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Hagerty et al.

[11] **3,744,291**

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[54] **PNEUMATIC HOLE PIERCING APPARATUS**

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[52] **U.S. Cl.** **72/325,** 72/705, 83/660

[51] **Int. Cl.** **B21d 31/02**

[58] **Field of Search** 72/705, 325; 83/30, 83/660, 683; 173/18, 112, 113, 116, 119, 134, 135

[56] **References Cited**

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3,392,792	7/1968	Hunter	173/102
1,792,888	2/1931	Benedict	173/112
2,787,178	4/1957	Maxim	173/119
3,483,727	12/1969	Giannetto	72/705
3,030,837	4/1962	Chartier	72/457
2,605,808	8/1952	Current	72/705
2,791,926	5/1957	Guyton	72/705

Primary Examiner—Charles W. Lanham
Assistant Examiner—M. J. Keenan
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[57] **ABSTRACT**

A pneumatically driven hole piercing apparatus is disclosed having an internally located valve actuator directly connected to the piercing tool to enable the air valve to be triggered by the tool. The hole piercing apparatus comprises a hollow cylindrical body having a threaded piercing tool movably mounted within the forward end thereof. An axially movable piston is located within the body and is adapted to strike the enclosed end of the piercing tool upon the admission of the piston motive fluid through a valve located at the rearward end of the body. A valve rod is also located within the body and is adapted to slidably extend through the piston for interconnecting the piercing tool with the valve. Upon a rearward movement of the piercing tool, the valve rod is moved rearwardly to unseat the valve. The motive fluid then enters the chamber within the body to urge the piston forwardly to strike the piercing tool and move it in the forward direction.

25 Claims, 5 Drawing Figures

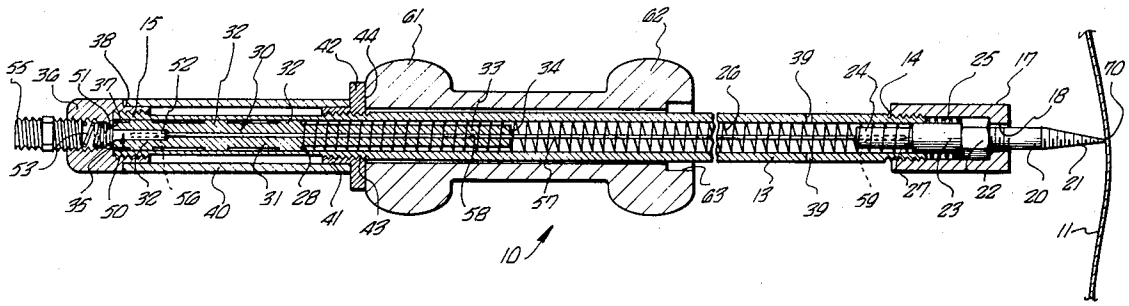


FIG. 1

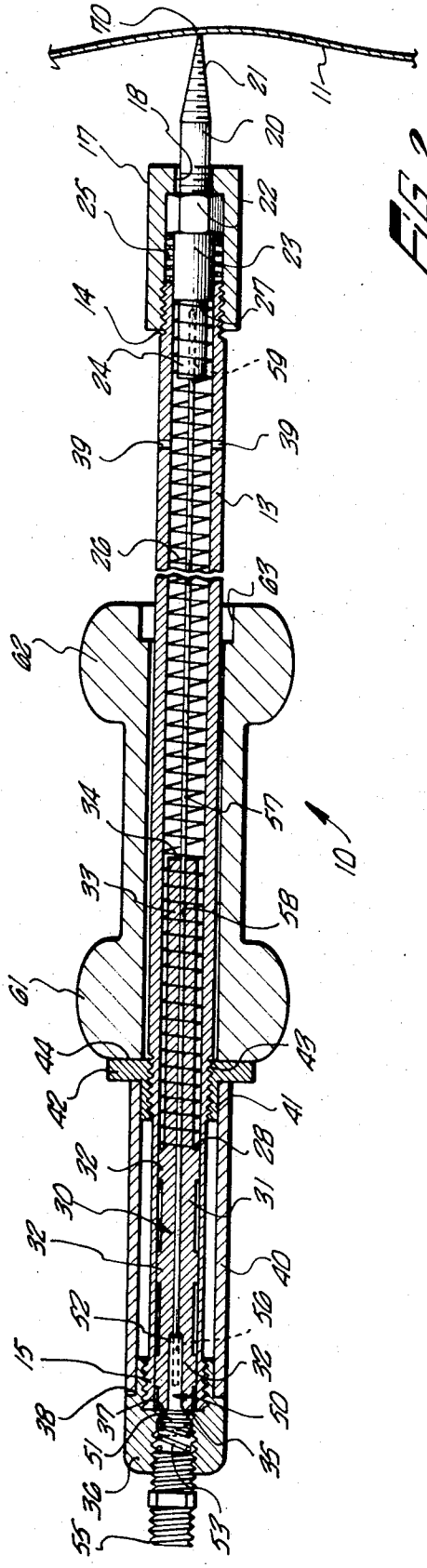
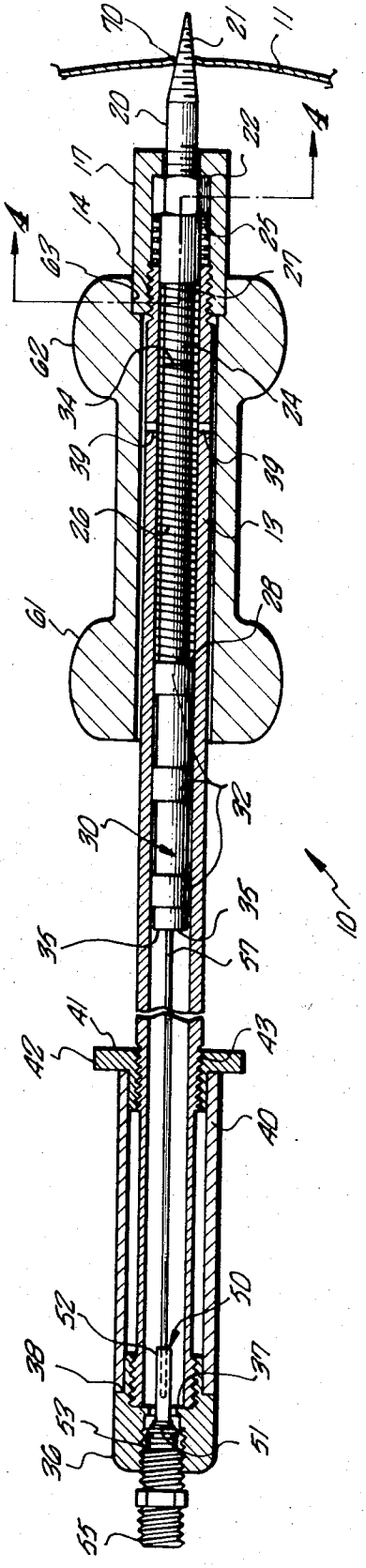


FIG. 2



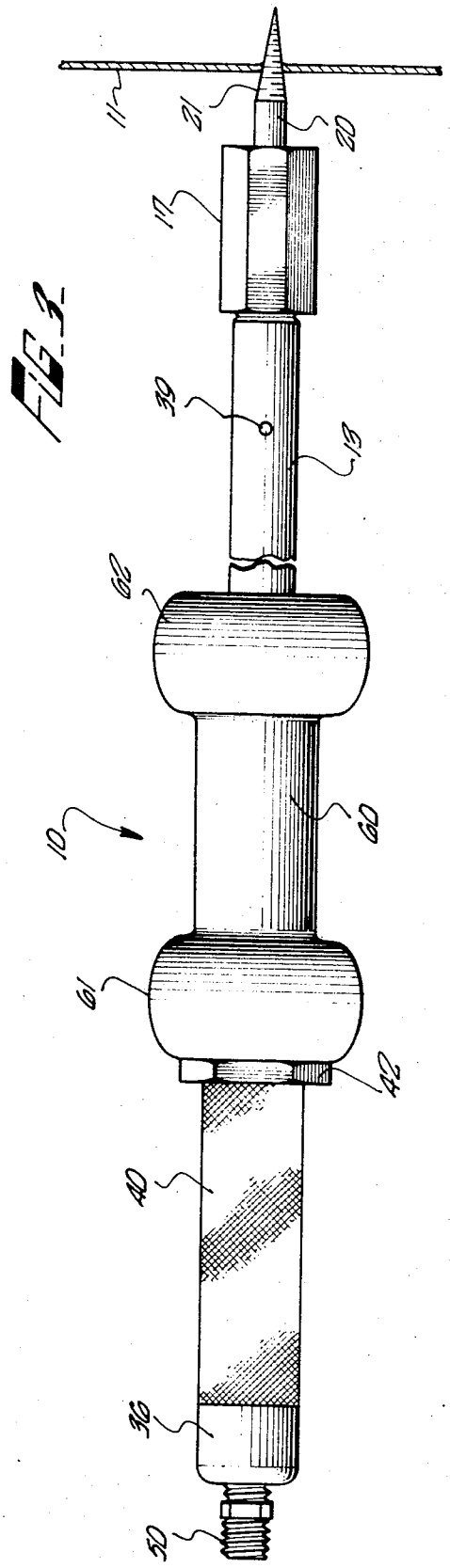


FIG. 3

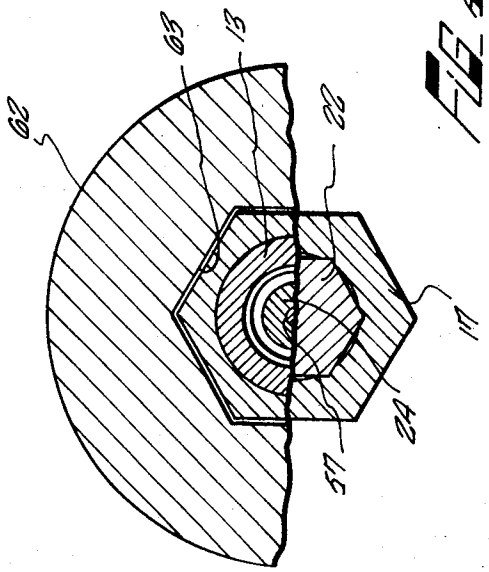


FIG. 4

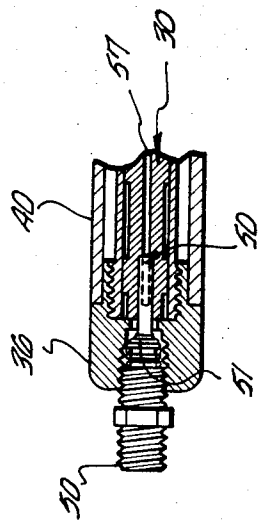


FIG. 5

PNEUMATIC HOLE PIERCING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to devices for repairing damaged metal on an automobile and more particularly to devices for piercing damaged metal to become anchored thereto in order to pull out the damaged metal to its original form.

2. Description of the Prior Art

In the present state of the art, there are four methods commonly used for repairing damaged metal on automobiles.

The first method utilizes an apparatus having a hydraulically driven piston which functions to drive a chain which is anchored to the bent portion of a tied-down car frame. Such an apparatus is shown in U. S. Pat. No. 3,566,667. In such an apparatus, the hydraulic piston functions to shorten the chain between the apparatus and the car frame connection to pull on the frame and return it to its aligned condition. Although this method is used extensively, the method is used mainly for realigning car frames and is not used to restore damaged metal on the automobile such as door and fender panels.

A useful method for repairing such panels utilizes an impact tool which is positioned behind the panel to punch out the metal to its original form. A tool of this type is shown in U. S. Pat. No. 3,392,792. Such a tool includes an impacting member located on the one end of a hollow cylindrical body. A pair of pistons are slidably mounted within the body and are adapted to be urged by motive fluid to strike the impacting member. The tool is of a sufficiently small size to enable it to be inserted through a small hole on the side or bottom of the panel. Once within the panel, the impacting member is positioned adjacent the indented or damaged portion of the panel. Upon actuation of the tool, the movement of the struck impacting member acts on the dented portion to urge it outwardly to its original condition. Even though this method is used extensively, this method is usually limited to the final stages of the repair work after most of the damaged metal has been restored.

A third method of repairing damaged metal is to utilize suction cups which are connected to the exterior side of the damaged metal. Once connected, the cups are pulled to draw the panel section outwardly. Although such a tool works efficaciously under certain conditions, the suction cups cannot operate on metal having small creases in it since such creases prevent the cup from creating an air-tight suction hold on the metal.

A fourth method utilizes an apparatus for piercing through the exterior of the damaged metal to be anchored thereto. Upon being anchored, the apparatus is pulled outwardly to draw the damaged metal in the same direction to its original form. A typical apparatus is shown in U. S. Pat. No. 3,483,727. The apparatus utilizes a threaded piercing tool movably mounted within the forward end of a body. The piercing tool is adapted to be spring loaded within the body to enable it to be projected forwardly to pierce a portion of the work piece to create a hole therein. Afterwhich the apparatus is rotated to thread the piercing tool into the hole to be anchored therewith. After the piercing tool is anchored to the metal, the tool is pulled outwardly to draw the damaged metal to its original form. Afterwards, the piercing tool is unthreaded and the small hole is cemented over with a compound and the entire panel is repainted.

Another type of hole piercing apparatus is found in U.S. Pat. No. 3,030,837. In this apparatus, a slide hammer, slidably mounted on the body, is utilized to supply the impacting force.

As can be seen, the hole piercing apparatus can operate on any type of damaged metal and is not limited to certain conditions of the metal as the suction cup devices are.

The shortcoming with present day hole piercing devices is found in their actuation systems. In present day devices, the piercing tool must be manually retracted completely within the body against the compressive force of a spring, and then released. Such a method is cumbersome and unsafe since the apparatus could slip from the operator's grasp during loading and the piercing tool could accidently strike the operator or other objects thereby causing a great deal of damage. Another dangerous feature with the spring loaded device is that the piercing tool is retained within the body by a small pin. Because of the large energy buildup of the piercing tool being retracted completely with the body, this pin could easily shear off during operation. As a result, the piercing tool could fly out of the forward end of the body and become a dangerous projectile. In fact, there is an accompanying warning with the apparatus not to trigger the apparatus unless the forward end of the body is positioned onto a workpiece.

Beside becoming a dangerous projectile, the completely retractable piercing tool is unsuitable because it is impossible to aim or position the piercing tool on the exact location desired to be struck. Quite often, the apparatus would move during actuation and the target area would be missed.

Present day piercing devices have not used pneumatically driven pistons to drive the piercing tools. The reason for this is that the current technology of pneumatically driven tools is unacceptable because these tools all have externally located triggers and valve actuators which are dangerous to use since they can be set off prematurely.

Moreover, present day piercing devices are unsuitable because they require an additional tool to unthread the piercing tool and remove it from the hole.

SUMMARY OF THE INVENTION

The present invention obviates the above-mentioned shortcomings by providing a pneumatically driven hole piercing apparatus in which the impacting member functions as the triggering mechanism for the valve actuation and the entire valving and actuating system is located completely within the body of the apparatus to prevent any damage from occurring thereto. The apparatus comprises a hollow cylindrical body having an axially movable piercing tool partially extending out of the forward end thereof, the piercing tool functioning as the impacting member. The forward portion of the piercing tool is pointed and threaded while the rearward portion thereof forms an abutment for contact with a striker piston located within the cylindrical body. The piston is pneumatically driven by motive fluid entering the interior of the body through a valve located at the rearward end of the body. A valve rod is located within the body and extends through the piston

and along the entire length of the body for interconnecting the piercing tool with the valve. The apparatus is also provided with a slide hammer axially mounted on the exterior of the cylindrical body for striking a striker nut integrally mounted on the rearward end of the body. The slide hammer is provided with a cavity which is adapted to receive an enlarged portion of the forward end of the cylindrical body.

To operate the apparatus, the piercing tool is placed against a workpiece. After contacting the desired area of the workpiece, the body of the apparatus is pushed forward against the workpiece to cause the piercing tool to partially retract within the body. This movement causes the valve rod connected thereto to unseat the valve located at the rearward end thereof to admit the motive fluid therethrough. The motive fluid then enters the chamber within the body to urge the piston forwardly to strike the piercing tool and move it in the forward direction. The movement of the piercing tool causes it to penetrate the workpiece. The piercing tool is then rotated to become anchored within the hole formed in the workpiece. The slide hammer is then manually operated to move rearwardly to strike the striker nut to move the entire assembly rearwardly. This movement draws the anchored workpiece outwardly in the same direction to restore it to its original form. After the rearward movement is completed, the slide hammer is moved forwardly to receive the enlarged portion of the body within its cavity to enable the hammer to be manually rotated to unthread the piercing tool from the hole.

An important advantage of the present invention is that the movement of the piercing tool is limited to a very short distance, thereby reducing the hazard of the piercing tool acting as a projectile. Moreover, by placing the piercing tool onto the workpiece before actuation, the area to be pierced is exactly located. As a result, more accurate control is achieved.

Another important advantage of the present invention is that the need for an external trigger and valve actuator is eliminated. This makes the operation safer and easier.

Still another advantage of the present invention is that the piercing tool can be uncoupled from the workpiece without any additional tool.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The present invention, both as to its organization and manner of operation, together with further objects and advantages thereof, may best be understood by reference to the following description, taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross sectional view of the hole piercing apparatus of the present invention;

FIG. 2 is a similar view of the apparatus during impact;

FIG. 3 is a similar view of the apparatus pulling out the damaged metal;

FIG. 4 is a cross sectional view of the apparatus taken along lines 4—4 of FIG. 2; and

FIG. 5 is a fragmentary sectional view of the rearward end of the apparatus modified to permit the apparatus to operate in a continuous mode.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, FIGS. 1 – 3 show a hole piercing apparatus generally indicated by arrow **10**, which is adapted to pull out damaged metal, hereinafter referred to as the workpiece **11**. The apparatus comprises an elongated hollow cylindrical body **13** having a threaded forward end **14** and a threaded rearward end **15**. The forward end **14** is adapted to threadedly receive a hexagonal bushing **17** having an aperture **18** formed in the forward end thereof. The interior of the bushing **17** is adapted to receive an axially movable piercing tool **20** having a threaded point **21** extending through the aperture **18**. The piercing tool **20** also comprises an enlarged hexagonal portion **22** adapted to register with a mating hexagonal cavity formed in the bushing **17**. This interengagement prevents the piercing tool **20** from rotating relative to the body **13** and the bushing **17** while still permitting the tool **20** to move axially therewithin. The piercing tool **20** further includes a cylindrical portion **23** and a reduced cylindrical portion **24**. The cylindrical portion **23** is of a cross section to snugly but slidably fit within the interior of the cylindrical body **13**. A compression spring **25** is mounted within the interior of the bushing **18** alongside the cylindrical portion **23**. The spring **25** functions to bear against the end of the cylindrical body **13** and the shoulder formed by the hexagonal portion **22** to apply a forward bias against the piercing tool **20**. The reduced cylindrical portion **24** is adapted to receive a compression return spring **26**, with the forward end of the spring **26** bearing against the shoulder **27** formed at the junction of the cylindrical portions **23** and **24**. The rearward end of the spring **26** is adapted to bear against a shoulder **28** formed on a piston **30**.

The piston **30**, axially slidable within the interior of the body **13**, comprises an elongated body **31** having three enlarged annular portions **32** formed thereon. The annular portions **32** are dimensioned to fit snugly within the interior of the cylindrical body **13** to function as seal members for preventing the passage of air from the rearward cavity of the body **13** past the piston **30** to the forward end thereof. The forward end of the piston includes a reduced cylindrical portion **33** for receiving the rearward portion of the spring **26**, with the reduced cylindrical portion **33** terminating at a front face **34**. The rearward end of the piston **30** forms a rear face **35**. A plurality of orifices **39** are formed on the forward end of the cylindrical body **13**.

The threaded rearward end **15** of the cylindrical body **13** is adapted to threadedly receive a bushing **36** having an apertured shoulder **37** formed therein. The exterior of the bushing **36** includes an annular recess **38** for receiving the rearward portion of a cylindrical handle **40**. The forward portion of the handle **40** extends over an annular portion **41** of a strike nut **42**. The strike nut **42** includes interior threads **43** which are adapted to be engaged with a threaded portion formed on the exterior of the cylindrical body **13**. The forward end of the strike nut **42** forms a front face **44**.

The interior of the bushing **36** is adapted to receive a valve **50** comprising a shoulder **51** and an elongated stem **52**. The stem **52** is adapted to extend through the aperture formed in the bushing **36** while the shoulder **51** is adapted to seat on the shoulder **37** of the bushing **36**. The rearward face of the valve **50** is adapted to en-

gage a compression spring 53 which is secured within the bushing 36 by bearing against a forward annular recess formed in a threaded nipple 55.

The forward end valve stem 52 includes a bore 56 for receiving the rearward end of a valve rod 57. The valve rod 57 extends through a bore 58 formed in the piston 30 and along the entire length of the cylindrical body 13 to be received within a bore 59 formed within the reduced cylindrical portion 24 of the piercing tool 20. The rearward end of the bore 58 is enlarged to receive the extent of the valve stem 52.

A slide hammer 60 is slidably mounted on the exterior of the cylindrical body 13. The slide hammer 60 includes a rearward head portion 61 and a forward portion 62 having a hexagonal cavity 63 which is adapted to extend over the hexagonal bushing 17. This interengagement is more clearly shown in FIG. 4.

FIG. 5 shows a modified form of the apparatus in which the piston 30 is modified by shortening the enlarged rearward end of the bore 58 so that it can contact the valve stem 52 to actuate the valve 50.

OPERATION

The rest, or unactivated, position of the apparatus 10 is shown in solid lines in FIG. 1. In this position, the piercing tool 20 is held in the forward position by the spring 25 which has a compressive force of 4 pounds. The forward position of the piercing tool 20 causes the valve rod 57 to keep the valve 50 seated.

To begin operation, the piercing tool 20 is positioned to contact the target area 70 of the damaged metal 11. Upon contacting the target area 70, the cylindrical body 13 is manually pushed forward. During this movement, the piercing tool 20 is initially retracted within the bushing 17 against the force of the spring 25. There is enough play within the bores 56 and 58 and the valve rod 57 that the valve 50 remains seated. Upon further forward movement of the body 13, the piercing tool 20 is further retracted to cause the valve rod 57 to push the valve 50 rearward against the force of the spring 53 which, in the preferred embodiment, is ten pounds. With the valve 50 unseated, as shown in dotted lines in FIG. 1, air under pressure is admitted into the interior of the body 13 to urge the piston 30 forward against the compression of the spring 26. At the end of the piston travel, as shown in FIG. 2, the piston front face 35 strikes against the rear face of the piercing tool 20 to urge it forward to penetrate the workpiece 11. After impact, the forward movement of the piercing tool 20 causes the valve rod 57 to move in the same direction to again seat the valve 50, thereby shutting off the admission of the compressed air. When this occurs, the piston 30 is returned to its initial position by the return spring 26. The air remaining in the rearward side of the piston 30 serves as a cushion to help stop the piston travel and prevent it from striking the shoulder 37 of the bushing 36 too hard. During the forward movement of the piston 30, the orifices 39 function to relieve the air in the chamber ahead of the piston. In a similar manner, during the rearward movement of the piston 30, the orifices 39 admit air to the chamber to prevent a suction created therein from inhibiting piston travel.

After the one shot impact, the slide hammer 60 is maneuvered to a position shown in FIG. 2. In this position, the cavity 63 of the slide hammer 60 is positioned over the hexagonal bushing 17 to aid in turning the body 13. Since the piercing tool 20 is keyed to the bushing 17 through its hexagonal portion 22, the tool 20 is rotated to screw into the hole formed in the workpiece 11. This action firmly anchors the piercing tool 20 to the workpiece.

To pull the workpiece 11 outward to its aligned condition, the slide hammer 60 is manually slammed rearwardly against the strike nut 42. The momentum of this impact causes the entire apparatus 10 and the workpiece 11 to be drawn rearward. If the workpiece 11 is not yet returned to its original position, the slide hammer 60 is again used to impact against the strike nut 42 until that position is attained.

When this position is achieved, the slide hammer 60 is returned to the position shown in FIG. 2 to aid in rotating the piercing tool 20 in the opposite direction to unthread the tool 20 from the hole. This hole formed in the workpiece 11 is then cemented over with a compound. This entire procedure is then repeated over other areas of the workpiece until the entire panel is repaired.

This single shot procedure is utilized in most applications. However, if a continuous or repeating mode is desired, a few simple modifications must be made to the apparatus. The first modification is that the enlarged rearward end of the bore 58 in the piston 30 is shortened so that it can contact the valve stem 52 to actuate the valve 50. In the previous embodiment, this enlarged portion of the bore 58 received the entire valve stem 52 but did not contact it. Instead the rear face 35 of the piston 30 contacted the shoulder 37 of the bushing 36 at the end of its travel. The second modification also reverses the strengths of the springs 25 and 53. In this embodiment, the spring 25 would have a compressive force of ten pounds while the compressive force of spring 53 would be four pounds.

In operation, the actuation of the apparatus is the same as the first embodiment; i.e., the body 13 is moved forward to retract the piercing tool 20 in order to actuate the valve 50. It should be noted that the retraction of the piercing tool 20 overcomes the ten pound bias of the spring 25 along with the bias of spring 53.

With the body 13 in the forward position and the piercing tool 20 in the retracted position, the unseating of the valve 50 admits compressed air to actuate the piston 30. The piston 30 then strikes the tool 20 to drive it forward. This closes off the valve 50 to permit the piston 30 to return. However, upon returning, the piston 30 strikes the valve stem 52 to unseat the valve 50. Air is admitted to again urge the piston forward to repeat the striking cycle.

It should be noted that this cycle is repeated with the body 13 being held in the forward position against the bias of spring 25. Since the bias of spring 53 is less, the valve 50 will continue to be actuated to admit the compressed air.

In order to stop the continuous operation of the apparatus, the body 13 is merely moved away from the workpiece 11. When this occurs, the bias of spring 25 forces the piercing tool 20 forward to permanently seat the valve 50. Since this force is greater than the force to unseat the valve 50, the action of the piston 30 cannot further actuate the valve 50.

As can be seen, an apparatus is provided utilizing novel triggering and valve actuation means to enable a hole piercing tool to utilize for the first time, pneumatic drive means.

It should be noted that various modifications can be made to the apparatus while still remaining within the purview of the following claims. For example, the valve actuation can be accomplished by having the handle movably mounted on the body, with the valve being actuated by relative movement between the handle and the body. In this manner, the valve rod would still be located within the body.

What is claimed is:

1. Apparatus for removing dents from an object comprising:
- a hollow body member having a forward and a rearward end;
- a piercing member, adapted to pierce the object and remain fixed in the object, movably mounted at the forward end of the body member;
- a piston member slidably mounted in the body and adapted to transfer energy to the piercing member for penetrating the object;
- valve means for admitting a quantity of motive fluid therethrough into the body member whereby the piston member is energized to move through the body member towards the piercing member;
- valve actuating means responsive to only the movement of the piercing member for controlling the valve means;
- means for automatically returning the piston member to an initial operative position when the valve means is closed; and
- means for exerting force on the object through the piercing member whereby the dent can be removed.

2. Apparatus as in claim 1 wherein the valve actuating means further includes a connecting member movably mounted within the body member and extending between the valve means and the piercing member.

3. Apparatus as in claim 1 wherein said valve actuating means further includes a valve rod interconnecting the piercing member with the valve means whereby any relative movement between the piercing member and the body member will actuate the valve means to admit the quantity of motive fluid.

4. Apparatus as in claim 3 wherein the valve rod is located within the interior of the body member.

5. Apparatus as in claim 4 wherein the piston member has a front face for striking the piercing member.

6. Apparatus as in claim 5 wherein the valve rod extends through a bore formed along the length of said piston.

7. Apparatus as in claim 6 further including a return spring biasly positioned within the body member between the piston and the piercing member.

8. Apparatus as in claim 6 wherein the valve means comprises a valve face adapted to be seated on a valve seat formed within the rearward end of the body member.

9. Apparatus as in claim 8 wherein the valve means further includes a valve stem having a bore for receiving the valve rod.

10. Apparatus as in claim 2 wherein the connecting member extends through the piston member, the piston member having a bore for permitting passage of the connecting member.

11. Apparatus as in claim 1 wherein the point of the piercing member is threaded.

12. Apparatus as in claim 11 wherein the piercing member is keyed against relative rotation with the body member.

13. Apparatus as in claim 11 wherein the means for exerting force includes a weighted slide hammer slidably mounted on the exterior of the body member, the slide hammer adapted to impact an abutting portion formed on the rearward end of the body member.

14. Apparatus as in claim 13 further comprising means on the forward ends of the body member and the slide hammer for rotating the body member manually.

15. Apparatus as in claim 14 wherein the rotating means comprises the forward end of the body member having an enlarged portion and the forward end of the slide hammer having a cavity for matingly receiving the enlarged portion of the body member.

16. Apparatus as in claim 15 further including a compression spring anchored to the body member and biased against the piercing member.

17. Apparatus as in claim 16 wherein the piston further comprises rear face means for striking and actuating the valve means during the return cycle of the piston.

18. A contact activated automatic hole piercing apparatus comprising:
- a hollow body member having a forward and a rearward end;
- a piercing member, for piercing an object, movably mounted at the forward end of the body member;
- a piston member slidably mounted in the central portion of the body member and adapted to transfer energy to piercing member for penetrating the object;
- valve means within the rearward end of the body member for admitting a quantity of motive fluid therethrough into the body member whereby the piston member is energized to move through the body member towards the piercing member;
- valve actuating means within the body member responsive only to movement of the piercing member for controlling the valve means and including a connecting member movably mounted within the body member and extending between the valve means and the piercing member; and
- means for automatically returning the piston member to an initial operative position when the valve means is closed whereby the apparatus is activated only upon contact movement of the piercing member.

19. Apparatus as in claim 18 further including a weighted slide hammer slidably mounted on the exterior of the body member, the slide hammer adapted to impact an abutting portion formed on the rearward end of the body member.

20. Apparatus as in claim 19 further comprising means on the forward ends of the body member and the slide hammer for rotating the body member manually.

21. Apparatus as in claim 20 wherein the rotating means comprises the forward end of the body member having an enlarged portion and the forward end of the slide hammer having a cavity for matingly receiving the enlarged portion of the body member.

22. Apparatus as in claim 18 wherein the piercing member is keyed against relative rotation with the body member.

23. Apparatus as in claim 18 wherein the connecting member is a valve rod that extends through a bore formed along the length of the piston.

24. Apparatus as in claim 23 further including a return spring biasly positioned within the body member between the piston and the piercing member.

25. Apparatus as in claim 24 wherein the valve means further includes a valve face adapted to be seated on a valve seat formed within the rearward end of the body member.

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