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STAPLING MACHINE

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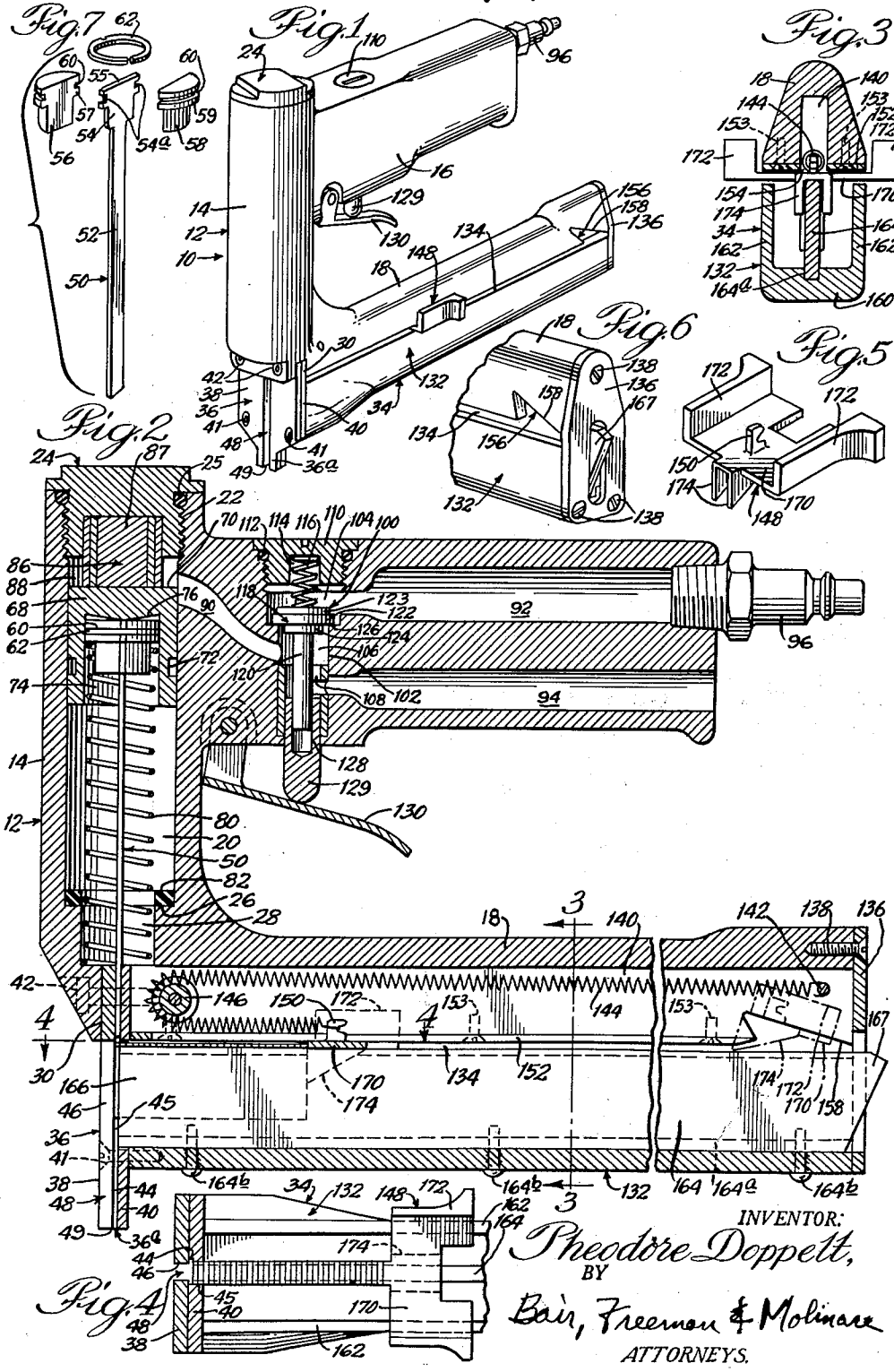

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STAPLING MACHINE

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This invention relates to a stapling machine and more particularly to a powerful lightweight stapling gun of an improved construction.

Stapling machines have been widely used to drive staples into various materials in order to hold them together. The stapling machines or tackers heretofore constructed, and in particular the compressed-air powered hand carried stapling machines or guns have had certain drawbacks. First of all they are rather inefficient and when they are powered by the usual portable air compressor, for example such as a ½ H.P. compressor, they could be fired at high speed only a limited number of times, e.g. 18–35 times, before the compressor would fail to supply sufficient air to maintain rapid operation. Obviously, this limits the speed of use of such a device and heretofore the deficiency could only be overcome by using larger, heavier, and more expensive air compressors that provide a larger volume of compressed air.

In addition, when prior air powered stapling machines have been used to drive staples into relatively hard materials such as Masonite, or wood panels, the resistance of the material to staple penetration has often caused the staple being driven to fail to be driven flush, or to jam the machine. This was at least in part due to fluctuations in the pressure of the compressed air supplied by the air compressor, or due to failure of the staple driver to effect proper engagement with the staple, or due to failure of the staple driver to deliver sufficient staple-driving force. Whenever this happens the progress of the work is slowed and the cost of labor is increased.

Another difficulty encountered with prior air-powered stapling machines is the recoil and vibration produced by the recoil of the staple-driving mechanism. This recoil and vibration has frequently resulted in fatigue and loss of efficiency of the worker.

Additionally, stapling operations often require the use of staples of different size and made from different gauge wire. Prior stapling machines have had limited effectiveness in driving staples of different sizes, and it is often necessary to utilize separate stapling machines for different range of sizes of staples being used. This is objectionably expensive.

Still another problem existing with prior air-powered stapling machines lies in the fact that there is frequent mechanical failure between the head and plunger of the staple-driving means. It has been observed that such failures have been caused by a pivotal connection between these parts which occasionally permitted the piston in the stapling machine to exert force on the plunger head at an angle relative to the plunger shank. This causes sufficient strain in the pivotal connection to eventually result in a mechanical fracture.

Another problem with prior stapling machines has been the undesirable leakage of compressed air between the air inlet passageway and the air outlet passageway when the control valve is operated. This wasted air additionally constitutes one of the reasons why the prior stapling machines could not be used at a high rate of speed when powered by a conventional portable ½ H.P. air compressor.

Thus, it is one object of this invention to provide a stapling machine which is more powerful than other stapling machines of comparable size and which does not jam regardless of the hardness of the material through which the staple is being driven.

A further object of this invention is to provide a stapling machine which drives a staple with a generally uniform driving force regardless of fluctuations in the air pressure delivered from the air compressor.

Another object of this invention is to provide a more powerful stapling machine which can fire staples practically continuously at high speed even though powered by a small ½ H.P. portable air compressor.

A further object of this invention is to provide a more durable stapling machine which has a small piston recoil and low vibration.

Still a further object of this invention is to provide a more powerful air-powered stapling machine which has a small piston stroke, resulting in decreased wear between the walls of the piston and the cylinder.

Yet another object of this invention is to provide a versatile stapling machine which is adapted to effectively drive a relatively large range of staple sizes.

And still another object of this invention is to provide a staple driving mechanism that is provided with a novel drive means which is actuated during a staple driving operation only after a predetermined driving force has first been established in the mechanism, whereby more effective operation of the stapling device is obtained.

And still a further object of this invention is to provide a staple driving mechanism that obviates the problems of mechanical failure and jamming heretofore encountered in other staple driving machines.

Another object of this invention is to provide an improved construction for a staple gun which is characterized by simplicity of construction and by replaceability of worn parts, thereby providing for simple repair of damaged staple guns without discarding of undamaged parts.

Further objects and advantages of this invention will become apparent as the following description proceeds and the features of novelty which characterize this invention will be pointed out with particularity in the claims annexed to and forming part of this application.

A preferred embodiment of the invention is shown in the accompanying drawings in which:

FIG. 1 is a perspective view of the improved stapling machine.

FIG. 2 is a vertical cross-section view taken centrally of the stapling machine shown in FIG. 1.

FIG. 3 is a cross-section view taken on the lines 3—3 of FIG. 2.

FIG. 4 is a cross-section view taken on the line 4—4 of FIG. 2.

FIG. 5 is a perspective view of the staple pusher.

FIG. 6 is a reduced perspective view of the extended end of the staple magazine.

FIG. 7 is an exploded fragmentary perspective view of the head of the plunger.

Referring now to the drawings, there is shown in FIG. 1, a perspective view of the stapling machine generally indicated at **10**, and comprising a housing indicated at **12** that includes a body portion **14**, an integrally attached transversely extending handle **16**, and an integrally attached and transversely extending part **18** that is spaced from handle **16**.

The body **14** of the housing **12** is provided internally with a cylindrical bore **20**. The wall of bore **20** adjacent the upper end thereof is threaded at **22**. A removable cap **24** carrying a sealing O-ring **25** cooperates with threads **22** to close off the upper end of the cylinder and to provide an air-tight seal. At the lower end of the cylindrical bore **20** there is provided an annular abutment shoulder, or base, **26** having a counterbore **28** centrally thereof which communicates with an elongated, diametrically disposed slot, or recess, **30** that opens outwardly of body **14**. Since the slot is, in its narrow di-

mension, of lesser width than bore **28**, the adjacent portions of the body **14** provides abutment surfaces for receiving plates **38** and **40** thereagainst.

The stapling machine **10** includes a magazine, indicated at **34**, which is sub-assembled as a unit for connection to the body **14**. The sub-assembly **34** includes a nose or plunger-and-staple guideway means **36** that is positioned in slot **30**. The plunger-and-staple guideway means **36** itself is a replaceable unit that is formed from two flat plate member **38** and **40** that are detachably held together by a first pair of screws **41** and a second pair of screws **42**. The second pair of screws also connect to the body **14** on opposite sides of slot **30**, and thereby serve as part of the means for securing sub-assembly **34** to body **14**.

The plate **40** is provided with a centrally positioned straight groove **44** which is channel shaped in cross section. An intermediate portion of the base of the groove **44** is cut away to form an opening **45** through which staples may be fed into groove **44**. Plate **38** is provided with a straight slot **46** of leaser width than groove **44** extending from the lower edge of plate **38** but terminating short of the top edge. The plate members **38** and **40** are removably held together to define plunger and staple guideway means with slot **46** centrally aligned with groove **44** so that portions of plate **38** overlie groove **44**, thereby defining a staple restraining guideway **48**. As seen in FIG. 4, the guideway is T-shaped in cross section with an open staple ejecting end **49**. The staples to be used are of a width greater than slot **46** so that the staple will always be properly positioned in the staple guideway means. With the foregoing arrangement, if there is wear in any one of the plates forming the jaw portion **36**, there is required only the replacement of the worn plate so that the unworn parts can still be used. In addition, as seen in FIG. 1, the lower parts of the plate members are reduced in width to form a comparatively narrow chin **36***a* which helps position the stapling machine on the work.

A plunger blade **50** is provided. The plunger blade is economically stamped from flat sheet metal and comprises a shank portion **52** and an enlarged integral head portion **54** with a straight upper edge **55**. The shank portion **52** of plunger **50** is slidably mounted in the plunger and staple guideway **48** and is positioned above and in registry with any staple therein, as seen in FIG. 2. The head portion **54** has cylindrical blade holding means releasably secured thereto in the form of a pair of semi-cylindrical blade holding parts **56** and **58**, having radially enlarged grooved flanges **57** and **59** that together define a peripheral groove **60** for receiving therein a split retaining ring **62**. The head **54** of the plunger blade is provided with notches **54***a* on opposite edges for register with groove **60**. The ring **62** thus operates to secure the parts to **56** and **58** to the plunger head **54**. The size of parts **56** and **58** is such that they do not overlie the upper edge **55** of head **54**, whereby exposing said edge **55** for cooperation with a plunger driving piston.

A piston **68** is mounted in bore **20** for slidable reciprocatory movement therein. The side surfaces of the piston are generally cylindrical, and in the embodiment its upper surface **70** is generally planar, although this is not a necessary condition. The fit between the sides of the piston and the cylinder is close enough to generally prevent the passage of air therebetween, but should prolonged use of the stapling machine result in wear which impairs the proper fit, a spring biased compression ring (not shown) may be inserted in the peripheral groove **72**, that is provided piston **68**, to restore the proper fit.

The underside of piston **68** is provided with a central recess **74** the bottom wall **76** of which is convex to provide substantially one point direct contact between the center of the top edge **55** of the head **54** and the center or apex of the convex wall **76**. It will be understood that the blade holding parts **56** and **58** cooperate with the cylindrical walls of recess **74** to properly position the plunger blade so that edge **55** of head **54** engages the apex of the convex wall **76**, as shown in FIG. 2. This arrangement is important because it obviates the use of a pivotal connection between the plunger shank and the plunger head which heretofore has been the frequent cause of mechanical failures in other stapling machines.

A coil spring **80** is mounted in bore **20** with one end pressing against the underside of flanges **57** and **59** and the other end entering bore **28** and seating against a portion of body **14** so as to normally bias piston **68** to its retracted position shown in FIG. 2. This arrangement effectively couples plunger blade **50** with piston **68** so movement of the piston **68** in bore **20** causes a corresponding movement of the shank **52** of the plunger blade **50** in the staple and plunger guideway **48**. When piston **68** moves downwardly, the spring **80** is compressed. Then when the force urging the piston down is removed, the energy stored in the compressed spring helps return the piston to its retracted position. The spring **80** is a light one and provides just enough force to restore the piston **68** to a position adjacent the closed end of bore **20**. A washer **82**, formed from rubber or some similar resilient material, is seated on the shoulder **26** and acts as a bumper to absorb the impact of the moving piston **68** at the bottom of its stroke.

The cap **24** has a boss **86** thereon which extends concentrically into the bore **20** in spaced relation to the walls of bore **20** to define an annular space, or gas chamber, **88** between boss **86** and the walls of bore **20**. Magnetic means are provided between the boss **86** and piston **68**, the one being a magnet and the other of magnetizable material. In the preferred embodiment a magnet **87** is provided in boss **86**, and the piston **68** is formed from a magnetizable material. When the piston is in its retracted position with its top surface **70** engaging the adjacent surface of magnet **87**, the piston is held in that position by magnetic attraction.

A conduit **90** is provided in handle **16** which opens into the side of gas chamber **88** above piston **68** when it is in retracted position, as shown in FIG. 2. When air under pressure enters chamber **88** from conduit **90** it exerts a force on the piston **68** that tends to move the piston along bore **20**. Actually, however, there is no movement of piston **68** until after the air pressure in chamber **88** rises to a level where it exerts a force on the piston sufficient to break the magnetic attraction between the magnet **87** and the piston **68**. When this happens, the piston **68** moves downwardly in bore **20** with what could be termed explosive force. Since piston **68** is coupled with plunger **50**, this movement of piston **68** produces a corresponding movement of the plunger. This is important because any staple in guideway **48** will then be driven toward the staple ejecting end **49** by the almost explosive force so it can penetrate harder materials than has been heretofore possible.

Additionally, the driving force of the piston **68** and the plunger **50** is so great that even when the staples are driven against an impenetrable material such as steel, the legs of the staples may crumble, but the staple will not jam in the guideway **48**. It is also noted that since a pre-determined force must exist in chamber **88** before piston **68** moves, the driving force on the staple is generally uniform and is independent of fluctuations in the air pressure output of the air compressor because if the output of the air compressor is so low that the pressure in chamber **88** does not reach the proper level the stapling machine simply won't operate. In contrast, when staples driven by prior stapling machines were directed against such hard materials as ceiling tile or wall paneling, sometimes the staples would penetrate the material, and sometimes they wouldn't, depending on the magnitude of the air pressure from the air compressor.

It is apparent that other modifications of this disclosed embodiment are possible. For example, the magnet could be secured to the top surface **70** of piston **68** and the base portion of cap **24** could be formed from magnet-

izable material. Alternatively magnets could be inserted in the inner walls of the cylinder to grip the side surfaces of the piston. In addition, a magnet could be attached both to the top surface **70** of the piston **68** and the bottom surface of the cap **24** to further increase the magnetic force holding the piston in its retracted position. It is also apparent that many other structural variations are available for delaying the movement of the piston until the pressure builds up to a desired value.

However there is a particular advantage in using magnetic means for holding the piston in its retracted position where the direction of magnetic attraction is axial, because with this arrangement, the coil spring **80** only has to be strong enough to lift the piston **68** to the vicinity of the magnet and the magnetic force will lift the piston the rest of the way. This means that the spring **80** may be weaker and consequently less energy will be used and lost in compressing it. This results in lower energy requirements from the air compressor which powers the stapling machine.

In particular, it has been found that with a magnetic retaining force of 9 lbs., and with chamber **88** having a volume of about 1/10 of the total expanded gas chamber volume when piston **68** is in its forward position, the stapling machine **10** may be fired as rapidly as possible for an almost indefinite period without exhausting the air supply from a small ½ H.P. air compressor, which is a size typically used in a portable operation. Furthermore, it has been observed that such a machine has very little recoil force and vibration so that the stapling machine can be used for long periods without causing fatigue.

As best seen in FIG. 2, the handle **16** on body **14** is provided with a high pressure air inlet pasageway **92** and a parallel air outlet passageway **94**. A conventional snap coupling hose connector **96** is screwed into the threaded end of inlet **92** and is adapted to be connected to the hose from an air compressor. The opposite end of the inlet **92** is arranged to communicate with conduit **90** through a valve means indicated generally at **100**.

As seen in FIG. 2, the valve means **100** includes an elongated bore **102** spaced portions of which communicate with inlet **92** and outlet **94** and with conduit **90**. The bore **102** includes an enlarged portion **104**, a reduced intermediate portion **106**, and a further reduced dimension portion **108**.

The walls of the enlarged portion **104** are threaded to accommodate a closure cap **110** carrying a sealing O-ring **112** to prevent leakage of high pressure air through cap **110**. A recess **114** is provided in cap **110** and receives one end of a coil spring **116** therein.

A valve **118** with an integrally attached valve stem **120** is provided with valve **118** positioned in enlarged bore portion **104**. Valve **118** provides a resilient sealing portion **122** clamped between discs **123** and **124** and adapted to seat on valve seat **126** located between inlet **92** and conduit **90**. The spring **116** normally biases the valve **118** to a closed position. A hard rubber sleeve **128** is telescopically mounted on the valve stem **120** and slidably in the reduced bore portion **108**. Telescoping of sleeve **128** on stem **120** is limited by engagement of the tip of stem **120** with the closed end of sleeve **128**. This sliding engagement is tight enough to prevent the passage of high pressure air between the sides of sleeve **128** and the walls of bore portion **108**.

The lower end **129** of sleeve **128** extends outwardly of bore **102**, as shown in FIG. 2. An actuating trigger lever **130** pivotally mounted on handle **16** is positioned to engage the lower end **129** of sleeve **128**. With this arrangement when the handle or side portion is gripped so lever **130** is actuated, sleeve **128** is forced up along bore **102** in the handle **16** to operate the valve means **100** as described below.

Before lever **130** is actuated, the sleeve **128** protrudes from bore **102** so as to expose outlet **94** to communication with the unoccupied portion of bore **102** which in turn communicates with conduit **90**. As the lever **130** is forced against the end **129** of sleeve **128**, the sleeve first telescopes onto stem **120** and slides in bore **102** to a position which closes off outlet **94**. Then sleeve **128** engages the tip of stem **120** and further movement unseats valve **118** from valve seat **126** thereby communicating inlet **92** with bore **102** and conduit **90**. When trigger **130** is released, the spring **116** and air pressure first restores valve **118** to seating engagement with valve seat **126**. Then the pressure of the air in conduit **90** exerts force on sleeve **128** to cause same to slide outwardly to expose the outlet **94**.

The foregoing operation is useful because after a piston stroke, the piston **68** moves back to its initial position and its return movement is softened by a cushion of momentarily trapped air in gas chamber **88** and conduit **90**. However, as the air pressure rises in the gas chamber **88** and conduit **90**, sleeve **132** is forced back to its initial position permitting air to escape fast enough so that the piston **68** can rapidly return to its retracted position. The net effect of this arrangement is to soften piston recoil without wasting air.

The part **18** of body **14** is part of the staple feeding means and cooperates with the magazine portion of sub-assembly **34**. The magazine portion of sub-assembly **34** is indicated at **132** and is spaced from part **18** by a longitudinal slot **134**. The extended ends of part **18** and magazine **132** are secured in spaced relation by a closure plate **136** that is connected to the two parts by screws **138**. The part **18** is longitudinally recessed at **140** and carries a transverse anchor pin **142** to which is anchored one end of elongated feed spring **144**, and a second pin or roller **146** over which the spring **144** is trained with the other end of spring **144** connected to the lug **150** of a staple feeder **148**. Shim means **152** in the form of one or more shim plates are secured to the lower side of part **18** by screws **153**. The shim means **152** is longitudinally slotted at **154** to provide for entrance of lug **150** into recess **140**. The extended end of part **18** and shim means **152** are shaped to define a triangular recess **156**, as seen in side elevation, that provides an inclined edge **158**.

As best seen in FIG. 3, the magazine **132** is U-shaped in cross section with a base **160** and spaced parallel legs **162**. A staple track or magazine rail **164** is removably but rigidly mounted in groove **164*a*** by means of screws **164*b*** in the magazine **132** intermediate legs **162** and parallel thereto, and in this embodiment the upper edge **165** of magazine rail **164** extends a little above the upper edge of legs **162**. One end **166** of rail **164** extends into slot **45** in plate **40** and terminates coplanar with the base of groove **44** as seen in FIG. 2. The rail **164** is dimensioned relative to slot **45** to permit passage of a single staple therebetween into guideway **48**. The other end **167** of rail **164** is tapered and protrudes rearwardly through an aperture in plate **136** to serve as a guide for inserting a stick of staples into the magazine **132**.

As earlier pointed out, the sub-assembly **34** of the jaw and magazine is removably mounted on body **14**. Since the size of the guideway **48** in jaw portion **36** and the size of magazine rail **164** controls the size of staples which the stapling machine can drive, it is apparent that by simply replacing the removably mounted sub-assembly **34** the size and shape of the staples that may be driven by the machine may be changed.

The staple feeder **148** is adapted to move along slot **134** during the staple feeding operation. The feeder has a planar base **170** that slides in slot **134**, a pair of upstanding grippable ears **172** located outwardly of part **18** and cooperating with part **18** to guide the feeder, and a pair of spaced depending legs **174** which straddle rail **164** and the lower edge of which slopes upwardly and rearwardly to planar base **170**. This sloping arrangement of legs **174** permits of positioning the feeder **148** in triangular recess **156** spaced above the upper edge **165** of rail **164** to permit insertion of a stick of staples into magazine **132**.

The size of slot **134**, between edge **165** and part **18** may be varied to accommodate staples of various thicknesses merely by varying the thickness of removable shim means **152**. By selecting the size of shim means **152** to the thickness of the staple stick, one may insure that staples will not climb up on one another in the magazine and thereby jamming in the magazine may be avoided.

To operate the staple gun, the staple pusher **148** is first retracted and pivoted to the dotted line position shown in FIG. 2. Then a stick of staples is inserted on magazine rail **164** in the magazine **132** and the staple pusher is pivoted back into slot **134** and permitted to engage the rear of the staple stick. This forces the staple stick forward until the first staple in the stick moves into the staple and plunger guideway **48**. Next a high pressure hose from an air compressor is attached to connector **96**. Then to drive a staple it is only necessary to hold the handle so the staple ejecting end **49** is properly positioned against the work and then the lever **130** is actuated as described above. This operates valve **110** and after the air pressure in the gas chamber **88** rises above a predetermined level the piston drives the single staple that is located in guideway **48** into the work.

While there has been shown and described a particular embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention and, therefore, it is intended in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a stapling machine of the type comprising a housing, elongated plunger and staple guideway means in said housing, said guideway means having an open staple ejecting end, a plunger slidable in said guideway means and positioned in registry with a staple therein whereby movement of said plunger in one direction thrusts said staple in said guideway means toward said staple ejecting end to effect driving of said staple, means for moving said plunger in said one direction to drive a staple, said housing having an elongated feed portion extending transverse to said guideway means, said feed portion comprising an elongated magazine rail fixed in said feed portion to slidably accommodate a stick of staples, said feed portion having a replaceable retainer spaced from said magazine rail and positioned close enough thereto to prevent staples from leaving the magazine rail in a direction generally transverse thereto, feeding means for biasing a stick of staples on said magazine rail toward one end thereof whereby the end staple in said stick is forced into said guideway means preparatory to being driven, and means for regulating the spacing between the said retainer and the magazine rail in accordance with the gauge of the wire composing the stick of staples, to prevent the feeding force on the staple stick exerted by the biasing means from causing staples in the staple stick to break off and climb on each other to jam the stapling machine.

2. A stapling machine as set forth in claim 1 wherein the means for regulating the spacing between the said retainer and the magazine rail comprises at least one shim plate removably mounted on the housing and spaced from the magazine rail.

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