Jan. 26, 1971 V. L. HESLOP ET AL 3,557,597

RIVETING APPARATUS

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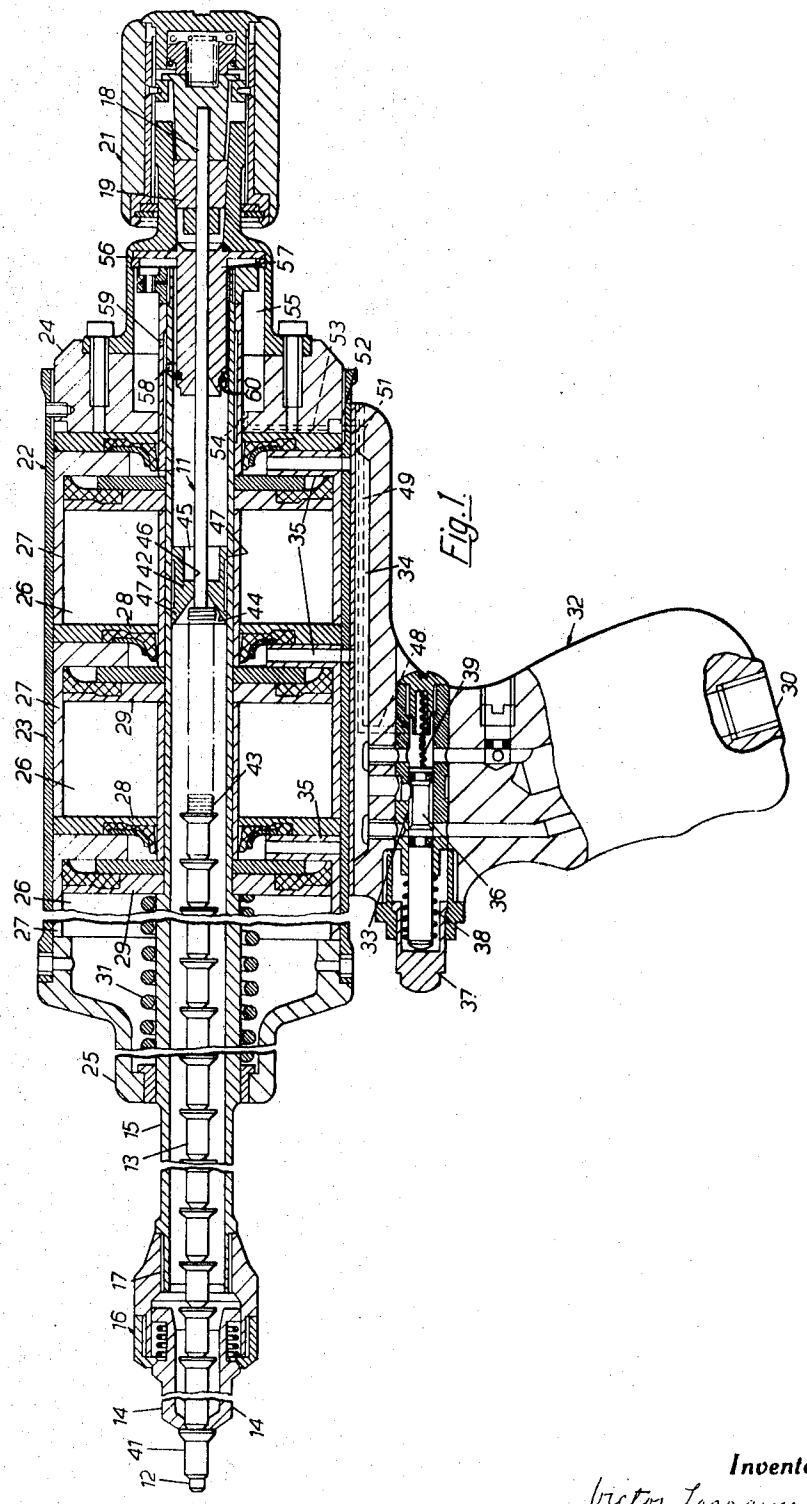

Fig. 1.

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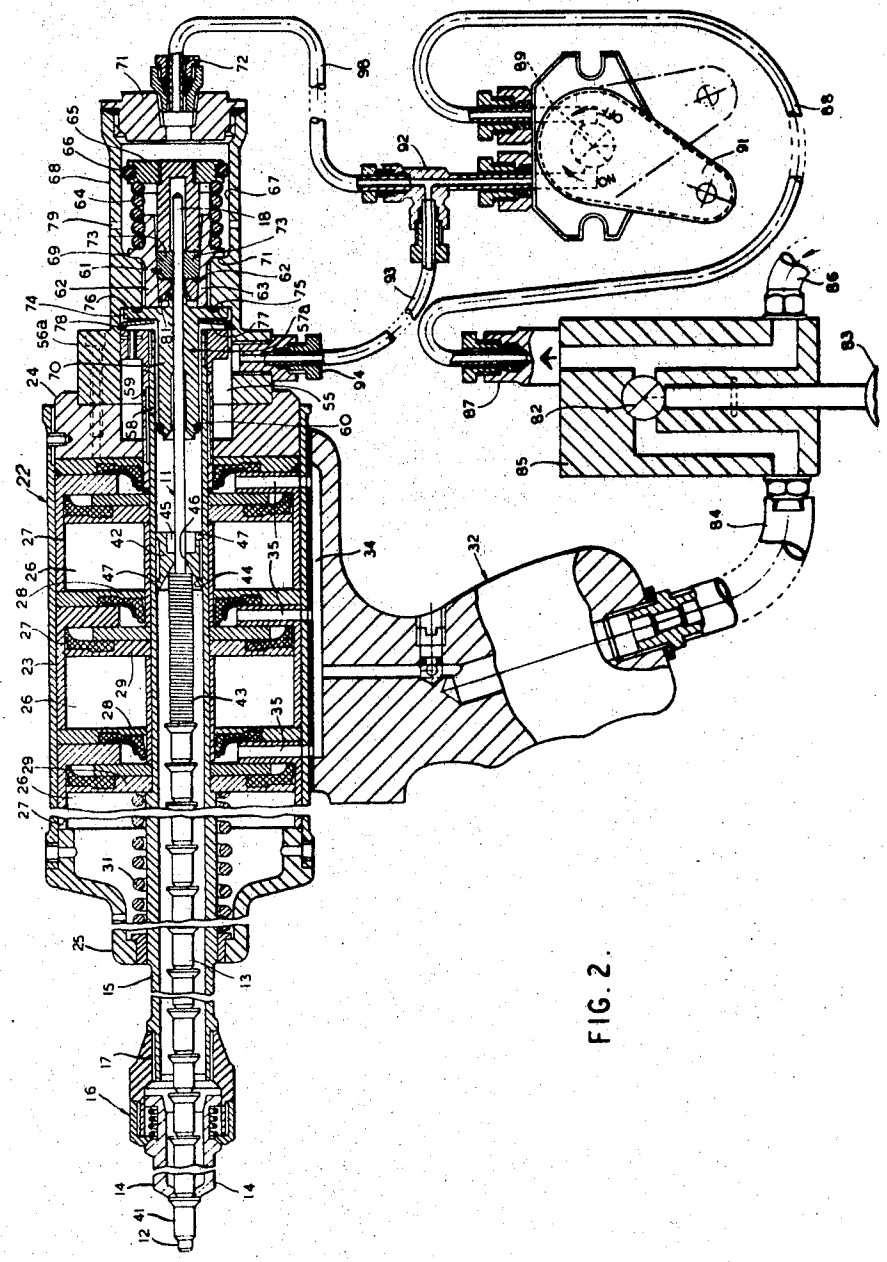

FIG. 2.

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RIVETING APPARATUS

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Int. Cl. B21d 9/05
U.S. Cl. 72—391 12 Claims

ABSTRACT OF THE DISCLOSURE

A repetition blind-riveting gun, of the type in which a column of tubular rivets is carried on a mandrel having an enlarged head which is pulled through each rivet in turn to expand it, has a pneumatically-operated device for feeding the column of rivets forward after each operation. This device comprises a piston, slidable along the mandrel, to the rear side of which compressed air is supplied once in each cycle of operation of the gun. There may also be provided a relief valve for automatically venting to atmosphere this compressed air supply if the mandrel is not securely gripped by the jaw-mechanism which holds it in the gun.

The invention relates to riveting apparatus, and more particularly to riveting apparatus of the kind which comprises: a mandrel adapted to carry a plurality of tubular rivets thereon and having an enlarged head which is pulled through each rivet in turn to set it by expanding its tail; jaws through which the mandrel extends, the jaws and the mandrel being relatively reciprocable axially of the mandrel during use of the apparatus thereby to provide a feed stroke during which the leading rivet passes through the jaws which then close to provide an abutment for the head of the rivet, and a working stroke during which the mandrel head and the jaws move relatively towards each other to expand the tail of the rivet; and rivet feeding means for automatically feeding rivets one at a time through the jaws.

Such a riveting apparatus is hereinafter referred to as "riveting apparatus of the kind specified."

The invention provides, in one of its aspects, riveting apparatus of the kind specified in which the feeding means is arranged to provide a thrust on at least the leading rivet sufficient to pass it through the jaws during the feed stroke whilst exerting a compressive thrust on the mandrel which is less than the aforesaid sufficient thrust and less than the maximum compressive thrust which the mandrel can sustain without distortion.

The invention provides, in another of its aspects, riveting apparatus of the kind specified in which the rivet feeding means is arranged to provide a thrust on at least the leading rivet sufficient to pass it through the jaws during the feed stroke without exerting any compressive thrust on the mandrel.

The invention provides, in another of its aspects, riveting apparatus of the type specified including power means for relatively reciprocating the jaws and mandrel, which power means are at least partially pneumatic, in which apparatus the rivet feeding means is pneumatically operated.

(The terms "pneumatic" and "pneumatically" are used in this specification to include the use of increased or reduced pressure of any suitable gas, unless the context demands otherwise.)

It is preferred that the riveting apparatus includes pneumatic control means for automatically operating the rivet feeding means in accordance with the relative axial position of the jaws and mandrel so as to pass the leading rivet through the jaws during each feed stroke.

Where the riveting apparatus includes a barrel or other tube-like member in fixed axial relationship to the jaws and through which the mandrel extends, the pneumatically operated feeding means preferably comprises a piston member slidable within the tube-like member and around the mandrel, and means for applying pneumatic pressure to the side of the piston member remote from the jaws.

Preferably the said means for applying pneumatic pressure includes the aforesaid pneumatic control means.

Preferably the pneumatic control means comprises a valve member reciprocable in unison with the mandrel along the tube-like member to co-operate with pneumatic port means carried by or in the tube-like member, thereby to apply pneumatic pressure as aforesaid in accordance with the relative axial position of the jaws and mandrel. Preferably the arrangement is such that pneumatic pressure is applied as aforesaid when the mandrel is positioned relatively to the jaws more than a predetermined extent in the direction opposite to that in which rivets are fed (i.e. at the beginning of the feed stroke).

Preferably the arrangement is such that after an initial application of pneumatic pressure, the pressure decays due to leakage. For example, it may be arranged that leakage occurs between the piston member and the mandrel, and/or the piston member and the tube-like member.

When the riveting apparatus includes a barrel or other tube-like member in fixed relationship to the jaws and through which the mandrel extends, and the pneumatically operated feeding means comprises a piston member slidable within the tube-like member and around the mandrel and means for applying pneumatic pressure to the side of the piston member remote from the jaws, preferably the riveting apparatus also includes mandrel gripping means for receiving and gripping the tail end of the mandrel, and pressure prevention means, operated by the mandrel-gripping means, to prevent the application of pneumatic pressure to the side of the piston member remote from the jaws automatically if and whenever a mandrel is not received and gripped by the mandrel-gripping means.

Preferably the pressure prevention means comprises venting means for venting or relieving any pneumatic pressure.

Where the mandrel-gripping means comprises externally-tapered jaw members urged into an internally-tapered housing so that the jaw-members are urged to close together to grip a mandrel received between them, the pressure prevention means is preferably responsive to the extent to which the jaw-members enter the housing which depends upon the presence or absence of a mandrel between the jaw-members. The said responsive means may comprise valve means including a valve member which is normally biassed into one position and arranged to be moved to a second position by the jaw-members when they enter the housing to the increased extent allowed by the absence of a mandrel between them.

Where the mandrel-gripping means is pneumatically actuated to grip a mandrel, there may be provided common valve means controlling the pneumatic supply to both the aforesaid pneumatically operated rivet feeding means and to the mandrel-gripping means.

Two specific embodiments of the invention will now be described by way of example and with reference to the accompanying drawings, in which FIGS. 1 and 2 are both axial longitudinal sections through a riveting gun.

The riveting gun illustrated in FIG. 1 includes a mandrel **11** extending substantially throughout the length of

the gun, and having an enlarged head **12**. A plurality of tubular rivets **13** are threaded on the mandrel, and the head **12** is pulled through each rivet in turn to set it by expanding its tail. These rivets are of the type well known in many countries under the trademark "Chobert". The gun has jaws **14** through which the mandrel etxends, the jaws **14** and mandrel **11** being relatively reciprocable axially of the mandrel during use of the gun. The jaws **14** are spring urged together to close behind a rivet which has been fed through them, so that its head end abuts against them. A tube-like member in the form of a barrel **15** extends through the gun, along most of the mandrel **11**, except for a short length at each end of the mandrel. The jaws **14** form part of a jaw assembly **16** which is screw-threaded at **17** to the end of the barrel **15** nearer the head **12** of the mandrel. The rear end **18** of the mandrel **11** is securely gripped in a chuck **19** which is mounted by means of an axially adjustable device **21** and a mounting boss **56** on the rear end wall **24** of the main body casing **22** of the gun. The body casing **22** comprises a cylindrical shell **23**, a rear end wall **24** and a front end wall **25**. The interior of the main body **22** is divided axially into three cylinder spaces **26** by means of fixed liners **27** and partitions **28**. Three pistons **29** are secured to the barrel **15** to co-operate with the three cylinder spaces **26**. The barrel is urged rearwardly with respect to the mandrel and main body casing of the gun by means of a strong helical compression spring **31** working between the front end of the front body member **25** and the nearest piston **29**. Thus the spring **31** urges the jaws **14** rearwardly (i.e. in the opposite direction to which rivets are fed through the jaws), with respect to the mandrel **11**, into the position which is shown in the accompanying drawing.

The triple piston and cylinder arrangement forms part of pneumatic power means for reciprocating the barrel and jaws with respect to the mandrel.

Secured to the bottom of the main body casing **22** is a handle casting **32** which forms a pistol grip for the gun. A compressed air supply hose (not shown) is attached to the gun by means of a connector **30** in the pistol grip. From this compressed air is supplied, under the control of valve means **33**, through a main supply conduit **34** in the top of the handle casting and through three separate bores **35** in the liners **27** to the space between each partition **28** and the piston **29** adjacent to it. The valve means **33** includes a valve member **36** movable axially by pressure of the operator's finger on a trigger button **37**. The valve member **36** is urged by means of springs **38** and **39** into the position shown in the accompanying drawing, in which it prevents the feeding of compressed air to the three pneumatic cylinders. When the trigger button **37** is depressed, the valve member moves axially to admit compressed air to the three cylinders. The barrel **15** and jaws **14** are thereby driven, against the urging of spring **31**, forwardly with respect to the mandrel **11**, thus pulling the mandrel head **12** through the tail of the leading rivet **41** which is outside the jaws **14**. This expands the tail of the rivet and upsets the rivet in the hole in the workpiece in which it is located. This movement of the gun constitutes the working stroke. When pressure on the trigger button **37** is released, the supply of compressed air to the cylinders is cut off and the barrel **15** and jaws **14** return, under the urging of the spring **31**, to the position shown in the accompanying drawing. This constitutes the feed stroke, during which the next leading rivet is fed through the jaws.

The gun in this example has pneumatically operated rivet feeding means which operates by pneumatically applying a thrust to the column of rivets on the mandrel at the beginning of, and during part of, the feed stroke.

The pneumatic feeding means includes a piston member **42** which is slidable along the mandrel behind the column of rivets and inside the barrel **15**. The piston **42** is a sufficiently close fit inside the barrel and around the mandrel that when pneumatic pressure from the compressed air supply to the gun is applied to the rear of the piston sufficient thrust is provided to force the leading rivet through the spring-loaded jaws **14**. However it is arranged that there is sufficient leakage of air around the piston and between the piston and the mandrel that the compressed air applied to its rear can slowly leak away. A helical compression spring **43** is provided between the rearmost rivet and the leading side of the piston, through which the thrust is transmitted from the piston to the column of rivets. The leading side of the piston has an internal taper **44** for receiving and locating the adjacent end of the spring **43**, while the rear side of the piston, to which the pneumatic pressure is applied, is counterbored at **45** so that only a small annular land **46** remains to seal (or nearly seal) around the mandrel. The periphery of the piston also has a shallow axial groove intermediate its ends thereby to leave two small annular lands **47** to seal (or nearly seal) against the barrel **15**. The short axial length of the three annular lands **46**, **47** and **47** allows the above mentioned leakage of air past the piston.

In order to supply pneumatic pressure to the rear of the piston **42**, a bore **48** is provided in the handle casting **32**, connecting the valve means **33** with a further bore **49** running along the handle casting, parallel to but spaced apart from the passage **34**, towards the rear end of the gun. The passage **49** communicates with a further radial bore **51** through the rear end wall **24** of the main body casing. A further radial passage **53** through the rear wall **24** communicates with a short axial passage **54** and thereby with the space **55** around the rear end of the barrel **15** and inside the mounting boss **56**. Secured to the chuck mounting device **21** and the mounting boss **56** is a forwardly extending plug **57** in substantially sealing relationship with the rear end of the mandrel. The forward end of this plug has a circumferential groove in which is seated an O-ring seal **60** which seals with the plug and also seals slidingly with the inside of the rear end of the barrel **15**. A port **58** in the rear end of the barrel communicates, by a further port **59** in a rearward extension of the rear end wall **24**, with the space **55**.

The operation of the pneumatic rivet feeding means and the pneumatic control means therefor is as follows. The arrangement of the bore **48** with the valve means **33** is such that, when the trigger button **37** is not depressed (i.e. when it is in the position shown in the accompanying drawing) the bore **48** communicates with the compressed air supply from connector **30**, so that compressed air is fed into the space **55** and through the barrel port **58**. However, the positioning of the barrel port **58** with respect to the O-ring seal **60** is such that when the gun is at the beginning of a working stroke (which is the normal condition of the gun when it is not actuated and is the condition shown in the accompanying drawing), the seal **60** lies between the port **58** and the piston **42**, thereby preventing the application of pneumatic pressure to the piston. The arrangement of the bore **48** with respect to the valve means **33** is also such that, when the trigger button is depressed to produce a working stroke of the gun, the valve member **36** cuts off the supply of compressed air to the bore **48**. Consequently, when, during the working stroke of the gun, the barrel **15** moves forwardly with respect to the mandrel so that the barrel port **58** moves to a position between the O-ring seal **60** and the piston **42**, there is no supply of compressed air behind the barrel port **58** so that pneumatic pressure is not applied to the piston **42** during the working stroke of the gun. (Any residual air pressure in the space **55** and its associated conduits is insufficient to have any substantial effect on the piston **42**.) When the working stroke has been completed and the rivet is set, the release by the operator of the trigger button **37** not only allows the barrel to return under the urging of spring **31** to its original position as previously described, but also reconnects the bore **48** to the gun compressed air supply and consequently

reconnects the compressed air to the space **55** and to barrel port **58**. When this reconnection of compressed air occurs, at the beginning of the feed stroke, the barrel port **58** is, as previously explained, between the O-ring seal **60** and the piston **42**. Consequently the compressed air applies pneumatic pressure to the rear of the piston **42**, thus transmitting sufficient thrust through the spring **43** to the column of rivets on the mandrel to pass the next leading rivet through the spring-loaded jaws **14** as the jaws move rearwardly with respect to the mandrel under the urging of spring **31**. As the feed stroke progresses the O-ring seal **60** again passes the barrel port **58** and seals off the supply of compressed air to the rear of piston **42**. Any residual air pressure in the space between the piston **42** and the O-ring seal **60** leaks away around the piston **42**, as previously explained, so that by the time the barrel and mandrel have returned to the relative positions illustrated in the accompanying drawing, there is substantially no pneumatic thrust on the piston **42**.

The rivet feeding means previously provided on such guns have relied upon the axial thrust imparted to the mandrel, in the direction towards the mandrel head, by the chuck **18**, to force the rivets towards the jaws and pass the leading rivet through the spring-loaded jaws. When using a riveting gun for small diameter rivets, which is fitted with a correspondingly small diameter mandrel, such a rivet feeding means can cause the rear part of the mandrel to distort or even collapse under the thrust required to force the leading rivet through the jaws. The gun described in the foregoing example, incorporating the pneumatic feeding means as described, is advantageous in that no compressive thrust is applied to the mandrel during the feed stroke, the thrust required to force the leading rivet through the jaws being applied to the rivet quite independently of the mandrel.

The cutaway portions of the piston 42 reduce the mass and inertia of the piston. This low inertia is advantageous. When a rivet is set and the mandrel head pulled through the rivet, the mandrel head is suddenly released and flies back through the jaws and strikes the tail end of the next rivet inside the jaws. If the piston and column of rivets have a high inertia, they will resist movement and the rivet struck by the mandrel head may be prematurely expanded. The low inertia of the piston helps to reduce this possibility.

The riveting gun illustrated in FIG. 2 is a modification of that illustrated in FIG. 1. It is essentially the same in construction and illustration as that illustrated in FIG. 1, and only the differences between the two guns will be described.

The two major differences of the gun illustrated in FIG. 2 from that illustrated in FIG. 1 are firstly that it has a pneumatically operated mandrel-gripping means in the form of a chuck mechanism **61**, and secondly that the arrangement for the supply and control of the compressed air to the gun are rather different. As in the previously described example gun, the chuck comprises a pair of externally tapered jaw members **62** urged into an internally tapered housing **63** to close together to grip the end part **18** of the mandrel between them. However, in the gun illustrated in FIG. 2 the jaw members **62** are urged into the tapered housing **63** by pneumatic pressure against the urging of a hedlical compression spring **64** which surrounds the jaw members. The rear end of the jaw members are held in a plunger **65** with an O-ring seal **66** around its periphery which seals against the walls of a bore **67** in the rearward extension **68** of the boss **56***a* at the rear of the gun which contains the chuck mechanism. The jaw housing **63** has an externally extending annular flange **69**, the forward side of which abuts against an annular shoulder **71** in the bore **67** and against the other side of which acts one end of the spring **64**. The other end of the spring **64** acts against the plunger **65** which carries the rear of the jaw members. The space in the bore **67** behind the plunger **65** is sealed by an end plug **71** through which compressed air can be supplied by a pipe connection **72**. When compressed air at a suitable pressure is thus applied to the rear of the plunger **65**, the urging of the spring **64** is overcome and the jaw members **62** are urged into the tapered housing (i.e. from right to left as viewed in FIG. 2) and forced together to grip the tail end **18** of the mandrel received between them. Each jaw member is provided with a hardened steel pad **73** having a serrated face to firmly grip the mandrel. When a mandrel is thus gripped between the jaw members, the extent to which the jaw members can enter the tapered housing is restricted by the fact that the mandrel between them does not allow them to close beyond a certain extent (i.e. the position illustrated in FIG. 2). If there is no mandrel between the jaw members when compressed air is applied through the pipe **72** to actuate the jaw members, the jaw members will move further into the tapered housing (i.e. further to the left as viewed in FIG. 2). In this example of the invention, this further movement of the jaw members when there is no mandrel between them, is utilized to vent to atmosphere the compressed air which is applied to the rivet feeding mechanism, thereby preventing operation of the rivet feeding mechanism if the mandrel is not received and gripped between the jaw members. In this example, this is achieved by modifying the plug **57** of the gun illustrated in FIG. 1 so that it acts as a venting valve which is opened if the jaw members move too far into their housing as previously mentioned. It will be seen from FIG. 2 that this valve member **57***a* comprises a cylindrical body portion **70** with a central bore which is a sufficiently close fit upon the mandrel to prevent the escape of compressed air between them to any appreciable extent. The rear end of the valve member has a radially extending flange **74** the rear face of which is provided with a sealing ring **75** which seats against an annular shoulder face **76** inside the housing **68**. The valve member **57***a* is urged against this seat by means of a saucer spring **77** acting against a circlip **78**. The space on the radially inner side of the port **58** and behind the O-ring seal **60** on the member **57***a* is in communication with one side of the valve thus provided. The other side of the valve is vented to atmosphere between the jaw members and through a passage **79** in the wall of the housing **68**.

If compressed air is applied to the rear of the plunger **65** in order to urge the jaw members **62** into their tapered housing, and there is no mandrel between the jaw members, then the jaw members move so far into their housing (to the left beyond the position illustrated in FIG. 2) that they abut a small extension **81** on the rear of the valve member **57***a* and drive the member forwards (i.e. towards the left as viewed in FIG. 2) against the urging of the saucer spring **77**. This movement unseats the valve seal **75** from the face **76** and so vents to atmosphere the compressed air in the space **55**, thereby preventing the mandrel feed piston **42** from urging the column of rivets forwards.

The other major difference of the gun illustrated in FIG. 2 is the arrangement for supplying compressed air to the various parts of the gun for the various functions. Instead of being provided with a main trigger-controlled valve in gun handle **32**, supply of compressed air for operation of the gun to set a rivet is controlled by a separate valve **82** with a control pedal **83** for foot operation. This valve is connected to the gun by means of a flexible hose **84**. The valve **82** and pedal **83** are mounted in a valve block **85** arranged for connection to a main compressed air feed hose **86**. The valve block **85** is also provided with a permanent connection from the main compressed air inlet **86** via a connector **87** and a further flexible hose **88** to a secondary control valve **89** provided with an operating handle **91**. The output from this control valve **89** is fed through a T-junction **92**, firstly via a flexible hose **93** to a connector **94** supplying compressed air to

the space **55** for operation of the rivet feeding mechanism, and secondly through a flexible hose **98** and connector **72** for operation of the mandrel-gripping jaw mechanism previously described.

The common valve **89** controlling the supply of compressed air both to the rivet feeding mechanism and to the mandrel-gripping mechanism ensures that the rivet feeding mechanism will be actuated only if and when the mandrel-gripping mechanism is also actuated. However, it may be that an operator does not insert the mandrel far enough into the gun for it to be properly gripped by the jaws. The valve mechanism incorporating the release valve **57***a* described above ensures that, should this happen, then the rivet feeding mechanism is not actuated. If the supply of compressed air to the rivet feeding mechanism were not vented to atmosphere in these circumstances, the application of compressed air to the rear side of the piston **42** would violently eject the complete column of rivets and the mandrel from the gun, which would be exceedingly dangerous.

The invention is not restricted to the details of the foregoing examples.

We claim:

1. Riveting apparatus, comprising:

a mandrel adapted to carry a plurality of tubular rivets thereon, said mandrel having an enlarged head which is pulled through each rivet in turn to set it by expanding it;

jaws through which said mandrel extends, said jaws and said mandrel being reciprocable relative to one another in a direction axially of the mandrel to provide a feed stroke during which said mandrel head and said jaws move relatively away from each other and the leading rivet nearest the mandrel head passes through the jaws which then close to provide an abutment for said rivet, and a working stroke during which said mandrel head and said jaws move relatively towards each other to pull said mandrel head through said rivet to expand said rivet;

a tube-like member connected to said jaws in concentric relation with said mandrel;

and pneumatically operated rivet feeding means including a piston member slidable on said mandrel within said tube-like member to feed rivets along said mandrel towards and through said jaws upon the application of pneumatic pressure to the side of said piston member remote from said jaws.

2. Riveting apparatus as claimed in claim **1**, said apparatus further including means for controlling the application of pneumatic pressure to said piston member in accordance with the relative axial positions of said jaws and said mandrel.

3. Riveting apparatus as claimed in claim **2**, in which said control means comprises port means carried by or in said tube-like member, and a valve member reciprocable in unison with said mandrel along said tube-like member to cooperate with said port means, thereby to apply pneumatic pressure to said piston member as aforesaid in accordance with said relative axial positions of said jaws and said mandrel.

4. Riveting apparatus as claimed in claim **3**, in which the relative axial positions of said mandrel, said port means and said valve member are such that pneumatic pressure is applied as aforesaid when said mandrel is positioned relatively to said jaws more than a predetermined extent in the direction opposite to that in which rivets are fed.

5. Riveting apparatus as claimed in claim **1**, which apparatus includes a pneumatic motor operatively connected to said jaws and said mandrel for moving them relatively to each other to provide said working stroke upon the application of pneumatic pressure to said pneumatic motor; first pneumatic valve means for controlling the application of pneumatic pressure to said pneumatic motor; and second pneumatic valve means for controlling the application of pneumatic pressure to said piston member of said rivet feeding means; said first pneumatic valve means and said second pneumatic valve means being operatively interconnected so that said second pneumatic valve means allows application of pneumatic pressure to said piston member only when said first pneumatic valve member interrupts application of pneumatic pressure to said pneumatic motor.

6. Riveting apparatus as claimed in claim **1**, including pressure leakage means, such that after termination of application of pneumatic pressure to said side of said piston member, said pressure drops due to leakage through said leakage means.

7. Riveting apparatus as claimed in claim **6**, in which said pneumatic leakage means is provided by a gap between said piston member and at least one other member, either said mandrel or said tube-like member.

8. Riveting apparatus as claimed in claim **1**, which apparatus further includes mandrel-gripping means for receiving and gripping said mandrel at a tail-end portion thereof remote from the head thereof, and pressure prevention means, operable by said mandrel-gripping means, effective to prevent the application of pneumatic pressure to said side of said piston member remote from said jaws automatically if and whenever said mandrel is not received and gripped by said mandrel-gripping means.

9. Riveting apparatus as claimed in claim **8**, in which said pressure prevention means comprises means for venting or relieving said pneumatic pressure.

10. Riveting apparatus as claimed in claim **8** in which said mandrel-gripping means comprises an internally tapered housing, externally tapered jaw members and means for urging said externally tapered jaws members into said internally tapered housing for gripping said mandrel, and in which said pressure prevention means is repsonsive to the extent to which said jaw members enter the housing in dependence upon the presence or absence of a mandrel between said jaw members.

11. Riveting apparatus as claimed in claim **10**, in which said responsive pressure prevention means comprises valve means including a valve member which is normally biased into a first position and which is moved to a second position by said jaw members when they enter said housing to the increased extent allowed by the absence of a mandrel between them.

12. Riveting apparatus as claimed in claim **8**, in which said gripping means is pneumatically actuated, and in which there is provided common valve means controlling the pneumatic supply to both the aforesaid pneumatically operated rivet feeding means and to said gripping means.

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