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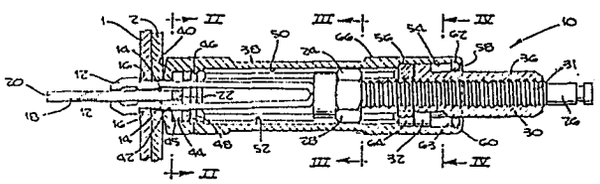
(54) Positive-release, wire-pin type clamp for use with automated insertion and withdrawal tool.

(57) An improved, positive-release, wire-spring type clamp (10) for automated, temporary clamping and unclamping of a plurality of apertured workpieces (1, 2) in which the tool-gripping surfaces (36, 66) of the body of the clamp (10) and driver nut (30) are provided with a universal cylindrically-shaped outer surface which may be inserted into and operated by motor-driven installation tools without regard to the relative angular position between the tool-gripping surfaces (36, 66) of the housing (38) and nut (30).



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AN IMPROVED, POSITIVE-RELEASE, WIRE-PIN TYPE CLAMP FOR USE WITH AUTOMATED INSERTION AND WITHDRAWAL TOOL

BACKGROUND OF THE INVENTION

In general, this invention relates to a wire-pin type clamping device used for temporary clamping of two or more workpieces having aligned holes within them in a desired relationship while some other operation is performed upon the workpieces.

More specifically, this invention relates to a positive-release type device and, most specifically, to a device adapted for use with automated, motor-driven insertion and withdrawal tools.

In industry, and in particular, the aerospace industry, it is desirable to have a simple mechanism for temporarily clamping parts in fabrication together in a desirable relationship such that some interim operation can be performed upon the parts. If the parts to be clamped each has a concident hole of relatively small diameter, the clamping can be accomplished by means of a body having a sliding, split pin which is extended through the aligned holes, then expanded and retracted forceably back into the body, whereby the parts are clamped together between the expanded ends of the pins and the retracting body. When the interim operations are completed on the workpieces, the device can then be withdrawn by a reversal of the above steps and re-used endlessly on other jobs.

Typical of the situations in which such clamps find application is the process of temporarily attaching aircraft skins to each other or to structural members while they are being permanently riveted together in an assembly.

Typically, the spring employed in these type of fasteners is fabricated in two identical halves, each having a wedge or ramp incline on its inner surface such

that when retracted axially against an inner-disposed spreader part, will cause them to separate and spread outward from each other.

Usually, the device is further comprised of some form of housing, usually cylindrical and having hexagonal surfaces, into which the spring is retracted by means of some force applied to the ends of the spring halves. In smaller applications, the clamping force is supplied by means of a coil spring which is compressed when the pin is extended from the housing.

In larger jobs, or those necessitating higher clamping forces, the pins are withdrawn into the housing to clamp the pieces by screw means which are actuated with hand tools, such as wrenches.

Exemplary of such devices adapted for use with the European-sized tools is that disclosed in the co-pending application, U. S. Serial Number 602,356. Typically, such clamps are provided with a first hexagonal tool-gripping surface on the outside of the housing to retain the device against rotation during the clamping process and a second hexagonal tool-gripping surface on a nut that is threaded onto an extension of the split spring such that, when the nut is rotated on the shaft to a point where it contacts the back of the housing, further rotation causes the pin to be withdrawn into the housing and the clamping force to be exerted by the pin.

It is not uncommon in high-volume production for hundreds or thousands of these devices to be in use simultaneously on complicated structures, such as air-frames, and a need was created for a means for a more-automated insertion and withdrawal of the clamp. This problem was first satisfied by equiping the installers with motor-driven hand tools having sockets on them adapted to the hexagonal head of the driving nut. By suitable application of motorized torque forces to the driver nut, the spring could be quickly and forcefully

engaged or withdrawn in the workpieces.

However, it was found that in such power-driven applications, a secondary problem was created in that the high torquing forces applied to the nut during the clamping caused the spring heads to wedge into the workpiece such that, when the driver nut was backed off from the housing, the wedge forces exerted between the workpiece and the spring were sufficient to retain the spring forcefully within the workpiece such that a blow to the device was often necessitated to remove it from the workpiece.

It was discovered that this device-retention problem could be overcome by suitably retaining the nut within the housing of the device such that, when the driver nut is forceably put in the withdrawal direction, it engages a retaining feature within the housing to exert a relative axial force between the spring and the housing, whereby the spring is forced out of the workpiece. It was further found that, by making the nut-retaining recess in the housing long enough to permit the nut to move axially a distance equal to the advance of several threads before nut engagement occurs, the power-driven insertion tool was able to develop additional inertia of rotation to assist in "breaking" the wedged pin from the workpiece. Exemplary of such "positive release" pin-type clamps is that disclosed in U.S. Letters Patent Number 3,289,525 to Lee.

Unfortunately, the prior art discussed hereinabove does not lend itself well to a more completely-automated installation and withdrawal procedure. In such an automated, high-volume application of the device, it is desirable to combine the housing-retention tool with a motor-driven, nut-gripping tool into one device to eliminate the need for separately restraining the housing during working. It is further desirable to incorporate these features in a tool such that, for purposes of

installing the device, the operator (whether human or robotic) may simply insert the rear of the device into the tool, push the pin through the workpieces, and trigger the tool to accomplish the clamping action. It would be further desirable, in order to remove the device, for the operator simply to place the tool over the back of the installed clamp, trigger the device and then withdraw the clamp from the workpieces.

Prior art devices such as the Lee patent referenced above do not lend themselves well to this desirable scenario for the following reasons: the tool-gripping surfaces of the housing and the driver nut are usually configured into a polygonal shape to accommodate retention and/or driver tools, such as a hexagonal drive socket. In either the clamped or unclamped position, these tool-gripping surfaces will be aligned at random with one another such that it is improbable that a tool provided with concentric, successive, retaining and driving features can be simply inserted onto the back of the device. Thus, while the operator has some degree of flexibility in the initial, radial-orentation of the tool onto the back of the device, it is difficult to assure that <u>both</u> the housing-retention surface and the nut-driving surfaces will be in the exact relative orentation to permit complete insertion of the tool onto the back of the device. This "misalignment" problem causes the installation tool to be improperly seated on the back of the device such that the clamp will be prevented from making up or releasing until the correct relative angular orentation of the two surfaces is achieved and the tool-gripping surfaces are properly engaged within the tool. Attempts by the operator to activate the power-driven tool without correct alignment between the device and the tool results in a futile spinning of the motor without engagement or disengagement, or a damaging "chatter" between the tool and the device in which the

head of the driver nut becomes burred and quickly worn away.

It is therefore desirable to provide a hand-held, motor-driven installation tool and a "universal" clamp adapted for use with the tool which is independent of the relative angular orientation of the tool-gripping surfaces of the clamp's housing and driver nut, and which can be simply inserted into the installation tool regardless of that orientation. There is presently a strong-felt need within the industry for such a universal clamp and clamp installation tool which will overcome the above-referenced problems.

Such a universal tool is the subject of the disclosure of a co-pending application, U.S. Serial No. 717,947 entitled "Installing Tool for Wedging-Type Fasteners" to the same inventor and commonly assigned, in which the gripping surfaces of the housing-retaining tool and the nut-driver gripping tool are adapted to a device having concentric, cylindrical tool-gripping surfaces. By this particular choice of gripping-tool surface configuration, the misalignment problem is obviated.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a positive release pin-type clamp having tool-gripping surfaces adaptable for use with a motor-driven universal installation tool.

It is the further object of the present invention to provide such a device that is reliable in its operation and capable of withstanding the wear and tear of repeated, heavy-duty automated installation and withdrawal.

It is yet a further object of the present invention to disclose such a device that is easy and inexpensive to manufacture.

These and other objects are preferably accomplished

by providing a clamp having a main housing portion having an exterior tool-gripping surface which is universally adapted to be grasped by a tool to hold the same regardless of the initial angular orientation of the tool with respect to the housing and further, containing a spring-driver nut rotatably retained within the housing and extending from the rear of the housing which is also provided with an exterior tool-gripping surface that is universally adapted to be grasped by a driver tool regardless of the initial angular orientation between the nut surface and the driver tool. The driver nut also contains a threaded bore through its length which engages a threaded shaft extending from a stud which retains the spring fingers within the interior of the housing. The stud is keyed by a non-rotation feature within the housing so as to prevent rotation of the stud and springs when the nut is rotated about its axis, which causes the spring to translate in and out of the housing without rotation. Disposed between the fingers of the wires is a spreader plate which is retained at one end within the housing. The spreader plate is so retained in the housing that it neither translates nor rotates with motion of the spring fingers relative to it. Thus, when the nut is rotated relative to the housing of the clamp, the elements of the wire pin are axially displaced with respect to the spreader, causing the ramp feature which is integral to the elements of the wires to engage or disengage with the spreader which, in turn, causes the wire elements to spread or compress against each other for clamping and unclamping of the workpieces.

So adapted, the clamp may be inserted and withdrawn into an appropriately-configured, power-driven insertion tool without the attendant problem caused by a misalignment of the nut with respect to the housing.

A more complete understanding of the improvement afforded by the present invention will become evident to

those skilled in the art from a consideration of the following detailed description of a preferred exemplary embodiment thereof and by reference to the included drawings, a brief description of which follows.

BRIEF DESCRIPTION OF THE DRAWING

Figure 1 is a section view through the side of a clamp in accordance with the present invention installed in a pair of workpieces;

Figure 2 is a sectional view taken at plane II-II in Figure 1;

Figure 3 is a sectional view taken at plane III-III in Figure 1;

Figure 4 is a sectional view taken at plane IV-IV in Figure 1;

Figure 5 is a side view of the clamp of the present invention taken in partial cross section with the pins fully extended.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to Figure 1 of the drawing, an improved, positive-release, wire-spring type clamp 10 for automated insertion and withdrawal is shown in cross section, installed in a pair of workpieces 1 and 2 having aligned apertures. The springs 12 are identical to each other and each has a workpiece gripping surface 16 disposed to grip the workpiece 1 on its inner surface when the springs 12 are spread apart. This is accomplished by withdrawing the springs 12 in an axial direction into the clamp 10 such that a ramp feature 14 disposed upon each of the springs 12 contacts the nose 20 of the spreader 18 disposed between the springs such that they are spread apart at their interior surfaces by the thickness of the spreader 18.

Spreader 18 is restrained from moving in the axial direction by "tee" fingers 22 which are retained within

the body of the clamp 10.

The spring fingers 12 are retained rigidly in one end of a stud 24 which has a threaded shaft 26 extending axially from the end opposite the springs 12. The stud 24 is provided with an anti-rotation feature 28 which is, in the perferred embodiment illustrated, a hexagonl-nut surface.

The stud 24 is translated axially within the housing without rotation by means of rotation of a driver nut 30 which contains a threaded internal bore 31 to engage the threaded shaft 26 of the stud 24. The driver nut 30 is rotatably-retained within the clamp pin by means of a flange feature 32 having a cylindrical shoulder 34 of a diameter larger than that of the tool-gripping surface 36 of the driver nut 30. This tool-gripping surface 36 is made cylindrical, thereby eliminating the need for a socket-engagement feature having an angularity, such as a hex head, which is dependent upon the angular orientation between the nut 30 and the driving tool socket for mating.

The springs 12, spacer 18, stud 24, and driver nut 30 are all retained axially within the clamp's outer housing 38. Clamp housing 38 is generally cylindrical in configuration, and in the perferred exemplarly embodiment, includes a nose part 40 formed into the housing 38 to contact the workpieces 1 and 2 and exert an axial force upon them. The springs 12 extend axially from the body of the clamp 10 through an opening 42 in the nose part 40 of the outer housing assembly 38, and the driver nut 30 extends from the opposite end of the clamp 10 through an opening 58 in the outer housing 38.

The housing 38 is provided with three, axially-disposed retention features along its length. The first of these features is a annular groove 44 to retain the "tee" fingers 22 of the spacer 18 in the axial direction. To accomplish this retention, the groove 44 is provided

with a washer 48 axially-disposed between first and second shoulders 45 and 46 formed into the housing 38. The shoulder 46 is created by roll-forming a flange into the housing 38 after the washer 48 and spreader 18 are inserted into the first retaining groove 44 in the exemplary perferred embodiment.

The housing 38 has a second annular groove 50 through which the stud 24 translates axially. This second annular groove 50 contains a anti-rotation feature 52 to mate and engage with a complementary anti-rotation feature 28 on the stud 24. This permits the stud 24 to move axially upon rotation of the driver nut 30, but prevents the rotation of the stud 24 (and hence, the springs 12 and shaft 26) within housing 38. In the exemplary perferred embodiment of Figures 1-5, the anti-rotation features 28 and 52 illustrated are a simple hexagonal cross section. However, as is evident to those skilled in the art, this feature may take other appropriate forms, e.g., a key sliding in a slot.

The housing 38 contains a third annular groove 54 disposed toward the outer end of the clamp 10 for rotatably-retaining the driver nut 30. This nut-retaining annular groove 54 is formed in a manner similar to that of the spacer-retaining groove 44, and has a retaining shoulder 56 disposed at one end of the groove 54 which is oppositely-disposed in the groove 54 to a nut-retaining washer 62. The nut-retaining washer 62 is inserted into a washer-retaining annular groove 63 in the housing 38 and retained in place by roll-forming a flange 60 to crimp the washer 62 in place. Oppositely-disposed in the nut-retaining groove 54 and bearing on the shoulder 56 is a thrust washer 64. The thrust washer 64 serves to retain driver nut 30 in the axial direction and additionally, serves as a bearing surface for the driver nut 30 through which the relative axial force is transferred between the housing 38 and the stud 24 during

clamp 10 installation, thus preventing galling and wear between the mating surfaces of the non-rotating housing 38 and the rotating driver nut 30.

The outer, tool-gripping surface 66 of the housing 38 is, like the tool-gripping surface 36 of the nut 30, provided with a universal, smooth surface that is cylindrical in shape. The outer diameter of the housing's tool-gripping surface 66 is, in the preferred embodiment illustrated, larger in diameter than the tool-gripping surface 36 of driver nut 30, thereby permitting a concentric, successive pair of gripping tools to be installed onto the back of the clamp by a stright, axial thrust of the driver tool onto the clamp without regard to the relative angular position between the housing 38 and the driver nut 30 or the relative angular position between the tool and the clamp 10.

Figure 1 illustrates the perferred embodiment of the present invention in the clamped position, with the workpieces 1 and 2 clamped between the gripping portion 16 of the springs 12 and the nose part 40 of the clamp 10. It is to be noted that the driver nut 30 is fully forward in the nut-retaining groove 54 and bears against the thrust washer 64 and that the actual length of the nut-retainer groove 54 is so adjusted as to permit the driver nut 30 to move axially for a length of several turns of the threaded shaft 26 before engaging either the thrust washer 64 or the nut-retaining washer 62 upon clamp 10 insertion or withdrawal, respectively. By so configuring the length of the retaining groove 54, the driver nut 30 may gain rotational inertia in either the withdrawal or insertion mode such that the driver tool is aided in "making" or "breaking" the clamping force. Similarly, it is to be noted that the length of the tool-gripping surface 36 of the driver nut 30 which extends beyond the end of the housing 38 must be sufficiently long such that, even when the driver nut 30 is

fully forward in the nut-retaining groove 54 (as in the fully-clamped mode illustrated in Figure 1), sufficient gripping surface 36 remains for the driver tool to grasp and drive the nut 30.

Figure 5 illustrates the clamp 10 with the springs 12 in the fully-extended position, i.e., the ramp feature 14 of the springs 12 are fully past the nose 20 of the spreader 18 such that the springs 14 are compressed together and the grasping shoulders 16 of the springs 14 may pass through the workpiece. It is to be noted that when the preferred embodiment of the present invention is in this fully-extended position, the driver nut 30 is fully extended from the housing 38 and the internal threads 31 of the driver nut 30 are fully disengaged from the threads of the shaft 26, such that driver nut 36 is free to rotate without exerting further axial force upon the stud 24.

In the exemplary perferred embodiment illustrated in the attached drawing, all parts of the clamp pin, including the springs 12, spacer 18, stud 24, shaft 26, nut 30, housing 38, and washers 48, 62 and 64 are made of various alloys of steel. These alloys were chosen for their various fabrication properties and because it is an object of the present invention to provide a clamp which is rugged and will withstand repeated clamping and unclamping actions, involving high torquing and clamping forces, in a high volume production environment with minimal wear and breakage of the clamps.

It is to be seen that the cylindrical portions of the clamp 10, including the stud 28 with its threaded shaft 26, the driver nut 32, and the housing 38 all lend themselves well to being made on automatic, screw-machine apparatus in high-volume production.

However, these particular embodiments, materials and methods of fabrication are mentioned only in passing and without limitation as to others which will suggest

themselves to those skilled practitioners to whom other clamp applications will suggest other materials and methods of fabrication. Likewise, it will be noted by those skilled in the art that various modifications, adaptations and equivalent embodiments may be made within the spirit and scope of the present invention which is defined and limited only by the following claims.

C L A I M S

1. An improved, positive-release, wire-spring type clamp (10) for automated, temporary clamping and unclamping of a plurality of abutting workpieces (1, 2) having a plurality of aligned openings in them, characterized by

(a) a plurality of wire-type springs (12)

(b) a spring explancer (18) disposed between the springs (12) to separate them;

(c) a cylindrical stud (24) having an anti-rotation feature (28) along part of its axial length, a threaded cylindrical shaft (26) disposed toward one end, and retaining means at the other end to retain the springs (12);

(d) a cylindrical driver nut (30) having an axially-threaded bore therethrough to engage the threads (31) of the shaft (26), a raised cylindrical shoulder (32) disposed toward one end of the nut (30) to retain the nut (30) in the axial direction, and a tool-gripping outer surface (36) disposed toward the other end;

(e) first retaining means (22) for retaining the spreader (18) in the axial direction;

(f) second retaining means (62) for rotatably retaining the nut (30) in the axial direction; and

(g) a cylindrical outer housing (38) having a tool-gripping outer surface (66) and an internal, axial bore therethrough to receive and retain the springs (12), spreader (18), stud (24), shaft (26), nut (30) and washer means (48, 62, 64) such that the spring (12) and spreader (18) extend out one end of the housing (38) and the nut (30) extends out the other end and wherein the bore is characterized by having a first internal annular groove (44) with retaining shoulders (45, 46) formed at one end to receive and retain the first retaining means (22) and spreader (18) in the axial direction, a second annular internal groove (54) with retaining shoulders (56) at the other end to receive and rotatably-retain the second retaining means (62) and nut (30) in the axial direction,

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and an intermediate internal annular groove (50) region having an anti-rotation feature (28) to engage the stud (24) such that the stud (24) can move axially without rotation whereby, when the nut (30) is rotated about its axis in one direction, the springs (12) will be pulled into the housing (38) while being expanded apart, and when the nut (30) is rotated in the other direction, the springs (12) will be expanded out of the housing (38) while being compressed together, and wherein the tool-gripping surfaces (36, 66) of the housing (38) and driver nut (30) are so configured to engage and fit within concentric driver tools independently of the relative angular orientation of the housing (38) and driver nut (30).

2. The clamp as recited in claim 1, characterized in that the tool-gripping outer surface (66) of the housing (38) is substantially cylindrical in shape.

3. The clamp as recited in claim 1 or 2, characterized in that the tool-gripping outer surface (36) of the driver nut (30) is substantially cylindrical in shape.

4. The clamp as recited in claim 3, characterized in that the tool-gripping surface (36) of the driver nut (30) is smaller in diameter than that of the housing (38).

5. The clamp as recited in any of the preceding claims, characterized in that the engaging anti-rotation features (28, 52) of the stud (24) and the intermediate annular groove (50) are hexagonal in cross section.

6. The clamp as recited in any of the preceding claims, characterized in that at least one of the retaining shoulders (45, 46) of the first internal annular groove (44) is roll-formed into the outer housing (38).

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7. The clamp as recited in any of the preceding claims, characterized in that at least one of the retaining shoulders (56) of the second internal annular groove (54) is roll-formed into the outer housing (38).

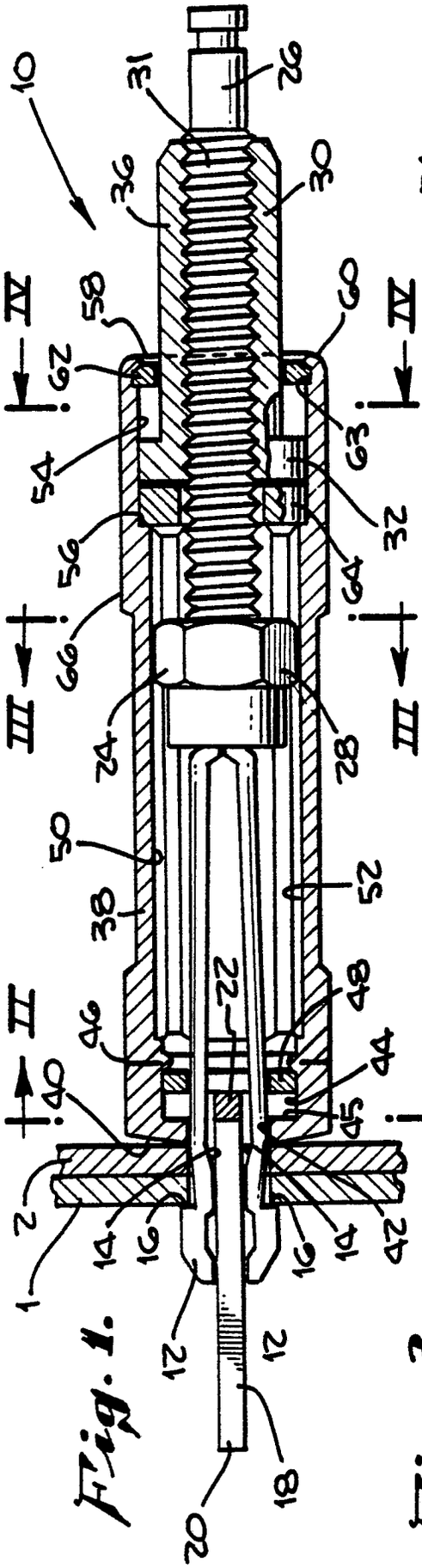

Fig. 1.

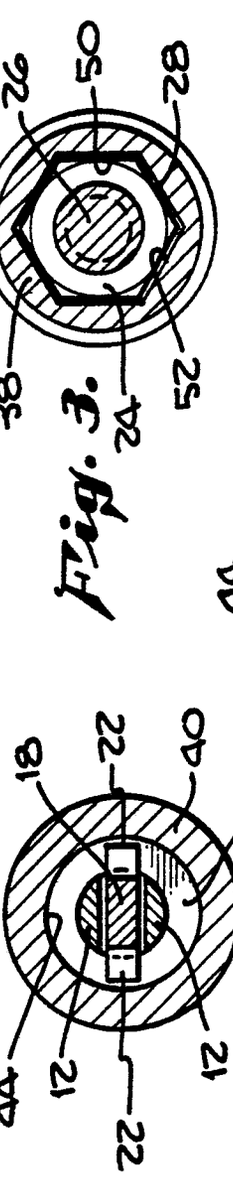

Fig. 2.

Fig. 3.

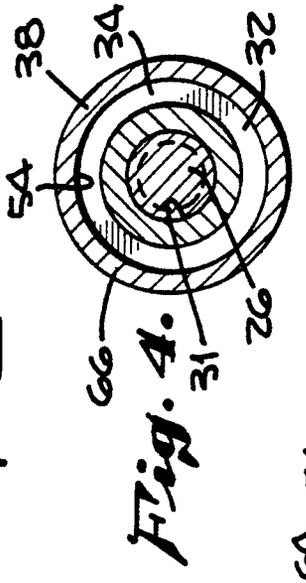

Fig. 4.

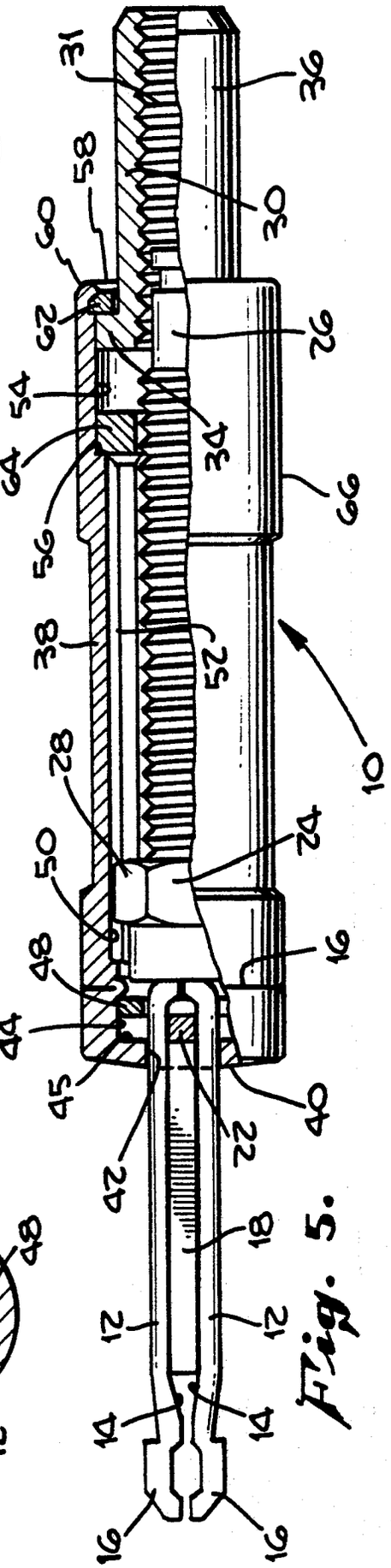

Fig. 5.

European Patent Office

EUROPEAN SEARCH REPORT

0198105
Application number

EP 85108572.0

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
D,A	US - A - 3 289 525 (LEE) * Fig. 1-3 * --	1-3,5-7	B 25 B 11/00 B 21 J 15/42
A	US - A - 3 263 320 (JONES) * Fig. 4 * ----	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

B 25 B 5/00
B 25 B 7/00
B 25 B 9/00
B 25 B 11/00
B 21 J 15/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	09-07-1986	BENCZE

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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