

[54] PORTABLE PNEUMATIC POWER TOOL

[75] Inventors: **Hans Wezel**, Maulbronn/Wuertt;
Manfred Zeller, Pforzheim, both of
Germany[73] Assignee: **Schmid & Wezel**,
Maulbronn/Wuertt, Germany[22] Filed: **Sept. 27, 1972**[21] Appl. No.: **292,631**

[30] Foreign Application Priority Data

Sept. 30, 1971 Germany..... 2148739

[52] U.S. Cl. 173/12, 173/15, 192/56 F

[51] Int. Cl. B25b 23/14

[58] Field of Search 173/12, 15; 192/56 F

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Primary Examiner—Ernest R. Purser

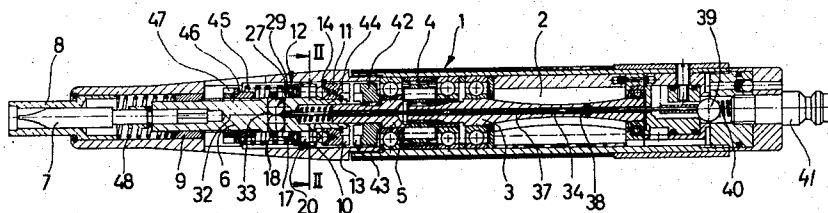
Attorney, Agent, or Firm—Michael S. Striker

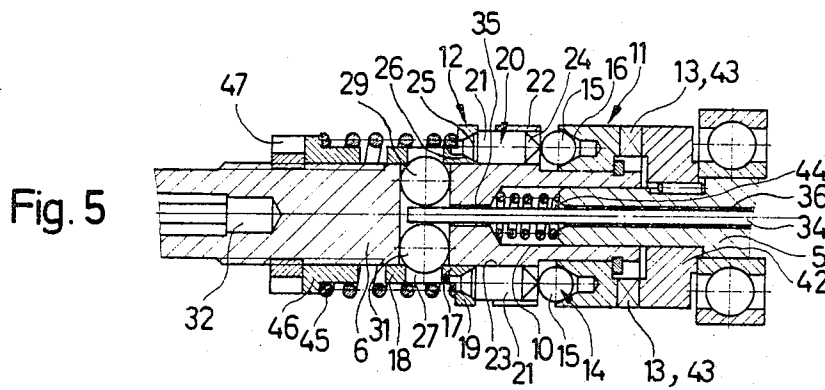
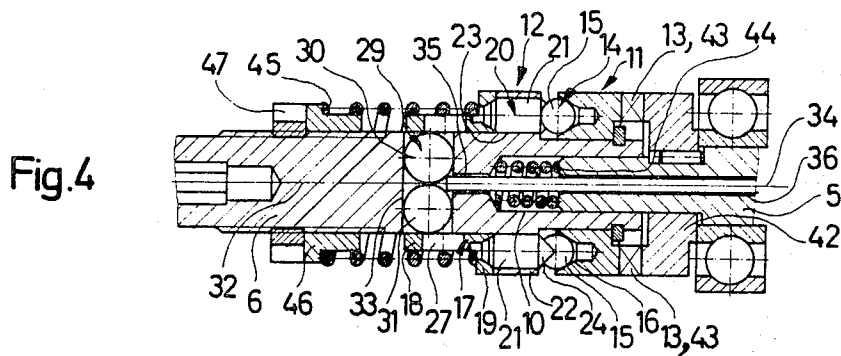
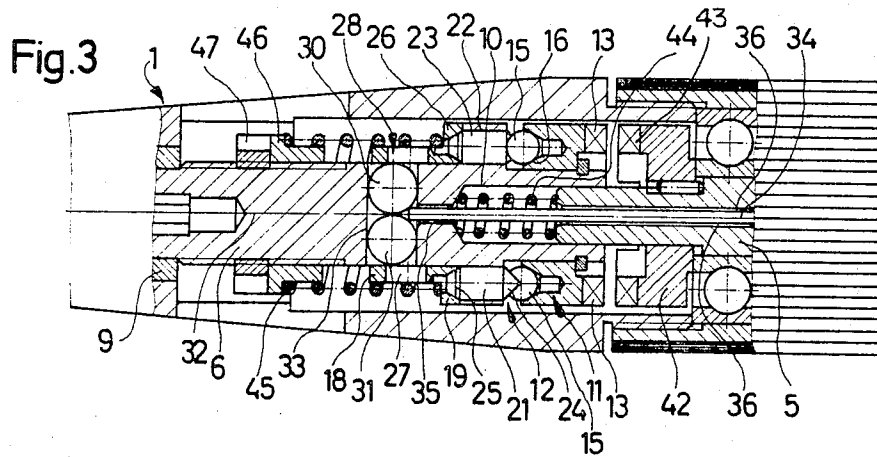
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ABSTRACT

A pneumatic screwdrive wherein the motor is started by opening a normally closed valve in automatic response to axial shifting of the tool spindle when the tip of the tool is pressed against a screw. The output device of the motor then drives a first coupling portion which drives a second coupling portion rotatably mounted on the tool spindle. The latter receives torque by way of an overload clutch having an annulus of balls mounted in the second clutch portion, a flanged sleeve movable axially of but rotatable with the spindle, a set of pins which are movable axially in a portion of the spindle, and an adjustable spring which determines the maximum torque to be transmitted to the tool spindle. The pins are driven by the balls, before the spring yields, to thereby rotate the sleeve. The valve is opened by a pair of spheres mounted in a diametral bore of the tool spindle and displacing a valve actuating rod when the spindle is moved toward the output device. The sleeve of the clutch has two radial bores which receive portions of the spheres to allow the valve to open when the spring yields in response to a predetermined resistance of the spindle to rotation with the output device.

16 Claims, 5 Drawing Figures





PORTABLE PNEUMATIC POWER TOOL

BACKGROUND OF THE INVENTION

The present invention relates to power tools in general, and more particularly to improvements in portable power tools wherein the rotary tool spindle can receive torque from a pneumatic motor. Still more particularly, the invention relates to improvements in portable pneumatic power tools which can be used as screwdrivers to drive home a screw or the like with a force which can be selected in advance by the user of the power tool.

It is already known to provide a portable pneumatic screwdriver with a housing which contains the motor and an axially movable tool spindle. The output shaft of the motor can rotate the tool spindle by way of a coupling which is engaged in response to depression of the tool spindle into the housing. A clutch is interposed between that portion of the coupling which is mounted on the tool spindle and the tool spindle proper, and the screwdriver further comprises means for starting the pneumatic motor in response to depression of the tool spindle, i.e., in response to engagement of the blade on the tool spindle with the slot on the head of a screw which is to be driven home. The clutch allows the spindle to come to a standstill when the screw offers excessive resistance to rotation with the output shaft. In one type of presently known pneumatic screwdrivers, the tool spindle is formed with inclined grooves for balls which cooperate with a clutch ring. When the selected maximum torque is exceeded, the balls bring about an axial movement of an arresting ring which in turn displaces the actuating member for a valve serving in connect the pneumatic motor with a source of compressed air. The motor is arrested simultaneously with disengagement of the coupling. However, and since the arresting ring is biased by a spring which determines the maximum torque to be transmitted to the tool spindle, a premature reengagement of the coupling is not excluded. Also, the maximum torque which the motor can transmit to the tool spindle cannot be selected with a requisite degree of accuracy. Furthermore, the just described power tool comprises an exceptionally large number of parts and its operation is not sufficiently reliable.

It was further proposed to hold one section of the clutch which drives the tool spindle in disengaged position as soon as the spindle offers a predetermined maximum resistance to rotation with the motor. This insures that the energy of the motor which continues to rotate by inertia after it is disconnected from the source of compressed gas cannot be transmitted to the tool spindle. To this end, the power tool employs a specially designed valve which controls the admission of compressed gas to the motor and applies an axial force to the rod which can open the valve so that the rod holds the one clutch section against engagement with the other clutch section. Such valves are unreliable in actual use and contribute excessively to the cost of the power tool. In addition, the power tool must employ a further valve which starts the motor and must be closed upon completion of each screw driving operation.

SUMMARY OF THE INVENTION

An object of the invention is to provide a pneumatic power tool, particularly a portable pneumatic screw-

driver, which is constructed and assembled in such a way that the motor automatically ceases to transmit torque to the tool spindle when the latter offers a predetermined resistance to further rotation and wherein the tool spindle can be repeatedly disengaged from the motor at the exact moment when its resistance to rotation reaches the predetermined value.

Another object of the invention is to provide a portable pneumatic screwdriver which is capable of automatically starting the motor in response to proper application of the tool to a screw or the like.

A further object of the invention is to provide a pneumatic power tool with novel and improved clutch means between the output device of the motor and the tool spindle and to provide the power tool with novel and improved means for actuating the valve which controls the admission of compressed gas to the motor.

An additional object of the invention is to provide a power tool wherein all parts automatically reassume optimum positions for renewed use as soon as a preceding screw driving operation is completed so that the operator need not make any adjustments between successive uses of the power tool.

The invention is embodied in a pneumatic power tool, particularly in a portable pneumatic screwdriver, which comprises a pneumatic motor having a rotary output device which may comprise a motor shaft, a coaxial drive shaft and a reducing gearing which rotates the drive shaft in response to rotation of the motor shaft, a source of compressed fluid (such source may include a nipple provided in or on the housing of the power tool and connectable to a conventional supply of compressed air), a normally closed valve which is interposed between the source and the motor so that the motor is started in response to opening of the valve, a rotary tool spindle which is coaxial with and is movable axially toward and away from the output device (the tool spindle will move toward the output device in response to connection of its tool with the head of a screw to be driven home and in response to the application of pressure against the housing of the power tool in order to move the housing toward the screw), a coupling having complementary first and second coupling portions respectively rotatable on (but movable axially with) the tool spindle and secured to the output device so that the first coupling portion engages the second coupling portion when the tool spindle is moved toward the output device, a clutch including a first clutch section rotatable with and shiftable axially of the tool spindle, a second clutch section provided on the first coupling portion, and a helical spring or analogous means for biasing the first clutch section into torque receiving engagement with the second clutch section so that the tool spindle normally rotates with the output device when the first coupling portion engages the second coupling portion and the first clutch section receives torque from the second clutch section, a valve actuating member which is movable to and from an inoperative position in which the valve is closed, displacing means mounted in the tool spindle and being arranged to move the valve actuating member from its inoperative position to thereby start the motor in response to movement of the tool spindle toward the output device, and receiving or anchoring means provided in or on the first clutch section to receive a portion of the displacing means in response to shifting of the first clutch section against the opposition of the biasing means when the

tool spindle offers a predetermined resistance to rotation with the output device whereby the displacing means allows the valve actuating member to reassume its inoperative position with attendant automatic stoppage of the motor.

The power tool preferably further comprises resilient means for yieldably urging the tool spindle away from the output device and means for adjusting the resistance of the biasing means of the clutch means to the shifting of the first clutch section. Such adjusting means thereby selects the exact resistance which the tool spindle must offer before the clutch means is disengaged to allow for rotation of the output device relative to the tool spindle.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved portable power tool itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an axial sectional view of a portable pneumatic screwdriver which embodies the invention;

FIG. 2 is an enlarged transverse sectional view as seen in the direction of arrows from the line II—II of FIG. 1;

FIG. 3 is an enlarged view of a detail in the screwdriver of FIG. 1, showing certain parts in the positions they assume when the screwdriver is not in use;

FIG. 4 illustrates a portion of the structure shown in FIG. 3, with the parts in positions they assume when the screwdriver rotates a screw; and

FIG. 5 shows the structure of FIG. 4 with the parts in positions they assume when the tool spindle offers excessive resistance to rotation with the output shaft of the pneumatic motor.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The portable pneumatic power tool of FIG. 1 is a screwdriver having a composite barrel-shaped housing 1 a median portion of which surrounds a compressed-air motor 2 having lamellae which are driven in response to admission of compressed air by way of a normally closed valve including a spherical valve member 39 and a valve spring 40 serving to normally urge the valve member 39 against a seat. The nipple for a conduit which serves to admit compressed air from a suitable source into the housing 1 is shown at 41. This nipple can be said to form part of the source of compressed air, and the valve including the parts 39, 40 is interposed between the source and the motor 2.

The output shaft 3 of the motor 2 extends forwardly toward the working end of the power tool and serves to rotate a drive shaft 5 through the intermediary of a reduction gearing 4. The forward end of the drive shaft 5 can be coupled to the rear end of an axially movable tool spindle 6. The front end of the tool spindle 6 carries a removable tool in the form of a blade 7 which is insertable into the slot of a screw. The blade 7 is surrounded by a tubular shield 8 which extends beyond the front end of the housing 1.

The front end portion of the tool spindle 6 is rotatable and reciprocable in a bearing sleeve 9 and the rear end portion of the tool spindle is provided with an axial bore 10 receiving a smaller-diameter front end portion of the drive shaft 5. The rear end portion of the tool spindle 6 is further connected for axial movement with one portion 11 of a claw coupling 12. The coupling portion 11 can rotate on the tool spindle 6 and has an annulus of claws 13 which face the drive shaft 5. The coupling portion 11 also supports an annulus of balls 15 which constitute one section 14 of an overload clutch. The balls 15 are received in conical sockets or recesses 16 provided in the front end face of the coupling portion 11. As shown in FIG. 2, the clutch section 14 may comprise four equidistant balls 15. The coupling portion 11 is rotatable on the tool spindle 6.

A complementary second section 17 of the overload clutch 12 is mounted in front of the coupling portion 11 and includes a cylindrical sleeve 18 having an annular flange 19. The tool spindle 6 is rigid with a sleeve 22 which is disposed between the clutch sections 14 and 17 and contains a torque receiving device 20 composed of four axially parallel pins 21. The pins 21 are reciprocable in axial parallel bores 23 of the sleeve 22. Each pin 21 has a pointed end portion 24 adjacent to the clutch section 14 and a conical end portion 25 received in a complementary conical recess or socket 26 of the flange 19. The sleeve 18 has two radial ball anchoring or receiving bores 27 bounded by annular surfaces 28. The bores 27 can receive portions of spherical displacing elements 30, 31 forming part of a displacing device 29 which is installed in a diametrically extending transverse bore 33 of the tool spindle 6. The axis of the bore 33 is normal to and intersects the axis 32 of the tool spindle 6. The radius of the tool spindle 6 equals the diameter of the spherical displacing element 30 or 31.

The spherical displacing elements 30, 31 can move rearwardly a valve actuating rod 34 which can lift the spherical valve member 39 off its seat against the opposition of the valve spring 40. The rod 34 is reciprocable in axial bores 35, 36, 37 which are respectively provided in the tool spindle 6, drive shaft 5 and output shaft 3. The axis 38 of the rod 34 coincides with the axis 32 of the tool spindle 6. As shown in FIG. 1, the front end face of the rod 34 normally abuts against the spherical displacing elements 30, 31 and the rear end face of this rod invariably abuts against the valve member 39. FIG. 1 shows the valve actuating rod 34 in its inoperative position.

The drive shaft 5 is rigidly connected with a second portion 42 of the claw coupling which is provided with claws 43 adopted to mate with the claws 13 of the coupling portion 11. A helical spring 44 between the tool spindle 6 and the drive shaft 5 tends to move the tool spindle forwardly, i.e., away from the drive shaft 5. The tool spindle 6 is surrounded by a torque limiting spring 45 which bears against the flange 19 of the clutch section 17 and reacts against an adjusting nut 46 meshing with the tool spindle 6. The nut 46 can change the bias of the spring 45 and can be held in selected axial position by a lock nut 47. The shield 8 is biased to its forward end position by a helical spring 48 which reacts against the bearing sleeve 9.

FIG. 3 shows that the outer diameter of the flange 19 equals the outer diameter of the sleeve 22 on the tool spindle 6. The sleeve 18 of the clutch section 17 is a

sliding fit on the tool spindle 6. The clutch section 17 includes the sleeve 18, the flange 19, the sockets 26 and the torque receiving pins 23.

The operation:

When the power tool is not in use, its parts assume the positions shown in FIG. 3. The claws 13 of the coupling portion 11 on the tool spindle 6 are disengaged from the claws 43 of the coupling portion 42, on the drive shaft 5 because the spring 44 maintains the tool spindle 6 in a starting position at a maximum distance from the output shaft 3. The balls 15 of the clutch section 14 engage with the pointed tips 24 of torque receiving pins 21 (which constitute the torque receiving device 20 of the clutch section 17) under the action of the spring 45 which biases the sleeve 18 and flange 19 of the clutch section 17 in a direction to the right, as viewed in FIG. 3. The valve member 39 is biased against its seat by the valve spring 40 so that the motor 2 is idle because it cannot receive compressed air from the nipple 41. The bias of the spring 45 is determined by the selected axial position of the adjusting nut 46, and such bias determines the magnitude of torque which the balls 15 of the clutch section 14 can transmit to the tool spindle 6 by way of the pins 21, flange 19 and sleeve 18.

If the power tool is to be put to use, the front end portion of the shield 8 is placed around the head of a screw (not shown) and the housing 1 is pushed forwardly by the hands of the user so that the shield 8 is depressed into the front end position of the housing 1 against the opposition of the helical return spring 48. The blade 7 enters the slot in the head of the screw. In response to further forward movement of the housing 1, the drive shaft 5 moves toward the tool spindle 6 against the opposition of the spring 44 so that the claws 43 of the coupling portion 42 engage the claws 13 of the coupling portion 11. At the same time, the spherical displacing elements 30, 31 hold the valve actuating rod against forward movement with the shafts 3, 5 so that the rod 34 lifts the valve member 39 off its seat (the seat moves forwardly with the housing 1) against the opposition of the valve spring 40 so that the nipple 41 can admit compressed air to the motor 2. The lamellae of the motor 2 are driven to rotate the output shaft 3 which rotates the drive shaft 5 by way of the reduction gearing 4. The claws 43 of the coupling portion 42 on the drive shaft 5 rotate the tool spindle 6 by way of the claws 13 of the coupling portion 11, the balls 15 of the clutch section 14, and the pins 21, flange 19 and sleeve 18 of the clutch section 17. The tool spindle 6 rotates the blade 7 which, in turn, rotates the screw so that the latter penetrate into the material of a workpiece, not shown. When the motor 2 drives the tool spindle 6, the parts of the power tool assume the positions shown in FIG. 4.

When the screw has been driven home, its resistance to rotation increases so that the spring 45 yields and allows the clutch section 17 to be shifted forwardly (in a direction to the left as viewed in FIG. 4) by the balls 15 of the clutch section 14. The tool spindle 6 comes to a halt because the forwardly shifted parts 18, 19 of the clutch section 17 allow the pins 21 to move forwardly so that they cease to be driven by the balls 15. The motor 2 continues to rotate the drive shaft 5 so that the sleeve 18 remains in its front end position in which its anchoring bores 27 register with the respective ends of the transverse bore 33 in the tool spindle

6. The valve actuating rod 34 is moved forwardly by the valve member 39 under the action of the valve spring 40 so that the valve member 39 engages its seat and seals the nipple 41 from the motor 2 which comes to a halt. The displacing balls 30, 31 penetrate into the respective anchoring bores 27 and hold the sleeve 18 (and hence the entire clutch section 17) against axial movement under the action of the spring 45. The balls 15 are disengaged from the pins 21 so that the shaft 3 of the motor 2 can rotate by inertia without transmitting any torque to the tool spindle 6. The claws 13 continue to engage with the claws 43 (see FIG. 5).

When the user thereupon detaches the shield 8 and blade 7 from the screw, the spring 44 is free to expand so that the tool spindle 6 moves forwardly to disengage the claws 13 from the claws 43 and to move the displacing balls 30, 31 beyond the front end face of the valve actuating rod 34. The spring 45 is then free to expand and to return the sleeve 18 to the axial position shown in FIG. 3. Therefore, the sleeve 18 returns the outer position of the displacing balls 30, 31 into the bore 33 so that the balls 30, 31 are located in front of the valve actuating rod 34. The power tool is then ready for use, i.e., all of its parts reassume the positions shown in FIG. 3.

When the parts assume the position shown in FIG. 5, the components 18, 19 of the clutch section 17 are mechanically locked in their illustrated positions so that they cannot be shifted by the spring 45. Thus, the motor 2 cannot rotate the tool spindle 6 because the torque receiving pins 21 are out of the reach of the balls 15 of the clutch section 14. The spring 40 is strong enough to move the valve member 39 against its seat as soon as the bore 33 of the tool spindle 6 registers with the anchoring bores 27 in the sleeve 18, i.e., portions of the balls 30, 31 then respectively penetrate into the adjacent anchoring bores 27 and the motor 2 is arrested. On the other hand, when the power tool is moved away from the screw, the spring 44 is free to automatically return the tool spindle 6 to its front end position and the spring 45 returns the sleeve 18 to the position of FIG. 3 so that the displacing balls 30, 31 are fully accommodated in the bore 33 and are ready to open the valve by way of the rod 34 as soon as the housing 1 is moved forwardly toward the head of a screw.

The clutch section 14 is preferably removable for inspection and/or replacement, together with the torque receiving pins 21. These parts preferably consist of a highly wear-resistant material.

An important advantage of the improved power tool is that the magnitude of torque to be transmitted to the tool spindle 6 can be selected with a high degree of accuracy and that the magnitude of such torque is not affected by inertia of the output shaft 3 which can continue to rotate after the tool spindle 6 is arrested. The power tool is relatively simple, handy, compact, rugged and reliable. Also, the motor 2 is started in automatic response to proper attachment of the blade 7 to the head of a screw and upon depression of the shield 8 into the housing 1, and the motor 2 is arrested in automatic response to a preselected resistance of tool spindle to further rotation with the drive shaft 5.

The parts 3, 4, 5 can be said to constitute a composite output device of the motor 2 because they invariably rotate as a unit (even though the drive shaft 5 is rotated

at a speed which is less than the speed of the shaft 3 due to the provision of reducing gearing 4).

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of our contribution to the art and, therefore, such adaptation should and are intended to be comprehended within the meaning and range of equivalence of the claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

We claim:

1. In a portable pneumatic power tool, particularly in a screw driver, a combination of a pneumatic motor having a rotary output device; a normally closed valve for connecting said motor with a source of compressed gas so that the latter is started in response to opening of said valve; a rotary tool spindle coaxial with and movable axially toward and away from said output device; a coupling having complementary first and second coupling portions respectively rotatable on said spindle and secured to said output device, said first coupling portion being movable into engagement with said second coupling portion in response to axial movement of said spindle toward said output device; a clutch including a first clutch section rotatable with and axially of said spindle, a second clutch section provided on said first coupling portion, and means for biasing said first clutch section into torque-receiving engagement with said second clutch section; a valve actuating member movable to and from an inoperative position in which said valve is closed; displacing means mounted in said spindle and arranged to move said actuating member from said inoperative position to thereby start said motor in response to movement of said spindle towards said output device; and anchoring means provided in said first clutch section to receive at least a portion of said displacing means in response to shifting of said first clutch section against the opposition of said biasing means when said spindle offers a predetermined resistance to rotation with said output device whereby said displacing means allows said actuating member to reassume said inoperative position with attendant stoppage of said motor, said displacing means being arranged to hold said first clutch section against movement into torque receiving engagement with said second clutch section when said displacing means extends into said anchoring means.

2. The combination of claim 1, further comprising resilient means for biasing said tool spindle away from said output device.

3. The combination of claim 1, further comprising means for adjusting the resistance of said biasing means to shifting of said first clutch section.

4. The combination of claim 1, wherein said actuating member is a rod and said valve comprises means for biasing said rod to said inoperative position, said rod being received in aligned axial bores provided therefor in said output device and said tool spindle.

5. The combination of claim 4, wherein said anchoring means includes at least one recess provided in said first clutch section and arranged to receive a portion of said displacing means under the action of said last mentioned biasing means and said rod in response to shift-

ing of said first clutch section against the opposition of said first mentioned biasing means.

6. The combination of claim 1, wherein said first clutch section comprises a sleeve shiftable axially of and arranged to rotate with said tool spindle, a flange provided on said sleeve, and at least one torque receiving element arranged to receive torque from said second clutch section and to thus rotate said flange when said tool spindle offers less than said predetermined resistance to rotation with said output device.

7. The combination of claim 6, wherein said sleeve is a sliding fit on said tool spindle, said anchoring means including at least one radial bore provided in said sleeve and said flange having a socket for said torque receiving element.

8. The combination of claim 1, wherein said second clutch section comprises at least one spherical torque transmitting element received in a conical socket of said first coupling portion.

9. The combination of claim 1, wherein said valve comprises a valve member and resilient means for biasing said valve member to a sealing position in which said valve is closed, said actuating member comprising a rod reciprocable in axial bores provided therefor in said tool spindle and said output device, said rod having a first end face abutting against said valve member and a second end face normally abutting against said displacing means under the action of said resilient means.

10. The combination of claim 9, wherein said output device comprises a rotary motor shaft and a coaxial second shaft driven by said motor shaft and arranged to rotate said second coupling portion.

11. In a portable pneumatic power tool, particularly in a screw driver, the combination of a pneumatic motor having a rotary output device; a normally closed valve for connecting said motor with a source of compressed gas so that the latter is started in response to opening of said valve; a rotary tool spindle coaxial with and movable axially toward and away from said output device; a coupling having complementary first and second coupling portions respectively rotatable on said spindle and secured to said output device, said first coupling portion being movable into engagement with said second coupling portion in response to axial movement of said spindle toward said output device; a clutch including a first clutch section rotatable with and shiftable axially of said spindle and comprising at least one pin-shaped element, a second clutch section provided on said first coupling portion, and means for biasing said first clutch section into torque receiving engagement with said second clutch section, said spindle comprising a sleeve arranged between said first and said second clutch sections and having at least one axially parallel bore in which said pin-shaped element is axially movably received and arranged to receive torque from said second clutch section when said motor drives said first coupling portion and said tool spindle offers less than a predetermined resistance to rotation with said output device; a valve actuating member movable to and from an inoperative position in which said valve is closed; displacing means mounted in said spindle and arranged to move said actuating member from said inoperative position to thereby start said motor in response to movement of said spindle towards said output device; and anchoring means provided in said first clutch section to receive at least a portion of the dis-

placing means in response to shifting of said first clutch section against the opposition of said biasing means when said spindle offers said predetermined resistance to rotation with said output device whereby said displacing means allows said actuating member to re-assume said operative position with attendant stoppage of said motor.

12. The combination of claim 11, wherein said first clutch section further comprises a flange adjacent to said sleeve and having a socket for a portion of said pin-shaped element, said biasing means comprising resilient means arranged to bias said flange toward said sleeve.

13. The combination of claim 12, wherein the outer diameter of said flange equals the outer diameter of said sleeve, said flange surrounding said tool spindle and being movable axially thereof under and against the action of said resilient means.

14. The combination of claim 12, wherein said pin-shaped element comprises a pointed first end portion receiving motion from said second clutch section and a conical second end portion received in said socket of said flange.

15. In a portable pneumatic power tool, particularly in a screw driver, the combination of a pneumatic motor having a rotary output device; a normally closed valve for connecting said motor with a source of compressed gas so that the latter is started in response to opening of said valve; a rotary tool spindle coaxial with and movably axially toward and away from said output device; a coupling having complementary first and second coupling portions respectively rotatable on said spindle and secured to said output device, said first

coupling portion being movable into engagement with said second coupling portion in response to axial movement of said spindle towards said output device; a clutch including a first clutch section rotatable with and shiftable axially of said spindle, a second clutch section provided on said first coupling portion, and means for biasing said first clutch section into torque receiving engagement with said second clutch section; a valve actuating member movable to and from an inoperative position in which said valve is closed; displacing means mounted in said spindle and arranged to move said actuating member from said inoperative position to thereby start said motor in response to movement of said spindle towards said output device, said displacing means comprising two discrete members located in a bore provided in and extending transversely of the axis of said tool spindle; and anchoring means provided in said first clutch section and comprising two discrete recesses provided in said first clutch section and each arranged to receive a portion of one of said displacing members in response to shifting of said first clutch section against the opposition of said biasing means when said spindle offers a predetermined resistance to rotation with said output device, whereby said displacing means allows said actuating member to re-assume said inoperative position with attendant stoppage of said motor.

16. The combination of claim 15, wherein each of said displacing members is a sphere and said actuating member is a rod which is reciprocable in an axial bore of said tool spindle.

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