(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 086 303**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **82306372.2**

(22) Date of filing: **01.12.82**

(51) Int. Cl.³: **H 01 R 43/04**

(30) Priority: **08.02.82 US 347014**

(43) Date of publication of application: **24.08.83 Bulletin 83/34**

(84) Designated Contracting States: **DE FR GB**

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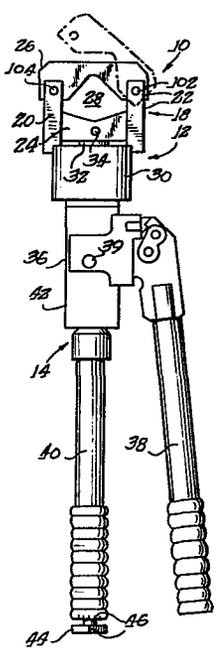
(54) Compression tool.

(57) A compression tool comprises a tool head (12) and a pair of dies (24, 26) mounted in the tool head for compressingly, surroundingly engaging a generally tubular workpiece. The dies (24, 26) define a minimum opening and a maximum opening therebetween for accommodating workpieces over a corresponding range of sizes. A fluid operated drive (30) urges the dies (24, 26) inwardly to compress the workpiece and a fluid pressure control (42) is provided for controllably varying the maximum pressure of the fluid supplied to the fluid operated drive (30) in accordance with the size of a workpiece to be compressed.



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COMPRESSION TOOL

Background of the Invention

This invention is directed generally to the field of compression tools and more particularly to a compression tool for compressing or crimping generally tubular workpieces such as connectors or terminals utilized for establishing electrical wiring connections.

A number of compression tools have heretofore been proposed for compressing or crimping the generally tubular terminal or connector members of the type utilized in electrical wiring installations. Briefly, these tubular connectors receive a wire or bundles of wire and must be crimped or compressed in order to securely form both a mechanical and electrical union between the connector or terminal and the wire.

The wire sizes and corresponding connector or terminal sizes vary over a considerable range for achieving different wire gauge connections. For example, the outer diameters to be compressed or crimped may range from as small as 1/4" to as large as 2".

Generally speaking, the crimping or compressing tools heretofore proposed for accommodating this range of sizes of connectors or terminals have been of two basic types: 1) a tool having a tool head provided with an interchangeable set of removable diesets, one dieset for each connector size or for sizes within given limited ranges; and 2) a tool having a tool head which carries a single, permanent crimping or compression member which is compressable to different degrees or extents in order to accommodate a given range of sizes.

The former type of tool can be rather difficult and timeconsuming to use, as the removable, interchangeable diesets must be frequently changed in the field, whenever different sized wires and the corresponding connectors or terminals are to be installed. The latter type of tool is generally referred to as a "dieless" compression tool. The term "dieless" refers to the single, permanent die or compressing structure which is utilized, rather than the multiple, interchangeable, removable diesets provided with the former type of tool. Tools of this latter type have heretofore proven relatively heavy and complex, and have been relatively difficult to operate. Moreover, many of these latter tools are prone to frequent malfunction due to the complexities of their design.

Additionally, the tools of the second type have generally provided an indentor-type of crimp, which is a crimp or compression centered about a single indentation, made by the tool, in the terminal or connector. However, a polygonal configuration of compression or crimping is generally regarded as superior in achieving both electrical and mechanical union of such a connector or terminal with electrical wires.

Objects and Summary of the Invention

Accordingly, it is an object of this invention to provide a novel and improved compression tool.

A more specific object is to provide a compression tool of the foregoing type which is capable of accommodating a relatively broad range of connector or terminal sizes.

A related object is to provide a compression tool of the foregoing type which provides a polygonal compression configuration to the connector or terminal compressed.

A further object is to provide a compression tool of the foregoing type which is relatively simple in design and easy to use and yet is highly reliable in operation.

Briefly, and in accordance with the foregoing objects, a compression tool according to the invention comprises a tool head, die means mounted in said tool head for compressingly, surroundingly engaging a generally tubular workpiece, said die means defining a minimum opening and a maximum opening therein for accommodating workpieces over a corresponding range of sizes, fluid operated drive means for driving said movable die means to compress said workpiece and fluid pressure control means for controllably varying the maximum pressure of the fluid supplied to said fluid operated drive means in a predetermined fashion in accordance with the size of a workpiece to be compressed.

Brief Description of the Drawings

Other objects, features and advantages of the invention will become more readily apparent upon reading the following detailed description of the illustrated embodiment together with reference to the accompanying drawings wherein:

FIG. 1 is an elevational view of a compression tool in accordance with the present invention;

FIG. 2 is an enlarged perspective view of die portions of the tool of FIG. 1;

FIG. 3 is a reduced view illustrating one aspect of operation of the dies of FIG. 2;

FIG. 4 is another reduced view illustrating another aspect of operation of the dies of FIG. 2;

FIG. 5 is yet another reduced view illustrating a further aspect of the operation of the dies of FIG. 2;

FIG. 6 is an enlarged sectional view, somewhat diagrammatic in form, of a pressure control portion of the tool of FIG. 1; and

FIG. 7 is a view similar to FIG. 6 and illustrating another aspect of the operation of the pressure control portion.

Detailed Description of the Illustrated Embodiment

Referring now to the drawings and initially to FIG. 1, a compression tool in accordance with the present invention is designated generally by the reference numeral 10. Broadly speaking, this compression tool 10 includes a tool head 12, a manually controlled tool actuating portion 14.

The tool head 12 comprises a die assembly 18 and a drive assembly 30 for actuating the die assembly 18. In the illustrated embodiment, the die assembly 18 includes a pair of elongate guide members 20, 22 which slidably mount a lower die member 24 therebetween. An upper die member 26 is mounted to respective top ends of the elongate guide members 20, 22. Between the lower die 24 and the upper die 26 a workpiece-receiving through opening 28 is defined. As will be more fully

explained later, and in accordance with a feature of the invention, these dies 24 and 26 and the guide members 20, 22 are arranged for compressing or crimping terminals or connectors into engagement with electrical cables or conductors. Moreover, the compression tool 10 readily accommodates such connectors or terminals and associated electrical cables over a relatively broad range of sizes. This novel arrangement avoids the necessity of providing a plurality of interchangeable, removable sets of dies for accommodating such a range of sizes of conductors and connectors or terminals.

The drive assembly 30 is mounted intermediate the die assembly 18 and the manual actuating portion 14. This drive assembly 30 is coupled with the lower die 24 for driving the lower die upwardly, sliding along the guides 20, 22, so as to compress a workpiece between the lower die 24 and upper die 26. In the illustrated embodiment, this drive assembly 30 comprises a hydraulic piston-and-cylinder or ram arrangement, the piston 32 thereof being coupled with the lower die member 24 by suitable means such as a pin 34 extending therethrough.

Hydraulic fluid under pressure is delivered to this hydraulic ram assembly 30 by means of a pump 36 mounted within an upper portion of the manual actuating portion 14. In this regard, the actuating portion 14 includes a first handle 38 which is pivotally mounted at a pivot point 39 to a second handle 40. This handle 38 is also operatively coupled for energizing or actuating the pump 36. Accordingly, pivotal mounting of the handle 38 with respect to the handle 40 defines a lever for actuating the pump 36. Hence, the pump 36 is primarily located within the handle 40 but is actuated by the pivotal movement of the handle 38.

The handle 40 also mounts a variable pressure control apparatus 42 (not shown in detail in FIG. 1) for controlling the maximum pressure of the fluid delivered to the hydraulic ram assembly 30 by the pump 36 in response to pivotal movement of the handle 38. This pressure control apparatus 42 is adjustable in response to manual rotation of an adjustment knob 44 rotatably carried in the handle 40. In the illustrated embodiment, this adjustment member or knob 44 is carried at the bottom of the handle 40. Preferably, indicia 46 are provided on the knob 44 and on the periphery of the handle 40 immediately adjacent thereto for selecting the maximum fluid pressure. In operation, the maximum pressure delivered to the hydraulic ram assembly 30 is therefore controlled in accordance with the setting of the knob 44. In this regard, the fluid pressure to be applied to the hydraulic ram assembly will generally increase as the pump handle 38 is actuated. However, a maximum pressure is preselected for each size of workpiece to be compressed by the die assembly 12. Hence, the range of relative movement of the die members 24 and 26, and the range of maximum pressure selectable by the knob 44 and pressure control apparatus 42 together define a range of sizes of workpieces which may be accommodated for compression by the tool 10.

Referring now to FIG. 2, the die assembly 18 including the guide members 20, 22, the lower die 24 and the upper die 26 will now be described in greater detail. Also illustrated in FIG. 2 is a typical electrical connector or terminal member 50 and an electrical conductor or wire 52 which is to be compressingly engaged or crimped within the tubular conductor or terminal 12 by the action of the tool 10 of the invention.

In accordance with a feature of the invention, a composite die is defined by the lower die member 24 and the upper die member 26, which comprises a plurality of intermeshing die surfaces, indicated generally by the reference numeral 51. These intermeshing die surfaces 51 define a relatively broad range of compression, thereby accommodating a corresponding range of sizes of connectors or terminals such as the terminal 50 for compression. In the illustrated embodiment, the intermeshing die surfaces 51 are defined by a plurality of die surfaces and intervening recesses on each of the lower die member and upper die member 26.

In this latter regard, in the illustrated embodiment, the lower die member 24 defines three substantially similar and parallel die surfaces 54, 56 and 58 which are separated by a pair of recesses 60, 62. Similarly, the upper die member 26 defines four die surfaces 64, 66, 68 and 70 which are substantially similar and parallel and are separated by three recesses 72, 74 and 76. The guides 22 and 20 hold the lower die member 24 and upper die member 26 in alignment such that the die surfaces 54, 56 and 58 of the lower die member 24 are in alignment with, and as the die member 24 advances, intermesh or interfit with the recesses 72, 74 and 76 of the upper die member 26. Correspondingly, the die surfaces 66 and 68 of the upper die member 26 are aligned with and, as the die member 24 advances, interfit with the recesses 60 and 62 of the lower die member 24. The remaining die surfaces 64 and 70 of the upper die member 26 align with and slidably engage over the outer sides of the die surfaces 54 and 58 of the lower die member 24.

In operation, and referring to FIG. 3, FIG. 4 and FIG. 5, the foregoing intermeshing of the respective die members 24 and 26 as the lower, movable die member 24 is advanced by the ram 30, is illustrated. It will be seen from an inspection of these three illustrations that the die assembly 12 as thus far described defines a range of sizes of the through opening 28 from a fully opened position illustrated in FIG. 3 to a fully closed position illustrated in FIG. 5. In this latter, fully closed position, the respective die surfaces and receiving recesses described above are fully interengaged and bottomed out with respect to each other. Hence, a corresponding range of sizes of workpieces such as the electrical connector or terminal 50 and associated cable 52 may be accommodated for compression by the die assembly of the invention as thus far described.

Reference is next invited to FIG. 6 and FIG. 7, wherein further details of the variable pressure control apparatus 42 are shown. Preferably, this pressure control apparatus 42 comprises an adjustable relief or bypass valve. In the illustrated embodiment, this pressure relief or bypass valve comprises a generally cylindrical valve chamber 80 which terminates in a conical section 82 defining a valve seat. A correspondingly cylindrical valve member 84 terminates in a generally conical end 86 for seating on the valve seat 82. The valve member 84 and in particular, the end 86 thereof is normally urged into seating engagement with the valve seat 82 by a compression spring 88 which is carried internally of the cylindrical valve portion 84. The opposite end of the spring 88 abuts an adjustable screw or stop member 90 which is threadably movable with respect to the valve chamber 80.

In operation, as the threaded stop member 90 is advanced with respect to the valve chamber 80, the compressive force applied to the spring 88 increases, tending to urge the valve portion 86 into seating engagement with the valve seat 82 with increasing force. Conversely, as the threaded stop member 90 is threadably retracted with respect to the valve chamber 80, a lesser such force is supplied by the spring 88. The stop member 90 is rotated for either threadable advancement or retraction by an elongate rod 92 which extends axially through the handle 40 (see FIG. 1) and is coupled at its opposite end to the adjustment knob 44.

The valve 42 is coupled in hydraulic circuit for varying the maximum pressure applied to the hydraulic ram assembly 30 by the pump 36. In this regard, a first hydraulic fluid line 94 carries hydraulic fluid from the pump 36 to the hydraulic ram assembly 30. The valve seat 82 communicates with this first fluid passageway 94 by way of a through bore or passageway 96. This bore or passageway 96 is normally held in a closed condition by the seating of the conical valve 86 upon the conical valve seat 82. However, when the fluid pressure in the passageway 94 applies a force to the end 86 of the valve member 84 at the passageway 96 which exceeds the force applied by the spring 88 to hold the valve 86 seated, the valve body 84 will be forced back, compressing the spring 88 and permitting fluid from the passageway 94 to enter into and through the passageway 96 to the interior of the valve body 80. In this regard a second, return bore or passageway 98 is provided in the valve body and is coupled for returning fluid to a suitable fluid reservoir (not shown).

A fluid return line (not shown) from the ram 30 is also preferably provided, including a suitable valve (not shown) to permit the ram to return the die 24 to its fully open position following compression. The conduit 94 preferably includes a suitable ball check element 100 for preventing back flow. The relative pressure in the line 94 at which the valve 84 unseats may be referred to as a relief pressure or by-pass pressure of the valve. This relief or by-pass pressure is adjusted to correspond to a predetermined or desired maximum pressure to be applied to workpieces or connectors of given sizes. In this regard, the indicia 46 on the handle 40 and/or adjustment knob 44 preferably indicate the desired positions of the adjustment knob 44 for a plurality of sizes of connectors or terminals compressable by the tool 10 of the invention.

In operation, when a connector or a terminal such as the terminal 50 is to be coupled with a cable such as the cable 50 by compression in the tool of the invention, the adjustment 44 is first set to an indicia 46 corresponding to the size of the terminal or connector 50. Thereupon, the handle 38 may be manually, pivotally actuated toward the handle 40 to energize the pump 36 and hence hydraulic ram assembly 30, driving the movable or slidable lower die member 34 upwards towards the relatively fixed or stationary upper die member 26. When the selected maximum or relief pressure has been reached, pressure will be relieved by the valve arrangement 42 of FIG. 6 and FIG. 7, permitting the lower die 34 to return to its open condition, whereupon the compressed and joined connector or terminal 50 and wire or cable 52 may be removed from the die opening 28.

In accordance with one practical and preferred form of the invention and referring again to FIG. 2, the upper die member 26 is preferably coupled with the top or upper portion of the respective guides 20, 22 by a pair of suitable pins 102, 104. Preferably, one of these pins 102, 104 is removable, whereby the upper die member 26 is hingedly movable with respect to one of the two guide members 20, 22. Consequently, a connector for joining a pair of wires in serial fashion may be accommodated by the tool 10 of the invention.

In this illustrated embodiment, the die surfaces 54, 56 and 58 of the lower die member are all generally V-shaped, whereby their outermost leading edges intermesh with like inwardly-formed portions of the recesses in the upper die member 26. Similarly, the die surfaces 64, 66, 68 and 70 of the upper die member 26 are also generally V-shaped to intermesh with similar recesses of the lower die member 24. Preferably, the leading edges of the respective die surfaces of both upper die member 26 and the lower die member 24 are generally flat or horizontal, that is, generally perpendicular to the direction of movement of the die 24, for defining a firm and definite seat with the respective and similar receiving recesses and thus positively defining the maximum extent of compression of the die assembly 12.

While the invention has been illustrated and described hereinabove with reference to a preferred embodiment, the invention is not limited thereto. Those skilled in the art may devise various alternatives, changes and modifications upon reading the foregoing descriptions. Accordingly, the invention includes such alternatives, changes and modifications insofar as they fall within the spirit and scope of the appended claims.

Claims:

1. A compression tool comprising a tool head, relatively movable dies mounted in said tool head for compressingly, surroundingly engaging a generally tubular workpiece, and a fluid operated drive for driving said movable die means to compress said workpiece characterized in that said dies (24, 26) define a minimum opening and a maximum opening therebetween for accommodating workpieces over a corresponding range of sizes, and in that a fluid pressure control (42) is provided for controllably varying the maximum pressure of the fluid supplied to said fluid operated drive in a predetermined fashion in accordance with the size of a workpiece to be compressed.

2. A compression tool according to claim 1 further characterized in that guides (20, 22) are provided and a lower die member (24) is slidably mounted to said guides (20, 22) and an upper die member (26) is non-slidably mounted to said guides (20, 22).

3. A compression tool according to claim 2 further characterized in that said upper die member (26) and said lower die member (24) include a plurality of intermeshing die surfaces (51).

4. A compression tool according to claim 3 further characterized in that each of said upper die member (26) and said lower die member (24) comprises a plurality of die surfaces (64, 66, 68, 70 and 54, 56, 58) spaced apart by a plurality of recesses (72, 74, 76 and 60, 62), and said guides (20, 22) align the die surfaces of each of said upper and lower die member with the recesses of the other to define said plurality of

intermeshing die surfaces (51), the maximum extent of said intermeshing defining said minimum opening of said die means.

5. A compression tool according to claim 2 or claim 4 further, characterized in that said intermeshing die surfaces (51) collectively define an elongated aggregate die surface which is substantially polygonal in cross-section.

6. A compression tool according to claim 1 or claim 5 wherein said fluid operated drive comprises a hydraulic piston coupled for inwardly compressingly moving said dies and a pump coupled in hydraulic circuit for energizing said piston and further characterized in that said fluid pressure control (42) comprises an adjustable pressure relief bypass (96) coupled in hydraulic circuit with said pump.

7. A compression tool according to claim 6 further characterized in that said pressure relief bypass is provided with a valve seat (82) and a valve member (84), a compression member (88) for urging said valve member (84) to a seated position against said valve seat (82) and an adjustable member (90) for varying the force applied to said valve member (84) by said compression member (88) and thereby varying the relief pressure of said pressure relief bypass.

8. A compression tool according to claim 10 further characterized in that said adjustable member (90) includes indicia (44) for indicating a plurality of positions of said adjustable member to define a relief pressure for each of a plurality of sizes of workpieces to be compressed.

Fig.1

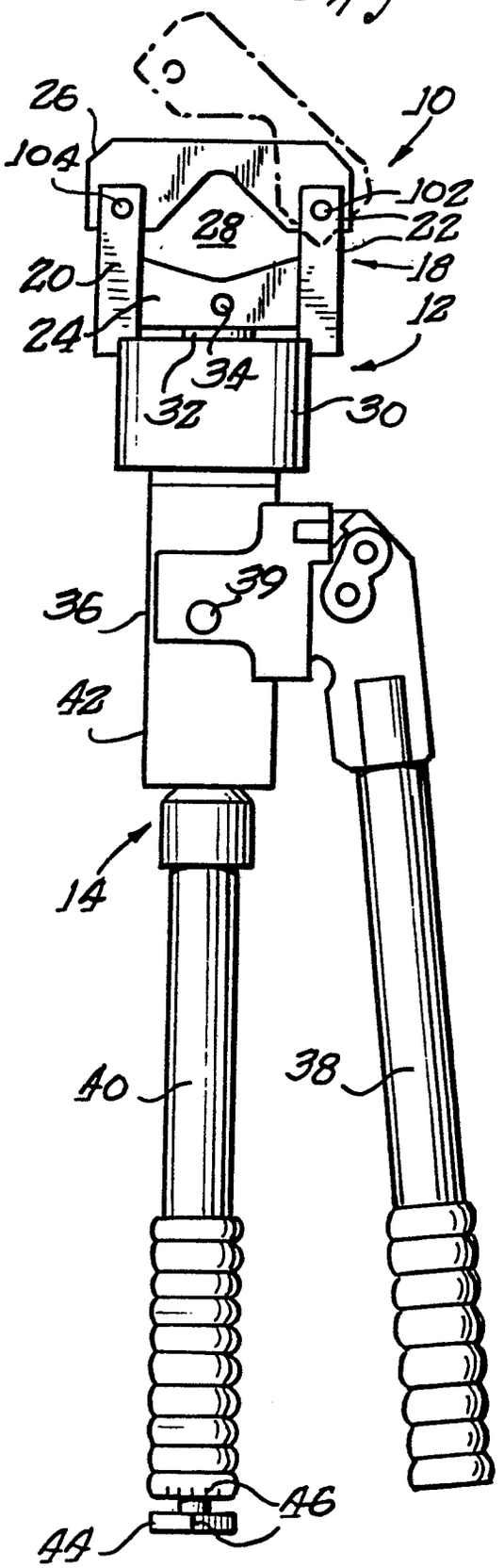


Fig.3.

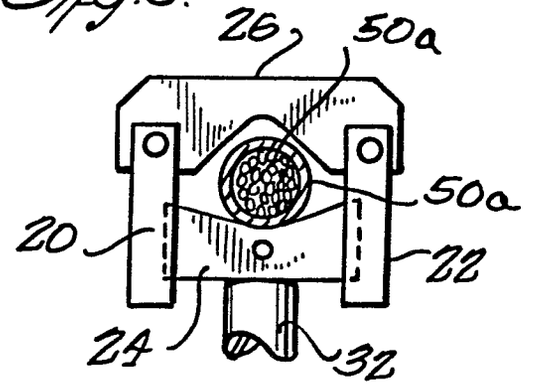


Fig.4

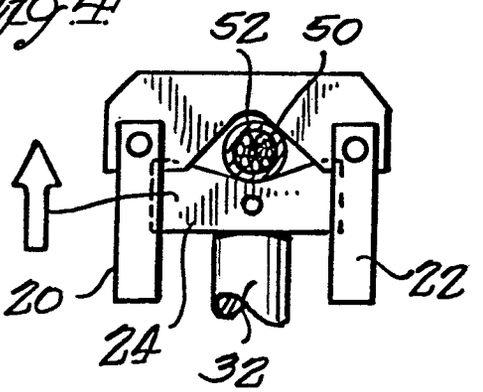
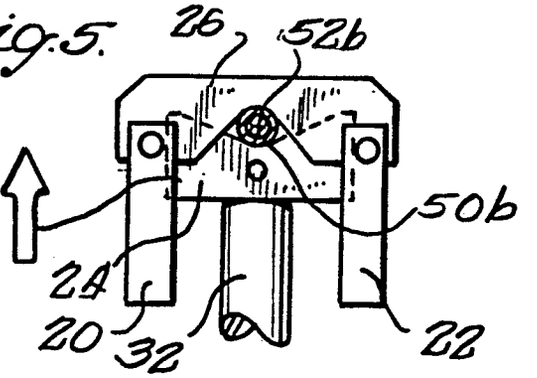


Fig.5.



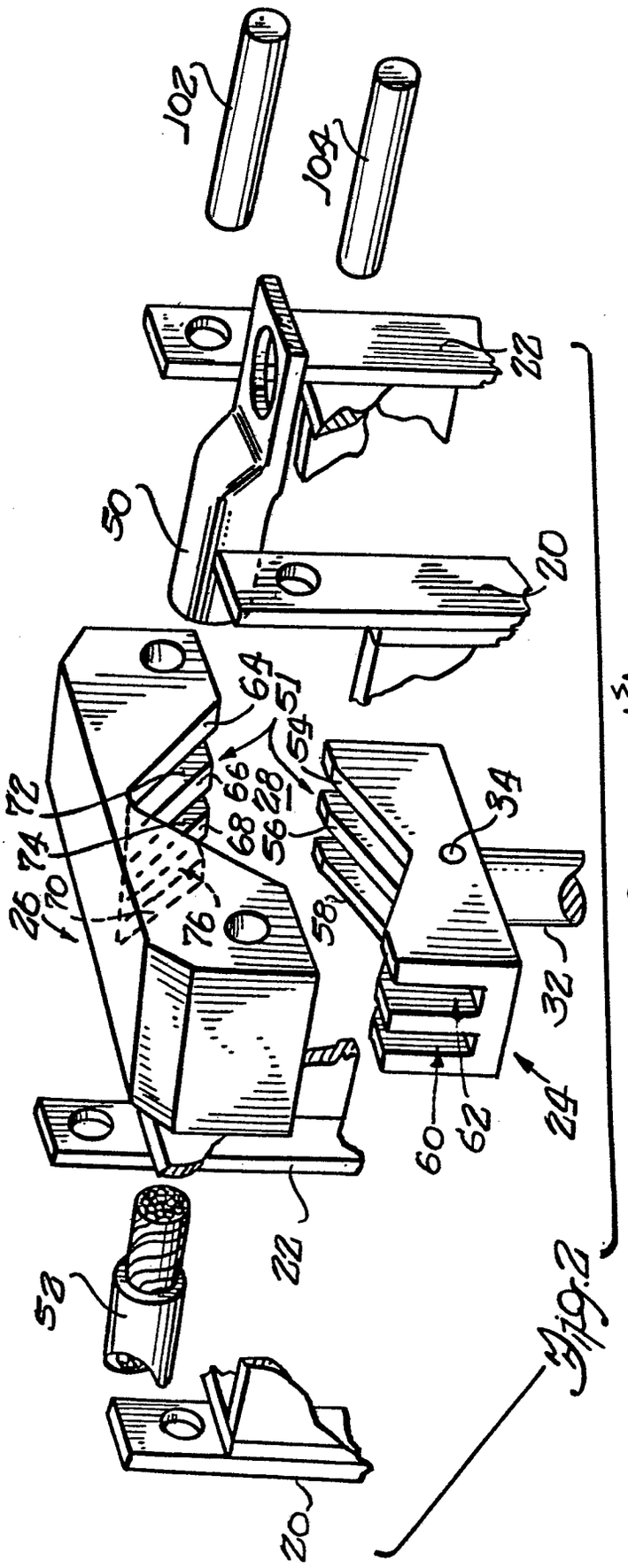


Fig.2

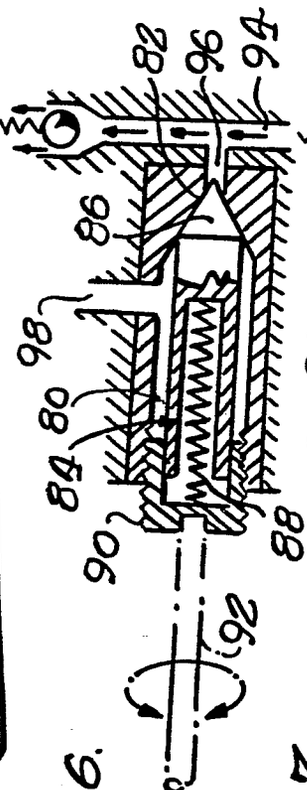


Fig.6.

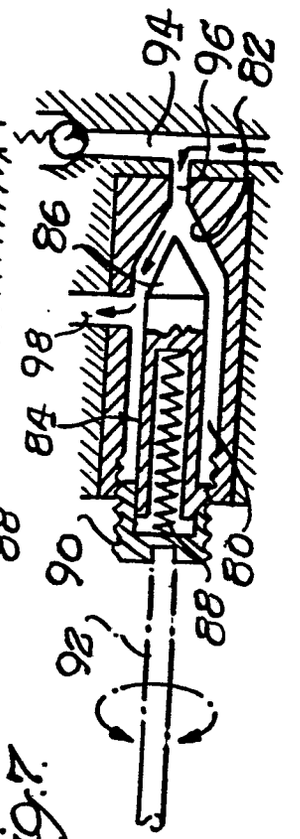


Fig.7.