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(54) Improved discrete wire insulation displacement connector.

(57) A discrete wire insulation displacement connector having a terminal (16) including an insulation displacement contact (46) comprising a pair of blades (48) defined by a line of cut (50). The edges of the contact ride in a guide channel in the connector housing (14). The housing (14) includes a pair of opposed sidewalls (18) joined by a pair of opposed spaced webs (40). A tapered access to the connector is defined by at least one flexible prong (24) integrally joined to the upper edge (22) of each of the connector's sidewalls and turned inwardly in opposed relationship. The trailing edges (26) of the prongs (24) cooperate with the upper edges (42) of the webs (40) to create an improved strain relief.

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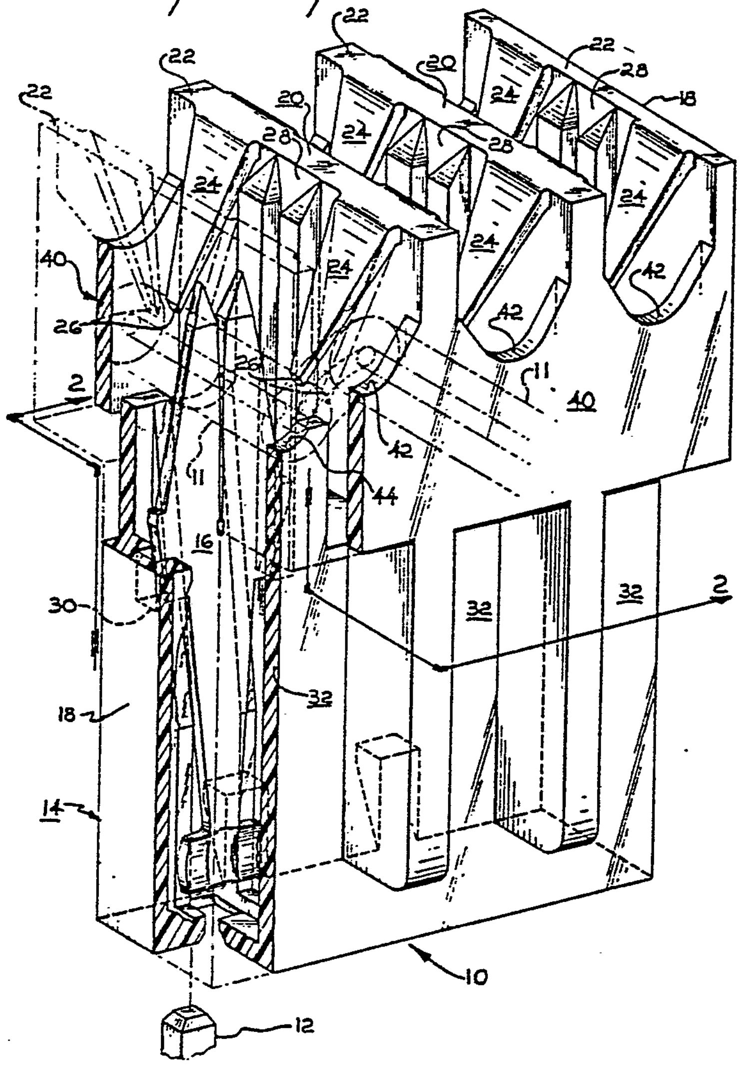
Fig. 1



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IMPROVED DISCRETE WIRE INSULATION DISPLACEMENT CONNECTOR.

Background of the Invention

This invention relates to an improved electrical connector, and, more particularly, to an improved connector which includes an insulation displacement contact for individual or mass termination of discrete wires having improved reliability and strain relief.

U.S. Patent 4,159,158, discloses and claims an electrical connector of the insulation displacement type for terminating discrete wires. The sidewall of the connector housing is provided with external ribs, the upper ends of which are arrow-shaped. The trailing edges of these adjacent arrow-like portions provide a constriction for receiving a wire to be terminated while also serving as a strain relief for the wire when an upward tensile pull is applied to it. These arrow-like members are molded as a rigid intergral part of the connector housing. They are relatively inflexible and may not provide effective strain relief for a range of wire sizes.

Summary of the Invention

The present invention provides an electrical connector having insulation displacement contacts for mass termination of discrete wires. The connector comprises a housing having a pair of opposed sidewalls, the upper edges of which have at least one flexible prong integrally joined thereto and turned inwardly in opposed relationship defining a tapered access for a discrete wire. The housing further comprises a pair of lower end walls joined to the sidewalls forming a lower elongated cavity and a pair of opposed webs spaced from the endwalls and joining the sidewalls, the upper edges of the webs being above the upper edges of the endwalls.

The connector of this invention has a terminal including an insulation displacement contact having a pair of blades defined by a line of cut. In a preferred embodiment, the contact includes a strain relief aperature at the base of the cut, and the edges of the blades are tapered inwardly to provide a "V" shaped entry to the cut. The terminal is mounted in the connector between the sidewalls in parallel spaced relation to the webs with the blades arranged to receive and terminate a wire inserted therebetween.

In one embodiment of this invention, each of the sidewalls has a generally vertical slot in opposed relationship extending downwardly from the upper edge to an intermediate termination, the opposed slots defining a guide channel. The edges of the contact are tapered outwardly and ride in the guide channel. In operation, the guide channel prevents the blades of the contact from skewing as a wire is being terminated.

The electrical connector of this invention may be produced as a single unit or it may be part of a multiunit component for terminating a plurality of discrete wires. It is capable of terminating a wide range of wire sizes, e.g., 22-30 awg, either solid or stranded, and the upper edges of the webs in cooperation with the inwardly turned prongs provide a substantially improved strain relief feature.

Brief Description of the Drawings

Figure 1 is a perspective view, in partial section, to reveal details of the connector of this invention.

Figure 2 is a sectional view taken along line 2-2 of Figure 1 showing a discrete wire terminated in the connector.

Figure 3 is a sectional view taken along line 4-4 of Figure 2 showing a wire about to be terminated, i.e., inserted, between the insulation displacement contacts.

Figure 4 is a sectional view taken along line 4-4 of Figure 2 showing the position of a wire having been terminated.

Figure 4a is a sectional view similar to Figure 4 showing the position of a large wire having been terminated.

Figure 5 is a sectional view taken along line 2-2 of Figure 1 showing wire position after mid-span termination.

Figure 6 is an elevational view of a terminal particularly suited for use in this invention.

Figure 7 is a schematic representation of the interrelationship between the force deformation curves for the family of wires of interest and the force displacement curves of the insulation displacement contacts.

Detailed Description of the Invention

As used hereinafter, the term "IDC" shall mean an insulation displacement contact. Thus, the term "IDC connector" shall mean an electrical connector having an insulation displacement contact for terminating discrete wires or ribbon cable prepared at an end to appear as discrete wires.

As shown in Figures 1 and 2, one embodiment 10 of this invention comprises an IDC connector for disengagably connecting individual wires 11 to spaced terminal posts 12 which can be mounted in and extended from a backplane or many other places. The connector comprises a housing 14 which may include one or more terminals 16.

The housing 14 comprises a pair of opposed exterior sidewalls 18. One or more interior walls 20 may also be provided depending on where the connector is to be used and the number of wires which are to be terminated. Each of the exterior sidewalls 18 and interior walls 20 has an upper edge 22 to each of which are integrally joined at least one prong 24. In a preferred embodiment of this invention each upper edge 22 has two prongs 24 integrally joined thereto. As shown in Figures 3 and 4, prongs 24 are turned inwardly in opposed relation to each other defining a tapered access to the connector for a discrete wire 11. Prongs 24 are flexible and will bend outwardly away from each other as a wire is being inserted into the connector. The prongs 24, because fo their elasticity, tend to return to their original position as soon as a wire has been inserted to a depth immediately below their trailing edges 26 as shown in Figure 4.

In a preferred embodiment of this invention, each of the sidewalls 18 has a generally vertical slot 28 on the inner opposing surfaces thereof. Interior walls 20, as well, are provided with a generally vertical slot 28 on each interior surface, each pair of opposed vertical slots defining a guide channel. Each guide channel extends downwardly from the upper edges 22 of the side and interior walls to an intermediate termination point 30. A terminal can then be mounted in the connector with it's edges riding in the guide channel. It will be appreciated by those skilled in the art that other methods may be employed for securing the terminal in the connector.

As shown in Figure 2, the housing 14 includes a pair of opposed lower end walls 32 which are joined to sidewalls 18 forming a lower elongated cavity 34. In the embodiment shown, elongated cavity 34 includes a peripheral edge 36 which defines a tapered opening 38 for receiving a terminal pin 12.

The housing 14 further includes a pair of opposed webs 40 which are spaced from lower end walls 32 and which join sidewalls 18. The upper edges 42 of webs 40 are located above the upper edges 44 of lower end walls 32. As shown in Figure 1, upper edges 42 and 44 may be gently curved to define a flattened "U" shape.

Housing 14 may be any suitable insulating material such as thermoplastic, e.g., unfilled polyester, which is generally injection molded.

Depicted in Figure 6 is an individual terminal 16 particularly suited for use in this invention. The terminal 16 includes an IDC 46 having a pair of blades 48 defined by a line of cut 50. Optionally, a strain relief aperature 52 can be provided at the base of cut 50. This aperture tends to prevent propagation of the cut beyond its intended limit. Ordinarily, the ends of blades 48 are tapered inwardly as shown defining a "V" shaped entryway 54 which guides the entry of a wire.

The edges of IDC 46 can be tapered outwardly and shaped to ride in the guide channel formed by slots 28. The lower portion of terminal 16 comprises a beam 56 which is integrally joined to IDC 46 and shaped and relieved to conform to the inner contours of the connector housing. Alternatively, beam 56, an elongated strip of sheet metal, may be formed into other shapes for mating to various forms of electrical devices such as substrates, boards and pins.

The terminals 16 may be stamped or cut from any suitable strip conducting material, such as phospor/bronze or other copper alloy. Preferably, the terminals are formed from spring tempered strip material having a thickness of about .008 to .025 inch (0.203 to 0.635 mm). It will be appreciated by those skilled in the art that the line of cut will open up generally parabolically as a wire is inserted. However, the IDC may be prestressed, i.e., the line of cut may be opened slightly in the die during the stamping operation, before it is mounted in the connector.

In operation, a wire to be terminated is located in the tapered access to the connector as shown in Figure 3. A suitable insertion tool 60 is employed to move the wire into the connector, flexibly displacing prongs 24. The termination is accomplished as wire 11 is inserted in the connector to a depth just below the trailing edges 26 of prongs 24 and blades 48 cut the insulation and positively contact the wire's conductor. After a wire has been terminated, prongs 24 tend to return to their initial position so that trailing edges 26 rest against the upper surface of the wire's insulation.

It is known and appreciated by those skilled in the art that motion of a wire relative to the IDC must be prevented to achieve a reliable connection. According to this invention flexible prongs 48 prevent a terminated wire from moving upwardly out of the connector while at the same time upper edges 44 prevent the wire from being moved downwardly into the connector any farther than is necessary for the conductor to reliably contact blades 48.

One of the most important features of this invention is that it provides the capability to successfully terminate wires varying greatly in size, for example, wires ranging from 22 awg to 30 awg on 0.100 inch centers and from 18 awg to 28 awg on 0.156 inch centers. Wires can be terminated according to the following procedure :

All wires to be terminated, regardless of size, are inserted into the connector using the same tool, which simply pushes the wire down until its top surface is just below the trailing edges of prongs 24.

As can be seen in Figures 4 and 4A, a conductor of a larger wire is automatically pushed further down into wire slot 50 than the conductor of a smaller wire.

Figure 7 is a schematic representation of the interrelationship between the force deformation curves for the family of wires of interest and the force displacement curves of the IDC. The places where a wire and an IDC curve intersect are points of equilibrium between wire and the IDC. This type of representation of IDC versus wire is well known to those familiar with the IDC art.

Because of space and cost considerations, the IDC's which are suitable for use in this invention are relatively small, e.g., usually only about 0.100 to0.200 inches long (2.5 to 5.0 mm). Such small IDC's tend to exhibit a large amount of plastic deformation when their displacement is relatively large and their stiffness is relatively high.

This is exactly what happens when a large wire (large displacement) is pushed relatively deep into the IDC line of cut (high stiffness). Figure 7 illustrates this behavior of the larger wire terminated to the IDC. The equilibrium between IDC and wire falls within the satisfactory range of wire deformation. The high initial stiffness is achieved by the wire being placed relatively deep in the slot formed between blades 48 and the large amount of plastic deformation in the IDC results from the high displacement caused by the larger diameter wire.

Figure 7 also shows that the IDC behavior when terminating smaller wire is markedly different when the larger wire is terminated. The IDC stiffness is lower because the wire is placed relatively less deep into the line of cut, and little or no plastic deformation occurs in the IDC because of the small displacement caused by the smaller diameter wire. Again, however, the equilibrium between IDC and wire falls within the range of satisfactory wire deformation.

The connector system performance for intermediate size wires is also quite satisfactory. In a typical 0.100 center connector, the large wire would be about 22 awg and the small wire would be about 30 awg.

In a preferred embodiment of this invention the width of the guide channel in which the IDC rides is no more than twice the thickness of the terminal, and preferably no more than

1.5 times the terminal thickness. The blades of the IDC are restrained and prevented from skewing.

Referring now to Figures 2 and 5 there is shown another important feature of this invention. Figure 2 illustrates a wire having been terminated at its end. Figure 5 illustrates a wire terminated mid-span. The upper edge 42 of web 40 cooperate with the trailing edge 26 of prong 24 to impart an "S" bend in a wire as it is terminated. The "S" bend is an important strain relief feature which practically eliminates movement of the wire conductor relative to the IDC.

As many widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that this invention is not limited to the specific embodiments thereof except as defined in the appended claims, and all changes which come within the meaning and range of equivalence are intended to be embraced therein.

WHAT IS CLAIMED IS : EL-4193 -

1. An electrical connector comprising a housing (14) having a pair of opposed sidewalls (18, 20) ;

each of said sidewalls having an upper edge (22), each of said edges having at least one prong (24) integrally joined thereto and turned inwardly in opposed relationship defining a tapered access for a discrete wire (11) ;

a pair of opposed lower end walls (32) joined to said sidewalls (18) forming a lower elongated cavity (34) ;

a pair of opposed webs (40) spaced from said endwalls (32) joining said sidewalls (18) and having upper edges (42) above the upper edges (44) of said lower end walls ;

a terminal (16), including an insulation displacement contact (46) having a pair of blades (48) defined by a line of cut (50), mounted between said sidewalls (32) in parallel spaced relation to said webs (40), said blades (48) arranged to receive and terminate a wire (11) inserted therebetween.

2. An electrical connector as defined in Claim 1 in which each of said sidewalls (18, 20) includes a slot (28) in opposed relationship defining a generally vertical guide channel extending downwardly from said upper edges (22) to an intermediate termination (30) ; and the outer edges of said contact (46) ride in said guide channel.

3. An electrical connector as defined in Claims 1 or 2 having a strain relief aperture (52) at the base of said cut.

4. An electrical connector as defined in Claim 3 in which said lower elongated cavity (34) includes a lower peripheral edge (36) defining a tapered opening (38) for receiving a terminal pin (12) and said terminal (16) includes a beam (56) integrally joined to said insulation displacement contact (46) and extending downwardly therefrom for contacting a terminal pin (12).

5. An electrical connector as defined in Claims 1 to 6

in which the ends of said blades (48) are tapered inwardly defining a "V" shaped entry (54) to said cut (50).

6. An electrical connector comprising a housing (14) having a pair of opposed exterior sidewalls (18), at least one spaced interior wall (20) parallel to said sidewalls defining a plurality of discrete cavities ;

each of said sidewalls and said interior wall having an upper edge (22), each of said edges having at least one prong (24) integrally joined thereto and turned inwardly into said discrete cavities in opposed relationship defining a tapered access thereinto for a discrete wire (11) ;

each of said sidewalls (18) having a generally vertical slot (28) on the inner surface thereof extending downwardly from said upper edge (22) to an intermediate termination (30) defining a guide channel ;

said interior wall (20) having a generally vertical slot on each surface thereof extending downwardly from said upper edge (22) in opposed spaced relation to the slot on the opposite surface of said cavity defining a guide channel ;

a pair of opposed lower end walls (32) joined to said sidewalls (18) and said interior wall (20) forming a plurality of lower elongated cavities (34) ;

a pair of opposed webs (40) spaced from said endwalls (32) joining said sidewalls (18) and said interior wall (20) having upper edges (42) above the upper edges (44) of said lower end walls (32) ;

a terminal (16) located in each of said cavities, said terminals including an insulation displacement contact (46) having a pair of blades (48) defined by a line of cut (50), the outer edges of each of said contacts riding in said guide channel.

Fig. 1

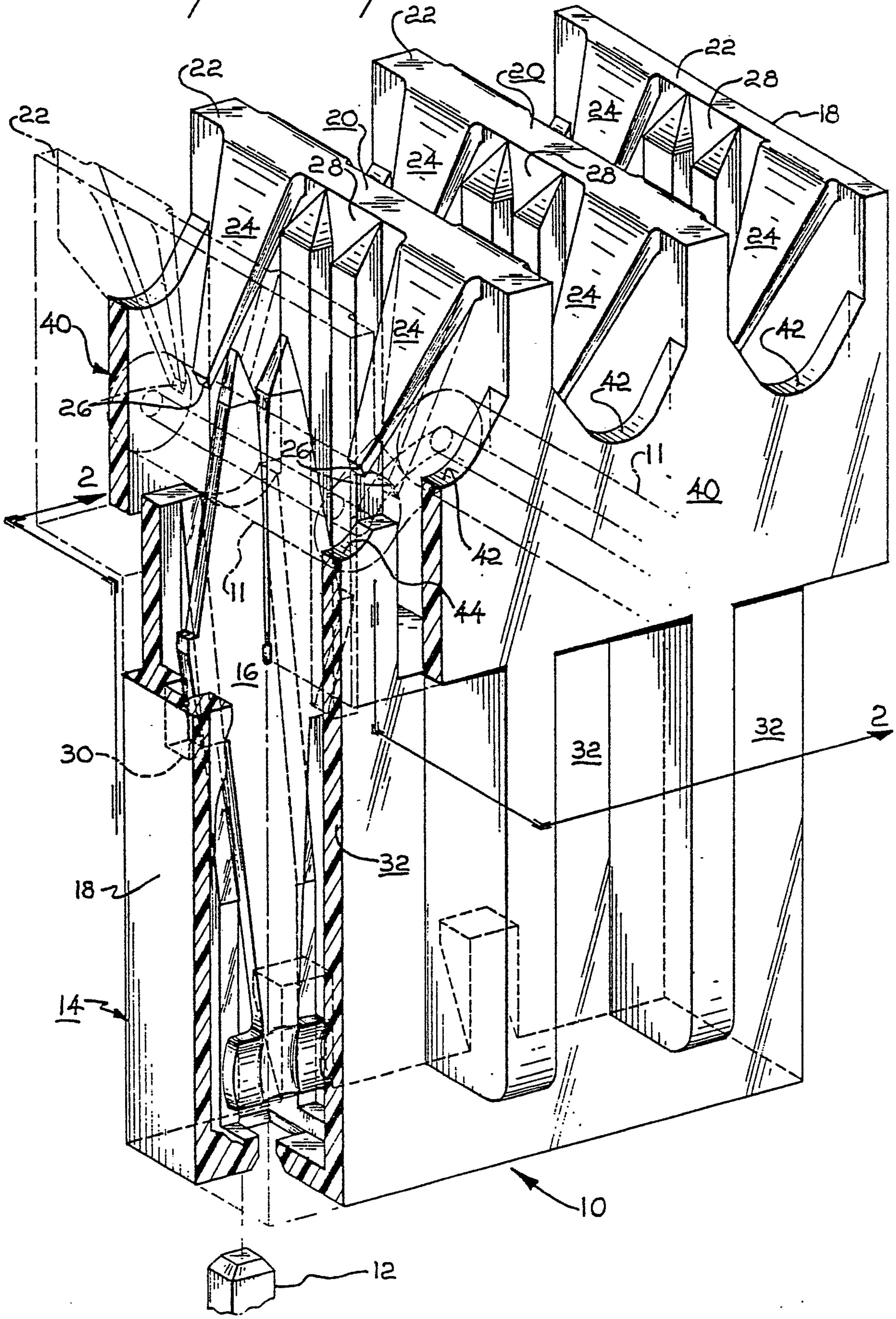
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Fig. 2

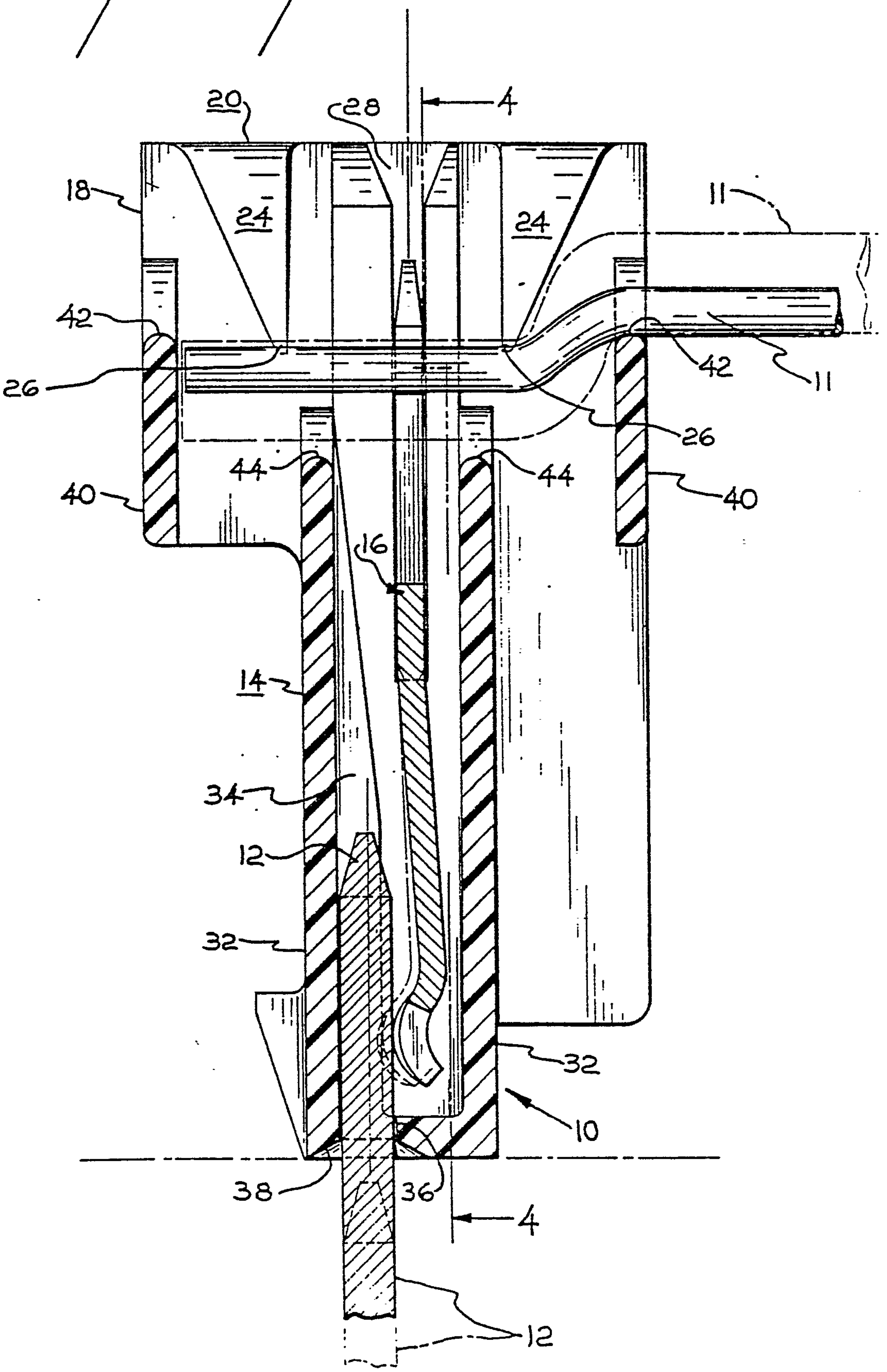
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Fig. 3

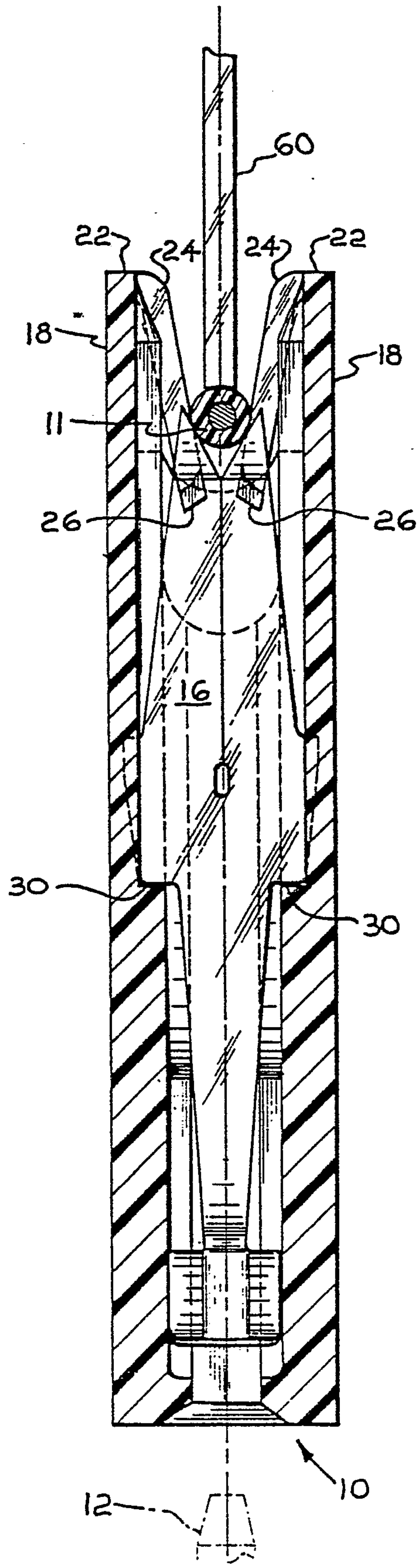
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Fig. 4

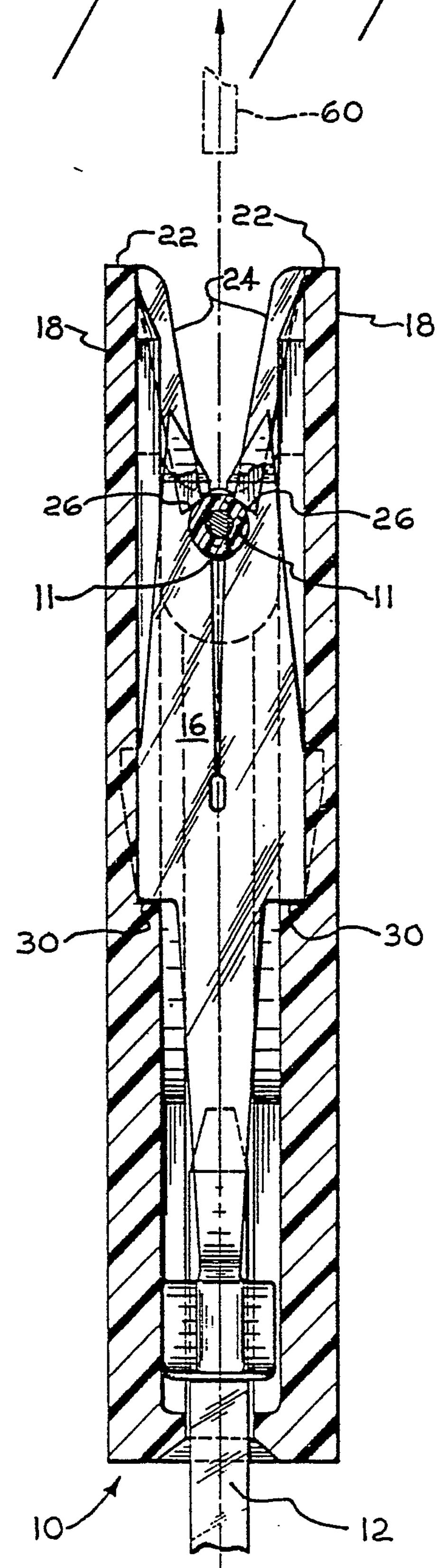
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Fig. 4a

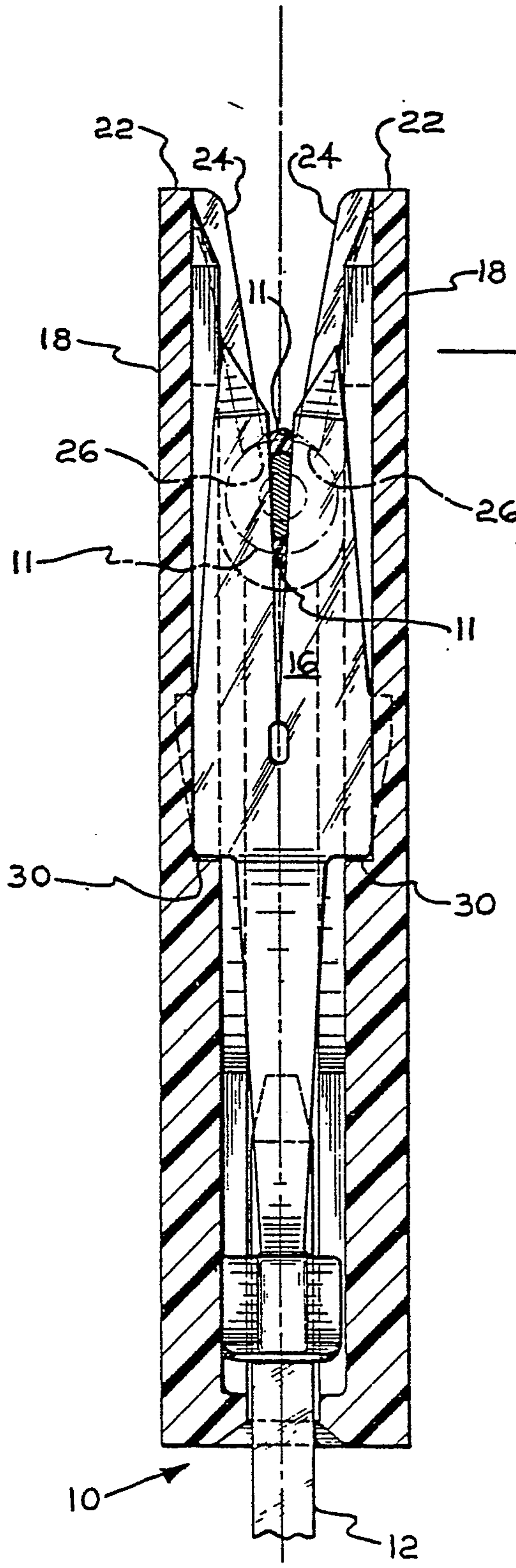

Fig. 6

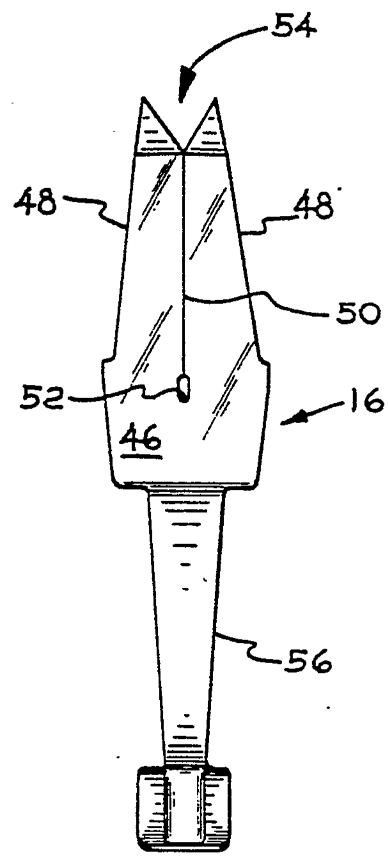

Fig. 5

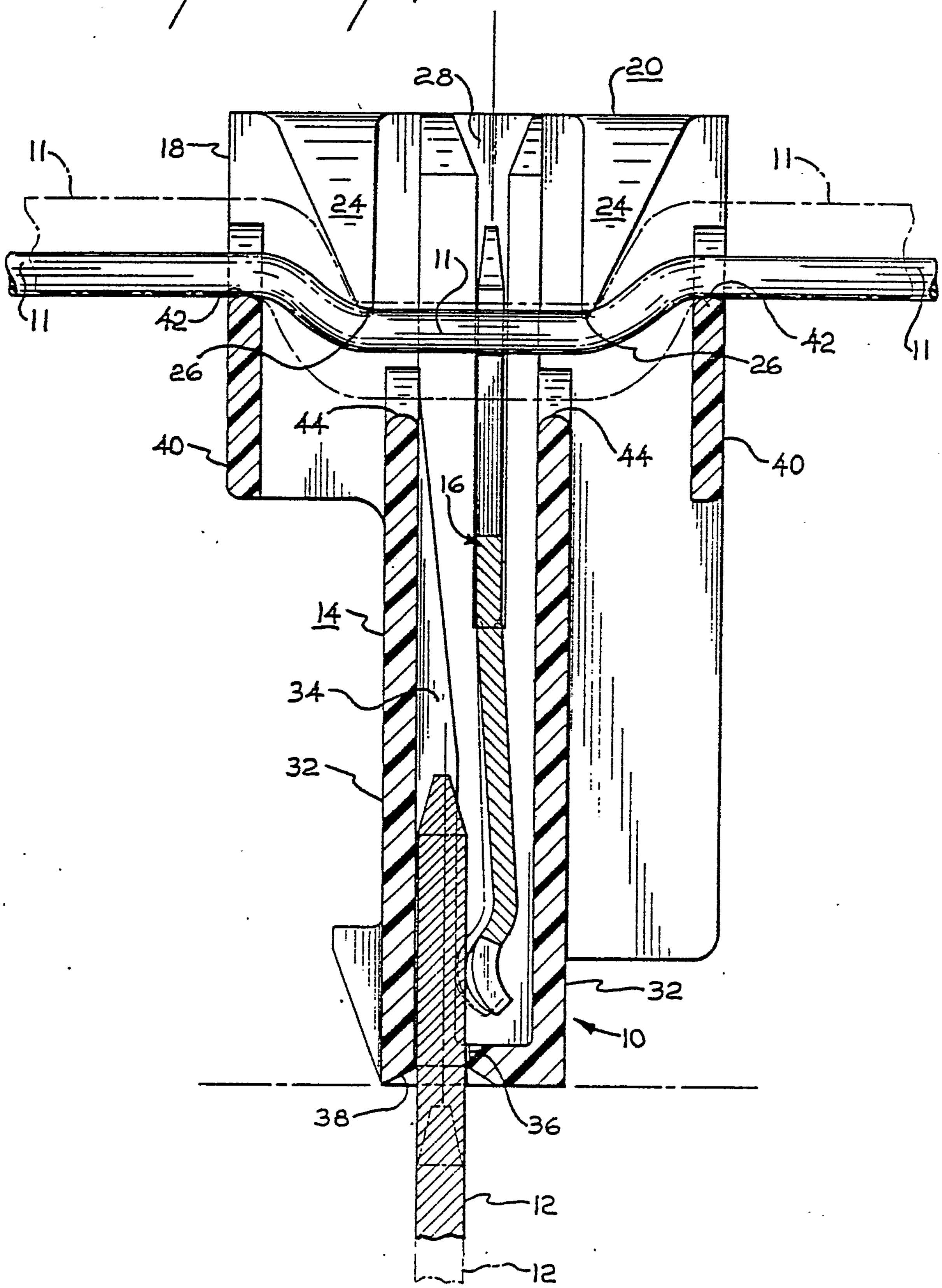
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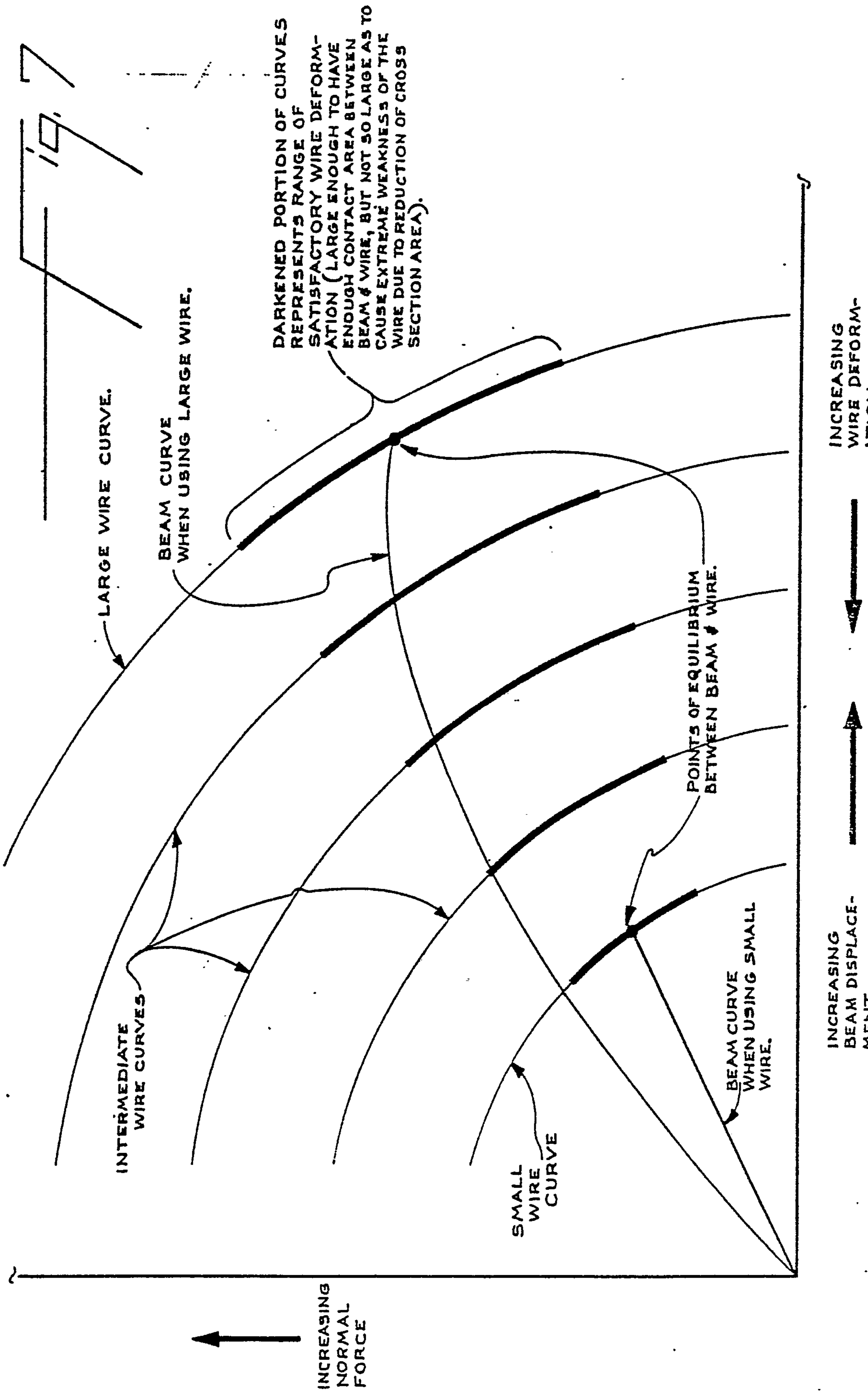
Fig. 7


DARKENED PORTION OF CURVES REPRESENTS RANGE OF SATISFACTORY WIRE DEFORMATION (LARGE ENOUGH TO HAVE ENOUGH CONTACT AREA BETWEEN BEAM & WIRE, BUT NOT SO LARGE AS TO CAUSE EXTREME WEAKNESS OF THE WIRE DUE TO REDUCTION OF CROSS SECTION AREA).
LARGE WIRE CURVE.
BEAM CURVE WHEN USING LARGE WIRE.
POINTS OF EQUILIBRIUM BETWEEN BEAM & WIRE.
INTERMEDIATE WIRE CURVES
SMALL WIRE CURVE
BEAM CURVE WHEN USING SMALL WIRE.
INCREASING WIRE DEFORMATION.
INCREASING BEAM DISPLACEMENT.
INCREASING NORMAL FORCE