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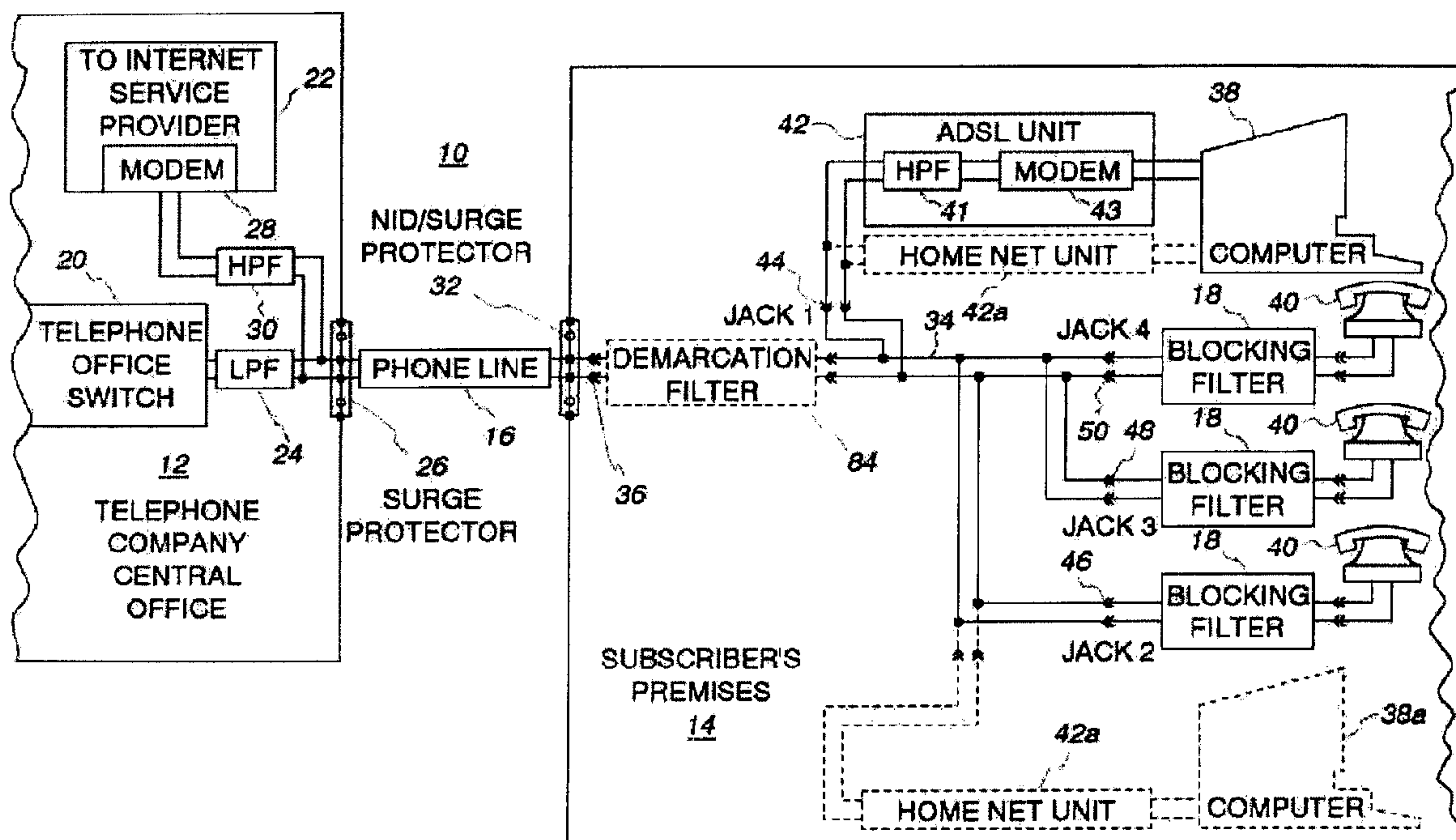
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(54) Titre : CIRCUIT DE FILTRAGE A BLOCAGE D'IMPEDANCE

(54) Title: IMPEDANCE BLOCKING FILTER CIRCUIT



(57) Abrégé/Abstract:

An impedance blocking filter circuit is provided for use in telecommunication systems for interconnecting between incoming telephone lines and customer's terminal equipment so as to unconditionally block impedances above 20 KHz due to the customer's terminal equipment from an ADSL network unit and/or home networking interface unit. The filter circuit includes first, second, and third inductors connected in series between a first input terminal and a first common point. A first resistor has its one end connected also to the first common point and its other end connected to a first output terminal. Fourth, fifth and sixth inductors are connected in series between a second input terminal and a second common point. A second resistor has its one end also connected to the second common point and its other end connected to a second output terminal. A capacitor has its ends connected across the first and second common points. In other aspects, the filter circuit also includes switching means for eliminating shunt additive capacitance and/or correction circuit means reducing significantly return loss.



ABSTRACT OF THE DISCLOSURE

An impedance blocking filter circuit is provided for use in telecommunication systems for interconnecting between incoming telephone lines and customer's terminal equipment so as to unconditionally block impedances above 20 KHz due to the customer's terminal equipment from an ADSL network unit and/or home networking interface unit. The filter circuit includes first, second, and third inductors connected in series between a first input terminal and a first common point. A first resistor has its one end connected also to the first common point and its other end connected to a first output terminal. Fourth, fifth and sixth inductors are connected in series between a second input terminal and a second common point. A second resistor has its one end also connected to the second common point and its other end connected to a second output terminal. A capacitor has its ends connected across the first and second common points. In other aspects, the filter circuit also includes switching means for eliminating shunt additive capacitance and/or correction circuit means reducing significantly return loss.

IMPEDANCE BLOCKING FILTER CIRCUIT

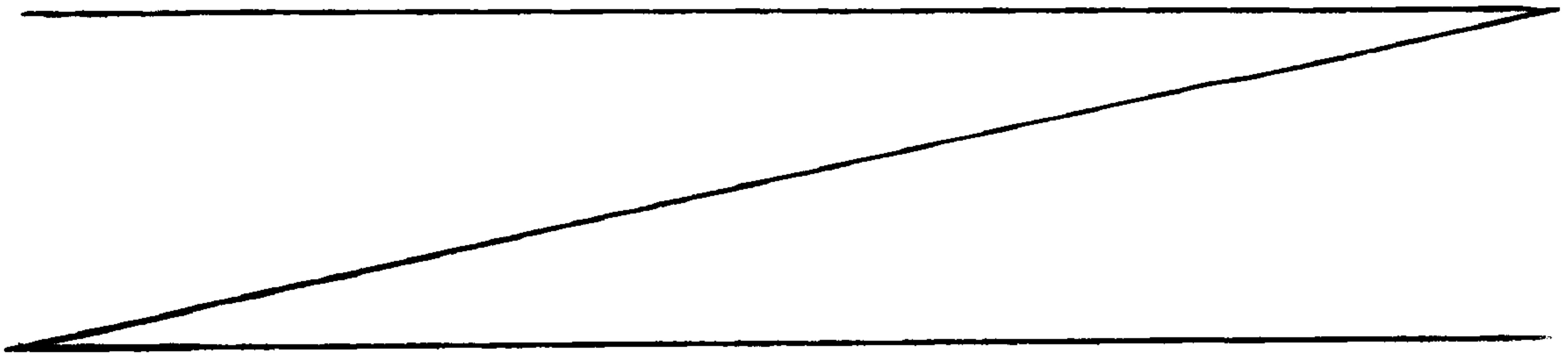
BACKGROUND OF THE INVENTION

1. Field of the Invention:

This invention relates generally to telecommunica-
5 tion systems and more particularly, it relates to an
impedance blocking filter circuit used in telecommunica-
tion systems for interconnecting between incoming tele-
phone lines from a telephone company's central office
(C.O.) and subscriber or customer telephone equipment
10 such as a telephone set located at a subscriber's
premises so as to unconditionally block telephone
impedance above 20 KHz.

2. Description of the Prior Art:

The prior art appears to be best exemplified in the
15 following U.S. Letters Patent which were developed in a
search directed to the subject matter in this applica-
tion:



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4,613,732	4,823,383
4,742,541	5,642,416
4,743,999	5,802,170

In U.S. Patent No. 4,823,383 issued to Cardot et al.
5 on April 18, 1989, there is disclosed a protection device
for terminal equipment on telephone subscriber premises
which includes a voltage surge protection circuit and/or
a filter for providing protection against radio
frequencies and interference. The filter is comprised
10 of series inductors **L1**, **L2**, **L3** and **L5** interconnected
between terminals **E1** and **S1** and series inductors **L'1**,
L'2, **L4** and **L'5** interconnected between terminals **E2** and
S2. A capacitor **C5** is connected between the junctions of
the inductors **L2**, **L3** and the inductors **L'2**, **L4**. The
15 surge protection circuit includes thermistors **TH1**, **TH2**
and voltage limiters **D1-D3**.

In U.S. Patent No. 5,802,170 issued to Smith et al.
on September 1, 1998, there is disclosed a customer
bridge module for connecting telephone company wiring and
20 subscriber telephone wiring in a telephone network inter-
face apparatus. In one embodiment, the customer bridge
module includes overcurrent protection and an RFI filter.
The overcurrent protection is formed by positive tempera-

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ture coefficient resistors **220**, **222** and inductors. The RFI filter is formed by inductors **224a-224c**, **226a-226c** and capacitors **236a-236c**. The inductors and capacitors are used to form a multi-pole low pass filter.

5 In U.S. Patent No. 5,642,416 issued to Hill et al. on June 24, 1997, there is disclosed an electromagnetic interference by-pass filter which suppresses RF noise currents conducted over the tip and ring leads of a telephone line-powered instrument. The filter includes
10 first and second inductors **51**, **53** and first and second capacitors **41**, **43**.

It is generally well-known these days that many telephone subscribers or customers also have a personal computer located on their premises. At times, the
15 computer user receives ADSL (an acronym for Asymmetric Digital Subscriber Line) signals from the Internet over the same telephone lines via an Internet Server Provider (ISP). In order to increase the speed of downloading of information from the Internet, an ADSL network interface
20 is typically purchased and installed between the incoming telephone lines and the user's computer. However, since one or more telephone subscriber terminal equipment such

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as telephone sets, facsimile machines and/or answering devices are also connected to the same incoming telephone lines via internal house wiring, ADSL interference problems may be caused by the terminal equipment which
5 can significantly limit or reduce the data rate. In one situation, it has been experienced that the change of state from "on-hook" to "off-hook" of the telephone equipment and sometimes the telephone terminal equipment even being "on-hook" can create a resonance effect to
10 occur so as to drop the impedance value to less than 10 Ω (Ohms) at a frequency as high as 500 KHz.

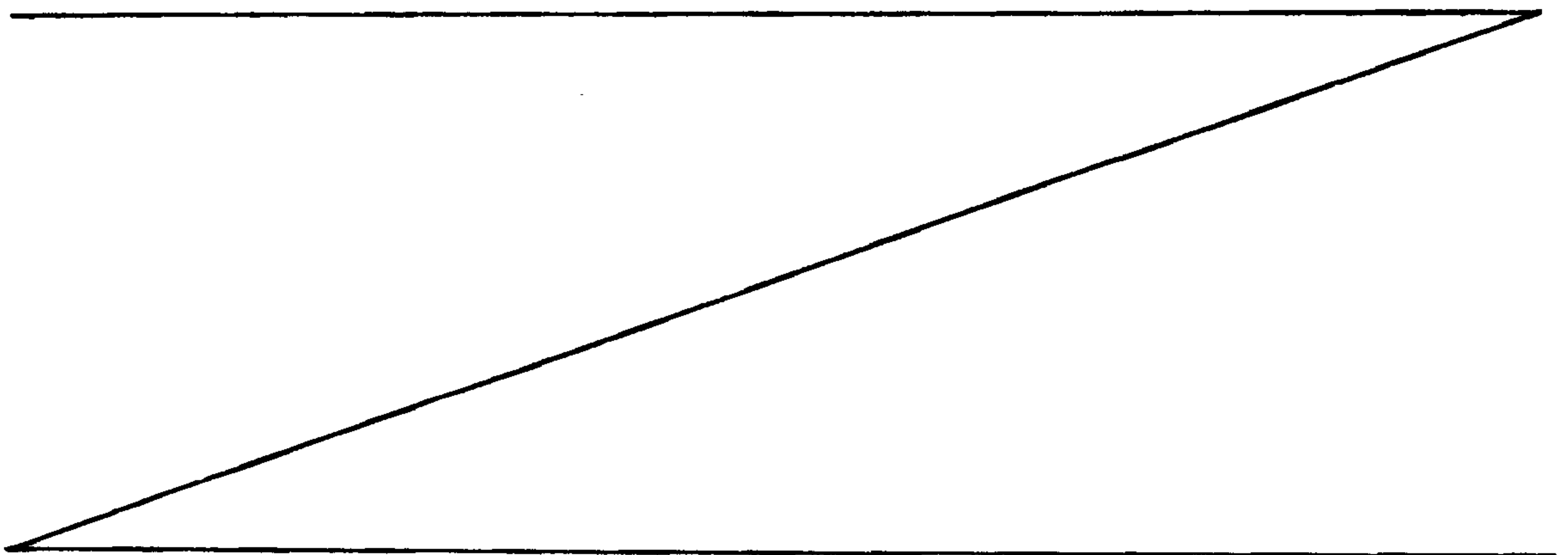
Accordingly, it would be desirable to provide an impedance blocking filter circuit for connection to the telephone terminal equipment causing the erratic input
15 impedances. The impedance blocking filter circuit of the present invention is of a modular design so as to be easily connected by the subscriber in series with the offending telephone terminal equipment. The impedance blocking filter circuit blocks unconditionally any
20 telephone impedances (e.g., open, short, capacitive, inductive, resonant, or any combination thereof) above the frequency of 20 KHz.

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SUMMARY OF THE INVENTION

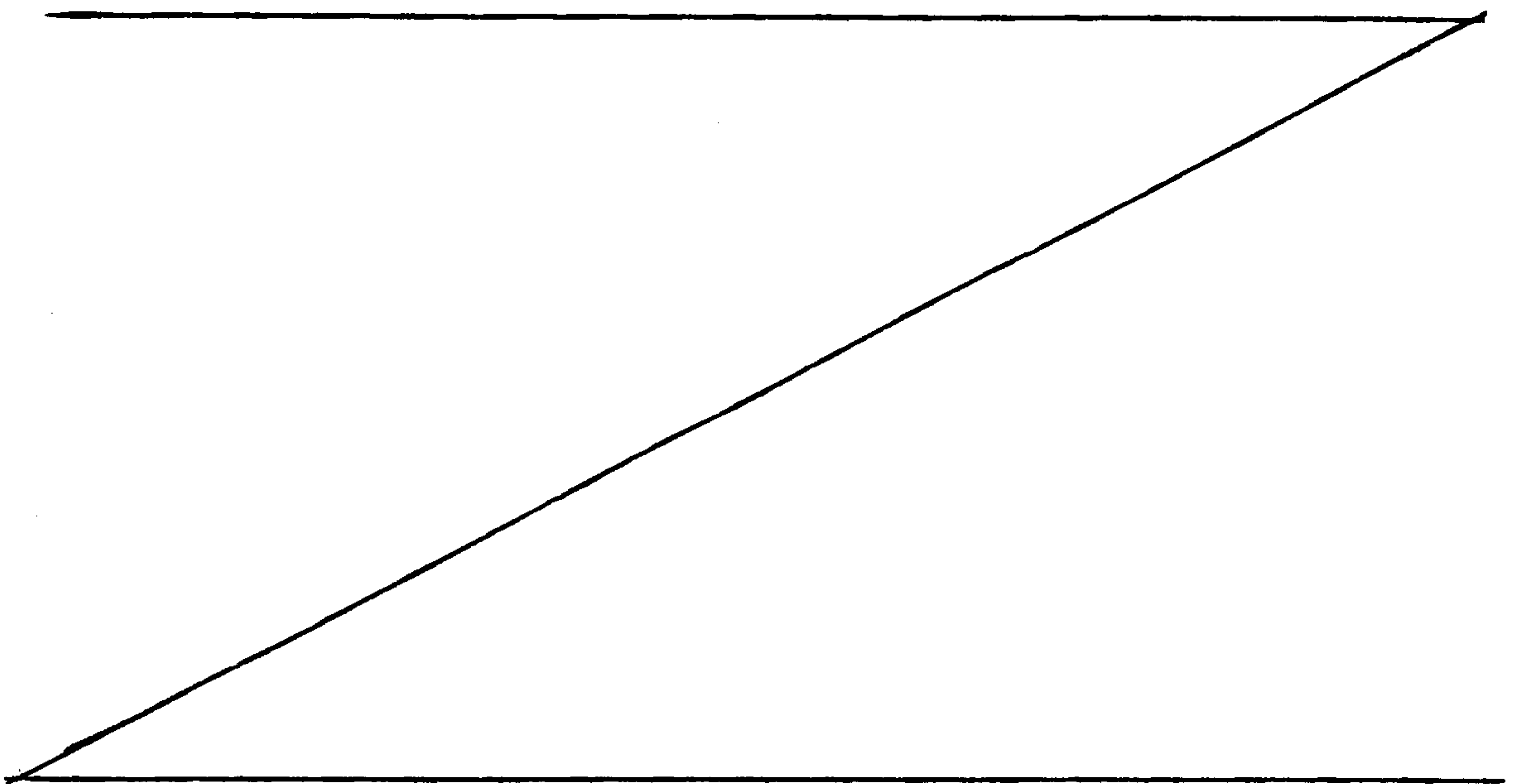
Accordingly, it is a general object of the present invention to provide an impedance blocking filter circuit which effectively and efficiently eliminates ADSL
5 interference caused by telephone terminal equipment.

According to one aspect of the present invention there is proved a telecommunications filter circuit comprising at least one first inductor electrically disposed between a first input terminal and a first common point; at least one second inductor electrically disposed between a second input terminal and a second common point; a first switch responsive to DC loop
10 current for selectively passing current therethrough; and a correction circuit interconnected between said common points and output terminals, said correction circuit being adapted to reduce return loss when equipment connected to said filter circuit changes state.



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In accordance with a preferred embodiment of the present invention, there is provided an impedance blocking filter circuit used in telecommunication systems for interconnecting between incoming telephone lines and customer's terminal equipment so as to unconditionally block impedances above 20 KHz due to the customer's terminal equipment from an ADSL network interface unit and/or home networking interface unit. The filter circuit includes first, second and third inductors connected in series between a first input terminal and a first common point. The first inductor has its one end connected to the first input terminal and its other end connected to one end of the second inductor. The second inductor has its other end connected to one end of the third inductor. The third inductor has its other end connected to the first common point. A first resistor



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has its one end also connected to the first common point and its other end connected to a first output terminal.

The filter circuit further includes fourth, fifth and sixth inductors connected in series between a second input terminal and a second common point. The fourth inductor has its one end connected to the second input terminal and its other end connected to one end of the fifth inductor. The fifth inductor has its other end connected to one end of the sixth inductor. The sixth inductor has its other end connected to the second common point. A second resistor has its one end also connected to the second common point and its other end connected to a second output terminal. A capacitor has its one end connected to the first common point and its other end connected to the second common point.

The foregoing applies specifically to the disclosure of related US Patent No. 6,188,750. A third embodiment of an impedance blocking filter circuit of the present invention is quite similar to the schematic diagram of Figure 3, except that the filter circuit therein has been modified so that the resistors **R1** and **R2**

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are replaced with first and second tank circuits **TC1** and **TC2**, respectively and a reed switch **K1** is connected in series with the capacitor **C1**. As a result, this third embodiment represents an improvement over the embodiment of Figure 3 since it overcomes the shunt additive capacitance problem and eliminates the deterioration in the return loss at the phone.

In addition, a fourth embodiment of an impedance blocking filter circuit of the present invention also added by way of this continuation-in-part application includes all of the components of the third embodiment and further has added successively seventh and eighth inductors **L7, L8**; a second capacitor **C2** and a second reed switch **K2** connected in series; and ninth and tenth inductors **L9, L10**. This produces a fifth-order filter circuit.

In a fifth embodiment, there is provided an impedance blocking filter circuit which is quite similar to the schematic circuit diagram of Figure 3, except that the filter circuit therein has been modified so to eliminate the resistors **R1** and **R2** and a reed switch **K1** is connected in series with the capacitor **C1**. The four

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inductors **L1-L4** and the reed switch **K1** are all housed within a multi-sectioned wound bobbin inductor structure so as to significantly reduce the inductors' interwinding capacitance.

5 In a sixth embodiment, there is provided an impedance blocking filter circuit which includes all of the components of the fifth embodiment and further has added successively seventh and eighth inductors **L7,L8**; a second capacitor **C2** and a second reed switch **K2** connected
10 in series; and ninth and tenth inductors **L9,L10**. The second reed switch **K2** is also housed within the multi-sectioned wound bobbin inductor structure. This produces a fifth-order filter circuit.

BRIEF DESCRIPTION OF THE DRAWINGS

15 These and other objects and advantages of the present invention will become more fully apparent from the following detailed description when read in conjunction with the accompanying drawings with like reference numerals indicating corresponding parts
20 throughout, wherein:

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Figure 1 is an overall block diagram of a telecommunication system for interconnecting a central office and a subscriber's premises, employing an impedance blocking filter circuit of the present invention;

5 Figure 2 is an exploded, perspective view of one form of a module housing the impedance blocking filter circuit;

Figure 3 is a schematic circuit diagram of an impedance blocking filter circuit, constructed in accordance with the principles of the present invention;

10

Figure 4 is a schematic circuit diagram of a second embodiment of an impedance blocking filter circuit, in accordance with the principles of the present invention;

Figure 5 is a plot of input impedances of the impedance blocking filter circuit of Figure 3 for various telephone equipment impedances as a function of frequency;

15

Figure 6 is a schematic circuit diagram of current limiting protection circuitry for use with the filter circuit of Figure 3;

20

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Figure 7 is a schematic circuit diagram of a home network demarcation filter for use with the filter circuit of Figure 3;

Figure 8 is schematic circuit diagram of a third
5 embodiment of an impedance blocking filter circuit in accordance with the present invention;

Figure 9 is schematic circuit diagram of a fourth embodiment of an impedance blocking filter circuit in accordance with the present invention;

10 Figure 10(a) is a top plan view of a dual winding inductor device housing one or two reed switches for use in the filter circuits of Figures 8 and 9;

Figure 10(b) is a side elevational view of the dual winding inductor device of Figure 10(a);

15 Figure 11(a) is a top plan view of a current sensor unit for housing a single inductor and a single reed switch for alternate use in the filter circuits of Figures 8 and 9;

Figure 11(b) is a side elevational view of the
20 current sensor unit of Figure 11(a);

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Figure 12 is a schematic circuit diagram of a fifth embodiment of an impedance blocking filter circuit utilizing a multi-sectioned bobbin structure;

Figure 13 is a schematic circuit diagram of a sixth
5 embodiment of an impedance blocking filter circuit utilizing a multi-sectioned bobbin structure;

Figure 14(a) is a side view of a multi-sectioned bobbin structure for use in the filter circuits of Figures 12 and 13; and

10 Figure 14(b) is schematic diagram of the multi-sectioned bobbin structure of Figure 14(a).

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now in detail to the drawings, there is illustrated in Figure 1 an overall block diagram of a
15 telecommunication system 10 for interconnecting a telephone company's central office (CO) 12 and a subscriber's premises 14 over a transmission media such as a conventional twisted pair of telephone lines 16. The telecommunication system 10 employs a plurality of impedance
20 blocking filter circuits, constructed in accordance with

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the principles of the present invention, in which each is contained in a modular housing 18.

The central office 12 includes a telephone office switch 20 and an Internet Service Provider (ISP) 22. The telephone office switch 20 is used to send voice signals via a low-pass filter 24 and a surge protector 26 to the telephone line 16. The ISP 22 transmits ADSL data signals to a modem 28 which are then sent to the telephone lines 16 via a high-pass filter 30 and the surge protector 26. It should be understood that the voice signals from the telephone office switch 20 and the ADSL data signals from the ISP 22 can be transmitted simultaneously to the telephone lines 16. Further, the voice signals (speech) are in the frequency band between 300 and 3400 Hz, and the ADSL data signals are in the frequency band between 20 KHz and 1.1 MHz .

The subscriber's premises 14 includes a Network Interface Device (NID)/surge protector unit 32 which is connected to the incoming telephone lines 16 on its input side and is connected to the subscriber's internal wiring or house wiring 34 on its output side via a demarcation RJ-11 jack and plug unit 36. As can be seen, the

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subscriber's premises further includes a number of terminal equipment such as a plurality of telephone sets 40. At times, the computer user will be downloading information to a personal computer 38 from the Internet
5 by receiving ADSL data signals transmitted by the ISP 22.

In order to optimize the downloading of this information from the Internet, the user can purchase and install an ADSL network interface unit 42 for connection between the computer 38 and a RJ-11 jack and plug unit
10 44. The ADSL network interface unit 42 includes a high-pass filter 41 connected to the RJ-11 unit 44 and an internal modem 43 connected to the computer 38. The RJ-11 unit 44 is connected to the house wiring 34 for receiving the ADSL signals from the telephone lines 16. However,
15 it will be observed that the plurality of telephone sets 40 are also connected to the same house wiring 34 via RJ-11 units 46, 48 and 50, respectively.

If it were not for the impedance blocking filter circuits 18 in the present invention, the output
20 impedance from each of the telephone sets 40 would be connected in parallel with the input impedance of the ADSL unit 42. Since the output impedances from the tele-

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phone sets are subject to wide variations due to, for example, changing from "on-hook" to "off-hook" so as to present either an open, a short, capacitive, inductive, resonant, or any combination thereof at frequencies above
5 20 KHz, this erratic impedance can significantly affect the rate of the ADSL data signals being received by the computer 38 via the ADSL network interface unit 42.

Therefore, the main purpose of the impedance blocking filter circuit of the present invention is to isolate
10 the terminal equipment (telephone sets) impedances from the ADSL unit 42 and the house wiring 34 so as to eliminate degradation of the performance of the ADSL unit 42. Further, the impedance blocking filter circuit serves to attenuate the ADSL data signal from being re-
15 ceived by the telephone sets 40 in order to prevent non-linear conversion to voice band signals. Moreover, to facilitate the installation required by the customer, the filter circuit is contained in the modular housing 18.

As can best be seen from Figure 2, one form of the
20 modular housing 18 includes a base 52 and a snap-on removable cover 54. The base has a printed circuit board 56 which is fixedly secured thereto by screws 58 and has

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mounted thereon the electrical circuit components for the filter circuit 59. One end of the modular housing 18 has a RJ-11 jack 60 formed integrally therewith for connection to the telephone set. This connection is achieved
5 by plugging a RJ-11 plug (not shown) from a telephone set into the jack 60. The other end of the modular housing 18 has a short length of cable 62 extending therefrom and terminating in a RJ-11 plug 64 which is connectable to the house wiring. In particular, the plug 64 is connected to the house wiring 34 by plugging the same into
10 a wall socket (not shown) having a RJ-11 jack.

In Figure 3, there is shown a detailed schematic circuit diagram of the impedance blocking filter circuit 59 of the present invention for connection in series
15 between the house wiring 34 and the terminal equipment (telephone set) of Figure 1. The filter circuit 59 includes two input (tip and ring) terminals 66, 68 which are connectable to the house wiring 34 via the RJ-11 plug 64 and two output (tip and ring) terminals 70, 72 which
20 are connectable to the telephone set 40 via the RJ-11 jack 60. The filter circuit 59 is comprised of inductors L1-L6, a capacitor C1, and resistors R1, R2.

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The inductors **L5**, **L3**, **L1** and the resistor **R1** are connected in series between the first or tip input terminal **66** and the first or tip output terminal **70**. Similarly, the inductors **L6**, **L4**, **L2** and the resistor **R2** are connected in series between the second or ring input terminal **68** and the second or ring output terminal **72**. The inductors **L5** and **L6** are each preferably formed of a ferrite toroid. The inductors **L3** and **L4** have the same inductance values, and the inductors **L1** and **L2** have the same inductance values. The inductor **L1** and the first resistor **R1** are connected together at a common point **A** and to one side of the capacitor **C1**. The inductor **L2** and the second resistor **R2** are connected together at a common point **B** and to the other side of the capacitor **C1**. The resistors **R1** and **R2** also have the same values.

As previously pointed out, the primary purpose of the impedance blocking filter circuit **59** is to block the impedances from the telephone set at above the frequency of 20 KHz from reaching the house wiring **34**, thereby preventing adverse performance of the ADSL network unit **42** (Figure 1). In particular, the ADSL data signals being in the frequency range of 20 KHz and 1.1 MHz are mainly blocked by the inductors **L1** and **L2**. However, it has been experienced that some telephone sets have an

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input capacitance of less than 5 nf which can cause resonant impedances to occur within the ADSL band. In order to eliminate this undesirable effect, the capacitor C1 is used to lower any resonance into an acceptable dead band at around the 10 KHz frequency. Further, the capacitor C1 also provides additional attenuation of the ADSL signals so as to prevent driving the telephone impedance into a non-linear region and converting the high frequency ADSL signals into audible signals which can be heard by the subscriber or converted to another ADSL band and cause ADSL interference. While there may still exist other minor resonances in the telephone set in the frequency range of between 20 KHz and 60 KHz, their undesirable effect is significantly reduced by the resistors R1 and R2 which produce a de-Q effect. It should be noted that the inductors L1 and L2 are formed as separate inductors so as to avoid longitudinal impedance problems as well as blocking differential impedances.

20 Since the inductors L1 and L2 have their own frequency limitations (e.g., self-resonant frequency), the inductors L3 and L4 are provided so as to block the telephone impedances in the frequency band of 1 MHz to 20 MHz. These inductors L3, L4 are necessary when

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phoneline home networking interface units (Figure 1) are being used in conjunction with the ADSL network interface unit 42, as will be explained hereinafter. The inductors L5 and L6 are provided so as to block the telephone set impedances in the frequency band of 20 MHz to 500 MHz, which will prevent any problems caused by TV/FM interference.

For completeness in the disclosure of the above-described filter circuit but not for purposes of limitation, the following representative values and component identifications are submitted. These values and components were employed in a filter circuit that was constructed and tested, and which provides high quality performance.

15	<u>PART</u>	<u>TYPE or VALUE</u>
	L1, L2	10 mH
	L3, L4	220 μ H
	L5, L6	ferrite toroid, 75 μ H
	C1	22 nf
20	R1, R2	22 Ω

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With these above values being used, the input impedance of the impedance blocking filter circuit 59 was plotted for various telephone equipment impedances (e.g., open, short, capacitive, inductive, resonant, or a combination of these conditions) as a function of frequency and is illustrated in Figure 5. As can be seen from the various curves, the input impedance across the input terminals 66, 68 of the impedance blocking filter circuit 59 for any telephone impedances connected across its output terminals 70, 72 is equal to or greater than 2K Ohms at frequencies above 40 KHz.

The impedance blocking filter circuit 59 of Figure 3 is basically a second-order filter and has been found to minimize adequately voice band transmission effects when up to eight (8) filter circuits are installed into the telecommunication system of Figure 1. In order to provide higher attenuation at frequencies above 20 KHz, there is shown in Figure 4 a schematic circuit diagram of a second embodiment of a third-order impedance blocking filter circuit 59a of the present invention. The third-order filter circuit of Figure 4 is substantially identical to the second-order filter circuit of Figure 3, except there has been added an inductor L7 and an inductor L8. The inductor L7 is interconnected between

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the common point **A** and the first resistor **R1**, and the inductor **L8** is connected between the common point **B** and the second resistor **R2**. The inductors **L7** and **L8** have the same inductance values.

5 Based upon tests conducted on the third-order filter circuit of Figure 4, it was observed that higher attenuation was provided at frequencies above 20 KHz. However, it was found that the number of such third-order filter circuits which could be connected to the telecommunica-
10 tion system of Figure 1 was limited to three or four. This is due to the fact that the inductor values of **L1**, **L2**, **L7** and **L8** of Figure 4 are smaller (on the order of 5-10 mH) than the ones in Figure 3, the capacitor value of **C1** of Figure 4 is larger (on the order of 33-47 nf) than
15 the one in Figure 3, and the additive capacitive loading caused by each added filter circuit will adversely affect the voice band performance. Thus, the optimized operation between voice performance and ADSL performance was found to exist when only three or four filter
20 circuits **59a** were installed.

While the filter circuit of Figure 3 performed adequately, the inventor has found based upon further test-

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ing that a transient problem will occur when the telephone set goes "off-hook" at the peak of the ring signal. This "off-hook" transient condition may cause current spikes to occur which are higher than 600 mA. As a
5 result, the high current will tend to saturate the inductors, thereby momentarily lowering the input impedance of the filter circuit and thus adversely affects the data on the ADSL signal being transmitted to the interface unit 42.

10 In order to overcome this current transient problem, the inventors have developed fast current limiting protection circuitry 74 for providing protection against the "off-hook" transients. In Figure 6 of the drawings, there is shown a schematic circuit diagram of the current
15 limiting protection circuitry 74 which is comprised of depletion mode N-channel field-effect transistors (FET) Q1, Q2; resistors R1a, R2a; and varistors RV1, RV2. The FET Q1 has its drain electrode connected to a first input terminal 76, its source electrode connected to one end of
20 the resistor R1a, and its gate electrode connected to the other end of the resistor R1a. The common point C of the gate electrode of the transistor Q1 and the resistor R1a is also joined to the first output terminal 78. Similarly, the FET Q2 has its drain connected to a second

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input terminal 80, its source connected to one end of the resistor R2a, and its gate electrode connected to the other end of the resistor R2a. The common point D of the gate of the transistor Q2 and the resistor R2a is also
5 joined to a second output terminal 82. One end of the varistor RV1 is connected to the drain of the transistor Q1, and the other end thereof is connected to the common point C. One end of the varistor RV2 is connected to the drain of the transistor Q2, and the other end thereof is
10 connected to the common point D.

In use, the current limiting protection circuitry 74 replaces the resistors R1 and R2 of Figure 3. The first and second input terminals 76, 80 of the protection circuitry 74 are connectable to the common points A and
15 B of Figure 3, and the first and second output terminals 78, 82 thereof are connected to the tip and ring output terminals 70, 72 of Figure 3. The transistors Q1, Q2 may be similar to the ones commercially available from Supertex Corporation under their Part No. DN2530N3. The
20 varistors may be similar to the type ZNR which are manufactured and sold by Panasonic Corporation. The resistors R1a and R2a have the same resistance value and are on the order of 5-20 Ohms depending on the thresholds of the transistors Q1, Q2. It should be understood that

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the transistors **Q1**, **Q2** have a large tolerance on current limit and the resistors **R1a**, **R2a** permit the desired current limit value to be adjusted. Alternatively, the resistors **R1a**, **R2a** may have a value of zero Ohms or be
5 entirely eliminated.

In normal on-hook operation, the transistors **Q1** and **Q2** are rendered conductive and have an on-resistance value of about 10 Ohms. When the telephone set goes "off-hook" into high ringing voltage, the gate-to-source
10 voltage of the forward conducting FET will become more negative due to the resistors **R1a**, **R2a**. As a result, the resistance of the transistors **Q1**, **Q2** will go very high which will limit the current spikes to approximately 70-100 mA. The transistor **Q1** serves to limit the current
15 flowing in a first direction, and the transistor **Q2** serves to limit the current flow in a reverse direction. Further, the varistors **RV1**, **RV2** defining transient protection means function to clamp transients caused by lightning and power shorts from damaging or destroying
20 the FETs **Q1**, **Q2**.

In view of continuing increased use of home computers and the high demand for accessing of

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information from the Internet in the last decade or so, many of the subscribers will be multi-PC homes. As shown in Figure 1, the subscriber's premises or small business will typically have a second computer **38a** also connected
5 to the same internal house wiring **34**. In order to effect high-speed data transfer in the multi-PC environment, there will be required phoneline home networking interface units **42a** for using the internal house wiring in the frequency band above 5 MHz so as to interconnect
10 the multiple computers **38**, **38a** or other devices at data rates above 10 MB/s as illustrated. While the impedance filter circuit of the present invention adequately filters and blocks the telephone impedances from the home networking signals, which are in the frequency band of 5-
15 10 MHz, it will be noted that the home networking signals from the telephone company's C.O. are however still connected to the house wiring via the NID/surge protector unit **32**.

In order to solve this problem, the inventor has
20 developed a home network demarcation filter **84** as shown in dotted lines in Figure 1 for connection at a point of demarcation (NID/surge protector unit **32**) between the telephone company's incoming lines **16** and the subscriber's internal house wiring **34** via the demarcation

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unit 36. A schematic circuit diagram of the home network demarcation network is depicted in Figure 7. The demarcation filter 84 includes two input (tip and ring) terminals 86, 88 which are connectable to the incoming
5 lines via the jack side of the demarcation unit 36 in the NID/surge protector unit 32 and two output (tip and ring) terminals 90, 92 which are connectable to the internal house wiring via the plug side of the demarcation unit 36. The demarcation filter is comprised of six inductors
10 L9-L14 and two capacitors C2, C3. In use, the demarcation filter is transparent to the ADSL data signals having the frequencies between 20 KHz and 1.1 MHz but will produce an attenuation of more than 40 dB for frequencies above 5.5 MHz. The demarcation filter will
15 also provide an inductive input impedance for above 5 MHz frequency band so as to prevent loading down the home networking signals on the incoming phone lines and also adds data security benefits.

From the foregoing detailed description, it can thus
20 be seen that the present invention provides an impedance blocking filter circuit used in telecommunication systems for interconnecting between incoming telephone lines and customer's terminal equipment so as to unconditionally block impedances above 20 KHz due to the customer's

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terminal equipment from an ADSL network interface unit and/or home networking interface unit. The impedance blocking filter circuit is comprised of six inductors, two resistors, and a capacitor.

5 While the second-order impedance blocking filter 59 of Figure 3 and the third-order impedance blocking filter 59a of Figure 4 both perform adequately for unconditionally blocking telephone impedances above 20 KHz, the inventor has found that based upon additional
10 testing they suffer from the disadvantages of causing (1) a shunt additive capacitance problem and (2) a deterioration in the return loss at a phone set, when the number of such filter circuits are added increasingly in parallel into the telecommunication system of Figure 1.

15 The shunt capacitance problem is caused by the added capacitance from all of the filter circuits connected to the on-hook phones. The return loss problem is due to the fact that the series inductances of the impedance blocking filter circuit connected to the telephone set
20 going "off-hook" will cause a resonance to occur in the frequency range of 2-5 KHz with the total capacitance seen, which is equal to the sum of the line capacitance plus the capacitance from the filter circuits. Further,

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as the total capacitance is increased this will also cause a lower resonant frequency which will create a phase shift so to unbalance the telephone hybrid. As a result, the side tone level of the "off-hook" telephone set is caused to increase.

In order to overcome this problem, there is provided in Figure 8 a third embodiment of a second-order impedance blocking filter circuit **59b** of the present invention. The third embodiment includes all of the circuit elements used in the filter circuit of Figure 3, except for the resistors **R1** and **R2**, and further includes a reed switch **K1** and a return loss correction circuit consisting of a first tank circuit **TC1** and a second tank circuit **TC2**.

In particular, the reed switch **K1** connected in series with the capacitor **C1** is connected between the common points A and B. Further, the first tank circuit **TC1** is comprised of a first winding inductor **W1**, a capacitor **C3**, and a resistor **R3** all connected together in parallel and between the common point A and the output tip terminal **70**. Similarly, the second tank circuit **TC2** is comprised of a second winding inductor **W2**, a capacitor **C4**, and a resistor **R4** all connected together in parallel

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and between the common point B and the output ring terminal 72. In addition, there provided optionally a metal-oxide varistor D1 connected in series with the capacitor C1 and in parallel with the reed switch K1. The
5 varistor D1 serves to protect the reed switch K1 from being damaged by transients when the telephone set is in the on-hook condition.

In use, when a telephone set goes "off-hook" DC loop current will flow which creates a DC magnetic field in
10 the first and second winding inductors W1, W2. This will cause only the reed switch K1 of the filter circuit 59b connected to the "off-hook" telephone set to become actuated or closed by the DC magnetic field. As a consequence, the shunt additive capacitances from all of
15 the filter circuits connected to the "on-hook" phones have been eliminated.

Moreover, the first winding inductor W1 and the capacitor C3 of the first tank circuit TC1 will cause a resonance to occur at the frequency of about 2 KHz. The
20 impedance of the first tank circuit TC1 above the resonant frequency will appear as a capacitive reactance, which will substantially cancel the inductive reactance

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of the filter circuit **59b**. The resistor **R3** sets the Q or the slope of the resonance so as to best match the effects of the inductive impedance of the filter circuit. In this manner, the return loss at the "off-hook" phone set is significantly improved, thereby reducing the side tone level of the telephone set. Similarly, the second winding inductor **W2**, the capacitor **C4**, and the resistor **R4** of the second tank circuit **TC2** operate in an identical manner to first winding inductor **W1**, the capacitor **C3**, and the resistor **R3** of the first tank circuit **TC1**.

In Figure 9, there is illustrated a fourth embodiment of an impedance blocking filter circuit **59c** of the present invention. The fourth embodiment includes all of the circuit components of the filter circuit **59c** of Figure 8 and has added an inductor **L7** and an inductor **L8**. The inductor **L7** is interconnected between the common point A and the first tank circuit **TC1**, and the inductor **L8** is interconnected between the common point B and the second tank circuit **TC2**. The filter circuit **59c** as described thus far is essentially a third-order filter circuit which provides a better stop band performance than the second-order filter circuit **59b** of Figure 8.

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Referring still to Figure 9, a second reed switch **K2** and a capacitor **C2** have been successively added to convert the third-order filter circuit to a fourth-order filter circuit which is optimized for better operation
5 for full rate ADSL modems. In particular, the reed switch **K2** connected in series with the capacitor **C2** is joined between common points C and D. In addition, there is provided optionally a metal-oxide varistor **D2** connected in series with the capacitor **C2** and in parallel with the
10 reed switch **K2**. Likewise, the varistor **D2** is used to protect the reed switch **K2** from being destroyed by transients when the telephone set is in the on-hook condition.

Further, an inductor **L9** and an inductor **L10** are
15 added successively so as to produce a fifth-order filter circuit. Specifically, the inductor **L9** is interconnected between the inductor **L7** at the common point C and the first tank circuit **TC1**. The inductor **L10** is interconnected between the inductor **L8** at the common
20 point D and the second tank circuit **TC2**.

In addition, a thermo-fuse **F1** may be optionally connected in series the inductors **L5**, **L3**, **L1**, **L7**, **L9** and

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the tank circuit **TC1** which are arranged between the input tip terminal **66** and the output tip terminal **70**. For example, the thermo-fuse **F1** may be electrically interconnected between the input tip terminal **66** and the inductor **L5**. Typically, the thermo-fuse **F1** is located physically adjacent to one of the inductors or the resistor in order to sense the highest temperature within the filter circuit. The fuse **F1** provides a safety feature and will open when the sensed temperature of the filter circuit exceed a specified trip temperature. The fuse functions as a safety protection means for preventing the filter circuit from overheating and causing a fire due to a power cross on the phone lines.

In Figure 10(a), there is shown a top plan view of a dual winding inductor device **T1** for use in the filter circuits of Figures 8 and 9. Figure 10(b) is a side elevational view of the dual winding inductor device. As can be seen, inductor device **T1** includes a cylindrical-shaped housing **110** which contains the first winding inductor **W1** of the first tank circuit **TC1**, the second winding inductor **W2** of the second tank circuit **TC2**, the reed switch **K1**, and the reed switch **K2**.

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In Figure 11(a), there is depicted a top plan view of an alternate current sensor unit **CS** for use in the filter circuits of Figures 8 and 9. Figure 11(b) is a side elevational view of the current sensor unit **CS**. The current sensor unit **CS** is formed of cylindrical housing **112** and contains a single inductor **L** and a single reed switch **K**. It should be apparent to those skilled in the art that the dual winding inductor device **T1** can be replaced with two such current sensor units **CS** so as to render the same operation. Since the windings **W1, W2** or the inductor **L** is used to drive the reed switches **K1, K2** (**K**), the reed switch is selected to be actuatable on a loop current threshold of approximately 14-20 mA. If the loop current threshold is below 14 mA, the reed switch may chatter during ringing on a 1 REN telephone and may thus shorten the useful life of the reed switch. On the other hand, if the loop current threshold is above 20 mA, then the amount of loop current may be insufficient to be actuatable in the worst case condition (e.g., the longest cable).

In Figure 12, there is illustrated a fifth embodiment of an impedance blocking filter circuit **59d** of the present invention. the fifth embodiment is substantially identical to the first embodiment of the

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second-order filter circuit of Figure 3, except that the resistors **R1** and **R2** have been eliminated and a reed switch **K1** has been added in series with the capacitor **C1** located between the common points A and B. Further, the

5 four single inductors **L1, L2** and **L3, L4** of Figure 3 have replace by a multi-sectioned wound bobbin inductor structure **T2**. It will be noted that the bobbin structure **T2** includes a tip winding **TW** (corresponding to replace inductors **L1,L3**) connected between the inductor **L5** and

10 the common point A , and a ring winding **RW** (corresponding to replace inductors **L2,L4**) connected between the inductor **L6** and the common point B. Further, the bobbin structure **T2** houses the reed switches **K1,K2**. The tip(ring) winding **TW(RW)** combines the inductor **L1(L2)** for

15 the ADSL frequency band (20KHz to 1.1MHz) and the inductor **L3(L4)** for the mid-frequency band (1MHz to 20MHz) into a single coil. It has been found that the filter circuit **59d** is more economical to manufacture and assemble, but yet eliminates the shunt additive

20 capacitance problem of the filter circuits connected the "on-hook" phone sets. Optionally, a return loss correction circuit consisting of a first tank circuit **TC1** and a second tank circuit **TC2** may be interconnected between the common points A,B and the output terminals

25 **70,72**.

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In Figure 13, there is shown a sixth embodiment of an impedance filter circuit **59e** of the present invention. the sixth embodiment includes all of the circuit components of the filter circuit **59d** of Figure 12 and has
5 added an inductor **L7** and an inductor **L8**. The inductor **L7** is interconnected between the common point A and the output tip terminal **70**, and the inductor **L8** is interconnected between the common point B and the output ring terminal **72**. The filter circuit thus far described
10 is essentially a third-order filter circuit for producing a better stop band.

Referring still to Figure 13, a second reed switch **K2** and a second capacitor **C2** have been further added so as to convert the third-order filter circuit to a fourth-
15 order filter circuit which is optimized for better operation for full rate ADSL modems. In particular, the second reed switch **K2** connected in series with the second capacitor **C2** are joined between nodes C and D. It will be noted that the second reed switch **K2** is also incorporated
20 into the bobbin structure **T2**. Further, an inductor **L9** is added between the inductor **L7** and the node E, and an inductor **L10** is added between the inductor **L8** and the node F in order to convert the fourth-order filter circuit to a fifth-order filter circuit. Optionally, a

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thermo-fuse **F2** may be connected in a manner similar to the one in Figure 9.

In Figure 14(a), there is shown a side view of a wiring bobbin structure **T2** having multiple sections **S1-S6** for use in the circuits of Figures 12 and 13. Figure 14(b) is schematic diagram of the bobbin structure **T2** of Figure 14(a). The bobbin structure includes a first narrow section **S1** on which is wound the inductor **L3**, first wider sections **S2,S3** on which are wound the inductor **L1**, a second narrow section **S4** on which is wound the inductor **L4**, and second wider sections **S5,S6** on which are wound the inductor **L2**. The inductors **L1,L3** are combined on the same coil and is represented by the tip winding **TW** in Figure 14(b). Similarly, the inductors **L2,L4** are combined on the coil and is represented by the ring winding **RW**.

The inventor has designed purposely the bobbin structure **T2** to include the narrow section **S1(S4)** on which is wound the higher frequency of the coil (e.g., inductor **L3,L4**) since there will be less winding capacitance so as to obtain a maximum useful frequency range. Further, by dividing the bobbin structure into a

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plurality of sections the beginning of the tip(ring) winding **TW(RW)** on pin 1 (pin 5) will be farther removed from the end of the tip (ring) winding on pin 4 (pin 8). As result, the interwinding capacitance will be reduced, thereby increasing the useful frequency range of the coil. The first reed switch **K1** with pins 2 and 7 is disposed within the center of the bobbin structure **T2** so as to be actuable by the windings **TW, RW**. Further, the second reed switch **K2** with pins 3 and 6 may also be formed with the center of the bobbin structure and actuated by the same winding **TW, RW**.

While there has been illustrated and described what is at present considered to be a preferred embodiment of the present invention, it will be understood by those skilled in the art that various changes and modifications may be made, and equivalents may be substituted for elements thereof without departing from the true scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the central scope thereof. Therefore, it is intended that this invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out the invention, but that the invention will include

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all embodiments falling within the scope of the appended claims.

CLAIMS:

1. A telecommunications filter circuit comprising:

at least first and second inductors electrically disposed in a series relationship between a first input terminal and a first common point;

at least third and fourth inductors electrically disposed in a series relationship between a second input terminal and a second common point;

a first switch disposed electrically between said first and second common points and responsive to DC loop current for selectively passing current therethrough; and

a correction circuit interconnected between said common points and output terminals, said correction circuit being adapted to reduce return loss when equipment connected to said filter circuit changes state.

2. A telecommunications filter circuit as claimed in claim 1, wherein said correction circuit comprises a first tank circuit and a second tank circuit, said first tank circuit being formed of a first winding inductor, a first tank capacitor and a first tank resistor all disposed in parallel and between said first common point and a first of said output terminals, second tank circuit being formed of a second winding inductor, a second tank capacitor, and a second tank resistor all disposed in parallel and between said second common point and a second of said output terminals.

3. A telecommunications filter circuit as claimed in claim 2, further comprising a fifth inductor having a first end connected to said first common point and a second end connected to said first tank circuit, and a sixth inductor having a first end connected to said

second common point and a second end connected to said second tank circuit.

4. A telecommunications filter circuit as claimed in claim 3, further comprising a second switch responsive to said DC loop current, and a second capacitor having a first end connected said sixth inductor at a first node and a second end connected to one terminal of said second switch, said one terminal being connected to said fifth inductor at a second node.

5. A telecommunications filter circuit as claimed in claim 4, further comprising a seventh inductor having a first end connected to said fifth inductor at said first node and a second end connected to said first tank circuit, and an eighth inductor having a first end connected to said sixth inductor at said second node and a second end connected to said second tank circuit.

6. A telecommunications filter circuit as claimed in claim 5, wherein said first switch includes a first reed switch and said second switch includes a second reed switch.

7. A telecommunications filter circuit as claimed in claim 6, wherein said first winding of said first tank circuit, said second winding of said second tank circuit, said first reed switch, and said second reed switch are arranged in a dual winding inductor structure.

8. A telecommunications filter circuit as claimed in claim 6, wherein said first winding of said first tank circuit and said first reed switch is arranged in a first current sensor unit, said second winding of said second

tank circuit and said second reed switch is arranged in a second current sensor unit.

9. A telecommunications filter circuit as claimed in claim 1, further comprising a varistor connected in series with at least one capacitor and in parallel with said first switch.

10. A telecommunications filter circuit as claimed in claim 1, wherein said correction circuit comprises a first tank circuit and a second tank circuit disposed in parallel.

11. A telecommunications filter circuit as claimed in claim 10, wherein said first and second tank circuits each comprise at least one winding, and said first switch comprises a reed switch disposed in dual winding inductor structure comprising said at least one windings of said first and second tank circuits.

12. A telecommunications filter circuit as claimed in claim 11, further comprising a second reed switch disposed in said dual winding inductor structure.

13. A telecommunications filter circuit as claimed in claim 1, wherein said first switch and at least one capacitor are disposed in electrical series with each other between said first and second common points.

14. A telecommunications filter circuit as claimed in claim 13, wherein said correction circuit comprises a first tank circuit and a second tank circuit disposed in parallel.

15. A telecommunications filter circuit as claimed in claim 14, wherein said first and second tank circuits each comprise at least one winding, and said first switch comprises a reed switch disposed in dual winding inductor structure comprising said at least one windings of said first and second tank circuits.

16. A telecommunications filter circuit as claimed in claim 1, wherein said at least first and second inductors comprise three inductors disposed in electrical series with each other.

17. A telecommunications filter circuit as claimed in claim 1, wherein said correction circuit is adapted to reduce return loss caused by inductive impedance when the customer's terminal equipment goes off-hook.

18. A telecommunications filter circuit as claimed in claim 1, further comprising third and fourth common points with at least one capacitor disposed electrically there between.

19. A telecommunications filter circuit as claimed in claim 18, further comprising at least one other capacitor disposed in electrical series with said first switch.

20. A telecommunications filter circuit as claimed in claim 1, wherein said correction circuit comprises at least first and second correction circuit capacitors and first and second correction circuit inductors, said first correction circuit capacitor and first correction circuit inductor being in electrical parallel with each other, said second correction circuit capacitor and second correction circuit inductor also being in electrical

parallel with each other, said first and second correction circuit inductors being disposed in electrical series between respective ones of said first and second common points and first and second of said output terminals.

21. A telecommunications filter circuit as claimed in claim 1, wherein said circuit comprises an impedance blocking filter circuit used in telecommunication systems for interconnecting between incoming telephone lines and customer's terminal equipment so as to unconditionally block impedances from above 20 KHz due to the customer's terminal equipment from an ADSL network unit and/or home networking interface unit.

22. A telecommunications filter circuit as claimed in claim 21, wherein said at least first and second inductors electrically disposed between a first input terminal and a first common point comprises first, second and fifth inductors connected in series between said first input terminal and first common point; said first inductor having its one end connected to said first input terminal and its other end connected to said second inductor, said second inductor having its other end connected to one end of said fifth inductor, said fifth inductor having its other end connected to said first common point.

23. A telecommunications filter circuit as claimed in claim 22, wherein said at least third and fourth inductors electrically disposed between a second input terminal and a second common point comprises third, fourth, and sixth inductors connected in series between said second input terminal and second common point, said

third inductor having its one end connected to said second input terminal and its other end connected to one end of said fourth inductor, said fourth inductor having its other end connected to one end of said sixth inductor, said sixth inductor having its other end connected to said second common point.

24. A telecommunications filter circuit as claimed in claim 23, wherein said first switch responsive to DC loop current for selectively passing current therethrough comprises first switching means having a first end and a second end and being responsive to said DC loop current for electrically connecting said first end to said second end.

25. A telecommunications filter circuit as claimed in claim 24, further comprising a capacitor having a first end connected to said first common point and a second end connected to said first end of said switching means, said second end of said switching means being connected to said second common point.

26. A telecommunications filter circuit as claimed in claim 25, wherein said correction circuit interconnected between said common points and output terminals comprises correction circuit means for significantly reducing return loss caused by inductive impedance when the customer's terminal equipment goes off-hook.

27. A impedance blocking filter circuit comprising:

at least first and second inductors disposed in electrical series between a first input terminal and a first common point;

at least third and fourth inductors disposed in

electrical series between a second input terminal and a second common point;

a first switch disposed electrically between said first and second common points and being responsive to DC loop current; and

at least one bobbin including at least first and second portions on which are wound one of said at least first and second inductors and one of said third and fourth inductors, respectively, said at least one bobbin being adapted to reduce interwinding capacitance so as to increase the useful frequency range of said filter circuit, said at least one bobbin further having a center portion for receiving at least a portion of said first switch.

28. An impedance blocking filter circuit as claimed in claim 27, further comprising at least one correction circuit interconnected between said common points and respective output terminals of said filter circuit, said at least one correction circuit being adapted to reduce return loss caused by inductive impedance when a customer's terminal equipment connected to said filter circuit changes state.

29. An impedance blocking filter circuit as claimed in claim 28, wherein said correction circuit is comprised of a first tank circuit and a second tank circuit, said first tank circuit being formed of a first winding inductor, a first tank capacitor, and a first tank resistor all disposed in electrical parallel and between said first common point and a first of said output terminals, said second tank circuit being formed of a second winding inductor, a second tank capacitor, and a second tank resistor all disposed in electrical parallel

and between said second common point and a second of said output terminals.

30. An impedance blocking filter circuit as claimed in claim 28, further comprising at least one capacitor disposed in electrical series with said first switch between said first and second common points.

31. An impedance blocking filter circuit as claimed in claim 30, further comprising a second switch responsive to said DC loop current and a second capacitor, said second capacitor and switch being disposed in electrical series between third and fourth common points of said filter circuit.

32. An impedance blocking filter circuit as claimed in claim 29, wherein said first switch comprises a first reed switch magnetically coupled to at least one of said winding inductors of said tank circuits.

33. An impedance blocking filter circuit as claimed in claim 31, wherein said first switch comprises a first reed switch magnetically coupled to at least one of said winding inductors of said tank circuits.

34. An impedance blocking filter circuit as claimed in claim 30, wherein said first winding of said first tank circuit, said second winding of said second tank circuit, and said first reed switch are arranged in a dual winding inductor structure.

35. An impedance blocking filter circuit as claimed in claim 27, wherein said circuit is used in telecommunication systems for interconnecting between

incoming telephone lines and customer's terminal equipment so as to unconditionally block impedances from above 20 KHz due to the customer's terminal equipment from an ADSL network unit and/or home networking interface unit.

36. An impedance blocking filter circuit as claimed in claim 35, wherein said at least first and second inductors comprise first, second and fifth inductors connected in series between said first input terminal and a first common point.

37. An impedance blocking filter circuit as claimed in claim 36, said first inductor has its one end connected to said first input terminal and its other end connected to one end of said second inductor, said second inductor having its other end connected to one end of said fifth inductor, said fifth inductor having its other end connected to said first common point.

38. An impedance blocking filter circuit as claimed in claim 37, wherein said at least third and fourth inductors comprises third, fourth, and sixth inductors connected in series between a second input terminal and a second common point.

39. An impedance blocking filter circuit as claimed in claim 38, wherein said third inductor has its one end connected to said second input terminal and its other end connected to one end of said fourth inductor, said fourth inductor having its other end connected to one end of said sixth inductor, said sixth inductor having its other end connected to said second common point

40. An impedance blocking filter circuit as claimed in claim 39, wherein said first switch comprises first switching means having a first end and a second end and being responsive to said DC loop current for electrically connecting said first end of said switching means to said second end.

41. An impedance blocking filter circuit as claimed in claim 40, further comprising a capacitor having a first end connected to said first common point and a second end connected to said first end of said switching means, said second end of said switching means being connected to said second common point.

42. An impedance blocking filter circuit as claimed in claim 41, wherein said at least one bobbin comprises bobbin means including at least a first narrow section on which is wound said third inductor, first wider sections on which are wound said fifth inductor, a second narrow section on which is wound said fourth inductor, and second wider sections on which are wound said sixth inductor, said bobbin means having a center portion for receiving said first switching means.

43. A method of filtering a telecommunications signal, comprising:

providing a filter circuit comprising:

- (i) at least one first and second pluralities of inductors electrically disposed between respective ones of first and second input terminals and first and second common points;
- (ii) a first switch electrically disposed between said first and second common points; and
- (iii) a correction circuit disposed electrically

between said first and second common points and first and second output terminals;
inducing a DC loop current through at least a portion of said filter circuit using said telecommunications signal;
selectively operating said first switch based on said DC loop current; and
selectively controlling return loss using said correction circuit when terminal equipment connected to said filter circuit changes state.

44. The method of claim 43, wherein said act of selectively operating comprises:

using at least portions of said correction circuit to induce a magnetic field proximate to said first switch; and

selectively operating said first switch based on said magnetic field.

45. A telecommunications filter circuit adapted to block impedances above a prescribed frequency, comprising:

a first plurality of inductors electrically disposed between a first input terminal and a first common point;

a second plurality of inductors electrically disposed between a second input terminal and a second common point;

a first correction circuit electrically disposed between said first common point and a first output terminal, said first correction circuit having at least one winding element;

a second correction circuit electrically disposed between said second common point and a second output terminal, said second correction circuit having at least one winding element; and

a first switch responsive to DC loop current for selectively passing current therethrough, said first switch being electrically disposed between said first and second common points;

wherein said first switch is magnetically coupled to at least one of said winding elements.

46. The telecommunications filter circuit of claim 45, wherein said prescribed frequency is approximately 20KHz.

47. The telecommunications filter circuit of claim 45, wherein said first and second correction circuits comprise tank circuits.

48. The telecommunications filter circuit of claim 45, further comprising:

third and fourth common points disposed electrically between said first plurality of inductors and first correction circuit, and said second plurality of inductors and second correction circuit, respectively; and

a second switch responsive to DC loop current for selectively passing current therethrough, said second switch being electrically disposed between said third and fourth common points;

wherein said second switch is magnetically coupled to at least one of said winding elements.

49. The telecommunications filter circuit of claim 45, further comprising a capacitor disposed in electrical series with said first switch.

50. An impedance blocking filter circuit used in telecommunication systems for interconnecting between

incoming telephone lines and customer's terminal equipment so as to unconditionally block impedances from above a prescribed frequency due to the customer's terminal equipment from an ADSL network unit and/or home networking interface unit, said filter circuit comprising:

a first plurality of inductive elements disposed substantially in electrical series between a first input terminal and a first common point;

a second plurality of inductive elements disposed substantially in electrical series between a second input terminal and a second common point;

at least one switch adapted to selectively alter its conduction in response to DC loop current;

at least one capacitor disposed substantially in series with said at least one switch, said at least one capacitor and switch being disposed electrically between second first and second common points; and

at least one correction circuit disposed electrically between at least one of said common points and at least one of said output terminals and adapted to significantly reduce return loss caused by inductive impedance when the customer's terminal equipment goes off-hook.

51. An impedance blocking filter circuit used in telecommunication systems for interconnecting between incoming telephone lines and customer's terminal equipment so as to unconditionally block impedances from above 20 KHz due to the customer's terminal equipment from an ADSL network unit and/or home networking interface unit, said filter circuit comprising:

first, second, and third inductors (L5,L3,L1) connected in series between a first input

terminal(66) and a first common point(A);

said first inductor(L5) having its one end connected to said first input terminal and its other end connected to one end of said second inductor(L3), said second inductor having its other end connected to one end of said third inductor(L1), said third inductor having its other end connected to said first common point;

fourth, fifth, and sixth inductors (L5,L3,L1) connected in series between a second input terminal(68) and a second common point(B);

said fourth inductor(L6) having its one end connected to said second input terminal and its other end connected to one end of said fifth inductor(L4), said fifth inductor having its other end connected to one end of said sixth inductor(L2), said sixth inductor having its other end connected to said second common point;

first switching means(K1) having a first end and a second end and being responsive to DC loop current for electrically connecting said first end to said second end;

a capacitor(C1) having a first end connected to said first common point and a second end connected to said first end of said switching means, said second end of said switching means being connected to said second common point; and

correction circuit means (TC1,TC2) interconnected between said common points and said output terminals for significantly reducing return loss caused by inductive impedance when the customer's terminal equipment goes off-hook.

52. An impedance blocking filter circuit used in telecommunication systems for interconnecting between incoming telephone lines and customer's terminal

equipment so as to unconditionally block impedances from above 20 KHz due to the customer's terminal equipment from an ADSL network unit and/or home networking interface unit, said filter circuit comprising:

first, second, and third inductors (L5,L3,L1) connected in series between a first input terminal (66) and a first common point(A);

said first inductor (L5) having its one end connected to said first input terminal and its other end connected to one end of said second inductor(L3), said second inductor having its other end connected to one end of said third inductor(L1), said third inductor having its other end connected to said first common point;

fourth, fifth, and sixth inductors (L6,L4,L2)connected in series between a second input terminal (68) and a second common point(B);

said fourth inductor (L6) having its one end connected to said second input terminal and its other end connected to one end of said fifth inductor (L4), said fifth inductor having its other end connected to one end of said sixth inductor, said sixth inductor having its other end connected to said second common point;

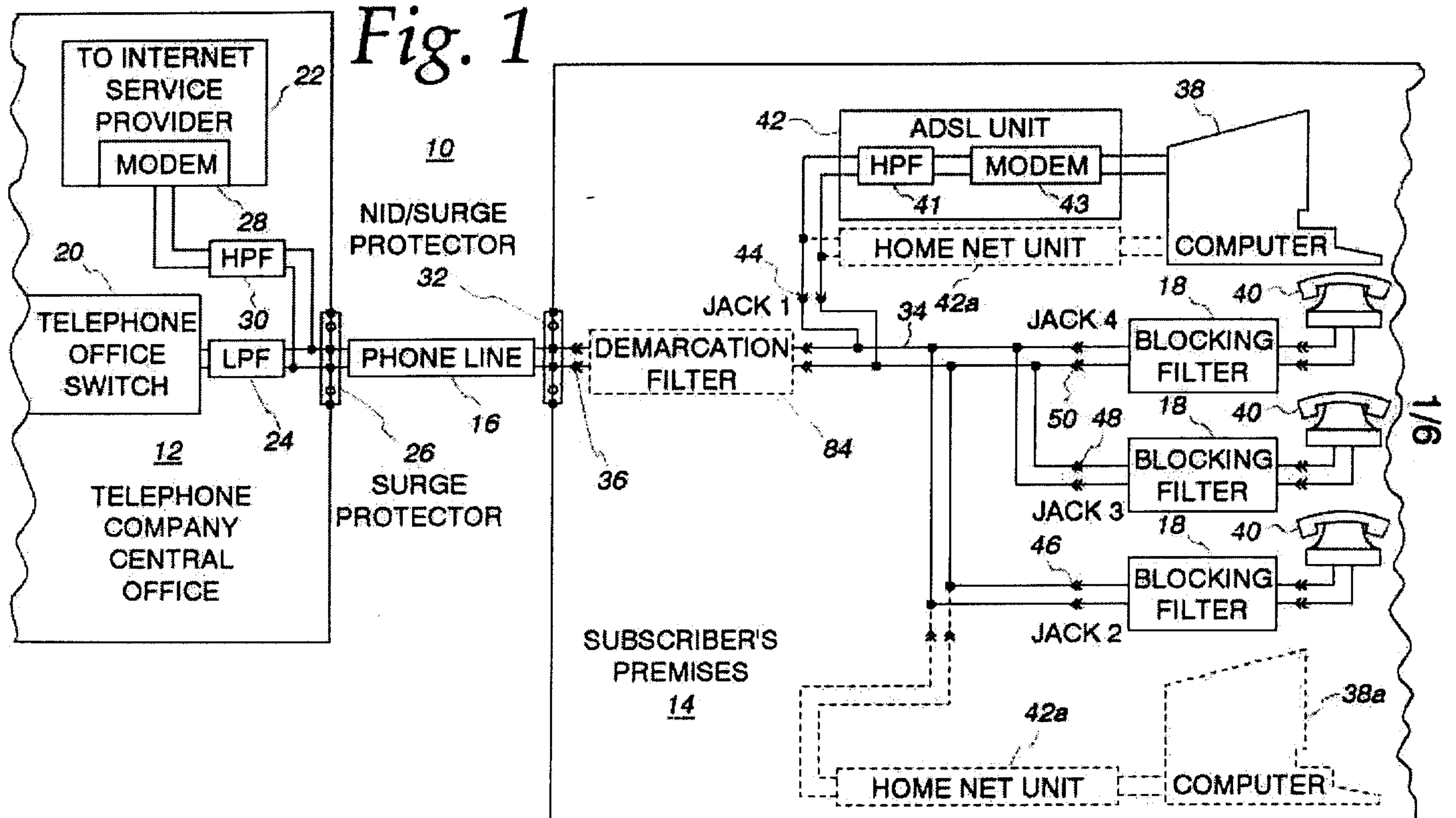
first switching means (K1) having a first end and a second end and being responsive to DC loop current for electrically connecting said first end to said second end;

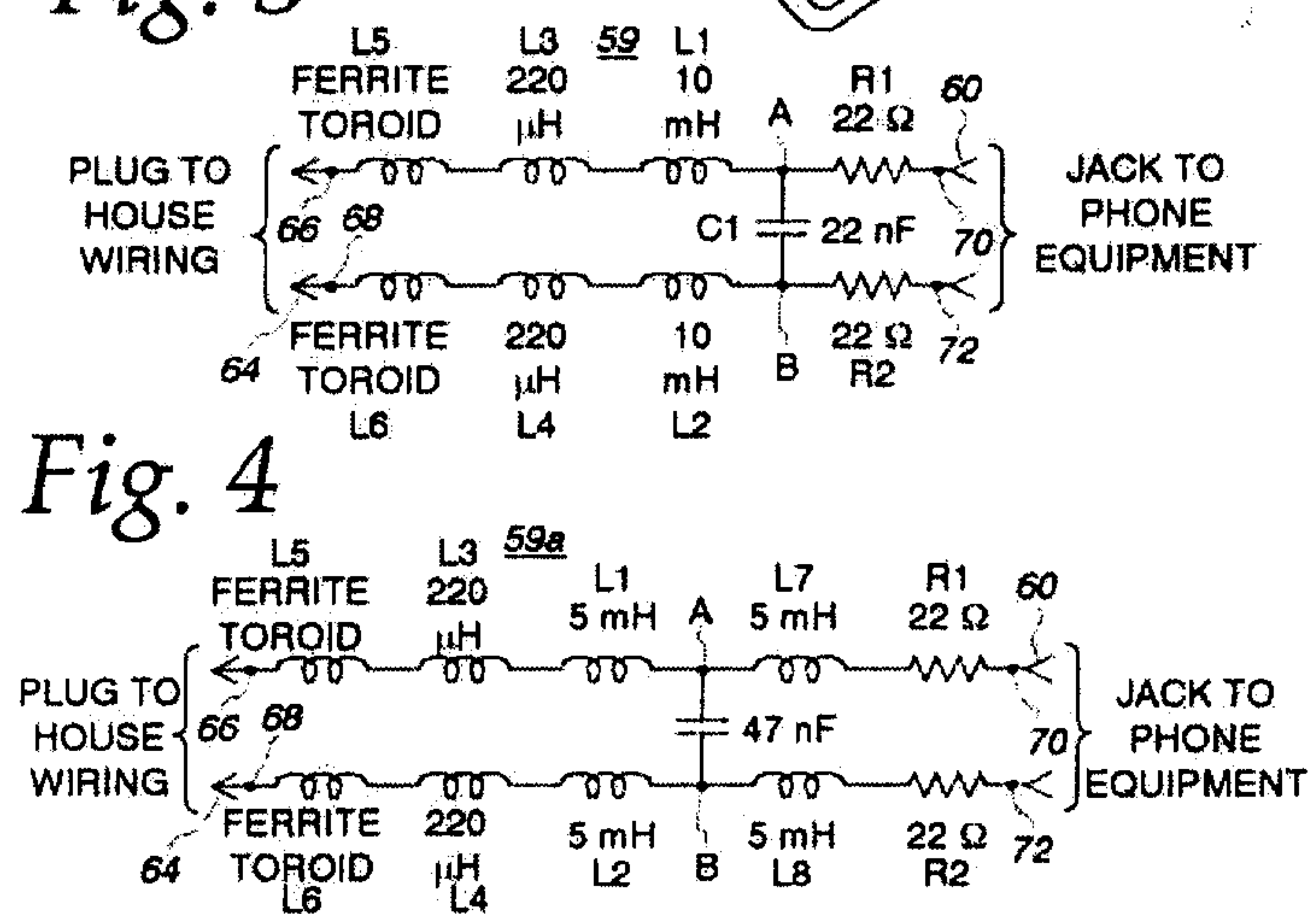
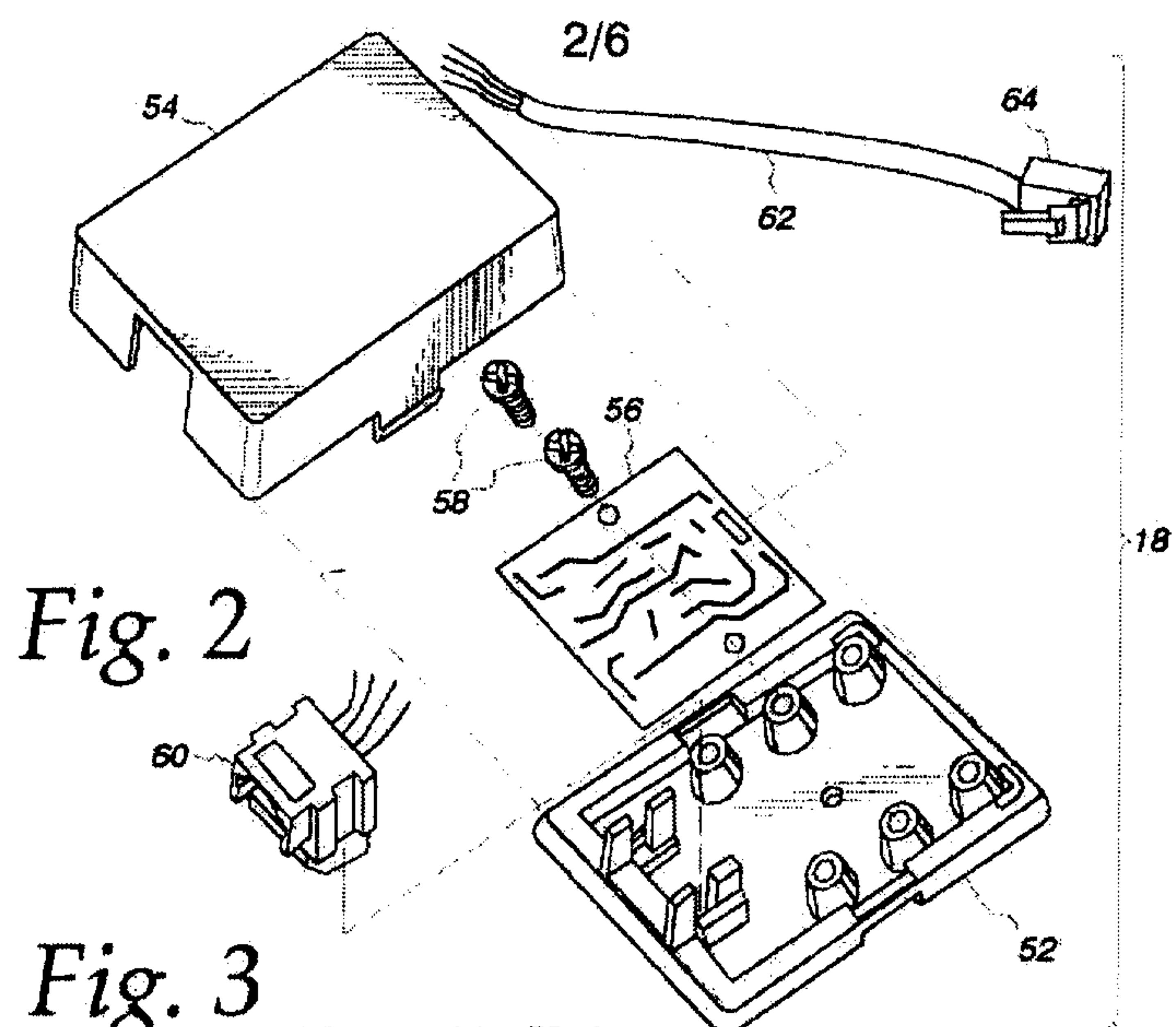
a capacitor (C1) having a first end connected to said first common point and a second end connected to said first end of said switching means, said second end of said switching means being connected to said second common point; and

bobbin means (T2) including at least a first narrow section (S1) on which is wound said second inductor, first wider section (S2,S3)on which are wound said third

inductor, a second narrow section (S4) on which is wound said fifth inductor, and second wider sections (S5,S6) on which are wound said sixth inductor for reducing interwinding capacitance so as to increase the useful frequency range, said bobbin means having a center portion for receiving said first switching means.

Fig. 1





3/6

Fig. 5

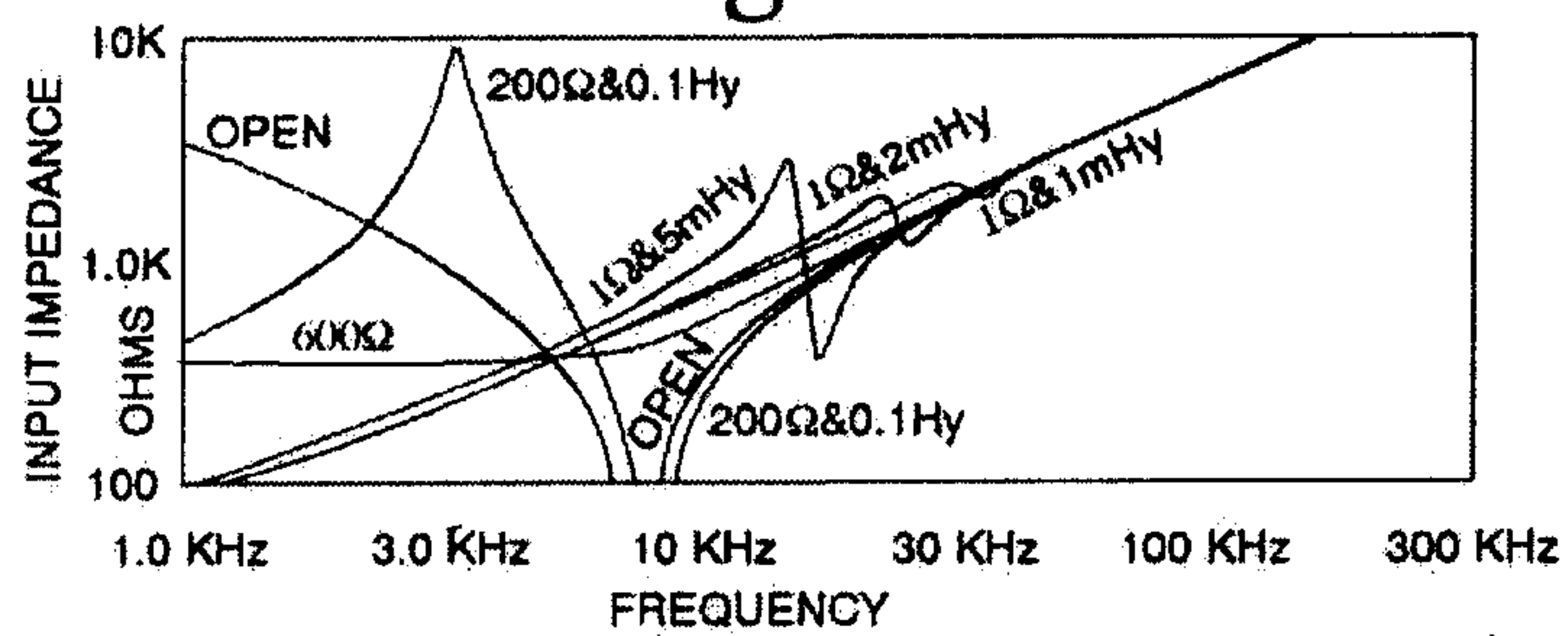


Fig. 6

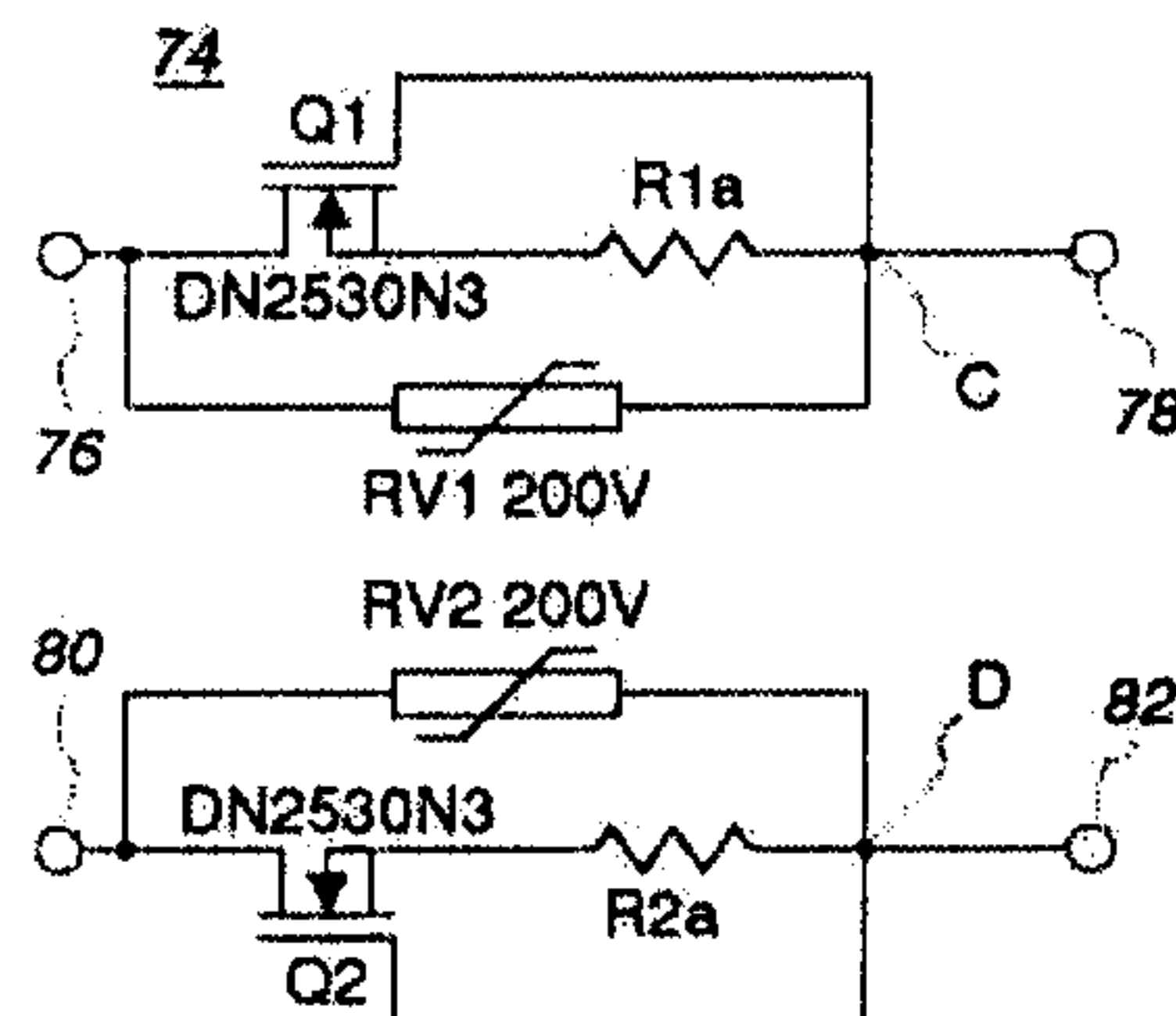


Fig. 7

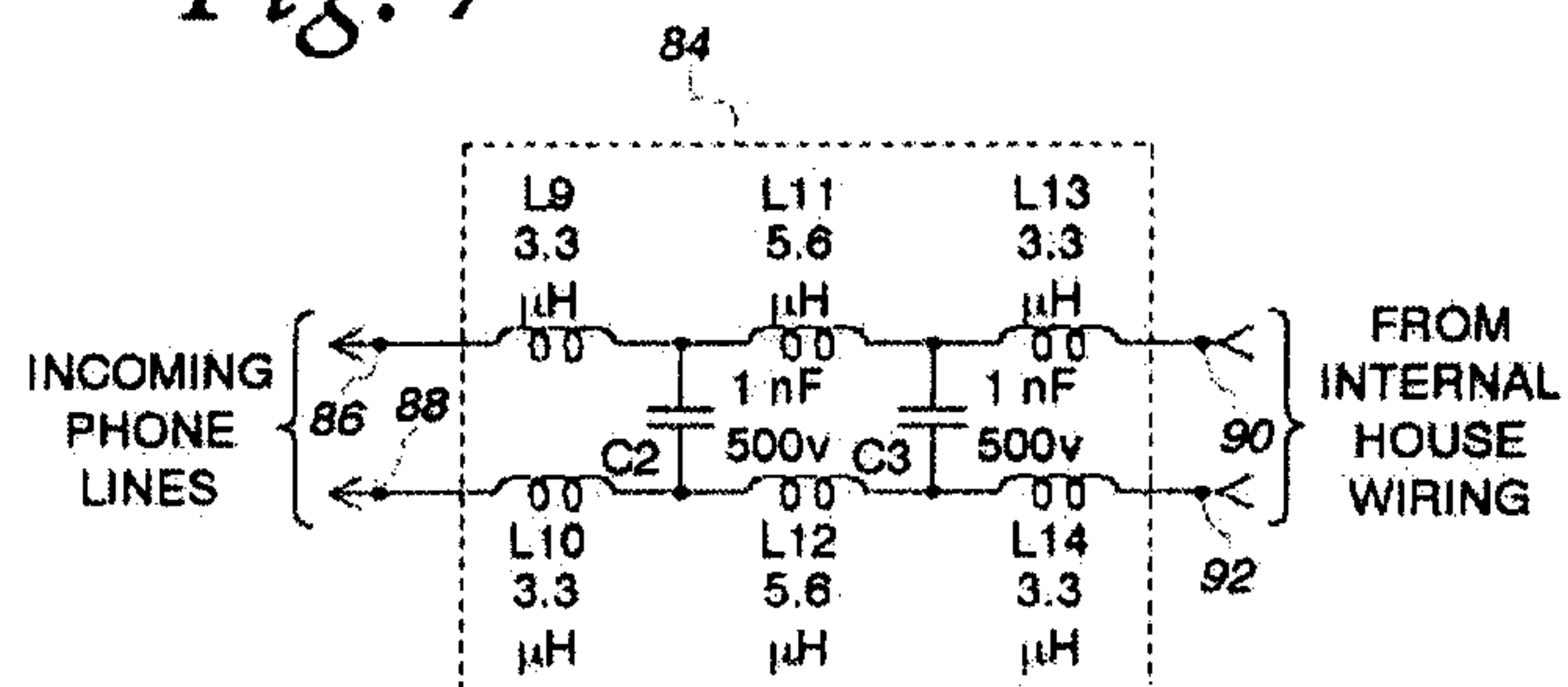
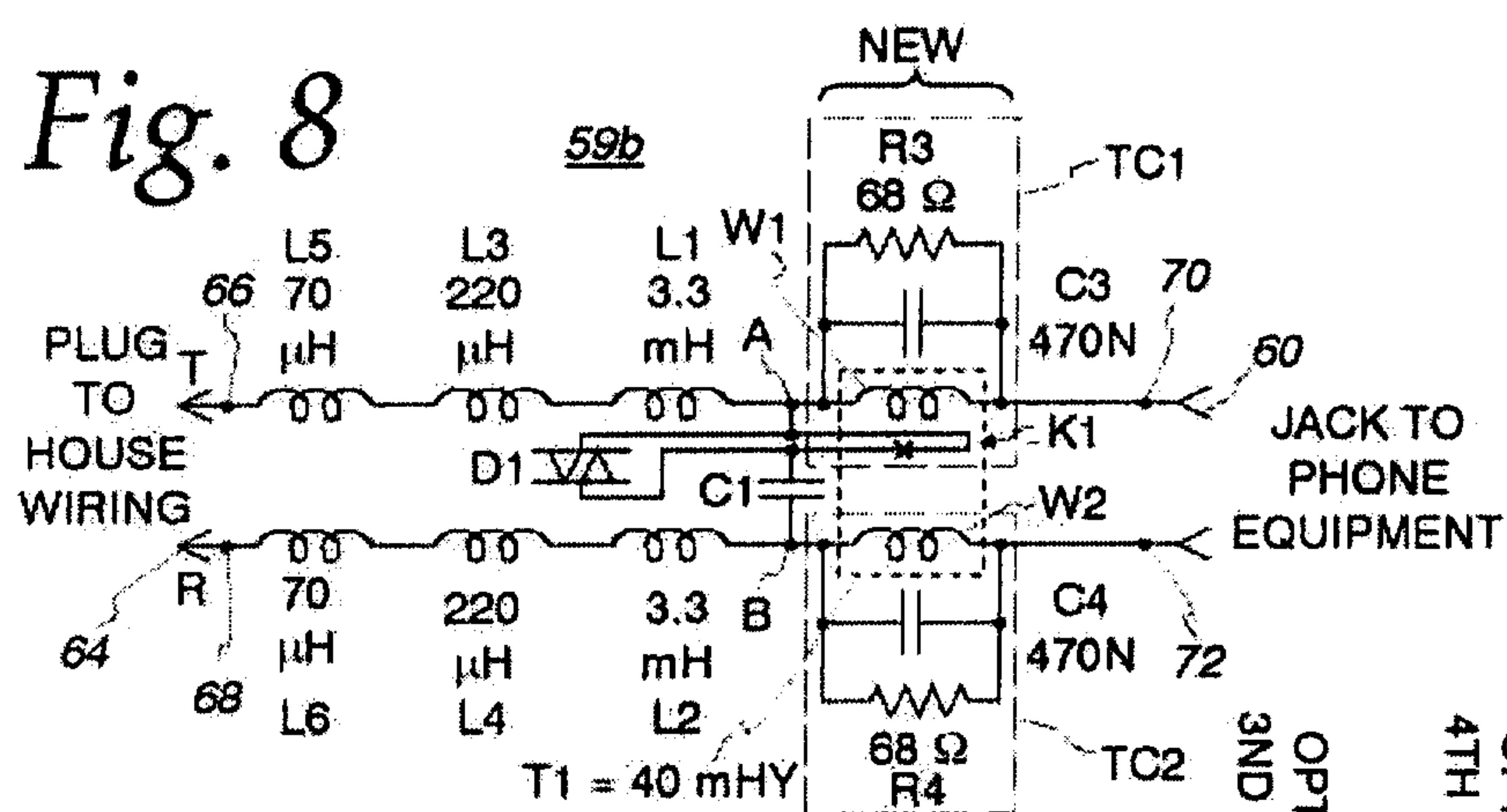
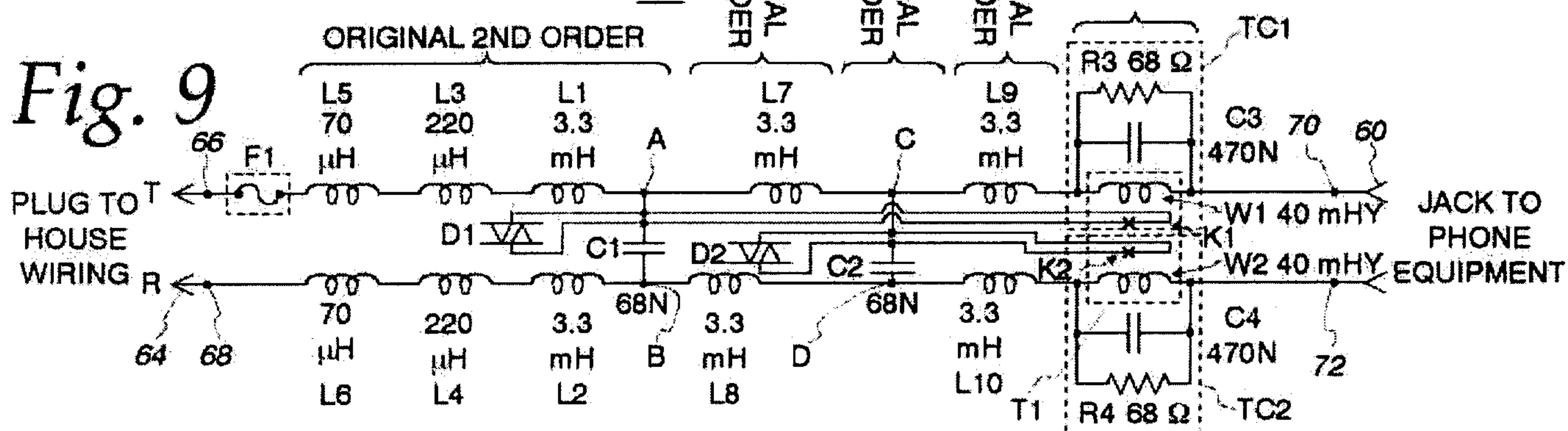


Fig. 8

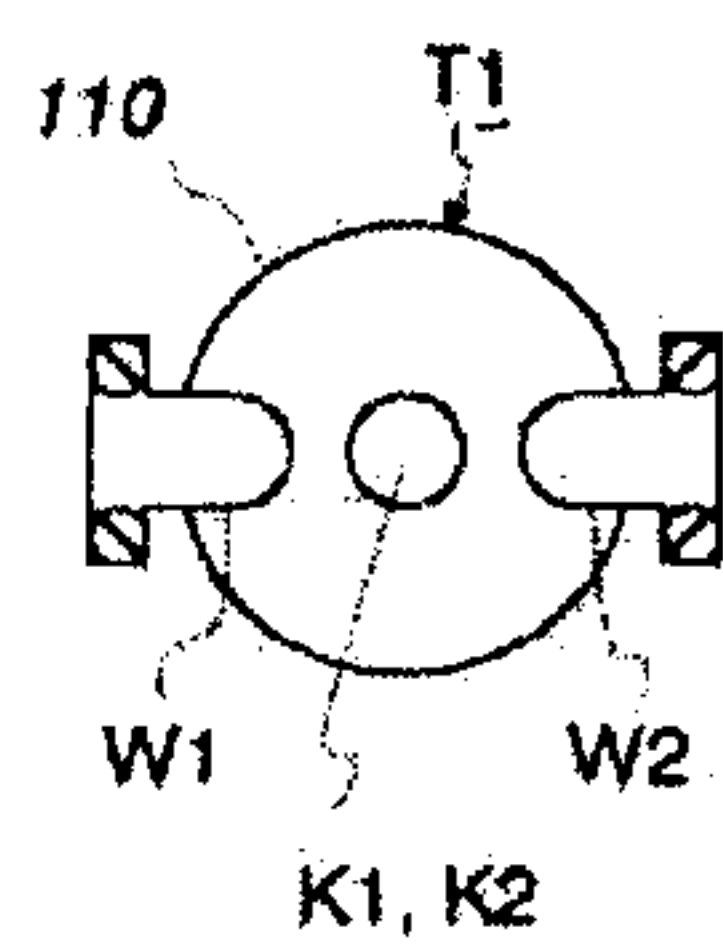
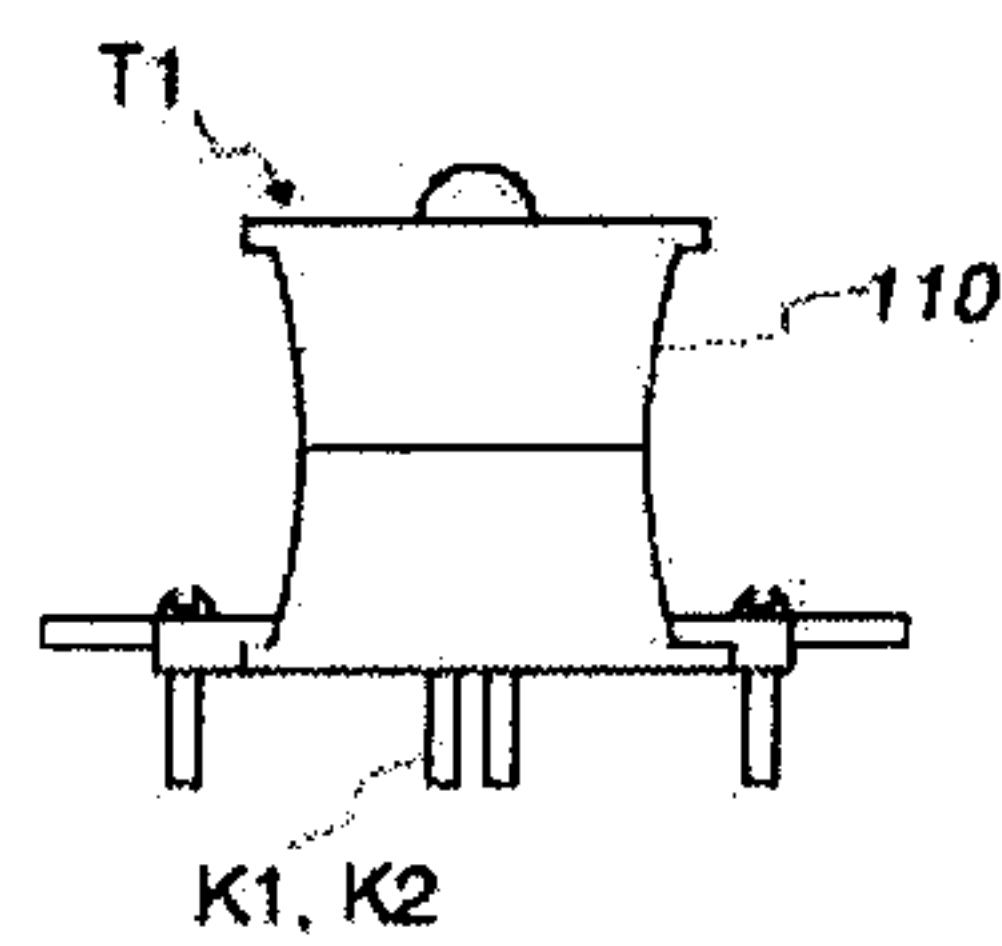
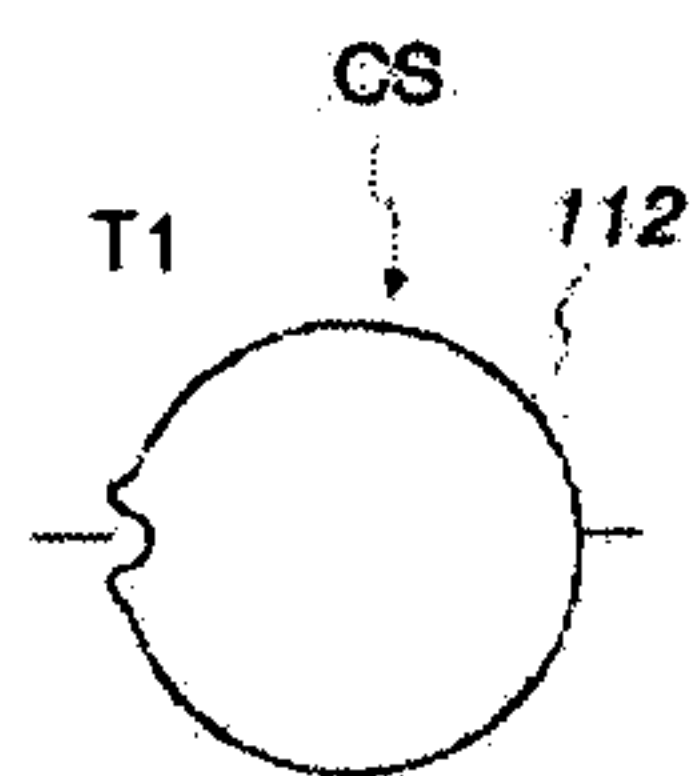
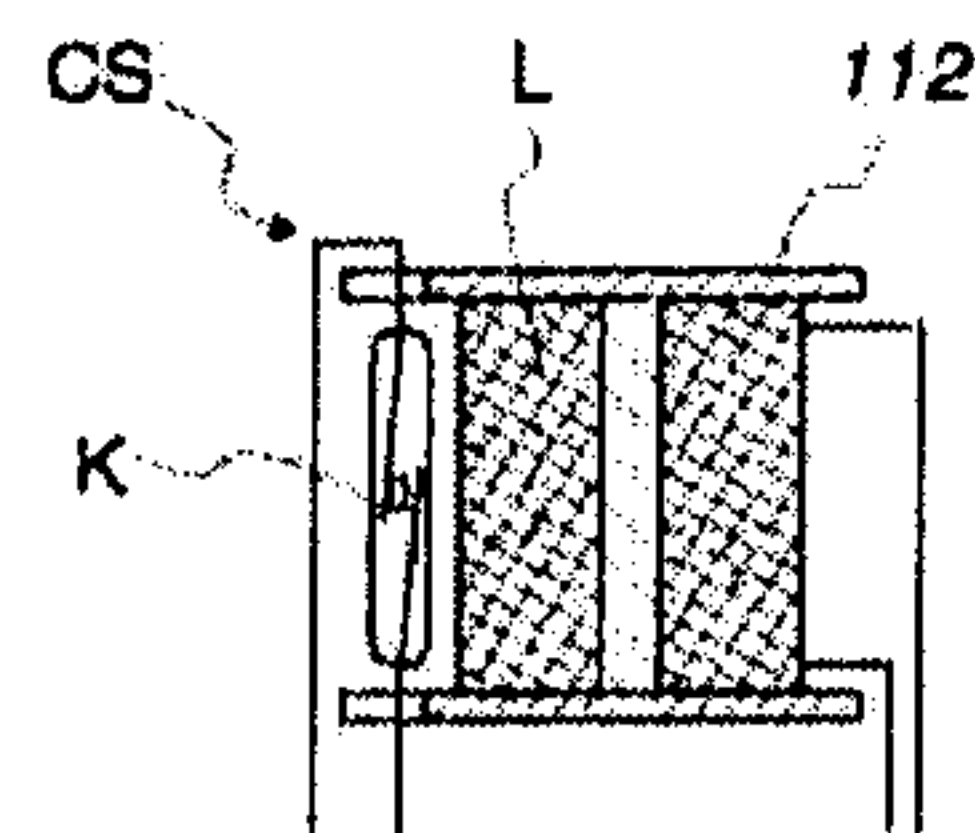


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Fig. 9



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Fig. 10(a)*Fig. 10(b)**Fig. 11(a)**Fig. 11(b)*

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