No. 805,499. PATENTED NOV. 28, 1905.

S. D. STOYCHEFF.

ELECTRIC DRILL.

APPLICATION FILED JUNE 26, 1903.

2 SHEETS—SHEET 1.

Fig. 1.

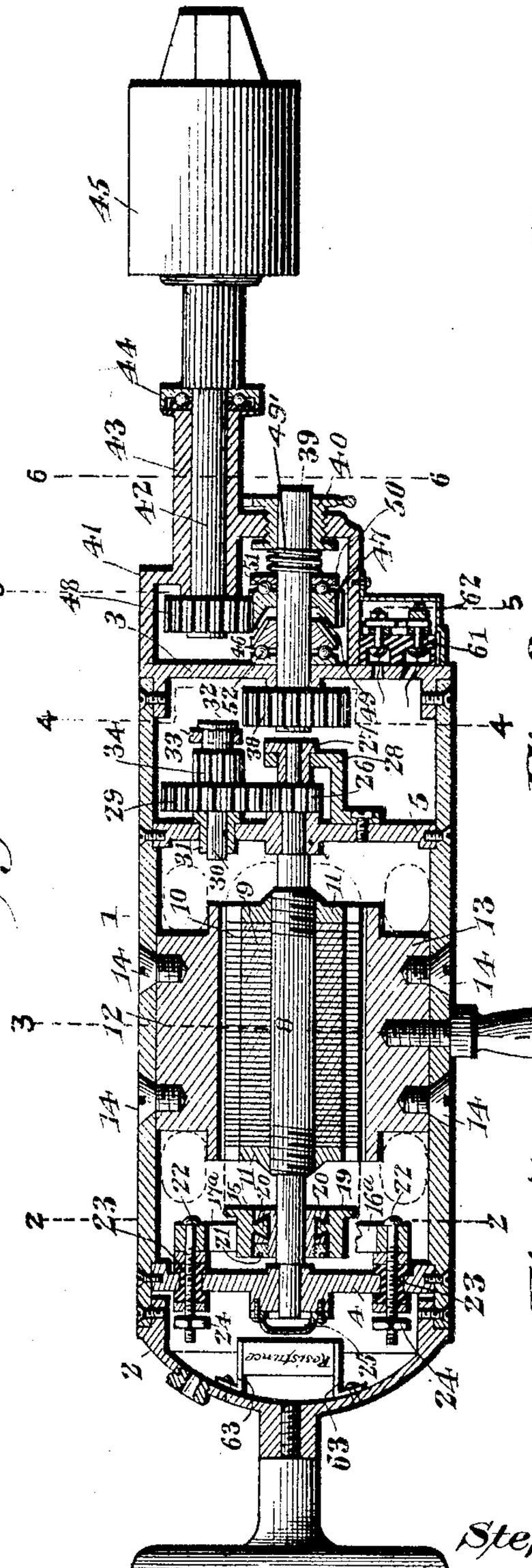


Fig. 3.

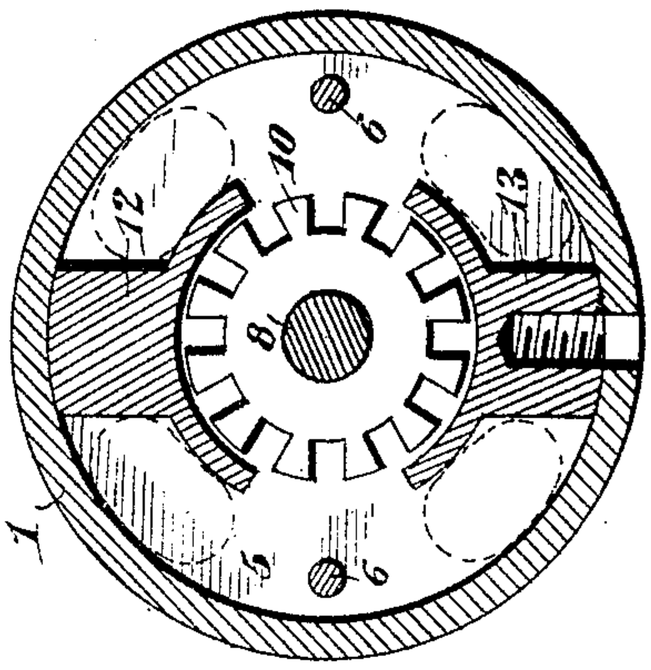


Fig. 2.

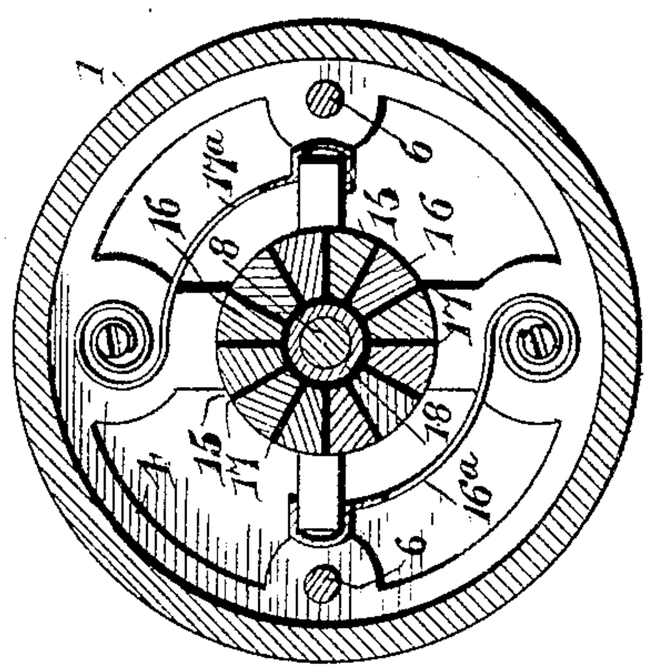
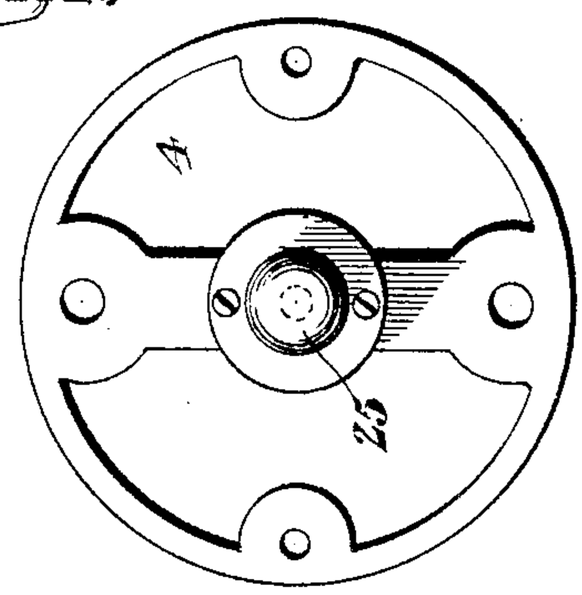


Fig. 4.



Witnesses

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2 SHEETS—SHEET 2.

Fig. 6.

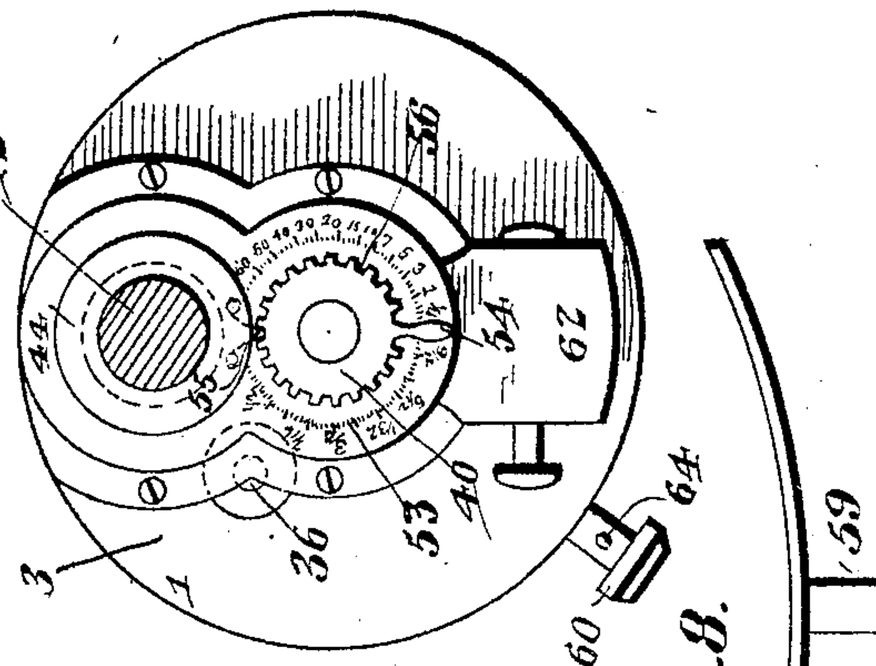


Fig. 8.

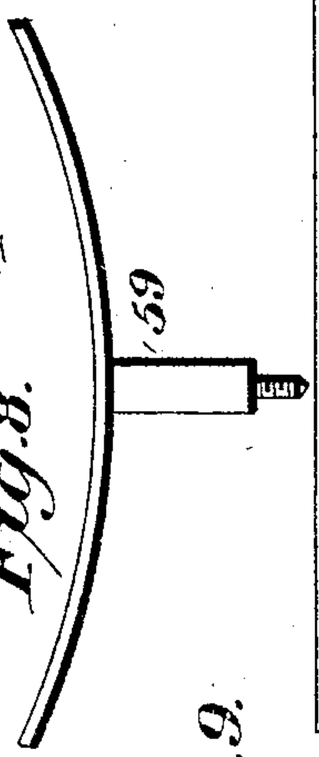


Fig. 5.

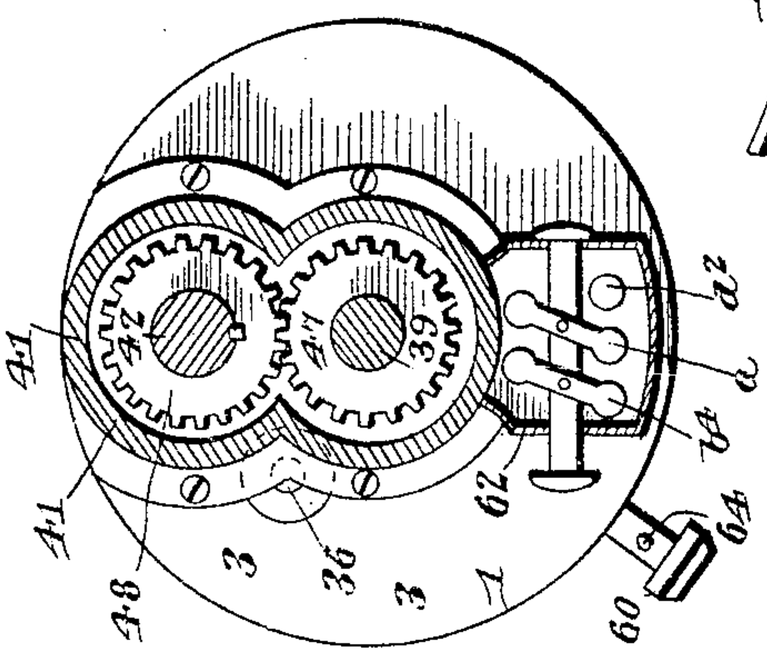


Fig. 9.

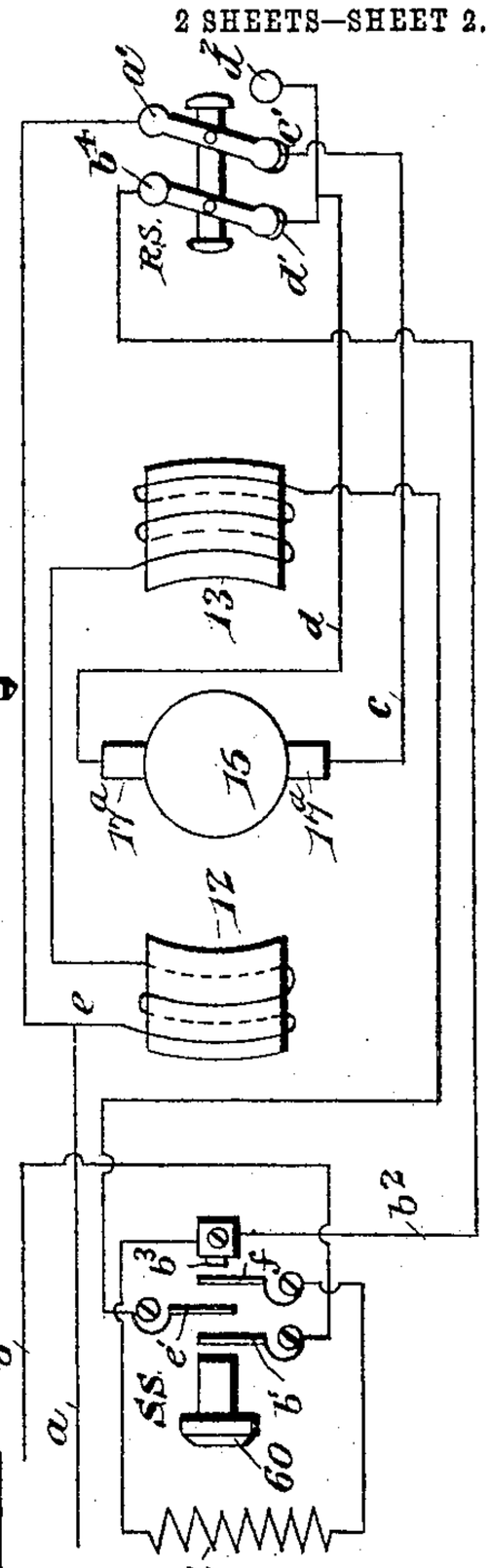


Fig. 4.

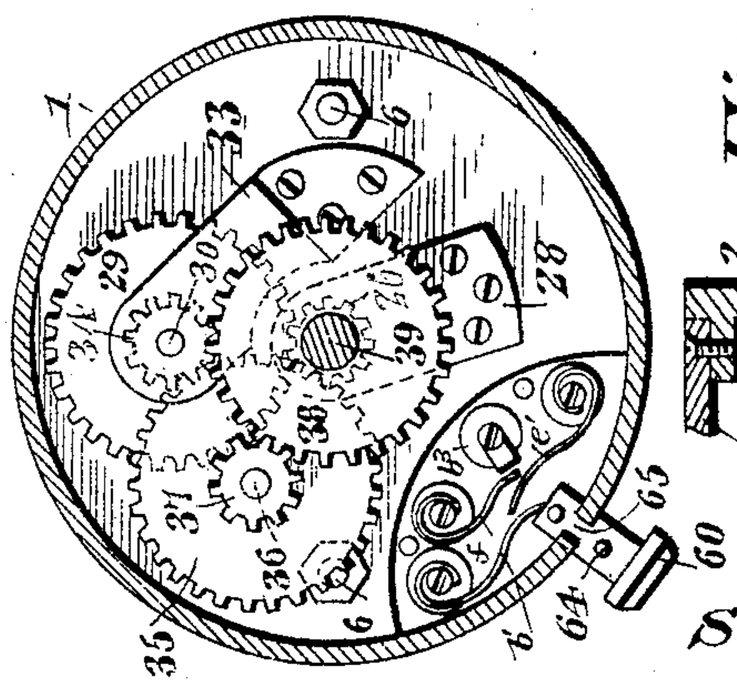


Fig. 10.

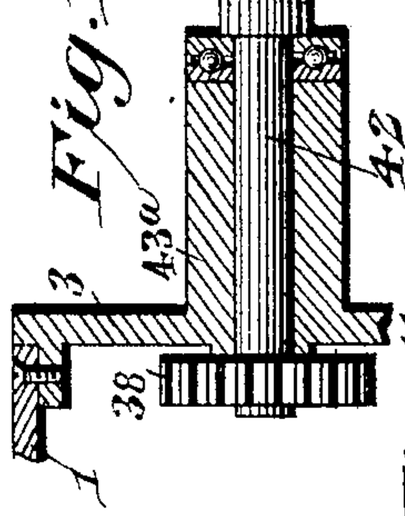
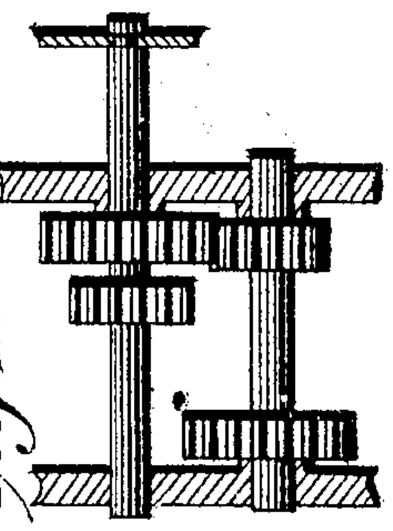


Fig. 11.



Witnesses
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UNITED STATES PATENT OFFICE.

STEPHEN D. STOYCHEFF, OF TOLEDO, OHIO.

ELECTRIC DRILL.

No. 805,499. Specification of Letters Patent. Patented Nov. 28, 1905.

Application filed June 26, 1903. Serial No. 163,263.

To all whom it may concern:

Be it known that I, STEPHEN D. STOYCHEFF, a citizen of the United States, residing at No. 222 Michigan street, Toledo, in the county of Lucas and State of Ohio, have invented a new and useful Electric Drill, of which the following is a specification.

This invention relates to a portable electric tool, the object being to provide within the smallest possible compass a tool-operating mechanism of maximum efficiency.

Another object of the invention is to mount within a small portable casing an electric motor of high speed associated, through intermediate gearing, with a tool-chuck and controlled by starting and reversing switches arranged for convenient manipulation to control the movement and direction of movement of the tool retained by the chuck.

A still further object of the invention is to equip the device with a safety appliance, preferably in the form of a clutch, located at a convenient point in the line of connection between the motor and the tool-spindle and arranged to yield for the purpose of breaking the connection between the tool and the motor when the resistance opposed to the movement of the tool exceeds a predetermined limit, thus preventing the burning out of the motor or the derangement or breakage of the tool or its connection.

Subordinate to the object last recited is the provision of means for regulating or adjusting the resistance or holding power of the safety-clutch and the association with said means of an indicator whereby the clutch may be adjusted with great nicety in accordance with the size of the tool employed.

A still further object of the invention is to so organize the wiring of the motor and the elements of the starting-switch that the tool-operating mechanism may be set in motion without undue jar or vibration and stopped promptly when desired.

Various other objects subordinate to those enumerated will appear during the course of the following description of that form of the invention which for the purpose of this disclosure is illustrated in the accompanying drawings and defined in the appended claims.

In the said drawings, Figure 1 is a longitudinal section through the device complete, certain of the parts being shown in elevation. Fig. 2 is a sectional view on the line 2 2 of Fig. 1. Fig. 3 is a similar view on the line 3 3 of Fig. 1. Figs. 4, 5, and 6 are sectional views on the lines 4 4, 5 5, and 6 6, respectively, of Fig. 1. Fig. 7 is a detail view of one of the bearing-heads. Fig. 8 is a detail view of the breastplate. Fig. 9 is a diagrammatical view illustrating the method of wiring the motor. Fig. 10 is a detail view of a modification contemplating the omission of the safety-clutch, and Fig. 11 is a detail view of a possible variation of the gearing to obtain two speeds.

Like characters of reference are employed to designate corresponding parts throughout the views.

1 indicates a cylindrical casing closed at its opposite ends by caps 2 and 3, secured thereto in any suitable manner. The casing or shell 1 is additionally stiffened by a pair of transverse bearing-heads 4 and 5, connected by a pair of tie-rods 6. These bearing-heads are designed to support axially within the casing a motor-shaft 8, enlarged intermediate its ends for the support of an armature 9 and having reduced ends afforded bearings in the heads.

The specific construction of the armature 9 may of course be varied within wide limits; but by preference it is made up of a series of peripherally-notched disks 10, separated—as, for instance, by thin paper layers—and retained in place by soft-iron core-caps 11, notched in correspondence with the disks 9 and screwed upon the opposite ends of the enlarged portion of the motor-shaft. The pole-pieces 12 and 13 of the motor are carried by the wall of the casing at diametrically opposite points, as shown in Fig. 3, and are secured—as, for instance, by screws 14.

The commutator 15 is mounted upon the shaft 8 adjacent to the head 4 and is preferably, though not necessarily, composed of a series of phosphor-bronze segments separated by mica or other suitable insulation 17. These segments surround a commutator-sleeve 18, directly connected with the shaft and formed with a head 19, engaging dovetailed retaining-tongues 20, formed by undercutting the inner ends of the segments 16, as shown in Fig. 1. The opposite end of the sleeve 18 is threaded, as shown, for the reception of a locking-ring 21, coöperating with the head 19 to clamp the segments in place. In coöperative relation with the commutator 15 are a pair of brushes 16^a and 17^a, of any desired construction, carried by brush-posts 22, passed through the head 4 and insulated therefrom by rubber or other suitable bushings 23, the

ends of the posts 22 at the side of the head 4 opposite the brushes being threaded for the reception of nuts 24, which may be screwed up to retain the posts in place and which also serve to connect the wires to the brush-posts.

At this point attention may be directed to the fact that by reason of the specific arrangement of parts it is simply necessary to remove the cap 2 and the head 4 in order to expose the commutator and brushes for cleaning or repair, and it will be noted in this connection that such partial disorganization does not require the removal of any part of the motor proper—that is to say, the commutator, armature, and pole-pieces may all remain in their normal positions.

For the purpose of lubricating the shaft-bearing in the head 4 the latter is provided with an oil-case 25, screwed to the head 4, inclosing the end of the head.

The armature and pole-pieces of the motor are of course wound in the usual manner, and proper connection is made with the commutator and line-wires; but for the present I shall confine the description to the mechanical elements of the structure and will thereafter explain the mode of wiring which I have devised.

The end of the shaft 8 which is afforded a bearing in the head 5 is extended beyond the head for the support of a pinion 26, and its extremity beyond said pinion is reduced and has an additional bearing in a phosphor-bronze bushing 27, detachably retained by an angular bearing-bracket 28, bolted to the head 5. (See Figs. 1 and 4.) The pinion 26 meshes with a gear-wheel 29, carried by a short counter-shaft 30, the opposite ends of said shaft being journaled in removable phosphor-bronze bushings 31 and 32, mounted in the head 5 and in a bearing-bracket 33, respectively. The bracket 33 is bolted to the head 5 and extends upwardly in an inclined direction, as shown in Fig. 4. Fixed to the gear-wheel 29 to rotate therewith is a pinion 34, meshing in turn with a gear-wheel 35, mounted on a shaft 36, extending between the head 5 and the cap 3. To this last-named gear-wheel 35 is fixed a pinion 37, meshing with a gear-wheel 38, keyed or otherwise secured upon the inner end of what I shall term the "clutch-shaft" 39, journaled at one end of the cap 3 of the casing 1 and at its opposite or outer end in an adjustable nut 40, threaded into the outer wall of a supplemental casing 41, screwed, as indicated in Fig. 5, to the outer face of the cap 3. It will now be observed that motion will be transmitted from the motor-shaft 8 to the clutch-shaft 39 through the interposed train of gearing consisting of the pinion 26, the gear 29, the pinion 34, the gear 35, the pinion 37, and the gear 38. This transmitted movement is designed to be communicated to the tool-spindle 42, journaled in a long bearing-sleeve 43, formed integral with the casing 41, the spindle being provided with a thrust-bearing 44 at the outer end of the sleeve 43 and also having a chuck or other tool-holder 45 mounted at its outer end for the attachment of a tool of any desired character.

It is contemplated by the present invention, however, to provide in the line of connection between the tool-spindle and the motor a safety device which will effect the automatic disconnection of the motor and spindle when the resistance opposed to further movement of the tool is sufficient to endanger the electrical connections of the motor, the elements of the gearing, or the tool itself. In the present form of the device this safety appliance is located in the line of connection between the clutch-shaft 39 and the spindle 42. Upon the clutch-shaft 39 is fixed one member 46 of an automatic safety-clutch. This member is in the form of a cone designed to be engaged by the other clutch member 47, loose upon the shaft 39. The member 47 is in the form of a pinion meshing with a spindle-pinion 48 and having in one side face thereof a trunco-conical depression 49, designed to frictionally receive the clutch member 46 for the purpose of effecting an operative connection between the clutch member or gear 47 and the clutch-shaft 39. This connection is obviously effected by reason of the frictional engagement of the two members of the clutch, and it is therefore evident that if the resistance opposed to the rotation of the drill is sufficient to overcome the frictional engagement of the clutch members the latter will yield or slip relative to each other, and the breaking of the tool or possible derangement of its operating mechanism will thus be prevented.

Since the use of a large variety of tools is contemplated, it follows that the yielding connection interposed between the tool and the motor must be capable of adjustment, since some classes of tools would require the application of such power for their effective operation as would endanger the integrity of other and lighter tools. In other words, it is necessary to provide means whereby the members of the safety-clutch will be caused to yield when the tool is opposed by a comparatively slight resistance or will remain effective until the tool is opposed by a much greater resistance. In the present embodiment of the invention the clutch regulating or adjusting means includes the nut 40, which, as we have seen, is screwed through the end wall of the supplemental casing 41 and constitutes a bearing for the clutch-shaft 39. This nut is designed to be screwed in and out for the purpose of regulating the tension of a clutch-spring 49′, preferably encircling the shaft 39 and interposed between the inner end of the nut and a thrust-plate 50, between which and the clutch member 47 a series of antifriction bearing-balls 51 are interposed. These balls serve to

reduce to a minimum the frictional resistance opposed to the rotation of the pinion or clutch member 47, and the friction incidental to the rotation of the other clutch member or cone 46 is likewise minimized by the interposition of an antifrictional thrust-bearing 52 between said member 46 and the cap 3 of the casing 1.

By mounting the clutch and its associated parts, as well as the tool-carrier, in a supplemental casing or casing extension carried by the cap 3, as described, it will be noted that the removal of the cap from the casing will carry with it these various parts without disturbing their proper relations and will at the same time expose the speed-gearing located between the head 5 and the end of the casing to facilitate cleaning and repair.

It would obviously be difficult to accurately determine the proper adjustment of the nut 40 for tools of different sizes. I have therefore associated with the clutch-regulator an indicator, which preferably comprehends an annular scale or series of graduations 53, exposed upon the outer face of the casing 41 and concentric with the nut 40. The indicator also comprehends an index arm or pointer 54, extending radially from the nut 40 and designed to traverse the graduations 53, associated with which latter are significant indications or designations—as, for instance, numbers corresponding with the various sizes or types of tools capable of manipulation by this operating mechanism. The proper adjustment of the nut to insure the breaking of the connection between the motor and the tool under a predetermined resistance opposed to the latter is determined by experiment, and the scale of the indicator is then laid out to bear such relation to the feed of the nut that the clutch-spring will be subjected to just the proper tension when the nut is turned to present the indicating-arm 54 opposite the number or designation corresponding to the particular tool to be employed. For the purpose of yieldingly retaining the clutch-regulator or nut 40 in its adjusted positions I preferably provide a spring-detent 55, mounted at a convenient point on the casing and disposed to engage peripheral notches 56 in the head of the nut. (See Fig. 6.)

For convenience of manipulation the casing is provided with detachable end and side handles 57 and 58, the first of which—that is to say, the end handle 57—may be replaced by the breastplate 59, if desired.

The arrangement of the wiring to secure the proper relation of the motor with respect to the starting and reversing switches and to the resistance designed to insure the starting of the motor gradually and without unnecessary jarring is indicated diagrammatically in Fig. 9. The line-wires a and b are carried into the casing 1 through an opening in the cap 2, the wire a being led directly to the arm a' of a reversing-switch R S and the wire b being led to the spring b' of a starting-switch S S. A continuation b^2 of the line-wire b is led from the contact-spring b^3 of the starting-switch to the other arm b^4 of the reversing-switch R S. From one of the commutator-brushes a wire c is led to the middle contact c' of the reversing-switch, and a wire d is led from the other commutator-brush to the outer contacts d' and d^2 of the switch R S. As will be noted, the motor is shunt-wound, the shunt e being led from the line-wire a around the pole-pieces of the motor and thence to a contact-spring e' of the starting-switch. The spring e' is interposed between the spring b' and a contact-spring f, disposed to contact with the spring b^3 and connected to one end of a resistance-coil R, the other terminal of the resistance-coil being connected to the spring b^3. Normally the springs b', e', f, and b^3 of the starting-switch S S are disposed out of contact, but are designed to be moved into contact by a finger-piece 60, projecting through the wall of the casing, as shown in Fig. 4, and having its inner end opposed to the spring b'.

It will now be seen that if the tool carried by the chuck 45 has been properly positioned with respect to the work the motor may be started slowly and afterward speeded by pressing in the finger-piece 60. By reference to Fig. 9 it will be seen that the inward movement of the finger-piece will first move the spring b' into contact with the spring e', thus closing a circuit through the feed-shunt e. Further movement will force the spring e' into contact with the spring f, constituting one terminal of the resistance R. This will close the line through the resistance-coil, since the wire b is connected to the spring b' in electrical connection with the spring f through the interposed spring e', the spring f being in turn connected to one terminal of the resistance-coil, the other terminal of which is in connection with the wire b^2. The presence of the resistance will obviously cause the motor to start slowly, so as not to endanger the tool. Further inward movement of the finger-piece will now move the spring f into contact with the spring b^3, and as all four of the contact-springs of the starting-switch will now be in contact the resistance will be cut out and electrical connection will be established directly between the line-wire b and its continuation b^2.

The reversal of the motor is secured by the manipulation of the reversing-switch R S in an obvious manner. The precise arrangement of the switches and wiring within the casing 1 is not material. I prefer, however, to mount the reversing-switch on an insulating-block 61, secured to the cap 3 below the clutch-casing 41 and inclosed in a switch-box 62. (See Figs. 1, 5, and 6.) The contact-springs of the starting-switch S S are preferably mounted on the head 5, (see Fig. 4,) suitable insulation being interposed, and the resistance-coil R

may be supported by brackets 63, secured to the cap 2. (See Fig. 1.) It is undesirable, and, in fact, under some conditions it is impossible, to retain the finger upon the finger-piece 60 during the operation of the tool, and I therefore provide said piece with a pin 64, which may be passed through a notch 65 in the casing and then moved out of coincidence with the notch by turning the finger-piece so that the latter will be held against outward movement until again turned to bring the pin opposite the notch. In Figs. 10 and 11 I have shown possible variations of the structure. For instance, the safety-clutch feed may be omitted, in which case the clutch-shaft 39 and its complementary parts would be unnecessary, and the spindle 42 would therefore be mounted in an axial bearing 43^a, extended directly from the cap 3, and would carry upon its inner end the gear 38, as shown in Fig. 10.

If it is desired to provide different speeds, an ordinary form of speed-changing mechanism—such, for instance, as is shown in Fig. 11—may be included in the train of gearing between the motor-shaft and spindle.

Particular attention is directed to the fact that by the novel arrangement of the wiring just described the field-shunt will always be closed before the line in starting and will always be opened after the line is opened in stopping the motor. Thus it will be impossible for the armature to be in circuit when the fields are not magnetized and liability of burning out the motor will be greatly diminished, if, in fact, it is not altogether obviated. Furthermore, the resistance being located in the line and so disposed that it will be cut out by the starting-switch immediately after the starting of the motor, the motor will be started without jar or vibration, but will, nevertheless, be operated under a full current. It will also be noted that the employment of a laminated longitudinally-wound armature in connection with separately-detachable longitudinally-wound pole-pieces will prevent the generation of eddy-currents and will enable either pole-piece to be removed and rewound without disturbing the other.

Assuming the device to be organized as shown in Fig. 1, a drill or other tool is connected to the spindle by means of the chuck 45, and the tension of the clutch-spring 49 is regulated by turning the nut 40 until the indicator 54 is opposite the scale indication corresponding to the tool employed. The tool is then presented to the work and the finger-piece 60 is pushed in, causing, as we have seen, the smooth starting of the motor at a slow rate of speed and its subsequent acceleration. The clutch-spring 49 will urge the clutch member 47 into frictional engagement with the cone 46, and motion will therefore be transmitted from the motor to the tool. When the resistance opposed to the tool is sufficient to break the frictional engagement between the members of the clutch, the latter will yield relatively, thus automatically breaking the connection between the motor and the tool to prevent the burning out of the motor or the burning out of the fuse, if the latter is employed, and also preventing possible injury to the tool or to the elements of the gearing.

It is deemed unnecessary to discuss at length the various uses to which a device of the character described may be put. It may be stated briefly, however, that it may be employed for the operation of a vast variety of turning, cutting, and drilling tools, screw-drivers, and the like and that it may be manipulated by hand in various positions or supported and fed by the carrier of the drill-press, the tool-post of a lathe, or by a feed-screw arrangement similar to that of ordinary ratchet-drills. When used in these various connections, the many novel features of the construction would be of great utility, the automatic safety-clutch being particularly useful when the tool employed is in the form of a screw-driver, since it will be seen that the screws will all be screwed in uniformly by reason of the fact that the clutch will automatically release the tool after a predetermined resistance is opposed by each screw.

It is thought that from the foregoing the construction, operation, and many advantages of my tool-operating mechanism will be clearly apparent; but while the present embodiment of the invention is thought at this time to be preferable I do not limit myself to the structural details defined, as, on the contrary, I reserve the right to effect such changes, modifications, and variations of the illustrated structure as may fall fairly within the scope of the protection prayed.

What I claim is—

1. In a portable tool-operating mechanism adapted for manual support, the combination with a casing, a motor-armature therein, and a tool-carrier extended from one end of the casing, of an operating connection between the armature and carrier, a friction-clutch in the line of such connection and housed within the casing, and means exposed upon the exterior of the casing for regulating the holding power of the clutch.

2. In a portable tool-operating mechanism adapted for manual support, the combination with a casing, a motor-armature therein, and a tool-carrier operatively connected with the motor-armature for actuation thereby, of means inclosed within the casing for automatically breaking the connection when a predetermined resistance is opposed to the carrier, and an adjustable regulating device, located exterior of the casing, to determine such resistance, and including a movable indicating-arm and an associated scale.

3. In a portable tool-operating mechanism adapted for manual support, the combination

with a casing, of a motor-armature therein, and a tool-carrier mounted exterior of the casing and operatively connected with the armature for actuation thereby, a friction-clutch interposed in the line of connection between the tool-carrier and the armature, a spring urging the clutch members into engagement, said clutch and spring being housed within the casing an adjusting-nut for regulating the tension of the spring, and an indicator, associated with the nut and disposed exterior of the casing, to indicate the extent of adjustment of the nut, and the consequent resistance required to be overcome in order to break the connection between the carrier and motor.

4. In a portable tool-operating mechanism adapted for manual support, the combination with a casing, a motor-armature therein, and a tool-carrier outside of the casing, of an operating connection between the armature and carrier including a shaft and a clutch, a clutch-spring, a regulating-nut adjustably mounted in one wall of the casing to serve as a bearing for the shaft, and bearing against the spring to regulate the tension thereof and thus determine the holding power of the clutch, and an indicator upon the exterior of the casing, said indicator having a series of gradations and a pointer movable thereover and connected to the regulating-nut.

5. In a portable tool-operating mechanism adapted for manual support, the combination with a casing, an inclosed motor-armature, and a tool-carrier extended from one end of the casing, of an operating connection including a shaft geared to the armature and carrier respectively, a friction-clutch in the line of connection between the shaft and carrier and housed within the casing, one of the clutch members having the form of a pinion mounted on the shaft, and means exterior of the casing for regulating the holding power of the clutch.

6. In a portable tool-operating mechanism adapted for manual support, the combination with a casing, a cap closing one end of the casing, a device extending from the cap to facilitate the manipulation of the mechanism, a transverse head located in the casing and spaced from the cap, a motor-armature mounted in the casing and including commutator-brushes mounted on the head and removable therewith from the casing to expose the commutator of the motor, a resistance device mounted on the cap and designed to be exposed by the removal of the cap from the casing, and suitable wiring including said resistance device.

7. In a portable tool-operating mechanism adapted for manual support, the combination with a casing, and transverse heads spaced from the ends thereof, of a motor-shaft journaled in the heads, a commutator mounted on the shaft adjacent to one head, an armature mounted on the shaft between the commutator and the other head, pole-pieces secured to the wall of the casing opposite the armature, brushes carrried by a head and engaging the commutator, suitable wiring, a tool-carrier at one end of the casing, and an operating connection between the carrier and the motor, said connection including speed-reducing gearing located between the other head and the adjacent end of the casing.

8. In a portable tool-operating mechanism adapted for manual support, the combination with a casing provided with transverse removable heads, and with a removable cap closing the end of the casing adjacent to one of said heads, an electrical resistance device carried by the cap, a motor-shaft journaled in the heads, and a tool-carrier operatively connected with the shaft and extended beyond one end of the casing, of an armature mounted on the shaft, a commutator likewise mounted on the shaft and disposed adjacent to that transverse head which is nearest the cap, brushes carried by said head and engaging the commutator, pole-pieces secured to the casing opposite the armature, and suitable wiring including the resistance device carried by the cap.

9. In a portable tool-operating mechanism adapted for manual support, the combination with a casing, and removable transverse heads spaced from the ends thereof, of a motor-shaft journaled in the heads, an armature and a commutator carried by the shaft between the heads, pole-pieces secured to the wall of the casing opposite the armature, brushes carried by one of the heads and engaging the commutator, gearing carried by the other head, a tool-carrier operated by said gearing and extending beyond one end of the casing, means within the casing for breaking the connection between the tool-carrier and the gearing when a predetermined resistance is opposed to the tool, means exterior to the casing for regulating such resistance, and suitable wiring.

10. In a portable tool-operating mechanism adapted for manual support, the combination with a casing provided with detachable end caps, and with removable transverse heads spaced from said caps, a motor-shaft afforded bearings in said heads, a motor mounted within the casing, and including an armature and a commutator mounted on the motor-shaft, pole-pieces secured to the casing opposite the armature, brushes carried by one of the heads and engaging the commutator, speed-gearing mounted in the casing between the other head and the adjacent end cap, a casing extension carried by said cap and having a bearing-sleeve, a tool-carrier journaled in said sleeve and having operative connection with the gearing, and a friction-clutch located in the line of connection and housed within the casing extension.

11. In a portable tool-operating mechanism adapted for manual support, the combination

with a casing provided with a transverse head, a second transverse head located within the casing and spaced from one end thereof, a motor-shaft afforded a bearing in both heads, an armature mounted on the shaft between the heads, a commutator mounted on the shaft between the armature and the head first named, brushes carried by said first-named head and removable from the casing therewith, to expose the commutator, speed-reducing gearing located between the second head and the adjacent end of the casing, and a tool-carrier extended from the casing and connected to the motor through the medium of the gearing.

12. A portable tool-operating mechanism adapted for manual support, in combination with a casing and caps closing the opposite ends thereof, of a pair of removable heads located within the casing and spaced from the caps, a motor-shaft afforded a bearing in both heads, an armature and a commutator carried by the shaft, field-coils disposed opposite the armature, commutator-brushes carried by one of the heads and removable therewith from the casing to expose the commutator, speed-reducing gearing carried in part by the other head, and a tool-carrier extending beyond one end of the casing and geared to the motor-shaft through the medium of the gearing.

13. In a portable tool-operating mechanism, the combination with a casing provided with caps closing the ends thereof, a motor-armature mounted within the casing, a motor-shaft, a transverse head located in the casing between the motor and one of the caps and affording a bearing for the motor-shaft, speed-reducing gearing located between the head and the adjacent cap of the casing, a second shaft extended through said cap and driven by the motor-shaft through the medium of the gearing, a supplemental casing carried by the cap last named, and a spindle afforded a bearing in the supplemental casing and geared to the second shaft, said spindle being adapted to drive a tool.

14. In a portable tool-operating mechanism adapted for manual support, the combination with a casing, end caps therefor, and transverse heads located within the casing and spaced from the caps, of a motor-shaft journaled in the heads, an armature and a commutator mounted on the shaft, pole-pieces secured to the wall of the casing opposite the armature, commutator-brushes carried by one of the heads and removable from the casing therewith to expose the commutator, speed-reducing gearing carried in part by the other head and located between said head and the adjacent end cap, a second shaft extended through said cap and driven by the motor-shaft through the medium of the gearing, a supplemental casing carried by the cap last named, and a tool-operating spindle journaled in the supplemental casing and geared to the second shaft.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

STEPHEN D. STOYCHEFF.

Witnesses:
CARL PURSEL,
HENRIETTA LAW.