Nov. 20, 1962 S. KUFEL, JR 3,064,626

POWER-DRIVEN STAPLING MACHINE

Filed Dec. 5, 1960 5 Sheets-Sheet 1

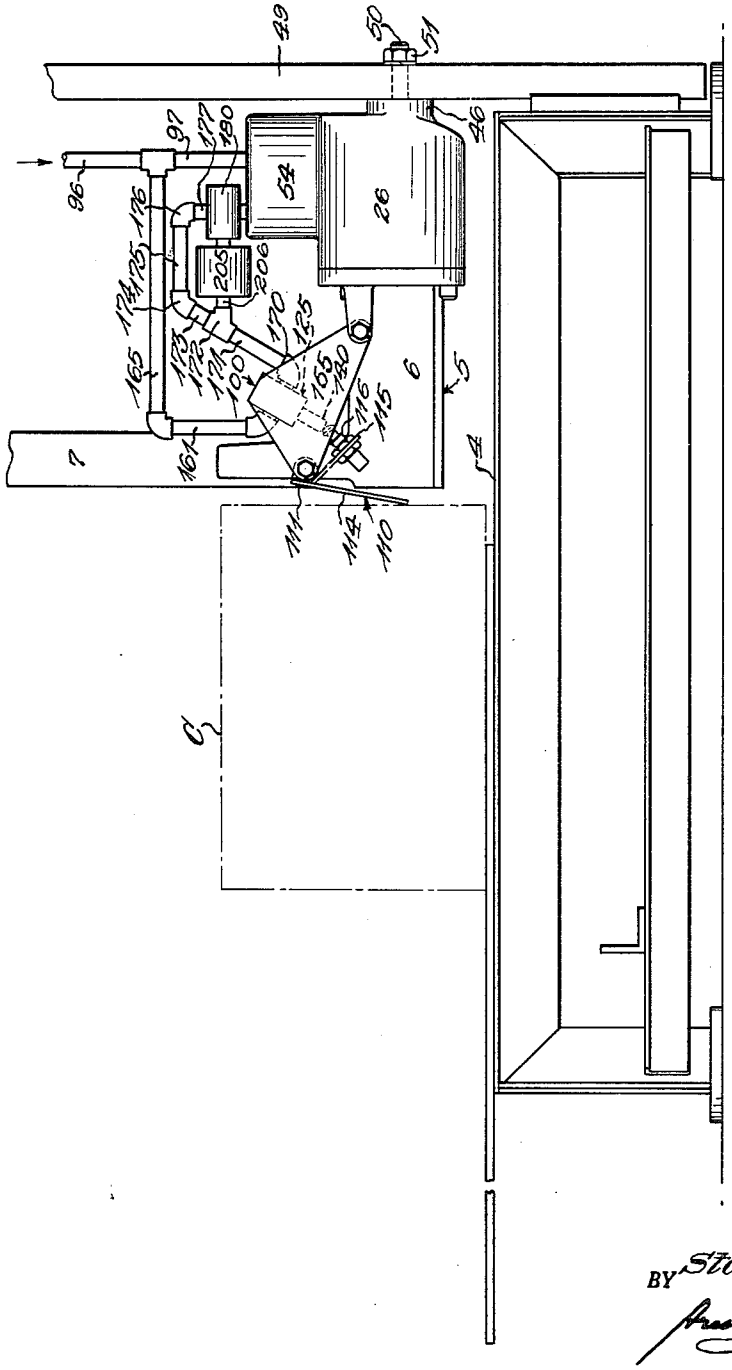

FIG. 1

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POWER-DRIVEN STAPLING MACHINE

Filed Dec. 5. 1960 5 Sheets-Sheet 2

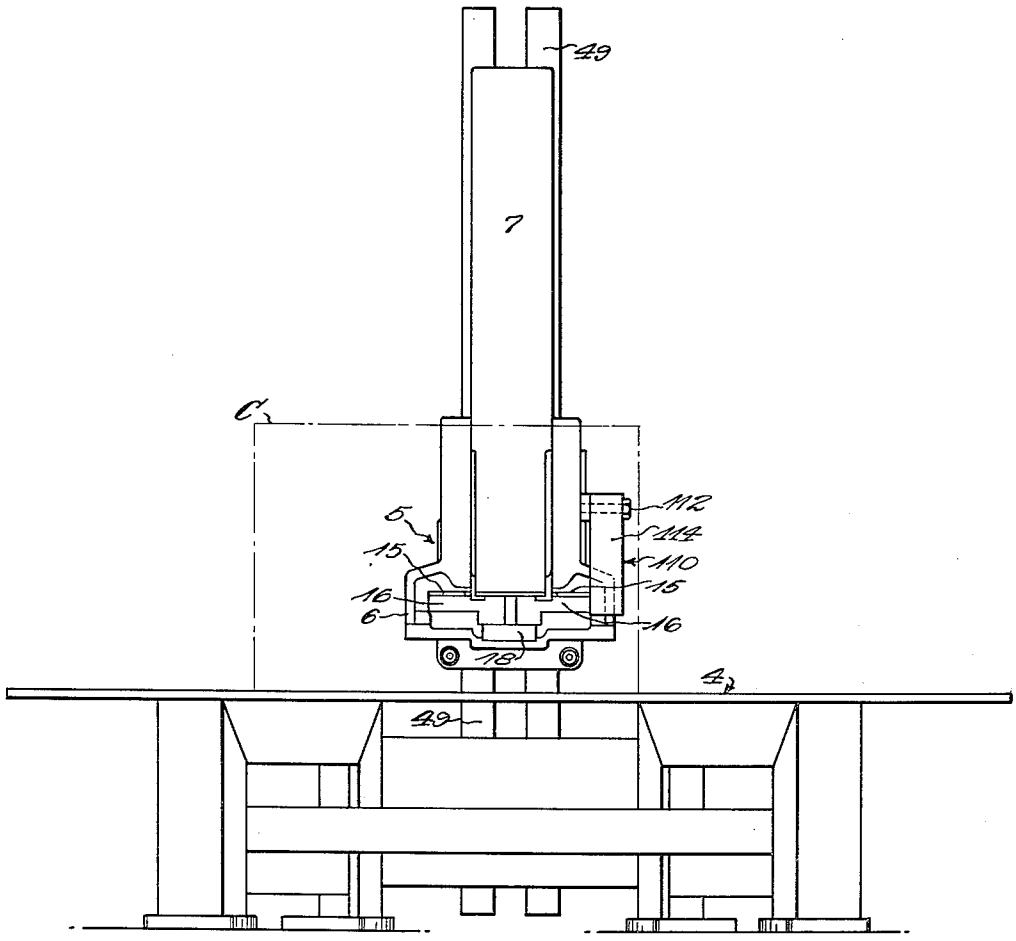

FIG. 2

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Nov. 20, 1962 S. KUFEL, JR 3,064,626

POWER-DRIVEN STAPLING MACHINE

Filed Dec. 5, 1960 5 Sheets-Sheet 3

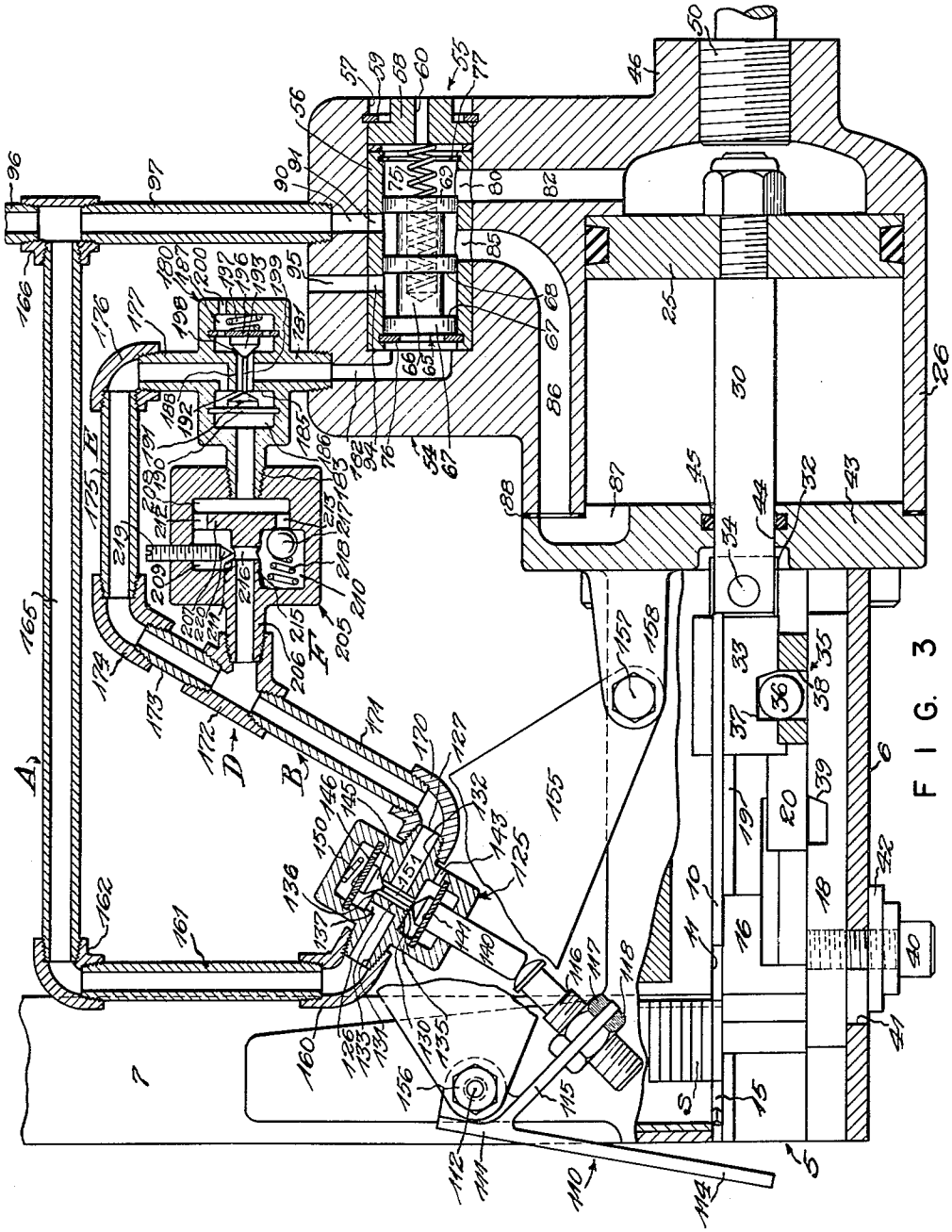

FIG. 3

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Nov. 20, 1962 S. KUFEL, JR 3,064,626

POWER-DRIVEN STAPLING MACHINE

Filed Dec. 5, 1960 5 Sheets-Sheet 4

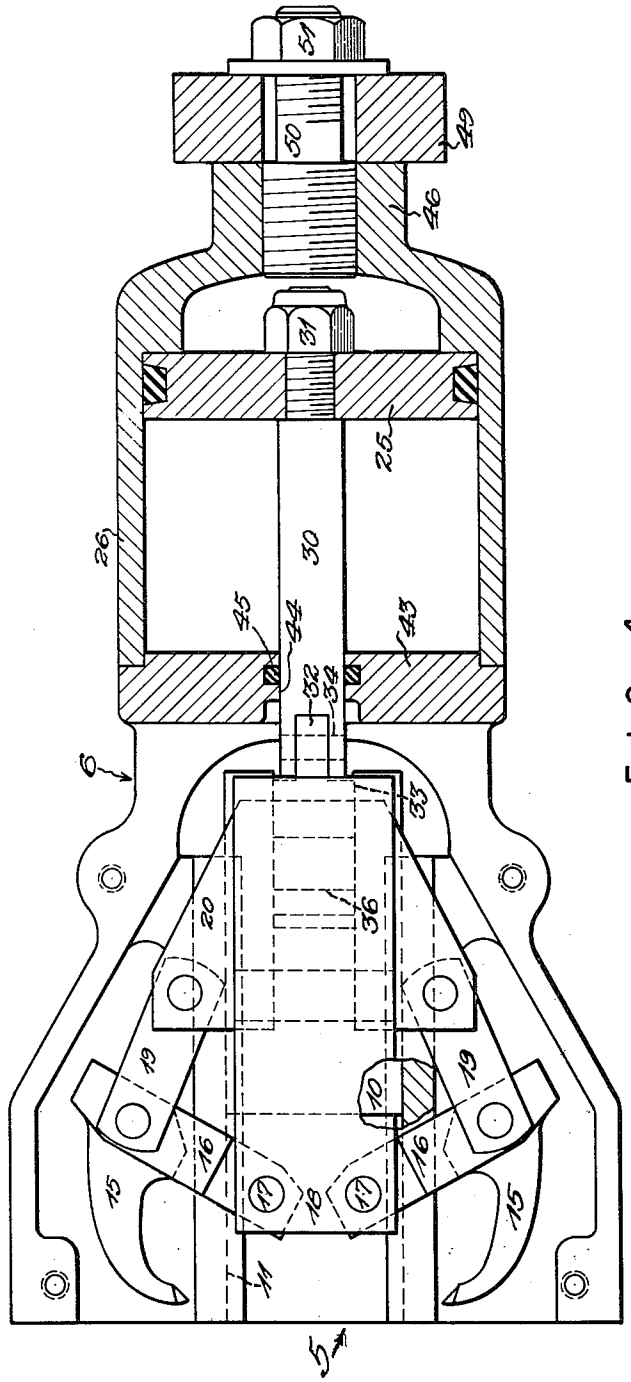

FIG. 4

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POWER-DRIVEN STAPLING MACHINE

Filed Dec. 5, 1960 5 Sheets-Sheet 5

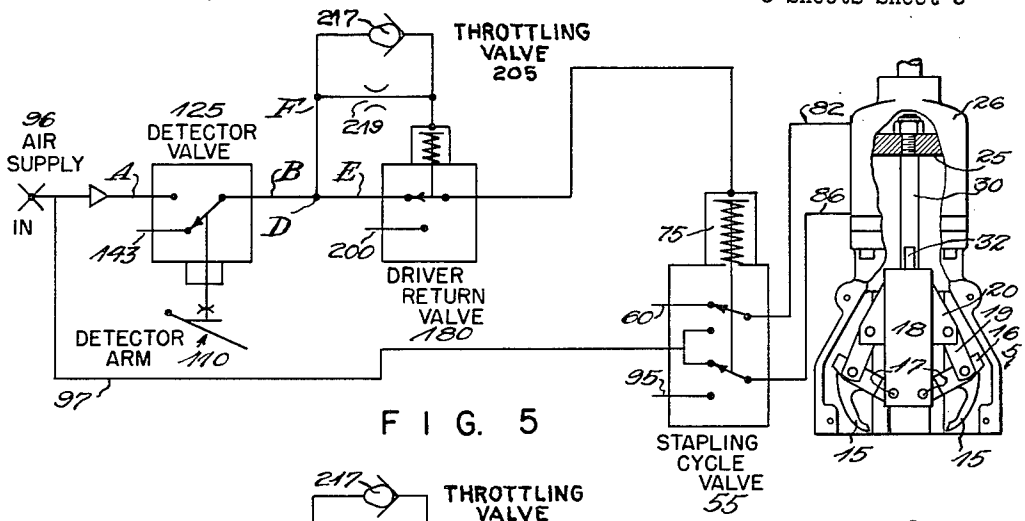

FIG. 5

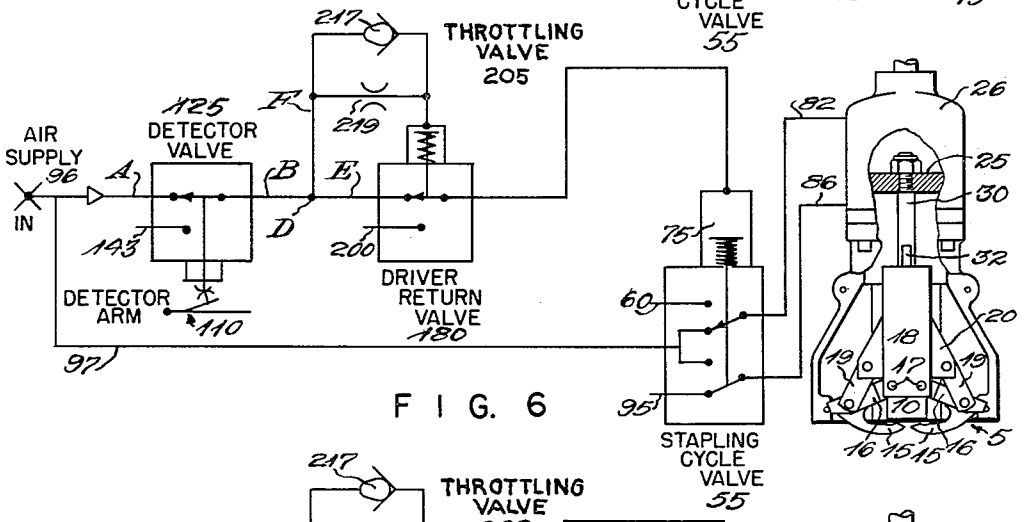

FIG. 6

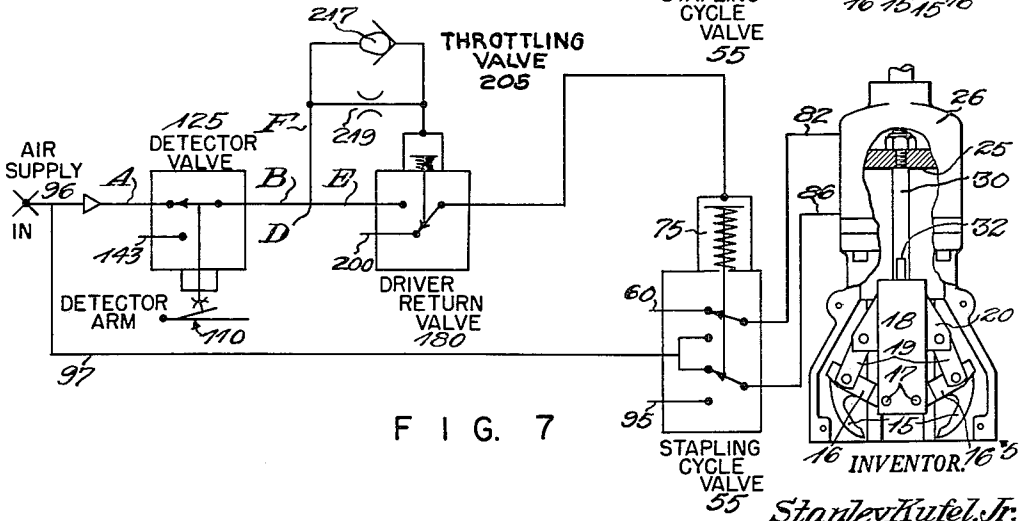

FIG. 7

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United States Patent Office 3,064,626 Patented Nov. 20, 1962

3,064,626

POWER-DRIVEN STAPLING MACHINE

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Filed Dec. 5, 1960, Ser. No. 73,662
16 Claims. (Cl. 121—11)

This invention relates in general to power units for operating various types of machines, and more particularly to fluid pressure operated means for driving stapling machines used to seal fiber cartons by stapling together the overlapping closure flaps thereof.

One object of the invention is to provide a power unit operated by pressure fluid such as compressed air supplied to a power cylinder for reciprocating a piston therein under automatic valve-control.

Another object is to provide detector means for automatically operating the valve-control by placing a carton or container in position for stapling its closure flaps.

Another object is to provide driving means powered by compressed air and entirely automatic in operation through a complete cycle after the starting means has been actuated by placing a carton in position to be stapled.

A particular object of the invention is to provide detector means engageable by the work-piece such as a carton for opening the starting valve to initiate the operation of the machine without the intervention of a trip device embodying a cam or similar mechanical elements for reversing the motion of the operating means.

Another object is to simplify the driving means by the elimination of cam-actuated trip means or similar mechanical elements subject to wear and deterioration at the engaging surfaces thereof.

More specifically, an important object of the improvement is to provide valvular means actuated solely by fluid pressure to reverse the direction of the pressure applied to the piston for returning it to first position.

Another object is to provide a machine of the type indicated having a stapling head mounted on a table or other work support for feeding cartons into position adjacent said head and in contact with detector means actuated thereby to initiate the operation of the valve-control for cycling the machine to complete the operation of driving and clinching the staples.

Another object is to provide a power cylinder having a piston therein operated by compressed air through an operative stroke with its motion reversed automatically without the use of a mechanical trip device or the like for returning the piston to first position.

Machines for sealing cartons by inserting staples through their flaps have previously been used in the present art. Originally, the usual method of clinching the staples was to manually insert a flat metal blade through the slot under the flaps to position it for engaging the legs of driven staples. More recently, machines adapted for the present purpose have been provided with rockable clinching arms having sharpened ends which pierce through the flaps in position to engage the legs of the staples. A reciprocable staple driver cooperates with the clinching anvils and it has been the experience that when the legs of a staple engage the anvils during movement of the latter into operative relationship a secure clinch is not always obtainable. The ends of the staple legs slide on the anvil and become displaced or distorted in shape so that a satisfactory clinch cannot be effected.

To overcome this defect or deficiency in prior devices the machine disclosed in United States Patent No. 2,899,679 of August 15, 1959 embodies certain improvements. An important feature of the improvement consists in means for arresting the motion of the clinching anvils before the staples perforate through the flaps. The anvils

being held stationary the legs of the staple will engage positively therewith to ensure a positive clinch. The present machine preferably embodies a stapling unit of this improved construction.

Previously used power driven stapling machines for sealing cartons are usually operated by electric motors, although in some instances compressed air serves as the motive force. The power unit may comprise a piston reciprocable in a cylinder to which compressed air is supplied through a valve system. Air is fed to the head end of the cylinder to drive the piston for moving the clincher anvils into operative relationship and thereafter actuating the staple driver; whereafter the motion of the piston is reversed to retract the anvils and withdraw the driver.

In power units previously used for driving stapling machines the means for changing the direction of feed of fluid pressure to reverse the stroke of the piston embodies a mechanical trip mechanism. Such a trip device requires cam means with a follower and considerable complication of the mechanism, besides rendering it subject to extreme wear. An important object of the present invention is to avoid the use of such mechanical trip devices for reversing the stroke of the piston by providing a novel and ingenious valve control means actuated solely by the available pressure fluid used to drive the machine.

A preferred form of construction of the stapling unit and the valvular control for the piston driving means is described by way of example in the following specification illustrated by the accompanying drawings in which:

FIG. 1 is a side elevational view in general of the complete machine showing the work-support or table with a stapling unit or stitcher head mounted horizontally thereabove at one end;

FIG. 2 is an end elevation of the same viewed from the left of FIG. 1 looking toward the stapling unit;

FIG. 3 is an enlarged transverse sectional view of the operating mechanism of the machine showing the power cylinder and drive piston for actuating the stapling means including the several conduits and valves for applying pressure fluid to reciprocate the piston in opposite directions under the control of a cycling valve;

FIG. 4 is a similarly enlarged sectional plan view of the pressure cylinder and drive piston with the staple-driving blade and clinching means illustrated as in retracted relationship;

FIG. 5 is a diagrammatic view of the system of conduits and control valves shown in connection with the staple driving and clinching means, both of which are illustrated as retracted to initial position;

FIG. 6 is a similar diagrammatic view showing the starting valve as actuated to apply pressure to the drive piston for operating the staple driving means and clinching means to apply a staple to the folded flaps of a carton and clinch its legs on the inside thereof; and

FIG. 7 is a similar view showing the drive piston as retracted to initial position and the staple driving and clinching means withdrawn into the stapling head after a complete operation of applying and cylinching a staple in the carton flaps.

As herein disclosed, the present invention is embodied in a machine or apparatus comprising a work-support or table 4 (FIG. 1) on which a stapling unit 5 (FIG. 3) is mounted extending horizontally thereabove to provide for feeding cartons to the stapling mechanism of the machine. The stapling mechanism is generally of the type shown and described in the prior patent referred to above, but it may take other forms and be disposed vertically or in upright relationship as is sometimes the practice.

Referring to FIGS. 1 and 3, a preferred form of construction of the stapling unit 5, disclosed in U.S. Patent

No. 2,899,679, consists of a horizontally extending framework **6** surmounted by a vertically disposed magazine **7** for containing a supply of wire staples *s*. A driver-blade **10** (FIG. 4) is reciprocable in a slotted throat **11** in the framework **6**, and a pair of arcuately-shaped clinching anvils **15** are pivotally mounted in the framework for oscillating motion to cause their sharpened ends to pierce through the flaps of a carton. The anvils **15** are carried by rockable arms **16** pivoted at **17, 17** to a plate-like member **18** which may be adjusted longitudinally for altering the location of the pivots **17** to regulate the amount of penetration of the anvils through the carton flaps in accordance with the character of the work to be performed; all as illustrated and described in the patent referred to above. The anvils **15** are operated by oscillating the arms **16** which are pivotally connected by links **19** to a reciprocating crosshead **20**. The crosshead **20** is reciprocated by a power-driven piston **25** slidable in the bore of a cylinder **26** secured to the end of the framework **6** of the stapling unit.

As shown in FIG. 4, the piston-rod **30** is connected by its screw-threaded end to the piston **25** with a nut **31** for securing it thereto, the opposite end of the rod being bifurcated to engage a lug **32** on the end of a plunger **33** with a pin **34** for fastening it thereto. As has been stated, the clinching anvils **15** are moved initially to pierce their ends through the flaps of a carton, whereafter a staple is driven therethrough by the driver-blade **10** while the anvils are held stationary for clinching the legs of the staple on the inside of the carton. This delayed action of the driver-blade is effected through the use of a releasable clutch or coupling **35** for selectively connecting the reciprocating members; said coupling comprising a locking element in the form of a roller **36** shiftable in cooperating slots **37, 38** and **39** in the reciprocating plunger **33**, the crosshead **20** and the adjustable mounting plate **18** for the anvil pivots **17**. The plate **18** is slidably adjustable in the framework **6** with a stud **40** projecting through a slot **41** to limit the extent of its displacement. A washer **42** on the stud **40** is tightened against the framework **6** to secure the plate **18** in adjusted relationship.

The power cylinder **26** may be constructed as a separate unit attached to a closure flange **43** forming a part of the framework **6** at one end thereof and having an axial bore **44** in which the piston-rod **30** slides with a suitable gasket **45** for sealing the joint. The opposite head end of the cylinder **26** is formed with a boss **46** arranged in abutting relation to the side of an upright member or standard **49** (FIG. 1) and fastened thereto by a stud **50** threaded into the bore of the boss with its reduced end projecting through a bore in the standard (FIG. 4). A nut **51** screwed against a washer on the stud **50** clamps the cylinder **26** to the standard **49** and supports the stapling unit **5** therefrom. As herein shown, the standard **49** may be fastened to the end leg of the table **4** for supporting it vertically therefrom.

Referring to FIG. 3, the cylinder **26** is herein illustrated as constructed with an integral housing **54** projecting thereabove and formed with various bores constituting ducts connects to the conduits that supply compressed air or other pressure fluid to the opposite ends of the cylinder. Within the housing **54** is a valve **55**, designated for convenience of description the cycling valve, for controlling the direction of flow of the pressure to opposite sides of the piston **25**. The casing for the valve **55** consists of a cylindrical sleeve **56** held in a horizontal bore **57** in the housing **54**. The bore of the sleeve **56** is partly closed at one end by a plug-like member **58** held in place by a spring-ring **59** sprung into a groove in the interior of the bore **57**. The closure plug **58** is provided with a relatively small axial exhaust opening **60** communicating with the atmosphere. Slidably mounted within the bore of the sleeve **56** is a spool-like valve member **65** formed with a central barrel **66** and three equally spaced annular flanges **67, 68, 69** projecting radially therefrom for engagement with the walls of said bore. A helical spring **75** enclosed in an axial bore in the valve member **65** with its end engaging against the end of the plug **58** normally tends to slide the valve member **65** towards the left as viewed in FIG. 3 to seat its flange **67** against a washer **76** held in a groove in the bore of the sleeve **56**. At the opposite end of the sleeve **56** is a relatively thin annulus **77** seated in a groove in the bore and serving as a stop for limiting the movement of the valve member **65** as it slides in the opposite direction or toward the right.

A port **80** (FIG. 3) in the bottom of the sleeve **56** at one end thereof communicates with a duct **82** which gives access to the head end of the cylinder **26** for applying pressure to drive the piston **25** in an operative stroke. A second port **85** in the bottom of the sleeve **56** opens into a duct **86** leading downwardly and outwardly toward the end of the cylinder **26** to discharge through a recess **87** into the bore of the cylinder **26** to apply pressure to the opposite side of the piston **25** for reversing its stroke. A gasket **88** at the end of the duct **86** seals the joint between the housing **54** and the closure flange **43**.

Pressure is fed to the valve **55** through a duct **90** in communication with a port **91** in the upper wall of the sleeve **56** and spaced therefrom is an exhaust port **94** opening into the atmosphere through a duct **95** for venting the pressure from one end of the valve **55**. Compressed air is supplied to the piston **25** from a suitable source (not shown) feeding through a vertical main conduit **96** and connected pipe **97**; FIG. 3 showing the valve member **65** as forced to the left by the spring **75** so that air may flow through the ports **91** and **85** to feed into the cylinder **26** for maintaining the piston **25** at the head end thereof or in initial relationship for starting a stapling operation.

The valve member **65** is shifted toward the right for opening the ports **80** and **91** to admit pressure to the head end of the cylinder **26** and drive the piston through an operative stroke by applying pressure to the left-hand end of the valve member in the manner as later more fully explained. Pressure is applied to the left-hand end of the valve member **65** through the opening in the washer **76** at the end of the sleeve **56**, such pressure being supplied through a by-pass conduit B leading from a detector valve designated **125** in FIG. 3 and more fully described hereinafter. Operation of the stapling mechanism is initiated by movement of a detector **110** with which the carton C to be stapled (FIG. 1) engages when it is placed on the table **4** and slid therealong toward the stapling unit **5**. The detector **110** may consist of a two-armed lever **111** pivoted on the end of a stud **112** projecting from the side of the magazine **7**. The lever **111** has its longer arm **114** projecting downward for contact with the carton C and is formed with an angularly-related arm **115** having a stud **116** at its end fastened in place by nuts **117, 118**. The stud **116** is formed with a reduced end terminating in a convex button used to operate the detector valve **125** which may be considered as the starting valve.

The casing for the starting valve **125** may be of generally cylindrical shape with tubular nipples **126, 127** protruding from its opposite sides and threaded externally for connection with the conduit piping later described. Bisecting the interior of the casing **125** is a relatively thick wall **130** formed with bores in continuation of the bores **131** and **132** of the nipples **126, 127**. A transverse passage **133** opening through the center of the wall **130** provides communication between the upper and lower chambers of the casing **125** with ports **135, 136** at the opposite ends thereof. The bore **131** is closed at its inner end but has an opening **137** at the top in communication with the upper chamber of the casing **125**; while the bore **132** leads into the central opening **133** for communication with either chamber of the casing. Slidable through a bore in the bottom of the casing **125** is a needle-like element or plunger **140** engageable by the end of the stud

116 on the detector lever 110. Surrounding the upper end of the plunger 140 as a mounting therefor is a flexible diaphragm 141 having its edges held in an annular groove in the interior of the lower chamber of the casing 125. The end of the plunger 140 is beveled to seat in the lower port 135 of the bore 133 as the plunger is slid upward by the action of the detector lever 110. The diaphragm 141 normally maintains the plunger 140 in the relationship shown in FIG. 3 with the port 135 open. An exhaust passage or vent 143 opening to the atmosphere is provided in the side of the lower chamber of the casing 125. A second closure element or plunger 145 of relatively short length is fast on a second diaphragm 146 with its beveled end adapted to close the upper port 136 of the central passage 133 in the wall 130. The diaphragm 146 has its edges held in an annular groove in the interior wall of the upper chamber and is provided with small holes for relieving the pressure against it on one side. A helical spring 150 engaging the upper wall of the casing 125 bears against the diaphragm 146 to force the closure plunger 145 downward for seating it in the upper port 136.

A pin 151 extending through the central passage 133 in the wall 130 connects the ends of the plungers 140 and 145 to adapt them to move together for alternately closing one of the ports and opening the opposite one. With the valve elements arranged in normal relationship as shown in FIG. 3, counter-clockwise movement of the detector lever 110 will force the plunger 140 upwardly to close the lower port 135 and simultaneously open the upper port 136. By this action air pressure may be admitted through the nipple 126 to pass into the upper chamber of the casing 125, down through the central passage 133 and out through the nipple 127 in the manner and for the purpose as later explained.

The valve casing 125 may be supported by any suitable means, being herein shown as mounted on a triangular plate 155 fastened to the framework 6 of the stapling unit 5. One end of the plate 155 is fastened to the stapling magazine 7 by a nut 156 on the end of the stud 112 which forms the pivot for the detector lever 110. The opposite end of the plate 155 is fastened in place by a bolt 157 inserted through a lug 158 projecting from the end of the cylinder 26 and screwed into the side of the framework 6.

The nipple 126 on the valve casing 125 is threaded into an elbow 160 screwed onto the lower end of a vertical conduit pipe 161. The upper end of the pipe 161 is connected by an elbow 162 to a horizontal pipe 165 which has its opposite end joined to the air-supply line 96 by means of a T 166 connected to the upper end of the feed pipe 97 previously mentioned. By these connections air pressure may be fed through the valve casing 125 and thence to the cycling control valve 55 as later explained.

When the starting valve 125 is actuated by the detector lever 110 pressure from the main line 96 is fed to the cycling valve 55 through a by-pass conduit B connected to the nipple 127 by an elbow 170. The elbow 170 is threaded to the end of a pipe section 171 having its opposite end connected by a T 172 to a shorter pipe 173 extending upwardly therefrom. The pipe 173 is connected by an elbow 174 to the end of a horizontal pipe 175 threaded into an elbow 176 that connects it to a nipple 177 on the side of a valve 180. The valve 180 has a nipple 181 at the bottom threaded into a bore in the top of the housing 54 for communication with a duct 182 leading to the end of the cycling valve 55. The valve 180 is of substantially the same construction and arrangement as the valve 125 previously described. A vertical wall 185 bisects its interior with a central passage 188 leading therethrough in communication with the two laterally opposed chambers 186 and 187. In the chamber 186 is a diaphragm 190 carrying a closure plug 191 adapted to seat in a port 192 at one end of the central opening 188. On the opposite side of the wall 185 is a closure plug 193 carried by a diaphragm 196 which is urged by a spring 197 for seating it in the opposite port 198. The two closure plugs 191, 193 are connected by a pin 199 to move together for opening one port and closing the opposite port as pressure is introduced into the valve casing 180. The valve casing 180 is formed with an exhaust or vent opening 200 at one end and diaphragm 196 may have small holes therein for relieving the pressure opposing its flexing.

Located within the loop of the by-pass conduit branch B last above described is a variable throttling valve 205 having means for adjusting it to feed a measured amount of pressure to valve 180 for finally building up sufficient pressure to operate the cycling valve 55 with delayed action for reversing the motion of the driving piston 25. The valve casing 205 has a nipple 206 at one side connecting it with the T 172 which joins the pipe sections 171 and 173 of the branch conduit B. The opposite side of the valve 205 is bored and threaded to receive a nipple 183 on the valve casing 180. The valve 205 may be of cylindrical shape with a transverse vertical wall 207 dividing it into a narrow chamber 208 at one side and top and bottom chambers 209 and 210 on the opposite side separated by a horizontal wall 215. The upper chamber 209 communicates with the narrow chamber 208 through an opening 212 in the top of the wall 207 and the bottom chamber 210 has an opening 213 at the bottom of said wall for communication with said chamber 208. Extending from the inner end of the nipple 206 is a horizontal wall 215 provided with a central transverse passage 216 for communication with the bore in said nipple and opening into the two chambers 209 and 210. A ball 217 in the lower chamber 210 is urged by a spring 218 to close the bottom opening or port 213, thus forming a check-valve for a purpose as later explained. A screw 219 threaded through a bore in the upper wall of the casing 205 has its lower end beveled to cooperate with the port at the upper end of the passage 216 in the wall 215 and serves as an adjustable needle for varying the effective capacity of said port to pass air therethrough into the chamber 209. By adjusting the needle 219 in relation to said port the throttling effect of valve 205 can be regulated for progressively building up the required amount of pressure to eventually actuate the valve 180 and exhaust the pressure from the cycling valve 55 through the vent 200. In this way the valve member 65 is relieved of pressure to cause it to be returned by the spring 75 to the position shown in FIG. 3 for reversing the motion of the piston 25 at the end of its operative stroke.

The construction and arrangement of the parts of the present apparatus having been described in detail, its method of operation is explained as follows with particular reference to the schematic views FIGS. 5 to 7.

Normally, with the machine in readiness for operation, the valvular elements of the control are in the relationship shown in FIG. 3 with the piston 25 at the head end of the cylinder 26. The piston 25 is maintained in this inoperative relationship by pressure of the air entering from the main supply pipe 96 through conduit pipe 97, duct 90 and port 91 as the valve member 65 is held at the left-hand end of the sleeve 56 under the force of the spring 75. At this juncture air is admitted to the power cylinder 26 through port 85, duct 86 and opening 87 to apply pressure for maintaining the piston 25 retracted. During this relationship of the parts the starting valve 125 is closed against the flow of air therethrough (FIGS. 3, 5) due to the fact that the plunger 145 is seated in the port 136 of the passage 133 and the pressure is dissipated in the upper chamber as it is allowed to seep through the perforations in the diaphragm 146 while the spring 150 holds the plunger 145 seated. As has been stated, the valve 125 receives air pressure from the main 96 through conduit pipes 165 and 161 connected to the nipple 126 on the side of the valve casing. For convenience

of explanation this branch of the conduit piping is designated A in both FIG. 3 and the schematic views, FIGS. 5 to 7.

To start the operation of the machine a carton C or other workpiece (FIG. 1) is placed on the table 4 and slid therealong toward the stapling unit 5, this operation being accomplished either manually or effected by suitable automatic feeding means. The carton C is thus caused to contact the detector lever 110 to swing it counterclockwise and thereby raise the stud 116 to engage it with the plunger 140 for forcing the latter upwardly in the valve 125. This action seats the end of the plunger 140 in the port 135 while simultaneously moving the upper plunger 145 to unseat it from the port 136 and thereby open the central air passage 133 at its upper end. Pressure entering through the nipple 126 will thus flow through the opening 137 into the upper chamber of the valve 125 and thence down through the central passage 133 to issue through the nipple 127 and feed through pipe 171 of the conduit designated B in the drawings. At point D in conduit B pressure is divided so that one part flows through pipes 173, 175 of conduit E for release through valve 180 to continue down through duct 182 for actuating the cycling valve 55. It will be understood that at this time pressure in the conduit branch E flowing down through nipple 177 enters the chamber 186 of valve 180 at the right of the diaphragm 190. Full pressure thus acts against the diaphragm 190 for maintaining the plunger 191 in position with the port 192 at the end of passage 188 open as shown in FIG. 3. It should be explained that the diaphragm 190 is not provided with perforations so that it is subject to substantially full pressure from the conduit branch E down through nipple 177 and into chamber 186 while the spring 197 maintains the plunger 193 seated in the port 198 to close it when port 192 is open; any pressure on the opposite side of the diaphragm 190 being negligible at this time as will be explained later in connection with the throttling action of the adjustable needle valve 205. In these conditions air under full pressure will flow through port 192 and passage 188 in valve 180 and continue down through nipple 181 and duct 182 to enter the left-hand end of the valve casing 56. The pressure entering this end of the valve casing 56 acts against valve member 65 to shift it to the right by compressing the spring 75. Such shifting of the member 65 establishes communication between port 85 and port 94 to release air from the left-hand end of the cylinder 26 for exhausting it to the atmosphere through duct 95. The piston 25 is thus relieved of the pressure maintaining it at the head end of the cylinder 26 so as to release it for starting a driving stroke.

As the valve member 65 is shifted to the right it also establishes communication between the port 91 and port 80 so that air from the main conduit 96 flows down through pipe 97, duct 90, port 91, port 80 and duct 82 to enter the head end of the cylinder 26 for applying pressure to the piston 25 to drive it through an operative stroke. As pressure is thus admitted at the head end of the cylinder 26 for driving the piston 25, the piston-rod 30 is moved to the left (as viewed in FIG. 3) to actuate the operating elements of the stapling unit 5 in the manner as explained in full in United States Letters Patent No. 2,899,679, previously referred to. In brief, the piston rod 30 reciprocates the plunger 33 (FIG. 4) and through its connection by the roller 36 (FIG. 3) with the crosshead 20 the latter is moved to rock the levers 16 and oscillate the clinching anvils 15. By this action the sharpened ends of the anvils are pierced through the flaps of the carton in position to clinch the legs of a staple driven therethrough. As the anvils 15 are brought into operative relationship the roller 36 is shifted out of the notch 37 and engaged with the notch 39 in the adjustable plate 18 which is clamped in place to hold it stationary. The anvils 15 are thus held stationary as the crosshead 20 is disconnected from the plunger 33 and the latter continues its movement to complete the stroke of the driver-blade 10 (FIGS. 3, 4) for driving a staple *s* through the flaps of the carton and clinching its legs on the inside thereof. With a stapling operation completed the piston 25 must be retracted to initial position to start a subsequent operation and the clinching anvils must be withdrawn from the flaps of the carton before the latter can be removed or shifted into position to receive another staple; as, for example, in stapling the flaps on both the top and bottom of the carton. It is to be understood that the present machine may be used in gang form to apply a plurality of staples simultaneously by employing several heads spaced across the width of the table 4.

After a stapling operation has been completed the valvular control means continues to cycle for returning the parts of the machine to initial position by retracting the piston 25. The return of the piston 25 is accomplished by a novel and ingenious valve-control for utilizing the air pressure in the machine without the intervention of cam-operated trip mechanism for performing this function. That is to say, whereas in previous machines a complicated arrangement of extraneous mechanical elements has been employed for reversing the stroke of the piston, in the present improved construction a by-pass conduit F including a variable throttling valve 205 therein displaces the cam means and eliminates the cause of wear between the mechanical parts of the machine. Referring to FIG. 3 of the drawings and the schematic views, FIGS. 5 to 7, the pressure flowing from the valve 125 through conduit B is divided at point D so that part thereof flows to the adjustable throttling valve 205 to feed therefrom to the valve 180 which actuates the cycling valve 55 to reverse the stroke of the piston 25. Thus the valve 180 functions as a reversing valve. Air under full pressure entering valve 205 through its nipple 206 is admitted through the central passage 216 to both chambers 209 and 210. Under normal conditions the pressure entering the lower chamber 210 cannot escape therefrom as the check-valve ball 217 is actuated by the spring 218 to close the port 213. On the other hand, the value of the air pressure flowing into the upper chamber 209 may be regulated by adjusting the needle 219 in the threaded bore in the casing 205 to vary the relationship of its tapered end to the upper port opening from the passage 216. Such adjustment is made to control the amount of pressure issuing through the opening 216 to feed into the upper chamber 209 and thence through the opening 212 into the narrow chamber 208. From the chamber 208 the air feeds into the valve 180 through its nipple 183 for operating the plungers 191, 193 to close the port 192 and simultaneously open the opposite port 198.

As the piston 25 reaches the end of its driving stroke sufficient pressure will have been accumulated by the valve 205 to cause it to actuate the reversing valve 180 and feed the air to the cycling valve 55 for shifting its valve member 65. That is to say, air entering the valve 205 from the branch conduit F will flow through the passage 216 to the chamber 209 with a predetermined value and feeding through the opening 212 to the chamber 208 will be delivered through nipple 183 into the left chamber 186 of reversing valve 180. When sufficient pressure has built up in valve 180 and applied against the left side of the diaphragm 190 to overcome the pressure on its opposite side and the resistance of the spring 197 acting against the diaphragm 196, the plunger 191 will be moved forward to seat it in the left-hand port 192 of the passage 188 and simultaneously unseat the plunger 193 from the opposite port 198. This action occurs because of the greater area exposed to pressure on the left side of diaphragm 190 than the lesser area opposed to pressure on its right side. The area exposed to pressure on the right side of diaphragm 190 is considerably reduced due to co-action between the plungers 193 and 191 which are connected together by the pin 199. The reason for this is that pressure against the end of the plunger 191 be-

comes ineffective since it is counterbalanced by pressure in the opposite direction acting against the end of plunger 193. Therefore, only the reduced area of the diaphragm 190 surrounding the plunger 191 remains exposed to pressure resistant to the force of pressure acting against the left side of said diaphragm. Consequently, when the pressure in chamber 186 of valve 180 reaches its maximum force the diaphragm 190 is flexed to close port 192 and open port 198. By this action the valve 180 is closed against release of pressure from its chamber 186 through the central passage 188 but is opened to receive back pressure from the cycling valve 55. In other words, air pressure in the left end of the valve casing 56 will be released to flow up through duct 182, thence through nipple 181 and passage 188 to enter the chamber 187 of valve 180. From chamber 187 of said valve 180 the air exhausts into the atmosphere through the vent 200. Immediately this relief of pressure in the valve 55 occurs the spring 75 will shift the valve member 65 toward the left to return it to its initial position illustrated in FIG. 3. With the valve member 65 in this last-described position the port 85 in the bottom of the casing 56 is in communication with port 91 at the top to permit air from the main 96 to flow down through pipe 97 and duct 90 into the left end of the cylinder 26. That is, the air will flow through port 85, duct 86 and recess 87 to discharge into the interior of the cylinder 26 for applying pressure to the piston 25 to force it toward the head end of the cylinder. In this way the piston 25 is restored to initial relationship to remain inactive until the machine is again started to operate for applying another staple to the carton; this subsequent operation being initiated after the carton has been moved into position for receiving another staple.

Usually the needle 219 in the variable throttling valve 205 is adjusted to meter the predetermined amount of pressure passing therethrough to effect a slight delay in the operation of the cycling valve 55. In this way, retraction of the piston 25 may be delayed for a slight interval of dwell at the end of its operative stroke for assuring that the legs of the staple are pressed tightly against the material of the carton flaps in a flat clinch. By adjusting the plate 18 in the stapling head 5 to the proper position the relationship between the clinching anvils 15 and the bottom edge of the staple-driver 10 may be so regulated as to cause the clinched legs of staple to be embedded into the material of the flaps.

As the motion of the piston 25 is reversed it will retract the plunger 33 and reconnect it to the crosshead 20, thereby withdrawing the anvil members 15 and releasing them from the carton flaps. The carton may then be displaced from contact with the detector lever 110 and moved to another position if desired; or in case several units of the machine are provided in spaced relation across the table a plurality of staples may be applied simultaneously to complete the sealing operation. Withdrawal of the carton C releases the feeler or detector lever 110 to relieve its pressure on the end of the plunger 140 and thereby permit the starting valve 125 to be reset in closed relationship until another carton is moved into position for stapling. Such actuation of valve 125 is effected by pressure from the residual air in valve 180 and 205 and conduit branches E, F, B after the return of the piston 25 to initial position. The air in chamber 186 of valve 180 will issue through nipple 183 into chamber 208 of valve 205 and react against ball-closure 217 to open port 213. Thus air entering chamber 210 in valve 205 is released through passage 216 and out through nipple 206 to combine with air in conduit B. The air in conduit B enters the starting valve 125 through nipple 132 and is released under full pressure to feed through the central passage 133 by the unseating of plunger 140 from its port 135; this latter action being caused by the spring 150 which at the same time moves plunger 145 to seat it in the port 136 and close valve 125 against ingress of air from supply conduit A. Due to this resetting of valve 125 the air will escape from its lower chamber through the vent 143 to exhaust into the atmosphere. In this way the parts of valve 125 are restored to their initial relationship for starting a subsequent stapling operation when another carton is moved into place to operate the lever 110.

To recapitulate, reference is had to the schematic views (FIGS. 5, 6, 7) which graphically illustrate three phases in the valvular control of the machine. FIG. 5 shows the closure member of cycling valve 55 held by spring 75 to release pressure through main supply conduit 96, 97 and admit it to the cylinder 26 for reaction against the piston 25 to maintain it inactive at the head end of the cylinder. At this time the detector lever 110 is inoperative to open the starting valve 125 and release air through conduits A, B, E, F and valve 180 to the cycling valve 55; that is to say, the air in valves 180 and 205 has been exhausted through vent 143 of valve 125 by the resetting of said valve in the manner previously explained in detail.

FIG. 6 illustrates the detector lever 110 as operated by contact of the carton to open valve 125 and release air through conduit branches A, B, E to feed to valve 180. From said valve 180 pressure is fed to cycling valve 55 to shift its closure and supply air to the head end of cylinder 26 to drive piston 25 for operating the stapling head 5.

FIG. 7 shows the detector valve 125 as still opened by the detector lever 110 with pressure feeding through bypass branch F to the throttling valve 205 to build up pressure in the driver return valve 180 and open its exhaust 200. In this way air is released from the cycling valve 55 to set it with its vent 60 open for exhausting pressure from the head end of the cylinder 26. At the same time said cycling valve 55 is set to apply air to the cylinder 26 for retracting the piston 25 and withdrawing the clinching members 15 from the flaps of the carton.

It will be observed from the foregoing specification that the present invention provides a novel and ingenious valvular control means for automatically and continuously operating a power unit driven by a motive force of compressed air or other suitable pressure fluid. Most important, each of the several valve units is controlled solely by fluid pressure without the use of mechanical trip devices such as cam-means or the like for reversing the stroke of the driving piston. Consequently, wear and deterioration of such mechanical elements is avoided to render the apparatus more efficient in operation and durable in use for long periods of time.

While the present improved apparatus is herein illustrated and described as embodying a preferred form of construction, by way of example, it is to be understood that modification may be made in the structure and arrangement of its parts without departing from the scope of the invention as defined in the following claims.

Moreover, my improved power unit may be applied to use for driving other types of machines without material modification in its structure and arrangement, all within the purview of the present invention. Therefore, without limiting myself in this respect, I claim:

1. In a power unit for driving stapling machines adapted for driving and clinching staples through the flaps of a container, the combination of a power cylinder, a piston reciprocable in said cylinder under the force of pressure fluid, conduits for supplying pressure fluid to said cylinder on the opposite sides of said piston, a valve in one conduit, means to actuate said valve for supplying pressure fluid to one side of the piston to drive it through an operative stroke, a single cycling valve for reversing the direction of flow of pressure fluid to said piston for retracting it in said cylinder, and a throttling valve for accumulating pressure to operate said cycling valve for reversing the stroke of said piston at the completion of each operative stroke.

2. In a power unit for driving stapling or like machines, the combination of a fluid pressure cylinder, a conduit system for supplying pressure fluid to said cylinder on alternately opposite sides of said piston, a starting valve in said

conduit system, means to actuate said starting valve to feed pressure fluid to said cylinder, a single cycling valve operable to control the direction of feed of the pressure fluid to either end of said cylinder, said cycling valve being normaly held in position for feeding pressure fluid to said piston to maintain it retracted at the head end of said cylinder, a reversing valve for resetting said cycling valve to reverse the flow of pressure fluid and drive said piston, and a throttling valve for accumulating pressure to reset said cycling valve to reverse the stroke of said piston after each operative stroke thereof.

3. In an apparatus for sealing cartons and the like embodying a stapling unit having means for driving staples through the flaps of a carton and clinching them on the inside thereof, the combination in a power unit therefor of a pressure cylinder, a piston reciprocable in said cylinder and connected to operate said stapling unit, a conduit system for supplying pressure fluid to said cylinder on opposite sides of said piston, a single cycling valve for controlling the direction of flow of the pressure fluid to said cylinder, said cycling valve normaly operating to direct the pressure fluid to the side of said piston for maintaining it withdrawn to inoperative relationship, a starting valve for applying pressure fluid to cause said cycling valve to direct the pressure fluid to the opposite side of said piston to initiate a driving stroke thereof, means to actuate said starting valve, a return valve for reversing the stroke of said piston, and a throttling valve in said conduit system operative to gradually apply pressure fluid to said return valve for actuating said cycling valve and finally shifting it for reversing the flow of pressure fluid to retract said piston and return it to first position.

4. In fluid pressure means for operating stapling and like machines, the combination of a fluid pressure cylinder, a piston reciprocable in said cylinder, a conduit system for supplying pressure fluid to said cylinder on alternately opposite sides of said piston, a single cycling valve for controlling the direction of feed of the pressure fluid to the different sides of said piston, means to adjust said valve for directing said pressure fluid to one side of said piston to retain it in inoperative relationship, a starting valve for applying pressure to the opposite side of said piston to drive it through an operating stroke, and a throttling valve in the conduit system for building up fluid pressure to shift said cycling valve and apply pressure fluid to the opposite side of said piston for returning it to first position at the head end of the cylinder.

5. In fluid pressure means for driving the reciprocating elements of a machine, the combination of a pressure cylinder, a piston reciprocable in said cylinder, a conduit for supplying pressure fluid to said cylinder to drive said piston in opposite directions, a single cycling valve normally controlling the direction of flow of pressure fluid to said cylinder to maintain said piston inactive at the head end thereof, a conduit leading from a supply of fluid to said cycling valve, a starting valve in said conduit for applying pressure fluid to said cycling valve for setting it to admit pressure fluid to the head end of the cylinder and exhausting pressure from the opposite end of the cylinder for driving the piston in an operative stroke, and a throttling valve for accumulating pressure in said conduit to shift said cycling valve to admit pressure to the opposite end of said cylinder and exhausting pressure from the head end of the cylinder for returning the piston to initial position to start another driving stroke.

6. Fluid pressure operated driving means comprising a power cylinder, a piston reciprocable in said cylinder, a single cycling valve for supplying pressure fluid to said cylinder to drive said piston in an operative stroke, said cycling valve being adapted to apply pressure fluid to the opposite side of said piston to reverse its motion, a starting valve for feeding pressure fluid from a supply to said cycling valve, and a variable throttling valve for progressively building up pressure to actuate said cycling valve to reverse the flow of pressure fluid to said piston.

7. In a driving unit of the type indicated, a power cylinder, a piston reciprocable in said cylinder, a supply of compressed air for reciprocating said piston, a single cycling valve for feeding air pressure first to one side of said piston to drive it in an operative stroke and to the opposite side of said piston for reversing its stroke, a reversing valve for actuating said cycling valve to reverse the stroke of said piston, and a variable throttling valve having adjustable means for progressively building up pressure in said reversing valve to reset the latter for actuating said cycling valve to reverse the direction of flow of pressure in said cylinder for returning the piston to first position after an operative stroke thereof.

8. In a device of the type indicated, a power cylinder, a piston reciprocable in said cylinder, a single cycling valve operable for supplying pressure fluid to said cylinder for driving said piston in an operative stroke, said cycling valve being subject to control for applying said pressure fluid to the opposite side of said piston to reverse its stroke, a reversing valve for actuating the controls of said cycling valve, and a variable throttling valve for progressively building up pressure to actuate said reversing valve to reverse the direction of flow of pressure by said cycling valve.

9. In a power unit for driving a stapling or other machine, the combination of a power cylinder, a piston reciprocable in said cylinder, means to supply pressure fluid to said cylinder for driving said piston, a single cycling valve for alternately feeding pressure fluid to opposite sides of said piston to impart reciprocation thereto, a detector valve for feeding pressure to said cycling valve to drive said piston through an operative stroke, a piston reversing valve, and a variable throttling valve connected to said reversing valve and provided with means for building up fluid pressure in said reversing valve to cause it to shift the controls of the cycling valve whereby to apply pressure to the opposite side of said piston to reverse its direction of motion for returning it to first position.

10. In a device of the type indicated, the combination of a power cylinder, a piston reciprocable in said cylinder by pressure fluid, a single cycling valve connected to said cylinder to alternately supply pressure fluid to opposite sides of said piston, a conduit for feeding pressure fluid from a source of supply to said cycling valve, means in said cycling valve for directing said pressure fluid first to one side of said piston and then to the opposite side thereof, a second conduit for supplying pressure fluid to actuate said cycling valve to control the direction of its feed to said cylinder, a reversing valve in said second conduit, a by-pass conduit connected to said second conduit to feed pressure fluid to said reversing valve, and a variable throttling valve in said by-pass conduit for progressively building up fluid pressure in said reversing valve to shift the controls of said cycling valve for applying pressure to return said piston to first position after each operative stroke thereof.

11. Fluid pressure operated driving means comprising a cylinder, a piston reciprocable in said cylinder, a single cycling valve connected to selectively supply pressure fluid to opposite ends of said cylinder for reciprocating said piston, a conduit for supplying pressure fluid to said cycling valve, means in said cycling valve for directing pressure fluid to the head end of said cylinder to drive said piston through an operative stroke, means in said cycling valve operated simultaneously therewith to exhaust the air from the opposite end of said cylinder during the operative stroke of said piston, said means being shiftable to alternately supply pressure to the opposite end of said cylinder to return said piston to first position, means in said cycling valve operative simultaneously therewith to exhaust the air from the head end of said cylinder during the return of said piston, a reversing valve for actuating said shiftable means in said cycling valve, and means to operate said reversing valve by progressively building up fluid pressure therein to cause it

to reset the shifting means of said cycling valve for reversing the direction of pressure supplied to said cylinder whereby to return said piston to first position.

12. A power unit comprising a cylinder, a piston reciprocable in said cylinder, a source of pressure fluid, a single cycling valve having means for selectively directing pressure fluid from said source to opposite sides of said piston, means in said cycling valve for alternately exhausting pressure from each end of said cylinder as said piston moves toward the respective end thereof, a reversing valve in communication with said cycling valve, and a throttling valve for accumulating pressure in said reversing valve to eventually set said cycling valve for reversing the direction of the pressure fed to the cylinder to return said piston to first position at the completion of each operative stroke thereof.

13. In a power unit for driving a machine, a cylinder, a piston reciprocable by pressure fluid in said cylinder, a source of pressure fluid, a single cycling valve for selectively directing pressure fluid to said cylinder on alternately opposite sides of said piston, a reversing valve for supplying pressure fluid to said cycling valve, a throttling valve for accumulating pressure in said reversing valve to cause it to reset said cycling valve to change the direction of pressure supplied to the cylinder for retracting said piston after each operative stroke thereof, and means for adjusting said throttling valve to reset said cycling valve in timed relation to the completion of each operative stroke of said piston.

14. In a power unit for driving the operating elements of a machine, a cylinder, a piston reciprocable in said cylinder, a source of pressure fluid for reciprocating said piston, a single cycling valve for controlling the direction of pressure fluid supplied to said cylinder, a reversing valve in communication with said cycling valve, a throttling valve for building up pressure in said reversing valve to reset it for changing the direction of pressure supplied to said cylinder by said cycling valve, and means for adjusting said throttling valve to regulate the timing of such change in the direction of pressure supplied to said cylinder to regulate the timing of said piston return after an operative stroke thereof.

15. In a power unit comprising a cylinder, a piston reciprocable in said cylinder, a source of pressure fluid for reciprocating said piston, a single cycling valve for alternately feeding pressure fluid to the opposite ends of said cylinder for reciprocating said piston, means for setting said cycling valve to feed pressure fluid to the head end of said cylinder to drive said piston in an operative stroke, a reversing valve in communication with said cycling valve, a throttling valve for building up pressure in said reversing valve to cause it to reset said cycling valve to change the direction of pressure fed to the cylinder and retract said piston after each operative stroke thereof, and means to adjust said throttling valve to control the amount of pressure fluid fed to said reversing valve and thereby regulate the timing of its resetting for retracting said piston at the end of its operative stroke.

16. In a power unit for driving a machine, a cylinder, a piston reciprocable in said cylinder, a source of pressure fluid for reciprocating said piston, a single cycling valve in communication with opposite ends of said cylinder for supplying pressure fluid thereto, means for setting said cycling valve to selectively feed the pressure fluid alternately to the opposite ends of said cylinder, a starting valve for feeding pressure fluid to the head end of said cylinder to initiate a driving stroke of said piston, means for setting said cycling valve to feed pressure fluid to the opposite end of the cylinder to reverse the stroke of said piston, a reversing valve in communication with said cycling valve, a throttling valve for progressively building up pressure in said reversing valve for causing it to reset said cycling valve after a predetermined time interval to reverse the stroke of said piston, and means for adjusting said throttling valve to vary the time of action of said reversing valve for resetting the cycling valve.

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