

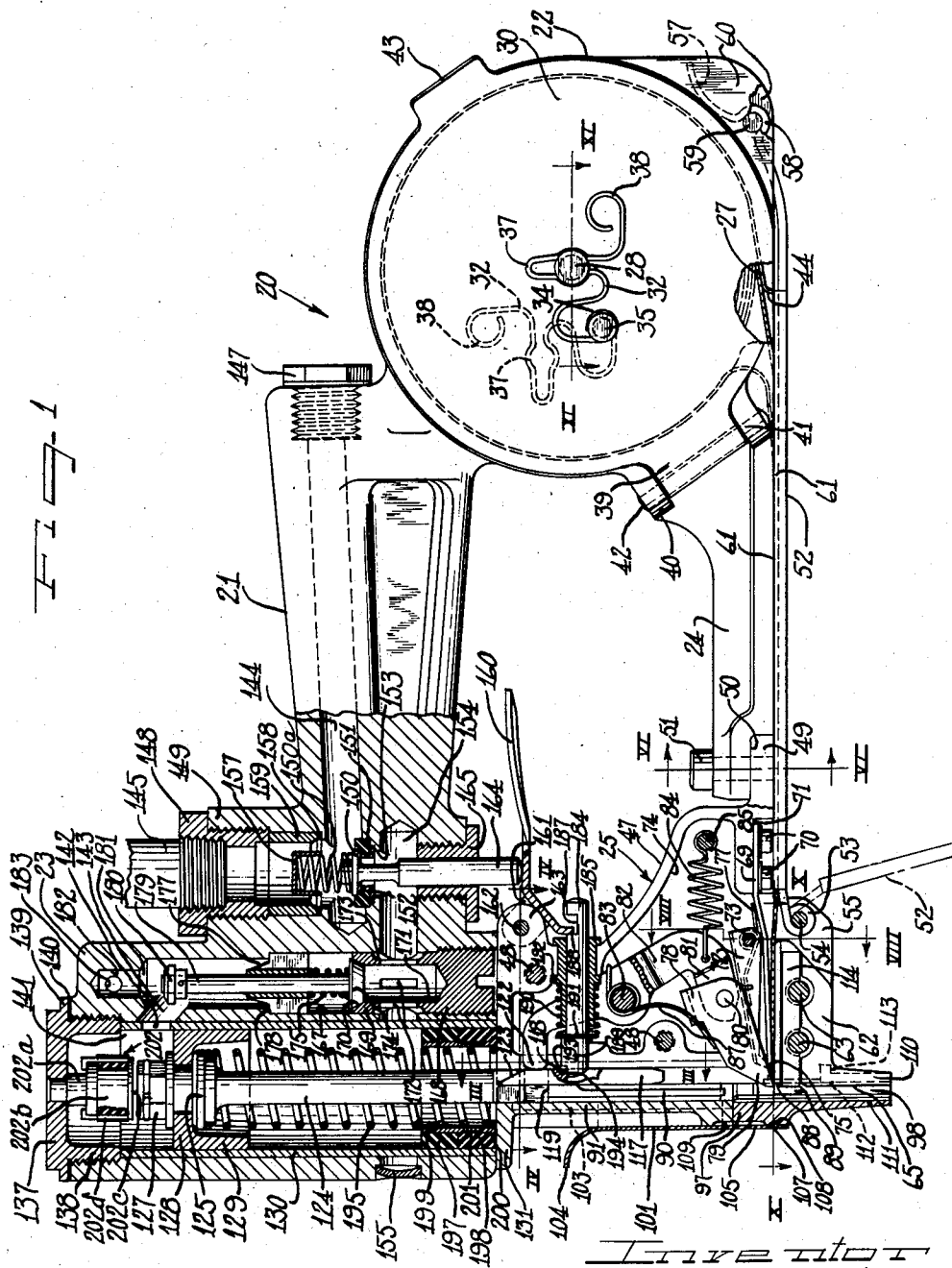
March 15, 1960

C. E. CROOKS ET AL
PNEUMATIC STAPLING MACHINE

2,928,094

Filed Nov. 30, 1953

5 Sheets-Sheet 1



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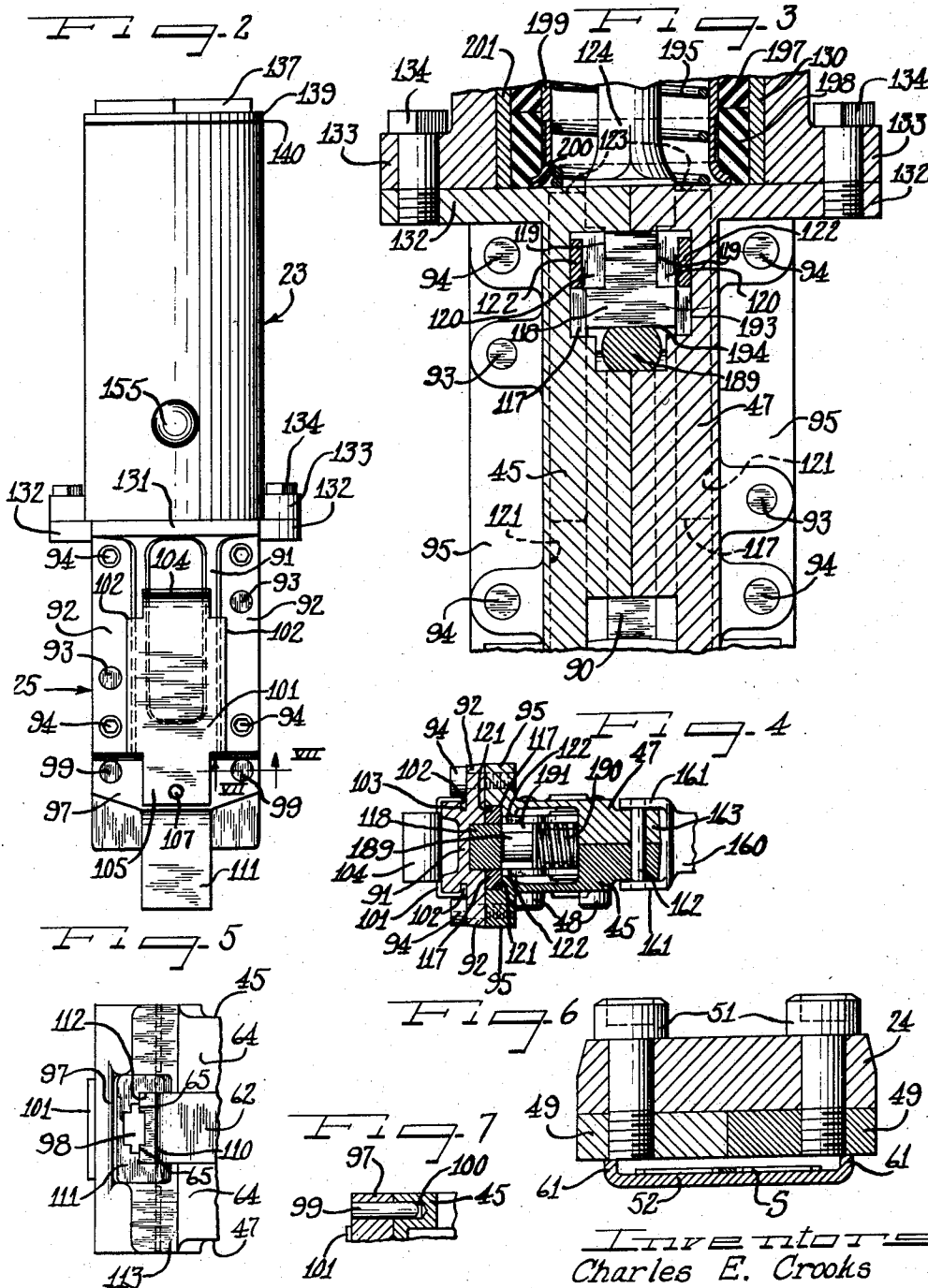
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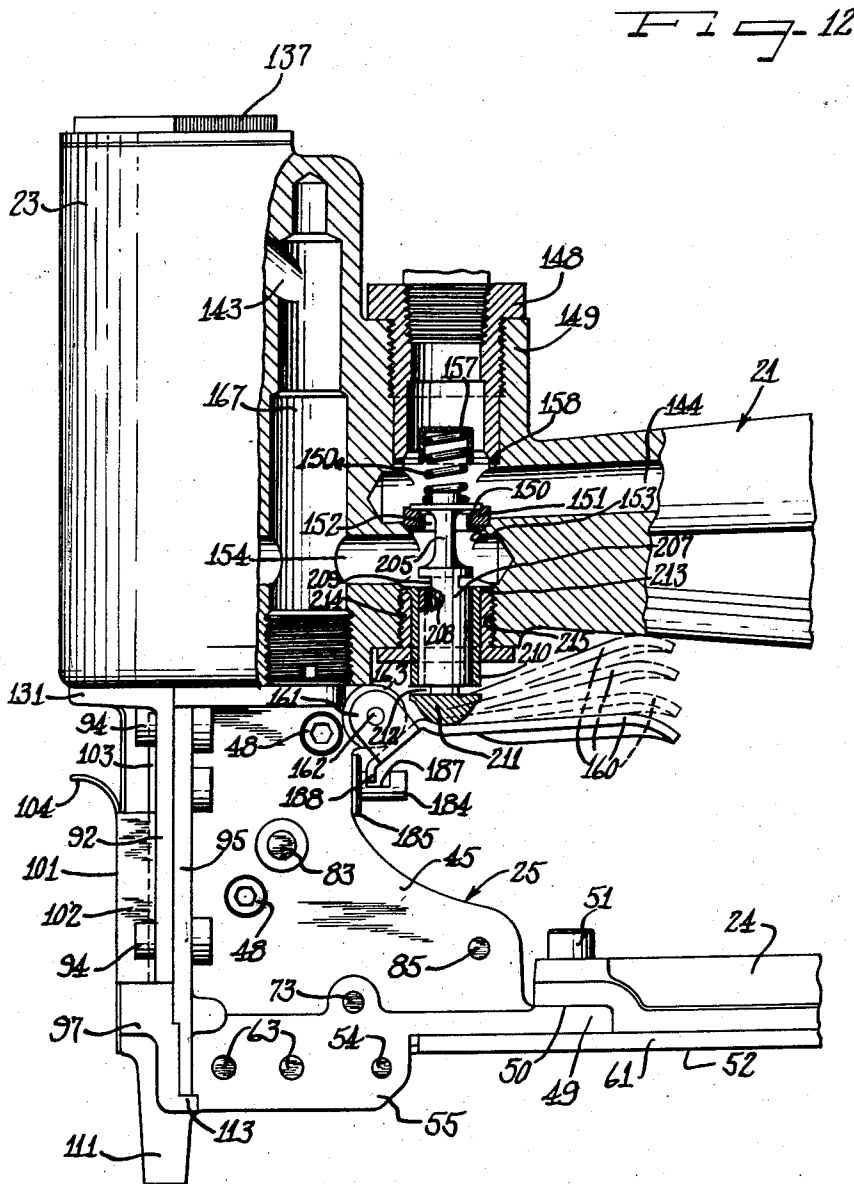
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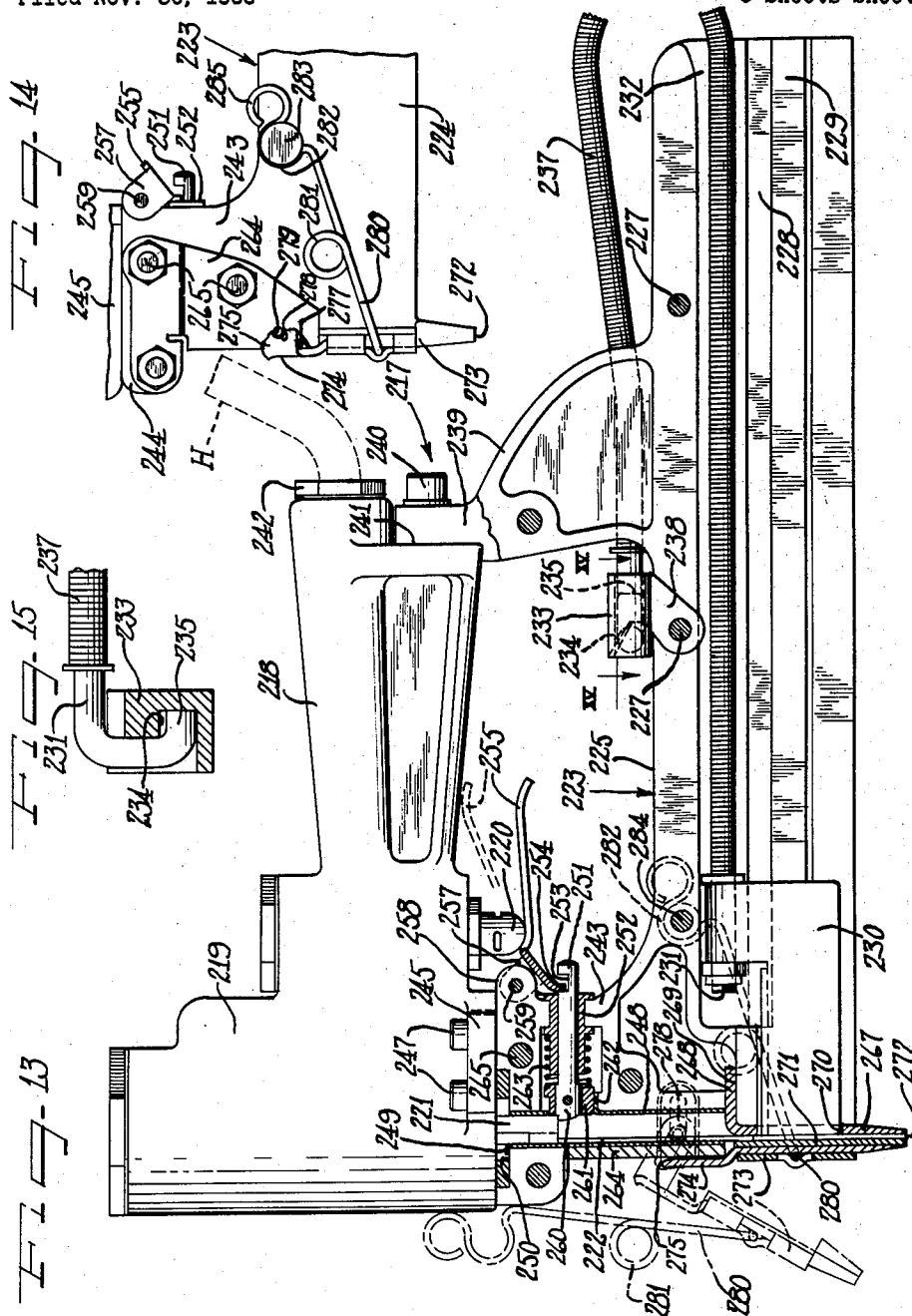
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5 Sheets-Sheet 5



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2,928,094

PNEUMATIC STAPLING MACHINE

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Application November 30, 1953, Serial No. 394,972

10 Claims. (Cl. 1—44.4)

This invention relates to pneumatic stapling machines and more particularly concerns improvements in the construction and operative characteristics in stapling machines of the manually operated portable type.

An important object of the invention is to provide an improved portable manually operable stapling machine, and more especially of the pneumatic type, affording a substantially balanced relationship of large capacity magazine means and driving mechanism with respect to a carrying handle.

Another object of the invention is to provide a pneumatic stapler having improved manually operable control means.

A further object of the invention is to provide a pneumatic stapler which is readily adaptable for forming and driving sheet metal staples from a continuous strip or for driving preformed staples.

Still another object of the invention is to provide improved mechanism in a pneumatic stapler for effecting substantially recoilless operation of pneumatic staplers.

Yet another object of the invention is to provide novel air control valve and delayed action sear mechanism for pneumatic staplers.

A still further object of the invention is to provide an improved assembly of cooperating mechanisms in a stapling machine to facilitate manufacture as well as servicing for repairs.

A yet further object of the invention is to provide an improved pneumatic stapler having novel means for handling staple blanks in continuous strip form supplied in coils or rolls of substantial size.

It is also an object of the invention to provide a novel pneumatic stapler construction having improved means for handling preformed staples.

Other objects, features and advantages of the present invention will be readily apparent from the following detailed description of certain preferred embodiments thereof taken in conjunction with the accompanying drawings in which:

Figure 1 is a side elevational view of a pneumatic stapler embodying features of the invention and with certain parts in section to reveal details of structure;

Figure 2 is a front elevational view of the machine of Figure 1;

Figure 3 is an enlarged fragmentary sectional detail view taken substantially on the line III—III of Figure 1;

Figure 4 is a sectional detail view taken substantially on the line IV—IV of Figure 1;

Figure 5 is a fragmentary bottom plan view of the nose portion of the machine;

Figure 6 is an enlarged fragmentary sectional view taken substantially on the line VI—VI of Figure 1;

Figure 7 is a fragmentary sectional detail view taken substantially on the line VII—VII of Figure 2;

Figure 8 is an enlarged fragmentary sectional detail view taken substantially on the line VIII—VIII of Figure 1;

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Figure 9 is an enlarged side elevational view of the removable nose or gate member of the machine;

Figure 10 is an enlarged fragmentary horizontal sectional detail view taken substantially on the line X—X of Figure 1;

Figure 11 is a fragmentary sectional detail view taken substantially on the line XI—XI of Figure 1;

Figure 12 is a fragmentary side elevational view, partially in section, of a pneumatic stapler showing a modified pneumatic control valve structure;

Figure 13 is a side elevational view of a pneumatic stapler according to the invention adapted for utilizing preformed staples;

Figure 14 is a fragmentary side elevational view of the lower front portion of the machine of Figure 13; and

Figure 15 is a fragmentary sectional view taken substantially on the line XV—XV of Figure 13.

A valuable feature of a pneumatic stapling machine 20 as depicted in Figure 1 resides in a nicely balanced relationship between a supporting and manipulating handle 21, a staple blank magazine structure 22 attached to the rear end portion of the handle, and a head structure 23 attached to the forward end portion of the handle 21. It will be observed that while the magazine structure 22 is disposed substantially below the rear end portion of the handle 21, the head structure 23 is disposed substantially above the handle. From the lower portion of the magazine structure 22 projects forwardly a base extension structure 24 which is connected to a forward lower staple handling and feeding assembly unit 25 that is also connected to the lower end of the head structure 23. By preference, the principal portions of the handle, the magazine structure 22, the head structure 23 and the base extension 24 are constructed in one unitary piece as a light weight metal casing or as a molded plastic unit, thus providing a rigid, light weight body.

For accommodating a substantial coil or roll of sheet metal staple blanks S in continuous strip form, the magazine structure or section 22 of the machine is constructed as a chambered, hollow housing providing a chamber within which is a sheet metal liner in the form of a can or container 27 (Figures 1 and 11). In this the staple roll is mounted to rotate about the axis of a horizontally disposed hub pin 28 secured at its base to a central inwardly directed boss 29 on the inner side wall defining the housing and thereby securing container 27 in place. At its outer end the pin 28 extends beyond the access opening in the housing so that the head end portion of the pin will project through a door-like cover on closure plate 30 having a central opening 31 for this purpose. Thereby, a pivotally mounted spring wire latch 32 is adapted to be engaged interlockingly in a head groove 33 in the pin.

As best seen in Figure 1, the spring latch member 32 comprises a piece of spring wire of suitable gauge having a pivot loop 34 engaging pivotally about a pin 35 mounted on the outer side of the cover 30 in spaced relation to the opening 31 therein. An intermediate constricted neck latch loop 37 is dimensioned to engage in resilient gripping relation about the reduced diameter neck of the hub pin head portion defined by the groove 33. At its distal end portion the spring latch member is provided with a handle loop 38. Thereby, manipulation of the spring latch member 32 between the latching position shown in full line in Figure 1 and the open position shown in dash outline can be readily effected by manipulating the handle loop 38 to snap the latching loop 37 on or off of the hub pin.

By preference, the cover plate 30 is pivotally mounted to be swung open for insertion of a staple roll into the magazine. For this purpose, the cover plate is provided with a peripheral hinge flange extension 39 adapted to fit between respective upper and lower spaced hinge

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bosses 40 and 41 provided for this purpose on the base extension 24 adjacent to juncture thereof with the magazine portion 22. A hinge pin 42 secures the hinge flange 39 pivotally in place between the lugs or ears 40 and 41. For manipulation the cover plate 30 has a handle flange lateral extension 43 projecting from the periphery thereof diametrically opposite to the hinge flange 39.

The strip of staple blanks S is fed from the supply roll within the chamber 27 through an opening 44 in the lower forward portion of the wall of the magazine defining the chamber. From the opening 44 the staple strip is directed forwardly under the base extension 24.

From under the base extension 24, the staple strip S is directed into the feed mechanism assembly 25 for delivery into position for forming of the individual partially formed flat staple blanks into staple-U shape and severance and driving of the formed staples from the machine into an object or assembly to receive the staple, effected by pneumatically energized means carried by the head structure 23 and in part associated with and guided by the housing structure of the mechanism 25. To this end, the unit 25 is provided with a housing comprising a pair of complementary similar left-hand and right-hand preferably cast or molded housing plates 45 and 47, respectively. The plates are constructed and arranged to be secured in cooperative face to face relation by means such as screws 48 (Figures 1 and 4).

For removable attachment to the base extension 24, each of the housing plates 45 and 47 is provided with a rearwardly extending lower base flange 49 which is adapted to fit into a downwardly opening rabbet groove recess 50 in the forward portion of the base extension 24. Screws 51 secure the respective base flanges 49 securely in place (Figures 1 and 6). The lower faces of the flanges 49 are preferably disposed in a plane with the lower face of the base extension 24 so as to provide therewith a smooth surface opposing the staple strip S movable thereunder from the supply magazine to the forming and driving station within the unit 25.

For protecting the staple strip S and preventing sagging thereof from its path, a cover 52 is provided (Figures 1 and 6). By preference, the cover 52 comprises an elongated member which is pivotally mounted so that it can be swung into open and closed positions. Herein, the cover member 52 is pivoted at one end so that it can be swung down for exposing the staple track and at the opposite end a latch structure is provided for retaining the cover in closed position. Conveniently, the cover 52 may be constructed as a sheet metal plate stamped into form, with one end portion, herein the front end portion, provided with a hinge curl 53 pivotally engaging about a pin 54 mounted between respective depending spaced flanges 55 on the housing plate members 45 and 47. At its opposite or rear end portion, the cover plate 52 is provided with a handle portion 57 formed with a latching loop 58 engageable in resilient latching relation with a pin 59 secured between a pair of spaced apart rearwardly extending flanges 60 provided for this purpose on the magazine housing 22. At its respective opposite longitudinal margins the cover member 52 is provided with respective narrow angular upstanding similar flanges 61 arranged to engage edge-wise with the bottom of the base extension 24 and the attachment flanges 49 so as to confine the staple strip S within the track provided between the cover 52 and the overlying surface of the base extension 24 and the flanges 49. To open the cover 52 the handle 57 is engaged and the latch loop 58 snapped off of the pin 59. The cover 52 may then be swung down, or up, depending on how the machine 20 is held, into open position as indicated in dash outline in Figure 1. Closing of the cover 52 is effected by swinging it back until the latch loop 58 is snapped into retaining engagement with the pin 59.

Forwardly from the track provided by the cover mem-

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ber 52 and the base extension 24, the staple strip S passes over an anvil 62 (Figures 1, 8 and 10) which comprises a block fixedly secured by means of screws or rivets 63 between respective complementary inwardly directed bosses 64 provided for this purpose on the inner sides of the depending housing plate flanges 55. Respective spaced, vertically extending forwardly directed ribs 65 (Figures 1, 5 and 10) on the front end portions of the anvil block have generally upwardly and forwardly facing anti-back tilt surfaces 67 cooperable with staple leg tips during severance and driving. In assembly the anvil 62 is disposed with its top surface in a plane with respective top surfaces 68 on the anvil supporting bosses 64 to provide a forward continuation of the staple strip track, and more particularly a table for the forward end portion of the staple strip S.

Holding the staple strip S down upon at least the forward portion of the anvil is an elongated cantilever leaf spring member 69 secured at its rear end portion as by means of screws 70 within a downwardly opening recess 71 in the housing plates 47 forwardly from the rear end flanges 49 thereof.

Cooperating with the forward portion of the anvil 62 and the forward portion of the hold down spring lever 69 to restrain backlash of the staple strip S is a spring biased, pivoted holding lever or dog 72 mounted upon a pin 73 extending between the side walls within a suitable chamber 74 provided by cooperative complementary internal recesses in the housing plates 45 and 47. The pin 73 supports the holding dog 72 pivotally at its rear end while the forward end of the dog has holding tips or points 75 which engage behind the second to the foremost staple blank to restrain the same against rearward movement while nevertheless enabling advance of the staple strip by staple blank increments by pivoting of the holding dog in opposition to a biasing spring 77.

Feeding of the staple strip S forwardly by staple blank increments is effected by a generally inverted U-shaped feed dog 78 having a pair of spaced feed fingers 79 disposed operatively at the forward end of the staple track at respectively opposite sides of the nose portion of the anvil 62. Pivotal support for the feed dog 78 is provided above the holding dog 72 by a pivot pin 80 carried by spaced twin forwardly directed arms 81 of a generally L-shaped upwardly directed feed lever 82. A transverse pin 83 extending between and supported by the housing plates 45 and 47 pivotally supports the lever 82 intermediate its length. A normal counter-clockwise bias (as view in Figure 1) is imposed upon the feed lever 82 by means such as a coiled tension spring 84 secured at one end to the lower portion of the feed lever and at its other end to an anchor pin 85 secured between the housing plates 45 and 47 spaced rearwardly from the feed lever. Normal downward bias upon the feed fingers 79 is imposed by a torsion spring 87 carried by the pivot pin 83 and having an arm pressing against the top of the feed dog 78 forwardly from its pivot 80, and with terminal engagement of the torsion spring with the lever 82.

At its forward end, the anvil 62 has a sharp shear edge 88 over which, in service, the neck of material which connects a formed staple 89 at the forward terminus of the staple strip in a manner to cooperate with a complementary shear edge at the tip of a staple driver 90, reciprocally mounted at the front of the unit 25 for severing and driving the formed staples.

Rectilinear vertical reciprocal driving and return strokes of the driver 90 are guided at the front of the housing of the unit 25 cooperatively by the respective housing plates 45 and 47 and a front plate member 91 (Figures 1, 2 and 4) having respective opposite vertical side flanges 92 secured by means of dowel pins 93 and screws 94 to complementary vertical front margin laterally extending flanges 95 on the housing plates 45 and 47 (Figure 3). At its lower end, the front plate 91 co-

operates with the upper end of a removable gate 97 assembled with the front end of the anvil 62 to provide a downward continuation of the driver guide and a drive-way 98 down which the staple 89 is driven by the driver 90 into a member or assembly to receive the staple.

Removable retention of the gate member 97 is effected by means of a pair of rearwardly extending pins 99 carried thereby and projecting into complementary respective sockets 100 (Figure 7) in the front margins of the respective body or housing plates 45 and 47. For retaining the gate member against displacement from the pin-retained position thereof, a sliding latch 101 is provided which is mounted on the front of the front plate 91 and has angularly turned vertical side margins provided with respective inturned vertical side margins provided with respective inturned retaining flanges 102 engaging in respective vertical channels 103 in the sides of the front plate forwardly of the side flanges 92. At its upper end the latch 101 has a handle 104 for manipulating the same while at its lower portion the latch member is provided with a depending latching flange 105 that has a dimple 107 extending inwardly for resilient snap-in interlocking latching engagement within a latching socket or recess 108 in the front of the gate member 97. Spaced appropriately above the latching socket 108, the upper portion of the gate member 97 and the contiguous lower portion of the forward surface of the front plate 91 provide a vertical clearance groove 109 receptive of the interlock dimple 107 after the same has been snapped out of the socket 108 upon movement of the latch member 101 upwardly for releasing the gate member 97.

By preference, the anvil 62 and the gate member 97 provide respective cooperating downwardly projecting nozzle-like nose portions 110 and 111 (Figures 1, 2 and 5) affording downward continuation of the staple drive-way 98 and enabling placement of driven staples within depressed or offset places or areas. For strength and stability, the anvil nose portion 110 is fitted into a rearwardly opening slot 112 in the gate nose portion 111. Furthermore, the gate member 97 is provided with a rearwardly extending ledge flange 113 which firmly underlies the forward portions of the side plates 45 and 47. This provides a solid, rugged interrelationship of the parts.

To prevent backward tilting of the legs of the staple 89 as it is severed from the strip, forwardly projecting slightly bowed, compressible leaf spring members 114 (Figures 1, 8 and 10) are mounted within longitudinal grooves 115 in the anvil 62. The tips of the anti-tilt springs 114 engage behind the legs of the staple 89 and thus prevent its tilting backwardly as the driver 90 bears down on the crown of the staple to sever it from the strip and drive the staple.

As each of the formed staples 89 is severed from the staple strip and driven by the driver 90, the succeeding staple blank is formed into U shape by bending down of the oppositely directed flat legs thereof about the nose portion of the anvil 62. This is effected by a forming device comprising respective elongated forming legs 117 (Figures 1 and 3) which are preferably formed separately from the driver 90 and assembled operatively therewith. To this end, the driver has a rearwardly directed lug portion 118 at the head end section thereof upon which the forming device is hung. While the upper portions of the legs may be connected by a yoke bar which engages the lug portion 118, they are preferably separate pieces. At each side of the head end section and extending through the side of the lug 118 is provided a fore and aft slot 119 within which is received non-rigidly a laterally extending lug 120 at the upper end portion of one of the staple forming legs 117. The width of the driver head lug 118 is approximately the same as the width of the anvil 62.

Thereby the forming legs 117 are maintained spaced apart at least as far as the width of the anvil nose.

At each side of the anvil nose and extending up therefrom are vertical guide channels 121 provided in the housing plates 45 and 47 for the forming legs 117. Thereby, in the reciprocations of the driver 90, the staple forming legs 117 are correspondingly reciprocated, so that during the driving stroke of the driver, the forming legs form the next succeeding staple blank into U form. By having the forming legs 117 formed as separate relatively loosely or non-rigidly supported elements on the driver 90, stresses and strains tending to cause fatigue fractures of the driver are avoided, and stripping of the legs from newly formed staples is substantially eased, thus making feasible the use of a lighter return spring for the piston and driver unit.

Herein, the staple forming leg members 117 are also utilized for actuating the feed lever 82. To this end, the feed lever has a pair of spaced apart upper forwardly directed head lugs 122 (Figures 1, 3 and 4) which normally bear, under the rocking bias of the spring 84, against the rear faces of the head end portions of the forming members 117. When the driving blade 90 is actuated in a driving stroke so that the forming legs 117 are moved downwardly, the feed lever head lugs 122 ride off of the upper extremities of the forming leg heads and snap forwardly toward or into engagement with the opposing surface of the front plate 91. The feed lever 82 is thus caused to rock counter-clockwise as viewed in Figure 1 and the feed dog 78 is thereby moved rearwardly, a staple increment to engage behind the next succeeding staple blank which in the course of the driving stroke which released the head lugs 122 is formed to staple-U shape. Then, as an incident to return stroke of the driver 90 and the forming legs 117, the feed lever head lugs 122 are engaged by upper or head cam surfaces 123 on the former legs and thereby moved rearwardly to swing the feed lever 82 clockwise as viewed in Figure 1 and thus drive the feed dog 78 forwardly to advance the staple strip a staple increment and thus move the terminal formed staple 89 into position to be driven by the next succeeding stroke of the driver 90.

Pneumatic motivation of the staple driver 90 is effected through the medium of a stem 124 which extends upwardly preferably integrally in one piece from the head section of the driver into the head structure 23. To this end, the stem 124 has on the upper end portion thereof a collar 125 to which is secured as by means of a nut 127 a piston 128 having a depending preferably substantially rigid skirt 129. Within the head portion 23 is a vertical bore that opens upwardly and downwardly therethrough and has therein a cylindrical liner 130 which provides a cylinder for the piston 128. At its lower end the cylinder 130 preferably engages against a head flange 131 at the top of the front plate 91 and against laterally projecting head flanges 132 on the respective housing plates 45 and 47 (Figures 1, 2 and 3). By preference, lateral complementary flanges 133 on the head structure 23 are secured as by means of screws 134 to the lateral flanges 132.

Above the piston 128, an air tight closure is provided by a screw cap 137 which is preferably provided with an externally threaded skirt flange 138 screwed down into the upper end of the cylinder bore and cooperating with the upper end of the cylinder sleeve 130 to retain the same against upward displacement. A lateral annular flange 139 on the screw cap overlies the upper end of the head portion 28 and compresses a sealing gasket 140 to provide an air tight joint.

The closure cap 137 cooperates with the upper end portion of the cylinder sleeve 130 to define above the piston 128 an air chamber 141 into which opens an air port 142 through the upper rear portion of the sleeve 130. Communicating with the air port 142 is an air passage

bore 143 leading into an upper rear portion of the head structure 23 of the body of the machine.

Compressed air for driving the piston 128 is supplied from a suitable source such as a compressor or storage tank into the handle 21 which for this purpose is provided with a longitudinally extending header chamber 144 which may be in the form of a longitudinal bore opening rearwardly from the handle and terminating in a blind end at the head structure 23. Provisions are preferably made for connecting an air hose or duct 145, leading from the air supply, to either the rear end of the header 144 or the front end of the header. In the present instance the rear end of the header 144 is shown as closed by a removable, threaded sealing plug 147. The air supply duct 145 is secured into a screw nipple 148 threadedly secured into a front inlet port boss 149 projecting upwardly at juncture of the handle 21 with the body 23 and communicating with the forward end portion of the header 144.

For controlling delivery of air from the header chamber 144 to the piston, manually controllable valve mechanism is provided, herein comprising a valve member 150 which is normally biased by a compression spring 150a against a resilient, preferably rubber or rubber-like seat 151 supported by an annular angularly cross-sectioned flange member 152 about the mouth of a vertical communication port 153 connecting the header chamber 144 with an underlying spaced delivery passage 154 extending forwardly from the forward portion of the handle 21 into the lower portion of the head structure 23. The passage 154 may be formed as a blind end bore which for convenience may be drilled through the head structure 23 intersecting the cylinder bore and closed off at its front end by a plug 155.

The valve biasing compression spring 150a is preferably maintained under compression by a cupped spider 157 against which the upper end of the spring thrusts. A lateral apertured flange on the spider is secured against a shoulder at the bottom of the forward inlet bore by means of a sleeve 159 which is driven thereagainst by the inlet nipple 148.

Manual operation of the valve 150 is effected by means of a lever 160 which is conveniently disposed to be actuated by the fore and index fingers of the user's hand by which the handle 21 is grasped. To this end, the operating lever 160 is mounted pivotally at its forward end portion as by means of a pair of spaced upwardly and forwardly directed ears 161 thereon connected by a pin 162 to a rearwardly directed head and supporting ear structure 163 on the housing plates 45 and 47 (Figures 1 and 4). Depending from the valve 150 is a valve stem 164 which projects slidably down through a guide bushing 165 and normally engages an intermediate portion of the operating lever 160 near the pivot ears 161 with a downward thrust as imposed by the biasing spring 150a. Thus, when the lever 160 is pressed upwardly, the valve stem 164 is driven upwardly against the bias of the spring 150a and the valve 150 is opened to admit air under pressure from the header 144 into the delivery passage 154.

From the delivery passage 154 the compressed air passes into another part of the delivery passage comprising a vertical communication bore 167 which intersects the bore of the passage 154 and communicates at its upper end with the delivery port passage bore 143. At its lower end, the bore 167 opens downwardly through the head portion 23 of the body casting of the machine and is closed by a screw plug 168 provided with an upper portion 169 that extends upwardly beyond the delivery passage bore 154 into blocking relation to the communication bore 167. There is provided an upwardly facing valve seat 170 at the upper end of the plug portion 169 defining the mouth of an upwardly opening blind end bore 171 in the plug 168 communicating through transverse slots 172 with an annular outer pe-

ripheral groove 173 in the plug 168 coinciding with the delivery passage 154. In this manner, air under pressure from the delivery passage 154 must pass into and upwardly through the plug 168 to unseat a plunger type check valve 174 from the seat 170.

Normally the check valve 174 is spring biased onto its seat 170 by means such as a light coiled compression spring 175 thrusting one end against the valve and at its other end against a guide bearing spider 177 which is fitted into the bore 167 against a downwardly facing shoulder 178 located in substantial spaced relation above the valve seat 170. The principal function of the spider 177 is to guide slidably a valve stem 179 extending upwardly coaxially from the valve 174 and at its upper end portion supporting an upwardly facing plunger valve 180 of preferably smaller diameter than the valve 174 and constructed and arranged to be disposed in unseated spaced relation below a valve seat 181 while the valve 174 is in closed, checking position on its seat 170.

It will be observed that the valve seat 181 is located above the port passage 143 which angles down into the bore 167 below the valve seat 181. Above the valve seat 181 is a coaxial reduced diameter blind end bore terminal portion 182 which has one or more exhaust ports 183 leading therefrom to atmosphere. Through this arrangement, it will be clear that in the spring biased seated, checking relation of the valve 174 the valve 180 is unseated with respect to the valve seat 181 and therefore the piston pressure chamber 141, and the upper portion of the passage within the bore 167 are vented to atmosphere through the exhaust port 183. However, promptly upon opening of the pneumatic piston operating system by opening of the valve 150, pressure of the compressed air, which may be up to one hundred pounds per square inch, unseats the valve 174 and simultaneously drives the valve 180 onto its seat 181, thereby checking the vent passage so that the compressed air is compelled to pass into the piston chamber 141 and therein develop a pressure head for driving the piston. Force of the compressed air retains the valve 180 upon its seat until the valve 150 is released and returns to its seat by virtue of the biasing spring 151 and the force of air pressure within the header 144. Thereupon the valve 180 virtually instantaneously snaps open as a result of pressure relief differential by leakage exhaust of air from behind the check valve 174 through clearance afforded therefor past the valve stem 164 through the bushing 165. This opens the exhaust passage through the vent ports 183.

Improved means are provided for assuring operation of the piston 128 and thereby the driver 90 in a driving stroke that terminates with a cushioned, decelerated recoilless stop. To this end, instead of gradual acceleration of the piston 128 upon opening of the pneumatic system through the medium of the operating lever or trigger 160, the piston is restrained against movement in the driving stroke until a full head of pneumatic pressure is built up within the chamber 141. Then the piston 128 is released and moves in the driving stroke under substantially full acceleration from the instant of release.

Means for restraining operation of the piston 128 incident to build up of a full pressure head thereabove is effected by means including a sear structure comprising a reciprocable pin member 184 supported for preferably rectilinear fore and aft reciprocation in a tubular bushing 185 supported in the upper portion of the housing of the unit 25 in proper position for actuation of the sear pin by the pneumatic system operating lever 160. The rear end portion of the pin 184 has an upwardly extending transverse, longitudinally elongated notch 187 therein within which is operable a front end depending terminal lug or flange 188 on the lever 160. The construction and relationship of the sear pin 184 and the lever lug or flange 188 is such that in the normal, at rest condition of the mechanism the flange is in the forward end of the notch 187, with the remainder of the notch affording a

clearance within which the flange 188 will move a predetermined distance as the lever 160 is rocked about its pivot 162 in the initial operation of the lever to open the valve 150. This affords a lost motion connection providing a time delay or lag in actuation of the sear pin 184 while the pneumatic system is opened fully to develop a full fluid pressure head above the piston 128. Continuing rocking movement of the lever 160 effects engagement of the shoulder on the pin 184 defining the rear end of the notch or slot 187 and thereby rearward movement of the pin 184.

As the sear pin 184 is moved axially rearwardly by the lever 160, an enlarged diameter front end portion bolt head 189 on the pin is drawn rearwardly against the force of a coiled compression spring 190 normally biasing the bolt head forwardly by thrusting of the forward end of the spring against a thrust washer 191 while the rear end of the spring bears against a lateral annular flange 192 on the bushing 185. As the bolt head 189 is drawn rearwardly, an upwardly facing front end shoulder 193 thereon is withdrawn from restraining relation to a downwardly facing shoulder 194 on the driver head rear lug 118. This releases the driver from restraint and the pneumatic pressure head above the piston 128 operates to drive the piston 128 and thereby the driver under substantially full acceleration in the driving stroke.

By virtue of the sudden expansion of the compressed air within the chamber 141 into the progressively increasing volumetric displacement within the cylinder as the piston 128 progresses, there is a slight reduction or dissipation in driving force toward the end of the driving stroke. In addition, a return spring 195 of preferably coiled compression type thrusting against the piston stem head 125 at its upper end and against the head surface of the housing of the unit 25 at its lower end, gradually builds up a stroke retarding load against advance of the piston, reaching maximum at the end of the driving stroke.

At termination of the driving stroke, the now substantially decelerated piston 128 comes to rest at the lower edge of the skirt 129 thereof against a resilient bumper comprising a pair of similarly dimensioned, coaxially disposed, contiguous upper and lower resilient annuli 197 and 198, respectively. The upper resilient bumper annulus, against which the piston flange 129 makes direct contact is preferably formed from a highly impact resistant rubber or rubber-like material. On the other hand, the lower cushioning resilient annulus 198 is preferably made from a softer cushioning rubber or rubber-like material.

To confine the annuli 197 and 198 against spreading radially inwardly into interfering relation with the adjacent lower coils of the deceleration and return spring 195, a preferably metal retainer cylinder or ring or bushing 199 is interposed between the inner walls of the resilient annuli and the coil spring. In order to avoid upward climbing of the bushing or ferrule 199 relative to the cushioning annuli, an outturned lower marginal flange 200 is provided on the ferrule to underlie the adjacent end portion of the lower cushioning annulus 198. Improved cushioning, shock absorbing resilient deflection of the lower, softer bumper annulus 198 is provided for by the provision of an annular outer peripheral flow relief groove 201 in the lower portion of the ferrule 199 opposing the annulus 198. Through this arrangement, not only is an efficient shock absorbing bumper provided for the piston, but transverse spring-induced shocks resulting from operation of the spring 195 through the piston 129 are effectively damped by the novel shock absorbing bumper construction.

In a typical operating cycle of the machine, the staple directing nose 110, 111 of the machine is located on the spot of the work into which a staple is to be driven and the trigger lever 160 is squeezed to rock the same clockwise, as viewed in Figure 1, in one continuous motion. This effects, progressively, opening of the pneu-

matic supply system valve 150, popping open of the check valve 174, simultaneous closing of the vent check valve 180, development of a pneumatic pressure head in the head chamber 141, and finally release of the sear pin 184. Thereupon the piston 128 moves with high velocity to actuate the driver 90 for driving the formed staple 89 and move the former arms 117 into staple forming relation to the nose portion of the anvil 62. At the same time the feed lever 82 rocks in a feed-dog retracting stroke under the influence of the tension spring 84. By having the piston rod 124 cylindrical (Figures 1 and 3) while the driver head portion 118 is rectangular (Figure 4) and of larger cross sectional area, driving stroke air vent or back pressure relief below the piston 128 is afforded through the driver guide below the head section 23.

As the piston 128 comes to a smooth, decelerated, recoilless and substantially shock-free halt at the end of the driving stroke, it may remain in the down position if the air control 150 has not been released for closing. However, if the trigger lever 160 has been released to close the valve 150, the air passage between the valve 150 and the piston 125 is disconnected from the air pressure source in the handle 21 and there is sufficient leakage past the valve stem 164 to dissipate the residual pressure in the air passage thus disconnected from the source. As a result, the check valve 174 will snap closed and simultaneously the vent check valve 180 will snap open so that air pressure behind the piston 128 is relieved through the vent ports 183, and the return spring 195 snaps the piston 128 to starting position, upward movement being limited by a depending axial shock absorbing bumper 202 carried by the crown of the cap 137.

The bumper 202 comprises a flat head stud 202a secured to the cap 137 and having a rubber or rubber-like bumper block 202b held on its lower face by a retainer plate 202c provided with arms 202d extending up into engagement over the rim of the stud head. Without the vibration damping afforded by the bumper 202, breakage of the rod 124 and driver unit 90 was experienced due to conflict of vibrations from opposite ends thereof meeting with explosive stress intermediately of the unit in repeated operation. Cooperatively, the bumpers 202 and 197-198 effectively damp sensory vibrations during operation of the machine.

During the return stroke of the piston, the tip of the sear bolt head 189 rides against the opposing vertical face of the piston rod 124 and the driver head lug 118 until the sear shoulder 193 snaps under the opposing sear rest shoulder 194 of the driver head lug. At the same time, the feed lever arms 122 which it will be observed clear the reciprocable sear assembly in straddling relation, are kicked back by the shoulders 123 of the former arms from the forwardly canted position of the feed lever arms to rock the lever 82 for causing the feed dog prongs 79 to advance the staple strip to move the newly formed staple 89 into driving position. The entire operating cycle is accomplished quite rapidly and smoothly. The nicely balanced weight distribution of the machine and the recoil-free, substantially shock-free operation of the machine permit use of the machine for long productive intervals without unduly fatiguing the workman handling the machine.

In Figure 12 is shown a staple forming and driving machine which in most respects is the same as the machine 20 of Figure 1, and similar reference numerals have been applied to similar parts. The principal difference in the machine of Figure 12 resides in the control valve structure for the pneumatic system of the machine.

Accordingly, the air pressure control valve 150 is provided with a reduced diameter depending stem portion 205 which extends down through the port in the valve seat and has a hollow, tubular cylindrical lower extension 207 provided with a downwardly opening bore 208 with port slots 209 opening thereinto adjacent juncture

of the cylindrical enlarged diameter portion with the reduced diameter stem 205. The hollow extension 207 is reciprocally slidably engaged in a reciprocable, cup-like check valve sleeve member 210 which is provided at its lower end with a head 211, with slot ports 212 opening through the cylindrical wall of the check valve sleeve 210 at juncture of the wall with the head. At its upper end, the check valve sleeve 210 has a lateral seating flange 213 which engages a complementary seat on the upper or inner end of a bushing member 214 externally threaded and screwed into an opening 215 coaxially located below the valve seat 151 and affording access into the delivery passage 154.

The construction and relationship of the cylindrical valve stem extension 207 and the check valve member 210 is such that in the non-operating condition of the mechanism, wherein the valve 150 is closed, and the seating flange 213 of the check valve member rests upon its seat, a free vent passage from the delivery chamber or passage 154 to atmosphere is afforded through the slot ports 209, the bore 208 and the exhaust ports 212. This affords an exhaust vent for air that must be released when the driver piston moves in its return stroke.

To initiate operation of the driver, the trigger lever 160 in Figure 12, is pressed upwardly toward the handle 21. In a first phase of movement of the lever 160 from the full line position to the first dash line position, the check valve head 211, engaged thereby, is moved upwardly until the head engages in closing relation with the lower end of the tubular valve stem extension 207 and thereby closes the mouth of the bore 208. Simultaneously, the sleeve 210 is moved upwardly into substantial closing relation to the slot ports 209. In a second phase of movement of the lever 160 from the dash line position to the second or dot-dash operating position in Figure 12, the valve 150 is opened, and since the exhaust vent passage is now closed the compressed air from the header 144 will pass through the delivery passage 154, the delivery bore 167 and the port passage 143 to the piston chamber. In a third phase of movement of the lever 160 from the dot-dash position to the third or double-dot-dash position the lever lug 188 engages and moves the sear pin 184 rearwardly to release the driver of the machine for movement in its driving stroke. When the lever 160 is dropped to its neutral, full-line position, the valve 150 snaps closed and the vent check valve 210 is positively driven open by the force of air under pressure from the returning piston and the air behind the piston is thus exhausted to atmosphere.

In Figures 13, 14 and 15, an adaptation of the invention to a pneumatic stapler 217 for utilizing preformed staples in stick form is shown. By preference, the machine 217 comprises a handle 218 and a head portion 219 which are constructed to provide a single casting or molded part. Within the handle 218 and the head portion 219 is provided a pneumatic supply system and a driving piston which in all essential respects may be the same as that provided for the machine 20, and the control valve structure may be the same as described in connection with the machine 20 or as described in connection with Figure 12. When provided with a valve assembly as in Figure 12, a vent check valve member 220 projects down below the forward end portion of the handle. Projecting down from the head portion 219 is a reciprocable piston rod 221 carrying a driving blade 222.

Detachably secured to the handle and head structure is a base assembly 223 which is preferably constructed to afford a housing comprising a pair of complementary left and right hand plates 224 and 225, respectively, which are assembled together and secured in face-to-face relation as by means of appropriately disposed screws 227. The plates 224 and 225 are primarily elongated members providing therebetween a longitudinal, rearwardly open,

staple track passage 228 having therein a longitudinal staple track bar 229 appropriately mounted to extend from the rear end of the staple track passage to the front end of the side plates.

For urging staples on the staple track bar 229 toward the front of the machine, a pusher 230 is provided which is mounted for reciprocal sliding movement upon a rod 231 which extends into the base housing 223 through a longitudinal rearwardly open chamber 232 provided therefor above the staple chamber 228 and then loops around and extends forwardly alongside the machine to a retaining bracket 233 providing a forwardly opening socket 234 into which a return bent terminal lug 235 on the rod engages in interlocking or latching relation. The rod 231 has mounted thereabout a light coil spring 237 which normally urges the pusher 230 forwardly. The length of the rod and more especially the portion thereof which extends about the outside of the base housing 223 enables compression of the spring 237 sufficiently to gain full advantage of the staple track for supporting a large supply of staples to be delivered forwardly for driving by the staple driver 222.

The bracket member 233 is constructed and arranged to be appropriately assembled with the base housing 223 and for this purpose has a depending flat lug flange 238 which is adapted to fit down between the upper portions of the base plates 224 and 225 for attachment therebetween as by means of one of the securing screws 227, at the desired location on the base.

Assembly of the base structure 223 with the handle 218 is effected by the provision of respective upstanding integral complementary arms or pillars 239 which are secured as by means of appropriate screws 240 to a rearwardly directed shoulder 241 on the lower rear end portion of the handle 218, leaving clearance thereabove for attachment of an air hose H by means of a nipple connector 242 to connect to a compressed air source in this instance through the rear end portion of the handle.

At the front end, the base assembly 223 is secured under the head portion 219 through the medium of upwardly directed attachment and housing portions 243 on the body plates 224 and 225 having upwardly facing lateral attachment flanges 244 at their upper ends cooperating with overlapping lateral flanges 245 on the lower portion of the head section 219 and secured thereto as by means of screws 247. A vertical guideway within which is disposed a liner 248 is provided between the plate portions 243 for the plunger portion 221 of the piston rod and for the driver blade 222. At its upper end portion the liner 248 has a lateral flange 249 which overlies a retaining ledge 250 provided therefor on the upper portion of the front housing structure.

For retaining the driver plunger 221 against a driving stroke until a full head of compressed air has developed thereover, a sear member in the form of a pin 251 is mounted reciprocally in a bushing 252 supported by the upper portion of the housing members 243 in position for engagement into a lost motion slot 253 in the pin of a depending terminal flange lug 254 of an operating lever 255 which is pivotally mounted by means of a pair of flange lugs 257 thereon pivotally connected to a rearwardly extending upper lug structure 258 by means of a pin 259. At its forward end portion the sear pin 251 has a sear head 260 which is engageable retainingly under the rear end portion of the plunger 221 rearwardly from the driver blade 222. A collar 261 pinned to the head 260 is slidably supported by a rearwardly extending flange portion 262 of the liner 248. A compression coil spring 263 thrusts against the collar 261 normally to urge the sear pin 251 into plunger restraining position.

To secure the upper portion of the front supporting plate sections 243 against spreading, a generally U-shaped member 264 is secured as by means of screws 265 in embracing relation about the front and sides of the sections 243.

To provide a driveway and locating nose through which staples are driven by the driving plate 222, a rear nose plate 267 of generally inverted L-shape is mounted back of the driving blade and has an upper rearwardly extending leg flange 268 supported upon a ledge 269 provided by the body plates 224 and 225. Staples are pushed by the pusher 230 from the staple track bar 229 through an opening 270 in the back plate 267.

Cooperating removably with the back plate 268 is a front plate 271 defining with the back plate a depending nose and a staple driveway 272 opening through the tip of the nose. The front plate 271 is carried as part of a gate assembly 273 having an upwardly extending flange 274 provided with rearwardly directed spaced parallel flange arms 275 extending slidably alongside the outer faces of the side plates 224 and 225 at the front thereof and through respective slots 277 in the front of the retainer bracket 264. Elongated slots 278 in the flange arms 275 have respective retaining and sliding-hinge pins 279 engaged therein enabling front to rear sliding of the flange arms 275 for swinging of the gate member 273 between the full line and dash outline positions shown. The pins 279 are riveted to the sides of the retainer bracket 264 and extend the required limited distance inwardly therefrom.

For retaining the gate member 273 releasably latched in position, a spring latch mechanism is provided, in the present instance comprising a U-shaped wire yoke member 280 having the bight portion thereof pivotally connected to the gate member 273, and with the arms thereof arranged to extend alongside the front of the base housing as shown. Intermediately, the arms of the latch member are provided with spring loops 281. At their terminal end portions, the latch arms are formed with spring snap loops 282 arranged to be resiliently interlockingly engaged upon annularly grooved latching collars 283 carried at the ends of a pin 284 extending through the body plates 224 and 225 adjacent the rear lower portion of the front sections 243 thereof. A terminal handle loop 285 is provided on each of the latch arms for convenience and manipulating the same into and out of latching engagement with the interlock collars 283.

After the machine 217 has been loaded with staples by disconnecting the pusher rod 231 from the retaining bracket 233 and withdrawing the pusher from the base structure 223 of the machine, and then replacing the pusher to drive the staples forwardly along the staple track 229 to locate the foremost staple in position for driving thereof by the driving blade 222, the machine is maneuvered by means of the handle 218 to locate the tip of the depending nose thereof on the article into which a staple is to be driven. The pneumatic system control lever 255 is then rocked upwardly from the full outline position to the dash outline position thereof for operation of the staple driving mechanism in the manner hereinbefore described in connection with Figures 1 and 12. Should it be necessary for any reason to open the staple driveway 272, the gate 273 can be readily unlatched and swung open. Should it be desirable to replace the base structure 223 with a longer or shorter structure, that can be readily accomplished by detaching the handle and head structure unit 218, 219 and reassembling the same with a base structure of suitable length.

By reason of the substantial length of the base structure 223 rearwardly with respect to the handle 218 a well balanced weight relationship is maintained since the rear portion of the base assembly tends to counterbalance the weight of the head structure 219.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention.

We claim as our invention:

1. In a pneumatically-operated fastener driving machine including structure supporting a fastener driver and means for supplying fasteners into position to be driven

by the driver, combination pneumatically-operated and mechanical means carried by said supporting structure for controlling the operation of the driver in a driving stroke, said combination means including a pneumatic control valve, a sear member normally operative to restrain the fastener driver against movement in a driving stroke, and an operating lever for sequential concurrent operation of said valve and said sear member, having a time lag or lost motion connection with said sear member to effect release of the sear member following operation of the valve by the lever to activate the pneumatic portion of the combination means.

2. A machine as defined in claim 1 wherein the sear member comprises a reciprocally guided pin having a notch therein, and the operating lever has a flange lug operatively disposed in said notch for effecting said lost motion connection with the sear pin.

3. In a portable stapling machine including a handle portion rearwardly from a head structure within which is reciprocally mounted a piston with a staple driver on the lower portion thereof, means under said head structure providing a guideway for the driver, means for supplying staples into position for driving by the driver, means for supplying compressed air to operate said piston including a control valve, a reciprocable sear member carried by said driver-guide providing means and normally biased into restraining relation to said driver, said sear member projecting into accessible position below said handle, and an operating lever mounted below the handle adjacent the head structure and operatively related to said valve and having a lost motion connection with said sear member so that when the lever is operated to open said valve, continuing operative movement of the lever will operate the sear member in time delay sequence following opening of the valve.

4. In a pneumatic stapler having a handle and head end structure providing a cylinder with a piston operating in the cylinder and cooperating with a driver for motivating the driver to drive staples supplied by a staple supply and positioning means, a compressed air supply chamber in the handle adapted to be connected to an air supply source, means for supplying pneumatic fluid to said cylinder, comprising a port from the handle supply, a valve normally closing said port and having a stem projecting exteriorly of the handle, a sear member supported by said head end structure for normally restraining the driver against movement in a staple driving stroke, an operating lever pivotally mounted on said head end structure externally of the handle and cooperable with said stem to open said valve when the lever is pivotally moved, and means on said lever and said sear member providing a lost motion connection enabling initial operation of the lever to open said valve through said stem followed by actuation of the sear to release the same from the driver in continuing pivotal movement of the lever.

5. In a pneumatic stapler having a handle and head end structure providing a cylinder with a piston operating in the cylinder and cooperating with a driver for motivating the driver to drive staples supplied by a staple supply and positioning means, a compressed air supply chamber in the handle adapted to be connected to an air supply source, means for supplying pneumatic fluid to said cylinder, comprising a port from the handle supply, a valve normally closing said port and having a stem projecting exteriorly of the handle, a sear member supported by said head end structure for normally restraining the driver against movement in a staple driving stroke, an operating lever pivotally mounted on said head end structure externally of the handle and cooperable with said stem to open said valve when the lever is pivotally moved, means on said lever and said sear member providing a lost motion connection enabling initial operation of the lever to open said valve through said stem followed by actuation of the sear to release the same

from the driver in continuing pivotal movement of the lever and means normally biasing said sear member toward the driver restraining position thereof.

6. In a stapling machine having a front end including an assembly affording the lower elements of the machine with means at the front of the assembly defining a staple driver guide and a staple driver in said guide, staple forming means on the driver providing a pair of opposite laterally extending shoulders with vertical surfaces leading to said shoulders, an anvil in said assembly co-operatively related to the driver for severance by the driver of a formed staple from a staple blank strip fed across said anvil, the anvil having a nose portion co-operative with said forming means to form successive staple blanks into staple shape, and feed mechanism including an operating lever projecting upwardly therefrom and pivotally mounted in said assembly and having a pair of spaced head lug portions, biasing means normally biasing the lever for engagement of said head lug portions with said vertical surfaces and operative to cause the lever to rock and cause said head lug portions to move forwardly over said shoulders as an incident to a staple driving stroke of the driver whereby the lever activates the feed mechanism in backup action, said shoulders acting upon said lug portions to return the same to said normal position upon return of the driver from the driving stroke, whereby to rock the lever to actuate the feed mechanism to advance the staple strip by a staple increment.

7. In a stapling machine for forming and stapling from a roll of sheet metal staple blanks in strip form, means supporting a staple driver and former in reciprocal operative relation thereto, a base structure extending rearwardly therefrom and joining a staple roll magazine from which a strip of staple blanks is adapted to be supplied under said base structure to said means for forming and driving by said forming and driving structure, said base structure presenting a flat bottom surface, and a cover for the strip comprising an elongated member pivotally mounted at one end and swingable into and out of covering relation to said bottom surface of said base structure for protectively covering the staple strip, said cover having longitudinal upwardly turned side flanges engaging said bottom surface and spacing the cover therefrom and thereby providing a track for the staple strip.

8. In a stapling machine for forming and stapling from a roll of sheet metal staple blanks in strip form, means supporting a staple driver and former in reciprocal operative relation thereto, a base structure extending rearwardly therefrom and joining a staple roll magazine from which a strip of staple blanks is adapted to be supplied under said base structure to said means for forming and driving by said forming and driving structure, and a cover for the strip comprising an elongated member pivotally mounted at one end and swingable into and out of covering relation to the bottom of said base structure for protectively covering the staple strip, said means having a pivot structure on which the cover is pivoted and said magazine structure having interlock means with which a latch on the opposite end portion of said cover is releasably engageable, the cover having on said opposite end portion a manipulating handle extension.

9. In a pneumatically operated fastener driving machine, supporting structure reciprocably guidably supporting a fastener driver and a motivating piston therefor, a sear pin reciprocably supported by said supporting structure for engagement of a shoulder on the sear pin with a shoulder on the driver, means normally biasing the sear pin for interengagement of said shoulders to hold the driver against motivation by the piston, means connected to said supporting structure for supplying pneumatic fluid for driving said piston, and means for

controlling said pneumatic fluid supply means and including a lever carried by said supporting structure and operative for controlling said pneumatic fluid supply, said lever having a connection with said sear pin for retracting the same to disengage said shoulders in predetermined correlated relation to release of pneumatic fluid to said piston.

10. In a stapling machine including a base structure supporting an anvil under means reciprocably supporting a driver in position to cooperate with the forward end of the anvil to sever and drive staples formed at the terminal end of a strip of sheet metal staple blanks, means for supplying a sheet metal strip of flat staple blanks to said anvil, means for incrementally advancing the strip, the forward end portion of the anvil having a shearing edge cooperative with the driver to sever the foremost staple blank to be driven and immediately back of said shearing edge a staple forming nose portion, and a pair of staple forming legs each having a lower staple forming end and an upper laterally extending lug, the driver having thereon a head lug provided at each side of the lug with a fore and aft slot within which said leg lugs are respectively engaged non-rigidly for co-reciprocal movement of the forming legs with the driver, the forming legs being guided in spaced relation relative to said forming nose to straddle the same in staple forming relation in each driving stroke of the driver, said non-rigid support of the forming legs on the driver avoiding stresses and strains tending to cause fatigue fractures of the driver in operation and also facilitating stripping of the forming legs from newly formed staples and relieving strain upon the return means for the driver.

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