

[54] **POWERED FASTENER DRIVING TOOL**

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[22] Filed: **May 11, 1971**

[21] Appl. No.: **142,202**

[52] U.S. Cl. **227/112, 227/118, 227/130**

[51] Int. Cl. **B25c 1/04**

[58] Field of Search 227/112, 118, 120, 136,
227/147, 130

[56] **References Cited**

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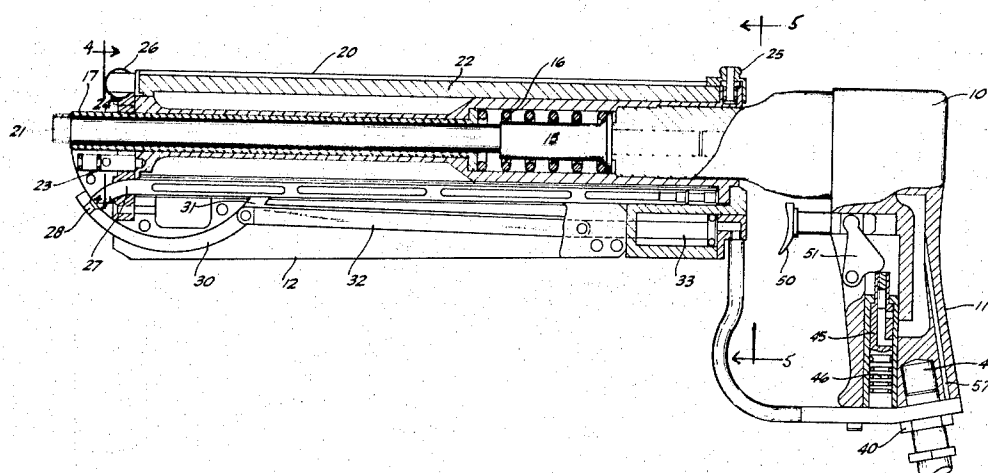
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[57] **ABSTRACT**

This invention relates to a power operated tool for delivering individual male fasteners in a desired position of orientation for drivably inserting each fastener into a receiving member. The invention provides a supply magazine holding a plurality of the fasteners in arranged order for individual delivery. A transfer mechanism is adapted to transport individual fasteners from the supply magazine to a driving station, from which it is drivably inserted into the receiving member. Depending upon the type of fastener, suitable apertures may be formed in the receiving member to admit the fasteners.

10 Claims, 10 Drawing Figures



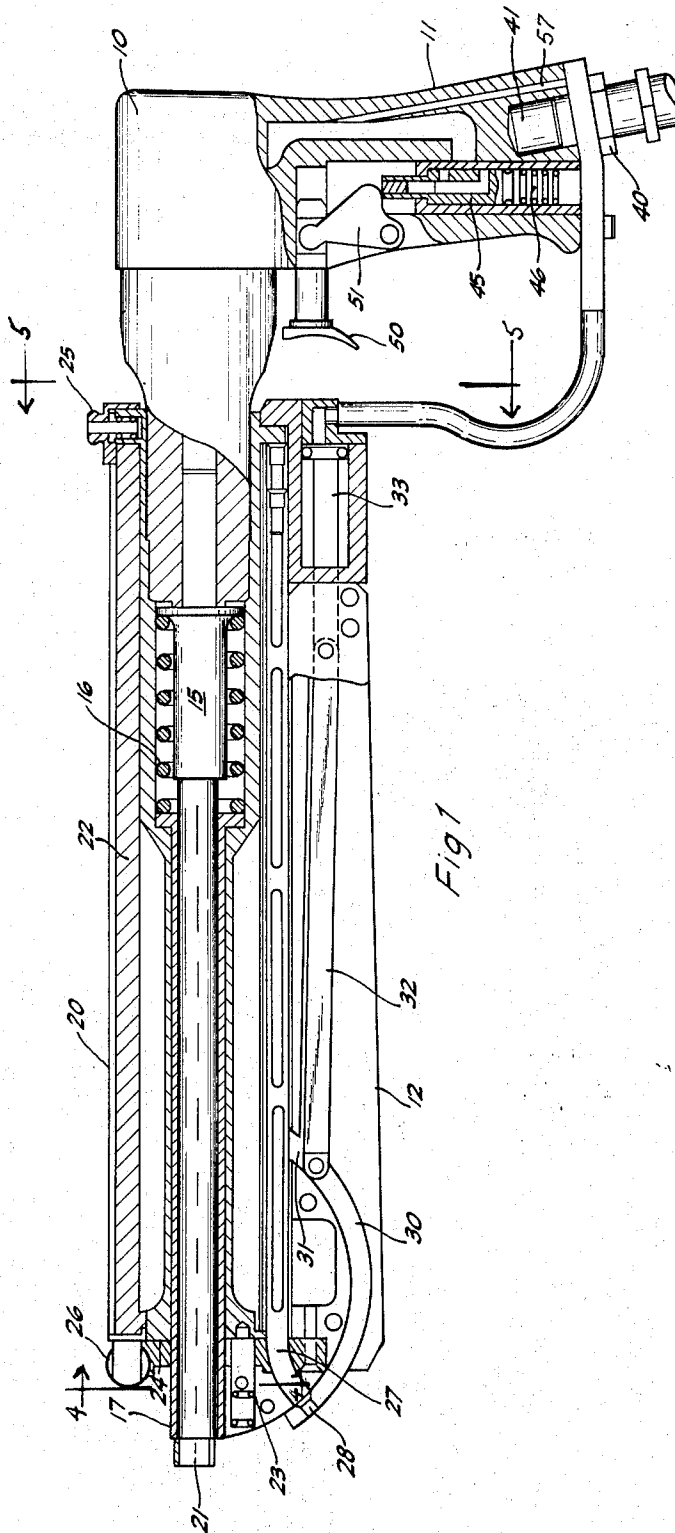


Fig 1

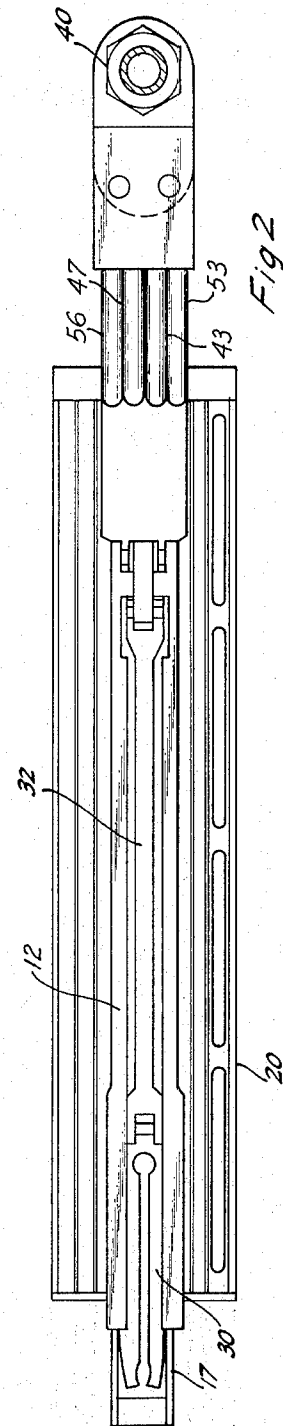


Fig 2

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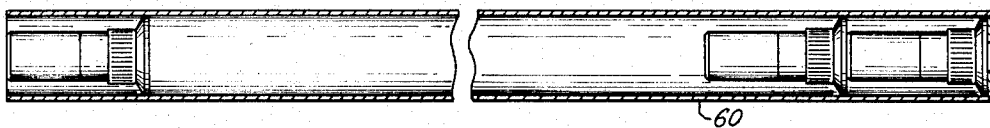


Fig 7

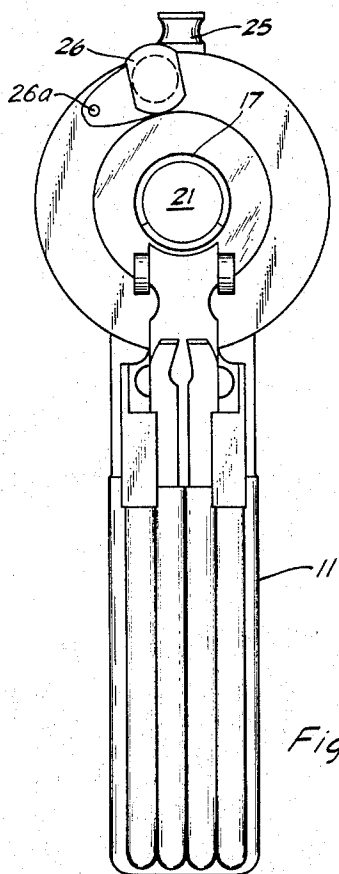


Fig 3

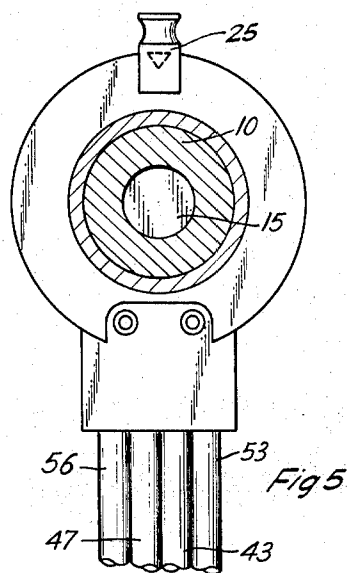


Fig 5

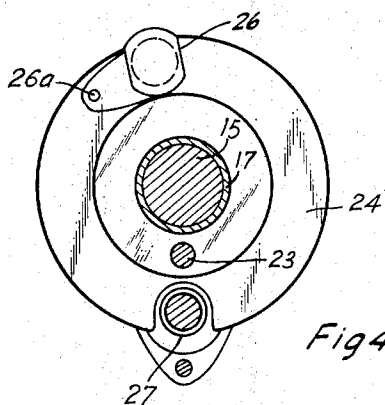


Fig 4

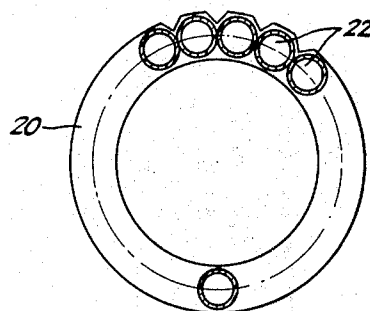
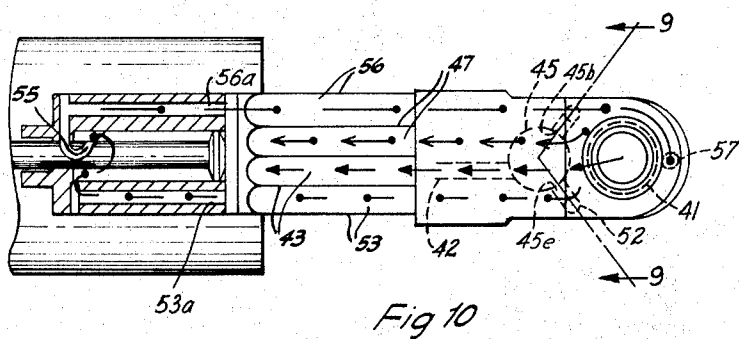
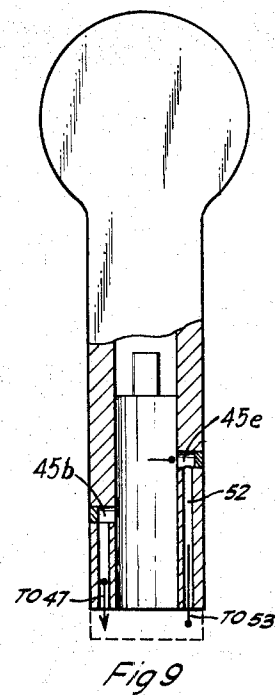
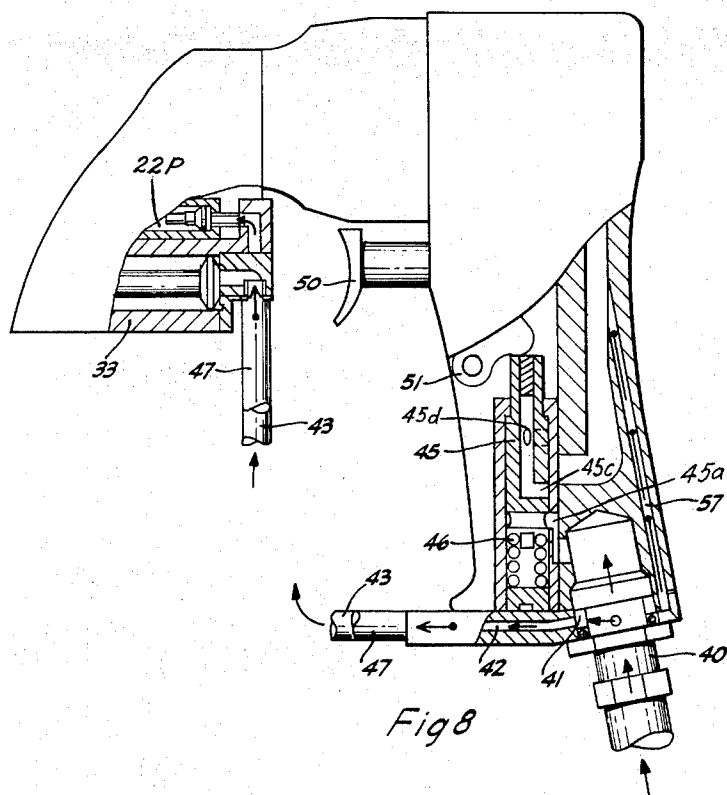


Fig 6

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POWERED FASTENER DRIVING TOOL

In many assembly operations employing fasteners having a head and integral shank extending therefrom, the cost of assembling component elements is increased by reason of the manual selection, orientation, and driving of the fasteners into a receiving member. This is particularly true in the assembling of a structure held in assembled condition by a great many fasteners of substantially identical size and shape.

An example of such a structure is a contemporary aircraft which includes thousands of bolted and riveted connections employing male fasteners. Although different sizes of fasteners are used in different applications, depending upon load and fatigue expected in the structure, the fasteners are of uniform size and shape within selected groups. Accordingly, the use of such fasteners has indicated a need for apparatus to deliver and insert individual fasteners into a receiving member, such as a portion of the aircraft frame and/or the metal skin of the wing or fuselage. Therefore, it is an object of the present invention to provide apparatus capable of fulfilling the heretofore recognized need in the assembling of aircraft components.

Several criteria for such apparatus exist, in addition to that of presenting individual fasteners in a selected position of orientation. These criteria include (a) the capability of delivering a substantial number of fasteners without replenishing the supply thereof at successive short intervals of time during assembly operations; (b) lightweight construction adapted to manual portability and operation; (c) prevention of inadvertent driving of a fastener which might mar and damage the surface of a receiving member; and (d) a configuration permitting operation in an environment affording small space for maneuvering the tool. The present invention provides a tool satisfying the criteria, and is particularly useful in assembly operations of aircraft employing threaded male fasteners. The invention will be described in that environment, although obviously not limited in use to only such an environment.

Accordingly, it is another object of the invention to provide a portable power tool capable of carrying a supply of male fasteners and delivering individual fasteners for insertion into a receiving member. A further object of the invention is to provide a tool capable of delivering and inserting discrete male fasteners, the operation of which is powered by separate means for each of the two functions, which are performed sequentially, and the separate means are controlled by correlated control means.

The invention will be more readily understood by reference to the accompanying drawings in which:

FIG. 1 is a view in side elevation of a power operated hand tool embodying my invention, with portions at the left side being broken away and shown in vertical longitudinal section;

FIG. 2 is a bottom view of the tool of FIG. 1;

FIG. 3 is a front elevational view of the tool of FIG. 1;

FIG. 4 is a view in vertical transverse section taken on line 4—4 of FIG. 1;

FIG. 5 is a view in vertical transverse section taken on line 5—5 of FIG. 1;

FIG. 6 is a vertical transverse section through the supply magazine and showing the chambers therein;

FIG. 7 is a fragmentary view in longitudinal vertical section showing a supply tube holding several male fas-

teners for which one specific embodiment of the invention is adapted to deliver and insert individually;

FIG. 8 is a fragmentary view, partly in vertical longitudinal section showing the control valve of the pneumatic system;

FIG. 9 is a view in rear elevation with portions broken away to show air passages in the piston grip of the tool in a plane generally indicated by line 9—9 in FIG. 10; and

FIG. 10 is a bottom view of the structure of FIG. 8, shown partly in section and schematically illustrating air flow through the several conduits of the pneumatic system.

Referring to FIGS. 1 and 2 of the drawings, the tool includes a frame generally indicated at 10, and in the embodiment shown is in the form of an external housing enclosing a conventional pneumatically powered reciprocating hammer. Such a hammer is available commercially as a pneumatic impact hammer, the details of which are well known in that art. Accordingly, they are not shown for the sake of brevity, since those details are not the essence of the invention. The frame upends at its rearward end, at the right as viewed in FIG. 1, into a pistol grip 11 and extends forwardly to provide a forestock 12. A workman is thus permitted two hand maneuvering and operation of the tool so as to take advantage of the low weight and compact dimensions.

A hammer 15 is mounted in frame 10 for reciprocal movement along an axis provided by a forward extension of the frame; the axis also serves as an axis of rotation for a supply magazine described below. The hammer is biased rearwardly relative to frame 10 by spring 16, which also serves as a forward bias for a partially shrouded nosepiece 17. The nosepiece is open at the bottom thereof to define a driving station at the forward end of the tool.

A generally cylindrical supply magazine 20 is mounted in the frame for rotation about the longitudinal axis 21 of the magazine. A plurality of chambers 22 are disposed in circumferentially spaced locations about axis 21 and adapted to hold a plurality of male fasteners oriented in head-toe relationship; a pair of such fasteners are shown in the right end of the lower chamber in FIG. 1. Each chamber 22 is generally cylindrical in configuration so that a plurality of fasteners can be stored in each chamber and advanced from right to left, as viewed, under the influence of pressure fluid.

A spring biased detent 23 is supported in a forward end plate 24 secured to the frame and engages the forward end of magazine 20. A latch 25 is carried on the frame at the rear of magazine 20 and must be raised to permit rotation thereof. The latch, in conjunction with detent 23, maintains the magazine in a selected position of rotation. A loading gate 26 is mounted for swinging movement about a pivot pin 26a between an open and closed position to permit loading of an individual chamber with fasteners. When open, the gate provides admission to a single chamber then circumferentially positioned in axial alignment with the gate. At the lower portion of plate 24, a discharge chute 17 is secured to provide communication with a single chamber axially aligned therewith, and terminates at a discharge station 28.

A transport fork 30 is supported in a curvilinear track 31 formed in forestock 12 for movement between the

discharge station 28 and the driving station adjacent the shrouded nosepiece 17. The fork 30 is provided with a pair of opposed tines of resilient material configured to receive the shank and the underside of the head of the particular male fastener for which this tool is adapted. An operating link 32 connects the transport fork with a pneumatically operated piston/cylinder assembly 33 mounted at the rear of stock 12.

A hose connector 40 in the frame is adapted to receive air under pressure from a source of supply, not shown. The connector forms a portion of a control circuit for the tool to admit air to the piston/cylinder assembly of the transfer fork and to the drive motor for the hammer 15; the air is admitted in sequence to insure operation of the hammer only upon full retraction of the transport fork 30 so as to avoid inadvertent operation of the drive hammer before a fastener is properly positioned at the drive station.

As shown in FIG. 8, the connector 40 communicates with an annular chamber 41 formed by the tubular connector and pistol grip 11. A channel 42 provided in the base of the grip leads to the end of a pressurized supply chamber by means of a conduit 43. The supply chamber so pressurized is indicated as 22P. The air under pressure urges fasteners in the chamber toward the discharge station 28.

Air from the source of pressure is also admitted through passage 45a to the control valve spool 45, which is biased upwardly by spring 46. With the valve spool in the position illustrated in FIG. 8, air from connector 40 flows through passage 45a, thence around the annular groove of valve spool 45, through passage 45b, and thence into the head end of into piston/cylinder assembly 33 through a conduit 47. The piston is thereby extended to move the transport fork 30 from the discharge station to the driving station.

A valve control trigger 50 through a pivotally mounted cam link 51 permits movement of valve spool 45 downwardly to a position interrupting communication between passage 45a and the annular groove of spool 45, thereby blocking flow to conduit 47 and the head end of piston/cylinder assembly 33. Simultaneously, air flows upwardly through passage 45a and channel 45c through port 45d and passage 45e in communication with channel 52. By way of a conduit 53 leading from channel 52, movement of the valve spool 45 to a downward position will admit air to the rod end of the piston of assembly 33; the route is through valve spool 45, channel 52 in the pistol grip which communicates with conduit 53 connected to the piston cylinder assembly 33 by way of a passage 53a formed in the assembly.

Upon full retraction of the piston of the assembly 33, a channel formed in the piston rod establishes communication between the source of pressure and the drive motor for hammer 15. As can be seen in FIG. 10, a channel 55 is formed in the piston rod and leads from the cylinder through a passage 56a to a conduit 56. The conduit carries air to the base plate of the pistol grip and upwardly through a channel 57 formed therein.

OPERATION

Each of the individual chambers 22 are loaded with a supply of male fasteners, such as illustrated in FIG. 7. A sealing tube 60 may be utilized to serve the dual purpose of a shipping container and an hermetic seal around the fasteners carried in the supply magazine 20.

The fasteners are pre-oriented to the head-toe positions shown.

Upon being connected to a source of air under pressure, air is admitted to that one of the chambers 22 which is then positioned in communication with conduit 43 and designated as 22P in FIG. 8. Accordingly, a fastener is pushed into the delivery station 28 and between the resilient tines of transport fork 30 to be held thereby. Concurrently, air is admitted to the head end of the piston in piston/cylinder assembly 33 through conduit 47 and thereby extend the piston. Consequently, transport fork 30, and the fastener then being releasably held therein, is moved from the discharge station 28 to the driving station adjacent nosepiece 17.

The workman manipulating the tool then inserts the shank of the fastener into an aperture provided in a receiving member, not shown. Depending upon relative diametrical dimensions, full insertion may not be accomplished by manual force. This is particularly true in the use of interference fits employed in some bolted connections. The power tool of the present invention provides a driving force by admitting air under pressure to the drive motor. This is accomplished by depressing the valve trigger thereby blocking air to the head end of the piston and admitting air to the rod end. Retraction of the fork 30 is permitted by reason of the resilient tines relasing the fastener, which has been partially inserted into the receiving member and held by slight manual force. Such force pushes nosepiece 17 to the rear against the biasing spring and thereby stabilizes the tool upon subsequent operation of the drive motor and hammer 15. The reactive force is analogous to that of a handgun type of firearm, in that a vertical upward thrust is imparted to the nose of the tool. Providing a biased nosepiece which requires a manual force to retract imparts stability to the tool and avoids damage to easily marred components, such as aluminum skin in aircraft assembly.

Upon full retraction of fork 30, the channel 55 in the piston rod establishes communication between the cylinder and the drive motor through conduit 56 and channel 57. It will be seen that no air is supplied to the drive motor until the transport fork is in a predetermined position, and in the embodiment shown, to a fully retracted position. This insures free movement of the fastener during driving and avoids any interference from the transport fork.

Fasteners are successively installed in the receiving member by repetitions of the above procedure. Upon release of the trigger, the piston extends and transports a fastener from the discharge station to the driving station. Subsequent depression of the trigger retracts the piston and sequentially operates the drive motor for so long as is required to fully insert the fastener. As each chamber 22 is emptied, the supply magazine is rotated to the next chamber by temporary release of the latch. Upon exhausting the supply carried in the magazine, each of the chambers may be replenished through the loading gate. Accordingly, the present invention provides a hand tool for individual delivery of fasteners in a position of orientation and means for subsequent driving into a receiving member.

I claim:

1. Apparatus for delivering and inserting discrete male fasteners into a receiving member, said apparatus comprising:

- a. drive motor means for drivably inserting individual fasteners into a receiving member;
 - b. a frame supporting said drive motor means;
 - c. a supply magazine carried by the frame and adapted to hold a plurality of male fasteners and to deliver individual fasteners at a discharge station;
 - d. means connecting the apparatus to a source of air under pressure (power);
 - e. (powered) transfer means carried by the frame and adapted to receive an individual fastener at said discharge station and to transport said fastener to a driving station;
 - f. motor means for said transfer means, and carried by the frame;
 - g. first power circuit means (selectively) (actuatable) (connectible) to establish communication with said source of (power) air under pressure and (for powering) said transfer motor means thereby to move said transfer means between said discharge station and said driving station; and
 - h. second power circuit means operable responsively to (movement) a predetermined position of said transfer motor means for powering said drive motor means.
2. The apparatus of claim 1 wherein said supply magazine comprises an elongated cylindrical element mounted in the frame for rotation about its longitudinal axis and provided with a plurality of cylindrical chambers parallel to said axis and arranged in spaced circumferential positions thereabout.
3. The apparatus of claim 1 wherein said transfer means transports a fastener in a curvilinear path of travel between said discharge and driving stations.
4. The apparatus of claim 2 wherein said fluid circuit means admits pressure fluid to a selected one of said cylindrical chambers in the supply magazine thereby to urge any fasteners therein toward said discharge station.
5. The apparatus of claim 1 wherein said supply magazine comprises an elongated cylindrical element mounted in the frame for rotation about its longitudinal axis and provided with a plurality of cylindrical chambers parallel to said axis and arranged in spaced circumferential positions thereabout, each chamber receiving a sealing tubular element containing the fasteners.
6. The apparatus of claim 5 wherein said first fluid circuit means admits pressure fluid to a selected one of said cylindrical chambers in the supply magazine

thereby to urge any fasteners therein toward said discharge station.

7. A power hand tool for delivering and inserting individual male fasteners into a receiving member, said tool comprising:

- a. a frame, including grip means;
- b. a drive motor mounted in the frame and having a reciprocable hammer element;
- c. an elongated cylindrical supply magazine mounted in the frame for rotation about its longitudinal axis and having a plurality of axially extending chambers parallel to said axis and circumferentially spaced therearound, each of said chambers being adapted to receive a plurality of male fasteners and to deliver same individually at a discharge station adjacent one end of the magazine;
- d. a transport fork adapted to releasably hold an individual fastener;
- e. fork mounting means carried by the frame and adapting the fork for movement between said discharge station and a driving station;
- f. a pneumatic piston-cylinder assembly connected to said fork for powered movement between said stations;
- g. means connecting the tool and a source of pneumatic pressure;
- h. first fluid circuit means to establish communication with the source of pneumatic pressure and the piston-cylinder assembly to operate the same and move the transport fork from the discharge station to the driving station; and
- i. second fluid means operable responsively to a predetermined position of said piston and for powering said drive motor.

8. The power tool of claim 7 wherein the frame carries detent means to hold the magazine in a selected rotational position.

9. The power tool of claim 7 wherein pneumatic pressure is admitted to one end of a selected one of said magazine chambers to urge any fasteners therein toward said discharge station.

10. The power tool of claim 7 wherein a protective shrouded nosepiece is carried by the frame to partially enclose a fastener held in the driving station, and wherein a biasing spring is provided to urge said nosepiece outwardly thereby to permit application of a force overcoming said spring and to provide stability to the tool during driving of the fastener into a receiving member.

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