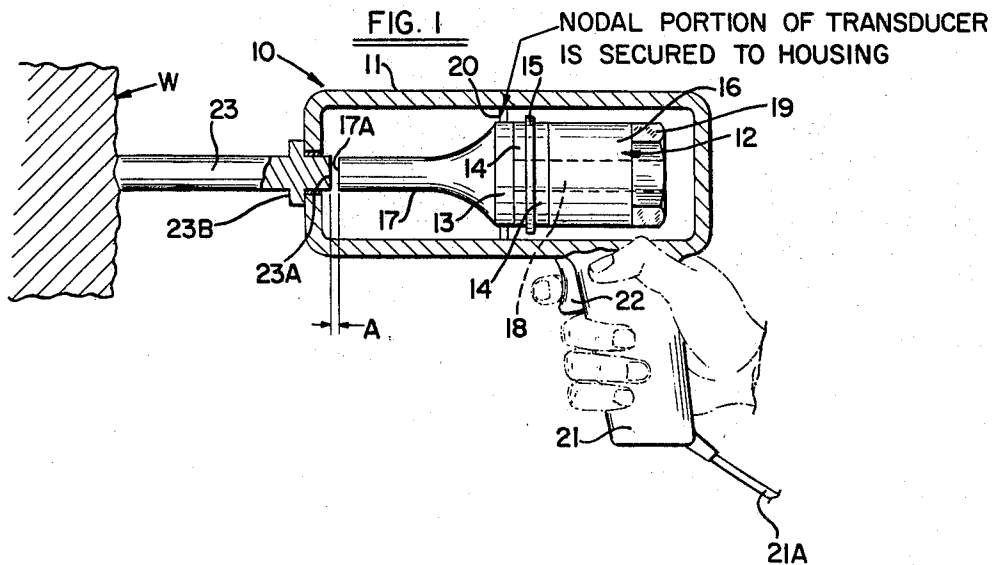
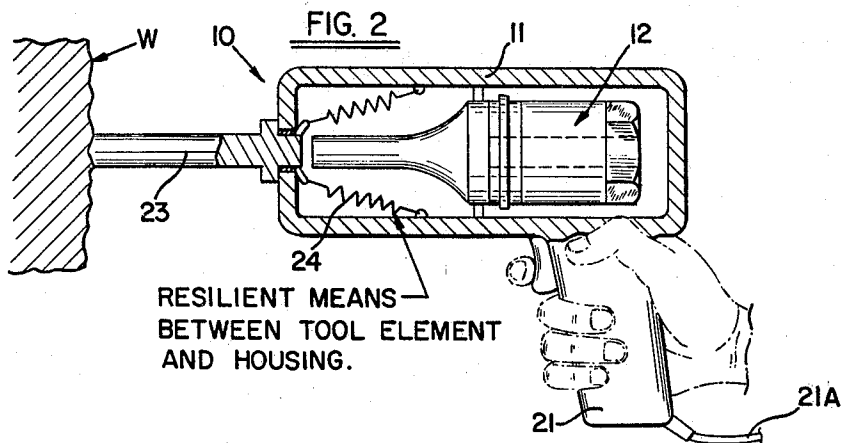
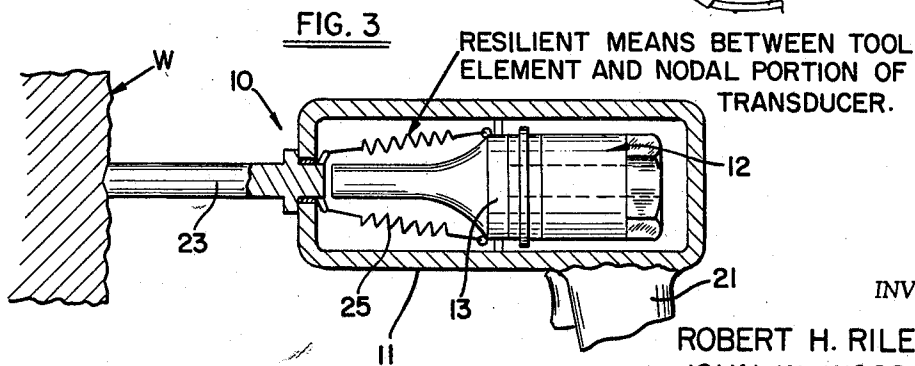


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3,485,307

PORTABLE SONIC HAND TOOL WITH MEANS FOR REDUCING
THE EFFECTS OF OPERATOR BIAS UPON
TRANSDUCER OUTPUT AND EFFICIENCY
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1

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PORTABLE SONIC HAND TOOL WITH MEANS FOR REDUCING THE EFFECTS OF OPERATOR BIAS UPON TRANSDUCER OUTPUT AND EFFICIENCY

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8 Claims

ABSTRACT OF THE DISCLOSURE

A portable sonic hand tool has a housing provided with a handle adapted to be grasped by the operator. A transducer means, which may be of the piezoelectric or magnetostrictive type, is disposed within the housing and exhibits cyclic elastic deformations or vibrations during the operation of the tool. The transducer has a substantially acoustically-nodal portion secured to the housing, and further has an impedance-transforming "horn" portion extending forwardly of its nodal portion. A tool element (or bit) is positioned on the housing, preferably being loosely received on the housing, and has a first portion extending within the housing for receiving a series of vibratory-type impacts from the horn portion of the transducer assembly, thereby transmitting vibratory energy to the work. The respective axial positions of the tool element and the horn portion of the transducer assembly, in their mean or "at rest" positions relative to one another, are predetermined for the particular application for optimum transducer efficiency. The tool element further has a second portion, such as a collar means, which is in abutting engagement with the housing. Thus, the forward pressure or bias exerted by the operator is applied from the handle to the tool housing, and through the housing, to the collar means on the tool element and then to the work. With this arrangement, and as distinguished from the prior art, the operator cannot exert a forward thrust directly on the transducer; and thus a means is provided for precluding an over-loading of the transducer under excessive operator bias, thereby maintaining optimum transducer performance and efficiency. In other embodiments, a resilient means is provided between the tool element and the housing and/or between the tool element and substantially the acoustically-nodal portion of the transducer.

OBJECTS OF THE DISCLOSURE

It is an object of the present invention to provide a means for eliminating any possible adverse effects or operator bias upon the output and efficiency of a transducer mounted in a portable sonic or ultrasonic hand tool.

It is a further object to provide and maintain in a sonic or ultrasonic hand tool, a predetermined relative axial positioning of the tool element and the impedance-transforming horn portion of a piezoelectric-type transducer, in their respective mean or "at rest" positions relative to one another, thereby maintaining optimum transducer performance and efficiency.

It is a still further object to provide a resilient means for constantly urging the tool element in abutting engagement with the housing of a portable sonic or ultra-

2

sonic hand tool, thereby tending to neutralize the effects of any rebound of the tool element from the work.

These and other objects of the present invention will become apparent from a reading of the following specification, taken in conjunction with the enclosed drawings.

DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a side elevation, partially in longitudinal section, of one embodiment of the portable sonic (or ultrasonic) hand tool of the present invention;

FIGURE 2 is a second embodiment thereof, showing the use of a resilient means between the tool element and the housing; and

FIGURE 3 is a third embodiment thereof, showing the use of a resilient means between the tool element and substantially the nodal portion of the transducer.

DETAILED DESCRIPTION

With reference to FIGURE 1, there is illustrated a sonic (or ultrasonic) hand tool 10 having a generally longitudinal housing 11 within which a resonant means comprising a transducer assembly 12 is disposed. Any type of transducer means may be employed, but preferably the transducer assembly 12 is of the piezoelectric type and exhibits cyclic elastic deformations (or vibrations) during the operation of the tool. Moreover, the construction and theory of operation of the transducer assembly form no part of the present invention, but may be obtained with reference to the McMaster et al. Patent No. 3,368,085, entitled "Sonic Transducer," issued on Feb. 6, 1968.

With this in mind, the transducer assembly 12 comprises an intermediate substantially acoustically-nodal portion 13, a pair of piezoelectric transducer crystals or elements 14, a contact element 15 between the transducer elements, a spacer portion 16, an impedance-transforming horn portion 17 forwardly of the nodal portion and formed integrally therewith, a central bolt portion 18 formed integrally with the nodal portion, and nut means 19 engaging the central bolt for retaining the assembly and for applying the desired degree of axial compressive bias. The compressive clamping of the transducer elements is habitually resorted to in the prior art and is illustrated in the non-expired patents to Heising, No. 2,044,000, and to Burkhardt, No. 2,368,609.

The nodal portion 13 of the transducer assembly is secured to the housing by suitable means, as at 20, in the manner of the prior art. The sonic tool further comprises a suitable handle means, such as the pistol-grip handle 21 adapted to be grasped by the operator and having a trigger 22 for controlling the energization of the tool from the line cord 21a. In lieu of the pistol-grip handle 21, any suitable handle may be provided, or else the tool housing itself could be grasped by the operator. Also, the electrical connections and the switching means from the line cord 21a through the trigger, and from the trigger into the transducer assembly, are conventional and have been omitted for ease of illustration.

A tool element 23 is provided, which may comprise a suitable masonry-drilling bit, a wood-gouging tool, or any other suitable work-engaging element. The tool element 23 is loosely (or removably) mounted on the housing and includes a first portion 23a extending within the tool housing, confronting the end face 17a of the horn portion 17 of the transducer assembly, and adapted to receive a series of vibratory-type impacts therefrom dur-

ing the operation of the tool. The tool element further includes a second portion, preferably comprising a collar means 23b, which is in abutting engagement with the tool housing.

In one embodiment, the first portion 23a of the tool element 23 is longitudinally spaced from the end face 17a of the horn portion 17 of the transducer assembly, in their respective mean or "at rest" positions relative to one another, by a predetermined distance (denoted as at A on the drawing) for optimum transducer performance and/or efficiency for the particular application intended to be performed during the operation of the tool. This distance A, in the one embodiment, is in the order of a few thousandths of an inch, but is exaggerated on the drawing for clarity of understanding. Further, in some applications, the tool element and the transducer horn may be just touching each other "at rest" but still, their relative axial positions will be predetermined (and repeatable) relative to one another. If the application or environment calls for a lower-amplitude type of physical vibration, then an intimate contact (or "touching") is more desirable; on the other hand, if a more pronounced higher-amplitude hammering or impacting is desired, as in certain aspects of masonry drilling, then a more pronounced spacing of the distance A is employed.

With the sonic tool of FIGURE 1, the forward pressure or bias exerted by the operator during the operation of the tool is applied to the handle 21, through the housing 11 to the collar 23b on the tool element 23, and from the tool element directly to the work W. In this manner, the operator's forward thrust or bias is applied against the tool element to the work; the position of the tool element is fixed in relation to the housing; the operator's bias is not exerted against the transducer directly (as is otherwise the case in the prior art constructions); and thus any adverse effects of operator bias upon the transducer output and efficiency are neutralized, since the transducer cannot be overloaded due to excessive operator bias. With this arrangement, energy may be continuously stored in the resonant transducer assembly 12, then taken out in a lower-frequency series of vibratory-type impacts applied to the tool element, without any undesirable interference that might otherwise arise from a variation in, or an excess of, operator bias applied to the sonic tool.

With reference to FIGURE 2, there is illustrated a first modification in which resilient means 24 is provided between the tool element 23 and the housing 11, thereby tending to maintain the collar means 23b in abutting engagement against the housing for the tool. The resilient means 24 may comprise a spring, as shown, or its equivalent.

With reference to FIGURE 3, there is illustrated a second modification in which resilient means 25 is provided between the tool element 23 and substantially the nodal portion 13 of the transducer assembly, which nodal portion is in turn secured to the housing 11.

These resilient means (24 or 25) tend to neutralize the effects of tool element rebound (sometimes referred to in the art as "bit bounce") and tend to maintain the tool element in the desired abutting engagement with the housing.

The combination of an adjustment in the distance A, that is, the relative axial positioning of the transducer and the tool element in their mean or "at rest" positions; the collar means on the tool element in abutting engagement with the housing so as to neutralize any possible effects of operator bias or thrust exerted on the tool; and the resilient means between the tool element and the housing (or between the tool element and the nodal portion of the transducer) allows energy to be continuously delivered and stored in the resonant system of the transducer assembly, then taken out in a lower-frequency higher-am-

plitude series of intermittent vibratory-type impacts delivered to the tool element and hence to the work, such that the amplitude of the impacts, their time duration and spacing relative to one another, may be controlled or optimized for any given application.

Obviously, many modifications may be made without departing from the basic spirit of the present invention; and accordingly, within the scope of the appended claims, the invention may be practiced other than has been specifically described herein.

We claim:

1. A portable sonic tool comprising a housing; handle means on said housing adapted to be grasped by an operator; a tool element loosely mounted on said housing and having a portion extending within the housing; a transducer mounted within said housing, and exhibiting, upon energization, cyclic elastic deformations at a first, high frequency, said transducer having an end portion extending from said mounting toward said tool element for delivering a series of vibratory-type impacts to said extending portion of said tool element at a second frequency, said second frequency being substantially lower than said first frequency; and means tuning said tool element to vibrate at said second frequency, said tuning means comprising the spring rate of said tool element and further comprising a structurally fixed relationship of the length of said extending portion of said tool element, of said end portion of said transducer, and of said housing therebetween, which defines the position and time of impact of said transducer on said tool element whereby said tool element is impacted at the peak of its stroke and at a point in the transducer cycle which cannot overload the transducer, regardless of the application of excess operator bias.

2. A portable sonic hand tool as claimed in claim 1 wherein said housing is rigid and wherein said length of said extending portion of said tool element is defined by collar means attached to said tool and arranged to abut the exterior of said housing.

3. A portable sonic hand tool as claimed in claim 1 wherein said tuning means further comprises resilient means controlling the rate of return of said tool after impact so that said tool reaches said impact position at substantially the same moment as said transducer so that said tool is resonantly driven at said second frequency.

4. A portable sonic hand tool as claimed in claim 3 wherein said resilient means is mounted between said tool element and said housing.

5. A portable sonic hand tool as claimed in claim 3 wherein said resilient means is mounted between said tool element and a substantially nodal portion of said transducer.

6. A portable sonic hand tool as claimed in claim 1 wherein said tuning means further comprises the spring rate of the material for which said tool is designed.

7. A sonic tool comprising a housing; a tool element loosely mounted on said housing and having a portion extending within the housing; a transducer mounted within said housing, said transducer, upon energization, exhibiting cyclic elastic deformations at a first, high frequency and having an end portion extending from said mounting toward said tool element for delivering a series of vibratory-type impacts to said extending portion of said tool element at a second frequency; said second frequency being substantially lower than said first frequency; and means tuning said tool to vibrate at said second frequency, said tuning means comprising the spring rate of said tool element and further comprising a structurally fixed relationship of the lengths of said extending portion of said tool element, of said end portion of said transducer and of said housing therebetween which defines the position and time of impact of said transducer on said tool element whereby said tool element is impacted at the peak of its stroke without loading said transducer.

5

8. A sonic tool as claimed in claim 7 wherein said housing is rigid; wherein said length of said extending portion of said tool element is defined by collar means attached to said tool and arranged to abut the exterior of said housing; and wherein said tuning means further comprises resilient means controlling the rate of return of said tool to said impact position so that said tool reaches said position at substantially the same moment as said transducer, said tuning means being designed to accommodate a predetermined work material having a known spring rate.

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6

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