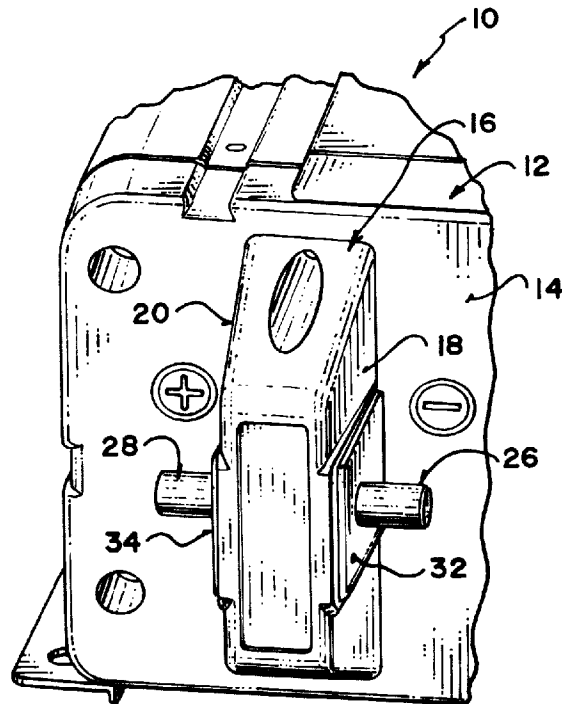




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(54) **METHODE POUR LA CONNEXION DE CONDUCTEURS DE
COURANT CONTINU**
(54) **DC CONNECTION METHOD**



(57) La présente invention a pour objet un dispositif servant à réaliser des terminaisons de conducteurs de courant continu haute tension. Le dispositif en question comporte une base, une terminaison isolée en projection, un premier et un deuxième connecteurs opposés, et une première et une deuxième barres omnibus. La base est

(57) An apparatus for high current DC conductor termination. The apparatus includes a base, an insulated terminal projection, first and second opposing connectors, and first and second bus bars. The base is securable to an electrical device. The insulated terminal projection extends from the base and has first and second



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destinée à être fixée à un appareil électrique. La terminaison isolée est en projection depuis la base et comporte un premier et un deuxième côtés opposés. Les premier et deuxième conducteurs opposés sont fixés sur les côtés opposés de la terminaison en projection, les premier et deuxième connecteurs opposés se trouvant essentiellement alignés aux fins de connexion des premier et deuxième conducteurs, respectivement. Les première et deuxième barres omnibus sont connectées aux premier et deuxième connecteurs et sont disposées côte à côte à l'intérieur de la projection aux fins de connexion et d'alimentation de l'appareil électrique.

opposite sides. The first and second opposing connectors are mounted on the opposite sides respectively of the terminal projection, the first and second opposing connectors being substantially in line and operable to connect to first and second conductors respectively. The first and second bus bars are connected to the first and second connectors and extend closely adjacent each other inside the projection and are operable to connect to the electrical device for electrical current conduction.

DC CONNECTION METHOD**ABSTRACT OF THE DISCLOSURE**

An apparatus for high current DC conductor termination. The apparatus includes a base, an insulated terminal projection, first and second opposing connectors, and first and second bus bars. The base is securable to an electrical device. The insulated terminal projection extends from the base and has first and second opposite sides. The first and second opposing connectors are mounted on the opposite sides respectively of the terminal projection, the first and second opposing connectors being substantially in line and operable to connect to first and second conductors respectively. The first and second bus bars are connected to the first and second connectors and extend closely adjacent each other inside the projection and are operable to connect to the electrical device for electrical current conduction.

DC CONNECTION METHOD**BACKGROUND OF THE INVENTION**

The present invention relates to a compact high current DC
5 connector and more specifically to the connection terminals
of large gauge cables to electrical devices such as DC-AC
inverters.

High current devices such as DC-AC inverters require the
10 connection of large gauge cables. Connectors are located
on these devices which are mounted in a wide variety of
places such as on or under shelves in a recreational
vehicle or boat or behind a seat in a truck. As such,
flexibility in the orientation of cable connections is
15 important.

Existing connection terminals for high current devices
generally involve the use of studs or lugs located side-by-
side on one surface of the device. The studs are threaded
20 metal rods which accept ring-type electrical connectors
attached to the ends of the cables. In most cases the rods
are connected to copper bus bars and the ring type
connectors are held in place on the studs with nuts and
washers. Lugs are assemblies which have openings to accept
25 the bare ends of the connecting cables, and generally have
a screw or other compression device to apply pressure to a
cable end to hold the cable end in the lug assembly. Studs
tend to be the more popular connection terminals as
installers prefer the use of ring terminals to terminate
30 cables.

One alternative to improve flexibility in cable orientation
is to position studs diagonally across a high current
device rather than side-by-side. However, this arrangement
35 takes up more space and often allows less than 360° of
connection orientation since the cables can interfere with

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the air flow from a fan or vent in the casing of the device.

One of the problems with existing positioning of high
5 current connectors results because they generally extend
from the same planar surface and this constitutes a hazard
since a screw driver or wrench can directly short circuit
the two connectors. Some form of connector cover may be
needed. Such a cover may restrict cable orientations and
10 adds additional cost to the device. Furthermore, with
existing connectors the individual connectors are
relatively far apart and thus make it difficult to add
Electromagnetic Interface (EMI) filtering to the connectors
or leads to the connectors. For example, the addition of
15 a common mode choke to most high current connectors is
difficult because the connectors are not positioned
sufficiently close together to permit a ferrite ring to fit
around them.

20 **BRIEF SUMMARY OF THE INVENTION**

In accordance with one aspect of the invention, there is
provided an apparatus for high current DC conductor
termination. The apparatus includes a base, an insulated
terminal projection, first and second opposing connectors,
25 and first and second bus bars. The base is securable to an
electrical device. The insulated terminal projection
extends from the base and has first and second opposite
sides. The first and second opposing connectors are
mounted on the opposite sides respectively of the terminal
30 projection, the first and second opposing connectors being
substantially in line and operable to connect to first and
second conductors respectively. The first and second bus
bars are connected to the first and second connectors and
extend closely adjacent each other inside the projection
35 and are operable to connect to the electrical device for
electrical current conduction.

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Preferably, the terminal projection has first and second faces facing outwardly of the projection, the first and second connectors being mounted on the first and second faces.

5

Preferably, the first and second faces are substantially parallel and spaced apart from each other such that the faces face in opposite directions.

10 Preferably, the projection extends generally at right angles to the base.

Preferably, the apparatus includes an electromagnetic interference filter electrically connected to the first and second bus bars, the electromagnetic interference filter being disposed closely adjacent the first and second connectors.

15

Preferably, the electromagnetic interference filter includes first and second capacitive filters connected to the first and second bus bars in spaced apart relation, and a ferrite ring encircling the bus bars.

20

Preferably, the ferrite ring is disposed between the first and second capacitive filters.

25

Preferably, the first capacitive filter includes a first circuit board having first and second conducting pads and preferably, the first and second bus bars have first and second contact points for contacting the first and second pads on the first circuit board such that the first circuit board is connected directly to the first and second bus bars.

30

35 Preferably, the insulated terminal projection and base is a unitary plastic molded unit.

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Preferably, the opposing connectors include first and second threaded studs respectively.

5 In accordance with another aspect of the invention, there is provided a method of terminating high current DC conductors. The method includes the steps of:

10 a) connecting first and second high current Dc conductors to substantially in-line first and second opposing connectors respectively on opposite sides respectively of an insulated terminal projection connected to a base securable to an electrical device;

15 b) conducting current to or from the first and second high current DC connectors to or from the electrical device by first and second bus bars extending closely adjacent each other inside the projection and terminating in the electrical device.

20 Preferably, the method further includes the step of filtering signals on the first and second bus bars to reduce electromagnetic interference.

25 Preferably, the method further includes the step of encircling the bus bars with a ferrite ring and capacitively coupling the first and second bus bars together and to a signal ground terminal of the electrical device, on each side of the ferrite ring.

30 Preferably, the method further includes the step of urging a first circuit board against the first and second bus bars such that first and second pads on the first circuit board are in direct electrical contact with the first and second bus bars respectively.

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BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

In drawings which illustrate embodiments of the invention,

- 5 Figure 1 is an isometric view of an apparatus for high current DC conductor termination, according to a first embodiment of the invention;
- 10 Figure 2 is a top sectional view through the apparatus shown in Figure 1;
- Figure 3 is an isometric view showing an interior of the apparatus shown in Figure 1 in a first stage of assembly;
- 15 Figure 4 is an isometric view showing an interior of the apparatus shown in Figure 1 in a second stage of assembly; and
- 20 Figure 5 is a schematic diagram of a filter according to the first embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

- Referring to Figure 1, an apparatus according to a first embodiment of the invention is shown generally at 10. The apparatus includes a cover portion 12, which forms a portion of a cover of an electrical device such as a DC to AC inverter, or the like. The cover portion 12 has a flat planar, exterior surface 14 and an insulated terminal projection shown generally at 16 extending generally at right angles to the flat planar exterior surface 14. The cover thus acts as a base of the apparatus, the base being securable to the electrical device. The insulated terminal projection and base is a unitary plastic molded unit.
- 35 The projection 16 has first and second substantially parallel opposing faces 18 and 20, tapered at a slight angle to the exterior surface 14 and which face outwardly

of the projection 16. The first and second faces are thus substantially parallel and spaced apart from each other such that the faces face in generally opposite directions.

5 Figure 2

The projection 16 has a hollow interior portion shown generally at 30. Within the hollow portion, first and second bus bars 32 and 34 extend closely adjacent each other on opposite sides of the projection, adjacent the first and second opposing faces 18 and 20 respectively. Each bus bar has an exterior portion 36 and 38 respectively, which extends exterior from the cover portion 12 into the hollow interior portion 30 of the projection 16. In this embodiment, first and second mounting studs 26 and 28 are secured and mounted to the exterior portion 36 and 38 of the first and second bus bars 32 and 34 respectively. The first and second mounting studs are opposite and in line, for mechanically securing wire ring terminals (not shown) or the like, to the first and second bus bars 32 and 34. The exterior portion of the bus bars thus act as first and second opposing connectors on opposite sides respectively of the terminal projection, the first and second opposing connectors being substantially in line and operable to connect to first and second conductors respectively.

The first and second bus bars 32 and 34 also have first and second interior portions 44 and 46 respectively which extend inside the cover portion 12, that is, they extend inside the device to which the connection terminals are connected. The first and second bus bars are thus connected to the first and second connectors, the first and second bus bars extending closely adjacent each other inside the projection and being operable to connect to the electrical device for electrical current conduction. The interior portions of the bus bars 32 and 34 have respective filter portions shown generally at 48 and 50 and have

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circuit connection portions **52** and **54** for connecting the bus bars to circuit components inside the apparatus to which the cover portion **12** is connected. It will be appreciated that the filter portions **48** and **50** are disposed
5 closely adjacent to the exterior portions **36** and **38** and are thus disposed closely adjacent to the first and second mounting studs **26** and **28** respectively.

Each of the first and second filter portions has stamped protrusions **56** and **58** which project generally inwardly
10 between the first and second filter portions **48** and **50** and which act as contact points to make contact with a first printed circuit board **60** inserted between the first and second filter portions **48** and **50**. A boss **62** is formed in
15 the cover portion **12** to receive a screw for mechanically anchoring the first printed circuit board **60** between the first and second bus bars.

Figure 3

20 Referring to Figure 3, the first printed circuit board **60** has first, second and third capacitors **64**, **66** and **68** which are connected to pads **70** and **72**, on a solder side of the first printed circuit board **60**. Referring back to Figure
2, the solder side of the first printed circuit board **60** is
25 in contact with the first and second stamped protrusions **56** and **58** and, therefore, these protrusions make contact with the first and second pads **70** and **72** respectively. Referring back to Figure 3, the first printed current board
30 **60** has a third pad **74** to which is connected a signal ground bracket shown generally at **76**, for connecting the third pad **74** to signal ground through an enclosure contacting surface **78** of the signal ground bracket **76**.

Figure 4

35 Referring to Figure 4, a ferrite ring shown generally at **80** is installed to encircle the first and second filter portions **48** and **50** of the bus bars **32** and **34** such that the

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first printed current board 60 is disposed between the cover portion 12 and the ferrite ring 80.

Still referring to Figure 4, a second printed circuit board 5 82 having fourth, fifth and sixth capacitors 84, 86, and 88 and first, second and third printed circuit board traces 90, 92 and 94 on a solder side of the second printed circuit board 82 and has a fourth trace 96 on the component side of the second printed circuit board 82, the fourth 10 trace 96 being through-hole plated to the second trace 92 to make connection therewith. The capacitors 84, 86 and 88 are connected to the traces 90, 92 and 94 and the traces 90 and 94 are connected directly to inwardly facing surfaces 98 and 100 of the bus bars 32 and 34. Thus, the second 15 printed circuit board 82 is mounted such that the ferrite ring 80 is between the first and second printed circuit boards 60 and 82.

A signal ground connection is made through hole 95 between 20 the fourth pad 96 and the chassis of the unit to which the cover is connected.

Figure 5

Referring to Figure 5, an electrical schematic diagram of 25 the first and second printed circuit boards 60 and 82 and the bus bars 32 and 34 is shown generally at 102. Effectively, the first printed circuit board 60 is electrically connected between filter portions 48 and 50 of the copper bus bars such that the first capacitor 64 is 30 connected between the bus bars, the second capacitor 66 is connected between the first bus bar 32 and the signal ground, or chassis ground and the third capacitor 68 is connected between chassis ground and the second copper bus bar 34, in a location between the first and second mounting 35 studs 26 and 28 and the ferrite ring 80.

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In addition, the second printed circuit board **82** is connected to the first and second bus bars **32** and **34** such that the sixth capacitor **88** is connected between the first and second bus bars **32** and **34**, the fourth capacitor **84** is
5 connected between the first bus bar **32** and signal ground and the fifth capacitor **86** is connected between signal ground and the second bus bar **34**. The second printed circuit board **82** is electrically connected to the bus bars **32** and **34** at a location between the device to which the
10 apparatus is connected and the ferrite ring **80**.

The effect of the first and second printed circuit boards **60** and **82** is to provide first and second electromagnetic interference filter stages on opposite sides of the ferrite
15 ring **80** on the bus bars **32** and **34** closely adjacent the first and second connectors. This reduces electromagnetic interference from being conducted by the connectors to equipment connected thereto.

20 As the pads on the first and second printed circuit boards **60** and **82** are directly in contact with the bus bars **32** and **34**, any inductance in connecting the capacitors to the bus bars is minimized. The short foil traces of the pads on the printed circuit boards have very minimal inductance.
25 Also, as the configuration of the first and second printed circuit boards **60** and **82** and ferrite ring **80** relative to the bus bars **32** and **34** results in the bus bars being positioned relatively closely adjacent and parallel to each other, any loop area bounded by the bus bars is kept to a
30 minimum and therefore, radiation of electromagnetic interference is kept to a minimum.

In addition, the disposition of the first and second mounting studs **26** and **28**, opposite each other eliminates
35 the possibility of wires connected to the studs from coming in contact with each other and eliminates the possibility of tools being dropped on the projection **16** and coming into

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contact with both the first and second studs at the same time thereby eliminating the possibility of an electrical short circuit between the studs. In addition, the first and second mounting studs **26** and **28** extend generally parallel to the exterior surface **14** of the cover portion **12** and thus allow connecting wires to be connected to the studs such that the connecting wires extend at virtually any angle within **180** degrees range on the exterior surface **14**. This allows flexibility in mounting the apparatus to which the cover portion **12** is connected, thus increasing the versatility of the apparatus.

Operation

Effectively, the user connects first and second high current DC conductors to the substantially in-line first and second opposing studs **26** and **28** respectively on opposite sides respectively of the insulated terminal projection **16** connected to the base **14** securable to an electrical device.

Current is conducted to or from the external portions **36** and **38** of the bus bars to or from the electrical device by the remainder of the first and second bus bars **32** and **34** which extend closely adjacent each other inside the projection **16** and which terminate in the electrical device. Signals on the first and second bus bars are filtered to reduce electromagnetic interference by encircling the bus bars with a ferrite ring and capacitively coupling the first and second bus bars together and to a signal ground terminal of the electrical device, on each side of the ferrite ring. A first circuit board is urged against the first and second bus bars such that first and second pads on the first circuit board are in direct electrical contact with the first and second bus bars respectively.

While specific embodiments of the invention have been described and illustrated, such embodiments should be

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considered illustrative of the invention only and not as limiting the invention as construed in accordance with the accompanying claims.

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THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. An apparatus for high current DC conductor termination, the apparatus comprising:
 - a) a base securable to an electrical device;
 - b) an insulated terminal projection extending from said base, said insulated terminal projection having first and second opposite sides;
 - c) first and second opposing connectors on said opposite sides respectively of said terminal projection, said first and second opposing connectors being substantially in line and operable to connect to first and second conductors respectively.
 - d) first and second bus bars connected to said first and second connectors, said first and second bus bars extending closely adjacent each other inside said projection and being operable to connect to said electrical device for electrical current conduction.
2. An apparatus as claimed in claim 1 wherein said terminal projection has first and second faces facing outwardly of said projection, said first and second connectors being mounted on said first and second faces.
3. An apparatus as claimed in claim 2 wherein said first and second faces are substantially parallel and spaced apart from each other such that said faces face generally in opposite directions.

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4. An apparatus as claimed in claim 3 wherein said projection extends generally at right angles to said base.
5. An apparatus as claimed in claim 1 further including an electromagnetic interference filter electrically connected to said first and second bus bars, said electromagnetic interference filter being disposed closely adjacent said first and second connectors.
6. An apparatus as claimed in claim 5 wherein said electromagnetic interference filter includes first and second capacitive filters connected to said first and second bus bars in spaced apart relation, and a ferrite ring encircling said bus bars.
7. An apparatus as claimed in claim 6 wherein said ferrite ring is disposed between said first and second capacitive filters.
8. An apparatus as claimed in claim 7 wherein said first capacitive filter includes a first circuit board having first and second conducting pads and wherein said first and second bus bars have first and second contact points for contacting said first and second pads on said first circuit board such that said first circuit board is connected directly to said first and second bus bars.
9. An apparatus as claimed in claim 1 wherein the insulated terminal projection and base is a unitary plastic molded unit.
10. An apparatus as claimed in claim 1 wherein the opposing connectors include first and second threaded studs respectively.

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11. A method of terminating high current DC conductors, the method comprising the steps of:
 - a) connecting first and second high current Dc conductors to substantially in-line first and second opposing connectors respectively on opposite sides respectively of an insulated terminal projection connected to a base securable to an electrical device;
 - b) conducting current to or from said first and second high current Dc connectors to or from said electrical device by first and second bus bars extending closely adjacent each other inside said projection and terminating in said electrical device.
12. A method as claimed in claim 11 further including the step of filtering signals on said first and second bus bars to reduce electromagnetic interference.
13. A method as claimed in claim 12 wherein the step of filtering includes the step of encircling said bus bars with a ferrite ring and capacitively coupling the first and second bus bars together and to a signal ground terminal of said electrical device, on each side of said ferrite ring.
14. A method as claimed in claim 13 further including the step of urging a first circuit board against said first and second bus bars such that first and second pads on said first circuit board are in direct electrical contact with said first and second bus bars respectively.

August 4, 1998

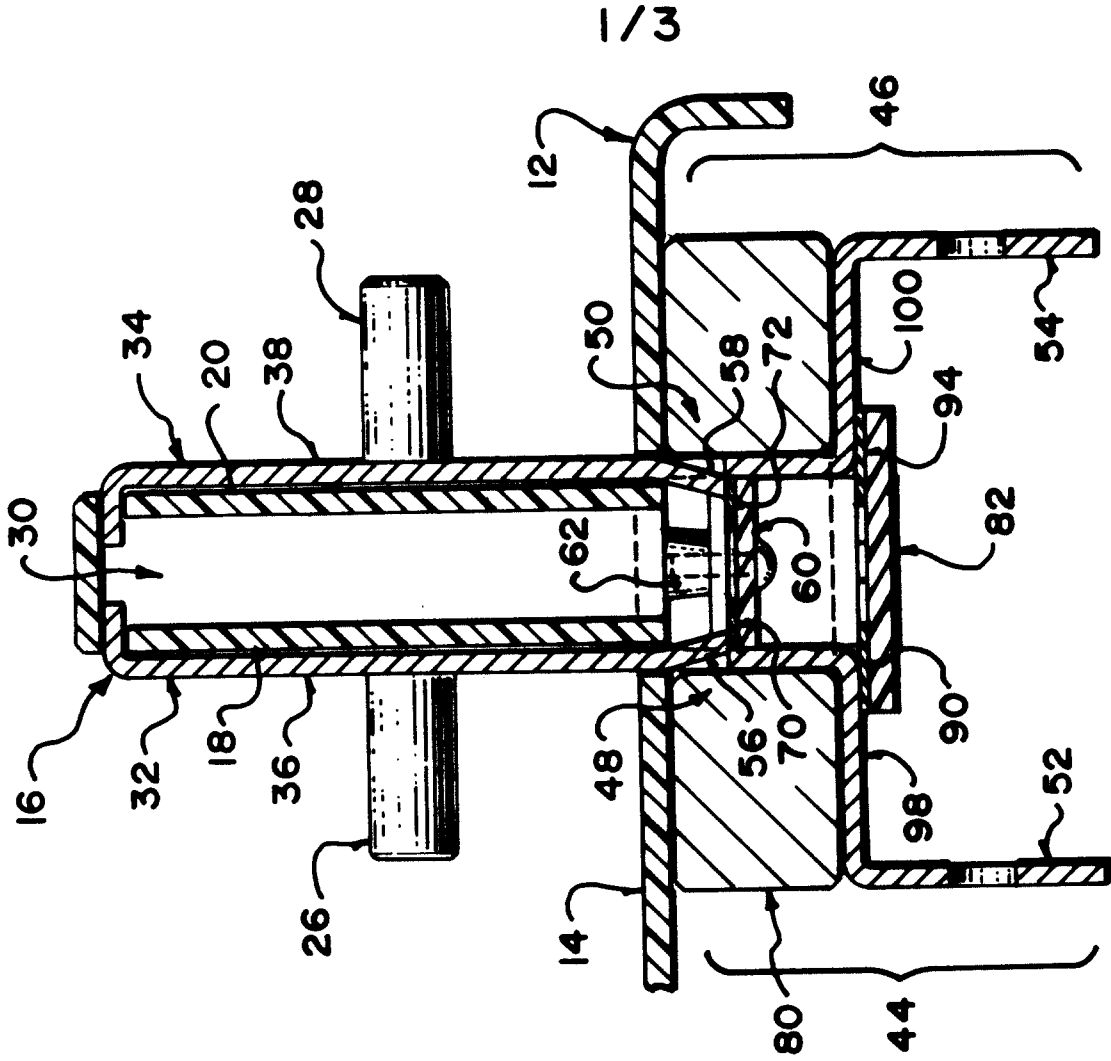


FIG. 2

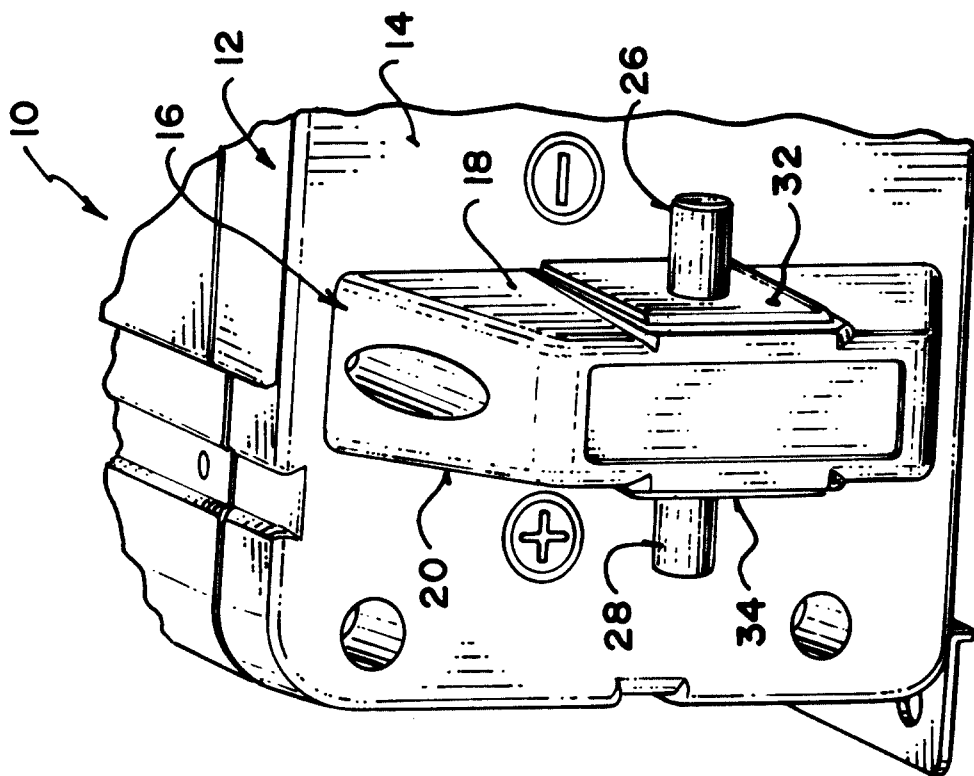


FIG. 1

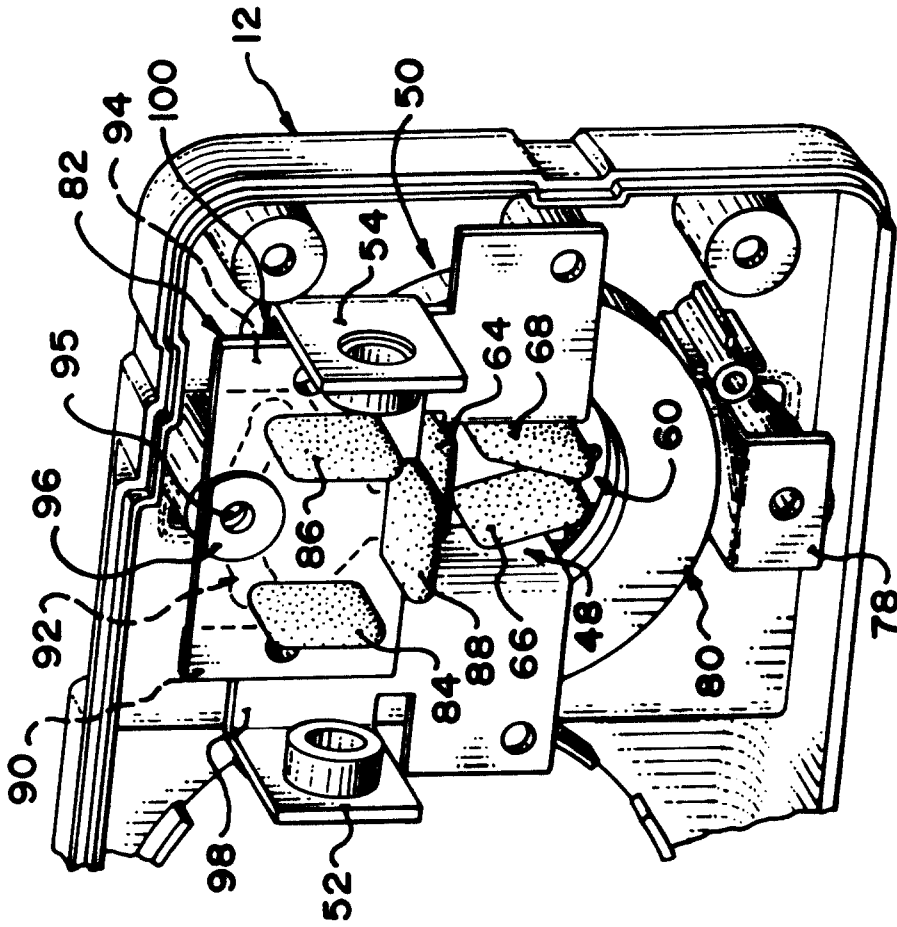


FIG. 4

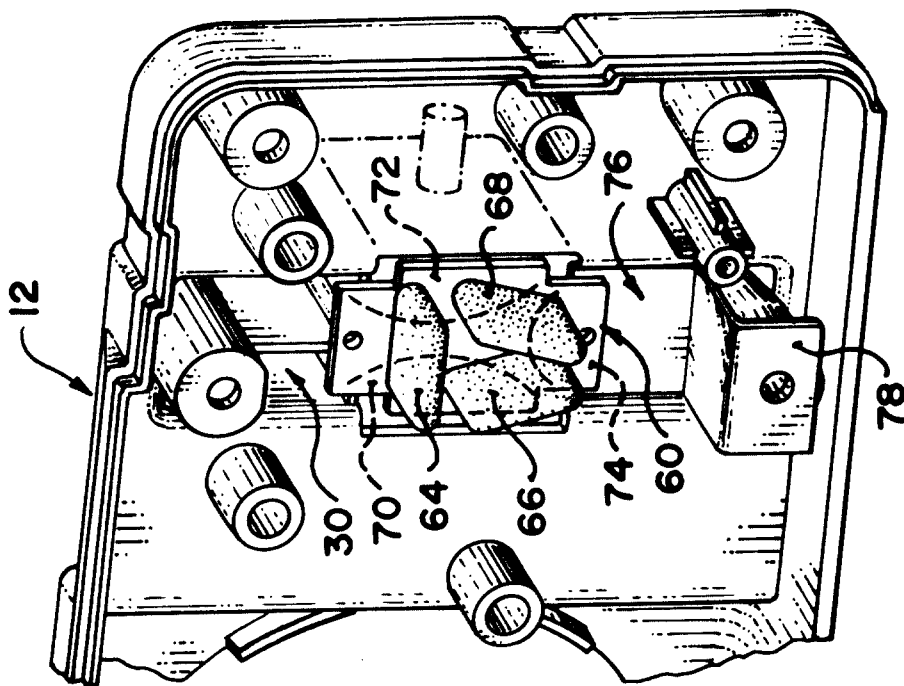


FIG. 3

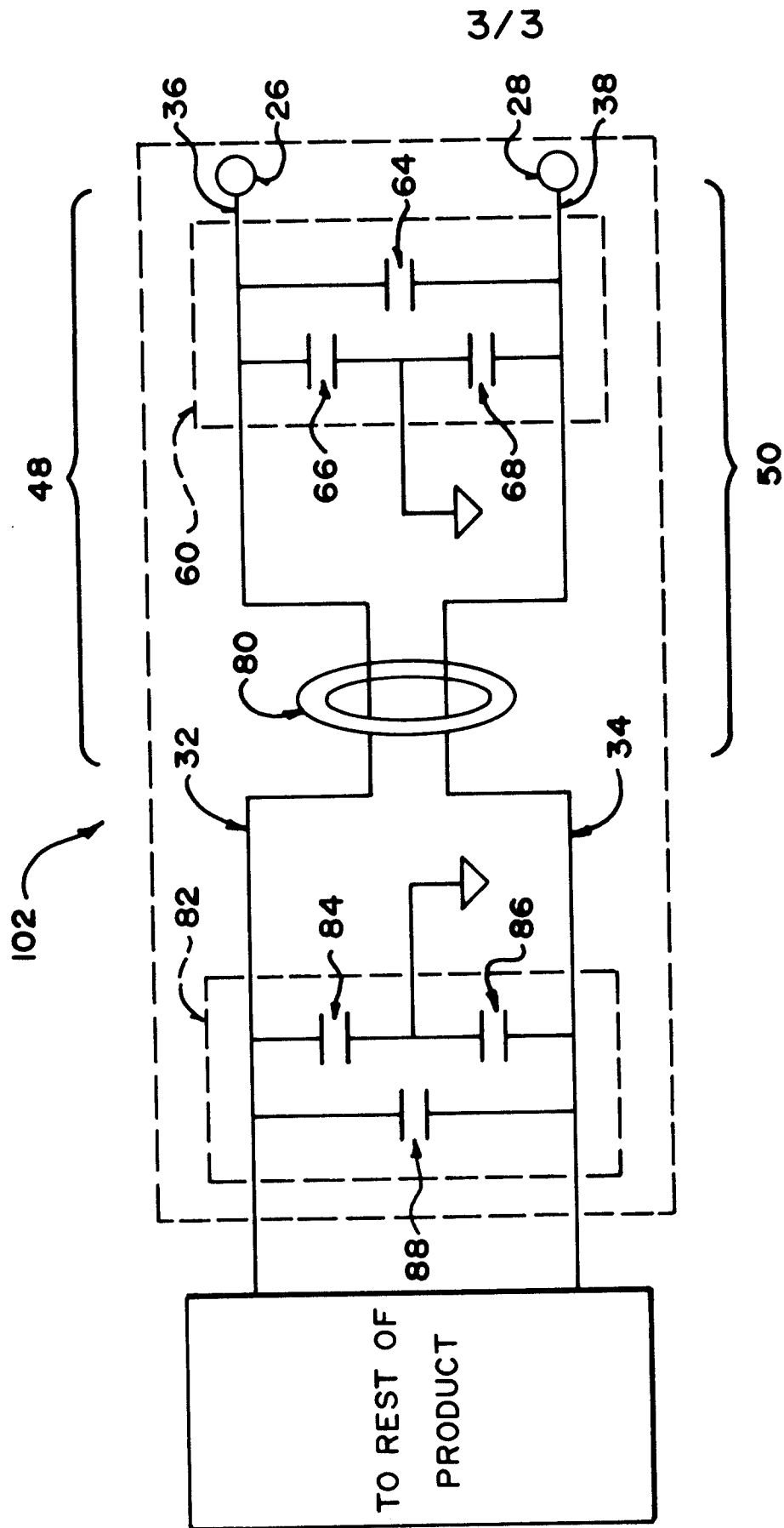


FIG. 5

