US 20140062589A1

(19) United States

(12) Patent Application Publication

Schenk

(10) Pub. No.: US 2014/0062589 A1

(43) Pub. Date: Mar. 6, 2014

(54) QUASI-BROADBAND DOHERTY AMPLIFIER WITH ASSOCIATED CAPACITOR CIRCUIT

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(21) Appl. No.: **14/115,061**

(22) PCT Filed: **Apr. 17, 2012**

(86) PCT No.: **PCT/EP2012/056989**

§ 371 (c)(1), (2), (4) Date: **Oct. 31, 2013**

(30) **Foreign Application Priority Data**

May 5, 2011 (DE) 10 2011 075 312.5

Publication Classification

(51) **Int. Cl.**

H03F 1/02 (2006.01)

H03F 3/68 (2006.01)

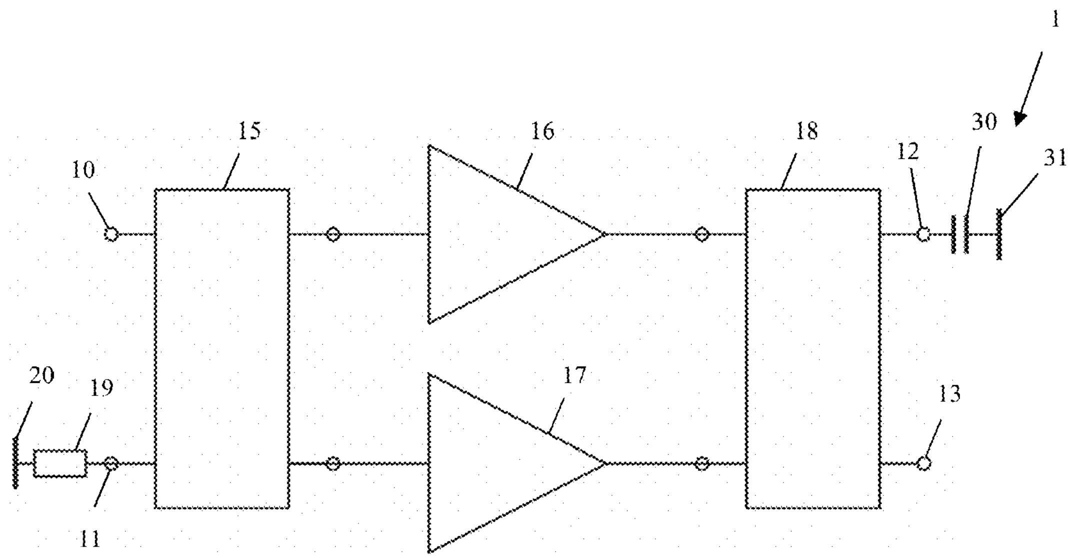
(52) **U.S. Cl.**

CPC ... ***H03F 1/02*** (2013.01); ***H03F 3/68*** (2013.01)

USPC .... **330/124 R**; 361/290

(57) **ABSTRACT**

An amplifier provides a first amplifier circuit (**16**), a second amplifier circuit (**17**), a first hybrid-coupler circuit (**18**) and a termination (**3**). The hybrid-coupler circuit (**18**) provides an output terminal (**13**) and an insulation terminal (**12**). In this context, the termination (**3**) is connected to the insulation terminal (**12**) of the hybrid-coupler circuit (**18**). The termination (**3**) comprises a first capacitor (**34**) and/or an inductance (**35**), which is disposed directly at the insulation terminal (**12**) of the hybrid-coupler circuit (**18**).



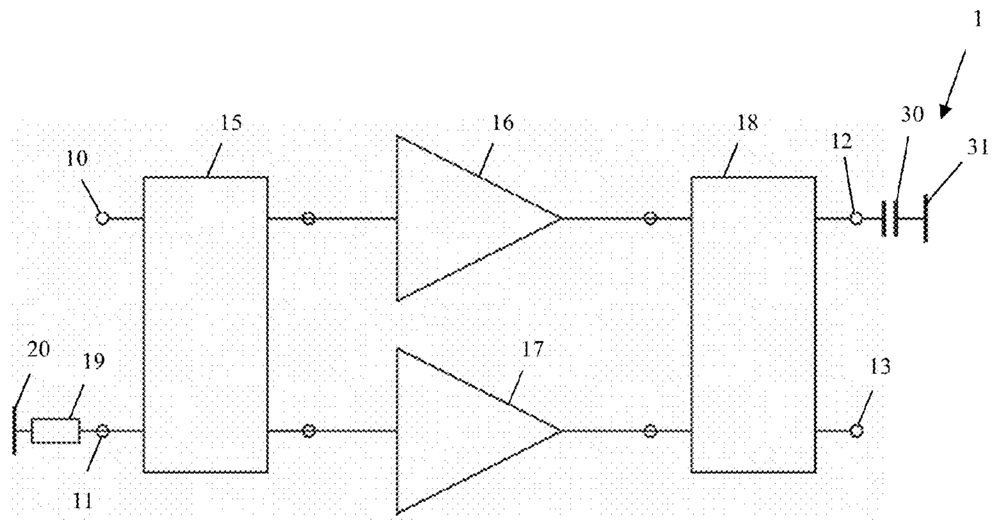

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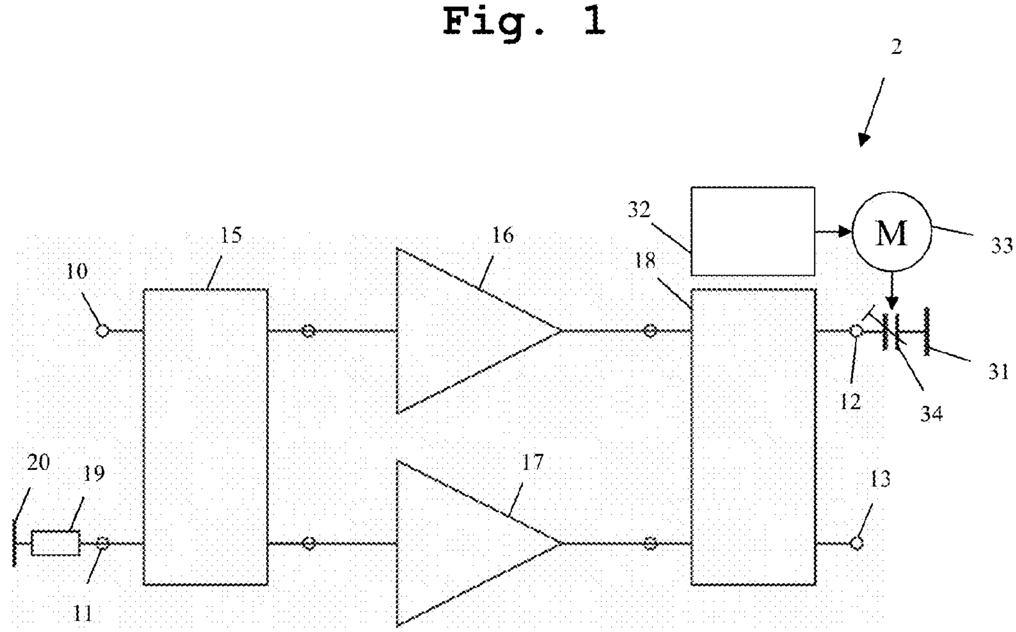
Fig. 1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32
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Fig. 2

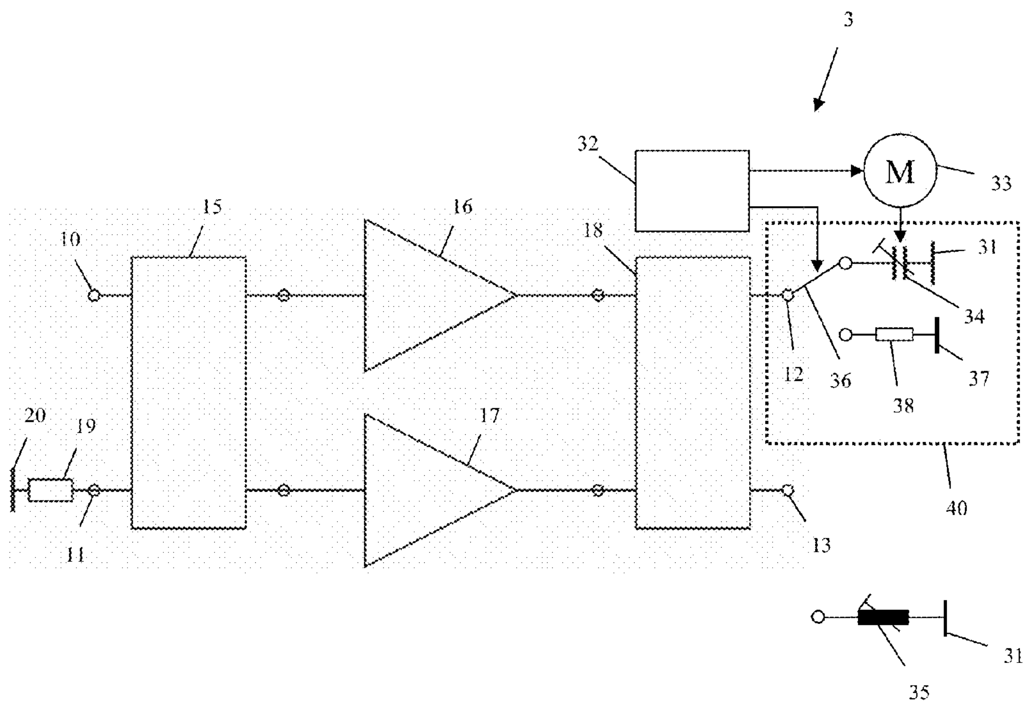

Fig. 3

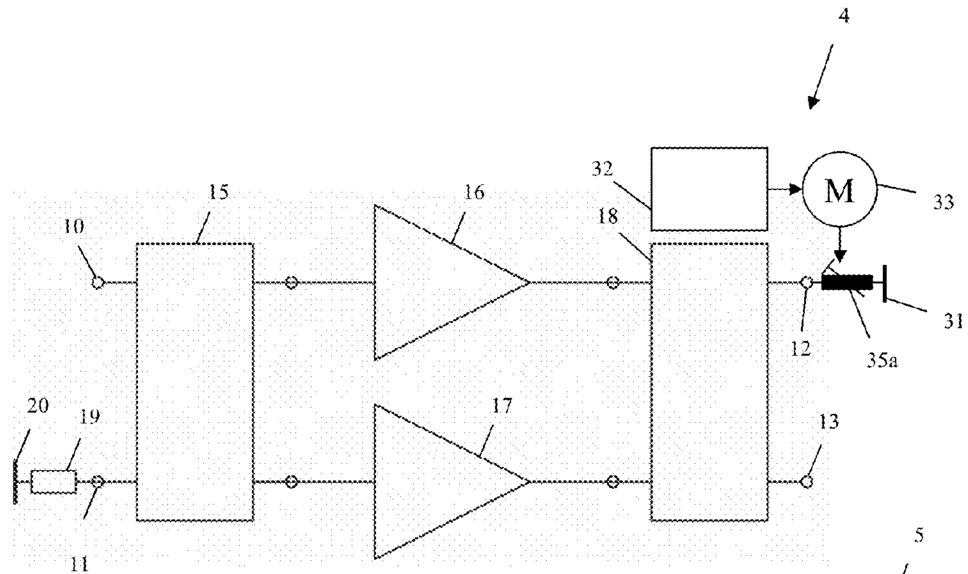
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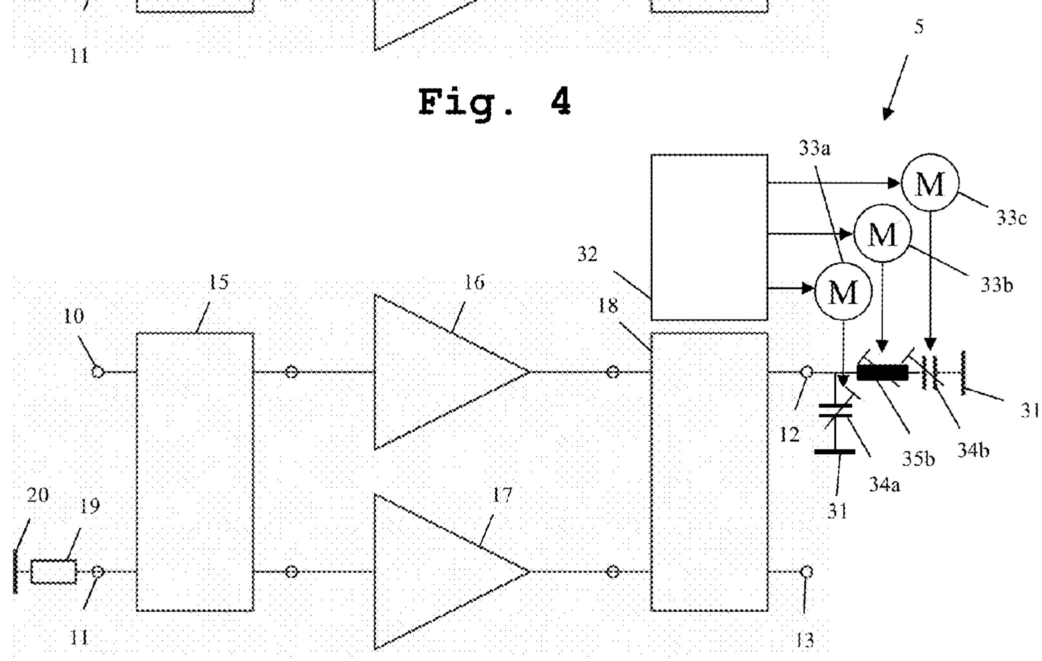
Fig. 4


5
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33c
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Fig. 5

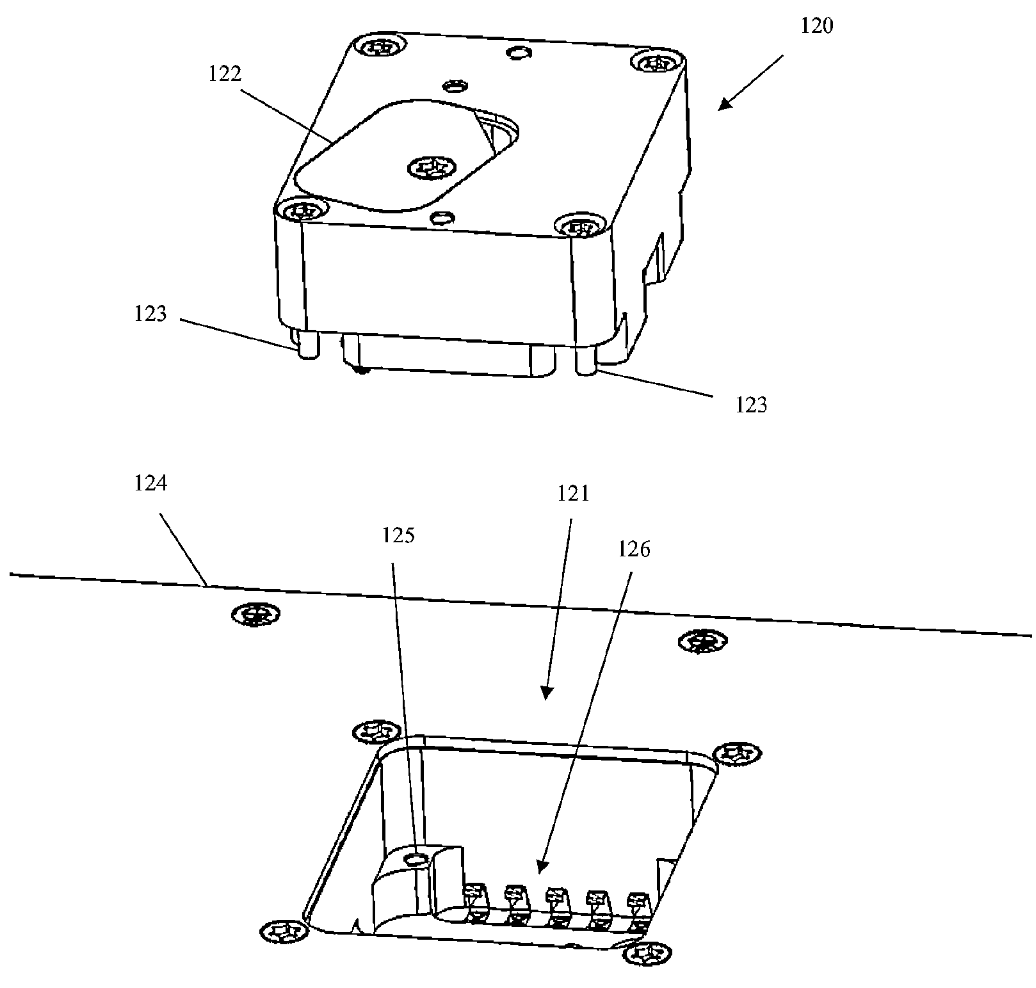

Fig. 6a

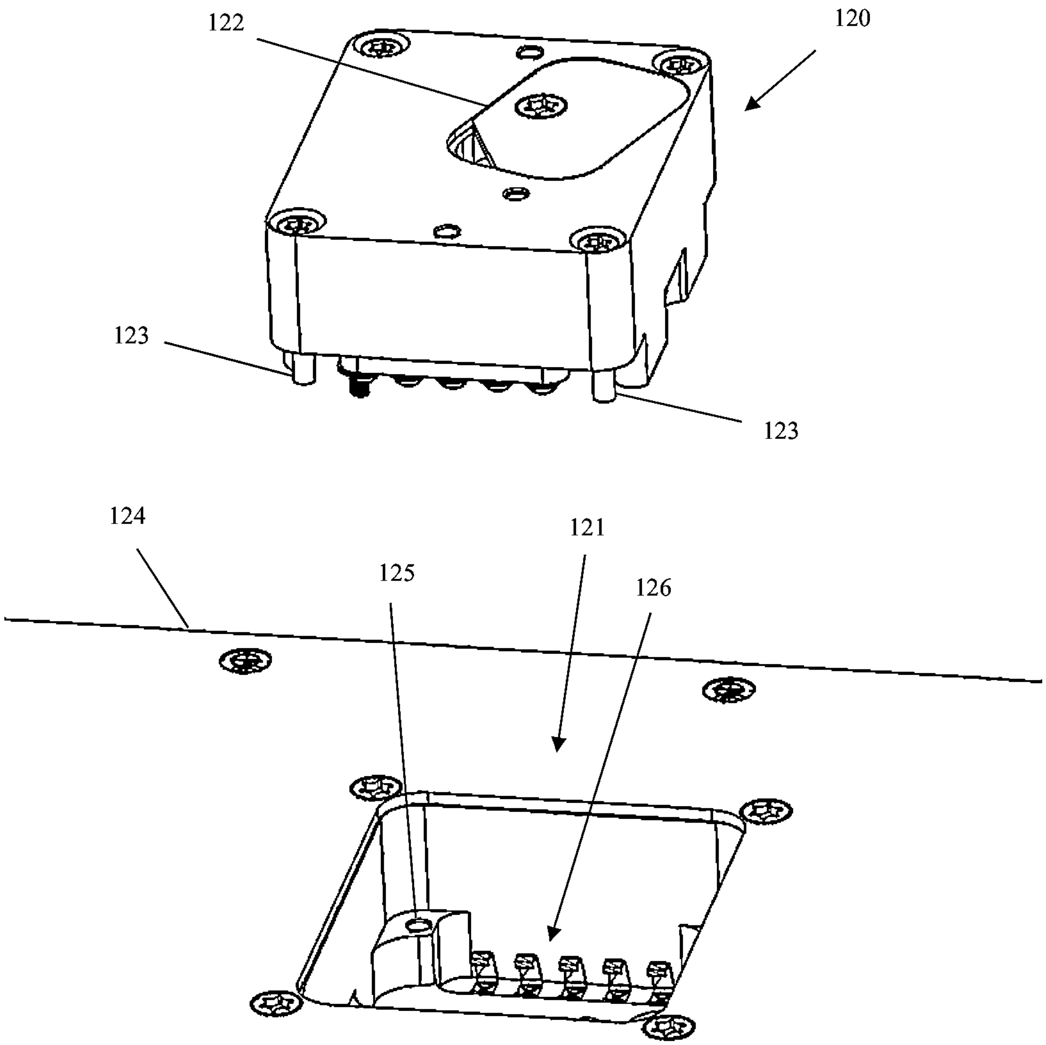

Fig. 6b

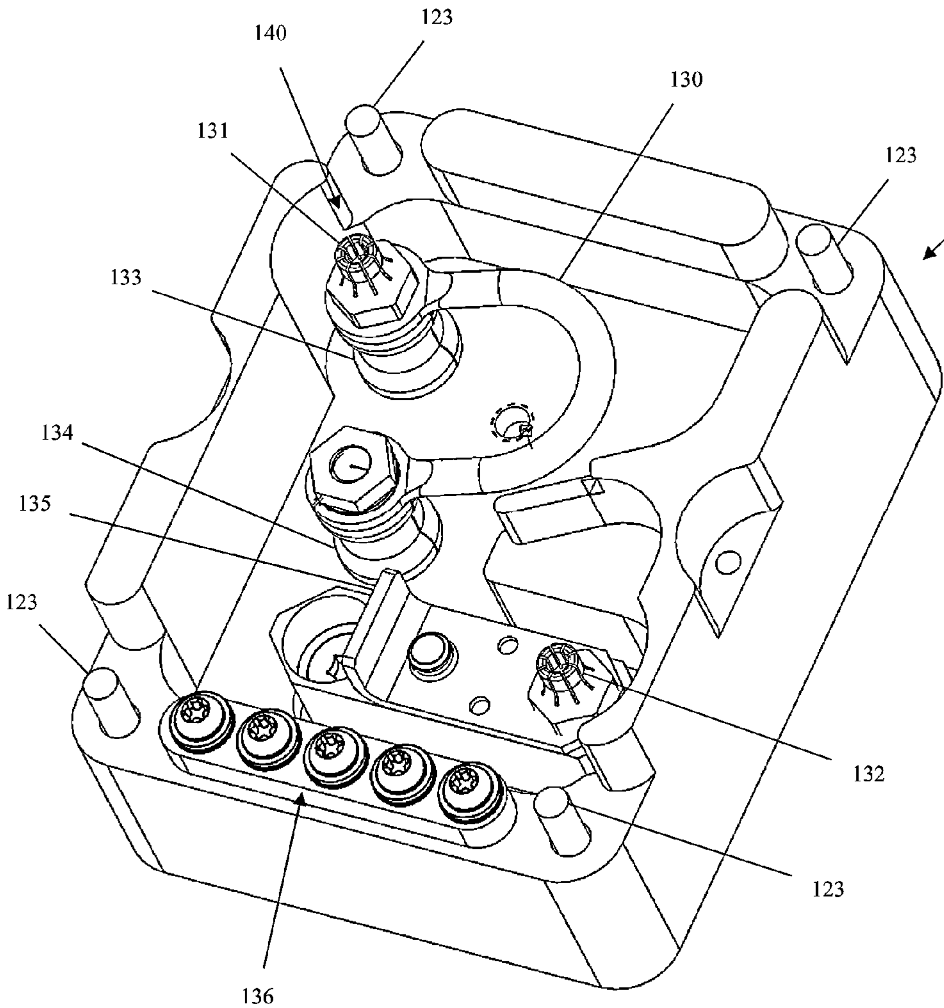

Fig. 7

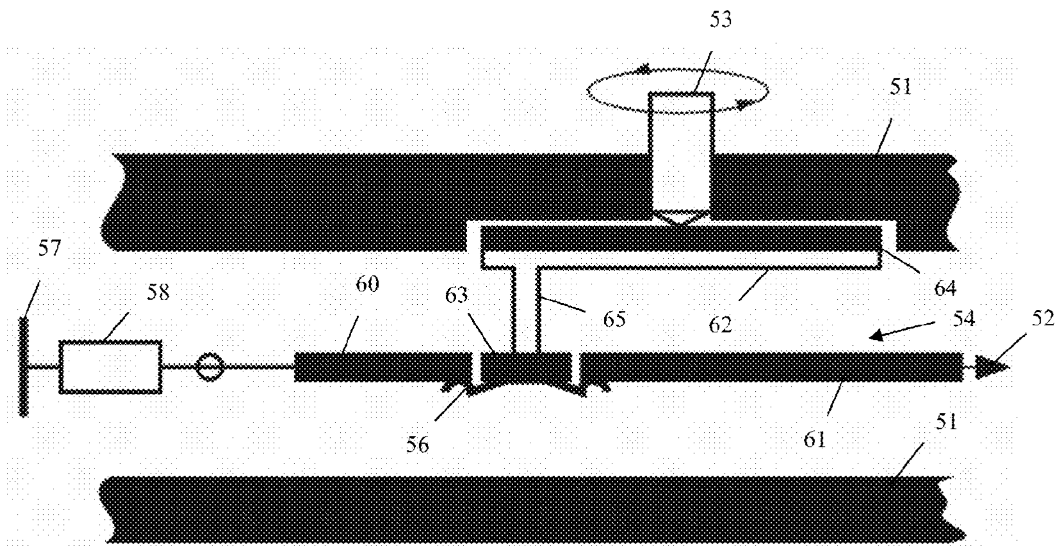
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Fig. 8

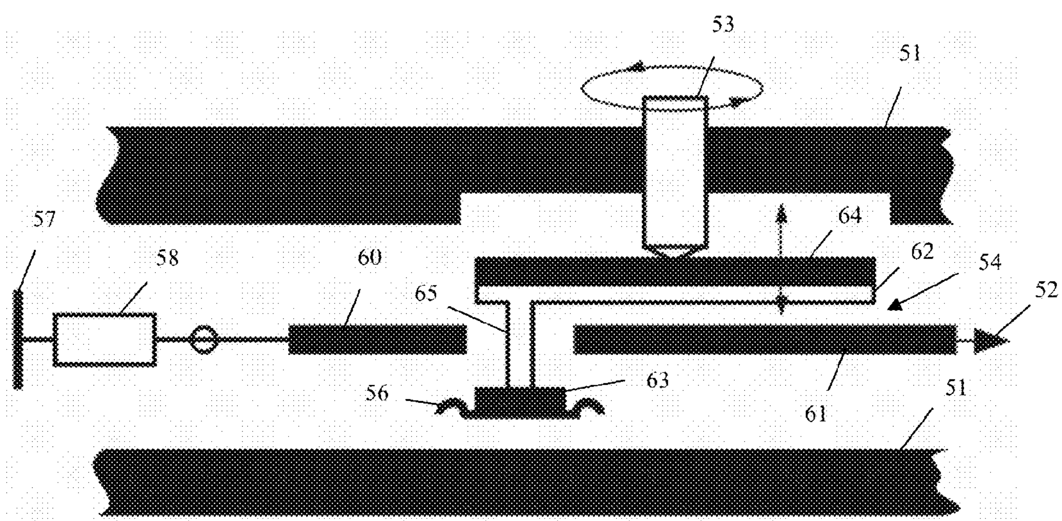
53
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Fig. 9

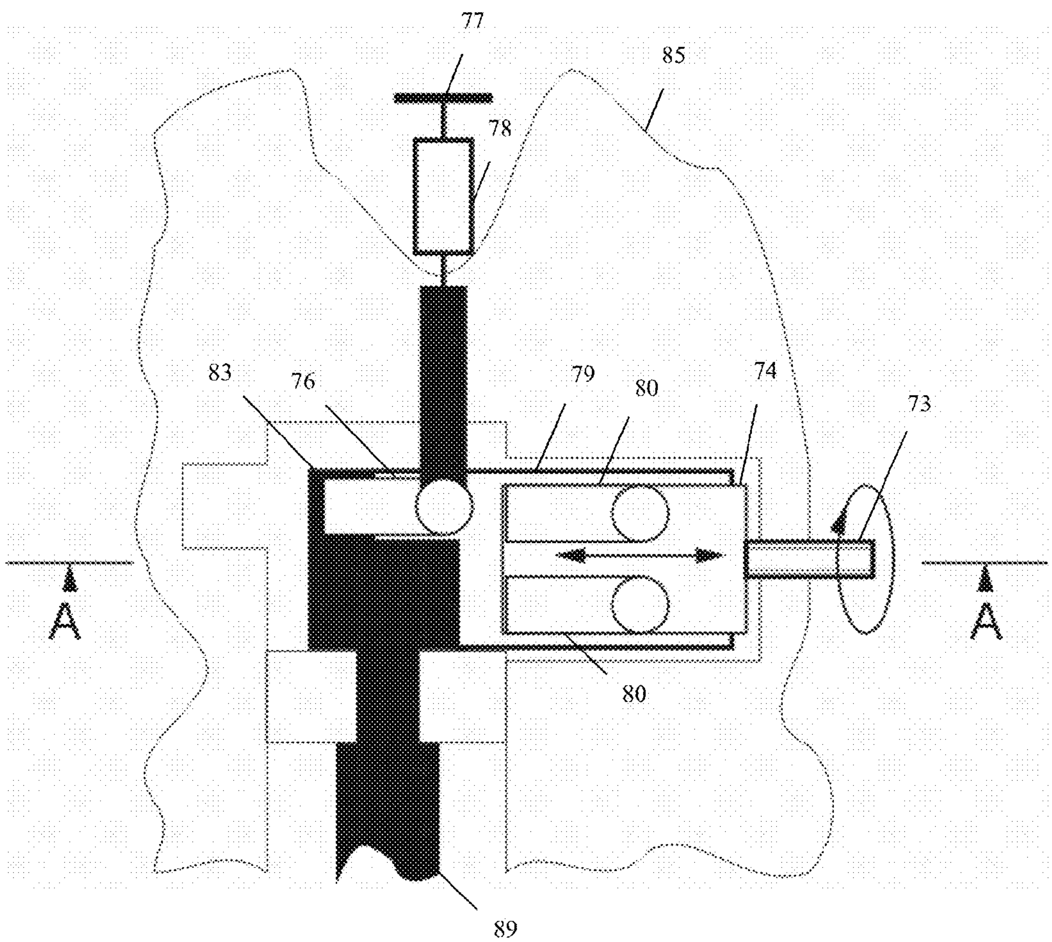

Fig. 10

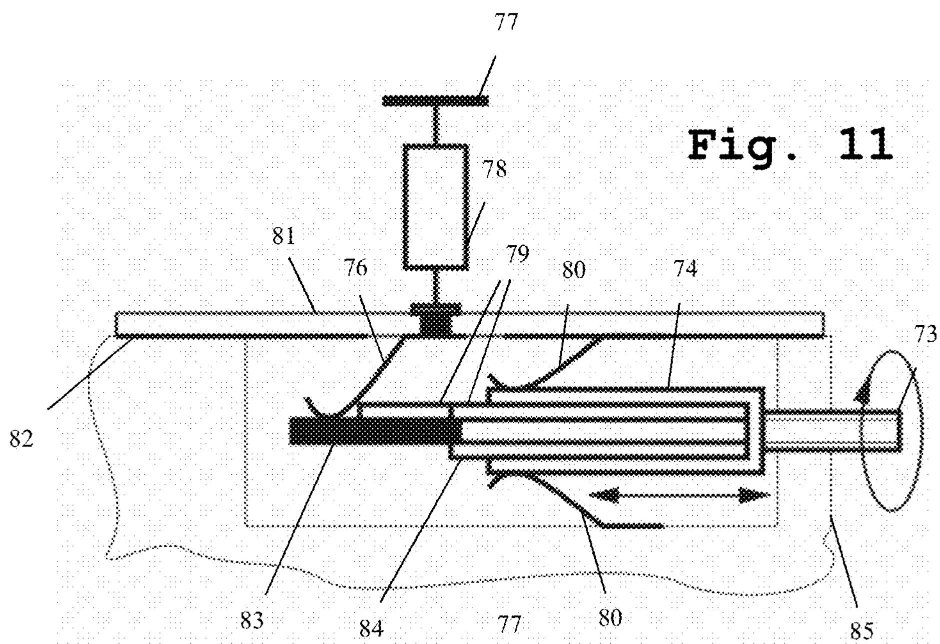
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Fig. 11

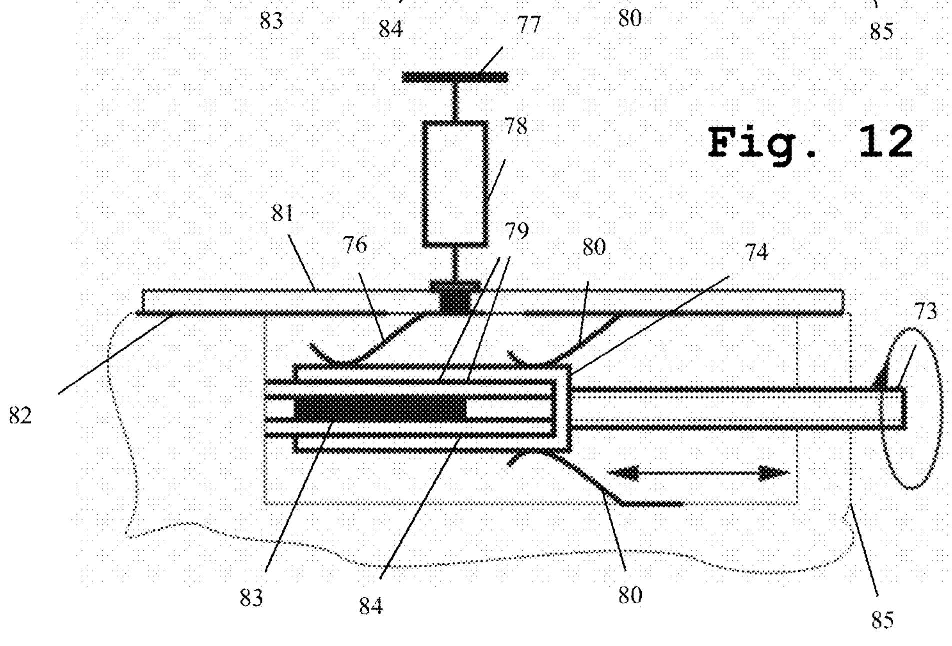
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Fig. 12

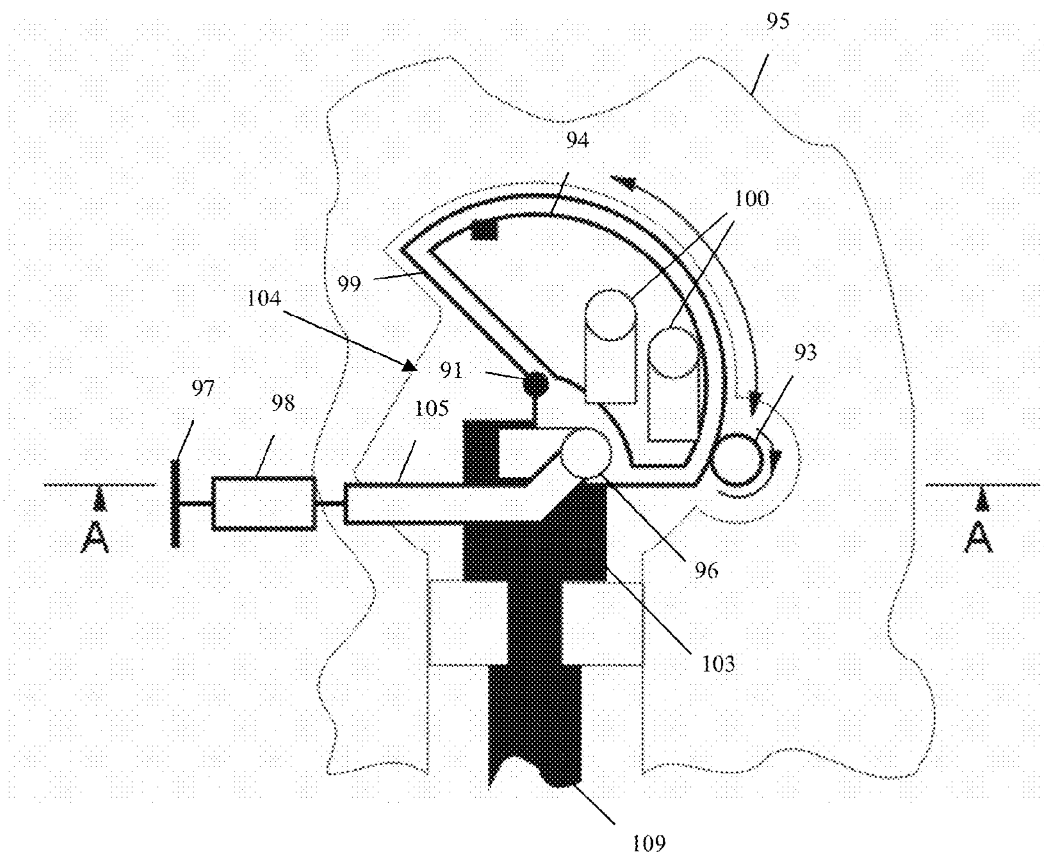

Fig. 13

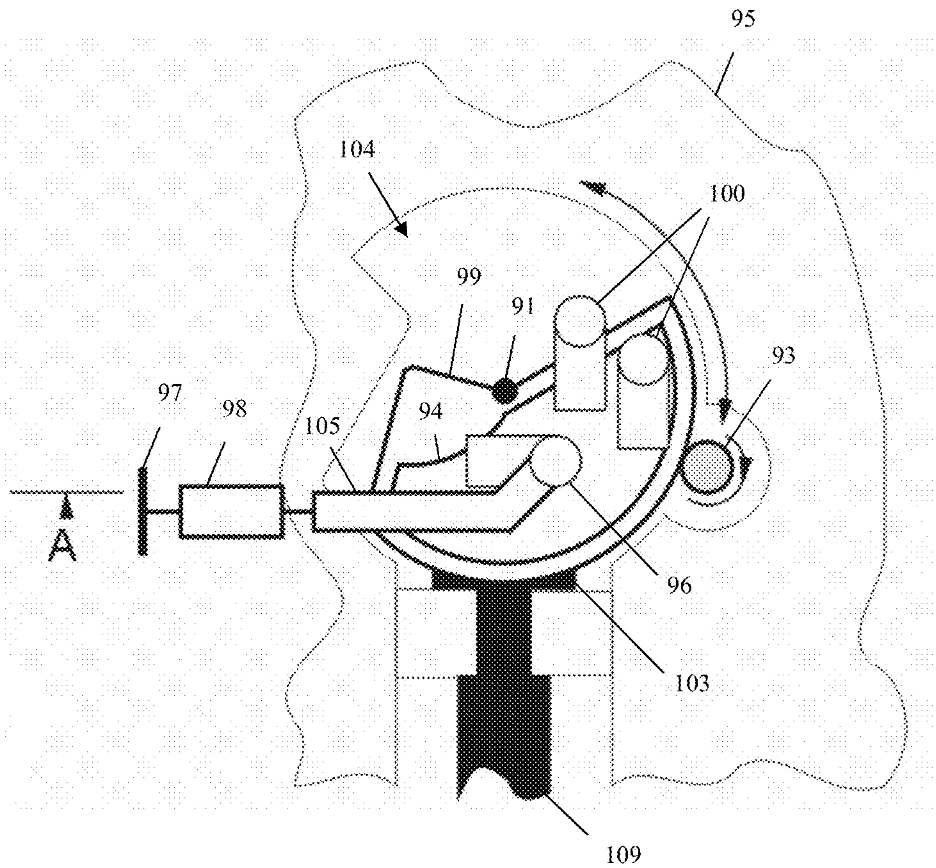

Fig. 14

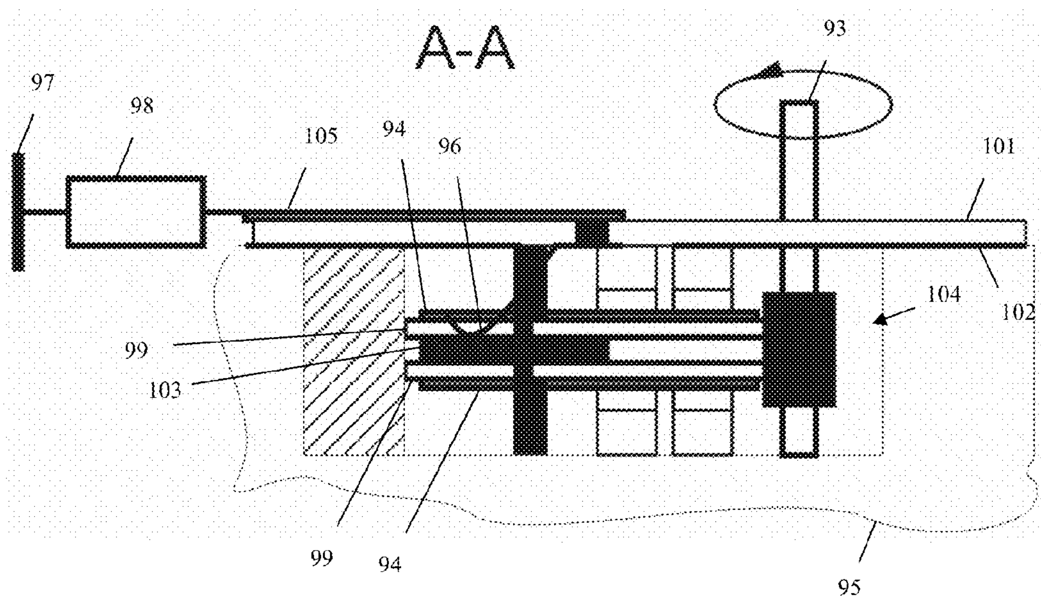

Fig. 15

QUASI-BROADBAND DOHERTY AMPLIFIER WITH ASSOCIATED CAPACITOR CIRCUIT

[0001] The invention relates to an amplifier, especially a Doherty amplifier and an associated capacitor circuit.

[0002] Doherty amplifiers are used conventionally to set up high-frequency amplifiers with high efficiency and high linearity.

[0003] A Doherty amplifier which uses a 3 dB coupler simultaneously as an impedance transformer for the main amplifier and as a power combiner for the main and auxiliary amplifier by terminating the de-coupled terminal of the 3 dB coupler, which is normally terminated with the system wave impedance, with a short-circuit or open-circuit line of a given length, is known from European Patent EP 1 609 239 B1. The arrangement shown in that context has the disadvantage that a frequency variation beyond the conventional Doherty bandwidth is not possible, and the space requirement for a low-loss line is relatively large.

[0004] The invention is based upon the object of providing a high-frequency amplifier and an associated capacitor circuit with a reduced space requirement which provides high efficiency and high linearity.

[0005] The object is achieved according to the invention for the device by the features of the independent claim **1** and for the capacitor circuit by the features of the independent claim **14**. Advantageous further developments form the subject matter of the dependent claims relating back to these claims.

[0006] An amplifier according to the invention provides a first amplifier circuit, a second amplifier circuit, a first hybrid-coupler circuit and a termination. The hybrid-coupler circuit provides an output terminal and an insulation terminal. In this context, the termination is connected to the insulation terminal of the hybrid-coupler circuit. The termination comprises a first capacitor and/or an inductance, which is arranged directly at the insulation terminal of the hybrid-coupler circuit. In this manner, a high efficiency and great flexibility of use is achieved.

[0007] The invention is based upon the insight that the electrical properties of a short-circuited or open line of a given length can be modelled by discrete elements. Instead of the relatively space-intensive line structure, a capacitor or an inductance can be used. Instead of generating the wave impedance required for the termination by means of a short circuit or open circuit, which is transformed by means of a line to the insulation terminal, the necessary wave impedance is generated according to the invention directly at the insulation terminal by means of a discrete capacitor and/or a discrete inductance. The space requirement for the circuit can be dramatically reduced in this manner.

[0008] By preference, the capacitor or the inductance is adjustable. The frequency range of the amplifier can accordingly be adjusted in a simple manner.

[0009] A quasi-broadband system can be achieved if the adjustment is implemented automatically, that is, for example, by means of a servo motor. In systems in which changes in frequency are only rarely necessary and the amplifier operates simultaneously only in one frequency range, the amplifier can therefore be used within a very broad frequency range.

[0010] By preference, it is additionally possible to switch between the capacitor or the inductance and a termination by means of a 50 ohm resistance. In this manner, it is possible to switch between a broadband amplifier of conventional design with relatively poor efficiency and a tuneable Doherty amplifier with relatively good efficiency.

[0011] The invention is described by way of example below with reference to the drawings in which advantageous exemplary embodiments of the invention are illustrated. The drawings are as follows:

[0012] FIG. **1** a first exemplary embodiment of the amplifier according to the invention;

[0013] FIG. **2** a second exemplary embodiment of the amplifier according to the invention;

[0014] FIG. **3** a third exemplary embodiment of the amplifier according to the invention;

[0015] FIG. **4** a fourth exemplary embodiment of the amplifier according to the invention;

[0016] FIG. **5** a fifth exemplary embodiment of the amplifier according to the invention;

[0017] FIG. **6***a* a sixth exemplary embodiment of the amplifier according to the invention in a first switching state;

[0018] FIG. **6***b* the sixth exemplary embodiment of the amplifier according to the invention in a second switching state;

[0019] FIG. **7** a detail view of the sixth exemplary embodiment of the amplifier according to the invention;

[0020] FIG. **8** a first exemplary embodiment of the capacitor circuit according to the invention in a first state;

[0021] FIG. **9** the first exemplary embodiment of the capacitor circuit according to the invention in a second state;

[0022] FIG. **10** a first view of a second exemplary embodiment of the capacitor circuit according to the invention in a first state;

[0023] FIG. **11** a second view of the second exemplary embodiment of the capacitor circuit according to the invention in the first state;

[0024] FIG. **12** the second exemplary embodiment of the capacitor circuit according to the invention in a second state;

[0025] FIG. **13** a first view of a third exemplary embodiment of the capacitor circuit according to the invention in a first state;

[0026] FIG. **14** the third exemplary embodiment of the capacitor circuit according to the invention in a second state; and

[0027] FIG. **15** a second view of the third exemplary embodiment of the capacitor circuit according to the invention in the first state.

[0028] Initially, the structure and method of functioning of the amplifier according to the invention will be explained with reference to FIGS. **1-7**. Following this, the structure and method of functioning of various forms of the capacitor circuit according to the invention will be explained with reference to FIGS. **8-15**. The presentation and description of identical elements in similar drawings will not be repeated in some cases.

[0029] FIG. **1** shows a first exemplary embodiment of the amplifier according to the invention. A power splitter **15** provides two input terminals **10** and **11**. An input signal can be fed in at the first input terminal **10**. The second input terminal **11** is connected to a resistor **19** and a ground connection **20**. Furthermore, a first amplifier circuit **16** and a second amplifier circuit **17** are connected to the power splitter **15**. These form the main amplifier and the auxiliary amplifier according to the Doherty principle. Outputs from these amplifier circuits **16**, **17** are connected to a hybrid-coupler circuit **18**. An insulation terminal **12** of this hybrid-coupler circuit **18** is terminated with a discrete capacitor **30** and a ground connection **31**. The capacitor **30** and the ground connection **31** therefore form a termination **1**.

[0030] The signal to be amplified is supplied to the input terminal **10** of the power splitter **15**. The latter splits the signal between the two amplifier circuits **16**, **17**, which amplify the signal according to the Doherty principle. The amplified signals are combined by the hybrid-coupler circuit **18** at its output terminal **13**. An optimum termination of the hybrid-coupler circuit **18** with a given frequency is achieved by the capacitor **30** and the ground connection **31** at the insulation terminal **12** of the hybrid-coupler circuit **18**. At the same time, a very small structural space is required.

[0031] A further advantageous embodiment is to exchange the first amplifier circuit **16** and the second amplifier circuit **17** in the circuit. A Doherty amplifier which operates in an inverse manner at a different frequency is obtained in this manner. The useful bandwidth of the system is doubled if the operating-point control can change the configuration. However, a coherent frequency range is not necessarily obtained.

[0032] FIG. **2** shows a second exemplary embodiment of the amplifier according to the invention. The circuit corresponds largely to the circuit from FIG. **1**. The discrete capacitor **30** with fixed capacitance from FIG. **1** is replaced here with an adjustable capacitor **34**. The capacitance of this capacitor **34** can be adjusted by a servo motor **33** which is controlled by the control device **32**. The capacitor **34**, the ground connection **31**, the servo motor **33** and the control device **32** thus form a termination **2**.

[0033] In this manner, it is possible to adjust the frequency for which the hybrid-coupler circuit **18** is optimally terminated. Since the amplifier operates simultaneously only on one frequency, it is unproblematic that the adjustment of the adjustable capacitor **34** by the servo motor **33** requires a certain time.

[0034] FIG. **3** shows a third exemplary embodiment of the amplifier according to the invention. This drawing also corresponds largely to the drawing from FIG. **1**. Additionally, in this case, the output terminal **12** of the hybrid-coupler circuit **18** is connected to a switch **36**. The switch **36** switches between the adjustable capacitor **34** from FIG. **2** and an ohmic terminating resistor **38** in series with a ground connection **37**. The capacitor **34**, the ground connection **31**, the servo motor **33**, the control device **32**, the switch **36**, the ohmic resistor **38** and the ground connection **37** therefore form a termination **3**.

[0035] This creates a possibility for switching between an operation as a Doherty amplifier and an operation as a conventional, broadband amplifier. In addition to the switching by means of the switch **36**, the operating points of the amplifier circuits **16** and **17** must also be matched. In this context, the switch **36** is additionally controlled by the control device **32** from FIG. **2**. Accordingly, a manual intervention is not required.

[0036] The combination of the switch **36**, the adjustable capacitor **34** and the alternatively connected ohmic resistor **38** thus forms a capacitor circuit **40**. The following drawings show a possible embodiment of such a capacitor circuit. As an alternative, the adjustable capacitor **34** can also be replaced by an adjustable inductance **35**, as illustrated below.

[0037] Alternatively, instead of the motor **33** and the adjustable capacitor **34**, a switch **36** with several capacitors of fixed capacitance can also be used. In this case the switching is implemented between the ohmic resistor **38** and several fixed capacitances. It is also conceivable to dispense with the switch **36** and the control device **32**. In this case, the terminal **12** is connected to the ohmic resistor **38** or a capacitor via a solder bridge.

[0038] FIG. **4** shows a fourth exemplary embodiment of the amplifier according to the invention. This amplifier corresponds largely to the amplifier from FIG. **2**. However, in this case, the adjustable capacitor **24** has been replaced with an adjustable inductance **35***a*.

[0039] FIG. **5** shows a fifth exemplary embodiment of the amplifier according to the invention. This amplifier corresponds partly with the amplifier from FIG. **2**. In this case, the adjustable capacitor **34** has been replaced with a first adjustable capacitor **34***a* connected to ground **31**, an adjustable inductance **35***b* and a second adjustable capacitor **34***b* connected to ground **31**. These are each adjusted by a dedicated servo motor **33***a*, **33***b* and **33***c*. The servo motors **33***a*, **33***b* and **33***c* are controlled by the control device **32**. With this configuration, an even larger bandwidth of the amplifier can be realised. A simple realisation can be achieved by selecting the interactivity to be non-adjustable. Complexity can be further reduced by adjusting the two adjustable capacitors **34***a* and **34***b* in a synchronous manner.

[0040] Instead of switching between different structural elements by means of an electrically controlled switch **36**, as illustrated in FIG. **3**, the use of a manually activated switch is also possible. It is also possible to switch between structural elements which are illustrated in the other drawings. The following section describes an exemplary embodiment in which a switching is implemented between an ohmic resistor as illustrated in FIG. **3** and an n-element as illustrated in FIG. **5**.

[0041] FIG. **6***a* and FIG. **6***b* show a sixth exemplary embodiment of the amplifier according to the invention. This amplifier provides an amplifier housing **124** and a plug-in module **120**. The amplifier housing **124** contains all of the structural elements of the amplifier with the exception of at least some the structural elements connected to the insulation terminal. The plug-in module **120** contains at least one part of the structural elements to be connected to the insulation terminal. The amplifier housing **124** provides a recess **121** for receiving the plug-in module **120**.

[0042] The plug-in module **120** comprises guide pins **123** which engage in guides **125** when the plug-in module **120** is inserted into the recess **121** of the amplifier housing **124** and accordingly allow the plug-in module **120** to be positioned in the amplifier housing **124** with high precision.

[0043] Spring contacts **126** for contacting the plug-in module **120** are additionally arranged in the recess **121** of the amplifier housing **124**. The function of the spring contacts **126** will be described in greater detail with reference to FIG. **7**. The plug-in module **120** further provides a removable cover **122**. When the cover **122** is removed, tuneable circuit elements can be tuned through this aperture. These elements will also be described in greater detail with reference to FIG. **7**.

[0044] The plug-in module **120** is accordingly embodied in such a manner that it can be inserted into the recess **121** in different orientations. FIG. **6***a* shows a first orientation of the plug-in module **120** relative to the recess **121**. FIG. **6***b* shows a second orientation of the plug-in module **120** relative to the recess **121**. Inserting the plug-in module **120** into the recess **121** in different orientations establishes a connection between different structural elements in the plug-in module **120** and the remainder of the amplifier within the amplifier housing **124**. That is, insertion with different orientations fulfils the function of switching between different connected structural elements. This will also be described in greater detail with reference to FIG. 7.

[0045] FIG. 7 shows a detail view of the sixth exemplary embodiment of the amplifier according to the invention. FIG. 7 shows the side of the plug-in module 120 disposed opposite to the view shown in FIGS. 6*a* and 6*b*. Here also, the guide pins 123 are clearly visible. The plug-in module 120 contains an n-element 140, which is formed from two adjustable capacitors 133, 134 and one inductance 130. The capacitors 133, 134 presented here are adjustable cylindrical capacitors. The capacitances of the cylindrical capacitors 133, 134 can be tuned by means of screws through the cover 122 illustrated in FIGS. 6*a* and 6*b*, which is arranged on the underside of the plug-in module 120 shown in FIG. 7. The use of other adjustable elements is also conceivable here. Instead of an n-element 140, a single adjustable capacitor or any of the elements shown in FIGS. 1-5 connected to the terminal 12 could be used as alternatives.

[0046] A socket contact 131 is additionally connected to a first terminal of the first capacitor 133. The inductance 130 is further connected to this first terminal. In this context, the inductance 130 is formed by a half winding, that is, a 180°-wire-loop. The inductance 130 connects the first terminal of the first capacitor 133 to a first terminal of the second capacitor 134. In each case the second terminals of the capacitors are connected to the housing, that is, to ground.

[0047] Beyond this, the plug-in module 120 contains a second socket contact 132, which is connected to a contact bridge 135. The contact bridge 135 is embodied in such a manner that it establishes a connection with a 50-ohm load arranged in the amplifier housing 124 when the plug-in module 120 is inserted into the recess 121 of the amplifier housing 124 in a first orientation. In this orientation, the port socket 132 establishes direct contact with the output 12 of the amplifier. That is, in this orientation, the contact bridge 135 connects the terminal 12 of the amplifier to a 50-ohm load. With regard to FIG. 3, this corresponds to the lower switch setting of the switch 36. This first orientation of the plug-in module 120 therefore corresponds with the conventional AB operating mode of the amplifier.

[0048] However, if the plug-in module 120 is inserted into the recess 121 of the amplifier housing 124 in the second orientation, the contact socket 131 makes contact with the terminal 12. In this manner, the terminal 12 is connected to the n-element 140. This second orientation of the plug-in module 120 therefore corresponds to a connection of an n-element to the terminal 12 of the amplifier, as illustrated in FIG. 5. A connection of this kind corresponds to the Doherty operating mode of the amplifier.

[0049] The plug-in module 120 additionally provides several coding screws 136. These are arranged on the plug-in module 120 in such a manner that, when the plug-in module 120 is inserted into the recess 121, they make contact with the spring contacts 126. These spring contacts 126 are arranged only on one of the two opposite sides of the recess 121 so that they can make contact with the coding screws only in the second orientation of the plug-in module 120, that is, when operating the amplifier as a Doherty amplifier.

[0050] As a result of the presence of the coding screws, the respective spring contact 126 disposed under them is closed. Accordingly, the spring contacts 126 are connected to a control device in such a manner that the latter recognises the switching state of every individual spring contact 126. The coding screws 136 can be tightened or loosened individually. They can also be removed individually. Accordingly, the bit pattern, which is formed as a result of the presence or absence of the individual screws or the depth of screwing of the individual screws, codes the tuning frequency of the π-element 140 currently adjusted. That is to say, when setting a frequency range for the Doherty operating mode of the amplifier according to the invention, the adjusted frequency is additionally manually modelled as a bit pattern in the coding screws 136. The amplifier therefore recognises, via the spring contacts 126, the frequency to which the π-element 140 is adjusted.

[0051] Via the 5 illustrated coding screws 136, 32 adjustable channels, that is, 32 channels are conceivable in principle. In practice, for example, 12 channels are operated in this context in the UHF range. With each individual setting, the system operates optimally on 3-4 channels and in an acceptable manner in the respectively adjacent channels. With corresponding tuning, the amplifier can be used in the Doherty mode over the entire frequency range between 470 and 862 MHz. Accordingly, there are 7 standard tunings which cover the entire frequency range. The standard tunings can also be optimised beyond this on given channels within their tuning range.

[0052] FIGS. 8 and 9 show a first exemplary embodiment of the capacitor circuit according to the invention. A first capacitor plate 61 is connected to a terminal 52, which corresponds to the output terminal 12 from FIGS. 1-5. Together with a second capacitor plate 64, this forms a capacitor 54. The second capacitor plate 64 is connected in this context to a motorised spindle 53. The spacing distance between the second capacitor plate 64 and the first capacitor plate 61 is adjusted by means of the motorised spindle 53. The motorised spindle 53 is accordingly driven by a servo motor. As an alternative, the use of a manually driven spindle is also possible.

[0053] An insulator plate 62, which provides a carrier 65, is connected to the second capacitor plate 64. In turn, the carrier 65 is connected to a conductor portion 63, which is connected to a switch terminal 56. By means of the switch terminal 56, the first capacitor plate 61 can be connected to a conductor portion 60. The conductor portion 60 is connected, in turn, to a terminating resistor 58 and the ground connection 57. The capacitor 54 here corresponds to the adjustable capacitor 34 from FIGS. 2-3. The switch terminal 56 here corresponds to the switch 36 from FIGS. 2-3. The terminating resistor 58 and the ground connection 57 correspond to the terminating resistor 38 and the ground connection 37 from FIG. 3.

[0054] FIG. 8 shows a first state of the capacitor circuit. The motorised spindle 53 has moved the second capacitor plate 64 to a maximum distance from the first capacitor plate 61. The insulator plate 62 and the carrier 65 pull the conductor portion 63, and with it also the switch termination 56, which is realised here as a contact spring, towards the first capacitor plate 61 and the conductor portion 60. The first capacitor plate 61, the switch connection 56, the conductor portion 63 and the conductor portion 60 are therefore electrically connected to one another. The terminal 52 is accordingly electrically connected to the terminating resistor 58 and through this to the ground connection 57. This corresponds to the lower switch position of the switch 36 from FIG. 3.

[0055] FIG. 9 shows a second state of the capacitor circuit. The motorised spindle 53 has moved the second capacitor plate 54, and with it also the insulator plate 62, the carrier 65, the conductor portion **63** and the switch terminal **56**, downwards. The switch terminal **56** has lost contact with the first capacitor plate **61** and the conductor portion **60**. This corresponds to the upper switch position of the switch **36** from FIG. **3**. As a result of the distance between the first capacitor plate **61** and the second capacitor plate **64**, the capacitance of the capacitor **54** is adjusted. That is to say, it is matched in this manner to the operating frequency of the amplifier within which this capacitor circuit can be used.

[0056] Since the insulator plate **62** and the carrier **65** are made from a non-conducting material, they only influence the field characteristic of the capacitor **54** to an insubstantial extent. By manufacturing the insulator plate **62** and the carrier **65** from a material which provides a similar dielectric constant to the surrounding medium, for example, air, the influence can be further reduced.

[0057] In the switch position illustrated in FIG. **8**, the first capacitor plate **61** acts only as a conductor which connects the terminal **52** to the terminating resistor **58**. In this context, the distance from the second capacitor plate **64** is so large that no significant effect occurs. Accordingly, the second capacitor plate **54** is disposed at ground potential via the motorised spindle and the housing **51**.

[0058] FIGS. **10-12** show a second exemplary embodiment of the capacitor circuit according to the invention. The view in FIGS. **11** and **12** corresponds to the section along the sectional line A from FIG. **10**. A housing **85** is disposed at ground potential. The housing **85** is covered on one side by a conductor plate **81**, which is provided with a metallised ground layer **82** on its underside. A conductor **89** is disposed in the recess of the housing **85**. This is realised here as a flat strip conductor. The upper end of the conductor **89** in this context is embodied to form a first capacitor plate **83**.

[0059] In a first state which is illustrated in FIG. **10** and FIG. **11**, the first capacitor plate **83** is connected, via a switch terminal **76**, which is realised here as a contact spring, to a terminating resistor **78** and a ground connection **77**. This corresponds to the lower switch position from FIG. **3**. The conductor **89** is thus connected at its lower end to the insulation terminal of the amplifier, in which the capacitor circuit shown here is inserted.

[0060] A motorised spindle **73** which can be driven, for example, by the servo motor **33** from FIG. **3**, is connected to a second capacitor plate **74**. The second capacitor plate **74** is connected to an insulator plate **79**. The insulator plate **79** provides a projection in the region of the switch terminal **76**. In this context, the second capacitor plate **74** is embodied in such a manner that it can surround the first capacitor plate. Accordingly, on its upper side, it is separated by the first insulator plate **69** from the first capacitor plate **83**. On its underside, it is held at a distance from the first capacitor plate **83** by a second insulator plate **84**, which is also connected to the second capacitor plate **74**.

[0061] In a first state, which is shown in FIG. **10** and FIG. **11**, the switch terminal **76** is disposed in contact with the first capacitor plate **83**. Accordingly, a conducting connection to the terminal **82** and the terminating resistor **78** is provided. In a second state, which is shown in FIG. **12**, the motorised spindle **73** has moved the second capacitor plate **74** and the first and second insulator plate **79**, **84** in the direction towards the first capacitor plate **83**. The projection of the first insulator plate **79** has lifted the switch terminal **76** from the first capacitor plate **83** and therefore interrupted the electrical connection of the line **89** to the terminating resistor **78**. At the same time, the second capacitor plate **74** has been fitted around the first capacitor plate **83**. As a result, the capacitance between the first capacitor plate **83** and the second capacitor plate **74** has risen significantly. Accordingly, the second capacitor plate **74** is disposed in electrical contact with contact springs **80**, which establish a contact with the housing **85** disposed at ground potential. The required capacitance can be adjusted by means of the motorised spindle **73**, via the precise positioning of the second capacitor plate **74**. This allows an adjustment of the operating frequency of the amplifier into which the capacitor circuit shown here is to be inserted.

[0062] FIGS. **13-15** show a further exemplary embodiment of the capacitor circuit according to the invention. In this context, a rotary capacitor is used to adjust the capacitance. A recess **104** is arranged in a housing **95** disposed at ground potential. The end of a line **109**, which is widened to form a first capacitor plate **103**, projects into the recess **104**. Furthermore, a second capacitor plate **94** which can be rotated about a rotary axle **91** is arranged in the recess **104**. Accordingly, the second capacitor plate **94** is embodied in such a manner that it can surround the first capacitor plate **103**. The second capacitor plate **94** is therefore connected to an insulator plate **99**, which is also designed in such a manner that it can surround the first capacitor plate **103**. In this case, the insulator plate **99** is disposed in contact with a motorised spindle **93**. By means of a friction wheel or a cogwheel, the motorised spindle **93** engages tangentially on the periphery of the plate and rotates the insulator plate **99** and the second capacitor plate **94** around the rotary axle **91**. As an alternative, a direct drive by the rotary axle **91** is possible. In this case, the motorised spindle **93** can be omitted.

[0063] A switch terminal **96**, which is embodied here as a contact spring, is connected by means of a conductor portion **105** to a terminating resistor **98** and via the latter to a ground connection **97**.

[0064] In a first state, which is illustrated in FIG. **13** and FIG. **15**, the switch terminal **96** establishes a contact between the first capacitor plate and the conductor portion **105**. The line **109** is accordingly electrically connected to the terminating resistor **98** and via the latter to the ground connection **97**. This corresponds to the lower switch position from FIG. **3**.

[0065] In a second state, which is shown in FIG. **14**, the second capacitor plate **94** and the insulator plate **99** are rotated around the rotary axle **91** in such a manner that the insulator plate **99** and the second capacitor plate **94** interrupt the contact between the switch terminal **96** and the first capacitor plate. The second capacitor plate **94** and the insulator plate **99** now surround the first capacitor plate **103**. The second capacitor plate **94** is disposed in electrical contact via contact springs **100** with the housing **95** disposed at ground potential. The state illustrated here corresponds to the upper switch position from FIG. **3**. The overlapping of the first capacitor plate **103** and the second capacitor plate **94** can be adjusted via the angle of rotation of the second capacitor plate **94** about the rotary axle **91**. In this case, the degree of overlap adjusts the capacitance of the resulting capacitor. The insulator plate **99** thus ensures a constant spacing distance between the first capacitor plate **103** and the second capacitor plate **94**. Accordingly, the operating frequency of an amplifier, in which the capacitor circuit shown here is used, is adjusted via the rotary angle.

[0066] As already illustrated with reference to FIGS. **11-12**, the housing **95** here also provides a cover by means of a conductor plate **101**. Here also, the underside of the conductor plate **101** is provided with a metallisation **102**.

[0067] The invention is not restricted to the exemplary embodiment shown. In particular, the capacitor circuit illustrated can also be used in other circuits. A switching or respectively a re-plugging of different structural elements than those illustrated here is also conceivable. All of the features described above or illustrated in the drawings can be advantageously combined with one another within the scope of the invention.

1. An amplifier; comprising
a first amplifier circuit;
a second amplifier circuit;
a first hybrid-coupler circuit including,
an output terminal and an insulation terminal; and
a termination is connected to the insulation terminal of the first hybrid-coupler circuit,
wherein the termination comprises a first capacitor and/or an inductance, which is arranged directly at the insulation terminal of the first hybrid-coupler circuit.

2. The amplifier according to claim **1**,
wherein the first capacitor and/or the inductance is connected directly, without intermediate connection of a line element or only with a line element of which the length is shorter than 1/10, of the shortest wavelength used, to the insulation terminal of the hybrid-coupler circuit.

3. The amplifier according to claim **1**,
wherein if the termination provides a first capacitor, the latter is embodied in such a manner that its capacitance is adjustable with reference to the operating frequency of the amplifier.

4. The amplifier according to claim **1**,
wherein if the termination comprises an inductance, the latter is embodied in such a manner that its inductance value is adjustable with reference to the operating frequency of the amplifier.

5. The amplifier according to claim **1**,
wherein if the termination provides a first capacitor, the latter is a rotary capacitor or a slide capacitor, preferably a mechanically adjustable rotary capacitor or a mechanically adjustable slide capacitor.

6. The amplifier according to claim **1**,
wherein: the termination comprises the first capacitor, a second capacitor and the inductance;
the first capacitor is connected to the insulation terminal and the inductance; and
the second capacitor is connected to the inductance.

7. The amplifier according to claim **6**,
wherein the second capacitor is a rotary capacitor or a slide capacitor, preferably a mechanically adjustable rotary capacitor or a mechanically adjustable slide capacitor.

8. The amplifier according to claim **1**,
wherein;
the termination further contains a switch and a terminating resistor,
the switch is connected at its input terminal to the insulation terminal,
the switch is connected at its first output terminal to the terminating resistor,
if the termination provides a first capacitor, the switch is connected at its second output terminal to the first capacitor, and if the termination provides an inductance and not a first capacitor, the switch is connected at the second output terminal to the inductance.

9. The amplifier according to claim **1**,
wherein the amplifier further provides a control device, which, if the termination provides a first capacitor, adjusts the latter, and/or, if the termination provides a second capacitor, adjusts the latter, and/or, if the termination provides an inductance, adjusts the latter, and/or, if the termination provides a switch, activates the latter.

10. The amplifier according to claim **8**,
wherein if the termination provides a switch and a first capacitor, these are formed by a capacitor circuit, and/or if the termination provides a switch and a second capacitor, these are formed by a capacitor circuit, and each capacitor circuit is a capacitor circuit according to claim **14**.

11. The amplifier according to claim **1**,
wherein:
the amplifier provides an amplifier housing and a plug-in module,
the amplifier housing provides a recess for receiving the plug-in module,
the plug-in module contains the first capacitor and/or the first inductance, and
the plug-in module is embodied in such a manner that, when the plug-in module is inserted into the recess in a first orientation, it connects the first capacitor and/or the first inductance to the insulation terminal.

12. The amplifier according to claim **11**,
wherein the plug-in module is embodied in such a manner that, when the plug-in module is inserted into the recess in a second orientation, it connects an ohmic resistor connected to ground to the insulation terminal.

13. The amplifier according to claim **11**,
wherein;
the plug-in module comprises coding screws,
the recess comprises spring contacts,
the plug-in module is embodied in such a manner that the coding screws establish contact with the spring contacts when the plug-in module is inserted into the recess, and
the coding screws encode a present tuning frequency.

14. A capacitor circuit, comprising:
a first capacitor plate;
a second capacitor plate;
an insulator plate, the second capacitor plate being rigidly connected to the insulator plate, whereas the second capacitor plate and the insulator plate are displaceable relative to the first capacitor plate; and
terminal, connected in a detachable manner to the first capacitor plate.

15. The capacitor circuit according to claim **14**,
wherein the insulator plate and the switch terminal are embodied in such a manner that the insulator plate separates the switch terminal from the first capacitor plate when the first capacitor plate approaches the second capacitor plate.

16. The capacitor circuit according to claim **14**,
wherein the insulator plate and the switch terminal are embodied in such a manner that the switch terminal comes into contact with the first capacitor plate when the first capacitor plate is moved away from the second capacitor plate.

17. The capacitor circuit according to claim **14**,
wherein the second capacitor plate and the insulator plate are mounted in a displaceable manner relative to the first capacitor plate by means of a sliding bearing.

18. The capacitor circuit according to claim **14**,
wherein the second capacitor plate and the insulator plate are mounted in a rotatable manner relative to the first capacitor plate via a rotary bearing.

19. The capacitor circuit according to claim **14**,
wherein
the switch terminal is a contact spring, and
the contact spring is disposed in contact with the first capacitor plate through spring tension.

20. The capacitor circuit according to claim **19**,
wherein the insulator plate is embodied in such a manner that it is displaced between the contact spring and the first capacitor plate when the first capacitor plate approaches the second capacitor plate.

21. The capacitor circuit according to claim **14**,
wherein
the insulator plate is connected by means of a carrier to a conductor portion, and
the switch terminal connects the conductor portion to the first capacitor plate or respectively separates the conductor portion from the first capacitor plate.

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