United States Patent [19]

Schmuck

[11] **3,921,729**

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[54] **ELECTROPNEUMATIC HAMMER**

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[73] Assignee: **Hilti Aktiengesellschaft**, Schaan, Liechtenstein

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[21] Appl. No.: **474,174**

Related U.S. Application Data

[63] Continuation of Ser. No. 308,666, Nov. 22, 1972, abandoned.

[30] **Foreign Application Priority Data**

Nov. 24, 1971 Germany 2158503

[52] **U.S. Cl.** **173/14**; 173/104; 173/116; 173/117

[51] **Int. Cl.²** **E21C 3/22**

[58] **Field of Search** 173/13, 14, 15, 16, 17, 173/116, 118; 74/583; 60/542, 543

[56] **References Cited**

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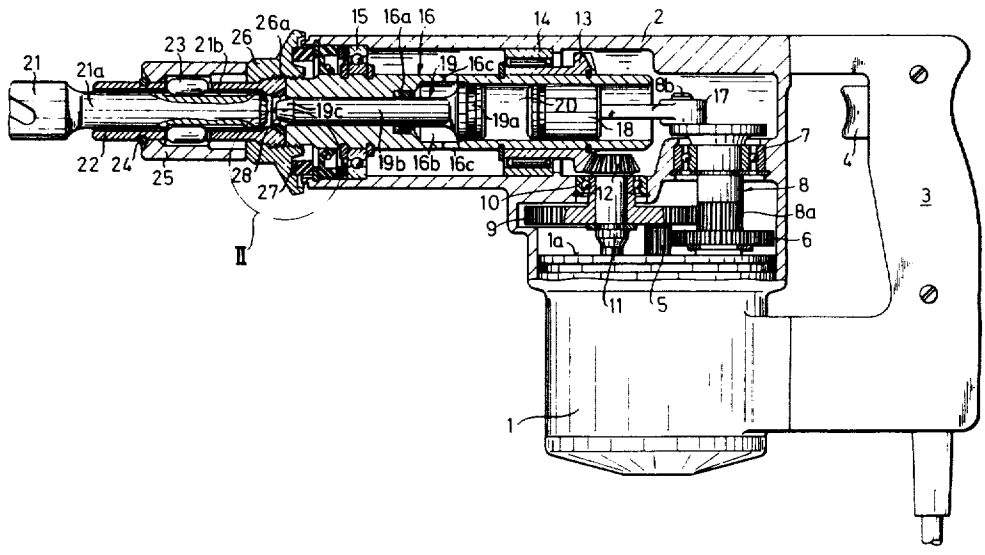
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[57] **ABSTRACT**

In a electropneumatic hammer, an air cushion is provided within the bore in a cylinder between a driving piston and a striking piston. As the driving piston reciprocates, through the medium of the air cushion, it causes the striking piston to move axially and impact against a tool in a tool carrier. Openings are provided in the cylinder which afford an air exhaust from that part of the bore forward of the rearward end of the striking piston, when it operates to hit against a tool in the tool carrier. However, if the tool is removed from its operating position within the tool carrier, the striking piston moves forwardly into the tool carrier and a radially expanding ring is arranged to engage the striking piston frictionally and prevent the continuation of the axial movement of the striking piston. When the striking piston moves forwardly and is secured by the ring, it moves past the openings in the cylinder so that the air cushion communicates with the openings and is no longer effective. The air cushion is reconstituted when the striking piston is released by inserting a tool into the operating position in the tool carrier.

2 Claims, 3 Drawing Figures



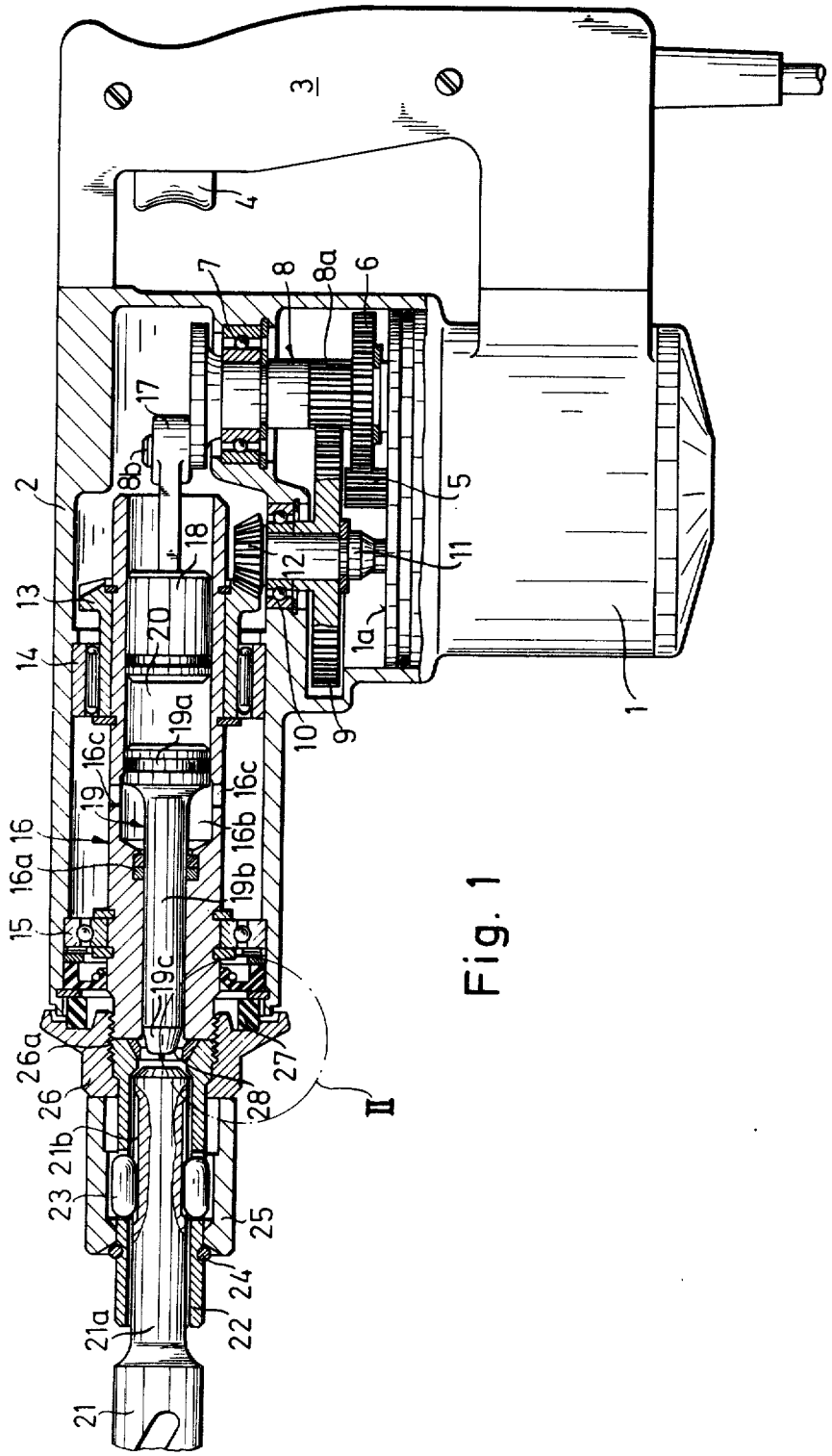

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Fig. 1

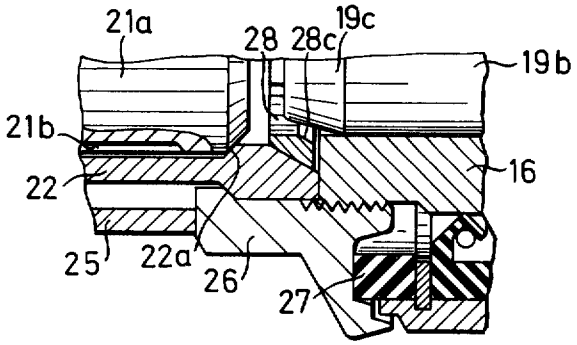


Fig. 2

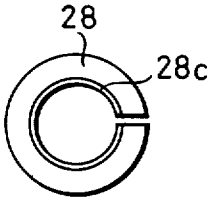


Fig. 3

ELECTROPNEUMATIC HAMMER

This is a continuation of application Ser. No. 308,666 filed on Nov. 22, 1972, now abandoned.

SUMMARY OF THE INVENTION

The present invention is directed to an electropneumatic hammer in which an impacting action is effected against a tool in a tool carrier by a striking piston axially displaceable within a cylinder and moved back and forth within the cylinder by a driving piston through the medium of an air cushion provided in the cylinder between the two pistons, and, more particularly, the invention concerns the arrangement of openings in the cylinder through which the air forming the air cushion can escape when the striking piston is displaced axially forwardly of its normal operating position because the tool, against which it hits, is not in the operative position in the tool carrier.

There are known hammers of the general type mentioned above in which a striking piston moving back and forth in a cylinder through the medium of an air cushion is limited in its forward position, as seen in the driving direction, by a tool or tool carrier shaft which projects into the cylinder. If the extent to which the tool or tool carrier shaft projects into the cylinder is reduced, the striking piston can advance forwardly in the cylinder so that the striking piston moves past the openings and the air forming the air cushion can escape with the result that the striking piston no longer reciprocates within the cylinder even if the driving piston continues to operate.

The interruption of the movement of the striking piston is of particular importance when the hammer, of the type described above, is lifted from the material on which it is acting, because it is no longer desirable to continue the operation of the striking piston, since its striking action must be absorbed by the structure of the hammer itself. Accordingly, tools or tool carriers are known which are arranged for axial displacement in the hammer housing so that, when the tool is lifted from the material being treated, the tool and/or its tool carrier can yield forwardly that is in the driving direction. When the tool or tool carrier moves forwardly in the axial direction, the striking piston can also move forwardly to the extent that the air cushion is released within the cylinder. Furthermore it is known, particularly in drill hammers, in eliminating the striking movement, to use a tool or tool carrier with a short shaft so that the striking piston can move forwardly in the driving direction past the openings in the cylinder.

When using hammers as described above, with the pistons arranged in the upward direction, there is the disadvantage that the striking piston drops into its rearward direction due to its own weight even if the tool is removed from the material being treated, so that the openings in the cylinder are covered in such a manner that the air cushion is retained and the striking piston continues its striking action. Furthermore, in the more powerful type of hammers which use a striking piston of relatively great weight, it is possible that the impact of the piston on the boundary surface within the cylinder or housing is so great that, even if the tool is in the inoperative position, the rebound of the striking piston is such that it covers the opening in the cylinder and the air cushion is reestablished and causes the impacting action of the striking piston to continue. Accordingly, the movement of the striking piston does not cease, even when the tool is not in engagement, and, as a result, it is necessary that the entire striking action intended to be delivered to a tool must be absorbed by the structure of the hammer. It can be appreciated that, if the striking piston continues to operate without delivering its striking energy to a tool, within a very short time the structure of the hammer will be exposed to considerable wear or severe damage.

Therefore, it is the primary object of the present invention, to provide a hammer in which, when the tool is in the inoperative position, the continued striking movement of the striking piston is prevented.

To prevent the continued striking action of the striking piston, retaining means are provided within the hammer to secure the striking piston in an inoperative position in which the air forming the air cushion is exhausted from the cylinder.

In accordance with the present invention, the retaining means hold the striking piston in a forwardly displaced position, so that, in any position of the hammer, the air cushion is reestablished only when the tool in the tool carrier is pressed against the material to be acted on and, by such movement, the striking piston is released from the retaining means. Accordingly, the striking action of the hammer is stopped immediately after the tool is lifted from the material against which it is acting, and no further blows of the striking piston occur which have to be absorbed by the structure of the hammer. Therefore, the hammer is protected against wear or damage, and it has the further advantageous effect for the operator that the hammer runs practically vibration-free when the striking piston is held in the restrained position. In drill hammers, by means of the retaining member of the present invention, there is the additional advantage that, when the striking movement is eliminated and a strictly rotary movement remains, the striking piston cannot move into a position covering the openings in the cylinder and reestablish the air cushion, and, as a result, damage or undesired vibrations are avoided.

Preferably, the striking piston is held in the restrained position by frictional contact between it and the retaining member. By friction contact is meant the type of contact afforded by friction rings, friction cams, ball notches, skid-type friction and the like. The specific type of retaining member used for achieving the frictional contact is disclosed here for exemplary purposes only and the use of other retaining means, such as magnets and the like are also possible.

Of particularly advantageous use as a retaining member is a ring positioned within the hammer so that the striking piston can be axially displaced through the ring and moved into frictional contact with it when the tool in the hammer is moved out of the operating position. The ring is expandable in the radial direction and, in the unexpanded state, it has a smaller inside diameter than the portion of the striking piston which engages it frictionally. The amount by which the inside diameter of the ring is smaller in the unexpanded state than the diameter of the striking piston depends on the radial expandability of the ring, which, in turn, depends on the material and form of the ring. As an example, if a rubber ring is used, it is relatively easy to expand it so that its inside diameter must be made correspondingly smaller than the part of the striking piston which extends through it. The use of any type of ring which affords a frictional contact has the advantage that the braking and retaining action is distributed uniformly

over the circumferential periphery of the striking piston and lateral displacement or unilateral stress on the piston can be avoided.

Preferably, a split metal ring is used which is under a certain initial stress and which, in the unexpanded state, has a slightly smaller inside diameter than that of the striking piston which extends through it into frictional contact. It is particularly advantageous to use spring steel in forming the retaining ring. Moreover, if the other surface of the ring has a frusto-conical configuration with its surfaces converging in the driving direction, and if the ring is mounted in a similarly shaped recess within the hammer, there is the effect that the ring is pressed into the recess as the piston penetrates through it and, as a result, the forces acting radially on the piston are increased and similarly the braking action is increased as the piston passes through the ring, until the forces developed become so great that the forward movement of the piston is arrested and it is retained by the ring. To afford both a simple assembly and easy replacement, a member can be designed to receive the ring, for example, the retaining ring can be fitted into an additional ring, which, in turn, is clamped between the cylinder containing the striking piston and the tool carrier for the tool. In such an embodiment, the additional ring can also serve to limit the axial path of the tool.

To facilitate the passage of the striking piston through the ring into the tool carrier for striking against the rearward end of the tool, the rearward edge on the inner surface of the ring and the forward end face of the piston are similarly beveled or tapered. The formation of a conically shaped space through which the piston extends is particularly suitable in this case, however, other types of configurations could also be used. By using a conically shaped space, as the piston extends through the ring, initially it causes the ring to widen gradually and then when the cylindrical surface of the piston contacts the ring the increasing braking action commences.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated and described a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing:

FIG. **1** is a side view, partly in section, of an electropneumatic drill hammer embodying the present invention;

FIG. **2** is an enlarged sectional view of a portion of the hammer shown in FIG. **1**; and

FIG. **3** is a front view of a retaining member illustrated in FIG. **1**.

DETAILED DESCRIPTION OF THE INVENTION

In FIG. **1**, an electropneumatic hammer is illustrated and includes a motor casing **1** mounted on a housing **2** with a handle **3** containing a push button or trigger **4** attached to the housing and motor casing.

Within the housing, rotary movement is transmitted from a motor pinion **5** through the medium of a gear wheel **6** to a crank shaft **8** mounted in a bearing **7**. The crank shaft **8** has gearing **8***a* in meshed engagement with a gear wheel **9**. The gear wheel **9** is positioned on a bevel pinion shaft **11** mounted at its upper end within a bearing **10** and at its lower end in the end face **1***a* of the motor casing **1**. At its upper end, extending through the bearing **10**, the shaft **11** forms a bevel gear **12** in meshed engagement with a corresponding bevel gear **13**. The bevel gear **13** is mounted on a cylinder **16** which, in turn, is rotatably mounted within the housing **2** by means of the bearings **14, 15**. Within the rearward end of the bore formed by the cylinder **16** is a driving piston **18** which is reciprocated by means of the rotating crank shaft **8**. A connecting rod **17** fitted onto the crank pin **8***b* connects the driving piston **18** to the crank shaft **8**. Positioned within the bore of the cylinder **16**, forwardly of the driving piston **18**, is a striking piston **19** which extends forwardly through the cylinder bore with its shaft or shank **19***b* supported by the forward end of the cylinder. The adjacent end surfaces of the driving piston **18** and the striking piston **19** are spaced apart and form a chamber **20** therebetween in which an air cushion is established for moving the striking piston back and forth as the driving piston reciprocates. The striking piston head **19***a* at the rearward end of its shank **19***b* contacts the inner surface of the cylinder. At the forward end of the cylinder, a tool carrier **22** is positioned into which the tool shaft **21***a* of a tool **21** extends. As the driving piston **18** reciprocates its movement is transmitted through the air cushion to the striking piston and, in turn, its kinetic energy is transferred abruptly to the tool shaft **21***a* held within the tool carrier **22**. Within the cylinder **16**, a seal member **16***a* seals the interior **16***b* of the cylinder from its forward end through which the shank **19***b* moves back and forth. The tool **21** is mounted for axial displacement within the tool carrier and is held against rotation by rollers **23** positioned within the grooves **21***b*. A sleeve **25** concentrically encircling the tool carrier **22** and held in place by a ring **24**, permits the release of the shank **21***a* of the tool by turning the sleeve in a known manner. As the sleeve is turned the rollers **23** are disengaged from the grooves **21***b* in the tool shank and the tool can be withdrawn axially from the tool carrier The tool carrier **22** is in threaded engagement with the thread **26***a* on a cap nut **26** and the same thread is also screwed onto the forward end of the cylinder **16**. Rotary movement of the cylinder is transmitted through the rigid screw joint provided by the cap nut **26** to the tool carrier **22** and thence to the tool **21** itself. For transmitting the rotary movement, the cylinder can also be in operative connection with the tool carrier **22** by means of a front claw coupling. Positioned between the cap nut **26** and the housing **2** is a packing **27** which prevents the penetration of dust into the hammer.

Within the enlarged portion of the cylinder **16**, defining the section **16***b* of the cylinder, are openings **16***c* so that air contained within the section **16***b* is discharged during the forward movement of the striking piston **19**. As the striking piston moves rearwardly, air is sucked in through the openings **16***c* into the section **16***b* of the cylinder located forwardly of the striking piston head **19***a*. In FIG. **1** and **2** the normal operating position of the hammer and its tool **21** is shown and during such operation, as the striking piston **19** moves back and forth, air flows out of and into the section **16***b* of the cylinder. In the position shown in FIG. **1** the tool **21** is pressed against the material to be acted upon so that its rearward end is displaced into the rearward end of the

tool carrier adjacent to the forward end **19***c* of the striking piston.

When the hammer is removed from the material being acted on, the forward movement of the striking piston **19** causes the tool **21** to be axially displaced in the forward direction through the tool carrier **22** out of its normal operating position. The grooves **21***b* permit the axial movement of the tool **21** relative to its tool carrier **22.** With the tool displaced axially forwardly within its tool carrier there is no longer a surface for the striking piston to impact against and the piston moves forwardly within the section **16***b* of the cylinder so that the openings **16***c* communicate with the chamber **20** and release the air forming the air cushion between adjacent ends of the driving and striking pistons. With the striking piston head **19***a* displaced forwardly of the openings **16***c* any air which is sucked in by the continued reciprocation of the driving piston **18** is again exhausted through the openings **16***c* and the air cushion is not reestablished. The axial displaceability of the tool **21** within the tool carrier **22** is insured by forming the grooves **21***b* of a greater length than the axial length of the rollers **23.**

To hold the striking piston **19** in its forward position so that the air cushion cannot be reestablished while the tool **21** is in the inoperative position, a split ring **28** is positioned in the rearward end of the tool carrier through which the striking piston passes in contacting the tool. When the striking piston is driven forwardly into the tool carrier, and the tool is displaced axially forwardly into the inoperative position, frictional contact is developed between the ring and the cylindrically shaped portion or shank **19***b* off the piston so that it is prevented from moving rearwardly due to its own weight or vibrations or rebounding toward the driving piston so that its head **19***a* closes the openings **16***c* and again establishes the air cushion within the chamber **20.** As can be seen in particular in FIG. **2,** the ring is split and its outer surface has a frusto-conical configuration converging in the forward direction of the hammer, so that a perfect elasticity, braking and retaining effect on the striking piston **19** is insured taking into account all the influences which act on the piston within the hammer. The recess within the rearward end of the tool carrier **22** into which the ring fits also has a frusto-conical surface similar to that on the exterior surface of the ring. The inner surface of the ring **28** adjacent the end of the tool **21** is cylindrically shaped, however, the rearward inner surface, that is the end surface closer to the cylinder **16,** has a beveled or tapered surface **28***c*, converging in the driving direction, for facilitating the passage of the forward end **19***c* of the piston shank **19***b* into the tool carrier, which forward end **19***c* has a beveled or tapered similar to that within the ring.

In FIG. **2** the tool **21** is shown in its operative position seated against the shoulder **22***a* in the rearward end of the tool carrier, however, in its inoperative position the tool is displaced forwardly so that the beveled forward end **19***c* of the striking piston **19** extends into the tool carrier and gradually moves into frictional contact with the ring **28** so that it is restrained against returning rearwardly into the cylinder **16.** When the tool **21** is pressed against a surface to be acted upon, the tool rides rearwardly within its carrier **22** and displaces the striking piston **19** from engagement with the ring **28** into the cylinder **16** so that its head **19***a* passes over the openings **16***c* in the cylinder affording the reestablishment of the air cushion within the chamber **20.** Accordingly, the operating position of the various parts indicated in FIG. **1** and **2** is again obtained. The shoulder **22***a* within the interior of the tool carrier axially limits the rearward movement of the tool by providing a tapered surface against which the beveled edge at the end of the tool seats. Another way of preventing the transmission of the striking action to the tool and thus affording a strict rotary motion consists in using an axially non-displaceable tool with a shaft that is so short it cannot be reached by the striking piston as it moves forwardly uncovering the openings **16***c*. If such a tool is used, it is also of paramount importance that the striking piston does not suddenly commence to strike accidently thus causing damage to the hammer structure as a result of the blows or hindering the hammer operator because of increased vibrations.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the inventive principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed:

1. An electropneumatic hammer arranged to impart a rotary and impacting action on a tool, comprising a housing, cylinder positioned within said housing forming an axially elongated bore having a forward end and a rearward end, a tool carrier mounted on and in communication with and extending forwardly from the forward end of the bore in said cylinder and arranged to hold a tool therein in an operating position, a striking piston mounted within and axially displaceable through the forward end of said cylinder into said tool carrier for imparting an impacting action to a tool positioned in the operating position in said tool carrier forwardly of the forward end of the bore in said cylinder, a driving piston positioned within and axially displaceable within the bore in said cylinder at the rearward end thereof, said driving piston being spaced rearwardly from said striking piston for forming an air cushion therebetween for transmitting the reciprocating action of the driving piston to said striking piston, means for reciprocating said driving piston within said cylinder so that through the medium of the air cushion therebetween said striking piston moves forwardly and rearwardly and in its forward motion strikes the tool in said tool carrier, the forward movement of said striking piston through the forward end of said bore into said tool carrier is limited by the tool positioned within the operating position in said tool carrier, openings in said cylinder communicating with the bore therethrough are located in said cylinder so that during impacting action said striking piston is restrained by the tool in said tool carrier from moving forwardly into the bore to the extent that the air cushion is exhausted through the openings in said cylinder whereby the air cushion is maintained between said striking piston and driving piston and, when the tool is not in the operating position within said tool carrier, said striking piston can move forwardly through the forward end of the bore in said cylinder into said tool carrier to the extent that the air cushion is opened to the opening in said cylinder and is no longer maintained between said striking piston and driving piston, wherein the improvement comprises means located within said tool carrier in the path of movement of said striking piston for securing said striking piston against axial movement when the opening in said cylinder communicates with the space between said striking piston and said driving piston for releasing the air cushion

therebetween and for releasing said striking piston when a tool is inserted into the operating position within said tool carrier, said means being arranged to engage said striking piston frictionally and to hold it in position spaced forwardly of said driving piston so that the opening in said cylinder communicates with the space between said striking piston and driving piston, said striking piston having an axially extending section displaceable through the forward end of said bore in said cylinder into said tool carrier when a tool is not in the operating position in said tool carrier, said means comprises a ring located in said tool carrier contiguous to the forward end of the bore in said cylinder so that when a tool is in the operating position in said tool carrier the leading end of said axially extending section of said striking piston can pass through said ring in contact free relation for imparting an impacting action against the tool located within said tool carrier, said axially extending section of said striking piston has a cylindrically-shaped part spaced rearwardly from its leading end and said cylindrically-shaped part has a diameter greater than the diameter at the leading end of said striking piston, the interior surface of said tool carrier is shaped to provide an annular shoulder immediately forward of said ring and arranged to contact the rearward end of the tool and to define its operating position, said ring is a split ring formed of metal and is radially expandable, in the unexpanded state said split ring has an inside diameter less than the diameter of the cylindrically-shaped part of said axially extending section of said striking piston so that the inside diameter surface of said ring frictionally engages the cylindrically-shaped part of said axially extending section of said striking piston rearwardly from its leading end for securing said striking piston against axial movement, said tool carrier has a recess in its end contiguous to the forward end of said bore in said cylinder for receiving said ring, the surface of said recess extending in the axial direction has a frusto-conical configuration with the frusto-conical surfaces diverging in the direction toward said cylinder, the outer surface of said ring has a frusto-conical configuration and is arranged to correspond to and to seat in closely fitting engagement against the frusto-conical surface in said recess, the end of said striking piston extending axially forward from the cylindrically-shaped part of said axially extending section thereof and which extends into said tool carrier is beveled forwardly from said cylindrically-shaped part to the leading end of said striking piston which contacts said tool carrier with said beveled surfaces arranged in converging relationship toward the end of said striking piston which impacts against the tool, and the end portion of the inner surface of said ring closer to said cylinder is correspondingly beveled to permit said striking piston to extend into contact with a tool in the operating position in said tool carrier without frictional contact between the cylindrically-shaped part of said axially extending section of said striking piston and said ring during normal operating conditions.

2. An electropneumatic hammer, as set forth in claim **1**, wherein said split ring is formed of spring steel.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3921729 Dated November 25, 1975

Inventor(s) Peter Schmuck

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the heading of the Patent [30] should read as follows:

--[30] Foreign Application Priority Data

Nov. 25, 1971 Germany.....2158503--.

Signed and Sealed this

twenty-fourth Day of *February 1976*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks