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APPARATUS FOR EMITTING AND RECEIVING ELASTIC WAVES

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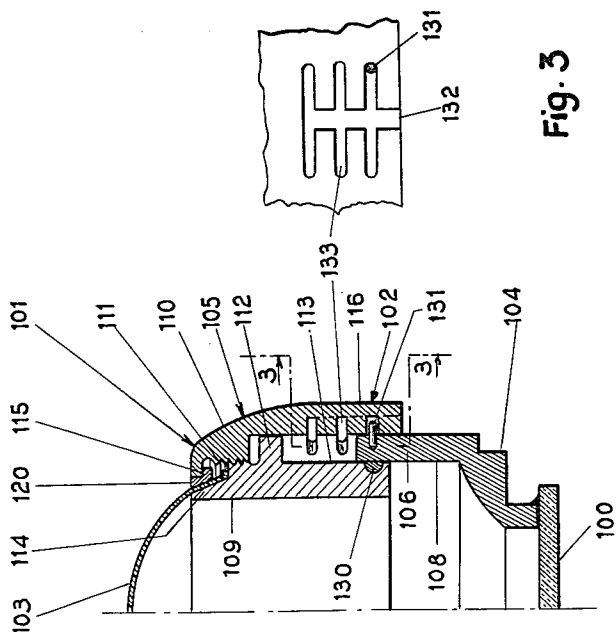


Fig. 2

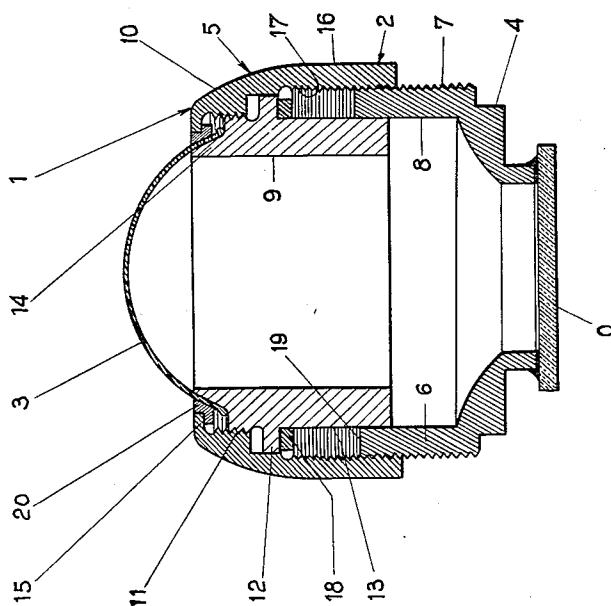


Fig. 3

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APPARATUS FOR EMITTING AND RECEIVING ELASTIC WAVES

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7 Claims. (Cl. 310—8.7)

The present invention relates to transducers apparatus for emitting and receiving elastic waves designed to be used for medical treatment or for the non-destructive examination of solid materials, etc.

It is known that certain elastic waves, for example sound waves in the audible or supersonic ranges, can be used for examining various bodies and materials to detect interior defects. These same waves are also often used for certain medical treatments, for example the treatment of dermatosis and other treatments where a massaging action is desired.

The examination of solid materials by elastic waves is effected by placing the body to be examined either between an elastic wave emitting device and a receiving device—for examination by transparency—or in front of the emitting and receiving devices for examination by reflection. Medical treatment by means of elastic waves is effected by placing a device which emits these waves in front of the part to be treated.

The present invention is applicable both to apparatus for emitting elastic waves and to apparatus for receiving such waves. The expression transducer is herein used to include apparatus for generating or emitting such waves and apparatus for receiving them as well as apparatus which both emits and receives.

Such apparatus includes a vibratile member for emitting or receiving the waves. In the case of high frequency sound waves, the vibratile member for emitting or receiving the waves may, for example, comprise a quartz sheet, block or crystal.

A difficulty arises in the practical operation of apparatus for emitting and receiving elastic waves because of the fact that the transmission of such waves cannot be effected through air except with a great diminution of their intensity. This is particularly true in the case of supersonic waves, the passage of which is practically prevented by even a thin film of air or other gas.

Under these circumstances, it is of fundamental importance to improve the contact between the emitter and the material on the one hand, and between the material and receiver on the other hand, in order to obtain sensitivity and exactitude in the examination of said material. In the case of medical treatment by such waves, the diminution of intensity of the transmitted waves by going through a layer of air constitutes a loss which appreciably affects the efficiency of the operation and makes it difficult to determine and regulate the proper intensity and duration of the treatment.

It is an object of the present invention to reduce as much as possible the diminution of the elastic waves in their transmission between the emitter and the material or body to be examined or treated and between said material or body and a receiver.

In an invention forming the subject matter of French patent application No. 501,552, now Patent No. 997,867, applicant has proposed the use of a "palpator" or "feeler" designed to transmit the elastic waves by means of a liquid contained in an enclosure having a wall portion

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of flexible material that is capable of yielding under the pressure of the liquid or squashing upon contact with a solid body, the wall being capable of sweating slightly so as to improve the contact with the body being examined or treated by providing a thin layer of liquid between said wall portion and body. The present invention relates to an improvement of this apparatus, to providing a simple construction so that the liquid can be introduced quickly and easily without the formation of air bubbles inside the feeler. The structure in accordance with the present invention further permits easy regulation of the turgescence or swelling of the flexible wall portion by pressure of the liquid and insures against leakage.

In accordance with the present invention, the means for transmitting elastic waves from a device emitting these waves to a body being examined or treated, or from said body to a device for receiving the waves, comprises a liquid-filled enclosure having solid parts a flexible wall and means for adjustably applying pressure to the liquid in the enclosure to vary the turgescence of the flexible wall portion. For this purpose, the extension of the solid parts capacity or volume of the enclosure containing the liquid through which the transmission of the elastic waves is effected is made variable between a maximum and a minimum value so that a quantity of liquid exactly filling the maximum capacity can be compressed at will by the reduction of said extension, the compression of the liquid causing increasing swelling or turgescence of the flexible material which constitutes a part of the wall of the enclosure.

The objects, advantages and nature of the invention will be more fully understood from the following description of the preferred embodiments of the invention shown, by way of example, in the accompanying drawings, in which:

Fig. 1 is an axial section of a preferred embodiment of the invention.

Fig. 2 is a partial axial section of another preferred embodiment.

Fig. 3 is a fragmentary inside view taken approximately as indicated by the line 3—3 in Fig. 2.

In order to simplify the drawings, portions of the apparatus not essential to an understanding of the invention have been omitted, it being understood that the invention is applicable to any suitable emitting or receiving apparatus having a quartz sheet or other vibratile member for emitting or receiving the waves.

The palpator or feeler for transmitting the waves between the vibratile member O of the emitting or receiving apparatus and the body to be examined or treated comprises a liquid-filled, hollow enclosure or container 1 having a tubular or annular wall 2. One end of the annular wall 2 is closed by the vibratile member O of the emitting or receiving apparatus. The other end is closed by a flexible wall 3 which may, for example, be a rubber, or plastic membrane.

In the embodiment shown in Fig. 1, the annular wall 2 comprises two interfitting coaxial annular members 4 and 5. The lower annular member 4 is somewhat cup-shaped, having a cylindrical wall portion 6 which is externally threaded at 7 and has a smooth interior surface 8. The upper annular member 5 comprises an inner portion 9 and an outer portion 10 which are interconnected by screw threads 11. The inner portion 9 is substantially cylindrical with an outwardly projecting annular shoulder 12 and a smooth cylindrical portion 13 fitting inside the cylindrical portion 6 of the lower member 4. At its upper end, the inner wall portion 9 is provided with a tapered collar 14. The outer wall portion 10 has an intumed rim 15 at its upper end and a lower skirt portion 16 having internal threads 17 adapted to engage the external threads 7 of the lower member 4.

Thus, the cylindrical portion 6 of the lower member 4 is adapted to be received in an annular space between the inner wall portion 9 and the outer wall portion 10 with a sliding fit between the lower member 4 and the inner wall portion 9 and a threaded interengagement between the lower member 4 and the outer wall portion 10. A sealing gasket 18, for example a rubber ring, is seated on the shoulder 12 of the upper wall member 5 and is adapted to be engaged by the edge 19 of the lower member 4 when the latter is screwed all the way in.

When the inner wall portion 9 and outer wall portion 10 are screwed together, the peripheral edge portion of the flexible wall 3 is gripped between the collar 14 and a metal ring 20 fitting inside the rim 15 of the outer wall portion 10 to provide a fluid-tight seal between the flexible wall 3 and the annular wall 2. A fluid-tight seal is likewise provided between the lower wall member 4 and the vibratile member O of the emitting or receiving apparatus in any suitable manner. The vibratile member O is glued on the lower wall member 4 in a fluid-tight seal by means, for example, of synthetic resins.

The assembly of the palpator or feeler shown in Fig. 1 is effected in the following manner. The two wall portions 9 and 10 are assembled and screwed together, clamping the peripheral portion of the flexible wall 3 between them, as described above. The gasket 18 is then introduced in the space between the members 9 and 10 and seated on the shoulder 12. The annular wall portion 4 and the annular wall portion 5 including the attached membrane 3 are both immersed in a vessel of water or other liquid with which the palpator or feeler is to be filled and, while thus immersed, the part 4 is screwed into the part 5.

As the part 4 is screwed into the part 5, the liquid confined in the enclosure 1 is more and more compressed, causing the progressive protrusion or turgescence of the membrane 3. This turgescence is brought to a maximum value by bringing the edge 19 of the lower part 4 almost in contact with the gasket 18, thus reducing the extension of the solid parts of the enclosure almost to its minimum value. At this stage, the tightness of the enclosure is not perfect, a slight leaking of liquid occurring between the cylindrical surfaces 8 and 13 and between the screw threads 7 and 17 of the members 4 and 5, respectively. Owing to this leakage, the turgescence of the flexible wall 3 slowly decreases. When this turgescence has reached the desired value, further leakage is stopped and perfect tightness of the enclosure is effected by screwing the member 4 tightly against the gasket ring 7.

A further embodiment of the invention is illustrated in Figs. 2 and 3 where corresponding parts are designated by the same reference numerals as in Fig. 1 with the addition of 100. The apparatus of this embodiment is similar to that of Fig. 1 and comprises emitting or receiving apparatus having a vibratile member 100 and a palpator or feeler in the form of an enclosure or container 101 comprising an annular wall 102 and a flexible wall or membrane 103. The annular wall 102 is made up of two interfitting coaxial annular parts 104 and 105. The part 104 to which the vibratile member 100 is secured has a cylindrical portion 106 having a smooth inner cylindrical surface 108. The other annular wall member 105 comprises an inner wall portion 109 and an outer wall portion 110 connected by interengaging screw threads 111. The inner portion 109 has an outwardly projecting annular shoulder 112, an outer cylindrical surface 113 and, at its upper end, a tapered collar 114. The outer wall portion 110 has an inwardly projecting rim 115 and a downwardly extending skirt portion 116 which surrounds, and is spaced from, the cylindrical surface 113 of the inner portion, to provide an annular space that receives the cylindrical portion 106 of the annular wall member 104, so that the two annular wall members 104 and 105 are telescopically slidable relative to one another.

As in the embodiment of Fig. 1, the peripheral portion of the membrane 103 is clamped between the tapered collar 114 of the inner wall portion 109 and a metal ring 120 fitting inside the rim 115 of the outer wall portion 110.

In the outer cylindrical surface 113 of the inner wall portion 109, there is provided one or more annular grooves into each of which a packing ring 130, of rubber, for example, is introduced. At one or more equally spaced points on the annular wall member 104, there are provided outwardly projecting pins 131 adapted to engage slots or recesses in the skirt portion of the outer wall part 110 to provide a bayonet joint. The grooves comprise an axially extending groove 132 and one or more branch grooves 133. In the embodiment illustrated in the drawings (Fig. 3), branch grooves are provided at opposite sides of the central groove 133 at three equally spaced points, so that the annular wall members 104 and 105 can be locked together in any of three positions.

After assembling the inner and outer wall portions 109 and 110 and the membrane 103, as described above, the annular wall portions 104 and 105 are immersed in the liquid that is to fill the container and the part 104 is introduced by general friction into the part 105 to a depth that produces the desired turgescence of the membrane 103. A fluid-tight seal between the parts 104 and 105 is provided by the gasket ring or rings 130. When the desired protuberance of the membrane 103 has been obtained, the parts 104 and 105 are locked by turning them relative to one another to cause the pins 131 to enter one or another of the branch grooves 133. Depending on the number and the spacing of the transverse grooves 133, it is possible to regulate the turgescence of the membrane 103 at different values, depending on the intended use of the apparatus.

The respective features of the embodiments shown in Figs. 1 and 2 are mutually interchangeable and combinable in different ways. For example, the embodiment of Fig. 1 having threaded connection between the two annular wall members 4 and 5 may be provided with one or more annular sealing gaskets, like gaskets 130 of Fig. 2, in order to provide a fluid-tight seal between the two wall members in all of their adjusted positions instead of only in the position of minimum extension. If desired, the interfitting wall members may be provided both with a gasket like the gasket 18 of Fig. 1 and one or more gaskets like the gasket 130 of Fig. 2. Moreover, these gaskets may be of any suitable shape and may, if desired, be self-sealing by the internal fluid pressure. It will be understood by those skilled in the art that still other structural arrangements are possible within the scope of the invention and it is accordingly not intended to limit the invention to the specific forms shown by way of example in the drawings.

What I claim and desire to secure by Letters Patent is:

1. In apparatus for emitting and receiving elastic waves such as supersonic waves, the combination of a vibratile member and wave transmitting means comprising a hollow liquid container and a body of liquid through which said waves are transmitted confined in the container, said container comprising an annular wall, one end of said container being closed by said vibratile member a highly elastic membrane having a highly variable surface area, closing the opposite end of the container, said membrane being joined at its periphery to said annular wall with a fluid-tight seal, said annular wall comprising two interfitting annular wall members which are movable relatively to one another in an axial direction to vary the volume encompassed by said annular wall between a maximum volume and a minimum volume, thereby to vary the degree of turgescence of said membrane, and means for providing a fluid-tight seal between said annular wall members.

2. Apparatus according to claim 1 in which the fit be-

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tween said interfitting wall members permits controlled leakage of liquid between said members except when said members are in minimum volume position.

3. Apparatus according to claim 1, in which said sealing means provides a fluid-tight seal between said members in all adjusted positions of said members within a predetermined range.

4. Device for transmitting elastic waves such as supersonic waves between a body and apparatus having a vibratile member, comprising a hollow liquid container and a body of liquid through which said waves are transmitted confined in the container, said container comprising a rigid annular wall, one end of said container being closed by said vibratile member, a flexible wall of highly expandable and contractible material closing the opposite end of the container, said flexible wall being joined at its periphery to said annular wall with a fluid-tight seal, said annular wall comprising two telescopically interfitting annular wall members one of which has an inner annular portion and a surrounding annular portion with an annular space between said portions and the other wall member being received in said annular space, said wall members being movable axially relative to one another to vary the volume encompassed by the walls of said container, means providing a fluid-tight seal between said wall members and means for retaining said wall members in the relative position to which they are moved.

5. In apparatus for emitting and receiving elastic waves such as supersonic waves, a housing divided into two parts, one of said parts having a resilient protuberant wall portion, a vibratile member associated with the other of said parts, a body of liquid filling said housing, said parts being slidable relative to one another, means for maintaining a fluid-tight seal between said parts during their sliding and in all positions to which they are slidable relative to one another and a bayonet-type connection provided between said parts and having a plurality of notches to lock said parts relative to one another in any of a plurality of selected positions.

6. In apparatus for emitting and receiving elastic waves such as supersonic waves, the combination of a vibratile member and wave transmitting means comprising a hollow liquid container and a body of liquid through which said waves are transmitted confined in the container, said container comprising an annular wall, one end of said container being closed by said vibratile member, a flexible wall, capable of yielding under the pressure of the liquid, closing the opposite end of the container, said flexible wall being joined at its periphery to said annular wall with a fluid-tight seal, said annular wall comprising rigid sections which are extensible relatively to one another in an axial direction to change the static pressure of the liquid on said flexible wall by the extension of said rigid sections between a maximum extension and a minimum extension, and means for providing a fluid-tight seal between said annular wall sections in all positions relative to one another, said liquid completely filling said container when said rigid sections are in the condition of maximum extension.

7. Apparatus according to claim 6, comprising means to fix the relative position of said annular wall sections at will.

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