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GB 1109560 **GB 0903812**
GB 0982559 **GB 0701664**

(58) Field of search
B4C

(54) **Improvements in or relating to pressure medium operated needle hammers**

(57) A pressure medium operated needle hammer, has needles (24) arranged in a reciprocatably movable driving member (3) by means of at least one flexible holder member (31, 39). A friction grip on the needles 24 by the holder member, causes the needles to follow the movements of the driving member 3 but permits an axial play of the needles within predetermined limits through overcoming the frictional resistance. The rear portions of the needles 24 are arranged in a sealed chamber (34) filled with a hydraulic medium (35) which damps percussion forces transmitted to the member 3 by the needles 24. Pressure medium entering a working chamber 21 causes the member 3 and a reaction member 4 to recede from one another to initiate hammering while return springs 6, (7) Fig. 1 (not shown) cause their mutual approach after hammering. The movements of the members 3, 4 during such reciprocation, balance one another and nullify recoil forces.

The holder 31 is encased by washers 32, 33 and sleeve 27. The holder 39 is fitted in a sleeve 36.

Fig. 2

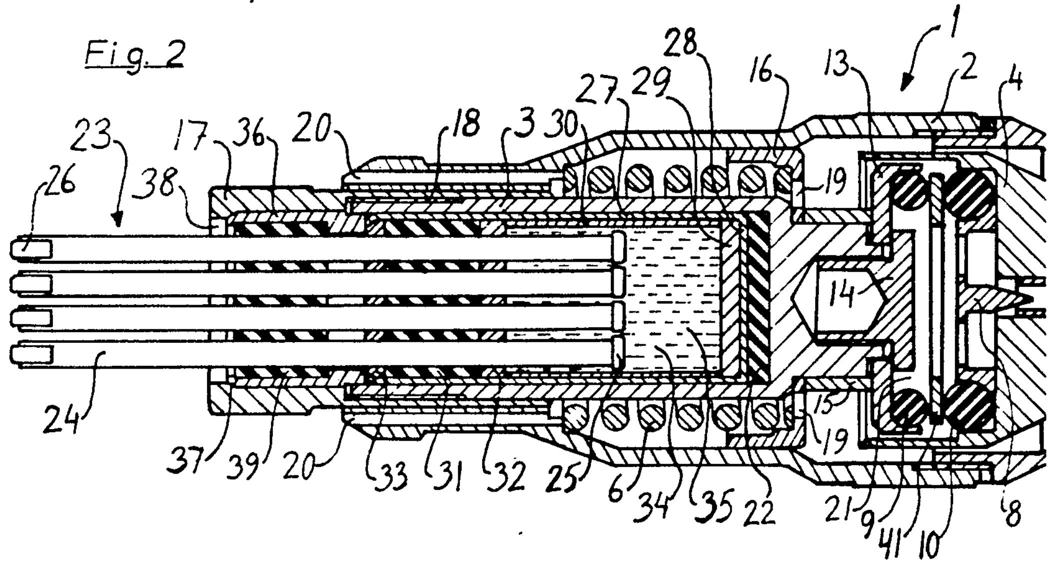

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Fig. 1

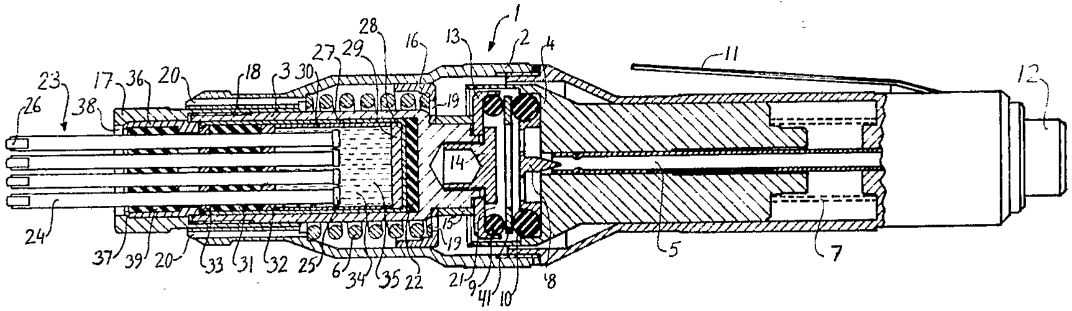


Fig. 2

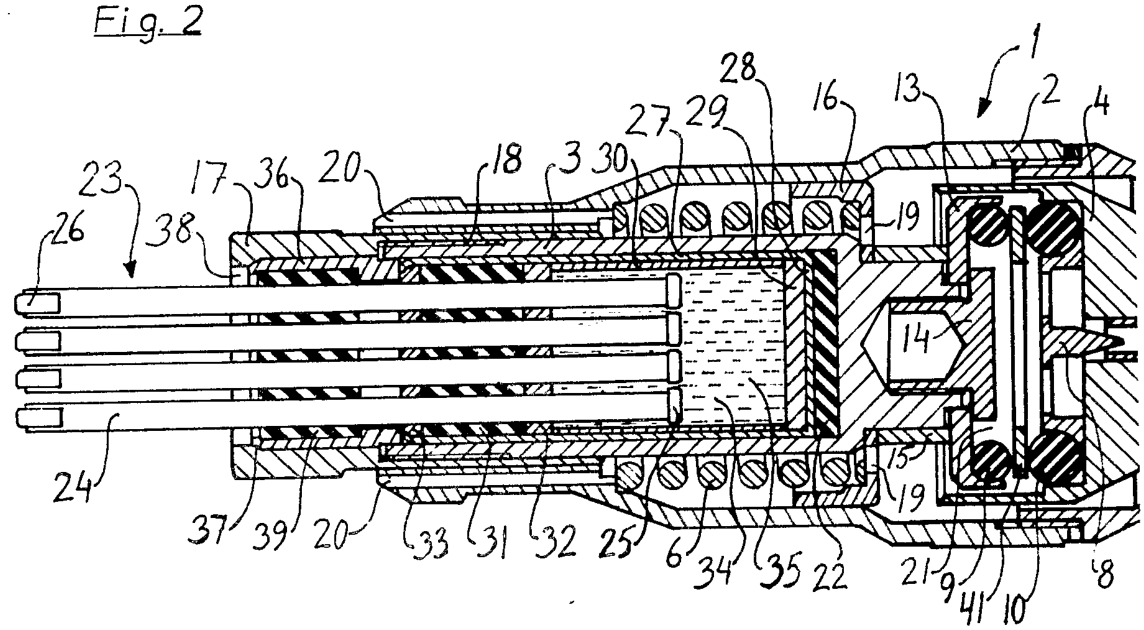
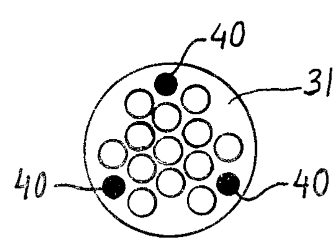


Fig. 3



SPECIFICATION

Improvements in or relating to pressure medium operated needle hammers

This invention relates to pressure medium operated hammers or needle scalers driven by means of a pressure fluid.

In known needle hammers, the needles are usually arranged in a holder in which, independently of each other, they are axially movable a limited distance in order to permit adjustment in relation to unevenness of a workpiece surface and/or an oblique angle of approach to that surface. The working effect is obtained by means of a reciprocating member arranged behind the needle assembly, which member during its forward movement strikes against the heads of the needles. During each stroke, the needle or needles taking up the rearmost position will, via their heads, receive the impact energy delivered, or the main part thereof, while those needles which take up a more forward position will not at all, or only with reduced power, be hit by the impact member.

This known principle entails a number of disadvantages:

1. For each working cycle, the working effect of the different needles of the needle assembly varies so considerably that not all the needles can be regarded as doing any useful work.

2. Due to the uneven distribution of the impact force, individual needles can be subjected to overloads causing durability problems.

3. The operation of the impact member produces a recoil effect, as well as shock waves which via the housing of the tool are transmitted to the hands of the operator and which, after extended use of the tool, may cause occupational injuries, such as so-called white fingers.

4. The sound level during the operation of the tool is high, partly due to the shock pulses generated when the impact member strikes against the heads of the needles, and partly due to the fact that the needles are usually guided with a relatively large play which permits them to swing in their lateral direction and clatter against each other and their retaining member or members.

According to the present invention, there is provided a pressure medium operated needle hammer having needles arranged in, and with their leading ends protruding from, a driving member reciprocally movable in the axial direction of the needles, the needles being caused to follow movements of said driving member by means of at least one flexible holder member which is provided with holes through which the respective needles are passed and which clasps each needle by means of a friction grip, and the needles being arranged in such a way that individual axial play of the needles within predetermined limits is permitted when the resistance of said friction grip is overcome.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 shows a sectional side view of a needle hammer in accordance with the invention,

Figure 2 shows, on a larger scale, a sectional side view of the front section of the same needle hammer, and

Figure 3 shows an end view of a detail of the needle hammer.

Reference numeral 1 denotes the needle hammer in general, and reference numeral 2 its outer shell or housing. A reciprocatable driving member 3 is balanced, in order to obtain recoilless operation, by a reaction member 4 which is caused to describe opposite movements to the member 3. The two members are affected, on the one hand, by a pressure medium which is admitted through a conduit 5 to a working chamber 21 formed between the members, said medium striving to separate the members and, on the other hand, by springs 6, 7 which, when the chamber 21 is opened during the separating movement, return the members in a direction towards each other. Therefore, the members will perform a rapid series of reciprocating movements, so long as the supply of pressure medium continues. In the working chamber 21, a feed valve 8 can be provided, which during the movements of the reaction member 4 alternately blocks and uncovers the outlet opening of the conduit 5 for the pressure medium. Elastic seals 9, 10 serve as sealing means for the working chamber and can consist of O-rings. A washer 41 is provided as a contact member between these O-rings.

The principle for the drive mechanism with the elastic seal rings 9, 10 is described in closer detail in British Patent No. 1498550, the balancing device with the reaction member 4 in British Patent No. 1524569, and the feed valve 8 in Swedish Patent Application No. 8204044-5.

Reference numeral 11 denotes a control lever for opening and closing the supply conduit 5 for pressure medium by means of a valve device not shown, and 12 is a connection nipple for connection of the tool to a source of pressure medium.

The driving member 3, and the parts related to the same, are best shown in Figure 2. The rear end of the driving member is fitted with a drive plate 13 retained by means of a screw 14 which clamps the drive plate against one end of a spacer sleeve 15. Between the opposite end of the spacer sleeve and a shoulder of the driving member 3 a flanged ring 16 is clamped which serves as a slide bearing for the driving member in the housing 2. At its front end, the driving member 3 is guided radially by means of a nut 17, which is threaded on the driving member by means of a thread 18 and is slidingly journalled in the front section of the housing 2. In the bearing ring 16 and the front section of the housing, holes 19, 20 are provided for allowing escape of the pressure medium which is discharged radially from the working chamber 21 past the seals 9, 10 when the chamber opens during the separating movement of the working member 3 and the reaction member 4.

The driving member 3 has the general shape of a cylinder open at one end. A buffer plate 22 of elastic material such as a polyurethane plastics of a relatively hard quality is supported against the bottom or end wall of the member 3. A needle assembly 23 is also arranged in the hollow driving member 3. This assembly comprises a number of needles 24 having heads 25 at their rear ends and short tungsten carbide pins 26 brazed in holes in the front ends of the needles. Further, the needle assembly includes a sleeve 27 with an end wall 28, a metal washer 29 supported against said wall, a spacer tube 30, a washer 31 of elastic material, such as a polyurethane plastics, and, on opposite sides of this washer, support members in the form of guide washers 32, 33 of a harder material, such as metal or a hard plastics. The washers 31-33 are provided with holes through which the needles 24 can be passed. The washer 32, the spacer tube 30 and the washer 29 define a chamber 34, part of which is occupied by the rear portions of the needles 24. The remaining chamber volume can be filled with a medium 35 which serves as a hydraulic medium. The needle assembly 23 can be made to keep together as a self-contained unit by joining the washer 33 and the end portion of the sleeve 27 together, e.g. by squeezing together said end portion around a narrowing end portion of the washer. In this form of one single unit, the needle assembly 24-35 can be inserted into and pulled out of the driving member 3.

The needle assembly 23 is secured in the driving member 3 by means of a sleeve 36, the inner end of which penetrates a short distance into the driving member 3 and exerts pressure on the washer 33. The sleeve 36 is surrounded by the nut 17 which has a tapering internal end portion 37 against which a correspondingly tapered portion of the sleeve is supported. The clamping pressure of the sleeve against the washer 33 is obtained by tightening of the nut 17. To obtain locking of the nut and, to prevent its unwinding from the driving member 3 when the needle hammer is operated, the sleeve 36 and the driving member 3 should be non-rotatably connected to each other, and the nut locked by friction against the tapered end of the sleeve. The non-rotatable connection can be obtained by means of a rib or the like extending radially from the sleeve 36 and connecting with a slot or groove in the end portion of the driving member 3. A reliable friction locking between the sleeve and the nut is obtained by means of a suitable choice of the shape of their tapered contact faces against one another, if necessary improved by slotting the end of the sleeve, so that it is compressed under resistance from a springing action, when the tapered surfaces are pressed against each other. To prevent the driving member 3 and the sleeve 36 from co-rotating when the nut 17 is turned, a claw spanner or similar can be used, the protruding claws of which are inserted into slots at the outer end of the sleeve 36 through an opening 38 of the nut.

In the sleeve 36 is fitted a guide washer 39 provided with holes for the needles 24 and suitably made of an elastic material similarly to the washer 31. The guide washer 39 is retained in the sleeve 36 in a suitable way, for example by having been forced past a constricted portion of the sleeve.

In the embodiment illustrated, the sleeve 31 serves to seal the chamber 34 completely against leakage of hydraulic medium 35. Therefore, the washer should be pre-tensioned with the necessary amount of force by means of compression between the washers 32, 33, which is done in connection with the washer's being forced into the sleeve 27 and joined to same, so that the complete needle assembly forms a joined-together and closed unit. In addition, the nut 17 will, when tightened, exert pressure on the washer 33 via the sleeve 36 on which the nut acts, which will further secure the joint. Due to its axial compression, the washer strives to expand radially, whereby it will press against the needles 24 as well as the surrounding wall of the sleeve 27 and seal efficiently against these.

To avoid variations in the pre-tension of the elastic washer 31, it is suitable to provide the washer with a number of spacer pins 40 (Figure 3), which are inserted into the washer outside the periphery of the series of holes for the needles 24 and which are a little shorter than the axial dimension of the washer 31, so that the washer is given the right amount of pre-tensioning when compressed a distance equal to the difference in length between the washer and the pins. When this has been done, the ends of the pins 40 will support against the washers 32, 33, and prevent further compression. Hereby, an entirely rigid axial connection is obtained all the way from the nut 17 to the bottom of the sleeve 27, by means of the different washers and spacer elements.

In contrast to the elastic washer 31, the elastic guide washer 39 does not need to be pre-tensioned and provided with spacer pins 40, since it only serves to guide the needles 24 radially, and slightly resiliently. The needles are guided both by the washers 32, 33, to prevent radial forces on the needles from acting disadvantageously on the sealing function of the elastic washer 31, and by the guide washer 39. The elasticity of the guide washer prevents the forming of a sharply defined breaking point on the needles 24, when these are subjected to radial forces during the operation of the needle hammer, but the deflection of the needles will be along an arc having a long radius. Provided that a suitable steel quality is chosen for the needles, they can withstand the radial forces without buckling and permanent deformation. Thanks to the resilient guiding of the needles and their being deflected mainly inside or close to the washer 39, and to their being journalled along a long total distance in the different washers, there are no problems with misalignment of the needles causing a prying or scraping effect against the edges of the holes in the washers 32, 33.

The mode of functioning of the needle hammer in accordance with the embodiment illustrated is as follows. By operation of the control lever 11, the feeding of pressure medium to the working chamber 21 is started, whereby the driving member 3 and the reaction member 4 are caused to reciprocate towards and away from one another. The total volume occupied by the rear ends of the needles 24 in the chamber 34 is kept substantially constant, since the hydraulic medium 35 resists compression due to a rearward movement of all the needles of the needle assembly 23, and since a corresponding forward movement, too, is counteracted by the creation of a negative pressure in the chamber 34. In addition, the friction grip of the elastic washers 31 and 39 around the needles contributes to the retaining of these in their positions. Consequently, the needles 24 will follow the reciprocating movements of the driving member 3. If, however, during its forward stroke, the needle assembly strikes against a work surface which is at an oblique angle to the direction of movement of the needles and/or presents elevations or cavities, so that all the portions of the work surface will not be simultaneously hit by all the needles, the needles which are the first to hit the work surface will be loaded and forced backwards in the chamber 34, the non-loaded needles being forced in the forward direction a corresponding amount, partly due to the overpressure produced in the chamber 34 by the needles which are forced back, and acting on the rear ends of the non-loaded needles, and partly due to the kinetic energy stored in the non-loaded needles, which makes them strive to continue their forward movement of their own accord. The needle assembly will hereby quickly adjust in the axial direction, so that the positions of the needles will correspond to the unevenness of the work surface, or its inclination to the direction of stroke of the needle hammer, and all the needles will, mainly simultaneously, hit the work surface and absorb mainly the same amount of load, i.e. will mainly do the same amount of useful work.

This evening out of loads is of great importance for the durability and life of the needles, and for the total amount of processing force which can be used. Further, a strongly contributing factor is the driving of the needles by means of a friction grip and a hydraulic medium, and not by means of metallic impacts against their heads. The needles' being elastically supported in the guide washer 39 is an additional important advantage, since no sharply defined point of buckling is created when the needles deflect as they are loaded during the processing of a work surface.

The amount of hydraulic medium 35 in the chamber 34 should be adjusted in such a way that the needles 24, when all of them are inserted the same distance into the chamber, have their rear ends in the middle of it. When the needles work in the way described above, certain needles will be pushed forward, and certain needles backward, from this mean position but, normally, not to such an extent that their heads contact the front or rear end wall of the chamber 34. This can occur only in case of considerably differing levels on a work surface. If, for example, the tool is operated close to the edge of a workpiece, with the majority of the needles engaging the workpiece, but one or two passing outside its edge and meeting no resistance, the result is that the loaded needles go backwards a short distance, while the added change of volume caused by these movements in the chamber 34 causes the smaller number of non-loaded needles to be pushed forward a longer distance, until the undersides of their heads contact the washer 32. This only means a slightly increased pressure on the washer, which is already, on the surfaces of its end wall which surround the needles, subjected to the same pressure per unit of surface as that acting on the rear ends of the needles.

The washer 32 is thus not subjected to any loads which are hard to handle. In the case of such load conditions that certain needles are forced backwards all the way to the washer 29 at the rear end of the chamber 34, the impact load which is thereby absorbed by the washer 29 and the end wall 28 of the sleeve 27 is damped by the elastic buffer plate 22. Such load conditions will occur only if the tool is used in such a way that only an individual needle, or a few needles, engage a workpiece, the majority of the needles going clear of it. Such a method of working is, of course, unsuitable for extended use, since the few needles working have to carry the total load alone. In normal cases, this method of working should not be needed, either. For the processing of very narrow surfaces, a needle assembly with few needles should be chosen, in order for its diameter to correspond in a suitable way to the application.

The axial length of the chamber 34 should, of course, be chosen in order to provide sufficient room for the backward and forward movements of the needles from their mean position, for example 15-20 mm in either direction.

When the needles impact against a work surface, the driving method described results in force pulse characteristics which produce considerably less strain on the material in the form of compression waves and tensile waves travelling through the needles than would be the case if, in the conventional way, they were subjected to metallic impacts against their heads simultaneously with being engaged against a hard work surface. It is therefore possible to fit the impact ends of the needles with tungsten carbide tips, for example in the form of short pins 26 of a relatively tenacious tungsten carbide quality. This increases the efficiency of the needles considerably and provides for tips which stay sharp all the time. Conventional, hardened steel needles are relatively quickly deformed at their ends. The tungsten carbide tips and the advantageous arrangement and driving of the needles in the present needle hammer result in a many times longer life of the needle assembly.

The chamber 34 which is filled with hydraulic medium must be sealed so completely at its forward end wall that the needle hammer can be used for a long time without loss of such an amount of hydraulic medium along the needles 24 or the side walls of the sleeve 27—past the elastic washer 31—that the mean penetration of the needles into the chamber 34 increases until they have too little play backwards. It has proved advantageous to use a medium which has less tendency towards seepage than ordinary hydraulic oil. In a prototype of the present needle hammer, a silicone monomer having a high molecular weight and advantageous sealing properties was used with a good result. The medium used has a high viscosity and tenacity and keeps together internally but has a low tendency towards adhering to the needles and following these through the seals in the form of a thin film.

When the needle hammer is operating, the movements of the driving member 3 and the reaction member 4 balance one another, so that no recoil forces are produced. The percussion forces which, when the needles 24 work against a workpiece, are transmitted to the driving member 3, are damped by the hydraulic medium 35 and are thereafter for the main part absorbed by the counterbalanced cushioned drive system of which the driving member is a part. During the separating movement of the driving and reaction members, braking and reversing of the movement is accomplished against the springs 6, 7, while the return movement is damped by means of a combination of an air cushion effect—when the members approach one another and the pressure increases in the chamber formed between them—and a spring action of the elastic seals 9, 10. It should further be noted that the drive chamber 21 between the driving member 3 and the reaction member 4 has no exactly defined axial position, but is formed where the members meet during their return movement depending on the load variations on the driving member. Therefore, the drive system is, to a high degree, self-compensating for varying loads.

Trials have shown that it is also possible to use a needle hammer mainly in accordance with the embodiment shown in Figures 1 and 2, but with no hydraulic medium in the chamber 34. In this case, the needles 24 are made to follow the movements of the driving member 3 only by means of a friction grip around them by an elastic washer 31, possibly supplemented by an elastic guide washer 39. The friction grip should be so adjusted that a certain amount of sliding of the needles axially in relation to the friction element occurs during the acceleration at the end positions of the strokes. Since the type of impact mechanism described operates in such a way that the driving member 3 is accelerated faster at the beginning of a forward stroke than at the beginning of a return stroke, the needles will, when the tool is operated with the needles unloaded, work their way backwards to the rear end wall of the chamber 34. Needles impacting against a work surface are therefore supported by this wall. Needles which do not immediately hit the work surface, due to its being uneven or inclined, are thrown forwards on account of a sharp braking of the driving member 3 and its elastic friction elements which hold the needles, caused by the contact between the rear ends of the needles hitting the work surface and the rear end wall of the chamber 34. Therefore, an axial adjustment of the needles with regard to an uneven or inclined work surface is obtained, so that all portions of the work surface are processed. However, the distribution of the loads and the working efficiency will not be as good as for the alternative described above, with a chamber 34 filled with a hydraulic medium. For light-duty applications, however, the design may be usable. The advantage is that the design is simpler and cheaper on a few points.

It will be appreciated that the present needle hammer enables the forces transmitted to the needle assembly of the tool to be more evenly distributed to the individual needles, whereby the strains on these are reduced and whereby a larger, simultaneous amount of work is performed per work cycle, since driving power is delivered to each needle. Further, the characteristics of the device make it suitable for obtaining, at the same time, an efficient damping of recoil and percussion forces and rattle-free guiding of the needles.

CLAIMS

1. A pressure medium operated needle hammer having needles arranged in, and with their leading ends protruding from, a driving member reciprocally movable in the axial direction of the needles, the needles being caused to follow movements of said driving member by means of at least one flexible holder member which is provided with holes through which the respective needles are passed and which clasps each needle by means of a friction grip, and the needles being arranged in such a way that individual axial play of the needles within predetermined limits is permitted when the resistance of said friction grip is overcome.

2. A needle hammer as claimed in claim 1, wherein said flexible material is a polyurethane plastics.

3. A needle hammer as claimed in claim 1 or 2 and having at least one support member made of a non-resilient material and provided with holes through which said needles are passed, said support member co-operating with the or each holder member to provide radial support for the needles.

4. A needle hammer as claimed in claim 3, wherein said non-resilient material is metal.

5. A needle hammer as claimed in claim 3, wherein said non-resilient material is a hard plastics.

6. A needle hammer as claimed in any one of the preceding claims, wherein rear portions of said needles are arranged in a chamber in said driving member and protrude forwardly from a forward end wall of said chamber, said wall being provided with holes through which said needles are passed, those parts of the chamber volume that are not occupied by said rear portions of the needles being arranged to be filled with a hydraulic medium, which by means of walls defining said chamber and by means of sealing against the peripheral surfaces of the needles in or at the holes for the needles in the forward wall, is prevented from escaping from the chamber.

7. A needle hammer as claimed in claim 6 as appendant to claim 3, wherein the or one of the support member(s) is capable of forming said wall.

8. A needle hammer as claimed in claim 6 or 7, wherein said hydraulic medium is a silicone monomer.

9. A needle hammer as claimed in claim 6, 7 or 8, wherein said at least one holder member clasping the needles or the rearmost one of these members when more than one such member is arranged along the needles, constitutes a seal for said chamber to prevent leakage of the hydraulic medium from said chamber.

10. A needle hammer as claimed in claims 3 and 6 or claim 7, 8 or 9 as appendant to claims 3 and 6, wherein said at least one holder member is arranged to be compressed between contacting members, one of which can, at the same time, constitute said at least one support member and forward end wall, respectively, in order to obtain clamping forces acting on the needles, and a frictional resistance determined by these forces, as well as a good sealing action against the needles and the contacting members.

11. A needle hammer as claimed in claim 10, wherein a plurality of spacer pins or similar are inserted in at least one said holder member, said pins acting, when the holder member is compressed between two contacting members which act against opposite sides of the holder member, as a stop for said contacting members and determining thereby the maximum amount of compression on said needles.

12. A pressure medium operated needle hammer, substantially as hereinbefore described with reference to the accompanying drawing.

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