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FLEXIBLE TOOL

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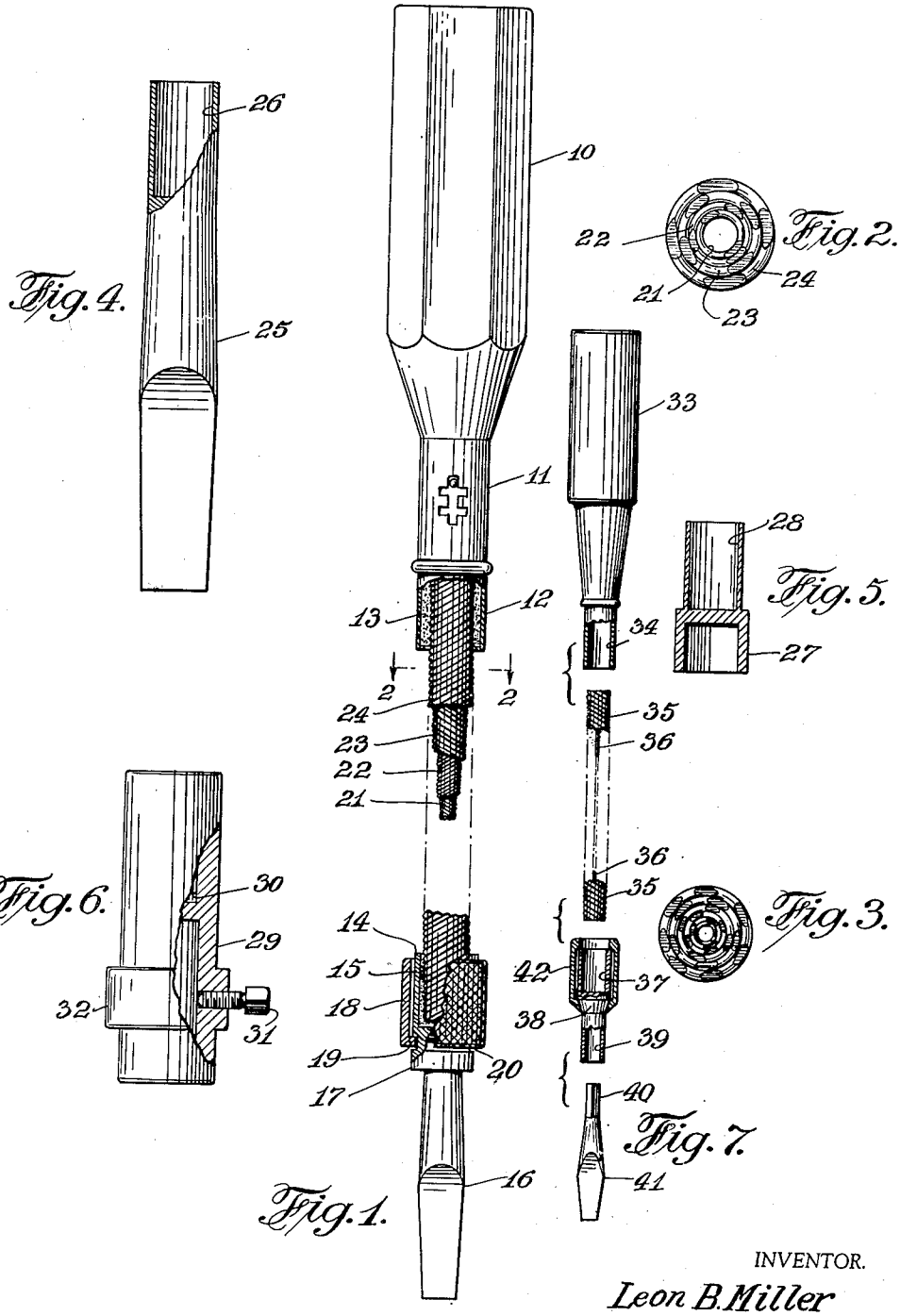


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

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FLEXIBLE TOOL

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4 Claims. (Cl. 145—61)

This invention relates to flexible tools similar to those described in my co-pending application, Serial No. 758,455, filed December 20th, 1934.

The prime object of this invention is to provide a tool, such as a screw driver, socket wrench, drill, reamer, or the like, with a flexible connection between the handle end and the work-engaging end which permits the operation of the latter end while the handle end is disposed either in alignment with said work-engaging end or at any desired angle thereto.

Another object of this invention is to so construct the flexible connection between the ends of the tool as to not only permit the working of the device while being flexed, but which will resist any torsional action in either bent or straight position, and which will, when not in use, assume its normal straight-line position between the tool ends.

Another object of this invention is to provide within a tool a connector consisting of more than two nested or laminated layers of closely and steeply wound coils in which the direction of winding of one coil is opposite to the direction of the next adjacent coil, and in which the material from which the coils are wound increases in size from within to without.

With the foregoing and still further objects in view, this invention will be more clearly understood from the following description, in conjunction with the accompanying drawing, forming part of my disclosure, but which drawing is not intended to limit my invention to the actual showing.

In the drawing, Figure 1 illustrates a typical construction of a screw driver, partly in section, and equipped with a flexible connector between the handle end and the work-engaging end of the tool.

Figure 2 illustrates an enlarged cross-section through one form of my flexible connector, such as may be taken on lines 2—2 of Figure 1.

Figure 3 illustrates a similar cross-section through a connector of a different construction.

Figure 4 illustrates a screw driver bit of a modified form from that shown in Figure 1.

Figure 5 illustrates a socket wrench attachable to the connector.

Figure 6 illustrates an adapter, which may be used instead of a screw driver bit and may be attached in the same manner to the flexible connector, and

Figure 7 shows a modified construction of a flexible screw driver preparatory to its assembly.

Referring now to the figures, numeral 10 denotes the handle end of my device, such as used in screw drivers or similar tools and which is preferably equipped at 11 with a ratchet arrangement to permit its operation in either a right-hand or left-hand direction, or to prevent it from moving in either direction. Below the ratchet arrangement, there is provided a receiving socket 12, into which is passed the upper end of my flexible connector and which is brazed or soldered within the socket, as indicated at 13. At the lower end of the connector, there will be observed the work-engaging end of my tool, also illustrating a socket member 14, in which the connector end is soldered or brazed in at 15. The work-engaging end in Figure 1 consists of a screw driver bit 16, extending from an enlargement 17, above which is located a cup 18 with the knurled outer surface, and the lower end of which 19 engages a suitable groove 20. Cup 18 serves for holding the screw driver end in position with reference to the work when the latter engages a screw or bolt, while handle end 10 may be operated from any desired direction.

The flexible connector consists of an innermost coil 21, formed by winding two relatively thin, resilient, steel wires at a certain pitch in one direction. Surrounding innermost coil 21 and in intimate contact therewith is the next coil 22, made from three somewhat heavier, resilient, steel wires, and wound in opposite direction to the winding of coil 21.

Surrounding coil 22 is a third coil 23, consisting of four resilient wires of heavier gage than those employed in coil 22, and wound in opposite direction to the windings of the latter coil.

Finally, there is an outer helix 24 of still heavier gage, surrounding coil 23 and consisting of four wires wound in opposite direction to the wires of coil 23. The arrangement of the coils and the number of wires employed in each of the coils may be clearly seen from Figure 2, and a similar arrangement of a flexible connector is shown in cross-section in Figure 3, where instead of four laminations of coils, six laminations are employed, and where the inner coil consists of two wires, the next adjacent of three wires, the third of four wires, the fourth of four wires, the fifth of five wires, and the outer coil of seven wires. Both illustrations (Figures 2 and 3) are shown without a mandrel, but it is obvious that in order to facilitate the winding of the innermost coil and for the purpose of giving the connector more rigidity, a wire mandrel may be placed into the center of the connector.

The purpose of constructing the flexible con-

nector in the manner stated above becomes quite obvious when it is considered that the tool may be twisted in either a right-hand or left-hand direction and must transfer such movements from the handle to the screw driver bit without any lost motion and without destruction to the connector. For this reason, the coils nested within one another are wound in opposite directions to one another so that when the strain is in one direction, tending to unwind one of the coils, the next adjacent coil will counteract such force since it will be, so to speak, wound tighter, thereby preventing the unwinding of the first mentioned coil. It is to be considered that the ends of the connector are immovably set within the sockets of the handle end and work-engaging end so that the ends of all coils are fused together, which fact prevents unwinding or otherwise dismembering of the individual coils. It will be also noted that in order to provide the required flexibility of the connecting member, the innermost coil is made of relatively thin wires, and only two wirers are employed to form the coil. Therefore, the pitch of the innermost coil is considerably less than the pitch of the outermost coil, which is made of heavier wire and in which four wires are used. The gradual increase in thickness from within to without and the employment of a smaller number of wires in the inner coils and a larger number of wires at the outer coils, and therefore the increased pitch of the coils from within to without, all tends to supply the necessary flexibility and the torsional resistance of the connector.

In Figure 1, the work-engaging end is provided with a collar or thimble **18**, by means of which the tool end may be held in proper position relative to the work which it engages, but such provision is not absolutely required, as shown in Figure 4, where a screw driver tool end **25** is illustrated, provided with a socket or depression **26**, adapted to accommodate the lower end of the flexible connector.

Another work-engaging end is shown in Figure 5 in the form of a socket member **27**, also provided with a connector engaging end **28**.

Still another work-engaging member is shown in Figure 6 consisting of a socket end **29**, provided with a connector engaging end **30**. The socket end is preferably equipped with a set screw **31**, passing through an annular enlargement **32**, which set screw is adapted to engage a tool, such as a drill, screw driver bit, reamer or socket wrench, which may be inserted into socket member **29**, and immovably held therein.

Figure 7 illustrates a modified construction of my screw driver in its dis-assembled state, showing each of its constituent parts preparatory to being set together. There is again shown a handle member **33**, terminating in a hollow socket **34**, which latter is adapted to receive the upper end of a flexible connector **35**. It will be observed that this connector is provided with a mandrel **36**, which is permitted to remain within the central coil of this connector.

Beneath the lower end of the connector, there is shown a modified assembly of a work-engaging construction which consists of a connector receiving member **37**, provided with a socket for accommodating the lower end of the connector. The lower portion of member **37** is shaped conically, as indicated at **38**, and terminates in another hollow socket portion **39**. This socket is adapted to receive the upper end **40** of a screw driver bit **41**.

In engagement with the conical surface **38** and with the top surface of socket member **37**, is an outer, preferably knurled ferrule **42**, adapted to freely rotate relative to the socket member. It serves the same purpose as ferrule **18**, described in connection with Figure 1.

In the modification of Figure 7, it will be observed that sockets **34** and **37** are relatively narrow and correspond with their inner diameters to the outer diameter of the connecting member **35**. This construction is intended to provide a different connection between socket extensions **34** and **37** and the flexible connector **35**, in that these socket portions are intended to be shrunk-on over the flexible connector.

The attachment of screw driver bit **41**, by means of its extension **40**, within socket **39** is preferably made by compressing the body of socket **39** against the flat surfaces of extension **40**, although any other manner of attachment may be employed.

In the foregoing description, I am speaking of flexible connectors consisting of more than two laminae of coils, in which two adjacent coils are wound in opposite direction to one another. Coils made of relatively heavy gage wire, such as shown in Figure 2, do not require that the mandrel, employed for forming the innermost coil, be retained within that coil, whereas, connectors made of relatively light gage wire coils preferably retain the mandrel within the innermost coil. In such event, the mandrel has a tendency of straightening out the connector, after release from a bent position, to assume its normal, straight position.

I have found during experiments conducted with the construction of different connectors, that at least three internested coils must be employed in order to produce the desired effects of flexibility and resistance to torsion. However, the most advantageous effects were achieved by employing connectors made of double coils, or multiples thereof, in which each double coil, one of the coils is wound in one direction while the other coil is wound in the opposite direction. Thus, I preferably employ either four, six, eight, or ten coils, etc., and the more coils I use, the greater number of wires I employ for each coil. Obviously, the number of wires change the pitches of the coils, and I so form my connectors that the innermost coils of less number of wires are also of lesser gage, and as I build up the coils from within to without, both the sizes and numbers of the wires are increased.

While I have shown specific forms of my invention, particularly including various modifications of the connector, as shown in Figures 1, 2, 3 and 7, with or without a mandrel at their center, and while I have shown such flexible connectors to be of undetermined length and diameter, it is self-understood that such connectors may be made of any length or any diameter as may be required for the purposes for which the tool is employed, and that the various details of constructions illustrated may be changed and improved, as well as the manner of interconnecting the different parts, and I therefore reserve for myself the right to make changes and improvements in my invention, without departing from the broad scope thereof, as set forth in the annexed claims.

I claim:

1. In a flexible tool, handle and work-engaging members, a flexible element connecting them and consisting of a plurality of laminated coils of multiple, resilient wires, increasing in wire cross-

section, number of wires and coil pitch from within to without, and alternating as to the direction of windings, all coil termini at both ends of said element being fused together for preventing their unravelling, said handle and work-engaging members provided with means for accommodating the fused ends of said element, and means for securely holding the element ends within said accommodating means.

2. In a flexible tool, as set forth in claim 1, said work-engaging member provided with means for directing, and for holding said member in engagement with the work, while the tool is being operated.

3. A flexible screw driver, comprising in combination, a handle member, a screw driver bit member, both members provided with sockets, a flexible connector immovably held at its ends within said sockets and consisting of at least four internested coils made of multiple, resilient wires, each coil having a uniform, substantially cylindrical shape throughout its entire length, the coils increasing in wire size, wire numbers and pitch from within to without, and being wound alternately in opposite directions, all coil termini at both ends of said flexible connector, held within said sockets, being fused together for preventing the unravelling of the coils.

4. In a flexible screw driver, a handle member, provided with a connector-receiving socket, a work-engaging mechanism provided with a freely operative collar, a connector-receiving socket, bit-engaging means and a bit secured within the latter, a flexible connector fixedly secured with its ends against movement within the connector-receiving sockets of said handle member and said mechanism, said connector comprising a plurality of coil laminae, alternating as to the directions of their windings, each coil consisting of a plurality of wires, the cross-section of the wires, their number and the pitch of the coils increasing from within to without, said coils being substantially cylindrical in shape over their entire length, the termini of all coils at both ends of said connector being fused together for preventing them from unravelling.

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