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Amtsberg et al.

[11] **3,785,442**

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[54] **PNEUMATIC NUT RUNNING TOOL WITH GOVERNOR SHUT-OFF CONTROL**

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[52] **U.S. Cl.**.......................... **173/12,** 137/58, 415/36

[51] **Int. Cl.**.. **B25b 23/14**

[58] **Field of Search**.. 173/12; 137/47–58; 418/40–44; 415/32, 36; 91/59

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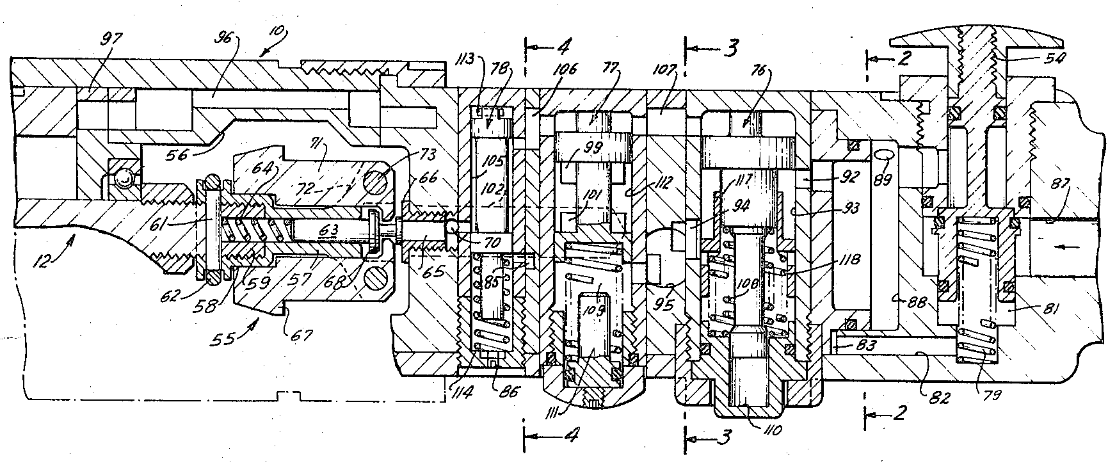
[57] **ABSTRACT**

A pneumatic tool provided with combined nut setting and crimping mechanism which responds to rotation of an air motor in one direction to set a nut and responds to rotation of the motor in an opposite direction to crimp the nut. Shiftable valving mechanism is included to direct operating air flow to drive the motor in one direction or the other. A throttle valve is depressible to initiate air flow to the valving mechanism and becomes pneumatically unbalanced against the force of a spring in open condition. A centrifugal motor speed responsive governor valve controls shifting of the valving mechanism and automatic return of the throttle valve to shut-off condition.

In another embodiment, the governor valve is incorporated in a conventional pneumatic nut runner to effect automatic shut off of air flow to the motor.

The term "governor" as used herein means a mechanism having the usual governor elements, i.e., flyweights, valve means, etc.; however, the governor used in the device of the invention functions to sense and respond to a predetermined speed at which certan valves will be made operative to perform desired operational results, all as will be apparent hereinafter.

15 Claims, 9 Drawing Figures



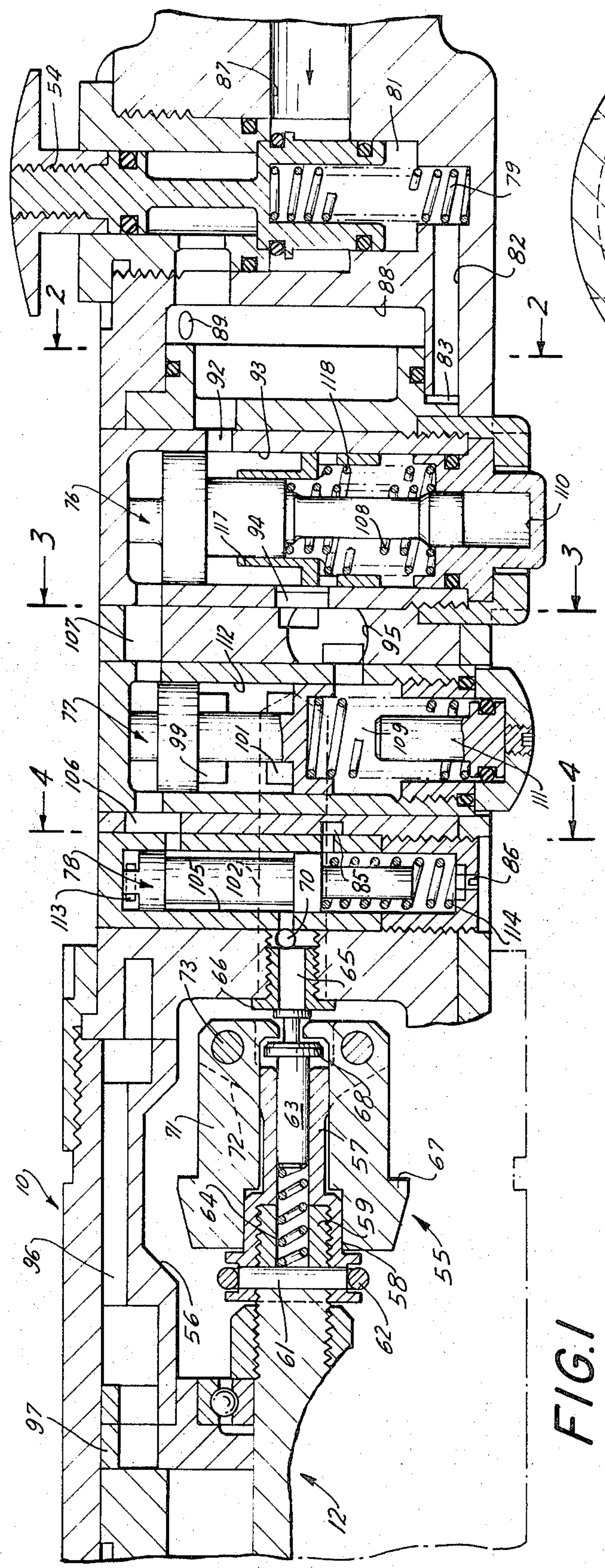


FIG. 1

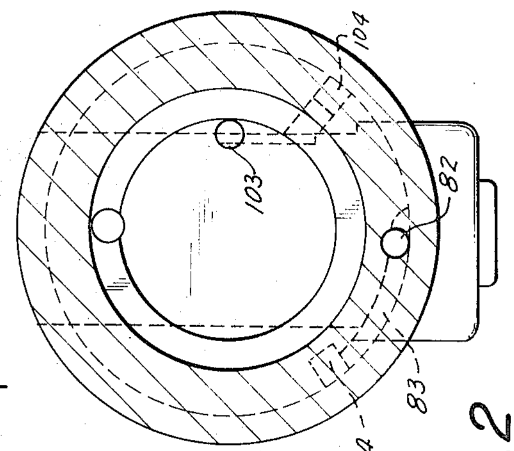


FIG. 2

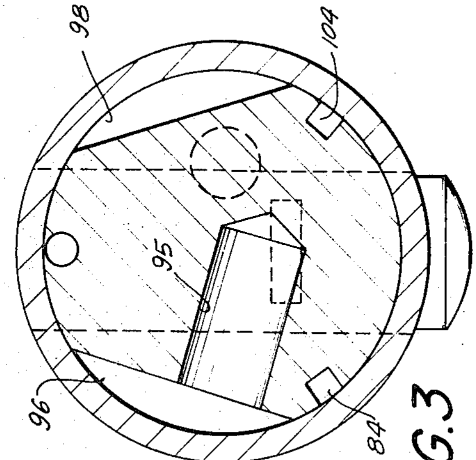


FIG. 3

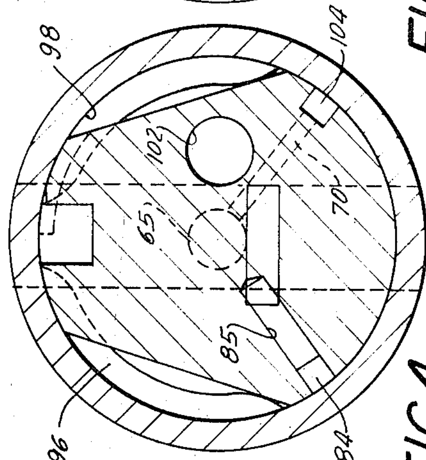


FIG. 4

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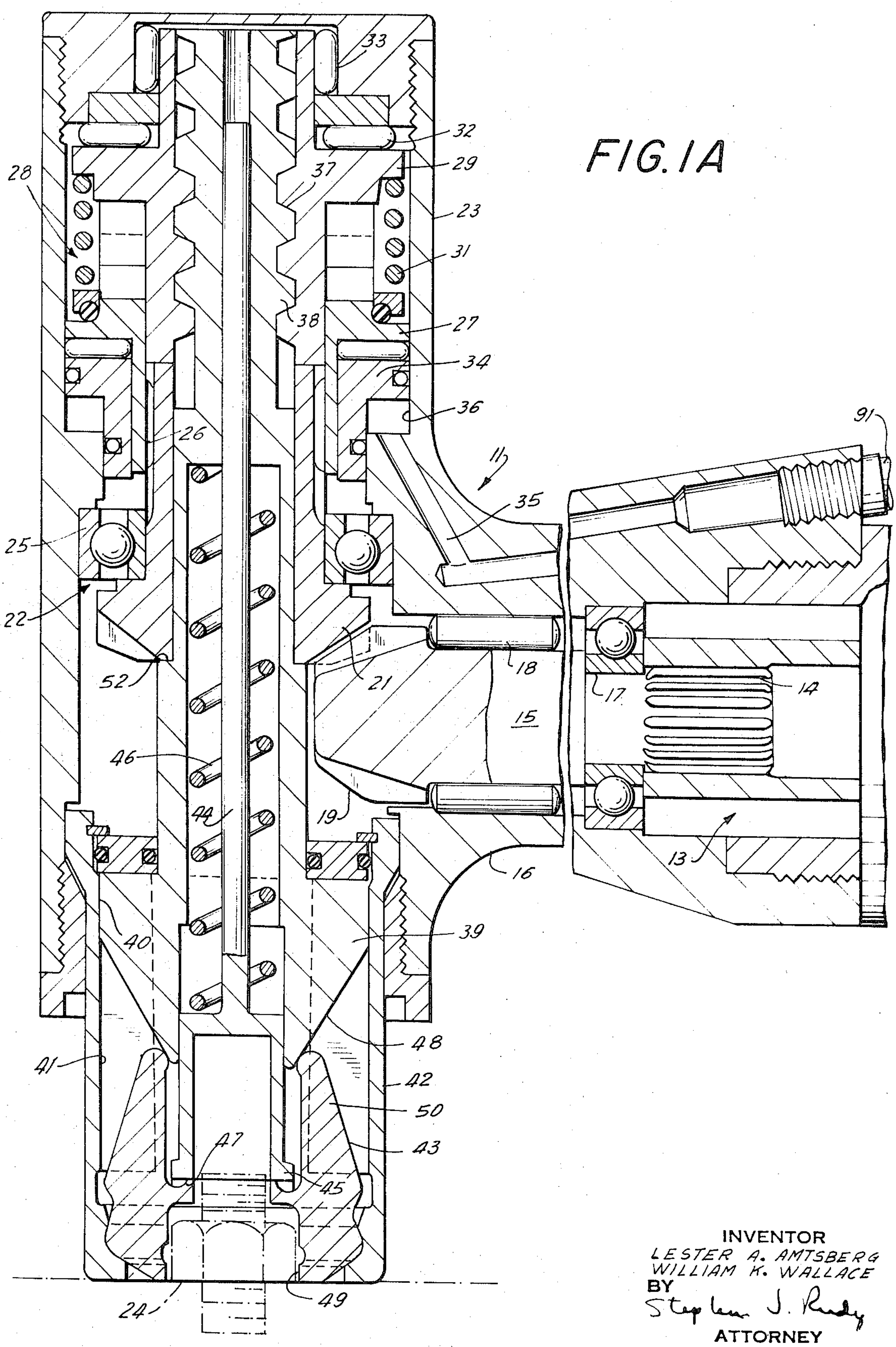

FIG. 1A

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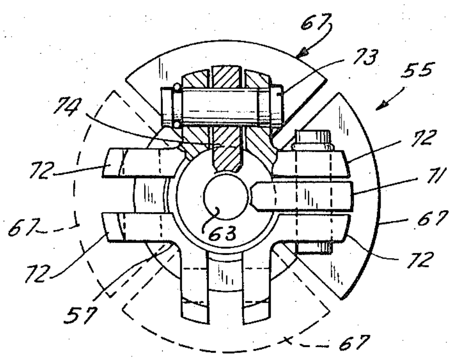
FIG. 5



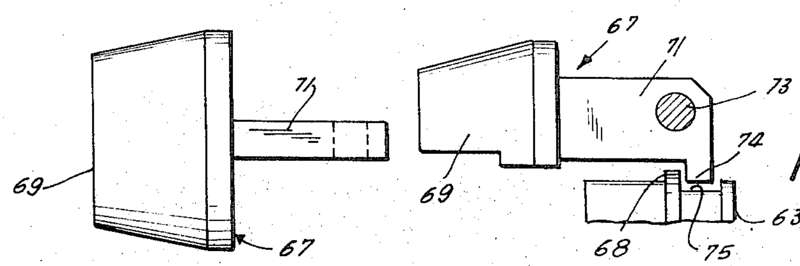


FIG. 7

FIG. 6

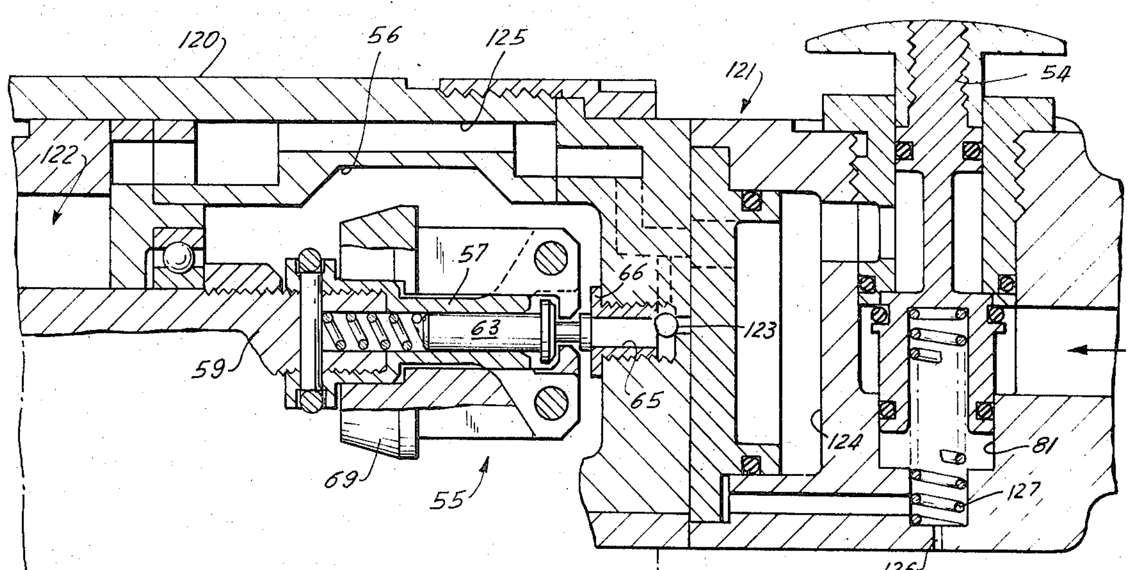


FIG. 8

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PNEUMATIC NUT RUNNING TOOL WITH GOVERNOR SHUT-OFF CONTROL

BACKGROUND OF THE INVENTION

This invention relates to the art of pneumatic nut runners provided with automatically operating air shut-off controls.

It is concerned in a first embodiment of the invention with a pneumatic tool in which nut running and crimping mechanism are combined.

A tool of this type having an automatic air shut-off control is described in our co-pending application Ser. No. 121,867, filed Mar. 8, 1971 which issued as U.S. Pat. No. 3,747,441 on July 24, 1973. In this known tool, following depression of a throttle valve, the tool runs through a complete cycle having a first stage in which a valving system directs inlet air to run the motor in one direction to set the nut; then responds to a stall condition of the motor to direct the air to run the motor in an opposite direction in a second stage to crimp the nut; and then responds to a stall condition to shut off further air flow to the motor.

In the tool described in the first embodiment of the invention, a governor controlled valve unit is connected in a shiftable valving system. In this tool following depression of a throttle valve, the tool runs through a complete cycle having a first stage in which the valving system directs inlet air to run the motor in a nut tightening direction. In this first stage, the governor unit responds to a rapid acceleration of the motor speed in excess of ten percent of its free speed to open its valve so as to maintain the throttle valve pneumatically unbalanced in an open condition; next, when the motor becomes loaded by reaction torque in the nut tightening operation and its speed drops below 10 percent of its free speed, the governor unit responds or senses the loaded condition and closes its valve to cause the valving system to direct the inlet air so as to operate the motor in an opposite direction for the nut crimping stage. Before the throttle valve can, as this second stage begins, become pneumatically balanced and shut off while the governor controlled valve is closed, the governor unit again responds to rapid acceleration of the motor above 10 percent of its free speed to maintain the throttle valve pneumatically unbalanced in its open direction. Finally, when the motor becomes loaded in the crimping stage and its speed drops below 10 percent of its free speed, the governor unit responds to close its valve, causing the throttle valve to become pneumatically balanced and restored to shut-off condition by its return spring.

This employment of the governor controlled valve unit represents a decided advance in this unit, in that it results in a precise pre-torque control over the operation of the motor. The governor unit begins to operate momentarily before final torque is delivered to the nut in each stage of operation, that is, when the motor speed drops below ten percent of its free speed. The motor drops operating precisely at the time of final torque delivery.

In a second embodiment, the governor controlled valve unit is incorporated in a conventional type pneumatic nut runner. In this tool, following actuation of the throttle valve, the governor unit responds to speed of the motor above ten percent of its free speed to maintain the throttle valve pneumatically unbalanced in an open condition. Next, the governor unit responds to deceleration of the motor below ten percent of its free speed to cause the throttle valve to return to closed condition.

BRIEF DESCRIPTION OF THE DRAWING

In the accompanying drawing:

FIGS. 1 and 1A, combined, comprise a pneumatic nut running and crimping tool illustrating a first embodiment of the invention, portions of the tool being shown in section and broken away in part for clarity of illustration;

FIG. 2 is a section on line 2—2 of FIG. 1;

FIG. 3 is a section on line 3—3 of FIG. 1;

FIG. 4 is a section on line 4—4 of FIG. 1;

FIG. 5 is a detail of the governor unit viewed from its valve end, portions being broken away and sectioned for clarity;

FIG. 6 is a detail of a governor weight;

FIG. 7 is a detail of the association of the stem portion of the governor weight with the governor valve; and

FIG. 8 is a fragmentary portion of a pneumatic nut running tool illustrating a further embodiment of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS

Reference is directed to the accompanying drawing, and now especially to the embodiment shown in FIGS. 1–7, wherein there is disclosed a pneumatically powered tool (FIGS. 1 and 1A combined) having a general housing 10, to the front end of which is detachably coupled an angle-head section 11.

Within the housing is a conventional reversible air driven rotary stall motor, generally indicated at 12, of the radially slidable vane type. Rotation of the motor is transmitted through conventional reduction gearing, generally indicated at 13 (FIG. 1A) and through a splined driving connection 14 to a spindle 15. The spindle extends axially into one arm 16 of the angle-head, wherein it is supported in bearings 17 and 18. A beveled pinion 19 on the spindle drivingly engages a bevel gear member 21 of a combined nut running and nut crimping mechanism 22. The mechanism is shown as arranged in a second arm 23 of the angle head, which arm extends at right angles to the longitudinal axis of the general housing of the tool.

The mechanism 22 has a first stage of operation upon application of torque to it in one direction by the spindle 15 to run a nut 24 down to a predetermined value of tightness; and the mechanism 22 has a subsequent second stage of operation to crimp the nut upon torque being applied to the mechanism by the spindle in an opposite or nut crimping direction.

The mechanism 22 is described in detail in our co-pending application Ser. No. 121,867, filed Mar. 8, 1971, for a Pneumatic Tool Having Combined Nut Running and Crimping Mechanism.

The beveled gear member 21 of mechanism 22 is journaled in a bearing 25; and has a splined driving connection 26 with a slidable dog member 27 of a clutch 28. The dog is normally biased out of clutched engagement with a drive-nut member 29 of the clutch by means of a spring 31. The drive-nut member is supported by bearings 32, 33. Upon admission of live air through a passage 35 to a chamber 36, a piston 34 is movable to slide the dog into clutched driving engagement with the drive-nut.

The drive-nut has an internal helically splined or screw drive connection **37** with an upper screw portion of a travel-wedge **38.** The wedge terminates at its lower end in a wedge head **39** which has a splined connection **40** about its upper area with an internal channelled wall **41** of a jaw holding sleeve **42.** The sleeve is mounted in the lower end of the angle head for relative rotation. Pivotally mounted in a lower end of the sleeve is a group of jaw elements or levers **43** spaced circumferentially equally apart.

A plunger **44** axially slidable in the travel-wedge has a peripheral end lip **45** which presses under the load of a spring **46** upon a lug **47** of each of the jaw elements so as to normally bias an upper tail end **50** of each jaw element inwardly into abutment with an angled surface **48** of the wedge head. In this normal condition, the lower inner faces **49** of the several jaw elements define an open hexagonal socket for reception of the nut **24.** The spring **46** also serves to normally bias the wedge upwardly to abut a shoulder **52** thereon against the underside of the gear member **21.**

The travel-wedge has rotatable and linear movement. When it rotates, it carries the sleeve **42** and jaw elements **43** about with it as a socket unit to run down and set the nut. When it moves linearly, its angled surface areas **48** cooperate with the tail ends **50** of the several jaw elements to swing their lower jaw faces **49** inwardly to crimp and lock the nut upon a stud.

The general housing section **10** (FIG. **1**) of the tool contains in its handle portion a shiftable valving system to be later described. The valving system functions automatically following opening of a throttle valve **54** to cause the tool to pass through a complete cycle of setting and crimping the nut, and then restores to normal condition without intervention of the operator.

A speed responsive centrifugal governor **55,** representing a decided advance in this art, is associated with the valving system. It senses the speed of the motor. It functions automatically toward the end of the nut tightening stage to cause the valving system to reverse the directional flow of air to the motor so as to cause the motor to run in a nut crimping direction; and it functions toward the end of the crimping stage to cause the valving system to shut off air flow to the motor and to restore to normal condition.

The governor is arranged in a chamber **56** of the housing, which chamber is continuously vented through the exhaust system of the motor. The governor includes a hollow or tubular cage or body **57** having an enlarged diameter portion **58** at one end in which is axially received the rear end **59** of the rotor shaft of the motor. The cage is fixed by a pin **61** and a threaded connection for rotation as a unit with the rotor shaft. A retaining ring **62** seated in a peripheral groove of the cage over the ends of the pin secures the pin against undesirable endwise movement. A governor valve **63** controlled by the governor has a portion slidably received in the interior of the cage. A governor spring **64** normally biases the valve outwardly of the cage to seat an end portion closed over a relief passage **65** extending through a valve seat defined by a bushing **66.** The valve is movable away from its seat by means of centrifugal governor weights **67** pivoted in the cage. A peripheral shoulder **68** about the valve is cooperable with an end wall of the cage to limit the extent of opening movement of the valve away from its seat.

Each governor weight **67,** of which there are four, has a heavy segmental head **69** (FIGS. **1, 5–7**) provided with a curved back and formed with a curved inner face which overlies the enlarged diameter portion **58** of the cage. Axially extending from the head of the weight is a stem **71** which is pivoted between a pair of radial ears **72** of the cage upon a retainer pin **73.** Each stem **71** terminates in a toe **74** which dips into a peripheral groove **75** about the governor valve. The governor is designed so that, when the motor exceeds approximately 10 percent of its free speed, the weights will swing outwardly to draw the valve to open condition from its seat so as to communicate an air feed port **70** through the relief passage **65** with the vented governor chamber **56.** When the speed of the governor drops below 10 percent of its free speed, the governor spring **64** reseats the valve to closed condition, and in doing so, returns the governor weights to normal condition.

Besides the governor controlled valve **63,** the valving system includes the throttle valve **54**; a first shiftable directional control valve **76,** a second shiftable directional control valve **77,** and a third shiftable directional control valve **78.**

The throttle valve is designed so that, after it has been manually depressed to open condition against the force of its return spring **79,** it will remain pneumatically depressed until completion of the operating cycle of the tool. Then it will be restored automatically to closed condition.

The chamber **81** under the throttle valve is normally connected through ports **82, 83, 84** (FIGS. **2** and **3**) and **85** (FIG. **4**) to a vent **86** (FIG. **1**). When the throttle valve is depressed to open condition, pressure of inlet air from supply passage **87** developing over the upper area of the valve, exceeds the force of the return spring **79** so as to hold the valve in open condition permitting removal of the operator's hand from the valve button.

Supply air then flows through the open throttle valve to a common chamber **88** from where it flows in part through a side port **89** and an external hose connection **91** with passage **35** (FIG. **1A**) to pressurize the piston chamber **36** in the angle head. This moves the piston **34** to force the clutch dog **27** into driving engagement with the drive nut **29,** as earlier explained. Air also flows from chamber **88** through port **92,** chamber **93** of directional control valve **76,** ports **94, 95, 96** (FIGS. **3, 4** and **1**) to motor feed ports in the motor end plate **97** to drive the motor in a nut tightening direction. In this action, the rotation of the motor is transmitted through the drive nut **29** and travel-wedge **38** to rotate the sleeve **42** and the jaw elements **43** to tighten the nut **24.** The residual exhaust from the motor escapes through port **98** (FIGS. **4, 3**), port **99** (FIG. **1**) chamber **101** of directional valve **77,** and vent passage **102** (FIGS. **1, 4**) to atmosphere.

Supply air from chamber **88** also flows through ports **103, 104** (FIGS. **2, 3**) port **70** (FIGS. **4, 1**), chamber **105** of directional valve **78,** port **106** to the chamber at the top of directional valve **77** and port **107** to the chamber at the top of valve **76.** When the motor, while running in the nut tightening direction, accelerates to above ten percent of its free speed, the governor weights **67** swing outwardly to open the governor valve **63** against the force of spring **64.** This causes air feed port 70 and the chambers atop valves 76 and 77 to be connected through the open governor valve with chamber 56 and the exhaust system before live air being supplied through port 70 can sufficiently build the pressure atop valve 76 to shift it downwardly against the force of its spring 108.

When the nut is then tightened to a value of torque that will load the motor enough to reduce its speed to a value less than 10 percent of its free speed, the governor spring 64 overcomes the force of the centrifugal weights and closes the governor valve 63 upon its seat. Live air feeding through port 70 now increases the pressure on top of valves 77 and 76. The pressure on top of valve 76 increases sufficiently to force it to shift downwardly against the force of its spring 108. In this shifting, valve 76 first closes over port 92 permitting the air in the chambers 93 and 109 below both valves 76 and 77 to be vented through port 95 to the motor. This pneumatically unbalances both valves 76 and 77, and the air pressure at their top ends forces them both downwardly against their respective stops 110 and 111.

The shifting of valves 76 and 77 connects air supply port 92 through the upper ends of the chambers of valves 76 and 77 with ports 99 and 98 (FIG. 3) leading through further feed ports in the motor end plate 97 causing the motor to now run in the opposite or in a nut crimping direction. The motor's residual exhaust now passes through ports 96 and 95 (FIGS. 4, 3, 1), chamber 112 of valve 77 and ports 101 and 102 (FIG. 4) to atmosphere. The chamber at the top of valve 78 is connected by port 113 to port 98 so that live air now passing through port 98 also pressurizes the top of valve 78 causing it to shift down against the force of its spring 114. In this shifted condition, valve 78 disconnects air feed port 70 from the top ends of valves 77 and 76 and connects it to chamber 81 under the throttle valve 54 through ports 85, 84, 83, 82 (FIGS. 4, 3, 2, 1). But before chamber 81 can become sufficiently pressurized to close the throttle valve, the motor accelerates in the nut crimping direction to cause the governor weights to unseat the governor valve 63 to connect ports 70 and chamber 81 with the motor exhaust system. The motor continues to run in the nut crimping direction causing the drive nut 29 to move the travel-wedge 44 axially downward between the tail ends 50 of the jaw elements 43 until they are pivoted into contact with the surrounding wall 40 of the holding sleeve 42. The motor then stalls permitting the governor spring 64 to overcome the force of the governor weights so as to reseat the governor valve 63 to closed condition. Live air is then directed from port 70 and the connecting ports to pressurize chamber 81 forcing the throttle valve 54 to close. This action terminates the air supply to the tool permitting all valves to return to their original position.

The sleeve valve 117 surrounding the directional valve 76 is a means of lowering the supply pressure to the motor in the nut tightening direction without affecting the supply pressure to the motor in the crimping direction. This enables the value of pre-torque applied to the nut to be changed without reducing the capacity of the motor in the crimping direction. The volume under valve 117 is connected to port 95 thus requiring a sufficient pressure drop between ports 92 and 95 to overcome the force of spring 118.

THE FIG. 8 EMBODIMENT

The governor controlled valve unit disclosed in FIG. 1 is shown at 55 in FIG. 8. It is arranged in a chamber 56 of the housing 120 of a nut running tool 121 of a type designed merely to tighten a nut. Only so much of the tool is shown as needed to explain the embodiment. The governor cage 57 is pinned, as in FIG. 1, upon a front end 59 of the rotor shaft of a conventional stall motor 122 of the radially slidable vane type. The rear end (not shown) of the rotor shaft is connected in conventional manner as through reduction gearing and a spindle to the usual nut running socket.

Chamber 56 is connected at all times with the exhaust system of the motor. It also is connectible through a relief passage 65 in the governor valve seat 66 with a live air feed control passage 123. The throttle valve 54 has an outlet passage which connects with a chamber 124. Chamber 124 connects with a main passage 125 in the wall of the housing, which passage serves to feed the inlet air to operate the motor in a clockwise or nut tightening direction. Feed passage 125 connects by the relatively restricted secondary passage 123 with the relief passage 65. Passage 123 also connects through wall passages with the chamber 81 at the underside of the throttle valve. A bleed port 126 connects chamber 81 with atmosphere.

The three directional control valves 76, 77, and 78 shown in the FIG. 1 embodiment are not needed in the FIG. 8 embodiment since the latter is merely a nut runner and does not include any crimping mechanism.

In the operation of the tool shown in FIG. 8, the throttle valve 54 is manually depressed against the force of its return spring 127 to open condition. Inlet air then flows around the neck of the valve to the motor feed passage 125 and also through the structure secondary passage 123 to the chamber 81 at the underside of the throttle valve. The inlet air flowing through the depressed throttle valve pneumatically unbalances the valve to hold it in open condition allowing the operator to release his hand from the valve button. Before pressure of air feeding through passage 123 can build up in chamber 81 sufficiently to cause closing of the throttle valve, the speed of the motor accelerates to exceed 10 percent of its free speed causing the governor weights 69 to centrifugally respond and draw the governor valve 63 to open condition relative to its seat 66. Air from chamber 81 and port 123 is then relieved through the open governor valve into the exhaust chamber 56.

When the nut is tightened to a valve of torque that will load the motor sufficiently to reduce its speed to a value less than ten percent of its free speed, the governor spring responds to return the weights 69 and to move the governor valve closed upon its seat. Pressure of feed air from passage 123 then builds up in chamber 81 sufficiently to move the throttle valve to shut off further air feed to the motor.

The air pressure in chamber 81 eventually bleeds off through the vent 126 to condition the throttle valve for a subsequent operation of the tool.

What is claimed is:

1. In a pneumatic tool including a rotary air driven motor, a spindle for transmitting the torque of the motor to a work load, and means responsive to reduction of speed of the motor to a certain value to shut off air feed to the motor, said means comprising: an ex-

haust chamber in which a shaft end of the motor projects, main passage means for feeding live air to the motor, an air-flow control valve in the passage means having a pneumatically unbalanced open condition against the force of a spring at its underside, a control feed secondary passage connected with and restricted relative to the main passage means for feeding live air to the underside of the control valve to pneumatically balance the control valve so as to allow it to be moved by its spring to a closed condition shutting off air feed to the motor, a port for communicating the secondary passage with the exhaust chamber for relieving live air from the secondary passage so as to maintain the control valve in a pneumatically unbalanced open condition, a governor valve slidable to open and closed positions relative to the port, and flyweight governor means carried by the motor responsive to centrifugal force to open the governor valve upon the speed of the motor obtaining a certain value and responsive to a reduced centrifugal force to close the governor valve so as to cause pneumatic balancing and consequent closing of the control valve to shut off air feed to the motor upon reduction of the speed of the motor below a predetermined value.

2. In a pneumatic tool including a rotary torque transmitting air motor, a manipulative slidable control member movable to open condition against the bias of a return spring for conducting live air through a main passage to the motor, means for pneumatically maintaining the control member in open condition against the bias of the spring, a control air feed passage connected with the main passage for conducting a relatively restricted live air flow to pressurize an end of the control member so as to pneumatically balance the latter and cause it to be returned to a shut-off condition by the bias of the spring, an exhaust port for relieving live air from the control passage so as to prevent the control member from becoming pneumatically balanced and returned to shut-off condition, a governor controlled valve movable from and to closed position relative to the exhaust port, and speed responsive centrifugally operable governor means carried by the motor having response to centrifugal force when the motor attains a certain speed to move the governor valve to open position, and having response to reduction of centrifugal force of the motor when the speed of the motor is reduced below a certain value to move the governor valve to a closed position over the exhaust port so as to cause the control member to become pneumatically balanced and returned by the spring to shut-off condition.

3. In a pneumatic tool as in claim **2**, wherein the slidable control member is a valve slidable in a chamber relative to inlet and outlet ports of the chamber, the outlet port being connected with the main passage.

4. In a pneumatic tool as in claim **3**, wherein said one end of the slidable control member is a bottom surface exposed to a lower volume of the chamber, the slidable control member has an upper surface exposed to an upper volume of the chamber, and a spring load in the lower chamber biases the slidable control member to a condition blocking the inlet port from the outlet port.

5. In a pneumatic tool as in claim **4**, wherein a manipulative stem projecting externally of the tool from the upper surface of the slidable control member is adapted to be depressed to move the latter to an open condition against the force of the spring so as to communicate the inlet port with the outlet port, and the slidable control member is adapted when so depressed to be pneumatically unbalanced in said open condition under pressure of inlet air applied to its upper surface in passing from the inlet port to the outlet port.

6. In a pneumatic tool as in claim **5**, wherein the governor means includes a body having centrifugally movable weights therein, the governor controlled valve has a collar engageable by the weights so as to draw the governor controlled valve away from the exhaust port upon centrifugal movement of the weights, and a spring biasing the governor controlled valve to closed condition over the port yieldably resists such movement of the governor controlled valve.

7. In a pneumatic tool as in claim **6**, wherein the weights are responsive to acceleration of the motor speed above a certain level to move centrifugally relative to the body of the governor so as to draw the governor controlled valve away from the port against the bias of the governor spring.

8. In a pneumatic tool as in claim **7**, wherein the governor spring is responsive to deceleration of the motor speed below said level to cause return of the valve to closed condition, and the collar of the valve has in said return movement cooperation with the weights to return them from their centrifugally moved condition.

9. In a pneumatic tool including a rotary air motor for transmitting torque to a work spindle; an exhaust chamber in which an end of the motor shaft extends a throttle valve chamber having a valve seat, a live air inlet and an outlet; a manipulative throttle valve biased by a spring load at its underside upon the seat closing over the inlet so as to shut off live air flow to the outlet, the outlet being connected by a main passage with the motor and by a secondary relatively restricted passage with an expansible chamber below the throttle valve, the restricted passage having a relief port opening into the exhaust chamber, the throttle valve having an upper surface area subject to pressure of inlet air when the valve is depressed so as to cause the valve to become pneumatically unbalanced against the force of the spring in an open condition; and a centrifugal governor disposed in the exhaust chamber and mounted to the motor shaft end, including a governor valve movable from and to closed condition relative to the relief port, a governor spring biasing the governor valve to its closed condition, and motor speed responsive centrifugally movable weights controlling opening of the governor valve; the governor valve being adapted to move to closed condition upon reduction of the rotational speed of the motor below a certain value, and the throttle valve being adapted upon development of a predetermined air pressure in the expansible chamber following closing of the governor valve to be moved by the spring load to its closed condition so as to shut off live air flow to the motor.

10. The combination of a rotary air motor for transmitting torque to a work spindle, passage means for feeding live air to the motor, a slide valve movable in the passage means for shutting off air feed to the motor, means for creating a differential pneumatic pressure at one end of the slide valve urging it to open condition relative to the passage means, means for causing a differential opposing greater pressure to develop at an opposite end of the slide valve urging it in a closing direction, a live air control feed passage connected with said opposite end of the slide valve for developing said greater pressure, and centrifugal governor controlled valve means operatively connected with the motor controlling opening and closing of an exhaust passage connected with the control feed passage, the governor controlled valve means being responsive to motor speed above a certain level to open the exhaust passage to prevent development of said greater pressure and being responsive to motor speed below said level to close the exhaust passage to allow development of said greater pressure, the slide valve being responsive to development of said greater pressure at said opposite end of the slide valve following closing of the exhaust passage to move to closed condition so as to shut off air feed to the motor.

11. In a pneumatic tool, the combination comprising a rotary air driven motor connected to transmit torque to a work spindle, valve means movable against the bias of a spring to open condition for feeding live air to the motor, means for applying a pneumatic force to one end of the valve means to maintain the valve means in open condition against the bias of the spring, and means responsive to reduction of the rotational speed of the motor to a predetermined value to pneumatically counterbalance said pneumatic force on the valve means so as to allow the spring to force the valve means to a closed condition shutting off flow of live air to the motor.

12. In a pneumatic tool as in claim **11**, wherein the means responsive to reduction of the rotational speed of the motor includes a restricted passage for feeding live air to the spring side of the valve means, and relief valve means responsive to centrifugal force for exhausting said passage of live air upon acceleration of the speed of the motor above a certain value and responsive to reduction of the rotational speed of the motor below said value for allowing development of live air pressure through said passage to the spring side of the valve means to close the latter and shut off feed of live air to the motor.

13. In a pneumatic tool, an air operated rotary motor for transmitting torque to a work spindle, and means mechanically connected to the rotary motor and directly responsive to centrifugal force to shut off operating air flow through the motor upon reduction of the rotational speed of the motor below a predetermined value.

14. In a fluid powered tool, a fluid operated rotary motor for transmitting torque to a work spindle, and means mechanically connected to the rotary motor and directly responsive to centrifugal force to terminate operating fluid flow through the motor upon reduction of the rotational speed of the motor below a recurring predetermined value.

15. The combination of a rotary air motor for transmitting torque to a work spindle, passage means for feeding live air to the motor, a slide valve movable in the passage means for shutting off air feed to the motor, means for creating a differential pneumatic pressure at one end of the slide valve urging it to open condition relative to the passage means, means for causing a differential opposing greater pressure to develop at an opposite end of the slide valve urging it in a closing direction, a live air control feed passage connected with said opposite end of the slide valve for developing said greater pressure, and centrifugally controlled valve means operatively connected with the motor controlling opening and closing of an exhaust passage connected with the control feed passage, the controlled valve means being responsive to motor speed above a certain level to open the exhaust passage to prevent development of said greater pressure and being responsive to motor speed below said level to close the exhaust passage to allow development of said greater pressure, the slide valve being responsive to development of said greater pressure at said opposite end of the slide valve following closing of the exhaust passage to move to closed condition so as to shut off air feed to the motor.

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