

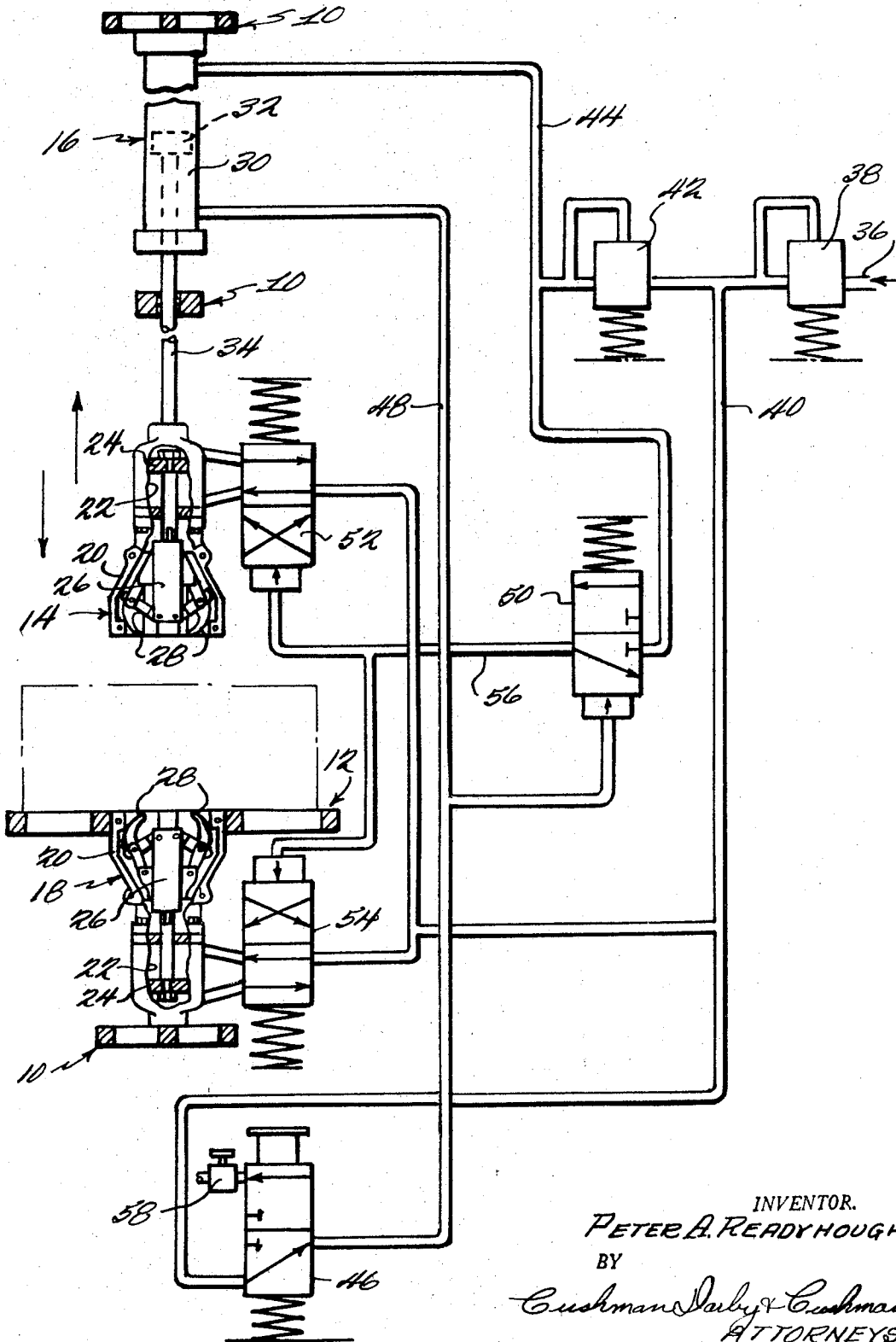
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STAPLING DEVICE CONTROL CIRCUIT

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STAPLING DEVICE CONTROL CIRCUIT

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5 Claims

ABSTRACT OF THE DISCLOSURE

A stapling mechanism of the type including a power operated clincher arm stapling device, a piston and cylinder unit for moving the stapling device toward and away from a workpiece and a fluid pressure control circuit therefor operable to effect movement of the stapling device toward the workpiece by establishing a predetermined pressure differential across the piston of the piston and cylinder unit which changes as a result of the change in motion of the stapling device due to its engagement with the workpiece. The change in the predetermined pressure differential is then used as a signal to actuate the stapling device to effect a stapling operation. The stapling device and piston and cylinder unit are returned sequentially, without the necessity of conventional timing circuitry, since the return movement of the stapling device is signaled by a pressure condition less than that required to return the piston and cylinder unit.

This invention relates to stapling mechanisms and more particularly to a stapling mechanism having an improved fluid pressure control circuit.

While the present invention has general utility as a stapling mechanism for driving fasteners of any type, a preferred embodiment is particularly suited for blind staple sealing filled corrugated cartons. Stapling mechanisms of this type are well known. In a typical installation, the carton is moved on a conveyor table under a top stapling device which is raised and lowered by a pneumatically operated piston and cylinder unit. The piston and cylinder unit operates to move the stapling device downwardly against the top of the box. Typically, a stapling device useful in sealing corrugated cartons includes, in addition to the usual staple driving element, clincher arms means which pierce the carton top and serve as anvils against which the staple is clinched during its driving movement by the driving element. After the staple has been driven and clinched by the stapling device, the piston and cylinder unit then serves to move the head upwardly to allow the carton to be moved to the next staple location or to be discharged after the work is completed. Often, a bottom stapling device is located in the conveyor table in line with the top stapling device and fires simultaneously. Many machines of this type are available, varying in complexity and number of added features, such as carton centering means, and the like. Occasionally machines are constructed with a larger number of stapling devices, as, for example, two top and two bottom stapling devices, for sealing a medium sized carton in one cycle.

The action of the clincher arm means in stapling devices of the type described above necessitates the engagement of the head of the stapling device with the carton prior to the carton piercing stroke of the clincher arm means. Moreover, the clincher arm means must be moved through a retraction stroke before the head can be moved out of engagement with the carton. In order to accomplish this action it has been conventional practice heretofore to provide a normally closed mechanically actuated trip valve on the moving head of the top stapling device which is

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shifted in response to engagement with the top of the carton. The signal from this trip valve may shift the main control valve of the stapling device or devices to extend the clincher arms, but this signal must be released to return the clincher arms before the top stapling device head is removed from the top of the carton. Since a mechanically actuated valve on the head is not reset until the head is raised, a timed circuit must be interposed between the trip valve and the control valve to release the signal after a predetermined interval. If the signal is released too early, movement of the top stapling device head with the clincher arms extended may tear the carton and ruin the seal.

An object of the present invention is the provision of a stapling mechanism embodying fluid pressure circuitry which eliminates the conventional mechanically actuated trip valve and its attendant linkages and piping mounted on the moving head of the top stapling device.

Another object of the present invention is the provision of a stapling mechanism of the type described having improved fluid pressure circuitry for controlling the operation of the stapling device without the necessity of providing adjustable timing circuitry elements.

Still another object of the present invention is the provision of a stapling mechanism of the type described which is simple in construction, effective in operation and economical to manufacture and maintain.

These and other objects of the present invention will become more apparent during the course of the following description and appended claims.

The invention may best be understood with reference to the accompanying drawing, wherein an illustrative embodiment is shown.

The drawing is a schematic view of a stapling mechanism embodying the principles of the invention.

As shown, the stapling mechanism of the present invention includes conventional components such as a frame assembly, generally indicated at 10, providing a horizontally extending table structure 12 for receiving a workpiece such as a carton, or the like, a top stapling device 14, mounted on the frame 10 above the table 12 for vertical reciprocating movement, as by a piston and cylinder unit 16, and a bottom stapling device 18 fixedly carried by the table structure 12 in a position of vertical alignment with respect to the top stapling device 14.

As previously indicated, the above-mentioned components of the present stapling mechanism may be of conventional construction. An example of these conventional components is described in detail in a publication entitled "Instruction and Parts List of the Bostitch D17BT Boxlok Top and Bottom Stapler." Another example of conventional component elements which may be utilized in the present stapling mechanism is disclosed in commonly assigned Kufel Patent 3,064,626, dated Nov. 20, 1962, the disclosure of which is hereby incorporated by reference into the present specification.

As disclosed in the aforesaid publication and Kufel patent, each of the stapling devices 14 and 18 includes a stapler head or housing 20 defining a driving cylinder 22 at one end thereof, a driving piston 24 reciprocally mounted within the driving cylinder, a staple driving element 26 operatively connected with the driving piston and clincher arm means in the form of a pair of pivoted clincher arms 28 operatively connected with the driving piston 24. The specific manner in which the clincher arms 28 and driver element 26 are operatively connected with the driving piston is disclosed in the aforesaid publication and Kufel patent. In this regard, further reference may be made to commonly assigned Allen Patent 2,899,679, dated Aug. 18, 1959, the disclosure of which is hereby incorporated into this specification.

For present purposes it is sufficient to note that the driving piston 24 of each stapling device is mounted within the associated driving cylinder 22 for movement between first and second positions. This movement is accomplished by communicating air under pressure with the driving cylinder on one side of the driving piston while exhausting the other, and then reversing these pressure conditions. During the movement of the driving piston 24 from its first position to its second position, the clincher arms 28 are moved through a workpiece piercing stroke and the driver element 26 is moved through a staple driving stroke. In this way, the staple driven by staple driving element is moved into the workpiece and clinched therein by engagement with the clincher arms. During the movement of the driving piston from its second position to its first position, the clincher arms are moved through a workpiece retraction stroke and the driver element is moved through a return stroke.

The piston and cylinder unit 16 is of conventional construction, including a cylinder 30 fixed to the frame assembly 10 and having a piston 32 of conventional construction mounted therein for vertical reciprocation between an uppermost limiting position and a lowermost limiting position. Connected with the lower side of the piston 32 is the upper end of a piston rod 34 which extends downwardly in slidably sealing relation through the lower end of the cylinder and has its lower end fixedly connected with the housing 20 of the upper stapling device 14. The upper stapling device is thus movable vertically through a path which corresponds with the vertical stroke of the piston and cylinder unit 16. The path of movement of the top stapling device 14 determines the range of carton sizes which can be accommodated by the stapling mechanism. The range itself can be adjusted by adjusting the vertical position of the piston and cylinder unit 16 with respect to the table structure 12 in conventional fashion.

The fluid pressure circuitry for controlling the operation of the piston and cylinder unit 16 and stapling devices 14 and 18 includes a main fluid pressure line 36 which is adapted to be connected to a source of fluid under pressure, such as an air compressor, or the like (not shown). The main pressure line communicates with a high pressure regulator 38, of conventional construction, operable to maintain the air in a main high pressure line 40 at a predetermined pressure as, for example, 80 p.s.i. The main high pressure line 40 communicates with a low pressure regulator 42, of conventional construction, operable to maintain the air in a main low pressure line 44 at a second predetermined pressure lower than the first as, for example, 30 p.s.i. (All pressures are p.s.i.g. unless otherwise noted.)

The upper end of cylinder 30 is communicated directly with the low pressure line 44 so that low pressure is at all times maintained within the upper end of the cylinder acting on the upper side of the piston 32. The lower end of the cylinder 30 is communicated with high pressure line 40 under the control of a control valve 46. As shown, the valve 46 is of any conventional design, preferably of the type which is normally spring-pressed into an open position to communicate the main high pressure line 40 with the lower end of the cylinder 30 through a pressure control line 48. The valve 46 is arranged to be moved manually out of its normal position into an actuating position wherein the main high pressure line 40 is closed and the control line 48 is restrictingly exhausted to atmosphere, as through a restricted orifice embodied in the valve or a flow restrictor provided beyond the exhaust outlet of the valve or upstream of the valve.

As stated above, when the control valve 46 is in its normal open position, high pressure in the main high pressure line 40 communicates with the lower end of cylinder 30 through the control line 48. Since this pressure is higher than the low pressure communicating

with the upper end of the cylinder 30, piston 32 is urged upwardly and maintained in its uppermost limiting position. When the control valve 46 is moved into its actuating position, the high pressure within the lower end of the cylinder 30 is allowed to restrictingly exhaust so that at the point at which the low pressure within the upper end of the cylinder is sufficient to overcome the diminishing pressure condition within the lower end of the cylinder, piston 32 will begin moving downwardly which, in turn, will move the top stapling device 14 downwardly. The restriction of the flow of the high pressure fluid within control line 44 to atmosphere is such that so long as the downward movement of the piston 32 continues, the pressure within the lower end of the piston and cylinder unit and the control line 48 will not reach atmospheric pressure. That is, when the control valve 46 is moved into its actuating position the high pressure in line 48 will drop from its normal valve of 80 p.s.i. down to a value at which movement of the piston occurs and this value is substantially maintained so long as the movement of the piston continues. For example, this reduced pressure may be somewhat greater than the pressure in the low pressure line 44 due to the piston rod displacement area. When the downward movement of the piston 32 is arrested, as by the stapling device 14 engaging the top of a carton to be sealed, the pressure within the lower end of the cylinder 30 and control line 48 will then exhaust to atmosphere.

In accordance with the principles of the present invention, this change in the pressure condition within the control line 48 which is occasioned by the engagement of the top stapling device with the top of the carton to be sealed, is utilized to signal the operation of the stapling device or devices. In the embodiment shown, the pressure change within the control line 48 is utilized as pilot pressure to operate a pilot pressure actuated valve mechanism 50 which, in turn, controls pilot pressure from the main low pressure line 44 to a pair of pilot pressure actuated four-way control valves 52 and 54. The control valves 52 and 54 serve to control communication of high pressure air to the driving cylinders 22 of the stapling devices 14 and 18.

In the embodiment shown, valves 52 and 54 are highly "boosted" valves capable of being actuated by pilot pressure substantially less than the pressure which the valves control. Both of the valves 52 and 54 are of conventional construction, preferably normally spring urged into a position wherein fluid from the main high pressure line 40 is communicated with the associated driving cylinder 22 on the side of the driving piston 24 acting to urge the driving piston into its first position. Each driving cylinder on the opposite side of the piston is exhausted to atmosphere in the normal spring pressed position of each of the valves 52 and 54.

OPERATION

When the stapling mechanism of the present invention is disposed in its inoperative position, the piston 32 of the piston and cylinder unit 16 is disposed in its uppermost position, which in turn positions the top stapling device 14 in its uppermost position so that a carton may be engaged upon the table structure 12 between the top and bottom stapling devices for the purpose of sealing the flaps thereof with staples. Control valve 46, when disposed in its normal position, permits the flow of high pressure fluid from the main high pressure line 40 to the lower end of the cylinder 30 through control line 48. The pressure in control line 48 also serves to actuate pilot pressure controlled valve 50, which is thus maintained in a position to exhaust pilot pressure lines 56. Since pilot pressure lines 56 are exhausted valves 52 and 54 are disposed in their normal spring pressed position, as shown, communicating high pressure from the main line 40 to the driving cylinders of the devices 14 and 18 on the side of the

driving pistons thereof acting to move the driving pistons into their first positions. The pressure in the lower end of the cylinder 30 serves to maintain the top stapling device 14 in its uppermost position, notwithstanding the fact that low pressure line 44 is communicated with the upper end of the cylinder. As previously stated, the high pressure (e.g. 80 p.s.i.) communicated with the lower end of the cylinder 30 is sufficient to overcome the low pressure (e.g. 30 p.s.i.) in the line 44 communicated with the upper end thereof.

The operation of the stapling mechanism is commenced by actuating the control valve 46, which closes off the communication of the main high pressure line 40 and restrictingly exhausts the control line 48 to atmosphere. As previously stated, the high pressure in the control line 48 will drop until the low pressure in line 44 communicating with the upper end of the cylinder 30 is sufficient to commence the downward movement of the piston 32 and hence the top stapling device 14 movable therewith. So long as the piston 32 and top stapling device 14 move downwardly, the pressure in the control line 48 will not reduce to atmospheric pressure but will be maintained at a valve somewhat above the pressure in line 44 (due to the piston rod displacement), as for example, 35 p.s.i. This value may closely approximate the pressure in line 44 due to the assistance of the gravity in the downward movement of the top stapling device.

When the stapling device 14 engages the top of the carton to be sealed and the downward movement thereof is thereby arrested, the pressure in the control line 48 will then exhaust to atmosphere. This change in the pressure in the control line 48 affects movement of the valve 50 into its normal spring-pressed position, when the pressure in the control line drops below the pilot actuating pressure thereof, as for example, 30 p.s.i. Here again, the gravity and inertia will affect the particular operation. Movement of valve 50 communicates the low pressure line 44 with the pilot pressure lines 56. As soon as the pilot pressure lines 56 are pressurized to a value substantially less than the pressure of high pressure line 40 as, for example 15 p.s.i., valves 52 and 54 are actuated to reverse the pressure conditions within the driving chambers 22 of the stapling devices 14 and 18, to thereby effect movement of the driving pistons from their first positions to their second positions.

In this way it can be seen that the pneumatic circuitry of the present invention is operable to effect a stapling operation immediately in response to the engagement of the top stapling device 14 with the top of the carton to be sealed. As previously indicated, during the movement of the driving pistons from their first position to their second position, the clincher arms 28 are moved through a carton piercing stroke and the staple driving elements 26 are moved through a staple driving stroke to drive and clinch staples within the top and bottom of the carton.

After the staples have been driven and clinched, the operator releases the control valve 46 permitting the latter to return to its spring pressed position, which communicates the high pressure line 40 with the control line 48. Since the valve 50 is set to actuate at a pilot pressure (e.g. 30 p.s.i.) which is less than the pressure in high pressure line 40 (e.g. 80 p.s.i.), valve 50 will move into its second position dumping the pilot pressure lines 56 to atmosphere before the pressure within the control line 48 has increased sufficiently to overcome the low pressure acting on the upper end of the piston 32. Thus, the initial dumping of the pilot lines 56 will permit spring pressed actuation of valves 52 and 54 which reverses the pressure conditions in the driving chambers 22 and commences the movement of the driving pistons 24 from their second position toward their first position. During the initial portion of this movement, clincher arms 28 are moved through their carton retraction stroke. In this way, the pneumatic circuitry is operable to retract the clincher

arms prior to the commencement of the upward movement of the top stapling device 14. It will be noted that this objective is accomplished without the provision of a conventional timing circuit.

The restriction to the flow of fluid out of the control line 48 to atmosphere determines the speed of descent of the top stapling device 14. If desired, an adjustable means, schematically illustrated at 58, may be provided to control the size of the restriction and hence control the speed of descent to accommodate varying characteristics of the cartons to be sealed.

While the circuit as described above is preferred, it will be understood that modifications may be utilized within the scope of the present invention. For example, the valves 52 and 54, rather than being of the highly boosted type, could be conventional pilot pressure operated valves in which the same pilot pressure is required for actuation as the pressure which is regulated (e.g. 80 p.s.i.). Under these conditions, valve 50 would be a highly boosted pilot pressure operated valve capable of being actuated by a pilot pressure considerably less than regulated pressure (e.g. 15 p.s.i.). Thus, instead of controlling the connection of the pilot pressure lines 56 with the low pressure line 44, as shown, under these circumstances the valve 50 would serve to control the connection of the pilot pressure lines 56 with the main high pressure line 40. It will also be understood that the valve 50 could be a four-way pilot pressure controlled valve of the highly boosted type (e.g., actuating at 15 p.s.i.) which would serve to directly control the pressure conditions (e.g. 80 p.s.i. opposed to atmosphere) within a single driving chamber of a single staple driving device or a pair of such devices, such as shown.

It will also be understood that the circuitry is not limited to manually actuated control valves and that it may be utilized in a fully automated machine. An example of an arrangement of this type is disclosed in commonly assigned Boulay et al. application Ser. No. 600,163, filed Dec. 8, 1966.

It thus will be seen that the objects of this invention have been fully and effectively accomplished. It will be realized, however, that the foregoing specific embodiment has been shown and described only for the purpose of illustrating the principles of this invention and is subject to extensive change without departure from such principles. Therefore, this invention includes all modifications encompassed within the spirit and scope of the following claims.

What is claimed is:

1. A stapling mechanism comprising means for receiving a workpiece to be stapled, a stapling device having power operated means actuatable to effect a stapling operation of said stapling device, means mounting said stapling device for movement toward and away from a workpiece received on said workpiece receiving means, said mounting means including a piston and cylinder unit operable in one direction to move said stapling device toward the workpiece and in the opposite direction to move said stapling device away from the workpiece, means for establishing a predetermined differential fluid pressure condition within said piston and cylinder unit on opposite piston sides thereof operable to effect a movement of said stapling device toward the workpiece so that upon engagement of said stapling device with the workpiece during such movement said predetermined fluid pressure condition is changed within said piston and cylinder unit as a result of the change in motion of said stapling device due to its engagement with the workpiece, and means operable in response to the change in said predetermined fluid pressure condition within said piston and cylinder unit for actuating the power operated means of said stapling device to effect a stapling operation thereof.

2. A stapling mechanism as defined in claim 1 wherein said means for establishing said predetermined differential fluid pressure condition includes means for communicating air under a first predetermined pressure with the

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side of said piston and cylinder unit acting to urge said stapling device toward the work piece and valve means operable in one position for communicating air under a second predetermined pressure higher than said first predetermined pressure with the opposite side of said piston and cylinder unit to thereby overcome the first predetermined pressure acting on the first mentioned side of said piston and cylinder unit and urge said stapling device away from the workpiece and operable in a second position for restrictingly exhausting the opposite side of said piston and cylinder unit to atmosphere to permit said first predetermined pressure acting on the first mentioned side of said piston and cylinder unit to urge said stapling device toward the workpiece and effect movement thereof at a rate such that the restrictingly exhausting air does not fall below a predetermined control pressure until the movement of the stapling device is arrested by engagement with the workpiece.

3. A stapling mechanism as defined in claim 2 wherein said power operated means includes a driving piston mounted for movement between first and second positions and wherein said stapling device further includes a staple driving element operatively connected with said driving piston for movement through a staple driving stroke in response to the movement of said driving piston from said first position to said second position and for movement through a return stroke in response to the movement of said driving piston from said second position to said first position and clincher arm means operatively connected with said driving piston and said staple driving element for movement through a workpiece piercing stroke in response to the movement of said driving piston from said first position to said second position so that a staple driven by said staple driving element is clinched by said clincher arm means and for movement through a workpiece retracting stroke in response to the movement of said driving piston from said second position to said first position.

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4. A stapling mechanism as defined in claim 3 wherein said pressure change responsive means comprises valve means operable when the air communicating with the opposite side of said piston and cylinder unit is below said predetermined control pressure for communicating air under pressure with said driving piston to establish a pressure differential across said driving piston acting in a direction to move said driving piston from said first position to said second position and operable when the air communicating with the opposite side of said piston and cylinder unit is above said predetermined control pressure for communicating air under pressure with said driving piston to establish a differential pressure across said driving piston acting in a direction to move said driving piston from said second position to said first position.

5. A stapling mechanism as defined in claim 4 including a second stapling device similar to said first mentioned stapling device mounted in spaced aligned relation with respect thereto and wherein said valve means includes a pair of pilot pressure actuated valves for controlling the communication of air under pressure with the driving pistons of both of said stapling devices and a control pressure actuated valve for controlling the communication of pilot pressure with said pilot pressure actuated valves.

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