spring biasing the mount to move relative the carriage away from the

working direction of a tool held by the chuck, releasable feeding means for progressively feeding the mount relative the carriage against the bias of the second named spring toward this working direction, an escapement for limiting movement of the mount relative the carriage away from this working direction by the bias of the second named spring upon release of the feeding means from the mount, and means worked by movement of the chuck relative the mount against the bias of the first named spring due to the thrust of the tool for releasing the reseasable feeding means from the mount.

6. A machine for lapping the bearing section of the die hole of a wire drawing die, said machine including the combination of a support, a carriage supported by said support for linear reciprocation, means for reciprocating said carriage, a chuck for the lapping tool, a mount for said chuck which is carried by said carriage for reciprocation relative thereto parallel to the latter's reciprocating direction and mounting said chuck so a tool held by the latter points parallel to the reciprocating directions of said mount and carriage, a spring biasing said mount to move relative said carriage away from the pointing direction of a tool held by said chuck, a ratchet carried by said carriage and geared to said mount with teeth pointing counter the direction the ratchet moves when said mount moves relative said carriage under the bias of said spring, a releasable pawl carried by said carriage and engaging said teeth to prevent movement of said ratchet due to said bias and to hold the mount against movement opposite said tool pointing direction, a releasable escapement carried by said carriage and engaging said teeth for limiting movement of said ratchet under said bias to a predetermined distance upon release of said ratchet, a pawl fixed in the path of said teeth as said ratchet reciprocates with said carriage to engage said teeth and move said ratchet in a direction feeding said mount relative said carriage in said tool pointing direction against said bias, a reciprocative thrust connection between said chuck and mount permitting their relative reciprocation parallel to the reciprocating directions of said mount and carriage and including a spring biasing said chuck to move relative said mount toward said tool pointing direction so this spring takes the tool working thrust, means responsive to movement of said chuck relative said mount against the bias of the second named spring for automatically releasing said releasable pawl carried by said carriage from said ratchet teeth, and means responsive to feeding of said mount relative said carriage in said tool pointing direction for a predetermined distance for automatically releasing all of said pawls and said escapement from said ratchet teeth.

ADOLPH D. KUTZLER.