Oct. 18, 1960 D. B. McILVIN 2,956,282

HAND-HELD AUTOMATIC DEVICES FOR DRIVING HEADED FASTENERS

Filed May 3, 1954 5 Sheets-Sheet 1

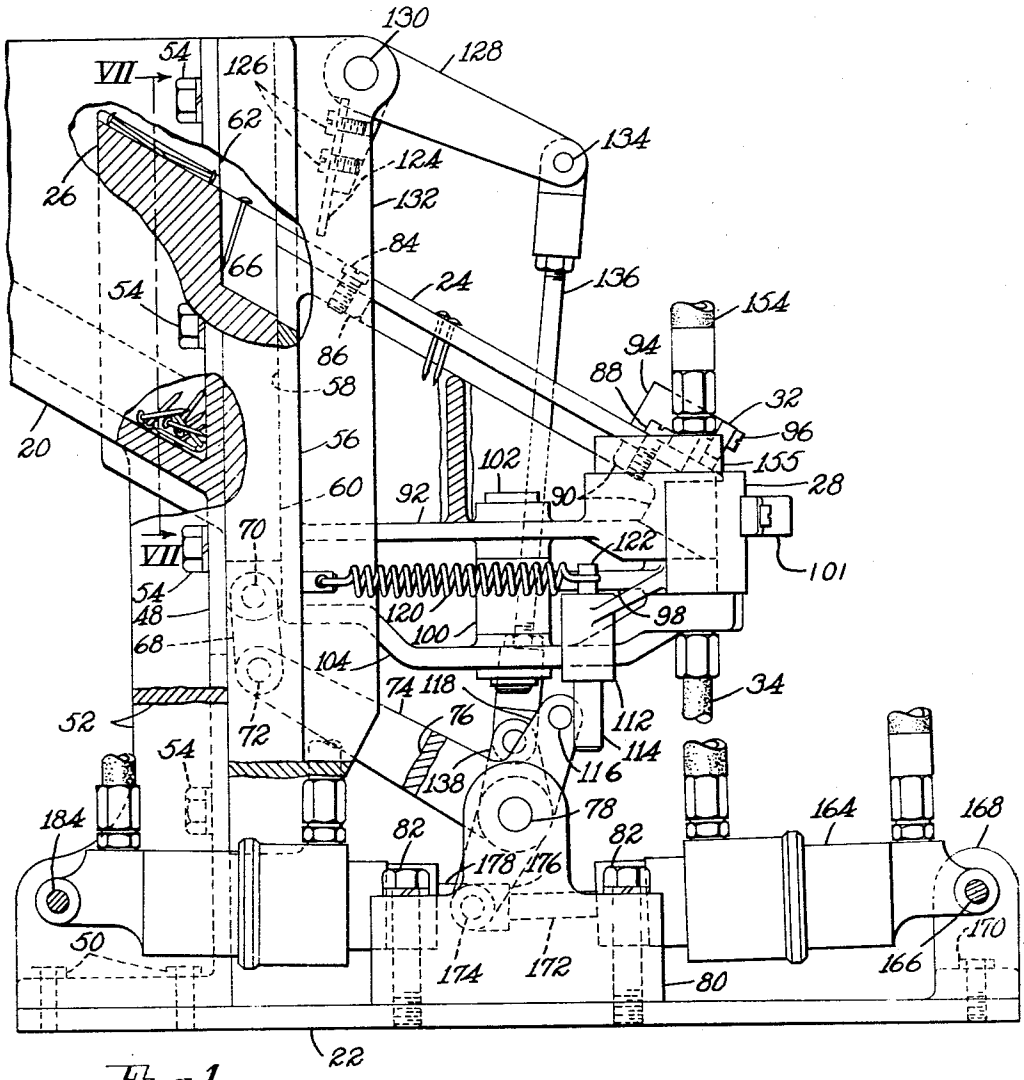

Fig.1

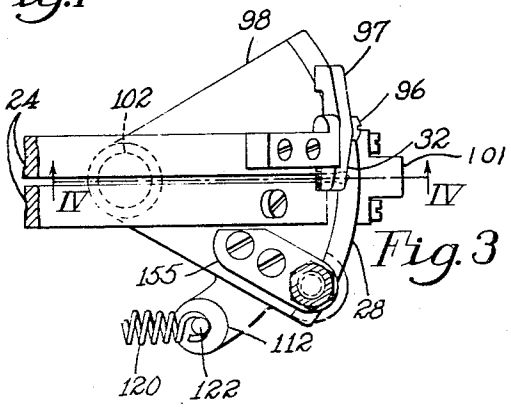

Fig.3

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HAND-HELD AUTOMATIC DEVICES FOR DRIVING HEADED FASTENERS

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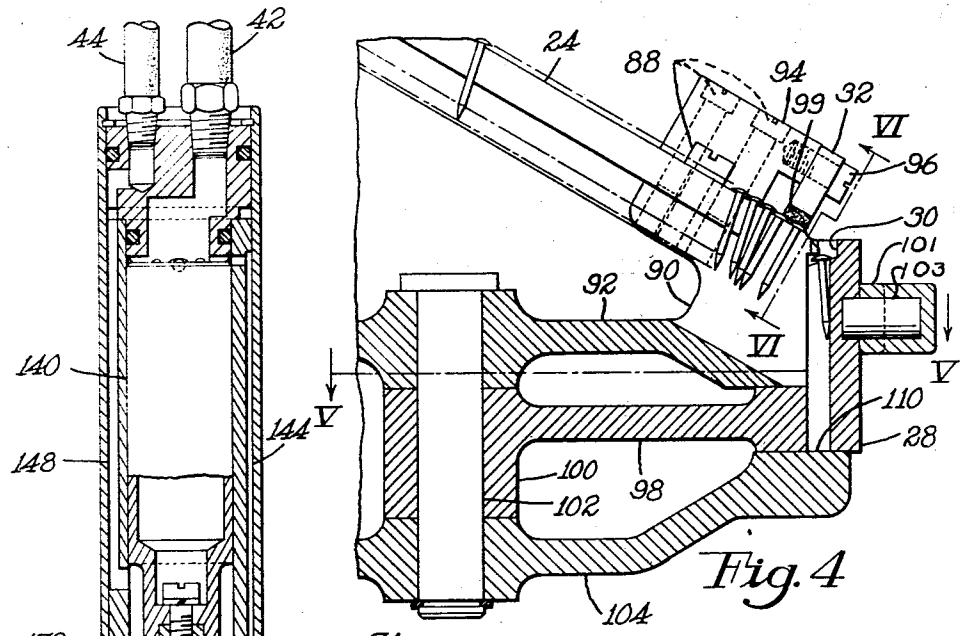

Fig. 4

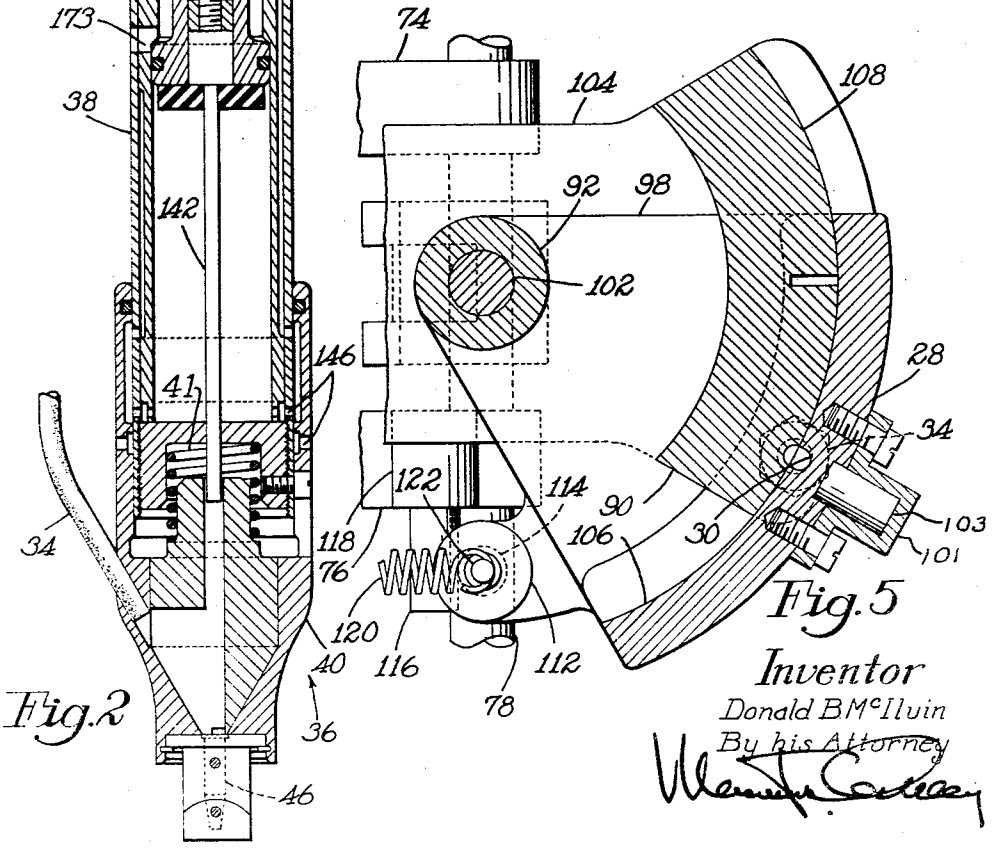

Fig. 2

Fig. 5

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HAND-HELD AUTOMATIC DEVICES FOR DRIVING HEADED FASTENERS

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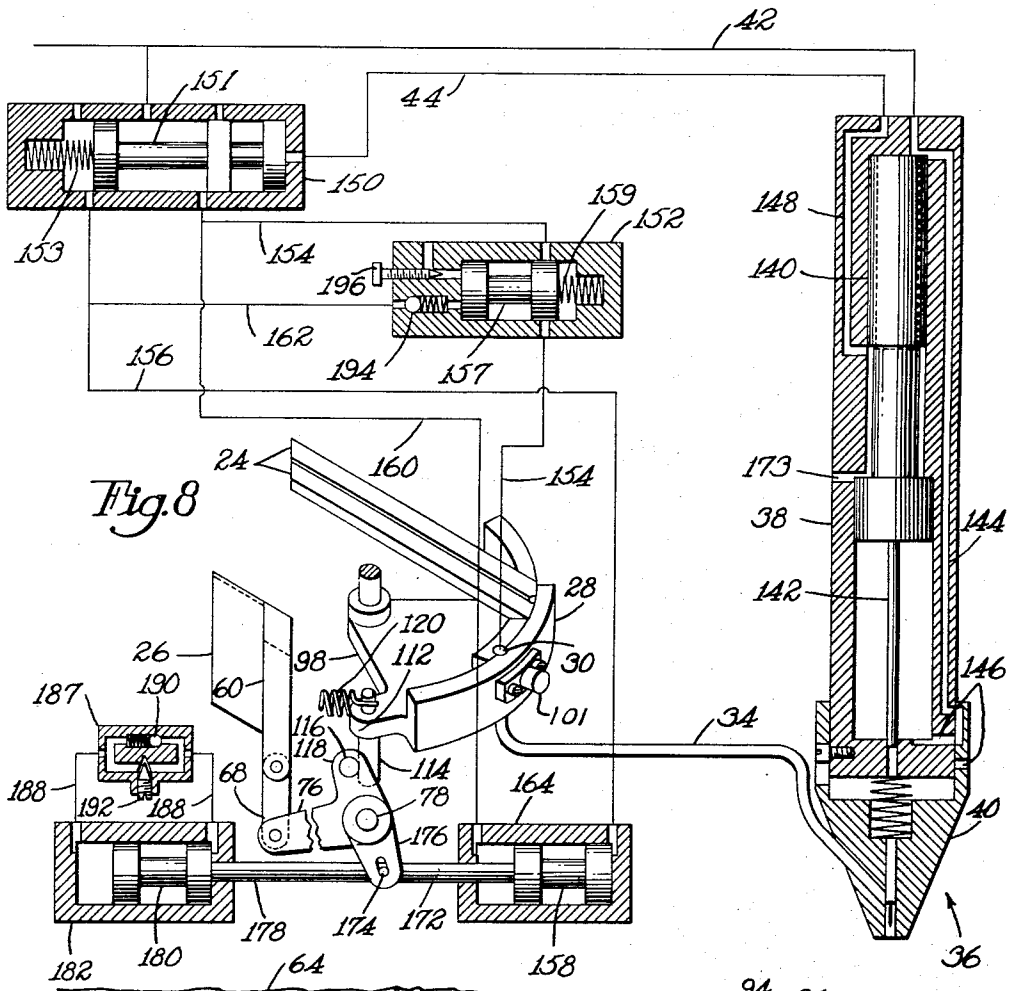

Fig. 8

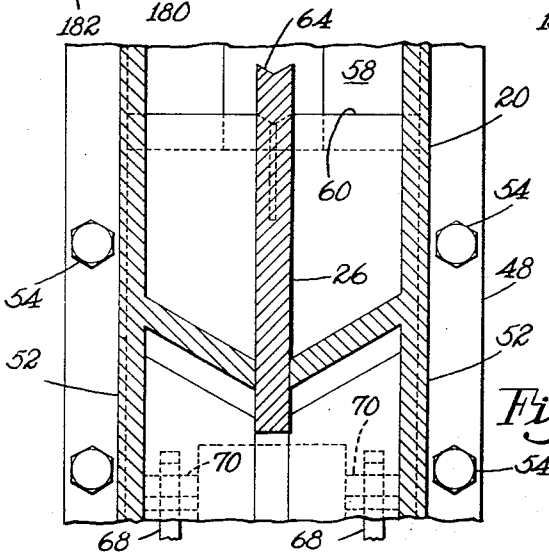

Fig. 7

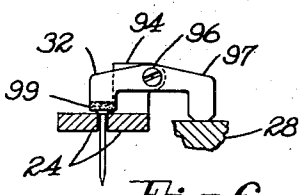

Fig. 6

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HAND-HELD AUTOMATIC DEVICES FOR DRIVING HEADED FASTENERS

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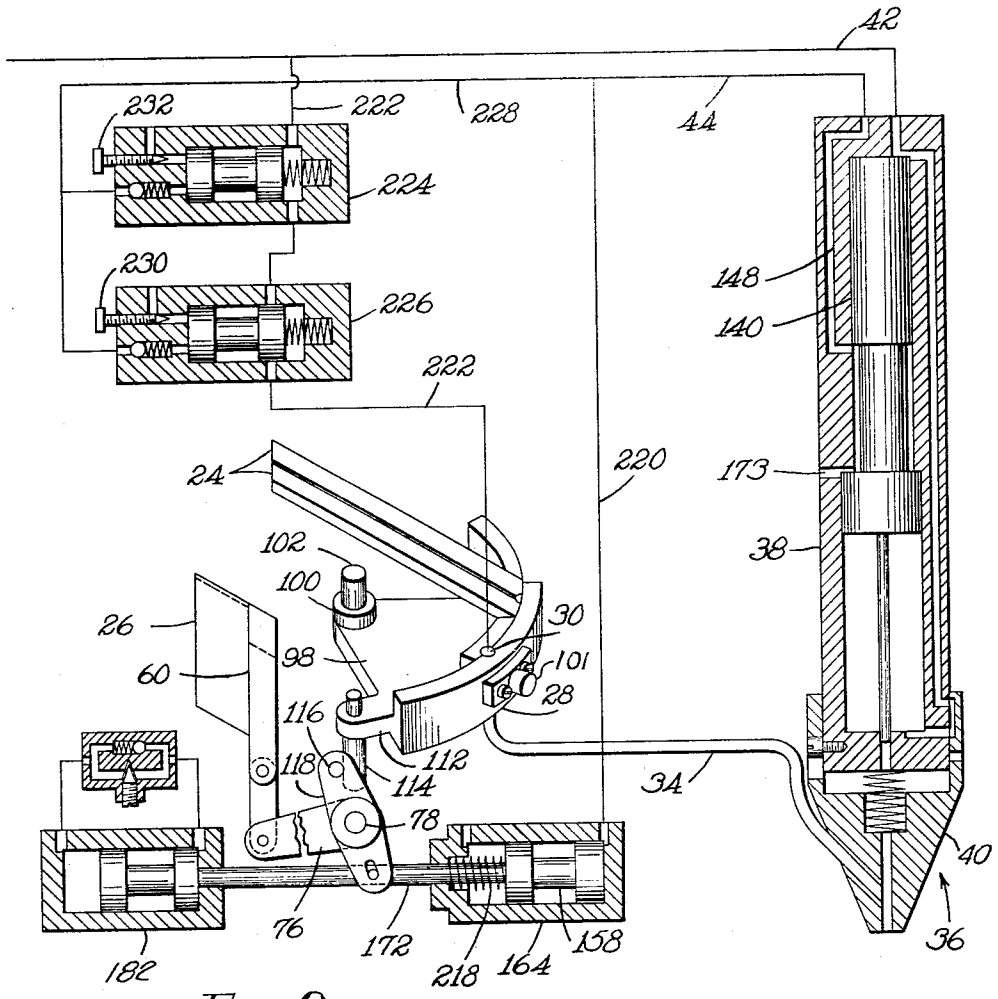

Fig. 9

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HAND-HELD AUTOMATIC DEVICES FOR DRIVING HEADED FASTENERS

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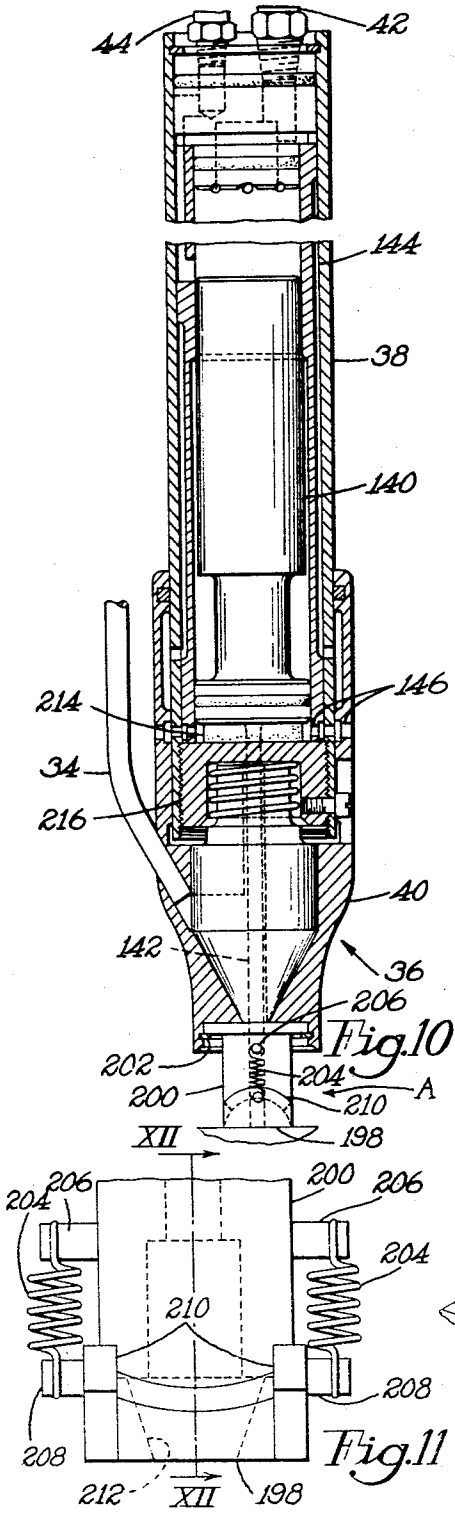

Fig.10

Fig.11

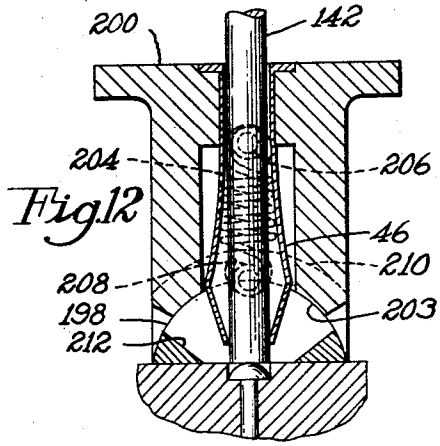

Fig.12

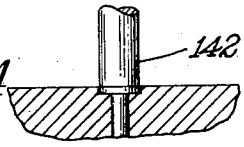

Fig.14

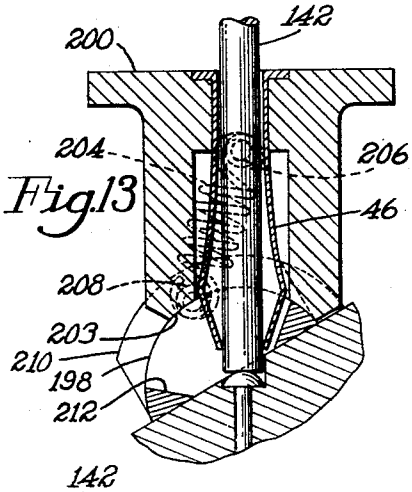

Fig.13

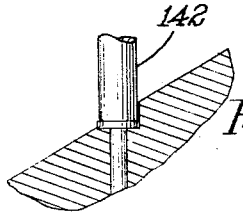

Fig.15

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United States Patent Office

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HAND-HELD AUTOMATIC DEVICES FOR DRIVING HEADED FASTENERS

Donald B. McIlvin, Danvers, Mass., assignor to United Shoe Machinery Corporation, Flemington, N.J., a corporation of New Jersey

Filed May 3, 1954, Ser. No. 427,022

22 Claims. (Cl. 1—18)

The present invention relates to fastener handling and inserting devices and more particularly to such devices having a portable gun for automatically inserting headed fasteners remotely of a fixed supply of fasteners. While the present invention is disclosed as embodied in a pneumatically operated device for automatically inserting headed fasteners, certain of its novel aspects are not limited to automatic inserting devices nor to pneumatically operated devices.

Automatic devices for driving fasteners are broadly well known. Such devices include an inserting gun, usually pneumatically operated, a remote supply of fasteners and means for separating a single fastener and delivering it to the inserting gun in response to the operation of the gun. The supply of fasteners is generally contained in heterogeneous fashion in a fixed hopper. Means are provided for orienting these fasteners in an orderly supply and further means are then provided for separating a single fastener from this oriented supply and introducing it into a delivery tube leading to the inserting gun. Generally, a blast of air assists in carrying the separated fastener along a delivery tube leading to the gun. It is apparent that each of the above described steps must be highly perfected to insure reliable operation of the entire combination and to enable insertion of fasteners in rapid succession.

It has been found that pneumatically operated inserting devices of this type are the most efficient and desirable. It is therefore desirable to have all other elements of the combination pneumatically operated in order to eliminate the expense involved in providing the necessary auxiliary equipment attendant with the provision of more than one energy source. Moreover, it is necessary that compressed air be utilized efficiently in performing all the various functions described above. For example, the means for orienting the fasteners should be intermittently operated and yet must be able to provide a sufficient supply of fasteners to enable rapid operation of the device. Furthermore, the air provided for carrying a separated fastener along the delivery tube should preferably be maintained at a minimum necessary to perform its function. This emphasizes a somewhat unobvious fact that even a small waste in the use of compressed air can render an otherwise practical device commercially unacceptable.

It is an object of the present invention to provide improved fastener handling means which are particularly adapted for use in combination with automatic fastener inserting devices.

It is another object of the present invention to provide in an automatic fastener inserting device improved means for providing a blast of air for carrying a separated fastener to remote portable inserting gun.

More particularly, and in accordance with the various features of the present invention, a hopper is provided for holding a relatively large number of headed fasteners. A lift slide reciprocates within this hopper delivering

fasteners to a slotted raceway. As the fasteners descend the raceway, the fastener body portions or shanks fall freely into the slot so that a supply of fasteners is maintained in the raceway suspended by their heads. At the bottom of the raceway are a presser foot and a reciprocating segment. During the operation of the device the presser foot grips one or more fasteners next above the bottommost fastener in the raceway, allowing the bottommost fastener to fall into a recess formed in the segment. As a feature of the invention the segment is formed of nonferrous material and a magnet is provided which insures that fasteners fall completely into this recess. The segment then moves from this fastener receiving position separating the bottommost fastener and carrying it into alinement with a delivery tube leading to an inserting gun.

The inserting gun is identical in all its features, with the exception of modification in its work engaging nozzle, to the inserting gun disclosed and claimed in my United States Letters Patent No. 2,820,966, granted January 28, 1958. This gun has a casing which is gripped by an operator and a yieldable nose piece which when displaced by engagement with a work piece automatically causes a driving piston and driver to drive a fastener which has temporarily been positioned in the nose piece. When the driver is in its driving position, a signal line connecting the inserting gun and a control valve adjacent the hopper is pressurized. Pressurization of the signal line shifts the control valve from a first to a second position.

The control valve controls a time delay valve and a primary piston. The primary piston controls the movement of the separating segment and the lift slide while the time delay valve controls the flow of air to the delivery tube. When the control valve is in its first position, the separating segment is in a fastener delivering position, the lift slide is in its lowermost position, and the time delay valve controlling the flow of air to the delivery tube is closed, at which time a previously separated fastener is in the nose piece of the inserting gun preparatory to being driven. When the gun is pressed against a work piece and the signal line is pressurized the control valve assumes its second position. Air then flows to the primary piston causing the separating segment to move to a fastener receiving position as the presser foot retains all but the bottommost fastener in the raceway allowing it to drop into the recess in the carrier. At the same time the lift slide is raised to deliver fasteners to the raceway. A closed circuit hydraulic system is provided in which the movement of the primary piston is restricted by flow of oil through an orifice thereby raising the lift slide in a gentle manner to transfer a maximum number of fasteners to the raceway. Also in the second position the time delay valve is opened. However, no air flows through the delivery tube as in the second position of the control valve, that valve blocks such flow. The time delay valve is constructed in such fashion that it is opened by air flowing from the control valve but may be closed only by escape of air through a restricted orifice under the action of an internal spring. Therefore, this valve remains open for a predetermined time after the pressure for opening it has been released. When the gun is rmoved from a work piece the signal line is depressurized and the control valve returns to its first position. The primary piston allows the separating segment to move to a fastener delivering position and the lift slide is lowered. The hydraulic arrangement is such that little or no resistance is offered to this return motion of the primary piston. Since the control valve in its first position allows the flow of air to the delivery tube as soon as the separating carrier is in a fastener delivering posi-

tion a short blast of air will be provided for blowing the fastener through the delivery tube to the inserting device preparatory to a further operation while the time delay valve remains open.

The above and other features of the invention including various novel details of construction and combination of parts will now be more particularly described with reference to the accompanying drawings and pointed out in the claims.

In the drawings,

Fig. 1 is a view in side elevation of the hopper and separating mechanism of the present invention with certain parts broken away and others shown in section for clarity;

Fig. 2 is a view in section of the inserting gun utilized in the present invention;

Fig. 3 is a view in plan of nail releasing elements of the present invention;

Fig. 4 is a section on the line IV—IV of Fig. 3 on an enlarged scale;

Fig. 5 is a section on the line V—V of Fig. 4;

Fig. 6 is a fragmentary view taken along the line VI—VI of Fig. 4 on a reduced scale;

Fig. 7 is a section on the line VII—VII of Fig. 1;

Fig. 8 is a diagrammatic view showing the fluid pressure control system for the present device and its relation to various operating elements;

Fig. 9 is a diagrammatic view showing an optional fluid pressure control system;

Fig. 10 is a vertical section through an inserting gun having a compensating nose piece;

Fig. 11 is a view looking in the direction of the arrow A in Fig. 10 and on an enlarged scale;

Fig. 12 is a section on the line XII—XII in Fig. 11;

Fig. 13 is a view similar to Fig. 12 but with the parts shown in a different working position;

Fig. 14 is a fragmentary view similar to Fig. 12 showing the relationship of the inserting gun driver to a flat headed fastener; and

Fig. 15 is a view similar to Fig. 14 with the driver in a different position.

Referring first to Fig. 1 a hopper **20** for holding a supply of nails or other headed fasteners is provided. This hopper is mounted on a base plate **22** which may be secured to any convenient support. Extending downwardly from the hopper **20** is a raceway **24**. A lift slide **26** is reciprocated within the hopper **20** to deliver nails to the raceway **24**. These nails slide down the raceway in proper orientation to a separating segment **28**. The separating segment has a countersunk slot **30** (Fig. 4) into which the endmost nail drops when the slot is in alinement with the raceway. A presser foot **32** (Fig. 6) grips nails adjacent the bottommost nail to prevent the entry of more than one nail into the slot **30**. This separated nail is then carried by the segment **28** to a point where the recess **30** is in register with a delivery tube **34** (Figs. 5 and 8). At this time a blast of air is provided to deliver the separated nail to an inserting gun **36** connected to the other end of the delivery tube **34** which automatically inserts nails so delivered. The inserting gun **36** may be identical in all features to the inserting gun disclosed and claimed in my above-mentioned patent. This gun is provided with a casing **38** (Fig. 2) which may be gripped by an operator and a nose piece **40** which is displaced against the action of a compression spring **41** upon engagement with a work piece to actuate the inserting device. The inserting gun has two lines **42**, **44** extending from its upper end leading to a relatively fixed point (shown only in Figs. 8 and 9) adjacent the hopper and separating mechanism shown in Fig. 1. The line **42** is at all times connected to a source of pressurized air and the line **44** is connected to valve controls provided for actuating the motions of the lift slide **26** and separating segment **28** upon pressurization of said line during the operation of the inserting gun **36**. Pressurization of the signal line **44** also actuates valve controls which provide a predetermined blast of air to blow a nail through the delivery tube **34** when the recess **30** of the separating segment **28** is in register with the delivery tube thereby delivering a single fastener to positioning means shown as a quill **46** within the nose piece **40** after each operation of the inserting gun **36**.

Three sides and the bottom of the hopper **20** are formed integrally with a cast frame member **48** (Figs. 1 and 7) which is secured to the base plate **22** by four screws **50** (only two of which are shown). The frame **48** is provided with two webs **52** extending from the hopper **20**. Secured to the frame **48** by screws **54** is a bracket **56** having a surface **58** which defines the front of the hopper **20**. The lift slide **26** is formed on a plate **60** which reciprocates within a groove defined by the surface **58** and a vertical track **62** within the frame **48**. A downwardly extending V-shaped track **64** is formed on the upper surface of the lift slide **26** with a slot **66** being provided toward its lower end in which the body portion of a nail may fall thus orienting nails with respect to the head as they slide down the track **64** and when the lift slide **26** is in its upper position onto the raceway **24** in properly oriented condition.

The lower end of the lift slide plate **60** is connected by two links **68** freely mounted on pins **70** and **72** to lifting levers **74**, **76** which in turn are securely attached to a shaft **78** journaled in mounting blocks **80** which are secured to the base plate **22** by screws **82**.

The raceway **24** comprises two spaced bars (Fig. 3) which at their upper ends are mounted by screws **84** to lugs **86** extending from the bracket **56**. The lower end of the raceway is secured by screws **88** to a projection **90** extending from a web **92** which in turn is integral with the bracket **56** (Figs. 1 and 4). The screws **88** also secure a mounting block **94** to which the presser foot **32** is pivotally attached by a screw **96**.

The presser foot **32** has a tail **97** (Fig. 3) extending on the other side of the pivot screw **96** the weight of which normally holds the presser foot above nails within the raceway **24**. The tail **97** extends into the path of movement of the segment **28** (Fig. 6) so that, when the segment **28** is in a fastener receiving position with the countersunk slot **30** in alinement with the raceway, the tail **97** is cammed upwardly by the upper surface of the segment (Figs. 4 and 6) whereby one or two nails in the raceway next above the bottommost nail are retained therein by a resilient pad **99** attached to the presser foot. It will be noted that the action of the presser foot **32** maintains the shanks of the retained nails normal to the plane of the raceway thereby preventing the possibility of more than one nail entering the slot **30**.

The separating segment **28** is preferably formed of aluminum or other nonmagnetic material to facilitate the action of a magnet **103** opposite the slot **30**. The magnet **103**, which is secured to the segment **28** by a cap **101**, assures that the shanks of nails completely enter the slot **30** thereby eliminating the possibility of a jam as the segment is moved from a fastener receiving position to a fastener delivering position.

The separating segment **28** is connected by a web **98** to a hub **100** which is journaled upon a shaft **102** mounted between the web **92** and a second web **104** also integral with the bracket **56**. The mating surfaces **106**, **108** of the separating segment **28** and the projection **90** respectively (Fig. 5) are concentric with the shaft **102**. The lower portion of the separating segment **28** rests upon a supporting surface **110** formed on the web **104**. A lug **112** extends laterally from the web **98** and has extending from its lower end a pin **114** which engages a second pin **116** projecting from a short lever **118** which is integral with the lever **76**. A tension spring **120** acting between a pin **122** extending from the upper surface ofthe lug **112** and the bracket **56** urges the separating segment **28** in a clockwise direction as viewed in Figs. 3 and 5.

Adjacent the upper end of the raceway **24** a clearing finger **124** (Fig. 1) is provided for returning to the hopper **20** any nails which are not properly oriented within the raceway **24**. The finger **124** is mounted by screws **126** to one end of a bell crank **128** journaled on a pin **130** extending between flanges **132** which are integral with the bracket **56**. The other end of the bell crank **128** is pivotally connected by a pin **134** to a downwardly extending link **136** the lower end of which is pivotally connected to a lever **138** secured to the shaft **78**.

The inserting gun **36** includes a two diameter piston **140** (Fig. 2) the lower portion of which has the larger diameter, a driver **142** extending from the lower end of said piston and means including a plurality of passageways **144** for introducing equal air pressure to both ends of the piston. Holes **146** formed in the casing **38** and the yieldably mounted nose piece **40** vent the air pressure on the lower end of the piston to atmosphere when the nose piece **40** is forced against the work piece. When the piston is in its lowermost position the signal line **44** is pressurized through a single passageway **148** communicating with the upper chamber of the gun. Normally the signal line **44** and passageway **148** are vented to atmosphere by way of a reduced portion of the piston **140** and a hole **173** formed in the casing **38**. Pressurization of the signal line **44** actuates control mechanisms which are to be described presently. For further details of construction and operation of the gun **36** reference is made to my above-mentioned patent.

In Fig. 8 the valve control system for the pneumatic operation of the various elements of the present device is diagrammatically shown. As mentioned above, the air supply line **42** is connected directly to a source of pressurized air at all times. The signal line **44** extends to a remote control valve **150** and is arranged when pressurized so that the piston **151** of the control valve is displaced from a first to a second position against the action of a spring **153**. The control valve **150** is likewise connected to a source of compressed air at all times. A line **154** extends from the control valve **150** and has its opposite end secured in a block **155** which is attached to the projection **90** of the bracket **56** (Fig. 1). The line **154** thus communicates with the delivery tube **34** when the separating segment **28** is in a fastener delivering position with the slot **30** in register with the delivery tube **34**. A time delay valve **152** is interposed in the line **154** to permit passage of only a short burst of air through the line **154** and the delivery tube **34**, said burst of air being just sufficient to deliver a separated fastener to the inserting gun **36**. Another line **160** extends from the same port of the control valve **150** as the line **154** and communicates with one end of a piston **158** which is slidably mounted in a cylinder **164** which, at its right hand end (Fig. 1), is pivotally mounted on a shaft **166** extending between lugs **168** secured to the plate **22** by screws **170**. A line **156** extends from a second port in the control valve **150** and communicates with the opposite end of the piston **158**. Also communicating with the second port of the control valve **150** is a line **162** which is adapted to introduce air into the time delay valve **152**. The time delay valve **152** includes a piston **157** which normally prevents flow of air through the line **154** and a one way check valve **194** through which air may be introduced to displace the piston **157** against the action of a spring **159**. When there is no further air being introduced through the valve **194**, the piston **157** remains displaced for a predetermined time as air is metered through a restricted orifice controlled by a screw **196**. The amount of air for delivering a nail to the gun **36** may be maintained at a minimum by proper adjustment of the screw **196**.

A rod **172** extends from the piston **158** and is pivotally connected by a pin **174** to a lever **176** which is fastened to the shaft **78**. Thus with displacement of the piston **158** motion is imparted through rotation of the various levers **176**, **74**, **76**, **118** and **138** to the various operating elements of the hopper and separating mechanism. The control valve **150** and the time delay valve **152** serve no other function than to control the flow of air and for that reason are shown only diagrammatically in Fig. 8. In practice they may be mounted in any convenient manner, preferably adjacent or on the base plate **22**.

The operation of the control valve **150** and its associated mechanism will now be described. For the purpose of this description the various lines extending from the control valve **150** may be termed as follows: first line **156**, second line **160**, third line **154** and fourth line **162**. The piston **151** of the control valve **150** is normally maintained in a first position by the spring **153** when the signal line **44** is depressurized. In this position the second line **160** is pressurized and maintains the piston **158** in its right-hand position as seen in Fig. 8. In this position the lift slide **26** is in its downmost position and the separating segment **28** is in a fastener delivering position with the slot **30** in register with the delivery tube **34**. Also in the first position of the piston **151** the portion of the third line **154** leading to the time delay valve **152** is pressurized. However, said time delay valve prevents flow of air to the delivery tube **34**. When the signal line **44** becomes pressurized when the gun is fired, as explained above and in my above-identified patent, the piston **151** of the valve **150**, which also may be called the master control valve, is displaced to the left against the spring **153**, when viewed as in Fig. 8, whereupon the first line **156** and the fourth line **162**, which are parallel, both connected to the same port in the valve **150**, are simultaneously pressurized from the main air supply line **42** which is maintained constantly pressurized. Also simultaneously, the second line **160** and the upper portion of the third line **154** are vented to atmosphere through the valve **150**. Pressurization of the first line **156** actuates the cylinder **164**, which is also referred to as the operating means, by displacing the piston **158** to its left-hand position thereby rotating the shaft **78** and raising the lift slide **26** to its upper position where it delivers nails to the raceway **24**. Rotation of the shaft **78** also causes the separating segment **28** to be shifted to a fastener receiving position wherein a single fastener drops into the countersunk slot **30**. At this time the clearing finger **124** rotates in a clockwise direction to return to the hopper **20** any nails which fail to fall into the raceway **24**. Simultaneously, the pressurization of the fourth line **162** actuates the supply control valve **152** by displacing the piston **157** to the right against the spring **159** so that there is uninterrupted communication between the master control valve **150** and the delivery tube **34**. Thus the supply control valve **152** is actuated in synchronism with the operating means **164** since the pistons **157** and **158** are moved simultaneously. As explained above, the actuation of the operating means **164** is to operate the separating segment etc., and the actuation of the supply control valve **152** is to open it so as to be ready to permit the passage of air through the line **154** when the same again becomes repressurized in a manner now to be explained. When the inserting gun **36** is removed from a work piece, the spring **41** returns the nosepiece to the position shown in Fig. 2 and the signal line **44** is depressurized by being vented to atmosphere through the hole **173**. The piston **151** of the control valve **150** then assumes its first position venting the first line **156** and the fourth line **162** to atmosphere. At this time, the control valve **150** pressurizes the second line **160** and the third line **154** by placing them in communication with the air supply line **42**. Pressurization of the second line **160** causes the parts, with the exception of the time delay valve **152**, to again assume the positions shown in Fig. 8

wherein the separating segment **28** is in a fastener delivering position. Due to the fact that the piston **157** is not immediately returned to its original position since air must pass through the restricted orifice controlled by the screw **196**, a short burst of air will flow through the third line **154** thereby delivering a separated nail through the delivery tube **34** to the inserting gun **36** where it is held preparatory to the next inserting operation.

Also attached to the pin **174** (Figs. 1 and 8) is a piston rod **178** which extends from a piston **180**. A cylinder **182** in which the piston **180** rides is pivotally mounted on a shaft **184** extending between the webs **52** of the frame **48**. The piston **180** is included with a closed hydraulic circuit which restricts the rate of movement of the piston **158** from its right to left-hand positions thereby causing the lift slide **26** to rise slowly so that fasteners are deposited upon the raceway **24** in a gentle manner thus assuring a delivery of a maximum number of fasteners per cycle to the raceway. The hydraulic circuit is arranged so that little or no restriction is placed upon the opposite motion of the piston **158** so that the downward movement of the lift slide **26** is substantially faster than its upward movement. In this manner the rate of cyclic operation of the separating mechanism and inserting device is greatly increased. To accomplish these ends the hydraulic circuit is provided with two lines **188** which communicate with respective ends of the piston **180** and a check valve **187**. The check valve **187** has a one way valve therein which permits unrestricted flow of fluid as the piston **180** moves to the right under the action of the piston **158** to lower the lift slide **26** and bring the separating segment **28** into a fastener delivering position. The check valve **187** also has a screw **192** which adjustably controls flow of fluid through a restricted orifice whereby the return of flow of oil may be controlled as the piston **180** moves to the left as the piston **158** is pressurized to raise the lift slide **26** and bring the separating segment into a fastener receiving position.

An optional valve control system is shown in Fig. 9. In this arrangement the piston **158** is maintained in its right-hand position by a spring **218** and thus the lift slide **26** is in its lowermost position and the separting segment **28** is in a fastener delivering position. The right-hand end of the piston **158** communicates directly with the signal line **44** through a line **220**, the other end of the piston **158** being vented to atmosphere. A line **222** connects the upper end of the delivery tube **34** to a source of pressurized air when the separating segment **28** is in a fastener delivering position. Flow of air through the line **222** is controlled by two time delay valves **224**, **226** which are of the same general construction as the time delay valve **152** described above with the exception that the time delay valve **224** is normally open. A line **228** provides communication between the signal line **44** and the valves **224** and **226**.

In operation, the signal line **44** is pressurized when the inserting gun **36** is pressed against a work piece, pressurized air flowing through the passageway **148** when the piston **140** is in its lowest position. It will be noted that the signal line **44** remains pressurized so long as the gun **36** remains in engagement with a work piece and for a further period as the piston **140** travels upwardly and until the passageway **148** is vented to atmosphere through the hole **123**. Pressurization of the signal line **44** causes the piston **158** to move to the left against the action of the above-described hydraulic system whereby the lift slide **26** is raised gently and the separating segment **28** moves to a fastener-receiving position. Pressurization of the signal line **44** causes the valve **224** to close thereby preventing flow of air through the line **222** as the valve **226** is opened. When the signal line **44** is depressurized, the piston **158** returns to the position shown in Fig. 9 under the action of the spring **218** (the hydraulic system provides no restriction to this movement) thereby lowering the lift slide **26** and bringing the separating segment to a fastener delivering position. The valve **226** remains open for a substantial period as the air which caused its displacement is metered through an orifice controlled by a screw **230**. Likewise the valve **224** remains closed for a predetermined time as air which caused its displacement is metered through an orifice controlled by a screw **232**. The screw **232** is adjusted so that the valve **224** will open precisely at the time when the slot **30** is in register with the delivery tube **34**. The screw **230** is adjusted so that the valve **226** will remain open only long enough to provide the minimum amount of air necessary to blow a separated fastener along the delivery tube **34** to the inserting gun **36**. A description of the fastener driving mechanism, employing the optional valve system of Fig. 9, through a complete cycle of operation appears hereinafter.

The nose piece **40** of the inserting gun **36** may be modified to provide a compensating work-engaging member **198**, best seen in Figs. 10 through 15. The nose piece **40** is provided with a cylindrical nozzle **200** attached to its lower end by a snap ring **202**. The work engaging member **198** is shown as a cylindrical segment for reasons that will further appear. The lower end of the nozzle **200** is provided with a seat **203** formed on the same radius as the cylindrical section of the member **198**, said member being held in engagement with said seat by two springs **204** which extend between pins **206**, **208** extending from the nozzle **200** and member **198** respectively. The member **198** is provided with flanges **210** which prevent sidewise displacement of the member with respect to the nozzle **200**. The springs **204** also act as centering springs to maintain the bottom work-engaging surface of the member **198** in a plane normal to the direction of movement of the driver **142**. The member **198** is also provided with a slot or passageway **212** which permits the passage of the driver **142** to drive nails positioned in the quill **46**.

It is to be noted that the center about which the cylindrical surface of the member **198** is formed is located a substantial distance below its bottom or work-engaging surface. The lower end of the driver has a fixed relationship with any point on the nozzle or nose piece each time it is driven, its motion being limited by engagement of a shock absorbing pad **214** on the bottom of the piston **140** with a cap **216** threaded into the lower end of the casing **38**. In normal operation the length of the driver is adjusted so that heads of fastenings are driven flush with the surface of a work piece when they are driven in a plane normal to the surface of the work piece as is seen in Figs. 12 and 14. The compensating member **198** enables fasteners to be driven into work pieces on an angle as is seen in Figs. 13 and 15. Due to the fact that the center of the cylindrical segment is beneath the surface of the work piece when the member **198** is in engagement therewith, the lower portion of the driver extends below the surface of the work piece and its upper surface is flush or substantially flush with the surface so that the heads of nails either round headed or flat are driven into the work piece in such a manner that their uppermost portions are either flush or substantially flush with the surface of the work piece regardless of the angle at which they are driven.

While the member **198** is hereby disclosed as a cylindrical segment, it is also possible to form it in substantially the same manner from a spherical segment. When formed from a spherical segment, the compensating member would provide a further advantage in being wholly universal. That is, nails could be driven on any angle (within its intended limits) in any plane. However, the cylindrical segment herein disclosed has been found to provide sufficient versatility and is felt to be preferable in view of its cheaper cost of manufacture. The compensating nose piece is not claimed herein but forms the subject matter of my divisional application Serial No. 574,409, filed

March 28, 1956, now United States Letters Patent No. 2,851,689, granted September 16, 1958.

Description of operation

The inserting gun **36** is ready to drive a fastener when its parts are in the position shown in Figs. 2 and 8. The various elements of the fastener delivering mechanism are likewise ready to deliver a fastener to the gun when they occupy the positions shown in Fig. 8. With the parts thus positioned the air supply line **42** is pressurized and equal air pressure is communicated to both ends of the driving piston **140**. The larger area on the lower end of the driving piston results in a greater force being applied to the lower end of the piston thereby maintaining the driver in an upper position in readiness to drive a fastener. A fastener is positioned in the nose piece **40** of the gun as a result of previous operation of the gun. With the parts positioned as shown in Fig. 8 the signal line **44** is depressurized, being vented to atmosphere through the passageway **148**, a reduced portion of the driving piston **140** and the hole **173**. The spool **151** of the control valve **150** is in its right-hand position providing communication between the source **42** of compressed air and the lines **154** and **160**, the lines **156** and **162** at this time being vented to atmosphere through the control valve **150**. Free passage of air through the line **154** is prevented by the time delay valve **152**, while pressurization of the line **160** causes the piston **158** of the air motor **164** to be maintained in its right-hand position. The lift slide **26** which is controlled by the air motor **164** is in its lowermost position while the separating segment **28** which is also controlled by the air motor **164** is in its extreme clockwise position with the slot **30** in a fastener delivering position in register with the line **154** and the delivery tube **34**. The presser foot **32** is lifted above the raceway **24** by the weight of its outwardly extending tail **97** allowing nails in the raceway to slide against the inner surface of the segment **28**.

With the gun and the fastener delivery mechanism in its ready condition describe above, an operator may insert the fastener positioned in the nose piece **40** of the gun in the following manner. The gun is grasped by its casing **38** and the yieldable nose piece pressed against a work piece thereby bringing the passageways **146** formed in the gun and the nose piece into communication so that the lower chamber of the gun **36** is vented to atmosphere. The pressure acting upon the upper end of the driving piston **140** then moves the driving piston downwardly with an explosive force to insert the fastener positioned in the nose piece. When the driving piston **140** is in its lowermost position, the top of the piston **140** comes to rest below the passageway **148** thus placing the passageway **148** under pressure from the upper chamber of the gun. In this manner the signal line **44** becomes pressurized. The air pressure in the signal line **44** displaces the spool **151** of the control valve **150** to its left-hand position. In this last mentioned position of the spool **151** the lines **154** and **160** are vented to atmosphere while the lines **156**, **162** are pressurized by being placed in communication with the source of pressurized air. Pressurization of the line **162** displaces the spool **157** of the time delay valve **152** to its right-hand or open position. Pressurization of the line **156** in combination with the venting of the line **160** causes the piston **158** to be displaced to its left-hand position. In response to the leftward movement of the piston **158** the levers **74**, **76** and **118** are rotated in a clockwise direction. Rotation of the levers **74**, **76** raises the lift slide **26** delivering a supply of nails to the raceway **24**. Rotation of the lever **118** causes the separating segment **28** to be moved in a counterclockwise direction to bring the slot **30** into a fastener receiving position in alinement with the end of the raceway. During the final movement of the segment **28** the presser foot **32** is brought into engagement with the next to the last fastener in the raceway **24** by engagement of the separating segment **28** with the tail **97** formed on said presser foot. Thus, the last nail in the raceway will fall into the countersunk slot **32**. The leftward movement of the piston **158** is controlled by the hydraulic arrangement which includes the piston **180** with oil being metered through the orifice controlled by the screw **192** during this leftward movement. Control of this movement is effected primarily to enable the gentle transfer of nails from the lift slide **26** to the raceway **24**. The operating condition of the present system will be maintained so long as the nose piece **40** of the inserting gun **36** is depressed against a work piece in the manner described above. When the inserting gun is removed from the work piece pressurized air is again introduced against the lower end of the driving piston **140** through the passageway **144** and due to the larger diameter of the lower portion of the driving piston said driving piston is displaced upwardly to its ready position. The signal line **44** remains pressurized until the final upward movement of the driving piston is substantially completed at which time said signal line is vented to atmosphere through passageways **148** and **173** as described above. The control valve **150** again assumes its ready position shown in Fig. 8 under the action of the spring **153**. The lines **156** and **162** are again vented to atmosphere while the lines **154**, **160** are pressurized. Pressurization of the line **160** causes the piston **158** to move to its right-hand position and the elements controlled thereby, namely the lift slide **26** and the separating segment **28**, also assume their ready positions as shown in Fig. 8. The time delay valve **152** does not close immediately upon depressurization of the line **162** as the air which has displaced it must be metered past the screw **196**. Therefore, for a controlled period air will flow through the line **154** and through the delivery tube **34** after the separating segment **28** has been returned to its fastener delivering position under the action of the spring **120**. Thus, the air flowing through the line **154** and the delivery tube **34** will carry the fastener transferred by the slot **30** to positioning means in the nose piece **40** preparatory to the next inserting operation.

The operation of the alternate construction shown in Fig. 9 is quite similar to what is described above; however, the single time delay valve **152** has been replaced by two time delay valves and the control valve **150** has been eliminated. In the ready position of the device shown in Fig. 9 the air supply line **42** is pressurized and the driving piston **140** is in its upper position. The signal line **44** is depressurized. The lift slide **26** is in its downmost position while the segment **28** is in its clockwise position with the slot **30** in a fastener delivering position. The preceding is merely a brief résumé of conditions which were more fully described above. The gun **36** is again operated depressing the nose piece **40** against a work piece causing the driving piston to move downwardly and insert a previously positioned fastener. When the driver piston is in its downmost position its signal line **44** becomes pressurized in the same manner as described above. The air pressure in the signal line **44** passes through the line **220** displacing the piston **158** to its left-hand position. The levers **74**, **76** and **118** are thereby rotated in a clockwise direction to move the lift slide into alinement with the raceway **24** and the separating segment **28** into a fastener receiving position. The hydraulic unit again retards the leftward movement of the piston **158**. Pressurization of of the signal line **44** also causes pressurization of the line **228** which in turn displaces the two time delay valves to their right-hand positions in which the valve **224** prevents flow of air through the line **222** while the valve **226** is open. After the inserting operation is completed the gun **36** is removed from the work piece and the driver piston again moves to its upper position thereby venting the signal line **44** and the lines **220** and **228** to atmosphere through the hole **173**. The mechanism controlled by the piston **158** is returned to its ready position under the action of the spring **218**. Air will now flow through the

line 222 to deliver a fastener carried by the slot 30 in the separating segment 28 after the slot has been brought into register with the line 222 and the delivery tube 34 in the following manner. The time delay valve 224 opens almost immediately after the line 228 is depressurized, the time delay period being adjusted so as to be substantially equal to the time necessary for the operating segment 28 to move from a fastener receiving position to a fastener delivering position. The time delay valve 226 remains open for a substantially greater period of time which is sufficient to allow enough air to pass along the line 222 to carry the fastener through the delivery tube 34 to the positioning means in the nose piece 40 of the inserting gun 36. In this manner it is also possible to deliver fasteners in this type of device through the use of a minimum amount of air.

Having thus described my invention what I claim as new and desire to secure by Letters Patent of the United States is:

1. In a fastener handling device the combination of a hopper for holding a supply of fasteners, a downwardly extending track associated with said hopper, a lift slide for delivering fasteners to said track, pneumatic means for cyclically reciprocating said slide and means for causing upward movement of said slide to be substantially slower than its downward movement.

2. In a fastener handling device the combination of a hopper for holding a supply of fasteners, a downwardly extending track associated with said hopper, a lift slide for delivering fasteners to said track, pneumatic means for cyclically reciprocating said slide and hydraulic means for restricting the rate of said reciprocating means in a direction causing upward movement of said slide whereby said lift slide delivers fasteners to said track in a gentle manner.

3. A fastener handling and inserting device having, in combination, an inserting gun, a hopper for holding a supply of fasteners, a downwardly extending track associated with said hopper, a lift slide for delivering fasteners to said track, pneumatic means for cyclically reciprocating said slide in response to operation of said gun, means for causing upward movement of said lift slide to be substantially slower than its downward movement and means associated with said track for automatically delivering one fastener at a time to said gun.

4. A fastener handling and inserting device having, in combination, an inserting gun, a hopper for holding a supply of fasteners, a downwardly extending track associated with said hopper, a lift slide for delivering fasteners to said track, pneumatic means for cyclically reciprocating said slide in response to operation of said gun, hydraulic means for restricting the rate of said reciprocating means in a direction causing upward movement of said lift slide whereby said lift slide delivers fasteners to said track in a gentle manner and means associated with said track for automatically delivering one fastener at a time to said gun.

5. A fastener handling and inserting device having, in combination, an inserting gun, a hopper for holding a supply of fasteners, a downwardly extending track associated with said hopper, a lift slide for delivering fasteners to said track, a pneumatically operated piston for cyclically reciprocating said slide, a control valve operated in response to operation of said gun for controlling flow of air to said piston in such manner that the lift slide is reciprocated each time the gun is operated, a closed hydraulic circuit effective on said piston to restrict its movement in a direction causing upward movement of said lift slide whereby the lift slide is raised slowly to deliver the fasteners to said track in a gentle manner, and means associated with said track for automatically delivering one fastener at a time to said gun.

6. In an automatic fastener inserting device the combination of a power operated inserting gun, means for holding a supply of fasteners, a delivery tube adjacent said supply which extends to said gun, means for delivering a single fastener to said delivery tube, valve means operative in response to each operation of said gun for actuating said delivering means, and a time delay valve operative in response to operation of said valve means for providing a short blast of air to carry the fastener along said delivery tube to said gun after it has been delivered by said delivering means.

7. In an automatic fastener inserting device the combination of a power operated inserting gun, means for holding a supply of fasteners, a delivery tube adjacent the supply which extends to said gun, means for delivering a single fastener to said delivery tube in response to each operation of said gun, a line connecting said delivery tube to a source of pressurized air, a time delay valve interposed in said line which normally prevents flow of air to said delivery tube, a control valve having a first position allowing passage of air along said line to said time delay valve and a second position in which flow of air to said line is prevented and in which said time delay valve is opened, means responsive to the operation of said gun for moving said control valve between its first and second positions each time the gun is operated, and means within said time delay valve for maintaining it open for a short period after said control valve moves from its second to its first position thereby providing a short blast of air to carry a fastener in said delivery tube to the inserting gun.

8. In an automatic fastener inserting device the combination of a pneumatically operated inserting gun, means for holding a supply of fasteners, a delivery tube adjacent the supply which extends to said gun, means for delivering a single fastener to said delivery tube in response to each operation of said gun, a line connecting said delivery tube to a source of pressurized air, a time delay valve interposed in said line which normally prevents flow of air to said delivery tube, a control valve having a first position allowing passage of air along said line to said time delay valve and a second position in which flow of air to said line is prevented and in which said time delay valve is opened, spring means for normally maintaining said control valve in one of its positions, a signal line connecting said control valve and said inserting gun, means within said gun for pressurizing the signal line during the operation of said gun whereby the control valve is moved to an alternate position each time the gun is operated, and means within said time delay valve for maintaining it open for a short period after said control valve moves from its second to its first position thereby providing a short blast of air to carry a fastener in said delivery tube to the inserting gun.

9. In an automatic fastener inserting device the combination of a pneumatically operated inserting gun, means for holding a supply of fasteners, a delivery tube adjacent the supply which extends to said gun, means for delivering a single fastener to said delivery tube in response to each operation of said gun, a line connecting said delivery tube to a source of pressurized air, a first and a second time delay valve interposed in said line, said first valve being normally open and said second valve being normally closed, said first valve having a shorter delay period than said second valve, and means responsive to the operation of said gun for actuating said valves.

10. The device defined in claim 9 in which the means for actuating the time delay valves comprises a signal line interconnecting each of said valves and the inserting gun and which is pressurized during the operation of the gun.

11. A fastener handling and inserting device having, in combination, an inserting gun, a hopper for holding a supply of fasteners, a downwardly extending track associated with said hopper, a lift slide for delivering fasteners to said track, a pneumatically operated piston for reciprocating said lift slide, a delivery tube adjacent said track which extends to said inserting gun, a separating member arranged to be moved by said piston between a

fastener receiving position at the lower end of said raceway and a fastener delivering position in register with said delivery tube, a control valve connected to a source of pressurized air, a first line extending from said control valve to one end of said piston, a second line extending from said control valve to the other end of said piston, a third line extending from said control valve to said delivery tube, a normally closed time delay valve interposed in said third line, a fourth line communicating with the control valve through which air may pass to actuate said time delay valve, said control valve having a first position in which pressurized air may pass through said second and third lines and a second position in which pressurized air may pass through said first and fourth lines, a signal line extending between said control valve and said inserting gun which is adapted to admit pressurized air for moving said control valve from its first to its second position, means for normally maintaining said control valve in its first position and means within said inserting gun for pressurizing said signal line during the operation of the gun.

12. The device defined in claim 11 in which a closed hydraulic circuit is provided, said circuit being effective on said piston to restrict its movement in a direction causing upward movement of said lift slide whereby the lift slide is raised slowly to deliver fasteners to said track in a gentle manner.

13. A fastener handling and inserting device having, in combination, an inserting gun, a hopper for holding a supply of fasteners, a downwardly extending track associated with said hopper, a lift slide for delivering fasteners to said track, a pneumatically operated piston for reciprocating said lift slide, a delivery tube adjacent said track which extends to said inserting gun, a separating member arranged to be moved by said piston between a fastener receiving position at the lower end of said track and a fastener delivering position in register with said delivery tube, spring means for normally maintaining said piston in a first position wherein the lift slide is in its downward position and the separating member is in a fastener delivering position, a signal line extending from said gun to a point adjacent said piston, means within said inserting gun for pressurizing said signal line during the operation of the gun, a first line which places one end of said piston in communication with said signal line wher whereby when said signal line is pressurized the piston is moved from a first to a second position, a second line connecting said delivery tube to a source of pressurized air, a first time delay valve which is normally open and which is interposed in said second line, a second time delay valve which is normally closed and which is interposed in said second line, said second valve being nearest to the delivery tube, a line connecting both time delay valves to said signal line whereby when said signal line is pressurized said first valve is closed and said second valve is opened, the time delay of said first valve being substantially shorter than the time delay of said second valve thereby providing a short blast of air for delivering a separated fastener along the delivery tube to the inserting gun each time the gun is operated.

14. The device defined in claim 13 in which a closed hydraulic circuit is provided, said circuit being effective on said piston to restrict its movement in a direction causing upward movement of said lift slide whereby the lift slide is raised slowly to deliver fasteners to said track in a gentle manner.

15. A fastener handling and inserting device having, in combination, an inserting gun, a hopper for holding a supply of fasteners, a downwardly extending track associated with said hopper, means for orienting fasteners in said track, a delivery tube adjacent said track which extends to said inserting gun, a separating member, means for moving said separating member between a fastener receiving position at the bottom of said track and a fastener delivering position in register with said delivery tube in response to operation of said gun, a slot in said separating member into which the bottommost fastener may fall when the separating member is in a fastener receiving position, and magnetic means for insuring that each bottommost fastener completely enters said slot.

16. The inserting device defined in claim 15 in which retaining means are provided for gripping the next to the bottommost fastener in said track when the separating member is in a fastener receiving position.

17. In a fastener handling device the combination of an inserting gun, a hopper for holding a supply of fasteners, a downwardly extending track associated with said hopper, means for orienting fasteners in said track, a delivery tube adjacent said track, a separating member, means for moving said separating member between a fastener receiving position at the bottom of said track and a fastener delivering position in register with said delivery tube, a slot in said separating member into which the bottommost fastener may fall when the separating member is in a fastener receiving position, magnetic means for insuring that each bottommost fastener completely enters said slot.

18. A fastener handling device as defined in claim 17 in which retaining means are provided for gripping the next to the bottommost fastener in said track when the separating member is in a fastener receiving position.

19. A fastener handling and inserting device having, in combination, a fastener inserting driver, a hopper for holding a supply of fasteners, a downwardly inclined track extending from said hopper, means for orienting fasteners in said track, a delivery tube in proximity to the lower end of said track for receiving a fastener, said delivering tube communicating with the driver, a fastener separating member adjacent the lower end of said track for separating the endmost fastener therefrom and for moving said fastener into register with said delivery tube, said separating member including a longitudinal slot into which the endmost fastener may fall when separated, and magnetic means for insuring that each fastener when separated completely enters said slot and is maintained by magnetic force so that the longitudinal axis of the fastener extends substantially in the direction of the axis of the slot.

20. The fastener handling and inserting device defined in claim 19 wherein the material of the separator member bounding said slot is nonmagnetic, and said magnetic means is disposed adjacent the bottom of the track but spaced therefrom by said nonmagnetic material.

21. A fastener feeding and driving mechanism having a driving tool, a fastener container, a passage for carrying fasteners from the fastener container to the driving tool, said passage comprising a track and a delivery tube, means for introducing fasteners from the fastener container into the track portion of said passage, means associated with said track for feeding the fasteners one at a time through the delivery tube to the tool, and means for operating the fastener introducing means and the fastener feeding means in predetermined timed relationship characterized by the provision of a pressurized fluid circuit having a connection to the driving tool for actuating said tool, a connection to the operating means for actuating said operating means, a connection to the delivery tube for chasing the fasteners through the delivery tube to the tool, a master control valve for controlling fluid pressure in the connection to the operating means and a supply control valve in the connection to the delivery tube actuated in predetermined timed relationship with the operating means.

22. A fastener feeding and driving mechanism having a driving tool, a fastener container, means for actuating the driving tool, a passage for carrying fasteners from the fastener container to the driving tool, said passage comprising a track and a delivery tube, means for introducing fasteners from the fastener container into the track portion of the passage, means associated with the track for feeding the fasteners one at a time through the delivery

tube to the tool, and means for operating the fastener introducing means and the fastener feeding means in predetermined timed relationship characterized by the provision of a pressurized fluid circuit having a connection to the operating means for actuating said operating means, a connection to the delivery tube for chasing fasteners through the delivery tube to the tool, a master control valve for controlling fluid pressure in the connection to the operating means and a supply control valve in the connection to the delivery tube actuated in predetermined timed relationship with the operating means.

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