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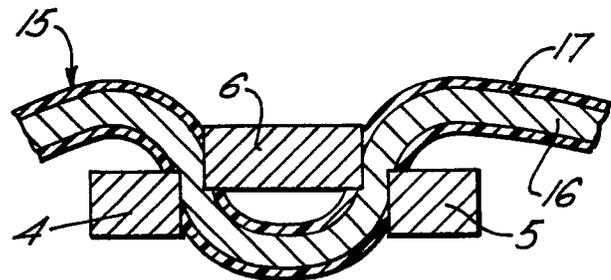
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54 **Electrical terminations and method of making the same.**

57 An electrical termination assembly includes a termination 1 formed by a flat resilient plate split into three limbs 4, 5 and 6 by slots 2. A wire 15 is threaded between the outer limbs 4 and 5 and the middle limb 6 and as the wire is urged into the termination 1, edges of the limbs 4, 5 and 6 cut through and insulating coating 17 of the wire and any oxide film and into the conductor 16 of the wire. The limbs 4 and 5 splay apart in the direction of a plane containing the termination 1 and the limbs 4 and 5 also splay apart from the middle limb 6 in a direction transverse to the plane. This provides the limbs with two directions of movement and this terminating assembly is particularly useful when the conductor 16 is made from aluminium.



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ELECTRICAL TERMINATIONS

This invention is concerned with electrical terminations for making an electrical connection to an electrical conductor.

5 A common type of electrical termination is formed by a flat resilient plate split into two limbs. A conductor is jammed into the termination between the two limbs and, as it is urged between the two limbs, it forces the two limbs apart in the direction of a plane containing the plate. A typical example
10 of such a bifurcated termination is shown in British Patent Specification No 1 030 235. As the conductor is jammed into the termination any insulation and/or any oxide film on the surface of the conductor is crushed and removed from the surface of the conductor
15 so that there is no need to strip the insulation from the conductor or clean the conductor before it is jammed into the termination. This ensures that the connection can be made more speedily and ensures that a good electrical contact is obtained between the
20 conductor and the termination. There are very many developments in this general type of terminal and one such is shown in British Patent Specification No 1 068 741. This specification discloses a modification of the termination shown in Specification No 1 030 235 and
25 discloses the provision of a slot of width narrower than that of the diameter of the conductor between the two limbs.

It is also known for this type of terminal to be capable of making contact with two separate conductors
30 and, in this case, the flat plate is split into three separate limbs. In essence, this type of terminal is two bifurcated terminals arranged back-to-back and an example of such a terminal is shown in British Patent

Specification No 1 317 426. Once again, in this specification, as the conductors are forced between the outer limbs and the central limb, the outer limbs splay outwards from the central limb in the direction of a plane containing the plate. With all of these types of terminal, there is only one degree of freedom in the movement of the limbs as the conductor is forced between them and this leads to a very coarse relationship between the restoring force exerted by the two limbs to return them to their original position and the splaying apart of the limbs as the conductor is forced between them. It is therefore very difficult to select the parameters of a bifurcated plate-type terminal so that there is sufficient restoring force between the limbs firstly to ensure that the insulation and any oxide coating is stripped from the conductor as the conductor is forced in between the limbs and secondly to ensure that the elastic limits of the material forming the plate is not exceeded as the conductor is jammed between the limbs so that the restoring force of the limbs provides the contact pressure against the conductor to maintain a good electrical contact between the conductor and the limbs and prevent the ingress of air into the contact surfaces. It is a well known desideratum to make electrical terminations as small as possible and, the shorter the length of the limbs of the terminal, the coarser the relationship between the restoring force and the separation of the limbs becomes. It is also desirable to be able to use the termination with a conductor made from aluminium or one made from copper. Aluminium conductors, as compared to copper conductors, are more difficult to make good electrical contact with since their higher reactivity means that an oxide film forms on their surface more readily and this makes it more

important to obtain adequate contact pressure between the termination and the aluminium conductor to prevent the ingress of air. Also, aluminium deforms readily by cold flow and, therefore, if it is subjected to high contact pressures in an attempt to exclude air from between its contact surfaces, the aluminium merely flows away from the point of highest contact pressure and this can lead to an aluminium conductor being sheared if the contact pressure is too great.

These properties of aluminium conductors have, in general, meant that they have not been used successfully with electrical terminations including a bifurcated plate. One attempt to improve upon the properties of bifurcated plate-type terminals has been recently illustrated in published British Patent Application No 2 013 423. This patent application describes an electrical termination of the bifurcated plate-type housed in an insulating housing. The insulated housing includes a wire gripping element to hold the wire on each side of the plate and then the plate is arranged at 45° to a line joining the two wire gripping elements. The bifurcated plate is held in a slot formed in the insulating housing and there is a clearance between the sides of the bifurcated plate and the sides of the slot. This clearance enables the limbs of the bifurcated plate to begin to splay apart as a conductor is jammed between them but, after a predetermined splaying apart of the limbs has taken place, further movement of the conductor in between the limbs causes a torsional movement of the limbs since further splaying apart is prevented. Thus, as the conductor is jammed between the limbs, the limbs have two degrees of freedom in that, firstly, they splay apart in the direction of a plane containing the bifurcated plate and, secondly, they twist. The provision of these

two degrees of freedom enables a more gradual relationship to be established between the separation of the two limbs and the restoring force exerted by the limbs on the conductor. This type of termination has
5 certainly proved perfectly adequate for conductors when they are made from copper but it is still difficult to design such a terminal which is completely reliable in operation with aluminium conductors..

10 According to a first aspect of this invention, a method of making an electrical termination assembly comprises providing an electrical termination including a flat resilient plate having two open-ended slots
15 arranged side-by-side to split the plate into three limbs all lying in the same plane, placing an electrical conductor between the middle limb and the two outer limbs, and urging the conductor into the termination in a direction towards the base of the slots, to jam the conductor between the edges of adjacent limbs in
20 so doing causing the two outer limbs to splay apart in a direction of said plane, and causing two outer limbs and the middle limb to splay apart in a direction transverse to said plane.

25 According to a second aspect of this invention, an electrical termination assembly comprises a flat resilient plate having two open-ended slots arranged side-by-side to split the plate into three limbs which all lie in the same plane in their relaxed state, and an electrical conductor jammed between the edges of the
30 middle and the two outer limbs, the conductor causing the two outer limbs to splay apart in a direction of said plane, and causing the two outer limbs and the middle limb to splay apart in a direction transverse to said plane.

35 By inserting a conductor into both of the slots,

formed in a three limbed termination, the limbs of the termination have two degrees of freedom in that they can move in a direction transverse to the plane containing the limbs and splay apart in the direction of the plane containing the limbs. These two degrees of freedom provide a less coarse relationship between the separation of the limbs and a restoring force of the limbs which provides the contact pressure against the conductor. In addition to this, since the conductor is jammed into two slots instead of one, there is twice the opportunity for making a good contact between the termination and the conductor.

Preferably, free end portions of the two outer limbs of the termination are bent away from the middle limb in a direction transverse to said plane and, in this case, the conductor is initially placed against the outturned end portions of the two outer limbs and against an end portion of the middle limb before being urged into the termination. The provision of the bent outturned portions of the two outer limbs enables the conductor to be placed between the outturned end portions of the two outer limbs and the end portion of the middle limb so that when it is urged into both slots it is forced between the middle limb and the two outer limbs.

According to a third aspect of this invention, an electrical termination comprises a flat resilient plate having two open-ended slots arranged side-by-side which split the plate into three limbs all lying in the same plane, free end portions of the two outer limbs being bent away from the middle limb in a direction transverse to said plane, the arrangement being such that, in use, a conductor is placed between the outturned end portions of the outer limbs and an end portion of the middle limb and urged into the termination towards the base of the slots which causes the conductor to jam between the edges of the adjacent limbs and causes the outer limbs to splay apart in the direction of said

plane, and the outer limbs and the middle limb to splay apart in a direction transverse to said plane.

5 The conductor is preferably urged into the termination by a three-legged insertion tool, the middle leg of the tool lying against one side of the middle limb of the termination and the outer legs of the tool lying against the other side of the outer limbs of the termination. The insertion tool is preferably a hand operated tool. Preferably the conductor is cropped to length upon insertion of the conductor into the termination with the insertion tool. To do this, the termination may include a bent tab which lays in the path of the conductor, one of the outer legs of the insertion tool cooperating with the bent tab to shear the conductor as it is inserted into the termination. However, the insertion tool may include a pair of wire cropping blades actuated by a lost motion mechanism so that, after the insertion tool has completed the insertion of the conductor into the termination, further downward movement of its handle does not result in further downward movement of the three legged tool but, instead, is converted into operation of the blades of the cropping tool to crop the conductor to length.

15
20
25 Preferably the middle limb of the termination is indented in a direction transverse to said plane and in a direction away from the end portions of the two outer limbs. This indentation in the middle limb provides a seat for the conductor. The indentation prevents the conductor from being driven outwards from the termination by the outwards component of the restoring force acting on the limbs. The indent also provides a positive location for the conductor and so enables the insertion of the conductor to be monitored.

30
35 Particularly when the conductor is made from

aluminium it is desirable to have a high restoring force between the limbs whilst the conductor is being inserted to ensure that any insulation on the conductor is removed and to ensure that any oxide coating on the surface of the conductor is also removed. However, it is also desirable that the contact pressure against the conductor after it has been inserted is not so great as to cause plastic flow of the conductor. Another advantage of the indentation is that it has the effect of reducing the contact pressure against the conductor as the conductor moves against the indented part of the middle limb. The depth of the indentation may be varied to adjust the degree of reduction in the contact loading and preferably the depth of the indentation in the middle limb is in a range from 25% to 50% of the thickness of the plate. It is further preferred that the depth of the indentation is in a range from 35 % to 40% of the thickness of the plate.

We have found that the resilient and elastic properties of all the common materials from which terminations are made, for example, nickel silver, phosphor bronze or beryllium copper are all sufficiently similar for the ratio between the size of the slots, the dimensions of the limbs, and the thickness of the conductor to be similar. It is preferred that the width of each of the slots is within a range from 50% to 90% of the width of the conductor. It is further preferred, and it is especially so when the conductor is made from aluminium, that the width of the slots is in a range from 60% to 80% of the width of the conductor, and the optimum width of the slot is substantially 70% of the width of the conductor.

Preferably, the termination is arranged so that the ratio of the thickness of its plate to the width of the outer limbs is in a range from $1:1\frac{1}{4}$ to $1:1\frac{3}{4}$

and the ratio of the thickness of the plate to the effective length of each slot is in a range from 1:10 to 1:14. The effective length of the slot is the length of the slot between the position of the conductor after it has been inserted into the termination and the base of the slot. It is this length which is one of the factors determining the contact pressure exerted on the conductor after it has been inserted into the termination. The width of the slot may be increased below the position occupied by the conductor and this enables the manufacture of the terminations to be simplified. In this case, it is the ratio of the thickness of the plate to the width of the limbs in the region between the conductor and the base of the slots which is important but, of course, it is the width of the slots at the rest position of the conductor which is critical. Preferably the ratio of the width of the outer limbs to the middle limb is substantially 1:2.

Preferably the tips of the end portions of the two outer limbs are parallel to the tip of the middle limb, and the tips of the outer limbs are spaced from the tips of the middle limb to provide an interference fit between them for the outside of an insulated conductor. When the tips of the limbs are arranged in this way, an insulated conductor can be manually fed into the nip between the tips of the outer limbs and the middle limb and then remains in this position until it is urged towards the base of the slots by the insertion tool.

Preferably the termination is mounted in a block of insulating material which includes means to grip and support an insulated conductor on at least one side of the termination.

A particular example and two modifications of a

method of making an electrical termination, an electrical termination assembly and an electrical termination in accordance with this invention will now be described with reference to the accompanying drawings; in which:-

5 Figure 1 is a front elevation of an electrical termination;

 Figure 2 is a side elevation of an electrical termination;

10 Figure 3 is a plan of an electrical termination mounted in a housing;

 Figure 4 is a section through the limbs of an electrical termination and a wire in contact with them;

15 Figure 5 is a perspective view illustrating the method of insertion of the conductor into the termination and showing a first modification of the termination; and,

 Figure 6 is a front elevation of a second modification of the termination.

 An electrical termination 1 is made from a flat plate of nickel silver and includes two parallel slots 20 2 arranged side-by-side which split the plate into three limbs, two outer limbs 4 and 5 and a middle limb 6. End portions 7 and 8 of the outer limbs 4 and 5 are bent outwards in a direction transverse to a plane containing the plate at an angle of substantially 30°. 25 These end portions may be bent at a steeper angle, for example 45° or a shallower angle, but it is preferred that they are bent at an angle of substantially 30°. Tips 9 and 10 of the limbs 4 and 5 are bent so that they are parallel to the end of the middle limb 6. The 30 middle limb includes an indented portion 11 which is indented in a direction transverse to the plane containing the plate and in a direction away from the bent portions 7 and 8 of the outer limbs 4 and 5.

35 The termination 1 may form part of any type of terminating assembly and may be arranged to be fixed or soldered to a circuit board or form part of any

electrical apparatus but frequently it is part
of a connecting block. In this case, the connecting
block may include a large number of terminations,
for example at least ten and these may all be connected
5 to a common base or, alternatively, be electrically
insulated from one another. When the terminal does
form part of a connecting block the, or each,
termination 1 is surrounded by a housing 12 of
insulating material. Naturally, when the connecting
10 block contains a number of terminations 1 the housing
is formed by a single unit arranged to contain
a number of the terminations 1 arranged in a generally
side-by-side configuration. The housing 12 includes
two clamping slots 13 and 14 aligned generally with
15 the plane containing the termination and, these
clamping slots 13 and 14 are arranged to grip the
insulating covering of an electrical conductor connected
to the termination 1.

The particular example of termination is intended
20 to be used with a wire having an aluminium conductor
of 0.5 mm diameter with a foamed polyethylene insulating
covering having a wall thickness of about 0.1 mm,
so giving an overall external diameter of 0.7 mm. Such
a wire is being introduced as a standard in the British
25 Telephone System. The termination 1 is made by a
punching and stamping operation upon a sheet of nickel
silver having a thickness of 0.8 mm. The limbs 4 and
5 have a width of 1.12 mm and the limb 6 has a width
of 2.25 mm. The slots 2 have a width of 0.35 mm and
30 the effective length of the slots, that is the distance
from the centre of the indent 11 to the base of the
slots 2, is 8 mm. The depth of the indent is 0.3 mm
and it has an overall length of about 1 mm. The length
of the tips 9 and 10 is also about 1 mm and the
35 separation of the tips 9 and 10 from the end of the

limb 6 in a direction transverse to the plane containing the termination 1 is arranged to be an interference fit on the outside of an insulated conductor and thus the tips of the limbs are separated by a bare 0.7 mm.

5 To use the termination 1, a wire 15 having a
conducting core 16 of aluminium and a foamed polyethylene
covering 17 is placed between the tips 9 and 10 and the
end of the middle limb 6 and then urged into the
10 termination towards the base of the slots 2. As the
conductor is urged downwards, it is carried between the
outer limbs 4 and 5 and the middle limb 6 and adjacent edges
of all three limbs 4, 5, and 6, cut through the insulating covering
17, through any oxide film formed on the surface of the
conductor 16 and into the conductor 16, as shown in
15 Figure 4. The wire is urged into the termination 1
until it reaches the indented portion 11. As the
conductor is urged into the termination 1, the limbs
4 and 5 splay apart from one another in the direction
of the plane containing the termination 1 and, also,
20 the limbs 4 and 5 splay apart from the limb 6 in a
direction transverse to the plane containing the
termination 1. When the termination is contained within
a housing 12, the wire is also gripped between wire
clamping slots 13 and 14 to provide some mechanical
25 restraint on the wire 15.

 Preferably, the wire 15 is urged into the
termination 1 using a three-legged tool as shown in
Figure 5. The three-legged tool includes a middle leg
18 having a lip 19 at its end and a pair of outer limbs
30 20. The three legs are parallel to one another but the
middle leg 18 is separated from the outer legs 20 in
a direction transverse to a plane containing the outer
legs 20. In use, the tool, which is a hand operated
tool, is placed with the middle leg 18 between the end
35 portions 7 and 8 of the limbs 4 and 5 and against one

side of the middle limb 6. The lip 19 passes round the outside of the wire 15, as shown in Figure 5, and the ends of the outer legs 20 bear against the wire 15. The tool is then urged downwards to urge the conductor
5 15 into the termination 1 and as the tool moves down, the outer legs 20 bear against the other side of the limbs 4 and 5, again as shown in Figure 5. When the operator feels the wire 15 "click-into" the indent
10 11 downward pressure on the tool is released and the tool withdrawn.

A first modification of the termination 1 is also shown in Figure 5 and, in this modification, a tab 21 is provided on the outer limb 5 of the
15 termination and this tab is bent at right angles to the plane containing the termination and extends into the path of the wire 15. This tab 21 cooperates with the end of one of the outer legs 20 of the tool to crop the wire 15 to length as it is inserted into the termination 1.

A second modification of the termination 1 is illustrated in Figure 6. To facilitate the stamping and pressing operation it is preferred that the slots
20 2 are made wider towards their bases and, in this example, the width of the slots 2 is increased from 0.35 to
25 0.6 mm in the region between the indented portion 11 and the base of the slots. When the width of the slots is increased in this region, it is the dimensions of the limbs bounding the wider portion of the slots which is most important in determining the characteristics of the
30 termination 1. Thus, in the termination shown in Figure 6 it is the portion of the limbs 4 and 5 against the wider portion of the slots which have a width of 1.12 mm and the portion of the limb 6 against the wider part of the slot which has a width of 2.25 mm.

35 Whilst the termination 1 and its modifications have

been especially designed to be used with a wire having
an aluminium conductor of a diameter of 0.5 mm, the
termination may be used for terminating wires having
copper conductors and, indeed, may also be used with
5 uninsulated conductors. Since copper does not deform
by cold flow to the same extent as aluminium, the
termination 1 may be used with a wider range of copper
conductors than with aluminium. As an example of this,
the termination shown and described is suitable for use
10 with wires having copper conductors with diameters in
a range from 0.4 to 0.9 mm.

C L A I M S

1. A method of making an electrical termination assembly comprising providing an electrical termination including a flat resilient plate having two open-ended slots arranged side-by-side to split the plate into
5 three limbs all lying in the same plane, placing an electrical conductor between the middle limb and the two outer limbs, and urging the conductor into the termination in a direction towards the base of the slots to jam the conductor between the edges of adjacent limbs
10 in so doing, causing the two outer limbs to splay apart in the direction of said plane and causing the two outer limbs and the middle limb to splay apart in a direction transverse to said plane.

2. A method according to claim 1, in which free
15 end portions of the two outer limbs are bent away from the middle limb in a direction transverse to said plane, and in which the conductor is initially placed against the outturned end portions of the two outer limbs and against an end portion of the middle limb before being
20 urged into the termination.

3. A method according to claim 1 or 2, in which the conductor is urged into the termination by a three-legged insertion tool, the middle leg of the tool lying against one side of the middle limb of the termination
25 and the outer legs of the tool lying against the other sides of the outer limbs of the termination.

4. A method according to claim 3, in which the conductor is cropped to length upon the insertion of the conductor by the insertion tool.

5. An electrical termination assembly comprising
30 a flat resilient plate having two open-ended slots arranged side-by-side to split the plate into three limbs which all lie in the same plane in their relaxed state and an electrical conductor jammed between edges
35 of the middle and the two outer limbs, the conductor

causing the two outer limbs to splay apart in the direction of said plane and causing the two outer limbs and the middle limb to splay apart in a direction transverse to said plane.

5 6. A termination assembly according to claim 5, in which free end portions of the two outer limbs are, in their relaxed state, bent away from the middle limb in a direction transverse to said plane.

10 7. An electrical termination comprising a flat resilient plate having two open-ended slots arranged side-by-side which split the plate into three limbs all lying in the same plane, free end portions of the two outer limbs being bent away from the middle limb in a direction transverse to said plane, the arrangement
15 being such that, in use, the conductor is placed between the outturned end portions of the outer limbs and an end portion of the middle limb and urged into the termination towards the base of the slots which causes the conductor to jam between the edges of adjacent
20 limbs and causes the outer limbs to splay apart in the direction of said plane, and the outer limbs and the middle limb to splay apart in a direction transverse to said plane.

25 8. A termination assembly according to claim 6, or a termination according to claim 7, in which the middle limb is indented in a direction transverse to said plane and in a direction away from the end portions of the two outer limbs.

30 9. A termination assembly or a termination according to claim 8, in which the depth of the indentation in the middle limb is in a range from 25% to 50% of the thickness of the plate.

35 10. A termination assembly according to claim 5, 6, 8 or 9, or a termination according to claim 7, 8 or 9, in which the width of each of the slots is within a range

from 60% to 80% of the width of the conductor.

5 11. A termination assembly according to claim 5, 6, 8, 9 or 10, or a termination according to claim 7, 8, 9 or 10, in which the ratio of the thickness of the plate to the width of the outer limbs is in a range from $1:1\frac{1}{4}$ to $1:1\frac{3}{4}$ and the ratio of the thickness of the plate to the effective length of each slot is in a range from 1:10 to 1:14.

10 12. A termination assembly according to claim 6, 8, 9 10 or 11, or a termination according to any one of claims 7 to 11, in which the tips of the end portions of the two limbs are parallel to the tip of the middle limb, and the tips of the outer limbs are spaced from the tips of the middle limb to provide an
15 interference fit between them for an insulated conductor.

20 13. A termination assembly according to claim 5, 6, 8, 9, 10, 11 or 12, or a termination according to any one of claims 7 to 12, in which the termination is mounted in a block of insulating material including means to grip and hold the insulated conductor.

Fig. 1.

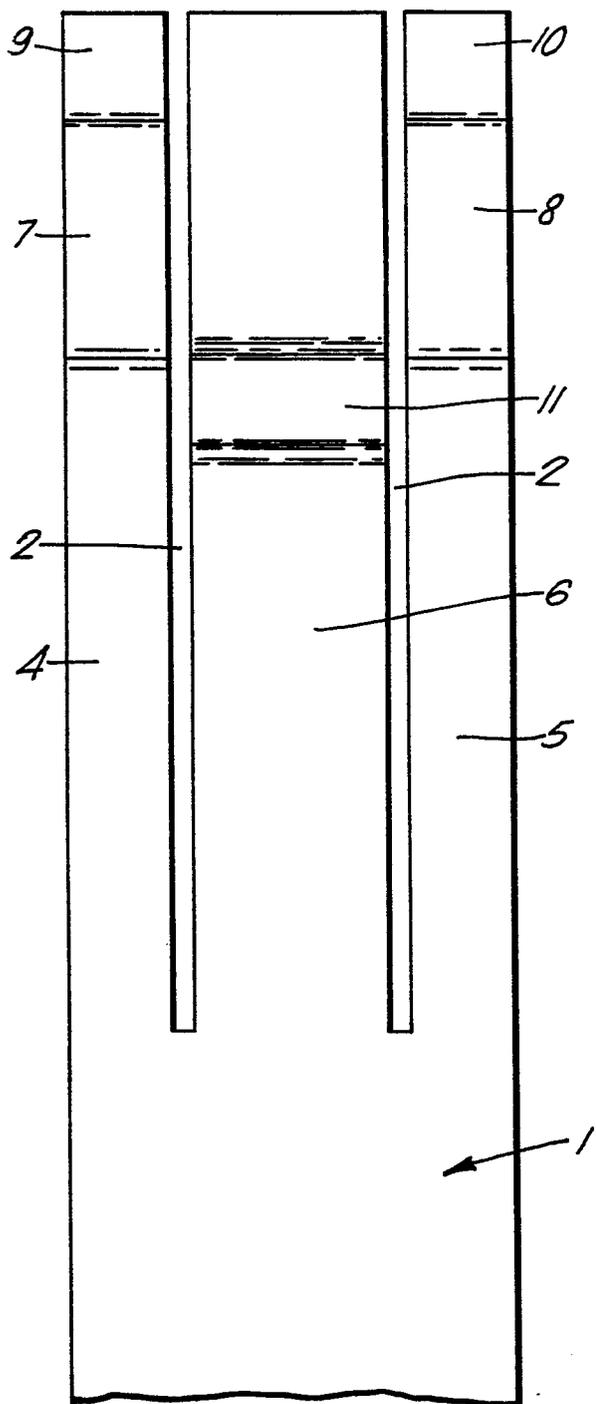


Fig. 2.

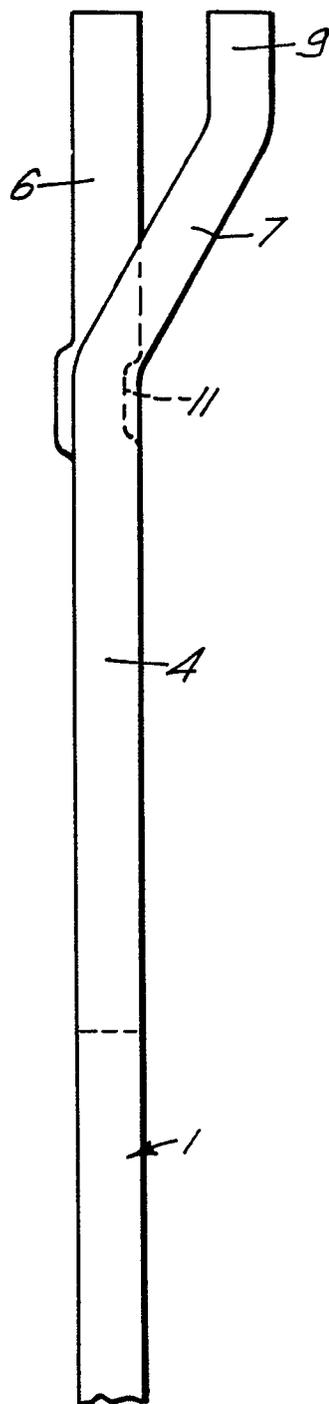


Fig. 5.

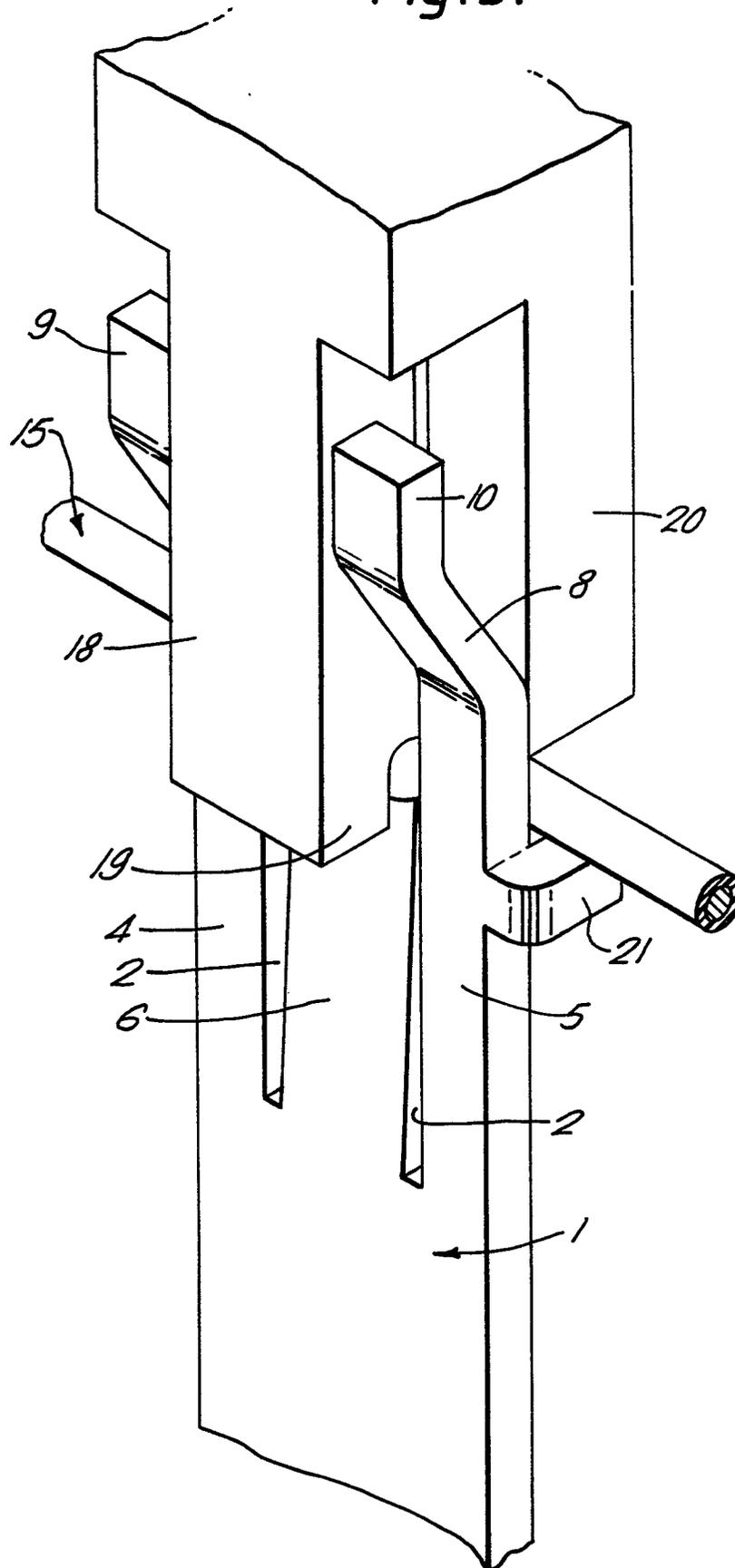
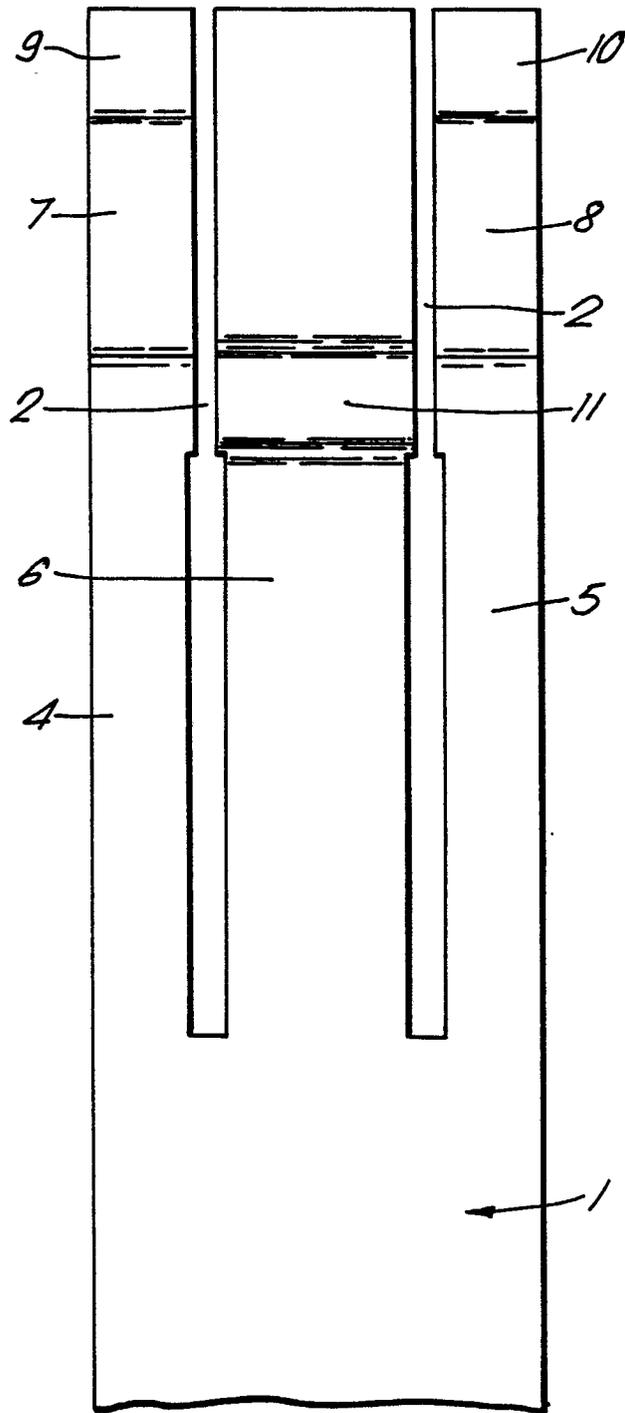


Fig.6.





DOCUMENTS CONSIDERED TO BE RELEVANT		CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)	
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
	<p><u>DE - A - 1 941 050</u> (SIEMENS) * Pages 5, 6; figures *</p> <p>--</p> <p><u>DE - A - 2 455 354</u> (YAMAICHI DENKI KOGYO) * Pages 8-11; figures 4b-10 *</p> <p>--</p> <p><u>DE - A - 2 330 038</u> (SPRECHER & SCHUH) * Pages 5,6,8,9; figures 1,4,5 *</p> <p>--</p> <p><u>DE - A - 2 241 518</u> (FELTEN & GUILLEAUME) * Page 7, paragraph 1; figures *</p> <p>--</p> <p><u>FR - A - 2 269 799</u> (A.C.E.T.P.) * Page 4; figures *</p> <p>--</p> <p><u>US - A - 4 029 384</u> (ILLINOIS TOOL WORKS) * Column 2, lines 47-64; figures *</p> <p>--</p> <p>A <u>DE - A - 2 142 850</u> (KRONE) * Page 2, paragraph 2; figure 2 *</p> <p>-----</p>	<p>1,2,5-7,13</p> <p>1,2,5-7,13</p> <p>1,2,5-7,13</p> <p>3</p> <p>4</p> <p>8</p> <p>13</p>	<p>H 01 R 4/24</p> <p>TECHNICAL FIELDS SEARCHED (Int.Cl. 3)</p> <p>H 01 R 4/24</p> <p>CATEGORY OF CITED DOCUMENTS</p> <p>X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons</p> <p>&: member of the same patent family, corresponding document</p>
<p><input checked="" type="checkbox"/> The present search report has been drawn up for all claims</p>			
Place of search	Date of completion of the search	Examiner	
The Hague	17-04-1980	RAMBOER	