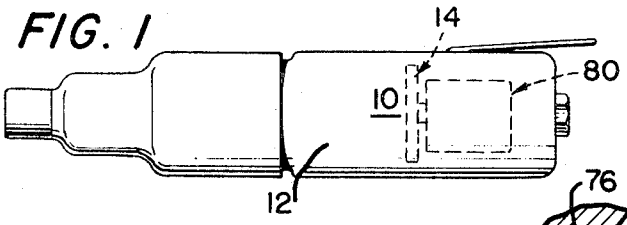
June 2, 1970 J. M. CLAPP 3,515,251

TORQUE RELEASE AND SHUTOFF DEVICE FOR ROTARY TOOLS

Original Filed Aug. 29, 1967

FIG. 1



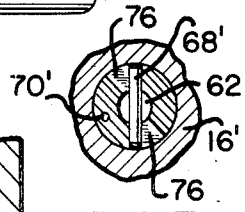


FIG. 7

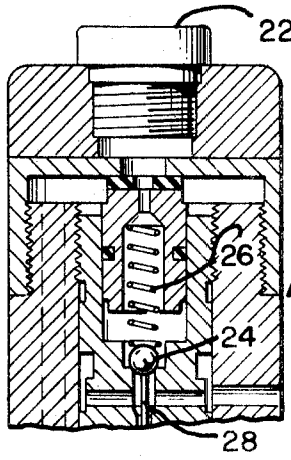


FIG. 3

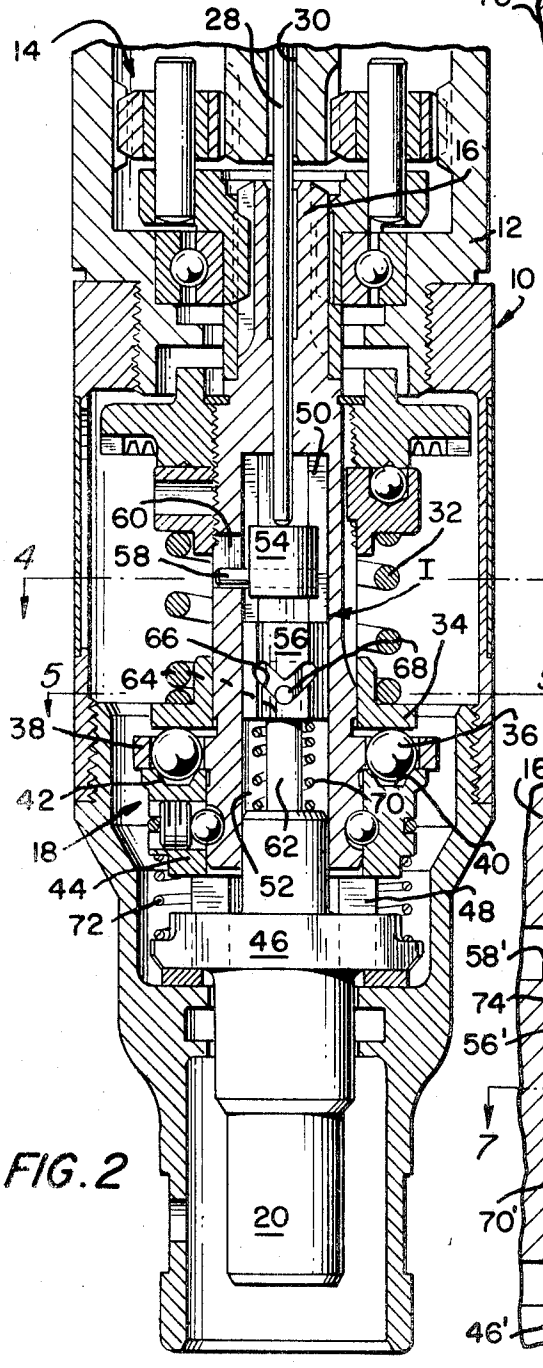


FIG. 2

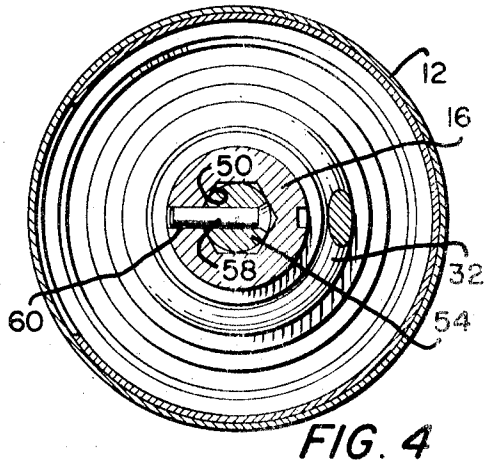


FIG. 4

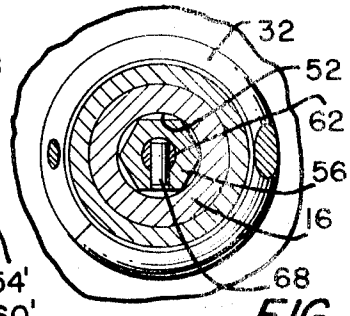


FIG. 5

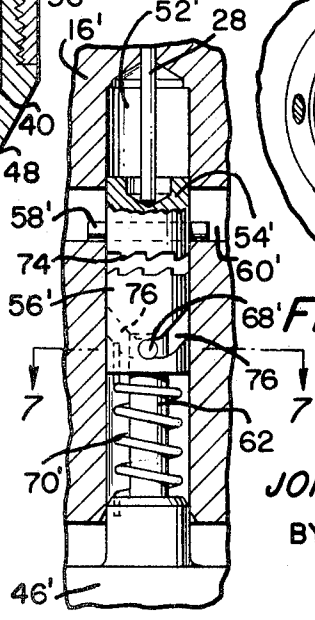


FIG. 6

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3,515,251

TORQUE RELEASE AND SHUTOFF DEVICE FOR ROTARY TOOLS

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Continuation of application Ser. No. 664,158, Aug. 29, 1967. This application Apr. 14, 1969, Ser. No. 824,720
Int. Cl. F16d 7/00
U.S. Cl. 192—150 20 Claims

ABSTRACT OF THE DISCLOSURE

In a power tool a torque-responsive clutch having camming means to turn off the motor; applicable to reversible type tools as well as uni-directional types.

This is a continuation of applicant's co-pending patent application, Ser. No. 664,158, filed Aug. 29, 1967, entitled "Torque Release and Shut Off Device for Rotary Tools," now abandoned.

This invention pertains to clutches and in particular to torque-responsive clutches which shut-off the driving motor upon reaching a preset torque value.

Such clutches known in the prior art are often of the stall type in which, upon reaching the preset torque value, the motor is caused to stall as the driven chuck is held in the workpiece, i.e., the member being driven. Upon withdrawal of the power tool from the workpiece the motor is released and the chuck is free to spin. In devices of this type there is a difficulty in that upon removing the chuck, and the driving tool held therein, from the workpiece, the motor is then freed, and the tool will spin immediately, causing deformation of the drive slot, driving head, or socket of the workpiece, causing damage to the driving tool itself, or putting the operator in danger of injury from the spinning, unloaded tool.

Other devices in this art having a torque-responsive clutch use a locking means, such as a sear or a latching device which is responsive to axial pressure along the chuck to enable the motor but has a linkage which, upon realization of the desired torque, releases the locking means. The linkages involved in these arrangements are rather complex; they function only through the enabling of a plurality of serially-arranged, inter-dependent devices; they require that one clutch member move axially relative to another clutch member, upon reaching the predetermined resistance to the rotation of the chuck, so as to move a drive rod, to release a sear, or locking member, to shut off power. Many of these prior art mechanisms are usable on but uni-directionally-rotated tools, or are usable on reversible tools but have torque-increasing utility in one direction and only total torque in the reverse direction.

It is an object of the present invention therefore to provide an improved torque-responsive clutch for use in mechanically powered tools which, by way of a novelly simplified arrangement, shuts off the motor upon reaching a preset torque value. Another object of this invention is to provide a torque responsive clutch which maintains torque control during separation of the clutch engaging members while presenting a fully halted motor and chuck. Another object of this invention is to provide a torque-responsive clutch which provides for a full run of torquing, forwardly or in reverse, and has means for disabling the motor and disengaging the clutch drive in the same last revolution of the motor drive shaft.

A feature of this invention comprises the use of a camming device between the chuck and the motor actuator rod. The camming device makes use of the last

quadrant of rotation of the motor, beyond torquing-limit, to disable the motor. Further objects and features of this invention will become more apparent by reference to the following description taken in conjunction with the accompanying figures in which:

FIG. 1 is a side view of a power tool of a type in which the novel clutch is used;

FIG. 2 is a partial cross-sectional view of a power tool such as that of FIG. 1, taken along the axis thereof, which incorporates a preferred embodiment of the torque responsive clutch according to the invention;

FIG. 3 is an axial, cross-sectional view of the valving arrangement of the power tool of FIG. 2;

FIG. 4 is a diametral cross-section of a portion of the novel camming arrangement taken along line 4—4 of FIG. 2;

FIG. 5 is a further diametral cross-sectional view of the camming plunger taken along line 5—5 of FIG. 2;

FIG. 6 is a partial axial and cross-sectional view of an alternate embodiment of the novel torque responsive clutch; and

FIG. 7 is a diametral cross-section of the camming plunger taken along the line 7—7 of FIG. 6.

Shown in FIGS. 1 and 2 is a power tool **10**, which may be a pneumatically-powered screwdriver, which incorporates the novel torque-responsive clutch according to the invention. The tool **10** has a housing assembly **12** enclosing a motor means **80**, shown symbolically, which may comprise an air motor. However, the objects of my invention could be equally satisfied in a power tool having electric, hydraulic, or other motor means. The motor means **80**, driving through a gear train **14**, powers a take-off shaft **16** coupled thereto which drives a torque-responsive clutch assembly **18**. The power tool has a chuck **20** disposed at one end thereof for receiving a bit, or the like, for addressing a workpiece. The housing assembly **12**, as is shown in FIG. 3, has an input port **22** for pressurized fluid for driving the motor means **80**. Disposed between the input port **22** and the motor means is turn-on, turn-off device **24** which is here shown to be a valve which admits fluid or prohibits the introduction of fluid to the motor means **80**. Biasing means **26** shown as a compression spring urges the vlave device **24** to a closed position. An actuator rod **28** disposed in an axial bore **30** in the center of the power take-off shaft **16** is used to unseat the valve device **24** so as to admit pressurized fluid therethrough and to the motor means **80**.

The functioning and interaction of the motor means **80**, the valve device **24**, and the actuator rod **28** are as known to those skilled in the art from the teachings of prior patents. U.S. Pat. No. 3,082,742, issued Mar. 26, 1963, for a torque tool control to J. B. Vilmerding et al., for instance, sets forth a vane type air motor, a valve device, and an actuator rod for displacement of the latter in accordance with the purposes here similarly pursued. These elements, then should require no further explanation in this disclosure.

The torque-responsive clutch **18** includes a loading spring **32** which is under compression and bears against a thrust plate **34**. The thrust plate **34** is thereby constrained against a plurality of balls **36** held by a caging plate **38** integral with shaft **16**. The opposite surfaces of the balls **36** nest in recesses **40** formed, equally-spaced and radially, in a facing surface **42** of a clutch jaw **44**. The chuck **20** has formed on the inner end thereof a clutch driver **46**. The clutch driver **46** is a flat plate having raised portion of metal disposed across the diameter of a face thereof; it receives maxillas or jaw members **48**, formed of, and extending from the interfacing surface of the clutch jaw **44**, across either sides of said raised portion.

The axial bore **30** formed in the center of power take-off shaft **16** has hexagonal and circular major portions **50** and **52**, respectively. A pair of serially disposed plungers **54** and **56** are slidably mounted within the major axial bore portions **50** and **52** of the shaft **16**. Plunger **54** is circular in its external configuration; plunger **56** is hexagonal. Plunger **54** has a limit pin **58** extending therefrom, the pin being disposed for a limited axial movement in a relieved area **60** provided therefor in power take-off shaft **16**, and provisioned to effect a rotation of plunger **54** with shaft **16**. The clutch driver **46** has a stub shaft **62** extending rearwardly therefrom which is received by a circular bore **64** formed in the center of plunger **56**. Plunger **56** also has a V-shaped slot **66** formed in a side thereof through which there projects a pin **68** fixed in, and extending perpendicularly from, stub shaft **62** of the clutch driver **46**. The actuator rod **28** bears against the motor-side face of plunger **54**. A spring **70** urges plunger **56** toward the motor end of the tool, tending to open the valve device **24**.

In operation, the motor means **80** drives the gear train **14** and imparts power to the take-off shaft **16** so as to rotate the chuck **20** through torque-responsive clutch assembly **18**. The chuck **20** receives a bit which is addressed to the workpiece while axial pressure is brought to bear on the power tool **10**. This causes the chuck **20** to sheathe or retract in the direction of the gear train **14**.

Clutch driver **46** slides rearward into further engagement with clutch jaw **44**. However, as clutch driver **46** slides rearward, it moves spring **70** and pin **68** simultaneously. The bias of spring **70** and translation of pin **68** displaces the plungers **54** and **56** within the major axial bore portions **50** and **52** of the power take-off shaft **16**. Displacement of plunger **54** translates the actuator rod **28** so as to unseat the valve device **24** and admit pressurized fluid to the motor means **80** to enable the latter. Accordingly, the chuck-mounted bit torques the workpiece. Upon reaching a desired torque value, the torque-responsive clutch assembly **18** causes the balls **36** to rise out of the recesses **40** provided in surface **42** by way of compensating for the resistance of clutch driver **46** and chuck **20** to further rotation. This ball-drive, spring-loaded, torque-responsive clutch assembly **18** is a teaching of the same, earlier-referenced, U.S. Pat. No. 3,082,742. The embodiment here depicted functions in similar fashion as the manner described in the referenced patent and, accordingly, requires no detailed recitation here. It should be sufficient to state that power take-off shaft **16** imparts rotary motion to caging plate **38**, and the rotation of the latter causes the balls **36** to carry clutch jaw **44** in rotation therewith. The engagement of the clutch driver **46** with the rotating clutch jaw **44** drives the chuck **20**. This chain of rotation is maintained until the resistance of the workpiece which is being addressed is greater than the ability of the bias of loading spring **32** to retain the balls **36** in their recesses **40**. At this point, the caging plate **38** continues to turn and the balls **36** find the loading spring **32** less resistive than the fully torqued workpiece. Accordingly, the loading spring **32** yields; it compresses sufficiently under the pressure of balls **36** rising out of the recesses **40** and bearing against the thrust plate **34**. The caging plate **38** carries the balls **36** through a quadrant of a turn where they re-nest in the next, adjacent recesses **40**. Simultaneously, my novel clutch camming arrangement halts the motor, as explained in the following passages.

The chuck **20** remains stationary as the motor means **80** gives the last turn to the power take-off shaft **16** and carries the caging plate **38** and balls **36** to the adjacent indexed position. The plunger **56** being nested in hexagonal portion **50** of the major axial bore of shaft **16** must necessarily execute the same last turn. Yet, pin **68**, being integral with stub shaft **62** of clutch driver **46** and chuck **20**, remains stationary. Accordingly, a leg of V-slot **66** provided in plunger **56** passes over the pin **68** as

plunger **56** executes that last indexed turn. In passing a leg of slot **66** over the pin **68**, and in turning, plunger **56** is caused to cam forward, away from the motor-side of the tool, against the bias of the spring **70** disposed against its forward face, fully into bore portion **52**. Displacement of plunger **56** provides a space therebehind into which plunger **54** moves under the urging of biasing means **26** disposed against the valve.

As explained in the foregoing, the V-slot **66** provided therein cams plunger **56** forward so as to allow plunger **54** to move axially, forwardly. Actuator rod **28**, being constrained thereagainst, follows therebehind to allow a closure of valve device **24** to halt the motor of means **80**. The V-slot **66** is provided to insure the functioning of this novel device in power tools which rotate unidirectionally, or in power tools which have both forward and reverse drives. The torque responsive clutch assembly **18** will index or slip but one quadrant so as to provide for the camming of plunger **56** while maintaining a full torque on the workpiece. Therefore, plunger **56** comprises a means for locking up the tool **10** in a fully torqued and halted condition. Both plungers **56** and **54** move forward, to facilitate the travel of rod **28** therebehind and to compress spring **70**. Also, one leg of V-slot **66** is caused to move fully across pin **68**, and must remain "locked" thus; plunger **56** is held in this cammed position, the caging plate **38** having completed the one quadrant indexing, and the motor means **80** being at halt. Accordingly spring **70** is locked in compression and device **24**, in response to spring **26**, keeps the motor means at halt. Upon withdrawal of the tool **10** from the workpiece, spring **70** re-cams and centers plunger **56** on pin **68**; the tool **10** is ready for further use.

The disposition of my novel clutch, as shown in FIG. 2, is one in which the motor means are at halt. Clutch driver **46** is fully forward, under the urging of a compression spring **72** disposed between clutch jaw **44** and clutch driver **46**. Both jaw **44** and driver **46**, even so, are engaged for concurrent rotation theretogether, but displaced therebetween to facilitate the halting of the motor means. The hexagonal bore portion **50** and circular bore portion **52** of shaft **16** join at line I, as shown in FIG. 2. Thus, plunger **56** is fully within bore portion **52**; plunger **54** is fully within bore portion **50**. The latter disposition is shown in FIG. 4; the former disposition is shown in FIG. 5. Clearly, then, were there any rotation of shaft **16**, this would be ineffective toward rotation of plunger **56**. And it is the achievement of this disposition which facilitates the halting of the motor means **80**.

Balls **36**, at torque limit, index one radial position; thus, the relative, radial movement between plate **38** and clutch jaw **44** is some 60° of arc. The camming displacement thereof rotates plunger **56** a same 60° of arc, after which it is disposed in bore portion **52**. The tool being at torque limit, pin **68** rotates not at all. When the tool is removed from the torqued workpiece, clutch driver **46** is free to move axially, forwardly. In doing so, pin **68** carried thereby "finds" the apex of V-slot **66**, and plunger **56** freely positions the apex thereof about pin **68** under the urging of spring **70**. The last, beyond-torque turn of shaft **16** will have rotated bore portion **50** some 60° of arc relative to plunger **56**. However, plunger **56**, in being hexagonal, and being positionally "normalized" on pin **68**, is again linearly aligned for re-engagement with bore portion **50** but now in 60° of relative displacement from the engagement last made.

Bore portion **50** and plunger **56** are hexagonally configured, in this preferred embodiment of my invention. Thus, the 60° of relative displacement is effected. Obviously, though, the mating bore portion **50** and plunger **56** could be of other geometric configurations: octagonal, triangular, square, etc. to yield 45°, 120°, or 90° of relative displacement, without departing from the teaching of my invention. The angular lay and extent of V-slot **66** are such as to effect the amount of displacement

which is requisite for proper functioning of plunger **56** and complementary to the hexagonal geometry here taught. Simply by varying the angular lay and extent, or both, in the formation of V-slot **66** it is possible to realize a complementary interaction of the latter with octagonal, triangular, square or other geometry.

In an alternate embodiment of my inventive clutch camming arrangement, shown in FIG. 6, I find it possible to dispense with the hexagonal bore **50**, and the hexagonal configuration of the one plunger. The clutch driver **46'** carries the stub shaft **62** to which pin **68'** is fixed. A spring **70'** is disposed about stub shaft **62**, the ends thereof fixed in clutch driver **46'** and a round, first plunger **56'**. Power take-off shaft **16'** has but a single circular bore **52'** formed therein to receive the stub shaft **62** and first plunger **56'**, as well as a round, second plunger **54'**. Narrow, and oppositely disposed, axially-extended slits **60'** are formed in shaft **16'** to receive a pin **58'** which is passed through second plunger **54'**. In the manner described earlier, with respect to pin **58** and plunger **54**, shown in FIG. 2, of the first embodiment, pin **58'** provides for rotation of plunger **54'** with shaft **16'**, and limits the axial travel thereof.

Plungers **54'** and **56'** have saw-tooth-like ridges **74** formed on the respective, interfacing ends of each, whereby rotation is imparted from plunger **54'** to plunger **56'** upon engagement of said plungers theretogether. Finally, plunger **56'** has angular slots **76** formed therein and therethrough, on opposite sides thereof, to receive pin **68'**, as shown in FIG. 7.

When the power tool is addressed to a workpiece, clutch driver **46'** is translated rearwardly. This causes an engagement of ridges **74** and results in an interfacing coupling of plungers **54'** and **56'**. Further, plungers **56'** and **54'** are caused to translate axially, rearwardly also, effecting a movement of actuator rod **28** and the enabling of the motor means **80**. The motor means powers the take-off shaft **16'** and, through pin **58'** causes a clockwise rotation, i.e., from right to left, as viewed in the drawings, of plunger **54'** and plunger **56'** engaged therewith. Further, drive is imparted through a similar clutch assembly **18** (FIG. 2) to torque clutch driver **46'**. When the workpiece being addressed is fully torqued, via the agency of clutch driver **46'**, the latter will halt, clutch assembly **18** facilitating this effect. Accordingly, pin **68'** is halted, while plungers **54'** and **56'** continue to execute what will be a last, powered turn. Constrained together under the urgings of springs **70'** and **26** (FIG. 3), said plungers turn in unison. Yet plunger **56'** is also cammed forwardly, slots **76** being caused to track along pin **68'**, compressing spring **70'**. Plunger **54'** yields to spring **26** and follows therealong, and valve **24** (FIG. 3) closes to halt the motor means **80**.

In counter-clockwise rotation, the motor means is not brought to a halt when the workpiece is fully torqued but, as study of the ridges **74** will evidence, the continuing rotation of plunger **54'** will not be imparted to plunger **56'**. Ridges **74** on plunger **56'** will remain stationary, and ridges **74** on plunger **54'** will continuously "index" thereabout, until the power tool is withdrawn from the workpiece. Thus, this alternate embodiment of my novelty cammed clutch can be used in a uni-directionally-driven power tool, and is responsive to torque to halt the motor, and in a bi-directionally-driven power tool, my latter embodiment being responsive to torque to halt the motor in one direction. In both applications my latter embodiment, no less than the former, preferred embodiment, achieves and maintains full torque on the workpiece when addressed for clockwise or counter-clockwise rotation.

I claim:

1. A clutch, for use with a power tool having a chuck, and a power train, including motor means and a gear train, for rotation of said chuck, comprising:

first means disposed between said chuck and said power train for translating motion therebetween and, responsive to a given torque loading of said chuck, for prohibiting said translation therebetween;

said first means including second means carried thereby for enabling and halting the rotation of said motor means;

said second means being disposed for a first motion relative said gear train for enabling said motor means, and disposed for at least a second motion transverse to said first motion, with the achievement of said given torque, for halting said motor means; and

a turn-on and turn-off device coupled to said second means for co-operation therewith for enabling and halting said motor means; and wherein

said second means comprise a plurality of plungers, and a rod disposed between said plurality and said device;

said plurality being movable to translate said rod to cause the latter to actuate said device.

2. The invention, according to claim **1**, further including:

first biasing means engaging said plurality to urge the latter against said rod so as to tend to actuate said device in a turn-on mode of operation; and

second biasing means disposed to urge said rod away from said device so as to tend to actuate said device in a turn-off mode of operation.

3. The invention, according to claim **1**, wherein:

said plurality includes first and second plungers; and

further including means coupling one of said first and second plungers with said chuck to provide for axial and rotary relative motion therebetween.

4. The invention, according to claim **1**, wherein:

second means include camming means to provide for axial and rotary relative motion between said chuck and said plurality to cause the latter to overcome the urging of said first biasing means.

5. The invention, according to claim **1**, wherein:

said second means include camming means to provide for axial and rotary relative motion between said chuck and said plurality to facilitate response of said plurality to the urging of said first biasing means.

6. The invention, according to claim **5**, wherein:

said camming means comprise a camming surface, which is presented by a given plunger of said plurality, and a cam follower, fixed to said chuck, disposed to track along said camming surface.

7. The invention, according to claim **6**, wherein:

said chuck and said plurality are co-axially disposed, said camming surface comprises angular slotting formed in said given plunger, and said cam follower comprises a pin in penetration of said given plunger via said angular slotting.

8. The invention, according to claim **1**, further comprising:

a power take-off shaft coupled between said power train and said chuck to provide for rotation of the latter, said shaft having an axial bore formed in the center thereof; and

wherein said plurality is disposed within said axial bore.

9. The invention, according to claim **8**, wherein:

said axial bore has a polygonal configuration along a section thereof; and

one plunger of said plurality is of polygonal shape and of a dimension to facilitate disposition thereof in said section for axial movement therewithin and for cooperative rotary motion therewith.

10. The invention, according to claim **1**, wherein:

said chuck has a round stub shaft extending therefrom and one plunger of said plurality has a circular bore formed therein which receives said stub shaft to allow said one plunger and said chuck to effect relative axial and rotary movement therebetween.

11. The invention, according to claim 1, further comprising:

means coupling said power train with one plunger of said plurality to effect rotation of the latter.

12. The invention, according to claim 1, further comprising:

means coupling said power train with one plunger of said plurality to effect rotation of the latter; and wherein

said plungers of said plurality have means integral therewith for causing at least one plunger of said plurality to engage another plunger of said plurality to effect rotation of the latter by the former.

13. The invention, according to claim 1, further comprising:

means coupling said power train with one plunger of said plurality to effect rotation of said one plunger; and

wherein said plungers of said plurality have means integral therewith for causing at least one plunger of said plurality to engage another plunger of said plurality to effect rotation of the latter by the former upon rotation of the former in a given direction and for causing disengagement of said one plunger and said another plunger upon rotation of said one plunger in a direction which is the reverse of said given direction.

14. The invention, according to claim 1, wherein:

said second means are disposed for a first motion relative said gear train, a second motion transverse to said first motion, and a third motion transverse to both said first and second motions.

15. A power-operated tool comprising:

a rotary motor;

supply means for conducting motor-driving energy to said motor;

control means having alternate positions and controlling said supply means so that in one position it prevents said energy from being supplied to said motor, and in its other position, it allows said energy to flow to said motor, said control means being normally in said one position and including biasing means urging said control means to said one position;

a tool spindle adapted to be connected to a workpiece for applying a torque load to the workpiece and operative, when pressed against the workpiece, to move said control means to its other position;

a torque responsive clutch which is normally engaged to interconnect said spindle to said motor, said clutch being operative, in response to a predetermined torque load on said spindle, to disengage wherein said motor can rotate relative to said spindle;

spring means operative, in its normal position, when said clutch is engaged and said spindle is pressed against a workpiece, to urge and hold said control means in its other position, said clutch being operative, when moving to its disengaged position, to move said spring means to an inoperative position wherein said spring means no longer holds said control means in its other position; and

lock means movable in response to the disengaging of said clutch to hold said spring means in said inoperative position wherein said control means can return to said one position preventing said motor-driving energy from flowing to said motor.

16. The tool of claim 15, wherein:

said lock means is operative, in response to the withdrawing fo the spindle from the workpiece, to unlock said spring means and allow it to return to its normal position.

17. A fluid-operated rotary tool comprising:

a housing including a fluid-operated rotary motor;

a supply passage for conducting power fluid to said motor;

a throttle valve in said passage movable between alternate positions closing and opening said passage,

said throttle valve being normally closed and including biasing means urging said throttle valve to a closed position;

a tool spindle adapted to be connected to a workpiece for applying a torque load to the workpiece and operative, when pressed against the workpiece, to move said throttle valve to its open position;

a torque responsive clutch interconnecting said spindle to said motor, said clutch being operative, in response to a predetermined torque load on said spindle, to disengage and disconnect said spindle from said motor;

spring means operative in its normal position, when said clutch is engaged and said spindle is pressed against the workpiece, to hold said throttle valve open during the operation of the tool, said clutch being operative, when moving to a disengaged position, to move said spring means to an inoperative position wherein said spring means no longer holds said throttle valve open; and

lock means cooperating with said clutch and movable to a position in response to the disengaging of said clutch wherein it locks and holds said spring means in said inoperative position wherein said biasing means moves said throttle valve to its closed position wherein the valve prevents the power fluid from driving said motor.

18. The tool of claim 17, wherein:

said lock means is operative, in response to the withdrawal of said spindle from the workpiece, to unlock said spring means and allow it to return to its normal position.

19. A fluid-operated rotary tool comprising:

a housing including a fluid-operated rotary motor;

a supply passage for conducting power fluid to said motor;

a throttle valve in said passage movable between alternate positions closing and opening said passage, said throttle valve being operable by an operator to an open position to start said motor and including biasing means urging said throttle valve to closed position;

a tool spindle adapted to be connected to a workpiece for applying a torque load to the workpiece;

a torque responsive clutch interconnecting said rotary drive from said motor to said spindle, said clutch being operative, in response to a predetermined torque load on said spindle, to progressively release and interrupt said rotary drive to said spindle; and

control means operative in response to the releasing of said clutch, to progressively close said throttle valve in step with the releasing of said clutch whereby said motor is progressively stopped as said clutch progressively releases.

20. The tool of claim 19, wherein:

said control means includes spring means which normally holds said throttle valve in its open position after being moved to the open position by an operator.

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