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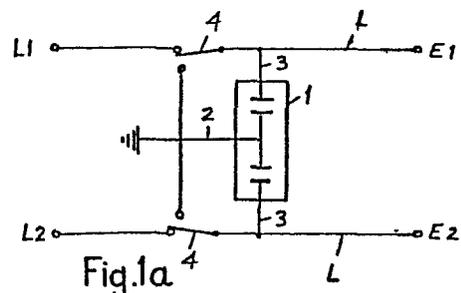
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⑤④ Circuit protection arrangement.

⑤⑦ A circuit protection arrangement for protecting a circuit against damaging signals, such as surges and transients, comprises the combination of a series protection element which becomes open circuit in the event of a damaging signal and a shunt protection element which becomes a low resistance circuit in the event of a damaging signal. The series protection element is a normally-closed switch device 4 which is actuated in response to heat generated in the shunt protection element, e.g. in the form of a gas tube 1, so as to open-circuit the series path and provide a short circuit of the shunt path. The protection arrangements may be applied to both unbalanced lines and balanced lines, such as L1, L2, feeding an input E1, E2 of the equipment to be protected.



CIRCUIT PROTECTION ARRANGEMENTS

1           The present invention relates to circuit  
protection arrangements for protecting a circuit  
against damaging signals, such as high voltage or  
current surges and transients, and which comprise both  
5 a series protection element and a shunt protection  
element arranged so that in the event of a damaging  
signal the series element tends to open circuit and the  
shunt element tends to short circuit.

          In practice with existing arrangements there is  
10 generally some finite leakage current across an "open  
circuit" series element; whilst an appreciable  
resistance, and hence a voltage drop, occurs across a  
"short circuit" shunt element; thereby reducing the  
effectiveness of the protection arrangement.

15           It is an object of the present invention to  
provide a circuit protection arrangement in which the  
aforementioned disadvantages are substantially reduced  
or avoided.

          From one aspect of the invention provides a  
20 circuit protection arrangement for protecting a circuit  
against damaging signals, such as surges and  
transients, comprising the combination of a series  
protection element which becomes open-circuit in the  
event of a damaging signal and a shunt protection  
25 element which becomes a low resistance circuit in the  
event of a damaging signal, wherein the series  
protection element is a normally-closed switch device  
which is actuated in response to heat generated in the  
shunt protection element to open-circuit the series  
30 path and provide a short circuit of the shunt path.

          The invention also provides a circuit protection  
arrangement for protecting a circuit against damaging

1 signals, such as surges and transients, comprising a  
changeover switch device which is normally restrained  
in one position in which it completes a series circuit  
and forms a series protection element, and a shunt  
5 protection element in thermal relationship with said  
changeover switch device such that heat generated in  
the shunt protection element in response to a damaging  
signal causes actuation of the changeover switch device  
to its other position in which it opens the series  
10 circuit and short circuits the shunt path.

The invention further provides a circuit  
protection arrangement comprising a changeover switch  
device which is normally retained in one position to  
provide a series protection element and which is  
15 thermally actuated to its other position by heat  
generated in a shunt protection element associated with  
said changeover switch device, and wherein when in said  
other position the switch device open circuits a series  
path and short circuits a shunt path.

20 The switching action is arranged to be  
irreversible, so that when the thermally actuated  
switch device has been switched to its other position,  
it will remain in this position even when the heat  
which caused its operation is removed.

25 In a preferred arrangement the switch device  
includes a contact which is biased towards the short  
circuit shunt position but which is retained in the  
normally closed series circuit protection position by  
means of a thermally softenable material, e.g. soft  
30 solder or fusible alloy, which softens to release the  
contact upon the application of sufficient heat from  
the shunt protection element.

Thus, the switch contact may be formed of a  
resilient wire or strip, which may include one or more

1 turns to impart an enhanced springiness to the contact.

Advantageously the shunt protection element comprises a gas discharge tube and the heat generated by the tube when it is struck is employed to cause the thermally responsive operation of the switch device.

The protection arrangements according to the invention may be applied to both balanced and unbalanced circuits and lines and advantageously the arrangements according to the invention may be in the form of a module which can be readily attached to and replaced in a circuit arrangement which is to be protected.

The invention will now be further described, by way of example, with reference to the accompanying drawings, in which:-

Figures 1a and 1b are schematic diagrams of the circuitry of two balanced protection arrangements according to the invention,

Figure 2a is a diagrammatic plan view of one embodiment of circuit protection arrangement according to the invention,

Figure 2b is a side elevational view based on the arrangement of Figure 2a and showing the components mounted on a circuit board,

Figure 3 is a diagrammatic plan view of another embodiment of circuit protection arrangement, and

Figures 4a and 4b are respectively a perspective view and a side elevational view of a further embodiment of circuit protection arrangement.

Referring to the drawings, the arrangements to be described are a balanced arrangement and similar references are used for corresponding parts of the protection arrangement in each line.

As shown in the schematic diagrams of Figures 1a

1 and 1b, a pair of lines L balanced with respect to  
earth and having input terminals L1 and L2 are  
connected to equipment to be protected via terminals E1  
and E2. Associated with the lines is a shunt  
5 protection element comprising a double gas discharge  
tube 1 having its common electrode connected to earth  
via connecting pin 2 and its outer electrodes  
respectively connected to the two lines L via  
connecting pins 3 which are also connected to the  
10 normally-closed switch contact 4 disposed in series in  
each line. These contacts 4 are each part of a  
changeover switch and are activated in response to heat  
generated in the gas discharge tube 1 so as to  
open-circuit the series path between the input lines  
15 and the equipment and short-circuit the shunt path  
provided by the tube 1. In Figure 1a, actuation of the  
switch contacts 4 serves to short-circuit the equipment  
side across terminals E1 and E2 whilst in Figure 1b,  
actuation of the switch contacts 4 serves to short  
20 circuit the input line side across terminals L1 and L2.  
If desired, the changeover switch could be arranged to  
short-circuit both the input side and the equipment  
side.

The convention adapted regarding input and output  
25 relates to an incoming fault current and any output in  
fault current let-through into the equipment from the  
protection arrangement. Obviously, wanted signal  
currents may pass in both directions and the protection  
arrangement may be regarded as transparent to such  
30 signal currents.

Figures 2a and 2b show an embodiment of the  
invention in which the components are mounted on a  
circuit board. Each switch contact 4 is in the form of  
a shaped resilient wire or strip which may be coiled

1 about a post 5 to increase its flexural range and which  
has one end soldered to a point 6 connected to the  
terminal E1 or E2. The spring contacts 4 are tensioned  
so that they are biased towards the centre earthed pin  
5 2 of the gas discharged tube, but they are constrained  
into contact with the pins 3 and also into contact with  
posts 7 connected to the line terminals L1 and L2 by  
fusible joints at points P1 and/or P2. It will be  
understood that both points P1 and P2 may be fusible  
10 joints or that the desired effect can be achieved if  
only one point is a fusible joint and the other point  
is merely a pressure contact between the parts. The  
fusible joints may be formed by a soft solder or a  
fusible alloy.

15 The fusible joints are intended to be softened by  
heat generated in the gas discharge tube 1 and whilst  
there is direct heat transfer to a fusible joint at  
points P1 via the pins 3, it is desirable to provide  
some form of heat transfer member, such as a metal  
20 strip between the insulating envelope of the gas  
discharge tube 1 and the posts 7 when fusible joints  
are located at the points P2.

The released position of a switch contact 4  
showing it in contact with the centre earthed pin 2 and  
out of contact with the pin 3 and post 7 is shown in  
25 dashed lines for the upper contact in Figure 2a. This  
is the position which the contact assumes under its  
natural spring bias when the fusible alloy at points P1  
and/or P2 has softened sufficiently to release it from  
30 its normally constrained position.

Figure 2b shows the arrangement mounted on a  
circuit board B.

Referring now to Figure 3, in the embodiment each  
switch contact 4 is again a resilient wire or strip

1 which in this case forms a generally vee-spring coiled  
at an intermediate point of its length about a post 5  
and has one arm 4a bearing against a pin forming the  
terminal E1 or E2. The contacts 4 are tensioned so  
5 that the other arms 4b are biased towards the centre  
earthed pin 2 of the gas discharge tube, but they are  
constrained into contact with the pins 3 and also into  
contact with pins forming the input terminals L1 and L2  
by fusible joints at point P1 and/or P2. It is again  
10 possible for both points P1 and P2 to be fusible joints  
or the desired effect can be achieved if only one point  
is a fusible joint and the other point is merely a  
pressure contact between the parts. The fusible joints  
may be formed by a soft solder or a fusible alloy.

15 As in the previous embodiment, the fusible joints  
are intended to be softened by heat generated in the  
gas discharge tube 1 and whilst there is direct heat  
transfer to a fusible joint at points P1 via the pins  
3, it is desirable to provide some form of heat  
20 transfer member, such as a metal strip between the  
insulating envelope of the gas discharge tube 1 and the  
posts P2 when fusible joints are located at the points  
P2.

The released position of a switch contact 4  
25 showing it in contact with the centre earthed pin 2 and  
out of contact with the pin 3 and post L1 is shown in  
dashed lines for the upper contact in Figure 2. This is  
the position which the contact assumes under its  
natural spring bias when the fusible alloy at points P1  
and/or P2 has softened sufficiently to release it from  
30 its normally constrained position. In the released  
position, the tension in the coiled portion of the  
spring ensures its continued pressure against the  
output pin E1, E2 as well as against the earth pin 2.

1 In practice, both springs operate at about the same  
time, so that the inputs L1,L2 are isolated and the  
outputs E1 and E2 are earthed.

In operation of the above devices, brief,  
5 infrequent, and low-energy transients are suppressed or  
"clipped" by the gas discharge tube 1 without raising  
its temperature sufficiently to release the spring  
contacts 4. The tolerance of the arrangement to these  
transients may be increased by providing a heat-sink  
10 for the gas discharge tube and/or by increasing the  
thermal resistance between the gas discharge tube and  
the blobs of fusible alloy at P1 and/or P2.

When, however, the temperature of the gas  
discharge tube rises sufficiently to melt the alloy and  
15 release the spring contacts 4, the equipment terminals  
E1.E2 are fully disconnected from the lines L1,L2 and  
shorted directly to earth at pin 2. Of course only one  
of the contacts 4 may so operate instead of both.

This temperature rise could occur as a result of  
20 a heavy surge caused by lightning or by induction from  
a power line under fault conditions, or a steady AC or  
DC current of a few amps resulting from accidental  
contact between the line and a power cable. It is the  
object of the present invention to provide effective  
25 protection from these and similar hazards.

For balanced lines comprising both L1 and L2 and  
a common earth, the module requires two spring contacts  
as indicated. The resulting configuration is known as  
a 5-point arrangement. For unbalanced or  
30 "line-and-earth" circuits, a 3-point arrangement with a  
single spring contact only is required. Either  
arrangement may readily be constructed as a module.

The spring contacts could conceivably be thin  
enough to be heated by an excess of current and so

1 either cause or aid melting of the fusible alloy.  
However, a study of working conditions on practical  
lines shows that such a level of current can only arise  
as a result of an intrusive voltage high enough to  
5 "strike" the gas discharge tube and hence the tube  
conducts and so generates enough heat unaided.

Consequently, a further advantage of this  
invention is that the spring contacts may be heavy  
enough to (i) avoid annealing and loss of tension due  
10 to the heating effects of fault-currents, (ii) add  
negligible series loss resistance to the signalling  
circuits and (iii) provide adequate contact pressure at  
any contact points which are not soldered.

Referring now to Figures 4a and 4b, there is  
15 shown an embodiment of protection arrangement formed as  
a module which is mechanically interchangeable with  
existing types of protection modules, as employed for  
example in telephone exchange equipment. By virtue of  
the use of metal strip contacts rather than wire, it  
20 provides better pulse current carrying capacity, due  
both to the larger cross-section of the conductors and  
the larger pressure contact areas.

A gas discharge tube 1 is supported from a  
platform 10 of insulating material by two arms 11  
25 formed of metal strip, which are respectively attached  
to annular terminals 3 connected to the outer  
electrodes of the gas discharge tube 1. The lower end  
of the arms 11 are connected to tag strips 12 depending  
below the platform 10 and forming the input connections  
30 L1 and L2. Also connected to or formed integrally with  
the lower ends of the arms 11 are U-shaped springs 4  
which are biased such that they tend to contact the  
ends of a bridge contact 13 having one central limb 13a  
in contact with the annular terminal 2 connected to

1 the common electrode of the gas discharge tube 1. A  
second central limb 13b is connected to an earth pin 15  
extending through the platform 10 and also serves to  
locate and support the bridge contact 12 above the ends  
5 of the U-shaped springs 4. Also attached to the  
platform 10 and having one end disposed below the ends  
of the springs 4 are tags strips 14 forming the output  
connections E1 and E2.

The springs 4 are normally held in contact with  
10 the ends of the strips 14 by means of a soft solder or  
fusible alloy, as shown in the drawings, thus providing  
a series connection between the input terminals L1,L2  
and output terminals E1,E2. However, upon overheating  
of the gas discharge tube 1, heat is conducted via the  
15 metal strips 11 and 13 to melt the fusible alloy,  
thereby releasing the U-shaped springs 4 so that they  
break contact with the strips 14 and make contact with  
the bridge 13, hence effectively open-circuiting the  
series paths between L1,E1 and L2,E2 and short  
20 circuiting the gas discharge tube.

Whilst particular embodiments have been described  
it will be understood that various modifications may be  
made without departing from the scope of this  
invention. Thus, the spring contacts performing the  
25 switching function may be of various other forms  
besides that specifically shown. Also the shunt  
protection device which generates the heat could be  
other than a gas discharge tube.

CLAIMS

- 1 1. A circuit protection arrangement for protecting a  
circuit against damaging signals, such as surges and  
transients, comprising the combination of a series  
protection element which becomes open circuit in the  
5 event of a damaging signal and a shunt protection  
element which becomes a low resistance circuit in the  
event of a damaging signal, wherein the series  
protection element is a normally-closed switch device  
which is actuated in response to heat generated in the  
10 shunt protection element to open-circuit the series  
path and provide a short circuit of the shunt path.
2. A circuit protection arrangement as claimed in  
claim 1, comprising a changeover switch device which is  
normally restrained in one position in which it  
15 completes the series circuit and forms the series  
protection element, and the shunt protection element is  
in thermal relationship with said changeover switch  
device such that heat generated in the shunt protection  
element in response to a damaging signal causes  
20 actuation of the changeover switch device to its other  
position in which it opens the series circuit and short  
circuits the shunt path.
3. A circuit protection arrangement comprising a  
changeover switch device which is normally retained in  
25 one position to provide a series protection element and  
which is thermally actuated to its other position by  
heat generated in a shunt protection element associated  
with said changeover switch device, and wherein when in  
said other position, the switch device open circuits a  
30 series path and short circuits a shunt path.
4. A circuit protection arrangement as claimed in

1 claim 1, 2 or 3, in which the switch device includes a  
contact which is biased towards the short circuit  
shunt position but which is retained in the normally  
closed series circuit protection position by means of a  
5 thermally softenable material, which softens to release  
the contact upon the application of sufficient heat  
from the shunt protection element.

5. A circuit protection arrangement as claimed in  
claim 4 in which the thermally softenable material is a  
10 soft solder or a fusible alloy.

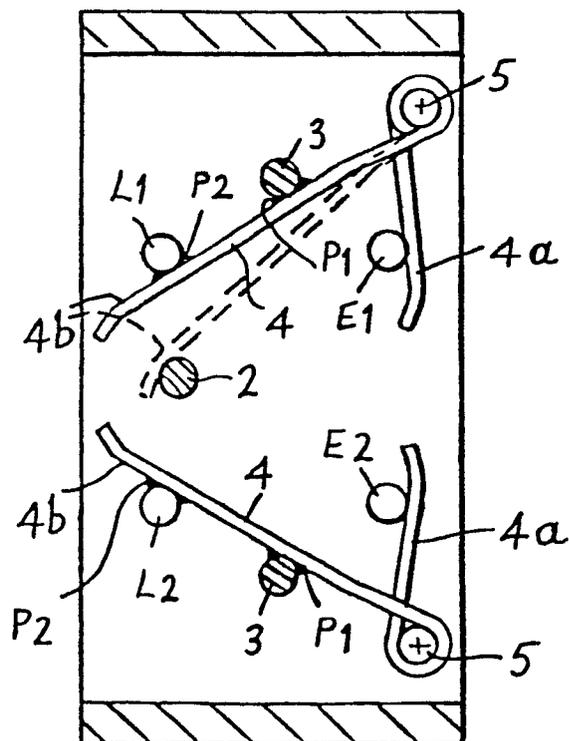
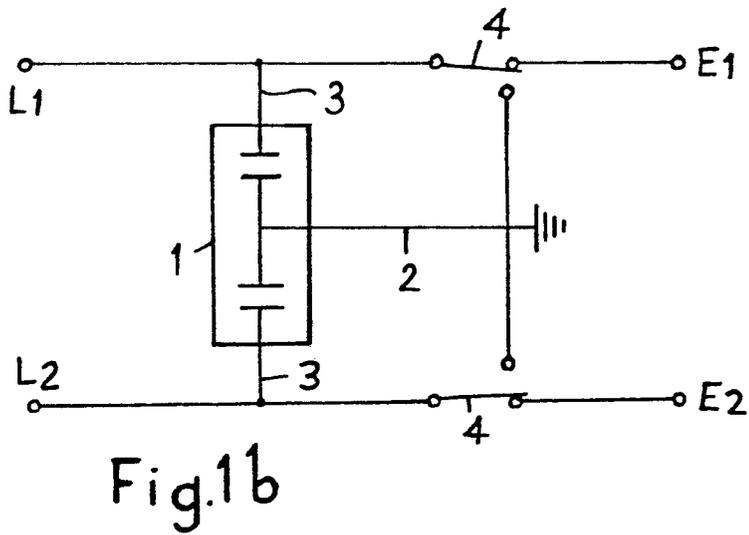
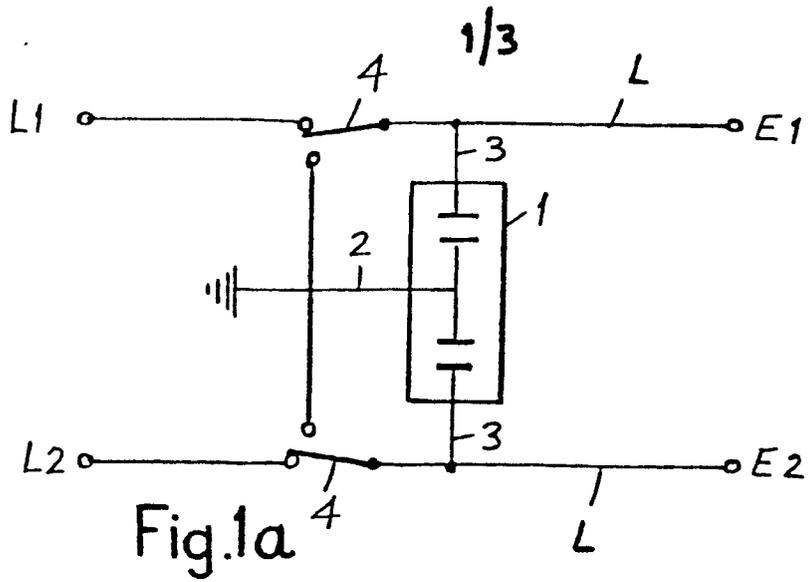
6. A circuit protection arrangement as claimed in  
any preceding claim, including one or more switch  
contacts formed of a resilient wire or strip.

7. A circuit protection arrangement as claimed in  
15 any preceding claim, in which the shunt protection  
element comprises a gas discharge tube and the heat  
generated by the tube when it is struck is employed to  
cause the thermally responsive operation of the switch  
device.

20 8. A circuit protection arrangement as claimed in  
any preceding claim, in the form of a module which can  
be readily attached to and replaced in a circuit  
arrangement which is to be protected.

9. A circuit protection arrangement as claimed in  
25 any preceding claim in combination with a pair of  
balanced lines, in which a switch device is connected  
in series with each line and the shunt protection  
element is connected across the lines.

30 10. A circuit protection arrangement as claimed in  
claim 9, in which the shunt protection element is a  
double gas discharge tube, having its common electrode  
connected to a reference potential, such as earth.



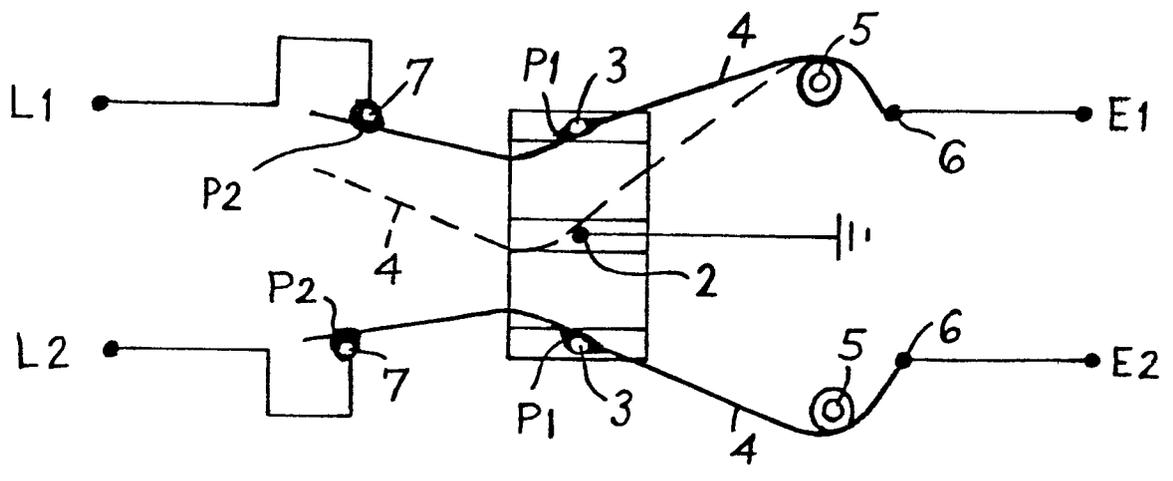


Fig.2a

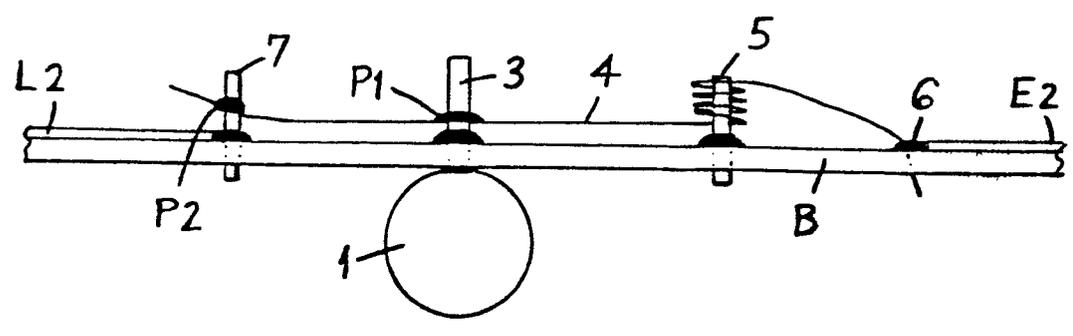


Fig.2b

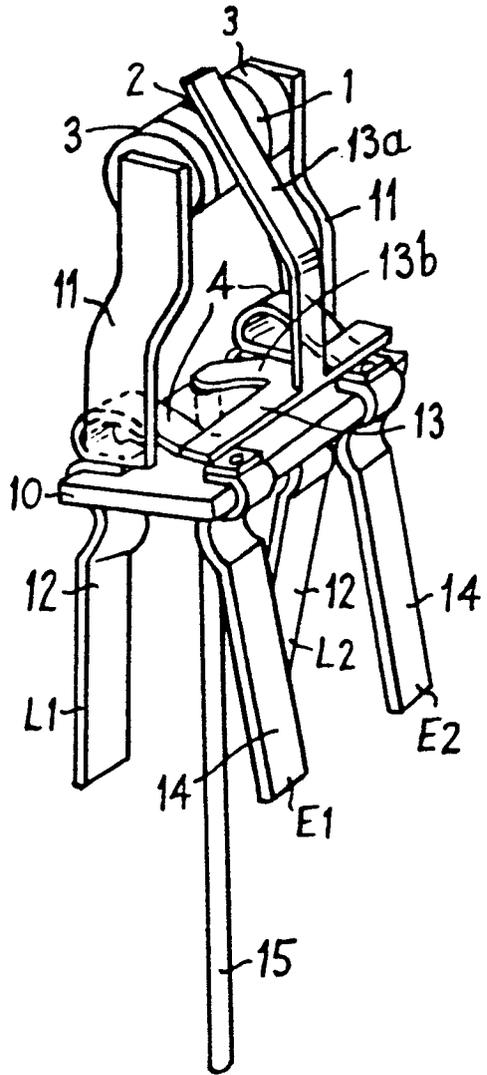


Fig. 4a

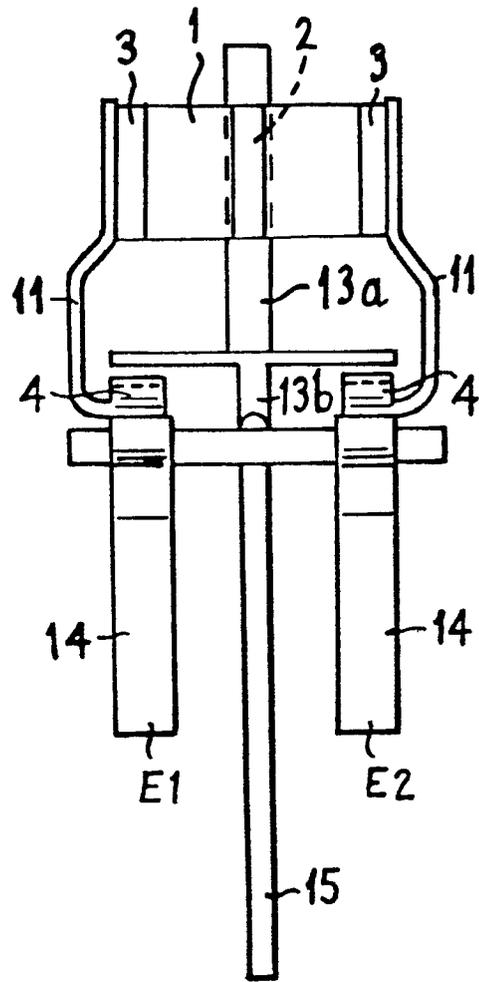


Fig 4b



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)
X	US-A-3 947 730 (DE LUCA) * Column 2, line 56 - column 4, line 17; figures 5-7 *	1-10	H 01 T 1/14
A	--- US-A-4 477 857 (CROCKER)		
A	--- US-A-4 034 326 (HILL) -----		
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 17-02-1986	Examiner BIJN E.A.
<p><b>CATEGORY OF CITED DOCUMENTS</b></p> <p>X : particularly relevant if taken alone  Y : particularly relevant if combined with another document of the same category  A : technological background  O : non-written disclosure  P : intermediate document</p> <p>T : theory or principle underlying the invention  E : earlier patent document, but published on, or after the filing date  D : document cited in the application  L : document cited for other reasons</p> <p>&amp; : member of the same patent family, corresponding document</p>			
			TECHNICAL FIELDS SEARCHED (Int. Cl. 4)
			H 01 T 1/14