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PNEUMATIC RIVET SETTING GUNS

Original Filed June 29, 1959

3 Sheets-Sheet 1

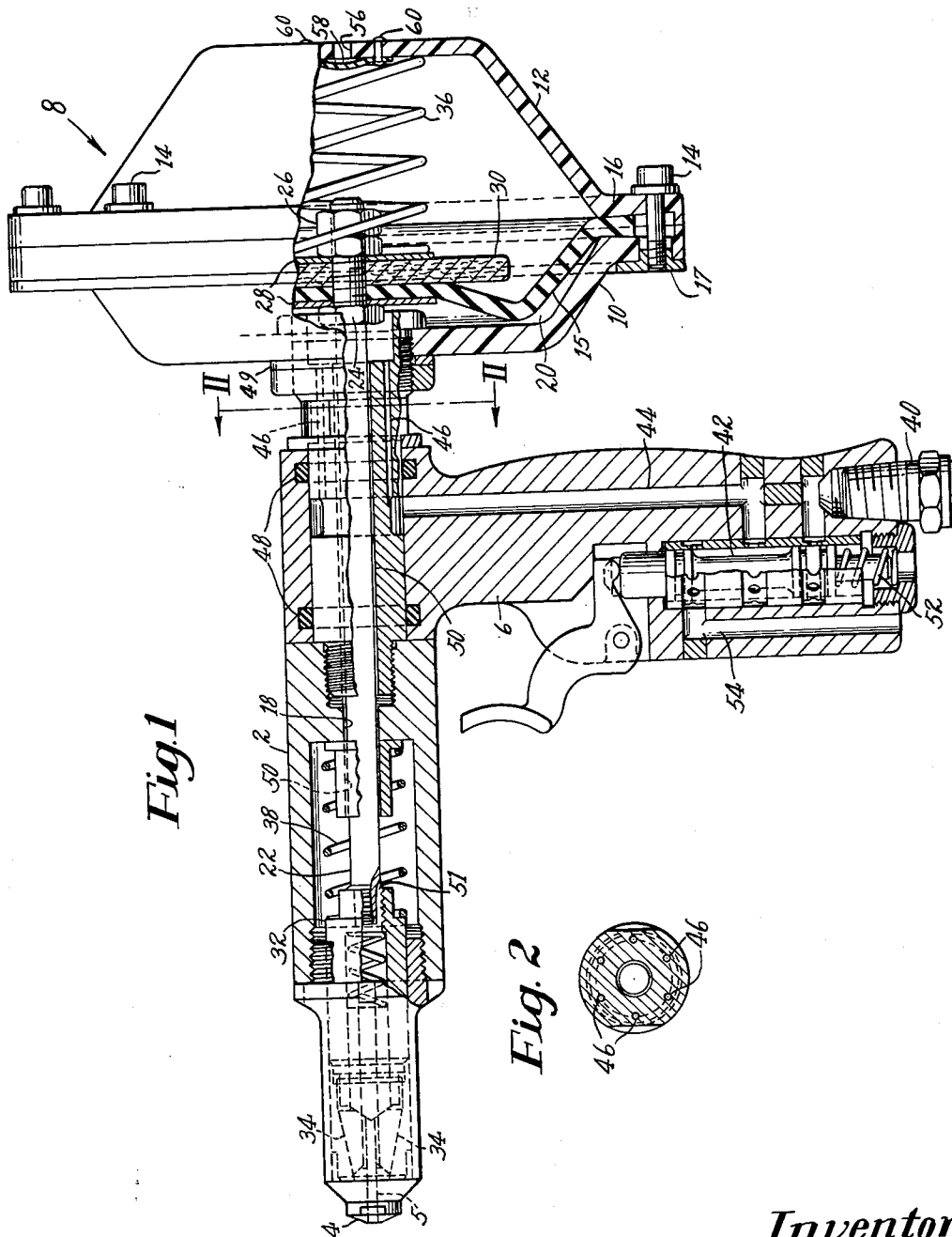


Fig. 1

Fig. 2

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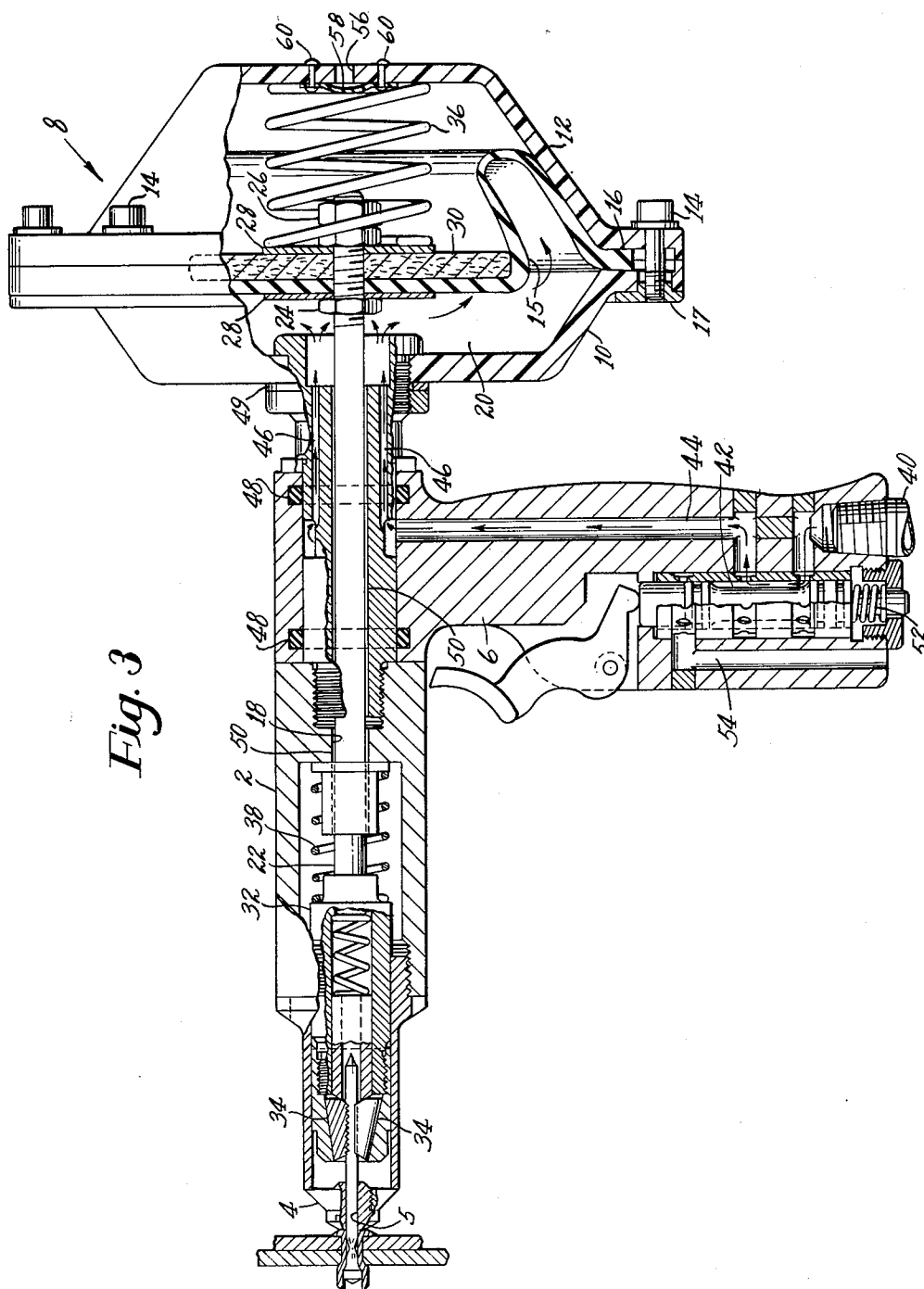


Fig. 3

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Fig. 4

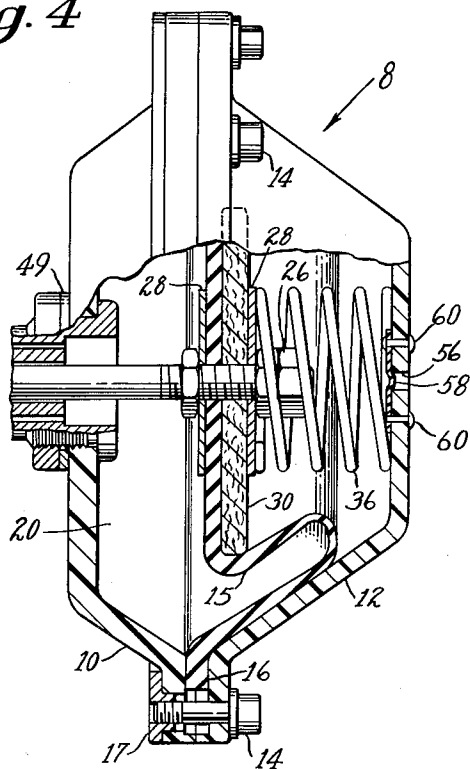
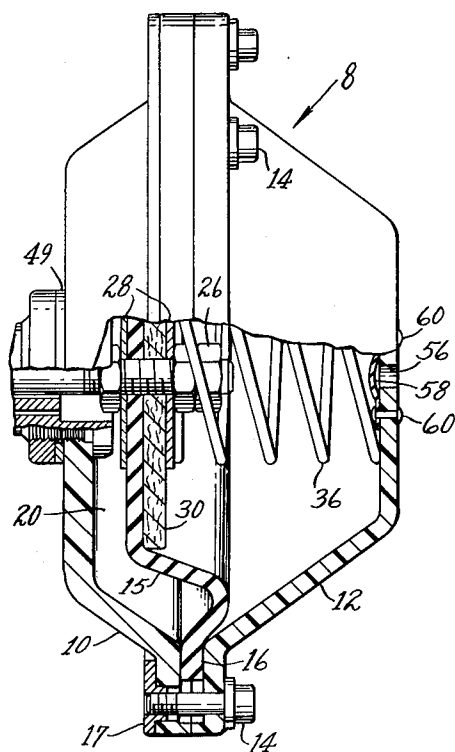


Fig. 5



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3,088,618

PNEUMATIC RIVET SETTING GUNS

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Continuation of application Ser. No. 823,745, June 29, 1959. This application Nov. 21, 1961, Ser. No. 153,910
7 Claims. (Cl. 218—48)

This application is a continuation of my application Serial No. 823,745, filed June 29, 1959, now abandoned and relates to the art of blind riveting wherein the barrel of a rivet is set by the tensioning of a mandril member to cause a headed end of the mandril to bear forcefully against the blind end of the rivet barrel, thereby deforming and setting the rivet. In particular, the invention relates to improvements in portable pneumatically actuated tools for engaging a stem portion of the rivet mandril and for applying thereto the requisite tensioning force for setting the rivet barrel.

Since such portable tools are customarily provided with a pistol-like hand grip or handle, and are pneumatically activated by fingering a trigger mechanism, these tools are frequently and will hereinafter be referred to as handheld rivet setting guns. Where industrial production requires that a large number of blind rivets be set in rapid succession, one operator may be employed to insert manually a rivet assembly in each drilled opening through the work pieces while a second operator follows along with a rivet-setting gun to tension the mandrils and set the rivets. If there be but a single operator working on a given work piece, he may either manually place the unset rivet assembly in the opening and then present the gun so that it engages the outwardly extending stem of the rivet mandril, or he may first insert the end of the mandril stem into the barrel throat or nosepiece of the gun before locating the rivet barrel in the drilled opening. Whichever be the established procedure, the gun operator is always required to exercise precise care in presenting the gun to the work piece in order to assure that the barrel of the gun is held in axial alinement either with the drilled opening or with the mandril stem that projects from the opening. This technique can be exercised efficiently only when the construction of the gun is such as to provide adequate visibility from the operator's viewpoint. That is to say, the nosepiece at the forward end of the gun should not be obscured by bulky operating mechanism. Additionally, the efficiency of an operator is critically affected by fatigue factors induced by prolonged manipulation of excessively heavy or poorly balanced rivet-setting guns. Another source of operator fatigue is the trigger activation of the gun. Since the trigger must be held squeezed against spring pressure during the entire rivet-setting operation, it is highly desirable to provide a fast acting gun that rapidly tensions the mandril to set a rivet and to break the mandril stem. Further inefficiency and operator fatigue result when the broken end of the mandril stem must be cleared from the throat of the nosepiece by directing the gun downward with a shaking motion to assist the gravitation of the stem from the gun.

The manufacture and sale of rivets has for many years been a large and highly competitive business wherein many manufacturers, in order to enhance the sale of their rivets, have expended extensive research toward the development of portable rivet-setting guns that would better suit their customers' requirements. As a result of the keen competition in this field there are now many commercially available power-actuated rivet-setting guns; some are electrically or hydraulically actuated, but the majority of the portable guns are operated by pneumatic

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pressure. While the prior art portable pneumatic guns tend, as a general rule, to be lighter in weight and less cumbersome to handle than the electric or hydraulic types, they leave much to be desired in regard to efficiency of operation and reduction of operator fatigue. Heretofore known pneumatic riveting guns have been powered by a pneumatic piston and rod axially movable, from one end to the other, within a cylinder. In order to provide sufficient tensioning force for setting the rivets, while at the same time keeping the piston and cylinder diameters small enough to permit a gun to be termed portable, it has customarily been necessary to combine some form of leverage mechanism with the pneumatic piston rod. This expediency, in addition to being costly to manufacture and maintain, results in slower tensioning movement of the mandril stem, thereby increasing the setting time for each rivet. The employment of leverage, in order to obtain the requisite mechanical force advantage, also requires frequent lubrication of those moving parts which, for the sake of safety, should be completely enclosed and therefore not readily accessible.

The foregoing discussion of those factors which are to be desired in a portable riveting gun and of the failure heretofore to provide a suitable gun construction has been set forth at length in order that one may more clearly appreciate all the advantageous features that are embodied in the invention about to be described.

One of the novel features of my rivet setting gun is that the power for tensioning the mandril stem of the rivet is applied pneumatically by a light weight, powerful and fast acting air motor of the flexible diaphragm type.

Another feature of my improved gun is that the air motor is arranged so as to provide a well balanced tool which is comfortable to hold and operate and which provides ample visibility in the forward regions for accurately guiding the gun to the work pieces.

A further feature is that great tensioning force may be obtained without the need for any mechanical lever, thus reducing the weight and cost of the gun while at the same time eliminating the need for periodic lubrication of enclosed moving parts.

Still another feature is the provision of novel means for automatically ejecting at low velocity the broken off mandril stems from the nosepiece of the gun. This low velocity ejecting action is accomplished pneumatically by merely releasing the trigger of the gun.

The above and other features of the invention, including various novel details of construction and combinations of parts, will now be more particularly described with reference to the accompanying drawings and pointed out in the claims.

In the drawings,

FIG. 1 is a side view, mostly in cross section, showing a rivet setting gun constructed in accordance with the invention and illustrated in the "at-rest" position;

FIG. 2 is a cross section showing a detail of parts viewed along the line II—II of FIG. 1;

FIG. 3 is a view similar to that of FIG. 1 but illustrating the parts as seen during the operative phase just prior to the severance of the mandrel stem;

FIG. 4 illustrates the position of the diaphragm parts just after severance of the stem; and

FIG. 5 illustrates an intermediate phase during the return of the diaphragm.

Referring to FIG. 1, which shows the parts of my handheld rivet setting gun as viewed in their "at-rest" position, the gun comprises an elongated sleeve-like body portion 2 terminating forwardly in a rivet engaging nosepiece 4 provided with a mandril stem receiving aperture 5; a gripping handle 6 depending from a rearward part of the body portion 2; and a flexible diaphragm pneumatic motor 8 secured to the rear end of the body portion 2. The dia-

phragm of the motor 8 is housed within two dish shaped members 10 and 12 each provided with annular peripheral flange portions adapted to be secured to each other by a series of screws 14. A resilient flexible rubber diaphragm 15, that is contour-molded to conform substantially to the inner wall shape of the forward housing member 10, is provided with an annular peripheral edge 16 which is tightly clamped between the peripheral flange portions of the members 10 and 12 by the tightening of screws 14 threaded into a retaining ring 17. An open bore 18 is provided longitudinally through the body portion 2 and, at the rear thereof, this bore leads into the forward pneumatic chamber 20 of the motor 8. An actuating rod 22 is slidably journaled within the bore 18, and the threaded rear end of this rod is secured, by clamp nuts 24, 26 to the central zone of the diaphragm 15. The securing means, in addition to the clamp nuts, include a pair of steel washers 28 adjacent to said nuts and a large fiber reinforcing disk 30 which is disposed adjacent the rear wall of the diaphragm 15 for the purpose of preventing any rearward distention of the center portion of the diaphragm. The forward end of the rod 22 is also threaded and is secured to the rear of a sleeve member 32 coaxially slidable within the enlarged forward bore of the body portion 2. The sleeve member 32 provides a housing for the mandril stem gripping and tensioning means which include a plurality of gripping jaws 34 and tapered cam means for opening and closing said jaws. Since the herein illustrated mandril gripping and tensioning means is of a well-known construction and is almost identical in structure and in operation to that described in United States Patent No. 2,845,197, issued July 29, 1958, in the name of Charles Newstead, it does not constitute a novel feature of the present invention and need not be described in any detail, other than to say that, upon rearward actuation of the rod 22 and sleeve member 32, the jaws 34 close forcefully upon the stem of a mandril so that said rearward actuation progressively stresses the mandril in tension until the rivet is set and a severance of the stem occurs. Also, upon the completion of the forward returning movement of the rod 22 and sleeve member 32, the jaws are forced apart to release their grip upon the broken stem portion so that the latter may be ejected from the nosepiece of the gun in a novel manner which will be described in full detail hereinafter.

The central zone of the diaphragm 15 and the rod 22 are both normally urged into the forward "at-rest" position of FIG. 1 by the yieldable force of two springs; a compression spring 36 which bears forwardly against one of the washers 28, and another compression spring 38 which bears forwardly against the rear end of the movable sleeve member 32. The pneumatic pressure for actuating the gun against the force of said springs is delivered to the gun through an air hose coupling 40 in communication with a trigger operated pneumatic control valve 42 which may be manually shifted from the closed position of FIG. 1 to the open position of FIG. 3 thereby to admit compressed air, through a passage 44, into the bore 18 from which the air is free to flow through a plurality of passageways 46 (FIG. 2) into the forward pneumatic chamber 20 of the diaphragm motor 8. It is to be noted that, while the air on its passage toward the chamber 20 is effectively sealed, by O-rings 48 and a gasket 49, against escape to the atmosphere through the various threaded fittings by which the gun is assembled, for a purpose that will be explained later, a small quantity of pressurized air is allowed to vent to the atmosphere through the nosepiece at the forward end. This venting is accomplished by providing a slight clearance 50 and a passage 51 between the actuating rod 22 and the surrounding body portions of the gun. Thus, as the pneumatic pressure increases within the bore of the chamber 20, a restricted flow of air is ported outward through the aperture 5 at the throat of the nosepiece 4. Since the throat aperture 5 is dimensioned to

fit closely around the cylindrical stem portion of an inserted rivet mandril, and since the restricted aperture 5 is the only means of egress for surplus air while pressurized air is being supplied to the gun, not only the bore of the pneumatic chamber 20 but the entire bore of the gun body portion 2 constitutes a pneumatic pressure chamber whenever an inserted mandril stem is being tensioned. The feature of pressurizing the entire internal length of the gun, up to the throat opening 5, is for the purpose of providing sufficient pneumatic pressure within the nosepiece to enable the severed mandril stem to be expelled from the gun by pneumatic pressure. However, it is not desirable to blow the stem clear of the gun violently with a high velocity air stream, such as would result if the normal operating pressure within the pneumatic chamber were not materially reduced before the gripping jaws 34 released their hold upon the mandril stem. In order thus gently to eject the stem from out the bore of the gun, the flow of compressed air entering the gun through the air hose coupling 40 must be shut off by releasing the trigger; additionally a sufficient volume of relatively low pressure air must continue to be provided, within the bore for expelling the severed stem, after the jaws 34 have been spring returned to their forward-most position whereat they release their grip on the stem. The unique feature, of supplying a substantial volume of pressurized air which has yet to be exhausted through the nosepiece by the effective force of the springs 36, 38 after they have completely returned the jaws 34 and the central zone of the diaphragm to their at rest position, is embodied in the resilient marginal portions of the diaphragm which portions, at that time, are still substantially dilated to provide a continuing supply of exhaust air to the forward end of the gun.

When the gun trigger is released by the operator, the valve 42 is returned, by a spring 52, to the "at-rest" position of FIG. 1, whereupon the air pressure from the hose coupling 40 is closed off from communication with the air passage 44. Simultaneously said passage 44 is placed in open communication with an air exhaust port 54 which vents some of the air from the chamber 20 under the urgency of springs 36 and 38 as said springs force the inflexible central zone of the diaphragm forward and again into adjacent relation with the forward housing member 10.

The operation of my novel rivet setting gun will now be described. While the gun is in the unpressurized, or "at-rest" position of FIG. 1, the nosepiece 4 is pressed into contact with the flanged end of a rivet barrel and the mandril stem of the rivet assembly is disposed within the throat aperture 5 of the nosepiece and between the jaws 34. A manual triggering of the gun shifts the valve 42 to close the exhaust port 54 and to open communication between the compressed air supply and the passage 44, thus progressively pressurizing the pneumatic chamber 20 and the interior of the gun body. As the pressure in the chamber builds up, the flexible diaphragm first yields rearwardly so that its central portion is in co-extensive contact with the forward face of the reinforcing disk 30 and the outer marginal portions of the diaphragm become distended and bellowed rearwardly. Now, as the rearwardly distended marginal portions approach their elastic limit, continued flow of pressurized air into the pressure chamber causes the rearwardly inflated diaphragm to force the disk 30 and actuating rod 22 rearwardly against the force of springs 36, 38. At the commencement of said rearward movement of the rod 22 the jaws 34 close upon and bite into the mandril stem, so that the continued movement of the parts rearwardly increasingly tensions the mandril stem (FIG. 3) until the rivet barrel is set and the stem is severed by reason of its tensile strength having been exceeded by the rearward pull of the jaws 34.

It is to be noted that the rear housing member 12 is provided with one or more vent holes 56 to permit the

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air within this housing cavity to be displaced outwardly by the rearward movement of the diaphragm 15. The combined area of the one or more openings 56 is sufficient to prevent any substantial build-up of pressure that might otherwise retard the rearward movement of the diaphragm during the mandril tensioning and rivet-setting phase of operation. However, upon completion of the setting phase and just prior to severance of the mandril stem (FIG. 3), a volume of maximum high-pressure air is within the pneumatic chamber 20, exerting a correspondingly high rearwardly directed force upon the diaphragm, the central portion of which, up to this phase, has been restrained in its rearward movement by the tensile strength of the mandril stem. Consequently, upon severance of the mandril stem, the only forces tending to restrain a sudden rearward movement of the central portion are exerted by the springs 36 and 38, which forces alone would be ineffectual to prevent a violent and destructive recoil action of the rod 22 and other connected moving parts. However, such a destructive rearward acceleration of these parts is effectively prevented by the cushioning action of that air remaining within the rear housing member 12, which air suddenly becomes pressurized because the opening 56 is too small to permit the total sudden displacement of air. When it is desired to use the gun for setting exceptionally large rivets employing correspondingly larger and stronger mandril stems, the cushioning effect of the air in the rear housing member can be greatly increased effectively to absorb the violent reactionary forces accompanying the severance of a larger mandril stem. This may be cheaply and conveniently accomplished by a baffle 53 affixed to the inside wall of the housing member 12. A suitable baffle is provided by a band of sheet rubber or other flexible strong material secured in place by rivets 60 in such a manner that the baffle material will overlay the vent hole 56, but will normally not form a seal over the opening. As best illustrated in FIG. 3, the material 53, instead of being secured in flat or stretched condition, is slightly bulged away from the opening in order, under normal operating conditions, to allow air to pass in either direction through the vent 56. However, when the violent rearward recoil accompanying the breaking of a large mandril occurs, the sudden pressure rise in the rear housing flattens the material 53 into sealing engagement with the area surrounding the vent hole (FIG. 4), thus momentarily preventing the escape of any air and thereby arresting the rearward movement of the diaphragm and rod 22. An operator will know, from the sound and feel of the gun, when a mandril stem has been broken, allowing the parts to shift rearward from the position of FIG. 3 to that of FIG. 4. He will then release the trigger to restore the parts to their "at-rest" position.

Having described the mode of operation by which the jaws are retracted rearwardly to set the rivet and to sever the tensioned mandril stem, there will now follow a description of the mode of operation by which the jaws are first returned to their open position and the severed stem is then pneumatically ejected from the nose of the gun.

FIG. 4 illustrates the position of the diaphragm and associated parts immediately following the severance of the stem and at the time when the operator releases the trigger to initiate the exhausting of pressurized air from the pressure chamber of the gun. It is to be noted that, while the marginal portions of the diaphragm are greatly distended rearwardly by the dilating pressure within the chamber, the central zone of the diaphragm is being held in a forwardly advanced position by the force of the return springs. It is both the force of these return springs 36, 38, and the resilient character of the diaphragm margin that will continue to provide a moderate degree of pressure within the bore of the gun, even after the jaws have returned. As the volume of air is progressively evacuated, through the port 54 and the aperture 5, the springs force the diaphragm portions

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from the positions of FIG. 4 to the positions of FIG. 5 which illustrates the positions of the diaphragm and associated parts immediately following the return of the jaws to their mandril-releasing position. It is to be noted, from a comparison of FIGS. 1 and 5, that although the rod 22 now has been fully returned forwardly, by the force of the return springs, there is still a volume of sufficiently pressurized air within the chamber to hold the marginal portions of the diaphragm in a rearwardly dilated condition. During the following resilient restoration of the marginal portions of the diaphragm to the at rest condition of FIG. 1, the pressure for the final exhausting of the pneumatic chamber is derived solely from the deflation of the inflated marginal portions of the diaphragm. Thus, after the jaws are opened, a volume of moderately pressurized air is provided for evacuation from the chamber 20, gently to expell the severed mandril stem out of the thus pressurized bore of the gun. It is to be noted that this air pressure which ejects the broken stem is produced by forward displacement of the diaphragm and air in the chamber 20, rather than by the direct force of the pneumatic pressure supply, which supply has been cut off before the jaws release their grip on the mandril. The latter feature is a distinct improvement over previous devices wherein severed mandril stems were ejected by air taken directly from the main pressure supply with the result that the gun became a potential danger by shooting the broken mandril at high speed for considerable distances.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. In a rivet setting tool having jaws which are power actuated rearwardly to grip, tension and sever a mandril stem portion of a rivet assembly and which are spring returned to their forward position whereat the jaws are adapted to release the severed mandril stem portion, the combination of: a pressure chamber within the forward end of which said jaws are operatively movable along a path in axial alinement with a mandril stem receiving throat apertured to fit closely around the stem of a mandril when inserted between the jaws; a flexible resilient diaphragm, the peripheral edge of which is secured to form a seal at the rearward end of the pressure chamber; an actuating rod operatively connecting the center portion of the diaphragm with said jaws; spring means yieldably urging the rod and diaphragm center forwardly to locate the jaws at their forward mandril-releasing position; and a source of pneumatic pressure including a shiftable air valve for porting compressed air into the pressure chamber, said pressure when first ported into the chamber causing the resilient marginal portions of the diaphragm to become dilated rearwardly beyond the center portion of the diaphragm, thereby enlarging the volume of the pressure chamber while said center portion is in its forward position, and later causing said center portion and interconnected jaws to be actuated rearwardly against the force of said spring means.

2. A tool according to claim 1, in which the center portion of the diaphragm is reinforced to prevent rearward dilation of said center portion.

3. A tool according to claim 1, in which means are provided for restricting the exhaust of pressurized air from said chamber, whereby said pressure continues to dilate the marginal portions of the diaphragm after the center portion has been returned to forward position.

4. A portable pneumatic tool for setting blind rivets, by imparting a tensioning force to pull and sever a mandril stem portion of a blind rivet assembly, comprising: a forwardly extending housing having a throat opening adapted to receive said stem portion when manually inserted therethrough and into the housing; mandril stem gripping jaws operatively mounted within said housing for movement from a forward mandril-releasing position

rearwardly to grip, tension and sever the stem; a flexible resilient diaphragm, the peripheral edge of which is secured in sealing engagement with the rearward end of said housing to provide an expansible pressure chamber; means connecting said jaws with the central zone of the diaphragm; spring means yieldably urging said central zone and jaws forward to the mandril releasing position; and a source of pneumatic pressure first for dilating the marginal zone of said diaphragm rearwardly beyond the central zone, thereby resiliently enlarging the volume of the pressure chamber while the central zone of the diaphragm is position forwardly by the force of the spring means, and later for causing said central zone and interconnected jaws to be moved rearwardly against the force of said spring means.

5. A tool according to claim 4, in which the central zone of the diaphragm is reinforced to prevent rearward dilation of said zone.

6. A tool according to claim 4, in which means are provided for restricting the exhaust of pneumatic pressure from the expanded chamber, whereby said marginal zone remains dilated rearwardly until after said central zone has returned to the forward mandril-releasing position.

7. A power tool for setting blind rivets by tensioning the stem of a rivet mandril until the stem is severed, comprising: a rigid body portion having a forwardly and rearwardly extending bore; a flexible resilient diaphragm, the peripheral edge of which is secured in sealing engage-

ment with the body portion surrounding the rearward end of said bore; a nose piece, forming a substantial closure for the forward end of the bore and having an aperture therethrough to receive and closely fit around the stem portion of a rivet mandril when inserted into the bore; said body portion, resilient diaphragm, nose piece and inserted stem portion providing a pneumatic pressure chamber; mandril stem engaging and tensioning jaws movably mounted within the forward end of the bore adapted to grip and to tension the mandril stem when moved rearwardly and to release the mandril stem when moved forwardly into abutting engagement with the nose piece; an actuating rod having one end operatively connected to said jaws and the other end secured to the central zone of said diaphragm; yieldable means normally urging said rod, central diaphragm zone and jaws forwardly into mandril-releasing position; and a source of pneumatic pressure, including a shiftable air valve for porting compressed air into said pneumatic chamber, forcefully to move the diaphragm, rod and jaws rearwardly to sever the mandril stem; said yieldable means acting to restrain the rearward movement of the central diaphragm zone until the rearward dilation of the resilient marginal zone of the diaphragm has substantially enlarged the volume of the pressure chamber.

No references cited.