PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :		(11) International Publication Number:	WO 99/35838
H04N 7/10, H03H 7/46	A1	(43) International Publication Date:	15 July 1999 (15.07.99)

(21) International Application Number: PCT/US98/26177

(22) International Filing Date: 10 December 1998 (10.12.98)

(30) Priority Data:
09/005,649 12 January 1998 (12.01.98) US

(71) Applicant: GENERAL INSTRUMENT CORPORATION [US/US]; 101 Tournament Drive, Horsham, PA 19044 (US).

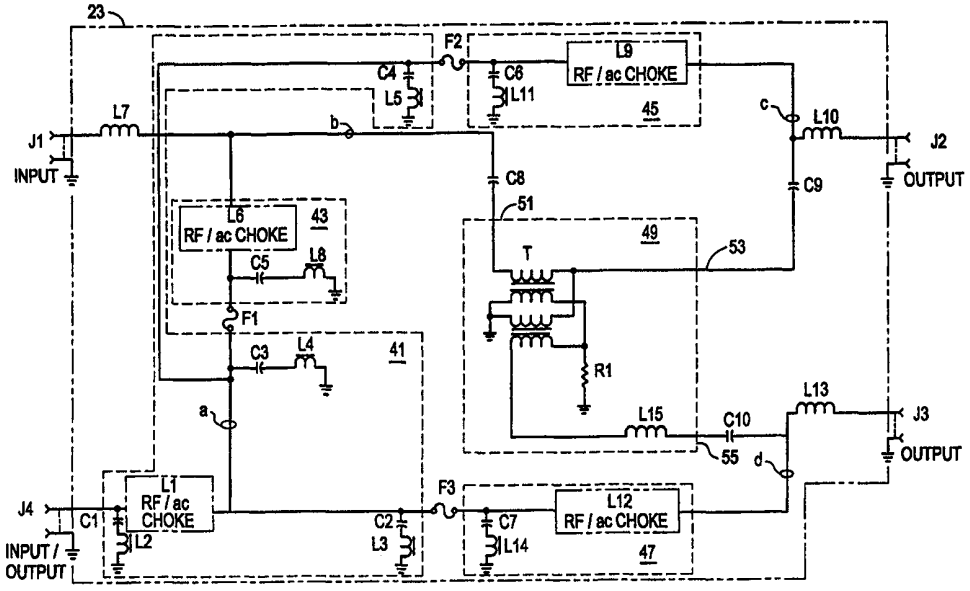
(72) Inventor: GRESKO, Richard; 1417 County Line Road, Huntingdon Valley, PA 19006 (US).

(74) Agents: VOLPE, Anthony, S. et al.; Volpe and Koenig, P.C., 400 One Penn Center, 1617 John F. Kennedy Boulevard, Philadelphia, PA 19103 (US).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: CATV PASSIVE COMPONENT WITH RF SPLITTER AND POWER ADDING/REMOVAL PORT



(57) Abstract

A CATV passive signal component is disclosed performing bidirectional power insertion or extraction while providing directional RF signal splitting. The signal splitter presents a low burden to the distribution system and can bidirectionally pass alternating or direct current already impressed on the RF signal, or provide an insertion or extraction function.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

CATV PASSIVE COMPONENT WITH RF SPLITTER AND POWER ADDING/REMOVAL PORT

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates generally to cable television communication system distribution components. More particularly, the invention relates to a passive signal component that obviates standard CATV power inserters by permitting power insertion or extraction in either direction of a bidirectional cable television communication system.

Description of the Prior Art

Many different types of cable television (CATV) communication systems exist providing a large diversity of services. Conventional one-way CATV systems primarily provide broadcast video services, which are sent over a CATV transmission network in a downstream direction, from a headend of a CATV network to a plurality of subscriber terminals. Bidirectional CATV systems allow subscribers to interact with their programming providers which have become commonplace in the industry as the diversity of services has grown. New services that are under development will rely on the full use and deployment of the return path communication.

The CATV transmission network usually comprises a trunk system designed for the bulk transport of the plurality of CATV services. Bridging amplifiers are used to feed signals from the trunk system to a distribution system, then onto individual subscriber drops.

A CATV transmission distribution plant includes coaxial cables, signal couplers/splitters, amplifiers, and subscriber taps. When placed in the signal path, passive transmission devices attenuate the signal. Normally, the system is designed with unity gain from the headend to each subscriber terminal, taking into account the signal losses throughout the trunk, branch lines and subscriber drops. As the signal proceeds along the distribution system, the attenuation of the coaxial cable and the burden of passive devices reduces the signal to a level such that amplification may be required. Line extender amplifiers, which provide the amplification, require a source of power.

The line amplifiers are usually suspended by the signal carrying coaxial cable support strand between telephone poles and are powered from the signal coaxial cable. Rather than distributing the power with separate power cables, alternating current is periodically inserted into the signal carrying coaxial cable via CATV power inserters.

A power inserter impresses the alternating current source on the coaxial cable without interfering with the RF signal. The power inserter houses a low pass filter for 60 cycle, 60 Vac and a band rejection filter for the RF signal present on the coaxial cable. The power inserter, namely the filter network, is located in a weather and RFI proof housing and is also suspended on the cable strand. Pole mounted ferroresonant transformers provide the reduction and isolation of the local utility power supply to the power inserter. The line amplifier separates the RF signal from the impressed 60

Vac with a low pass filter to rectify the current for use in powering the amplifier. A high pass filter passes the RF signal to the amplifier gain stages.

Rather than using a separate device for power insertion, it is desirable to include power insertion or extraction at the signal splitters.

To reduce the complexity of CATV distribution systems and further increase installation flexibility and overall performance, it is desirable to include more power insertion options in standard CATV signal splitters.

SUMMARY OF THE INVENTION

A CATV signal component is presented that allows direct, bidirectional power insertion or extraction while providing RF signal splitting. The signal splitter has a low burden on the distribution system and can bidirectionally pass alternating or direct current already impressed on the RF signal or provide an insertion or extraction function.

Accordingly, it is an object of the present invention to provide a CATV signal splitter with a power port.

It is a further object of the invention to provide a signal splitter while allowing either power insertion or extraction with a minimal system burden.

Other objects and advantages of the signal component will become apparent to those skilled in the art after reading the detailed description of the preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram illustrating a typical CATV forward frequency/return frequency transmission distribution plant.

Figure 2 is a front view of a CATV enclosure embodying the present invention.

Figure 3 is a rear view of the removed face plate showing a typical circuit board layout for the present invention.

Figure 4 is an electrical schematic of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiment will be described with reference to the drawing figures where like numerals represent like elements throughout.

With reference to **Figure 1**, the topology of a typical CATV distribution plant **15** for distributing cable television signals downstream to a subscriber and for receiving return path messages from a subscriber CATV terminal **17** is shown. The CATV distribution plant **15** connects a headend to a plurality of subscribers through subscriber terminals **17**. The distribution plant **15** begins with a coaxial or fiber optic trunk line **19** coupled to the headend **21**. Some portions of the CATV plant may use optical fiber cable instead of coaxial transmission cables.

At points where the transmission cable divides, signal splitters/combiners **23** are installed. Drop lines **25**, branch lines **27** and trunk line **29** provide the bidirectional transport

medium between headend **21** and subscriber terminals **17** for the CATV system. Bidirectional signal amplifiers **31** are distributed throughout the cable plant **15** to boost and equalize a transmitted signal and insure that proper signal strength levels are maintained.

A frequency agile RF data return transmitter **33** is included in each terminal **17** and permits a subscriber to communicate with the headend **21** by transmitting messages in the return direction of the CATV plant **15**. The headend **21** includes a frequency agile RF data receiver **35** for receiving messages transmitted by multiple return transmitters **33**.

As shown in **Figure 2**, the present invention **23** includes an RF signal input port **P1**, first **P2** and second **P3** RF signal output ports and an alternating current input port **P4**. The device **23** is housed in a lightweight diecast aluminum alloy housing **37** with a rotatable faceplate **39** providing strand or pedestal mounting and RFI shielding. **Figure 3** shows the device **23** with the faceplate **39** removed and the circuit board visible. The four external ports **P1**, **P2**, **P3** and **P4** couple internally to a connector platform (not shown). The face plate plugs into the connector platform coupling the external ports to corresponding RF input jack **J1**, first **J2** and second **J3** output jacks and an alternating current input jack **J4**.

Referring now to **Figures 3** and **4**, the device **23** includes both power inserter and signal splitter functions. The power inserter includes the ac input, filtering and distribution, and coupling to the RF signal connections.

A three-pole **41** low-pass (low-frequency) filter is coupled to the signal terminal of the ac input jack **J4** and comprises first **C1**, second **C2**, third **C3** and fourth **C4** capacitors and a first inductor **L1** arranged in a pi-network with each capacitor having ferrite beads placed on one of their leads to prevent parasitic oscillations. The ferrite beads form corresponding second **L2**, third **L3**, fourth **L4** and fifth **L5** inductors. The pi-network provides low-pass filtering from an external alternating current power supply (not shown) which may be local to the device **23**.

At a first node **a**, the filtered alternating current is distributed by first **F1**, second **F2** and third **F3** fuses to their respective RF signal jacks **J1**, **J2** and **J3**. First **43**, second **45** and third **47** two-pole, low-pass filters are coupled between each fuse and RF signal jack to provide additional filtering.

A fifth **C5** capacitor and a sixth inductor **L5** comprise the first **43** two-pole low-pass filter. The first **43** filter is coupled to a seventh **L7** inductor at a second node **b** and to the first fuse **F1**. The seventh **L7** inductor is also coupled to the signal terminal of the RF input jack **J1**. A ferrite bead placed on one lead of the fifth capacitor **C5** forms an eighth **L8** inductor.

A sixth capacitor **C6** and a ninth inductor **L9** comprise the second **45** two-pole low-pass filter. The second **45** filter is coupled to a tenth **L10** inductor at a third node **c** and to the second fuse **F2**. The tenth **L10** inductor is also coupled to the signal terminal of the first RF output jack **J2**. A ferrite

bead placed on one lead of the sixth capacitor **C6** forms an eleventh **L11** inductor.

A seventh capacitor **C7** and a twelfth inductor **L12** comprise the third **47** two-pole low-pass filter. The third **47** filter is coupled to a thirteenth **L13** inductor at a fourth node **d** and to the third fuse **F3**. The thirteenth **L13** inductor is also coupled to the signal terminal of the second RF output jack **J3**. A ferrite bead placed on one lead of the seventh **C7** capacitor forms a tenth **L14** inductor.

The splitter **49** comprises a fifteenth **L15** inductor as a calculated load, a first resistor **R1** and an impedance matching transformer **T1**. The splitter **49** has an input **51** and first **53** and second **55** outputs and are coupled to each RF jack inductor **L7**, **L10**, and **L13**. The splitter **49** divides the RF signal while also inserting a calculated loss if required by the cable network design. The function of a splitter is well known to those skilled in the art of electronics and a functional discussion is beyond the scope of the present invention.

Eighth **C8**, ninth **C9** and tenth **C10** capacitors form one-pole high-pass filters passing the RF signals to and from the splitter while blocking the low frequency alternating current. The eighth **C8** capacitor is coupled between the splitter input **51** and second node **b**, the ninth **C9** capacitor is coupled between the first splitter output **53** and third node **c** and the tenth **C10** capacitor is coupled between the second splitter output **55** and the fourth **d** node.

Since the coaxial cable is a transmission line conveying high frequency signals, the splitting network permits the

division of the input signal without return reflection. The individual component values for the preferred embodiment are shown in **Table 1**.

TABLE 1

COMPONENT	SPECIFICATIONS	COMPONENT	SPECIFICATIONS
C1	0.047 μF, 400 Vac	L5	Ferrite Bead
C2	0.01 μF, 400 Vac	L6	Power Passing Choke
C3	0.01 μF, 400 Vac	L7	1½ Turns, ⅛ in. Dia.
C4	0.01 μF, 400 Vac	L8	Ferrite Bead
C5	0.047 μF, 400 Vac	L9	Power Passing Choke
C6	0.047 μF, 400 Vac	L10	1½ Turns, ⅛ in. Dia.
C7	0.047 μF, 400 Vac	L11	Ferrite Bead
C8	910 pF, 500 Vac	L12	Power Passing Choke
C9	820 pF, 300 Vac	L13	1½ Turns, ⅛ in. Dia.
C10	910 pF, 500 Vac	L14	Ferrite Bead
L1	Power Passing Choke	L15	1½ Turns, ⅛ in. Dia.
L2	Ferrite Bead	R1	82 Ω, ¼ W
L3	Ferrite Bead	T2	Splitter Transformer
L4	Ferrite Bead		

The present invention **23** routes the alternating current through the low-pass filters **41**, **43**, **45** and **47** between each jack **J1**, **J2**, **J3** and **J4**. The RF signal is passed between the RF signal jacks **J1**, **J2** and **J3** through the splitter **49**. The high frequency RF signals are blocked by the low-pass filters establishing a current path while the low frequency alternating current is blocked by high-pass filters (**C8**, **C9** and **C10**) establishing a signal path. The RF signal and alternating current paths are combined at the RF input **J1** and output jacks **J2** and **J3**. Power already present on the cable **27** at either the signal input **P1** or output ports **P2** and **P3** may

be accessed at the alternating current jack **J4** for powering other CATV equipment.

The ability to impress an alternating or direct current source onto a signal is well understood by those skilled in the art of electronics. The combining of the alternating current and RF signals at the signal jacks form a composite waveform with the RF signals carried on the low-frequency alternating current sine wave. The function of the various orders of low-pass filters removes the low frequency alternating current from the composite signal leaving behind the RF portion which are the CATV services. In the presently preferred embodiment, alternating current is used to provide power throughout the CATV infrastructure. It is also possible that direct current may be similarly impressed upon the signal creating an offset in the RF signal indicative of the voltage magnitude.

While the present invention has been described in terms of the preferred embodiment, other variations which are within the scope of the invention as outlined in the claims below will be apparent to those skilled in the art.

* * *

CLAIMS

1. A passive component for splitting RF frequencies and distributing an impressed current having a signal input port and a plurality of signal output ports comprising:

a splitter having an input and a plurality of outputs;

said splitter input coupled to the signal input port via an upstream power/signal separator circuit;

each of said splitter outputs are coupled to one of the plurality of output ports via a downstream power/signal separator circuits;

each said power/signal separator circuits having a signal connection, a power connection and a combined power/signal connection wherein said splitter is coupled to said signal connection of said power/signal separator circuits and said signal ports are coupled to said combined power/signal connections of said power/signal separator circuits;

the power connections of said power/signal separator circuits are coupled together to define a power node; and

said power node is coupled to a current port.

2. The passive component according to claim 1 further comprising a power filter coupled to said current port and to said power node.

3. The passive component according to claim 1 wherein said power/signal separator circuits further comprise:

a low-pass filter coupled between said power connection and said combined power/signal connection for blocking high frequencies and passing low frequencies; and

a high-pass filter coupled between said signal connection and said combined power/signal connection for passing high frequencies and blocking low frequencies.

4. The passive component according to claim 3 wherein said high-pass and said low-pass filters have predetermined responses determined by varying orders.

5. The passive component according to claim 1 wherein a calculated loss may be inserted in one or more of the plurality of splitter outputs.

6. The passive component according to claim 1 wherein said passive component has a defined signal direction from the signal input port to the plurality of output ports.

7. The passive component according to claim 2 wherein said power filter comprises a pi-network low-pass filter.

8. The passive component according to claim 7 wherein said pi-network low-pass filter has a predetermined response.

9. The passive component according to claim 1 whereby power extraction or insertion may be performed at said current port.

10. A CATV passive component for splitting RF frequencies and distributing an impressed current having a signal input port and a plurality of signal output ports comprising:

a splitter having an input and a plurality of outputs;

said splitter input coupled to the signal input port via an upstream power/signal separator circuit;

each of said splitter outputs are coupled to one of the plurality of output ports via a downstream power/signal separator circuits;

each said power/signal separator circuits having a signal connection, a power connection and a combined power/signal connection wherein said splitter is coupled to said signal connection of said power/signal separator circuits and said signal ports are coupled to said combined power/signal connections of said power/signal separator circuits;

the power connections of said power/signal separator circuits are coupled together to define a power node; and

said power node is coupled to a current port.

11. The CATV passive component according to claim 10 further comprising a power filter coupled to said current port and to said power node.

12. The CATV passive component according to claim 10 wherein said power/signal separator circuits further comprise:

a low-pass filter coupled between said power connection and said combined power/signal connection for blocking high frequencies and passing low frequencies; and

a high-pass filter coupled between said signal connection and said combined power/signal connection for passing high frequencies and blocking low frequencies.

13. The CATV passive component according to claim 12 wherein said high-pass and said low-pass filters have predetermined responses determined by varying orders.

14. The CATV passive component according to claim 10 wherein a calculated loss may be inserted in one or more of the plurality of splitter outputs.

15. The CATV passive component according to claim 10 wherein said passive component has a defined signal direction from the signal input port to the plurality of output ports.

16. The CATV passive component according to claim 11 wherein said power filter comprises a pi-network low-pass filter.

17. The CATV passive component according to claim 16 wherein said pi-network low-pass filter has a predetermined response.

18. The CATV passive component according to claim 10 whereby power extraction or insertion may be performed at said current port.

FIG.1

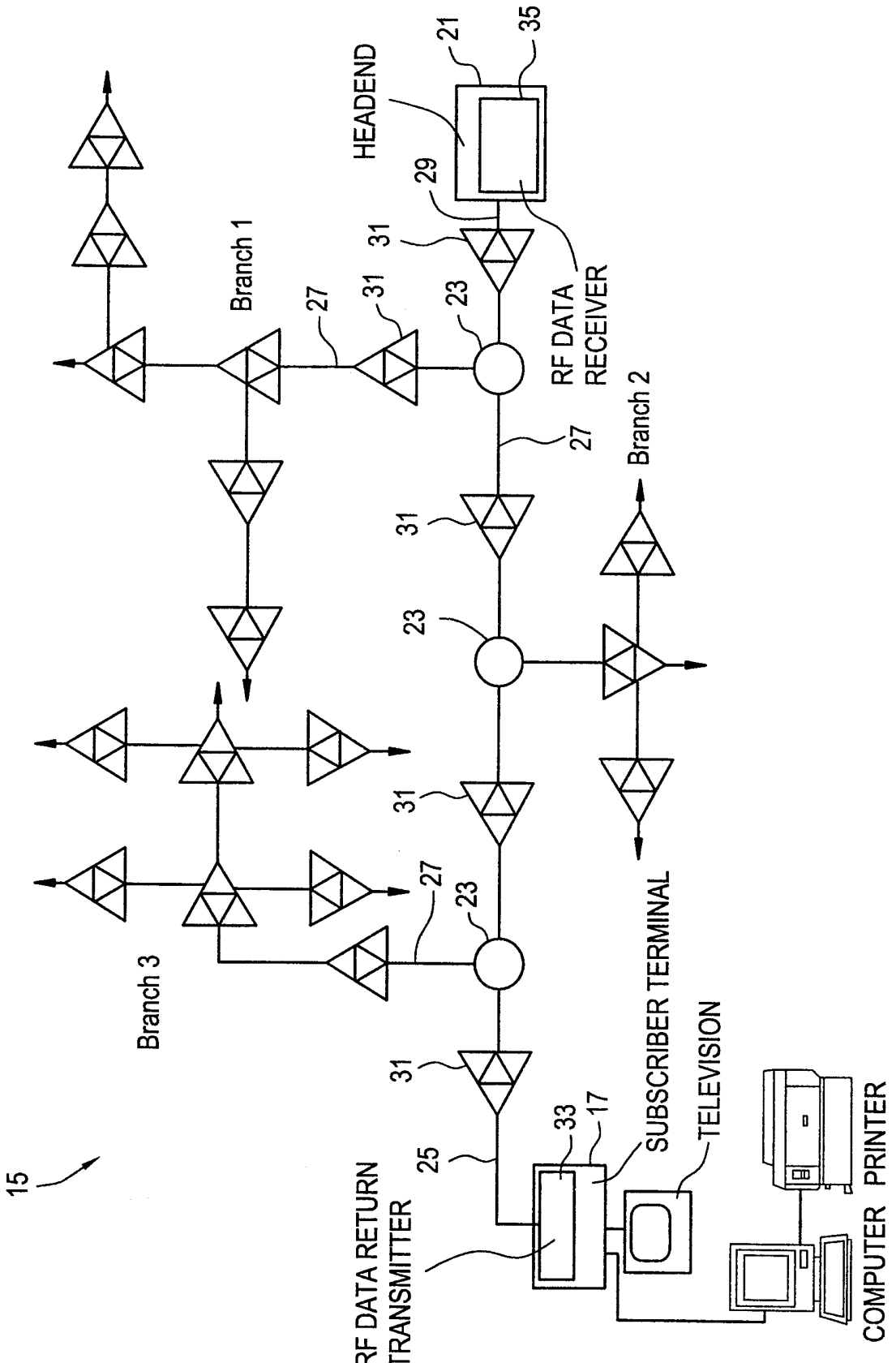

15
HEADEND
21
35
29
31
RF DATA RECEIVER
23
27
Branch 1
Branch 2
Branch 3
RF DATA RETURN TRANSMITTER
25
33
17
SUBSCRIBER TERMINAL
TELEVISION
COMPUTER
PRINTER

FIG.2

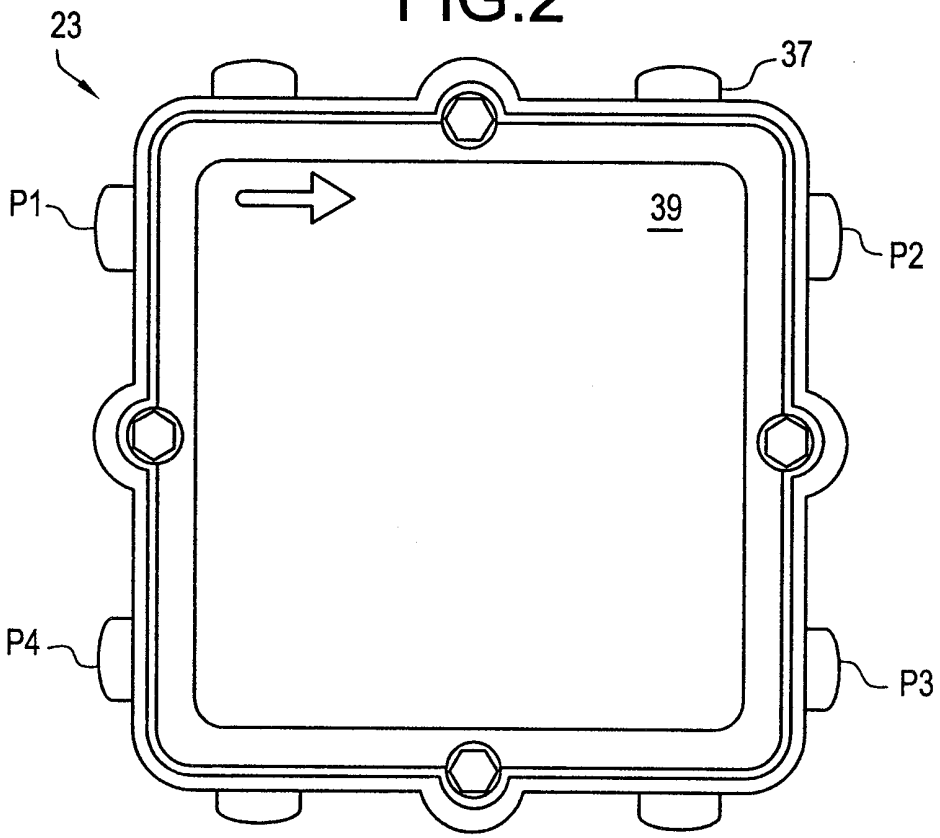

23
37
P1
39
P2
P4
P3

FIG.3

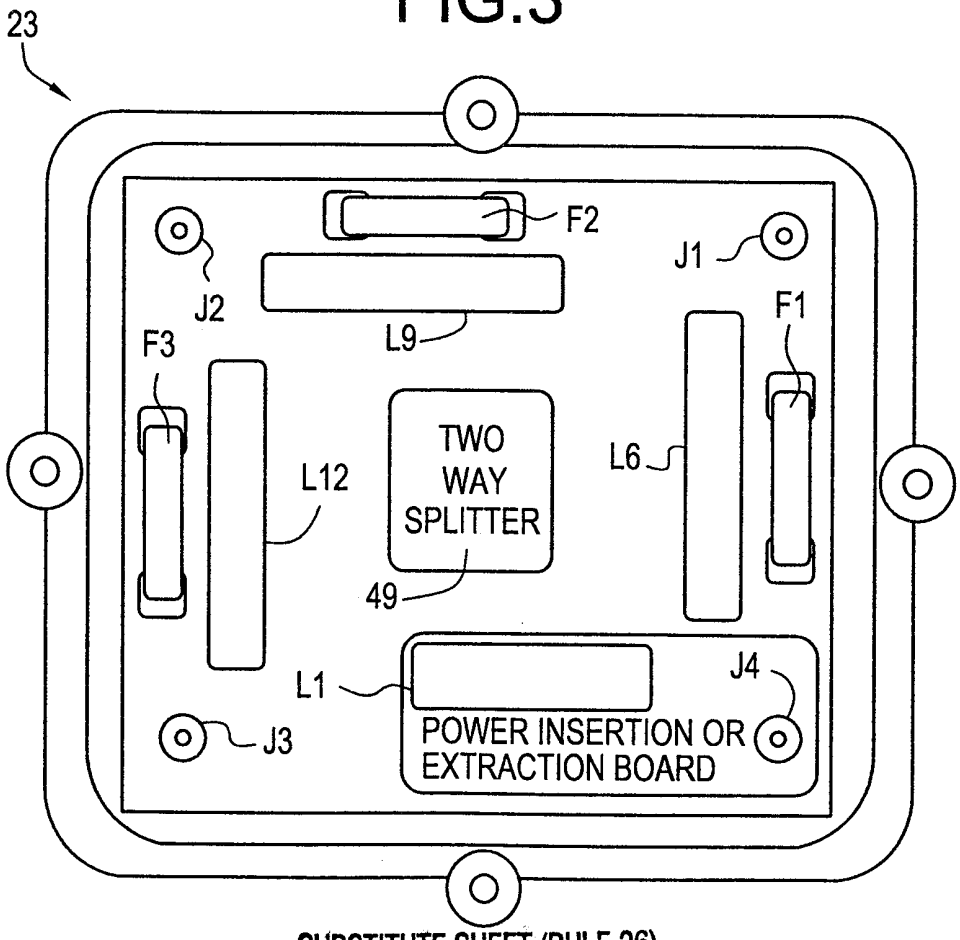
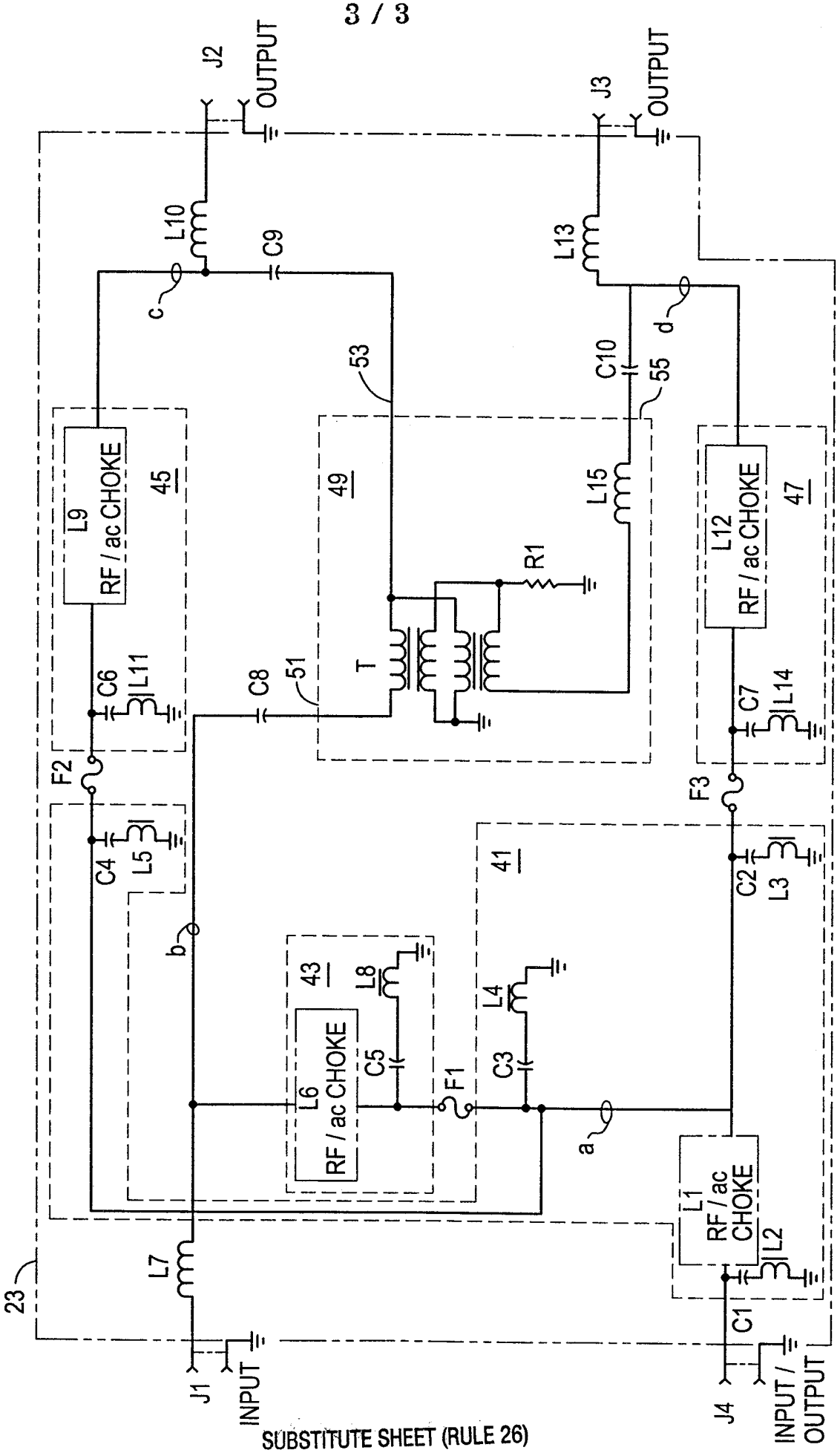

23
F2
J1
J2
F1
L9
F3
L12
TWO
WAY
SPLITTER
L6
49
L1
J4
J3
POWER INSERTION OR
EXTRACTION BOARD

FIG.4


J2
OUTPUT
J3
OUTPUT
L10
C9
L13
c
d
C10
53
55
49
L15
R1
45
L9
RF / ac CHOKE
47
L12
RF / ac CHOKE
C6
L11
C8
51
T
C7
L14
F2
F3
C4
L5
41
C2
L3
b
43
L8
L4
L6
RF / ac CHOKE
C5
F1
C3
a
L1
RF / ac CHOKE
L2
L7
23
C1
J1
INPUT
J4
INPUT / OUTPUT

INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/US 98/26177

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04N7/10 H03H7/46

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04N H03H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 671 885 A (PENNYPACKER FRANK C) 20 June 1972 see column 5, line 65 - column 9, line 55; figures 5-13 ---	1,10
A	WO 97 32438 A (ERICSSON RAYNET) 4 September 1997 see page 3, line 34 - page 4, line 19 see page 9, line 1 - page 10, line 34; figures 3,4 ---	1,10
A	WO 97 47082 A (JELINEK CATHERINE W ;PALAZZO MARK A (US); VOGT STEPHAN W (US); SCI) 11 December 1997 see the whole document ---	1,10

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 February 1999	26/02/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Beaudoin, O

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/US 98/26177

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	WO 96 10853 A (ROSE WALTER GMBH & CO KG ;RAYCHEM LTD (GB); TOURNEL WILLY (BE); KO) 11 April 1996 see page 2, line 22 - page 3, line 24; figure 1	1,10

1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter ɔnal Application No
PCT/US 98/26177

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3671885 A	20-06-1972	CA 899475 A	02-05-1972
		CA 909892 A	12-09-1972
		US 3747028 A	17-07-1973
WO 9732438 A	04-09-1997	US 5845190 A	01-12-1998
		AU 1965797 A	16-09-1997
WO 9747082 A	11-12-1997	AU 3373697 A	05-01-1998
WO 9610853 A	11-04-1996	AU 701374 B	28-01-1999
		AU 3571795 A	26-04-1996
		BR 9509225 A	27-01-1998
		EP 0784879 A	23-07-1997
		HU 77151 A	02-03-1998
		JP 10506499 T	23-06-1998