FASTENER DRIVING TOOL

Filed Feb. 28, 1968 5 Sheets-Sheet 1

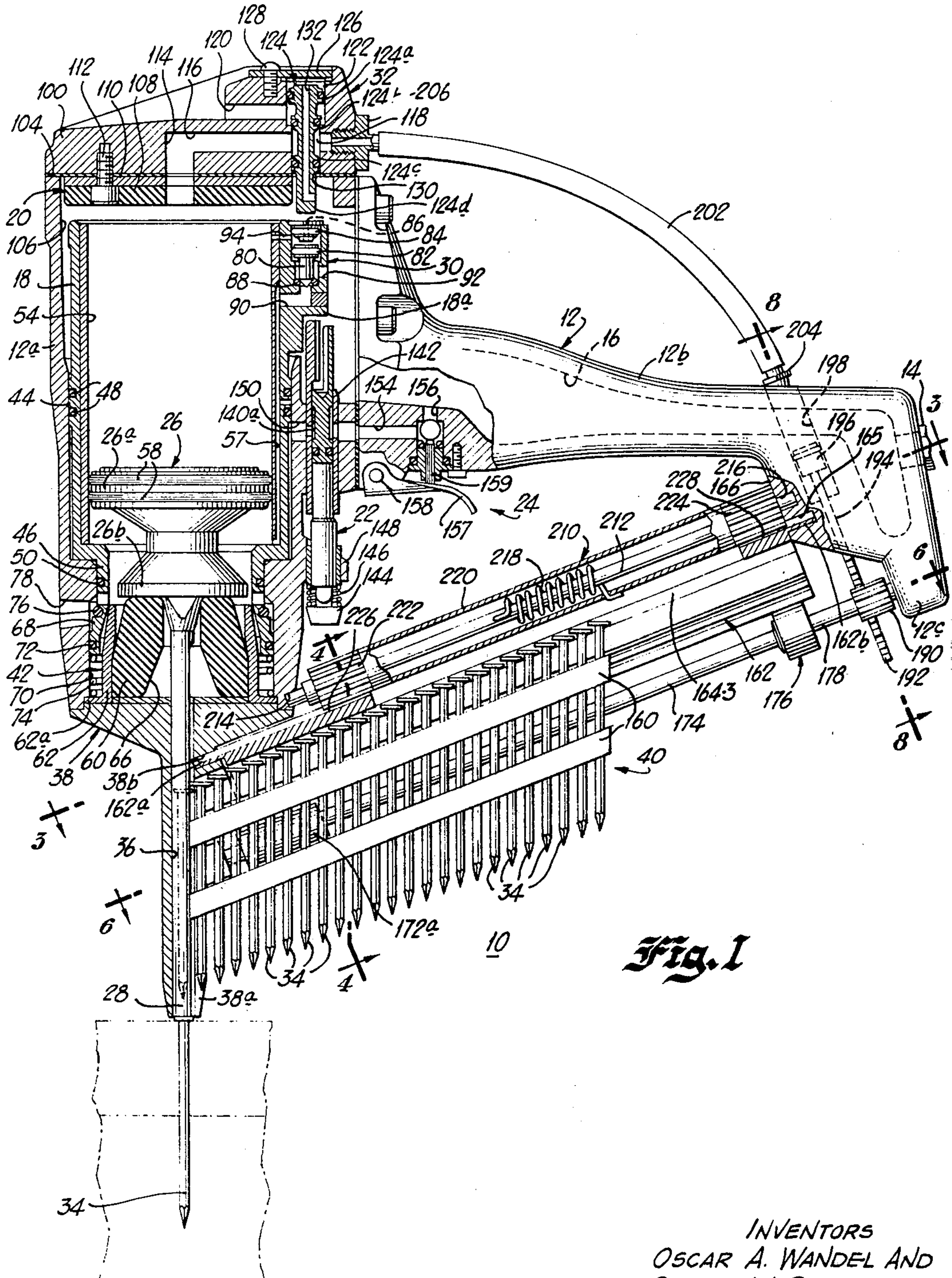

Fig. 1

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April 7, 1970 | O. A. WANDEL ET AL | 3,504,840

FASTENER DRIVING TOOL

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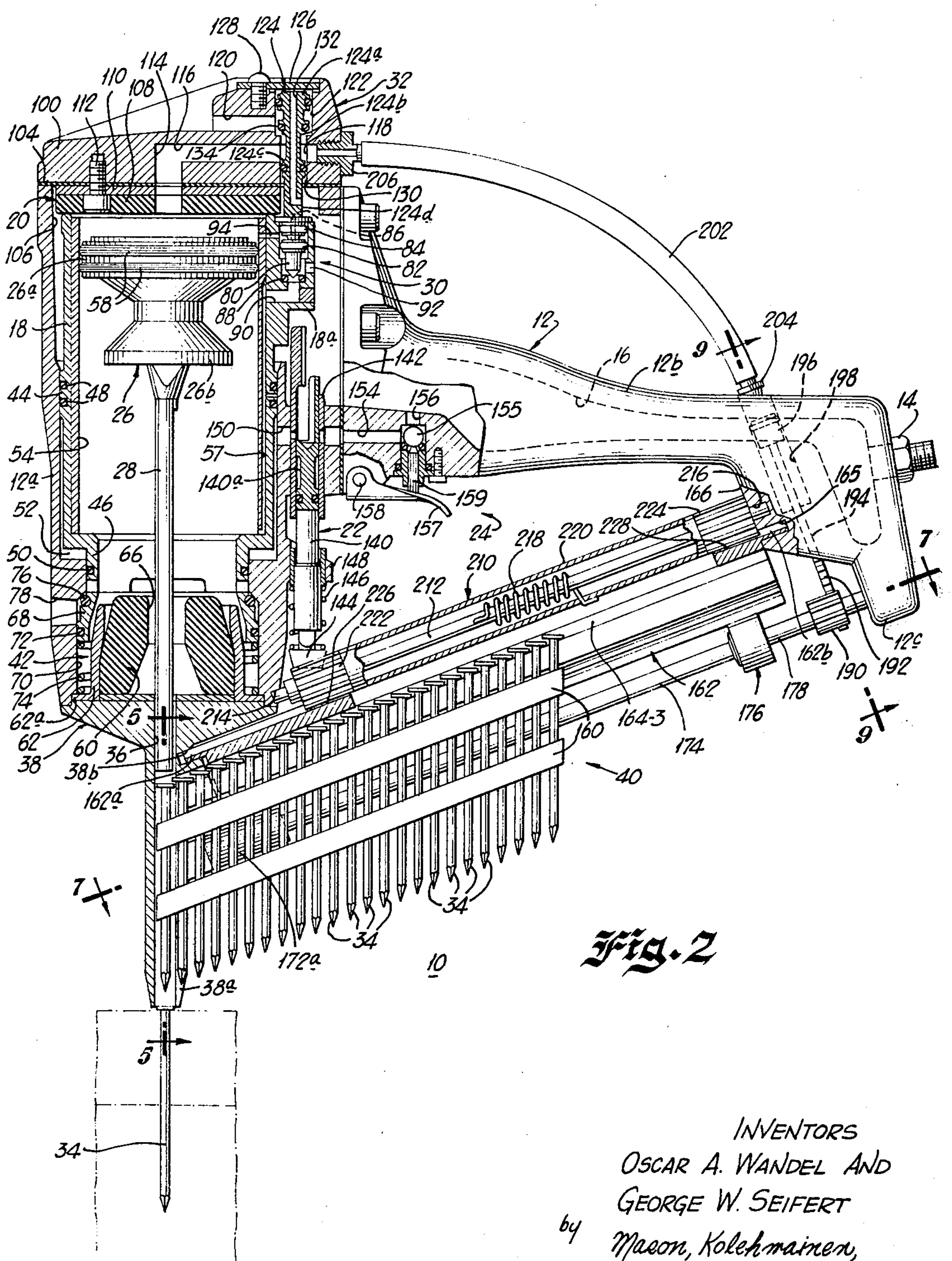

Fig. 2

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FASTENER DRIVING TOOL

Filed Feb. 28, 1968 5 Sheets-Sheet 3

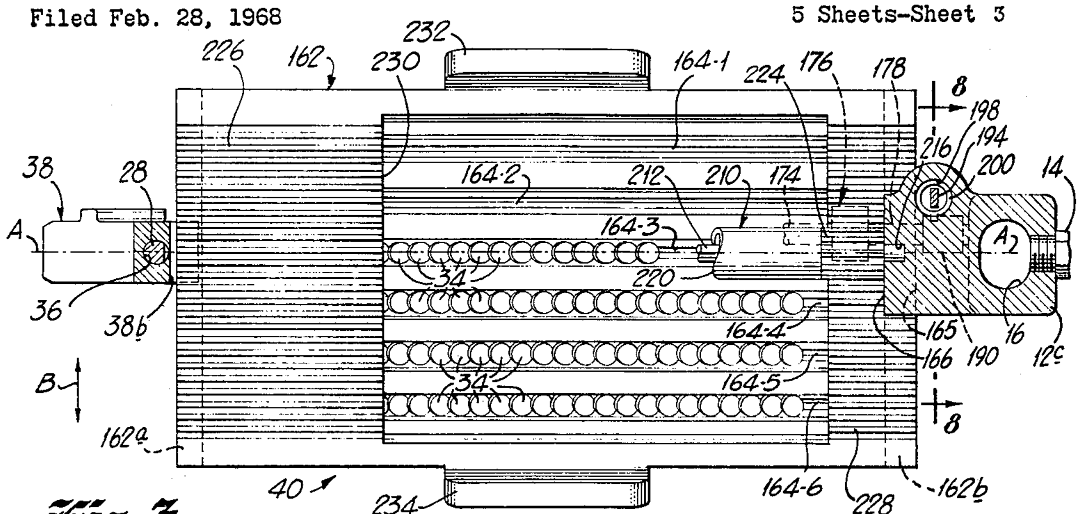

Fig. 3

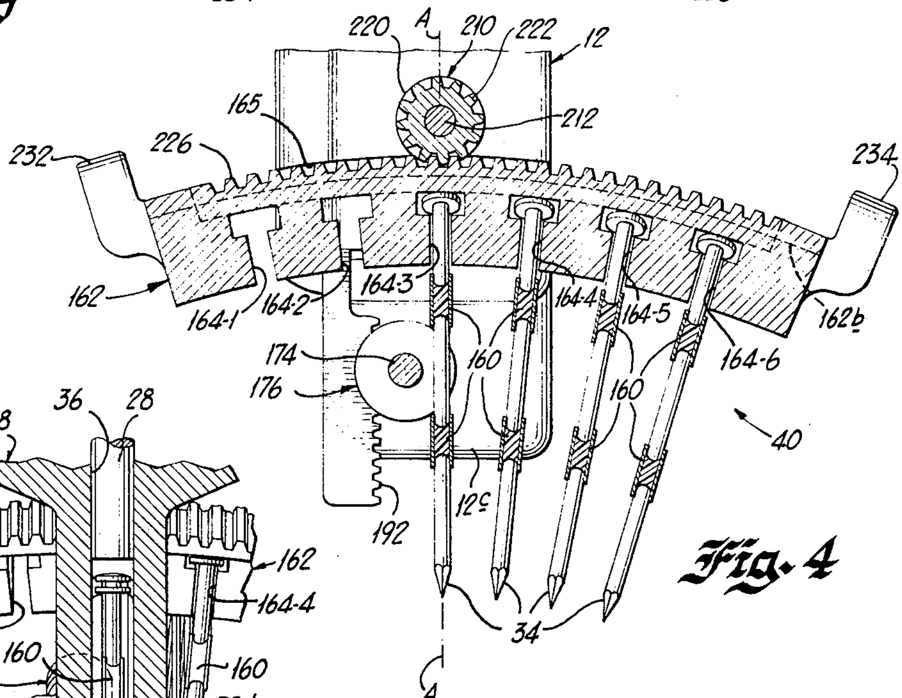

Fig. 4

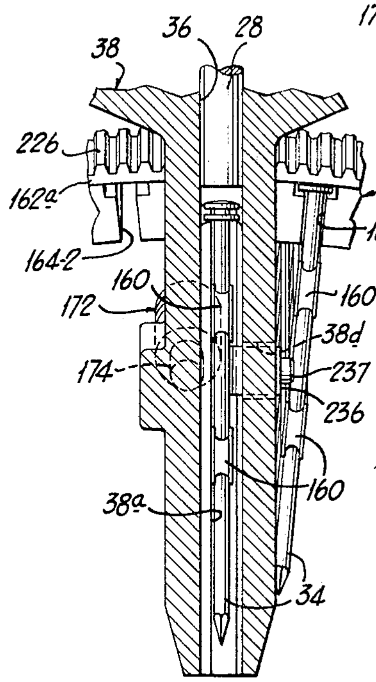

Fig. 5

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FASTENER DRIVING TOOL

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Fig. 6

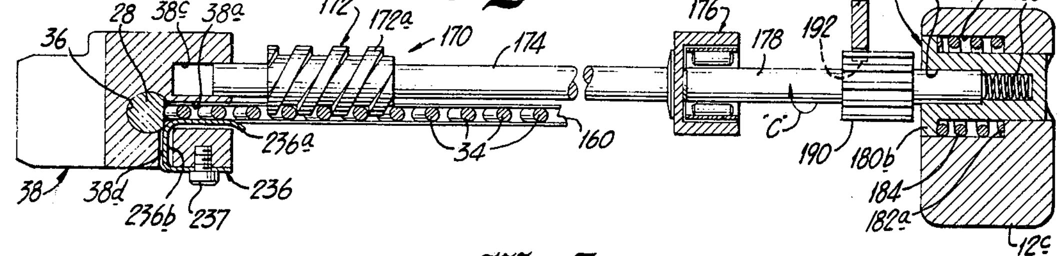

Fig. 7

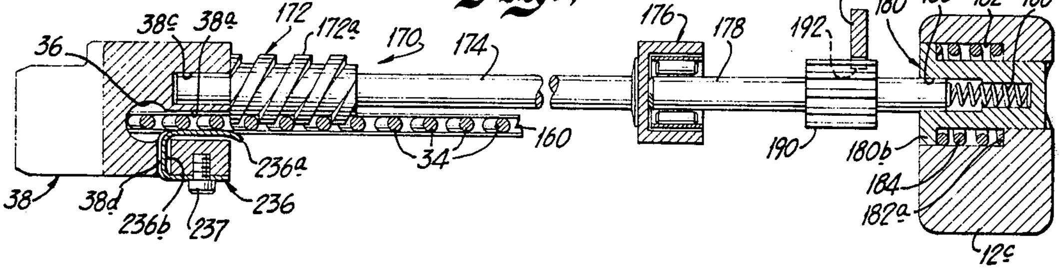

Fig. 8

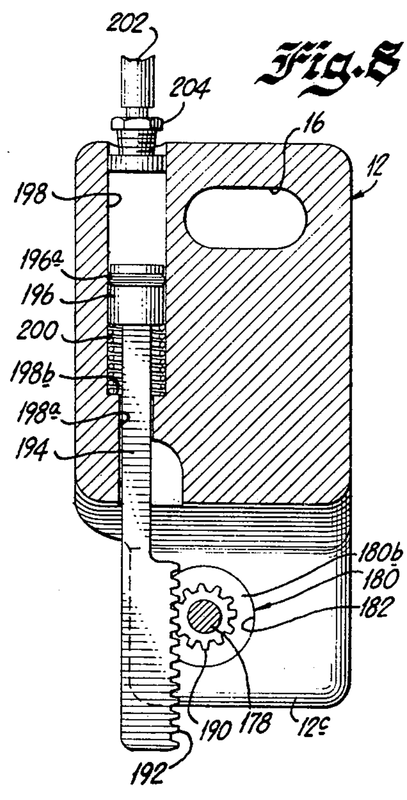

Fig. 9

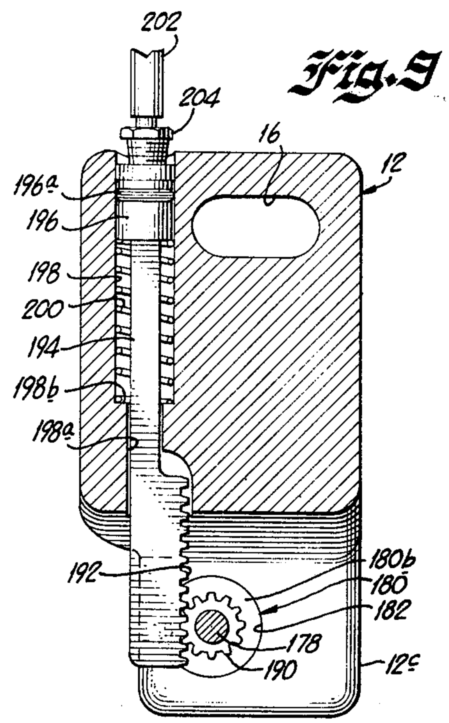

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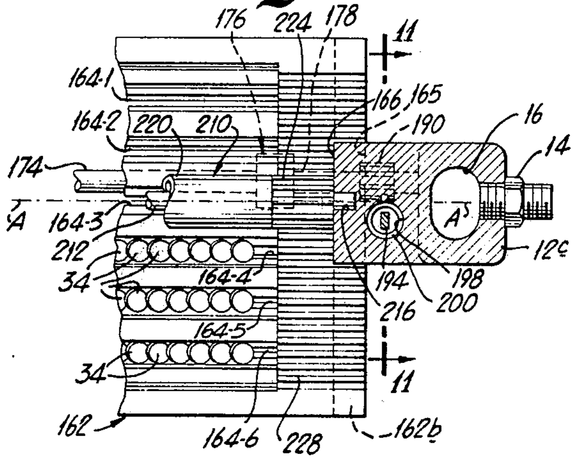
Fig. 10



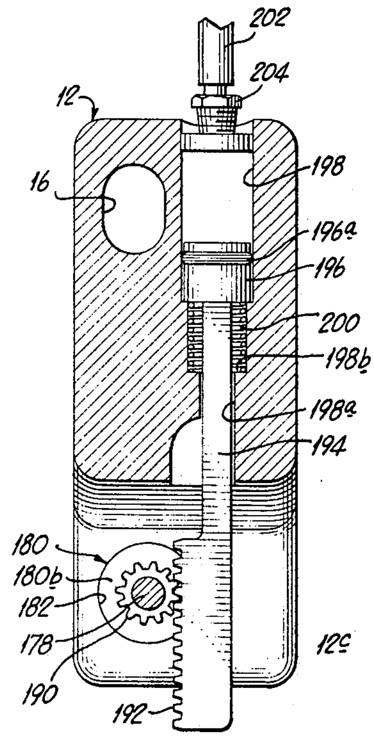


Fig. 11

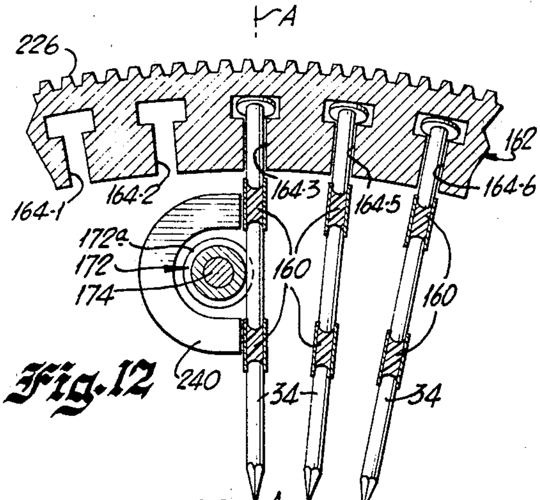


Fig. 12

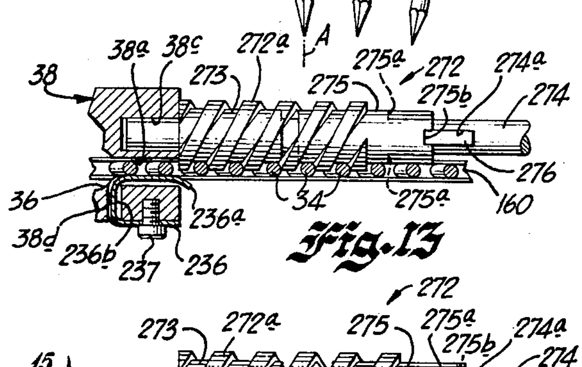


Fig. 13

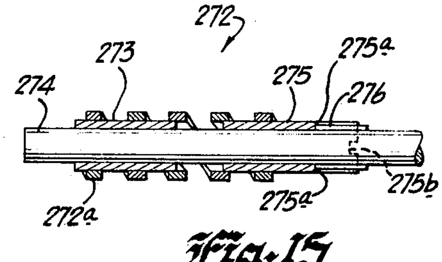


Fig. 15

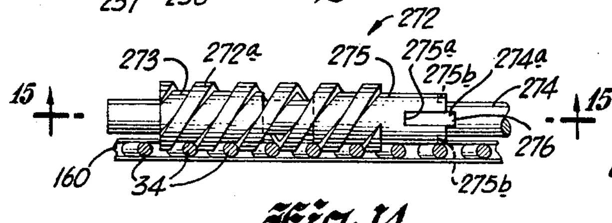


Fig. 14

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3,504,840

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3,504,840

FASTENER DRIVING TOOL

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Int. Cl. B25c 1/04
U.S. Cl. 227—130 21 Claims

ABSTRACT OF THE DISCLOSURE

A fastener driving tool comprising a drive track and a driver slidable in said track. A magazine assembly for supplying fasteners to said drive track including support means for holding a row of fasteners disposed with their shanks in spaced apart relation and a helical worm with a portion thereof disposed between a pair of adjacent fasteners in said row. Rotor means for tuning said worm to advance fasteners toward said drive track in synchronism with the power and return strokes of said driver in said drive track.

The present invention relates to a new and improved fastener driving tool and, more particularly, to a tool having a new and improved magazine for holding a supply of fasteners and feeding them into the drive track of the tool.

With the advent of a new electrically and pneumatically powered fastener driving tool having the capability of driving relatively large fasteners, such as common nails and the like, it has been a problem to provide an automatic magazine assembly for the tool capable of holding a relatively large supply of fasteners and capable of positively feeding the large fasteners, one at a time, into the drive track in synchronism with the power and return strokes of the driver. Many prior magazine assemblies do not have the capability of holding a large enough supply of fasteners and oftentimes are so large and heavy as to inhibit the portability and ease with which the tool can be handled and positioned for driving fasteners. In many instances fasteners would fail to feed properly into the drive track, and frequently jams or other malfunctions would occur in operation.

It is therefore an object of the present invention to provide a new and improved fastener driving tool.

Another object of the invention is the provision of a new and improved fastener driving tool which eliminates the aforementioned difficulties encountered in prior art tools.

More specifically, it is an object of the present invention to provide a power driving fastener driving tool having a new and improved magazine assembly.

Still another object of the invention is the provision of a new and improved magazine assembly of the character described having the capability of holding a quantity of relatively large fasteners, such as common nails and the like, yet remaining relatively small in size and light in weight so as not to reduce or limit the ease with which the tool may be handled and oriented for driving fasteners.

Still another object of the present invention is the provision of a new and improved magazine assembly of the character described employing operatively reliable and positive means for feeding the fasteners into the drive track of the tool in synchronism with the movements of the driver.

Yet another object of the invention is the provision of a new and improved magazine assembly of the character described which is completely automatic in operation, easy to load with a large number of fasteners, and more reliable in operation.

Another object of the invention is the provision of a new and improved magazine assembly of the character described employing novel worm gear means for positively and reliably feeding the fasteners into the drive track of the tool.

A further object of the invention is the provision of a new and improved magazine of the character described in the preceding paragraph which is capable of handling several different types of fasteners with a minimal amount of adjustment being required to change from one type or size fastener to another.

Another object of the present invention is to provide a new and improved magazine assembly having novel means for adjusting the worm gear feeding mechanism to accommodate different types and sizes of fasteners.

Yet another object of the invention is the provision of a new and improved magazine assembly of the type described capable of holding multiple rows of fasteners and employing novel means for automatically shifting each row into feeding alignment with the drive track until the supply of fasteners is exhausted.

Still another object of the invention is the provision of a new and improved magazine assembly of the character described employing worm gear feeding means and novel means for driving the worm to advance fasteners toward the drive track in selected synchronism with the movements of the driver of the tool.

Briefly, the foregoing and other objects and advantages of the present invention are accomplished in one embodiment thereof comprising a tool having a drive track, a driver slidable in the track, and a magazine assembly for holding a supply of fasteners and feeding them one at a time into the drive track. The magazine assembly includes means for supporting at least one row of fasteners in alignment with the drive track and arranged with their shanks in spaced apart relation. A helical worm is disposed adjacent the row of fasteners and a portion of the worm extends between at least one pair of adjacent fasteners for advancing the fasteners toward the drive track upon rotation of the worm. Means are provided for rotating the worm to advance fasteners toward the drive track in synchronism with the movements of the driver of the tool.

For a better understanding of the invention, reference should be had to the following detailed description, when taken in conjunction with the claims, in which:

FIG. 1 is a sectional view of a new and improved fastener driving tool in accordance with the invention taken on a longitudinal plane;

FIG. 2 is a sectional view similar to FIG. 1 but illustrating the piston and drive in another operative position approaching a rest position at the ends of a return stroke;

FIG. 3 is a sectional view taken substantially along line **3—3** of FIG. 1 and illustrating in detail the magazine assembly of the tool in accordance with the present invention;

FIG. 4 is a transverse cross-sectional view through the magazine assembly taken substantially along line **4—4** of FIG. 1;

FIG. 5 is a transverse cross-sectional view through the drive track of the tool taken substantially along line **5—5** of FIG. 2;

FIG. 6 is a transverse longitudinal cross-sectional view through the magazine assembly taken substantially along line **6—6** of FIG. 1;

FIG. 7 is a transverse longitudinal sectional view through the magazine assembly taken substantially along line **7—7** of FIG. 2;

FIG. 8 is a transverse cross-sectional view taken substantially along line **8—8** of FIG. 1;

FIG. 9 is a transverse cross sectional view taken substantially along line **9—9** of FIG. 2;

FIG. 10 is a fragmentary top plan view of the rear and portion of a modified form of magazine assembly in accordance with the invention;

FIG. 11 is a transverse cross-sectional view taken substantially along line **11—11** of FIG. 10;

FIG. 12 is a transverse cross-sectional view of yet another embodiment of a magazine assembly in accordance with the present invention;

FIG. 13 is a fragmentary top plan view of a modified magazine feeding assembly in accordance with the invention;

FIG. 14 is a fragmentary top plan view of the assembly of FIG. 13 but illustrating the assembly adjusted for accommodating a different size nail strip; and

FIG. 15 is a longitudinal cross-sectional view taken substantially along line **15—15** of FIG. 14.

Referring now more specifically to FIGS. 1 and 2 of the drawings, thererin is illustrated a fastener driving tool which embodies the present invention and which is indidated generally as **10**. The tool **10** comprises a housing **12** including a generally vertically extending head or forward portion **12***a*, a rearwardly extending hollow handle portion **12***b*, and a short, downwardly extending handle butt portion **12***c* at the rear end of the handle. The interior of the head portion **12***a*, handle **12***b*, and handle butt portion **12***c* provides a reservoir **16** for holding pressurized fluid, such as compressed air, which is supplied to the tool by a flexible line connected to an inlet fitting **14**.

The drive system for the tool **10** includes a cylinder **18** movably mounted within the head portion **12***a* and having an open upper end that is adapted to be selectively connected to the reservoir **16**. The cylinder **18** is normally biased to place its open upper end in engagement with a main valve assembly **20** under the control of a safety or touch-trip valve assembly **22** and a manual trigger valve assembly **24**. A fastener driving assembly including a piston **26** slidably mounted within the cylinder **18** and having a depending driver element or rod **28** secured thereto is normally biased to a position adjacent the main valve **20** under the control of a piston return valve assembly indicated generally as **30**. An exhaust valve assembly indicated generally as **32** for controlling the selective connection of the upper end of the cylinder **18** to the atmosphere is disposed on the housing **12** offset from the axis of the cylinder **18** to reduce the overall height of the tool **10**.

When the tool **10** is to be operated, the safety valve assembly **22** and the manual valve assembly **24** both are operated to move the cylinder **18** downwardly away from the main valve assembly **20**. As the cylinder **18** moves downwardly, the exhaust valve assembly **32** is closed (FIG. 1) and compressed air from the reservoir **16** enters the upper end of the cylinder **18** and drives the piston **26** and the connected driver **28** downwardly to engage and set a fastener or nail **34** supplied to a drive track **36** in a nosepiece or nosepiece structure **38** by a magazine assembly indicated generally as **40**. When the cylinder **18** moves downwardly, a venting assembly indicated generally as **42** places the lower end of the cylinder **18** in communication with the atmosphere so that the air disposed below the piston **26** can be discharged to the atmosphere to prevent pneumatic damping of the downward movement of the piston.

When the valve assemblies **22** and **24** are released (FIG. 2), the cylinder **18** is moved upwardly to engage the main valve assembly **20** and close off communication between the reservoir **16** and the upper end of the interior of the cylinder **18**. When the cylinder **18** moves to a position engaging the main valve assembly **20**, the exhaust valve assembly **32** is actuated to place the upper end of the interior of the cylinder **18** in communication with the atmosphere. This discharges the entrapped air above the piston **26** and controls the piston return valve assembly **30** so that compressed air is supplied below the piston **26**, the vent assembly **42** being closed by the upward movement of the cylinder **18**. The compressed air supplied by

the valve assembly **30** retracts the piston **26** and the driving element **28** upwardly to a rest position to complete a cycle of operation of the tool **10**.

Referring now more specifically to the drive system embodied in the tool **10**, this system is of the same general type as that shown and described in detail in United States Patents No. 2,979,725, No. 3,253,760, and No. 3,190,187. This drive system includes a pair of cylindrical portions **44** and **46** in the head portion **12***a* in which are slidably received two different diameter portions of the cylinder **18**. The larger diameter or upper portion of the cylinder **18** is sealed by two O-rings **48** which slidably engage the cylinder portion **44**, and a lower or smaller diameter portion of the cylinder **18** is sealed by an O-ring **50** engaging the cylindrical portion **46**.

An intervening space or cavity **52** (FIG. 2) defined between the O-rings **48** and **50** is selectively supplied with compressed air or connected to the atmosphere by the control valve assemblies **22** and **24**. In the normal condition of the tool **10**, one or both of the valve assemblies **22** and **24** supply compressed air to the space **52** which acts on the downwardly facing surfaces on the cylinder **18** within the space **52** which are greater in area than the upwardly facing surfaces acted on by the compressed air within the reservoir **16** to provide an upwardly directed component of force biasing the open upper end of the cylinder **18** upwardly against the main valve assembly **20** to prevent communication between the upper end of the cylinder **18** and the reservoir **16**.

The interior of the cylinder **18** is fitted with a replaceable inner cylinder liner **54** preferably formed of a self-lubricating material or metal, and a portion of the outer wall of the cylinder liner **54** is spaced from the inner wall of the cylinder **18** to provide an air conveying space **57** forming a part of the piston return system controlled by the piston return valve assembly **30**. The piston **26** includes a greater diameter upper portion **26***a* carrying a pair of O-rings **58** which slidably engage the inner wall of the cylindrical liner **54**.

A smaller diameter lower portion **26***b* of the piston **26** is adapted to engage a resilient bumper **60** (FIG. 1) disposed within a cylindrical retaining sleeve **62** which rests on the upper wall of the nosepiece structure **38**, which nosepiece structure is fastened to the lower end of the head portion **12***a* of the housing **12** by a plurality of machine screws to close the lower end of the head portion **12***a*. The driver **28**, which is secured to the piston **26**, passes through an opening **66** in the resilient bumper **60** to enter the upper end of the drive track **36** formed in the nosepiece structure **38**.

The venting assembly **42** for controlling the selective connection of the lower end of the interior of the cylinder **18** to the atmosphere comprises an integral cylindrical sleeve portion or annular valve element **68** at the lower end of the cylinder **18** that is slidably mounted in a lower cylindrical portion **70** of the head portion **12***a* with the interface between the cylindrical portion **70** and the sleeve **68** being sealed by an O-ring **72** carried on the sleeve **68**. A compression spring **74** interposed between a flange **62***a* of the retaining element **62** and the lower end of the sleeve **68** normally biases a resilient O-ring **76** carried on the sleeve **68** into engagement with an inclined wall surface connecting the cylindrical portions **46** and **70** to close the lower end of the interior of the cylinder **18**.

When the cylinder **18** moves downwardly, its lower end engages the upper end of the sleeve **68** and moves this sleeve downwardly against the force of the compression spring **74** to move the valve element **76** out of engagement with the inclined wall. This places the lower end of the interior of the cylinder **18** in communication with the atmosphere through one of a plurality of exhaust ports **78**. When the cylinder **18** is restored to its normal position at the end of the driving stroke, the compression spring **74** slides the sleeve **68** upwardly so that the valve element **76** again engages the inclined wall surface to close communication between the lower portion of the interior of the cylinder **18** and the atmosphere.

The piston return valve assembly **30** is shown and described in detail in the above-identified Patent No. 3,190,-187. As set forth therein, the piston return valve assembly **30** is automatically responsive to the pressure within the upper end of the cylinder **18** or the position of the piston **26** to selectively supply compressed air from the reservoir **16** to the lower end of the interior of the cylinder **18** to return the piston **26** to its normal position engaging the main valve assembly **20**. The piston return valve assembly **30** is mounted in a protuberance or projection **18a** formed on the cylinder **18** and includes a valve element **80** having a piston portion **82** slidably mounted within a two diameter cylinder formed in the portion **18a**. The upper end of the larger diameter portion of the cylinder is closed by a member **84** having a passageway **86** through which compressed air from the reservoir **16** is continuously supplied. This air acts on the piston portion **82** to provide a downwardly directed component of force that seats the valve **80** on a resilient valve element provided by an O-ring **88**. This closes off communication through a passageway **90** and a port **92** between the reservoir **16** and the air conveying space **57** which is defined between the cylinder **18** and the cylindrical insert **54** and which communicates with the lower end of the interior of the cylinder **18** below the piston **26**.

Whenever the tool **10** is actuated to move the cylinder **18** downwardly, the piston **26** is driven downwardly to engage the bumper **60** and remains in this position when the cylinder **18** is returned to its normal position engaging the main valve assembly **20** by the release of the control valve assemblies **22** and **24**. When the exhaust valve assembly **32** is operated to connect the upper end of the interior of the cylinder **18** to the atmosphere, the compressed air interposed between the piston portion **82** and the member **84** is largely exhausted to the atmosphere through a passageway **94**, the upper end of the cylinder **18**, and the exhaust valve assembly **32**. The compressed air acting on the lower end of the piston portion **82** lifts the valve element **80** out of engagement with the valve seat **88** so that compressed air enters the lower end of the cylinder **18** below the piston **26**. This compressed air moves the piston **26** upwardly to engage the main valve **20**. In this position, the port terminating the inner end of the passageway **94** is sealed by the O-rings **58**. The compressed air entering through the passageway **86** now accumulates above the piston portion **82** and overcomes the upwardly directed force due to the compressed air supplied from the reservoir **16**. At this time, the exhaust valve **80** moves downwardly to engage the resilient O-ring **88** and terminates the supply of pressurized fluid to the lower end of the interior of the cylinder **18** below the piston **26**. The piston **26** is retained in its upper position by the frictional engagement of the O-rings **58** with the inner wall of the cylindrical insert **54**.

The main valve assembly **20** is carried on a closure cap **100** which is secured to the head portion **12a** of the housing by a plurality of machine bolts with a resilient sealing gasket **104** interposed between the head portion **12a** and the closure cap **100** so as to close the open upper end **106** of the head portion **12a**. The main valve assembly **20** includes a resilient element **108** of a diameter slightly larger than the upper end opening in the cylinder **18**. The resilient element **108** is vulcanized or otherwise rigidly and permanently secured to a plate **110** that is secured to the lower surface of the closure cap **100** by a plurality of machine screws **112**. In prior constructions, the resilient element **108** of the main valve assembly has been mounted in such a manner that it can be deflected or pulled downwardly by the compressed air acting thereon when the cylinder **18** is lowered.

The exhaust valve assembly **32** is selectively responsive to the position of the cylinder **18** either to connect the upper end of the interior of this cylinder to the atmosphere, in the normal condition of the tool **10** (FIG. 2), or to close the exhaust connection whenever the tool **10** is operated. The exhaust valve assembly **32**, which is completely carried on the closure cap **100**, is offset radially from the center or axis of the cylinder **18** to permit a reduction in the overall height of the head portion **12a** of the tool **10**. The exhaust system controlled by the valve assembly **32** includes a vertically extending passageway **114** passing through the resilient valve element **108**, the plate **110**, and the closure cap **100** in a position generally aligned with the axis of the cylinder **18**. A transverse passageway **116** in the closure cap **100** connects the passageway **114** with a small diameter cylinder **118** forming a part of the housing for the control valve **32**. An additional passageway **120** communicating with the atmosphere at one end is connected to the cylindrical chamber **118** by a larger diameter cylinder **122** also forming a part of the exhaust valve assembly **32**.

This assembly includes a valve element **124** having an upper piston portion **124a** and an intermediate valve portion **124b** which are disposed within the cylinder **122**. The upper end of the cylinder **122** is closed by a cap or closure **126** held in position by a cap screw **128**. A lower sealing portion **124c** of the member **124** is disposed within a smaller diameter cylinder **130** forming a continuation of the cylinder **118**. The lower end of the valve member **124** includes an operator portion **124d** which is aligned with and adapted to be engaged by the closure member **84** mounted on the projecting portion **18a** of the cylinder **18**. The operator portion **124d** does not close the passageway **86** in the closure member **84**. In the normal condition of the tool **10**, the lower end of the operator **124d** engages the member **84** on the projecting portion **18a** of the cylinder **18** to hold the exhaust valve assembly **32** in the open position illustrated in FIG. 2 in which the upper end of the interior of the cylinder **18** is connected to the atmosphere through the passageways **114** and **116**, the cylinders **118** and **122**, and the passageway **120**.

When the tool **10** is operated so that the cylinder **18** moves downwardly, the member **84** on the projecting portion **18a** moves out of engagement with the operator **124d** on the exhaust valve member **124**. At this time, the compressed air continuously supplied to the upper surface of the piston portion **124a** from the reservoir **16** through an axially extending passageway **132** in the valve member **124** acts on the upper surface of the piston portion **124a** and provides a greater downwardly directed force than the upwardly directed force resulting from the compressed air in the reservoir **16** acting on the lower surface of the sealing portion **124c**. This net downwardly directed force moves the valve member **124** downwardly until a valve element provided by an O-ring **134** carried on the valve portion **124b** seats on the shoulder between the cylinders **118** and **122**. This prevents communication between the passages **116** and **120** and closes the connection between the upper end of the cylinder **18** or the reservoir **16** and the atmosphere.

When the cylinder **18** is restored to the normal or rest position at the upper end of the head portion **12a**, the member **84** on the projecting portion **18a** engages the lower end of the operator **124d** and moves the valve member **124** upwardly against the pneumatic bias to the position illustrated in FIG. 2. In moving upwardly, the valve member **124b** lifts the O-ring **134** out of engagement with the shoulder between the cylinders **118** and **122** so that the upper end of the interior of the cylinder **18** is connected to the atmosphere over the system of passageways set forth above. This is effective through the passageway **94** to place the upper end of the piston portion **82** at or near atmospheric pressure so that the piston return valve assembly **30** operates in the matter described above. The exhaust valve assembly **32** remains in this condition until the tool **10** is next operated to lower the cylinder **18**.

The safety valve assembly **22** and the manual valve assembly **24** for controlling the operation of the tool **10** are substantially the same as those described in the above-identified patents. In general, the safety valve assembly **22** includes a valve stem **140** having a grooved or reduced diameter portion **140***a* adjacent its upper end which is slidably received within a sleeve **142** carried on the housing **12**. The lower end of the valve stem **140** is connected to a collar **144** so that a compression spring **146** interposed between a projection **148** on the head portion **12***a* and the collar **144** biases the valve stem **140** to the position shown in FIG. 2 in which compressed air from the reservoir **16** flows into the space **52** through a passageway or port **150**. The collar **144** is connected to an operator element (not shown) that is slidably mounted on the nosepiece structure **38**. The lower end of the operator element normally projects below the lower end of the nosepiece structure **38** and is adapted to engage a workpiece. Thus, when the tool **10** is moved into engagement with the workpiece, the operator is moved upwardly to produce a corresponding movement of the valve stem **140** against the action of the compression spring **146**. When the valve stem **140** moves upwardly, the upper end of the stem closes off direct communication between the passageway **150** and the reservoir **16**, and the notched or recessed portion **140***a* moves into alignment with a passageway **154**.

The passageway **154** communicates with the manually controlled trigger valve assembly **24** which includes a ball valve element **155** and a passageway **156** communicating with the reservoir **16**. Thus, compressed air from the reservoir **16** normally passes through the passageways **156**, **154**, and **150** to the space **52**.

When the manual valve assembly **24** is actuated by pivoting a trigger **157** in a counterclockwise direction about a pivot pin **158**, a fluted valve stem **159** moves upwardly to seat the ball valve **155** in a position closing the port terminating the passageway **156**. This movement of the ball valve **155** also places the passageway **154** in communication with the atmosphere through the flutes along the stem of the operator pin **159**. Thus, the space **52** is placed at atmospheric pressure, and the compressed air within the reservoir **16** acting on the upwardly facing surfaces of the cylinder **18** produces a downwardly directed force which moves the cylinder **18** downwardly to cause the sequential operation of the valve assemblies **32** and **42** in the manner described above. When either or both of the valve assemblies **22** and **24** are released, compressed air from the reservoir **16** enters the space **52** through the passageway **150** or through the passageways **156**, **154**, and **150** to provide an upwardly directed force acting on the cylinder **18** to move it upwardly into engagement with the main valve assembly **20**. This closes the valve assembly **42**, opens the valve assembly **32**, and causes the operation of the piston return valve assembly **30** for the period of time necessary to return the piston **26** and the driver **28** to the normal or rest position.

The novel magazine assembly **40** constructed in accordance with the features of the present invention is adapted to feed individual nails **34** one at a time into the driver track **36** in synchronism with the movements of the driver **28**. The nails are supplied from a plurality of carrier strips loaded into the magazine, and each carrier strip holds a substantial number of nails held together by longitudinal strip members **160** applied transversely across the nail shanks. Preferably, the carrier strips or nail assemblages are of the type shown and described in U.S. Patent No. 3,212,632, wherein the nails are arranged with their shanks in spaced apart, parallel relation and their heads are in stacked relation, as shown best in FIGS. 1 and 2. In each carrier a pair of parallel strip members **160** are integrally formed to extend transversely across the nail shanks longitudinally of the assemblage, one strip being arranged parallel to the line of nail heads and another strip spaced below and generally parallel with the pointed ends of the nails.

In order to hold a plurality of carrier strips or nail assemblages in the magazine and thereby provide capacity for a relatively large number of individual nails **34**, the magazine **40** includes a movable support member **162** having an arcuate or curved, transverse, cross section (FIGS. 4 and 12) and a plurality of longitudinally extending, spaced apart, parallel grooves **164–1** through **6** are formed in the member, each holding a separate carrier of nails. Each of the grooves **164–1** through **6** is adapted to support the nail heads in a carrier strip and permit the longitudinal movement of the nails along the groove toward the drive track of the tool.

The nail support member **162** is movable laterally with respect to a feeding axis or plane A—A (FIG. 4) extending rearwardly of the longitudinal axis of the drive track **36** so that each of the grooves **164–1** through **6** may be successively aligned with the drive track until all of the nails in the groove are advanced into a feed slot **38***a* formed in the nosepiece and extending rearwardly of the drive track (FIGS. 6 and 7). To this end, the forward end of the magazine nail support member **162** includes a forwardly projecting lip or ridge **162***a* (FIGS. 1 and 2) at the forward end slidably disposed within a transversely curved slot **38***b* formed in the rearward face of the nosepiece. The rearward end of the support member **162** is provided with a similar rearwardly projecting support lip or ridge **162***b* laterally slidable within a transversely curved groove or slot **165** defined in a forwardly facing surface portion **166** of the handle butt portion **12***c*. Accordingly, the member **162** is laterally movable or shiftable as represented by the arrow B (FIG. 3) in relation to the feeding plane A—A so that each of the nail supporting grooves **164–1** through **6** can be successively aligned with the feed opening **38***a* in the rear of the nosepiece **38** which communicates with the drive track **36**.

In order to advance the nails **34** forwardly from the respective grooves **164–1** through **6** into the feed slot **38***a* toward the drive track **36**, the magazine assembly **40** includes a feeding or nail advancing assembly **170** comprising a worm gear **172** mounted adjacent the forward end of a rotatable shaft **174**. The worm gear **172** includes a spiral helix or worm **172***a* having a plurality of convolutions adapted to extend between the spaced shanks of the nails **34** as best shown in FIGS. 6 and 7. When the worm is rotated in the direction of the arrow C in FIG. 6, the nails are advanced forward with respect to the drive shaft **174**. The pitch of the helical worm **172***a* is chosen to accommodate the spacing between the nail shanks and provide good contacting engagement between the advancing side face of the worm against the rearward facing surfaces of the nail shanks.

The forward end of the worm shaft **174** is supported in a cylindrical recess 38*c* opening rearwardly on the rearward face of the nosepiece member **28**. As shown in FIGS. 6 and 7, the shaft **174** is rotatable and, in addition, is slidable longitudinally of the magazine. As best shown in FIG. 4, it will be seen that the shaft **174** is laterally offset from the nail feeding plane A—A and is generally parallel thereto, so that when one of the T-shaped grooves **164–1** through **6** is aligned with the feed slot **38***a*, the helical worm engages the nail shanks from one side and advances them forwardly with respect to the shaft as it is rotated. The rearward end of the worm drive shaft **174** is connected by means of a one-way slip clutch assembly **176** to a short, rear, drive shaft **178** having its rearward end supported in the axial bore **180***a* of a flanged bushing **180** which is seated in recess or bore **182** formed in the handle butt portion **12***c*. The bushing **180** includes a radial flange at the forward end thereof which is biased forwardly in the bore **182** by means of a relatively strong compression spring **184**, the rearward end of which is seated against an internal shoulder **182***a* formed in the bore. The spring **184** is adapted to permit longitudinal movement of the bushing **180** within the bore **182** should a jam-up of the drive track occur, and thus damage would be minimized. The rear shaft **178**, the forward drive shaft **174**, and the worm gear **172** are normally biased forwardly to the position shown in FIG. 7 by a loading spring **188** which is seated at the closed end of the bore **180***a* in the bushing **180**.

The slip clutch assembly **176** is operable to drive or rotate the forward shaft **174** in one direction only, as indicated by the arrow C in FIG. 6 when the rearward shaft **178** is rotated in the same direction. When the rear shaft **178** is rotated in the opposite direction, the slip clutch **176** permits the forward shaft **174** to remain stationary when the worm gear is engaging the nails **34**.

The rear drive shaft **178** is rotated by means of a gear **190** mounted intermediate the ends of the shaft, and the gear is rotated by a vertically movable rack member **192** forming the lower end portion of a reciprocating plunger **194** having a piston **196** at the upper end (FIGS. 8 and 9).

The piston **196** is mounted for sliding movement in a cylindrical bore **198** formed in the handle butt portion **12***c* and generally perpendicular to the drive shafts **178** and **174** of the feed assembly **170**. The lower end portion of the bore **198** in the handle butt portion **12***c* is reduced sealed within the bore **198** by means of an O-ring **196***a* against which is seated the lower end of a compression spring **200** which normally biases the piston **196** upwardly to the position shown in FIG. 9. The piston **196** is sealed within the bore **198** by means of an β-ring **196***a* and when pressurized fluid is supplied to the upper end of the bore **198**, the piston and rack portion **192** are driven downwardly thereby rotating the gear **190** in the direction of the arrow C (FIG. 6). This rotates the rear drive shaft **178** which drives the worm **172** via the forward drive shaft **174** and slip clutch assembly **176**. When pressurized fluid is exhausted from the upper end of the bore **198** above the piston **196**, the compression spring **200** causes the piston and rack portion **192** to move upwardly from the position of FIG. 8 to the position of FIG. 9. This causes the shaft **178** to rotate in the opposite direction, and during this time the slip clutch **176** permits the forward drive shaft **174** to remain stationary without rotation. The upper end of the bore **198** in the handle butt portion **12***c* is connected to the valve passage **118** associated with the exhaust valve assembly **32** via a fluid line **202**. An end fitting **204** connects the lower end of the fluid line to the upper end of the bore **198** and an end fitting **206** connects the upper end of the fluid line to the exhaust passage **116** which is in communication with the vertical valve passage **118**.

Because the upper end of the fluid conduit **202** is in communication with the exhaust passage **116** when a power stroke is initiated, as shown in FIG. 1, pressurized fluid introduced into the upper end of the cylinder **18** also flows through conduit **202** into the upper end of the bore **198** causing the piston **196** and rack portion **192** to move downwardly. This rotates the worm gear **172** in the direction shown by the arrow C in FIG. 6, but because the driver **28** is occupying the lower end in the drive track **36** during this time, the nails **34** in the groove in feeding alignment with the drive track cannot advance. Accordingly, the worm **172** and shaft **174** move longitudinally rearwardly with respect to the nails, causing compression of the spring **188** (FIG. 6). After a power stroke has been completed, the piston **26** and driver **28** move upwardly on a return stroke. When the lower end of the driver moves above the head of the leading nail in the feed slot opening **38***a*, the compressed spring **188** forces the feed shaft assembly **170** forwardly to the position of FIG. 7, and the worm helix **172***a* moves the leading nail into the drive track **36**.

During the upward travel of the piston and driver on a return stroke, the exhaust passage **116** is vented to the atmosphere through the exhaust valve assembly **32**, as previously described, and accordingly the pressurized fluid in the upper end of the bore **198** above the piston **196** is open to exhaust to the atmosphere through the fluid conduit **202**, passages **118, 122**, and **120**. During this time the spring **200** moves the piston **196** upwardly to the position shown in FIG. 9 in preparation for the next cycle of operation.

From the foregoing description it will be seen that the nail feed assembly **170** is operable in synchronism with the movements of the piston **26** and driver **28** to feed a nail **34** into the drive track after each power stroke has been completed as the driver **28** moves upwardly on a return stroke toward the rest position. The worm helix **172***a* provides for positive advancement of the nails along the grooves **164** through **164–6** and preferably the worm continuously engages several nails in a strip so that there is little chance of the worm skipping or jumping past the nails without advancing them.

In order to laterally shift the magazine support member **162** to bring each of the nail supporting grooves **164–1** through **6** therein into feeding alignment with the feed slot **38***a* in the nosepiece, the magazine **40** includes a lateral shifting assembly **210**. The shifting assembly **210** includes an axle **212** which is parallel with and spaced above the shafts **174** and **178**. The forward end of the axle **212** is seated in a recess **214** in the tool housing **12***a*, and the rearward end is supported in a recess **216** formed in the face **166** of the handle butt portion **12***c*. The axle **212** is secured against rotation on the tool housing and a torsion spring **218** is mounted on the axle intermediate its ends with one end of the spring connected to the axle and the opposite end of the spring extending radially outward to engage a tubular sleeve **220**. The sleeve is rotatable on the axle **212**, and the torsion spring **218** exerts torque on the sleeve, tending to cause rotation of the sleeve in a clockwise direction, as viewed in FIG. 4. The forward end of the sleeve **220** includes a gear portion **222** journaled for rotation on the axle **212**, and similarly a gear portion **224** is provided at the rearward end of the sleeve. The gear portions **222** and **224** drivingly engage forward and rearward, toothed, rack portions **226** and **228**, respectively (FIG. 3) formed on the upper surface of the magazine support member **162**. When the sleeve **220** is rotated on the axle **212** by the spring **218**, the gear portions **222** and **224** engage the rack portions **226** and **228** at the forward and rearward ends of the magazine support member **162** and urge the member to shift laterally from right to left (FIG. 4). As the nails **34** in each of the T-shaped grooves **164–1** through **6** are exhausted, the force of the bias spring **218** automatically shifts the support member **162** laterally to align the next nail support groove in the member on the feeding plane A—A so that the worm gear **172** can engage the nails and advance them forwardly into the feed slot **38***a* of the nosepiece. The shifting assembly **210** is operable to automatically shift the next succeeding groove in the support member **162** into feeding alignment with the drive track after all of the nails in the preceding groove have been advanced into the feed slot **38***a* in the nosepiece. This process is repeated until the nails **34** in all of the grooves **164–1** through **6** contained in the magazine support member **162** have been advanced into the feed slot **38***a* of the nosepiece.

The lateral shifting assembly **210** also serves an important function in continuously biasing the shanks of the nails **34** against the worm gear **172** so that convolutions of the helical worm **172***a* will seat in the spaces between adjacent nail shanks and thereby insure positive feeding or advancement of the nails when the worm **172** is rotated, as previously described. Engagement of the nails **34** with the worm gear insures proper alignment of each groove **164–1** through **6** with the drive track and prevents the shifting assembly **210** from skipping any groove which contains nails.

In order to facilitate loading of the carrier strips into the grooves, the upper surface of the magazine support member **162** is provided with an enlarged rectangular opening **230** which extends between the rack portions **226** and **228** and is in communication with all of the grooves in the support member. The nail strips are inserted into the grooves from the top through the opening **230**. In order to limit the lateral movement of the support member **162** when empty, a pair of stop members or handles **232** and **234** are formed on opposite sides thereof. When loading the magazine with nails, the support member is laterally shifted manually from left to right (FIG. 4) until the stop **232** is against the sleeve **220** and all of the grooves **164–1** through **6** are open and exposed from the top so that nail strips may be inserted therein without interference. In effecting the manual lateral shifting of the member **162**, the handle **234** is grasped and moved from left to right until the handle **232** engages the sleeve **220**, and this action winds up the torsion spring **218**. After the carrier strips have been loaded into the grooves **164–1** through **6**, the handle **234** is released and the torsion spring **218** causes the support member **162** to move laterally from right to left until the nails **34** in the first groove **164–1** are against the worm gear **172**. After all of the nails in the groove **164–1** have been advanced into the feed slot **38*a***, the torsion spring **218** shifts the support member laterally to align the next groove **164–2** with the drive track, and this process is repeated until all of the nails in the grooves of the magazine have been advanced into the feed slot, whereupon the spring **218** again shifts the support member to a position wherein the handle **234** is touching the sleeve **220** preventing further lateral movement of the nail support member. The opening **230** in the top portion of the magazine support member **162** provides an easy and convenient means for inserting the strips of nails downwardly into the T-shaped grooves **164–1** through **6**. Because the grooves **164–1** through **6** slope upwardly as they extend rearwardly from the drive track **36**, the nail strips, once inserted in the grooves move forwardly in their respective grooves by gravity until the leading nail in the strip is within or closely adjacent to the mouth of the feed slot **38*a*** in the noseipece.

Referring now to FIGS. 5, 6, and 7 of the drawings, in order to securely hold the nails **34** within the feed throat **38*a*** of the nosepiece, there is provided a U-shaped spring biasing member **236** having one leg **236*a*** which is mounted in the feed throat and bears laterally against the shanks of the nails **34** therein. The spring member **236** also includes a bight portion **236*b*** which is freely movable within a slotted out portion **38*d*** extending laterally of the drive track **36** and feed throat. The outer leg of the spring member is secured to the side face of the nosepiece **38** by a small cup screw **237**. When the number of the nails **34** remaining in a nail strip is low, the spring **236** insures that the nails bear firmly against one side of the feed throat **38*a*** and prevents cocking of the nails during feeding or as a driving stroke of the driver **28** proceeds.

As best shown in FIGS. 6 and 7, the feed slot **38*a*** is long enough to accommodate a plurality of nails **34**, and these nails are firmly held in position within the feed throat by the inner leg **236*a*** of the spring member **236**. Each time the lateral shifting mechanism **210** operates to shift the next groove **164** into feeding alignment, the nails remaining in the feed throat **38*a*** are firmly held by the spring **236** and as each new strip of nails in a succeeding groove is moved into alignment, the leading nail in the new strip is positioned properly with respect to the rearwardmost nail in the feed throat **38*a*** in order to provide a continuity of feeding action.

Referring now to FIGS. 10 and 11, there is shown another embodiment of a magazine assembly constructed in accordance with the present invention. This embodiment is similar to the magazine assembly **40** previously described but the piston bore **198** and the piston **196** are located on the left-hand, rather than the right-hand, side of the feeding plane A—A as viewed in FIG. 10. Accordingly, when the piston **196** is moved downwardly by air pressure in the upper end of the bore on the power stroke of the driver, the rack portion **192** engages the gear **190** causing it to rotate in a clockwise direction (FIG. 11). The slip clutch **176** permits the gear shaft **178** to rotate freely in a clockwise direction without rotation of the forward worm drive shaft **172** which remains stationary. During the downward stroke of the piston **196**, the spring **200** is compressed to the position shown in FIG. 11 and, after completion of a power stroke of the driver during movement of the piston **26** upwardly on a return stroke, the exhaust valve assembly **32** is open and at this time the spring **200** then operates to move the piston **196** and rack portion **192** upwardly. As this occurs, the gear **190** is rotated in a counterclockwise direction to turn the shaft **178** which drives the worm **172** through the slip clutch **176** and shaft **174** to feed or advance another fastener forwardly into the drive track. In the prior embodiment a feed stroke of the magazine assembly was accomplished by the force exerted longitudinally on the shaft **174** by the previously compressed spring **188**, while in the latter embodiment the force for a feeding stroke is supplied by a compressed return spring **200**. In the latter embodiment the shafts **174** to **178** do not move longitudinally as in the former because the feeding stroke of the magazine is simultaneous with the upward or return stroke of the driver.

Referring now to FIG. 12, therein is illustrated another embodiment of a magazine employing additional means for insuring positive lateral contact between the nails **34** being fed and the worm gear member **172**. A permanent magnet **240** is mounted with its attractive poles in close proximity adjacent the feeding plane A—A, to the worm gear **172**. As each nef strip of naisl in a groove **164** is shifted into feeding position on the plane A—A, the poles of magnet **240** attract the shanks of the nails **134** and hold them securely in the grooves between adjacent convolutions in the helical worm **172*a***, thus insuring positive engagement between the worm and the nail shanks.

Referring now to FIGS. 13 through 15, therein is illustrated a modified form of worm assembly **272** which is adjustable so that different sized nails or carriers with different spacings between adjacent shanks can be accommodated in the tool without requiring several worm gears of suitable different pitches. For this purpose, the worm feed assembly **272** includes a forward cylindrical sleeve portion **273** fixed on the shaft **274** and a similar sleeve **275** spaced rearwardly thereof but movable longitudinally on the shaft **274** with respect to the forward sleeve **273**. A helical worm member **272*a*** is formed of spring steel and at least a portion of the forwardmost turn or convolution is permanently affixed or secured to the forward sleeve **273**. At least a portion of the rearwardmost coil or convolution of the worm is likewise fixedly secured to the longitudinally slidable rear sleeve **275**. Intermediate the forwardmost and rearwardmost convolutions thereof, the worm is otherwise freely movable on the respective sleeves so that by movement of the rear sleeve forwardly the worm pitch is reduced and, conversely, by rearward movement of the rearward sleeve the worm pitch is increased. FIG. 13 shows the worm adjusted for a short pitch while FIG. 14 shows the worm adjusted for a larger pitch. In order to maintain the selected pitch desired, the shaft **274** is provided with a rectangular diametrically disposed slot **274*a*** therein for receiving a key member **276** inserted therein. The rearward end portion of the rear sleeve **275** is formed with a first pair of relatively long, longitudinally disposed slots **275*a*** which are formed on diametrically opposite sides thereof and, in addition, includes a pair of shorter longitudinally extending slots **275*d*** radially spaced with respect to the longer slots **275*a***. In FIG. 13 the worm **272*a*** is set for a minimum pitch and, accordingly, the rearward sleeve **275** is rotated so that the shorter sleeve slots **275*b*** are aligned with the key member **276** inserted in the shaft slot **274*a*** and the shorter sleeve slots **275*b***. If it is desired to increase the worm pitch, the sleeve **275** is moved forwardly on the shaft until clear of the slots **275*b*** and is turned until the longer slots **275*a*** are aligned with the key members **276**. The sleeve is then released and the worm biases the sleeve rearwardly until the key is seated in the slots **275*a***. More than two pairs of slots can be furnished to provide for any number of on intermediate worm pitches and other means could be employed to provide for holding the worm at selected different pitches without departing from the scope of the present invention.

Although the present invention has been described with reference to several illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this invention.

What is claimed and desired to be secured by Letters Patent of the United States is:

1. A fastener driving tool comprising a drive track, a driver reciprocally slidable in said track on repetitive cycles for driving said fasteners, and a magazine for feeding successive fasteners into said drive track during each cycle of operation of said driver, said magazine including support means for holding a row of fasteners disposed with their shanks in spaced apart relation, a helical worm laterally offset from said row and having a portion thereof disposed to extend across said row between a pair of adjacent fastener shanks therein, said worm engageable against the shanks of successive fasteners in said row for moving the same along said support means toward said drive track, and rotor means for rotating said worm during each cycle of operation of said driver.

2. The fastener driving tool of claim **1** including motor means for moving said driver in said cycle including a power stroke and a return stroke, and means operatively interconnecting said motor and rotor means to rotate said worm a selected amount during each cycle of operation of said driver.

3. The fastener driving tool of claim **1** wherein said support means comprises means for holding a plurality of rows of said fasteners and shifting means for moving said support means to align a succeeding row of fasteners with said drive track after the fasteners of a preceding row are exhausted.

4. The fastener driving tool of claim **3** wherein said shifting means is operable to bias fasteners laterally toward said helical worm into position wherein a portion of the worm is disposed between a pair of adjacent fasteners.

5. The fastener driving tool of claim **1** including magnet means for attracting said fasteners toward said worm.

6. The fastener driving tool of claim **1** wherein said worm includes a plurality of convolutions and means for adjusting the pitch of said worm to accommodate a plurality of spacing between adjacent fasteners.

7. The fastener driving tool of claim **2** wherein said worm is rotated to advance said fasteners toward said drive track during a return stroke of said driver.

8. The fastener driving tool of claim **1** wherein said worm is reciprocal toward and away from said drive track to advance fasteners into driving position during forward travel toward said drive track.

9. The fastener driving tool of claim **8** wherein said worm is movable toward and away from said drive track during rotation thereof by said rotor means.

10. A fastener driving tool comprising a drive track, a driver reciprocally slidable in said track on successive operating cycles, and a magazine for feeding fasteners into said drive track, said magazine including support means for holding a plurality of separate rows of fasteners disposed with their shanks in spaced apart relation, said support means including a plurality of spaced apart slots, each slot adapted to hold a row of fasteners, means for laterally shifting said support means to align each of said slots with said drive track after the fasteners in a preceding slot have been exhausted, and feeding means independent of said support means for advancing fasteners in the slot aligned with said drive track toward said drive track, said feeding means including a helical worm engaging the fasteners in the slot aligned with said drive track to advance the same along said slot towards said drive track, and rotor means for turning said worm a selected amount of rotation during each cycle of operation of said driver.

11. The fastener driving tool of claim **10** wherein said support means includes an opening above said slots permitting the insertion of a row of fasteners in each slot from the top thereof.

12. The fastener driving tool of claim **1** wherein said rotor means includes a first shaft supporting said worm, a second shaft for driving said first shaft, and one-way clutch means interconnecting said shafts to rotate both shafts in one direction to advance fasteners along said aligned slot and permitting the second shaft to rotate in an opposite direction without rotation of said first shaft.

13. The fastener driving tool of claim **12** wherein said shafts are movable longitudinally during rotation and spring means for biasing said shafts toward said drive track.

14. The fastener driving tool of claim **12** including reciprocal rack means engaging said second shaft and piston means for moving said rack means in one direction to rotate said second shaft.

15. The fastener driving tool of claim **14** including spring means for moving said rack means in an opposite direction.

16. The fastener driving tool of claim **14** including means for supplying pressurized fluid to operate said piston means during a power stroke of said driver.

17. The fastener driving tool of claim **15** wherein said piston means is operable to deflect said spring means during a power stroke of said driver, said spring means being operable to move said rack means to rotate said second shaft to advance fasteners in said aligned slot after completion of a power stroke of said driver.

18. A fastener driving tool comprising a drive track, a driver mounted in said track for movement on successive operating cycles comprising a driving stroke and a return stroke, magazine means for holding a supply of fasteners in at least one row disposed with their shanks in spaced relation, a helical worm having at least a portion thereof extending between an adjacent pair of fastener shanks in said magazine and engaged with at least one of said shanks to advance fasteners in said row into said drive track, and rotor means for rotating said worm in one direction during each operating cycle of said driver.

19. The fastener driving tool of claim **18** including motor means for actuating said rotor means to advance a fastener toward said drive track, each operating cycle of said driver.

20. The fastener driving tool of claim **19** wherein said motor means includes a reciprocating rack drivingly engaging said rotor means, said rack movable to rotate said rotor means in one direction on a power stroke of said driver and in an opposite direction on a return stroke of said driver.

21. The fastener driving tool of claim **20** wherein said motor means includes piston means for moving said rack in one direction and spring means for moving said rack in the opposite direction.

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