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ANTENNA AMPLIFIER FOR TRANSCEIVER

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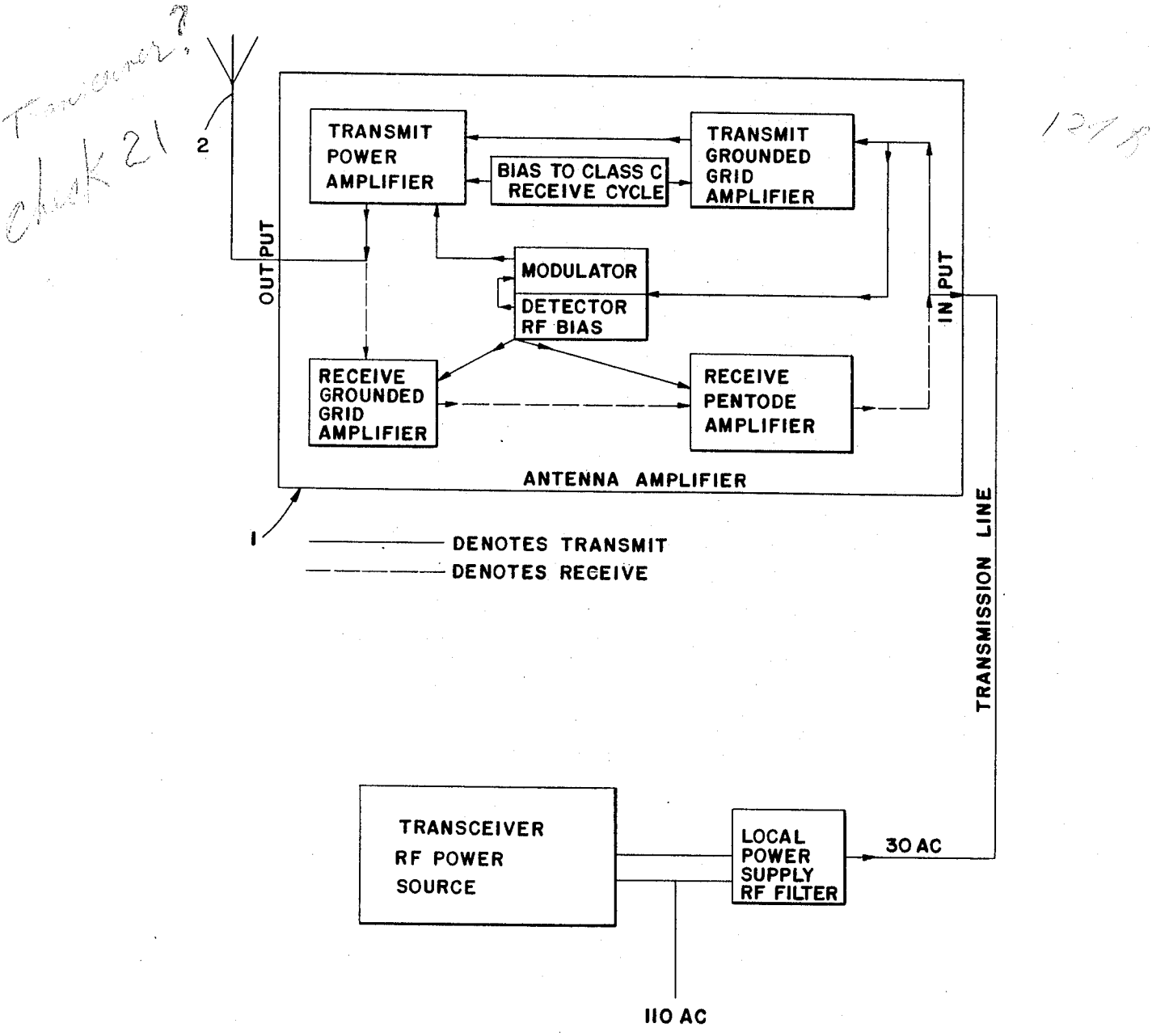

Fig. 1

INVENTORS
RALPH O. BYKERK
MILTON R. FRIEDBERG
BY
Eby, Learned & Gordon
ATTORNEYS

ANTENNA AMPLIFIER FOR TRANSCEIVER

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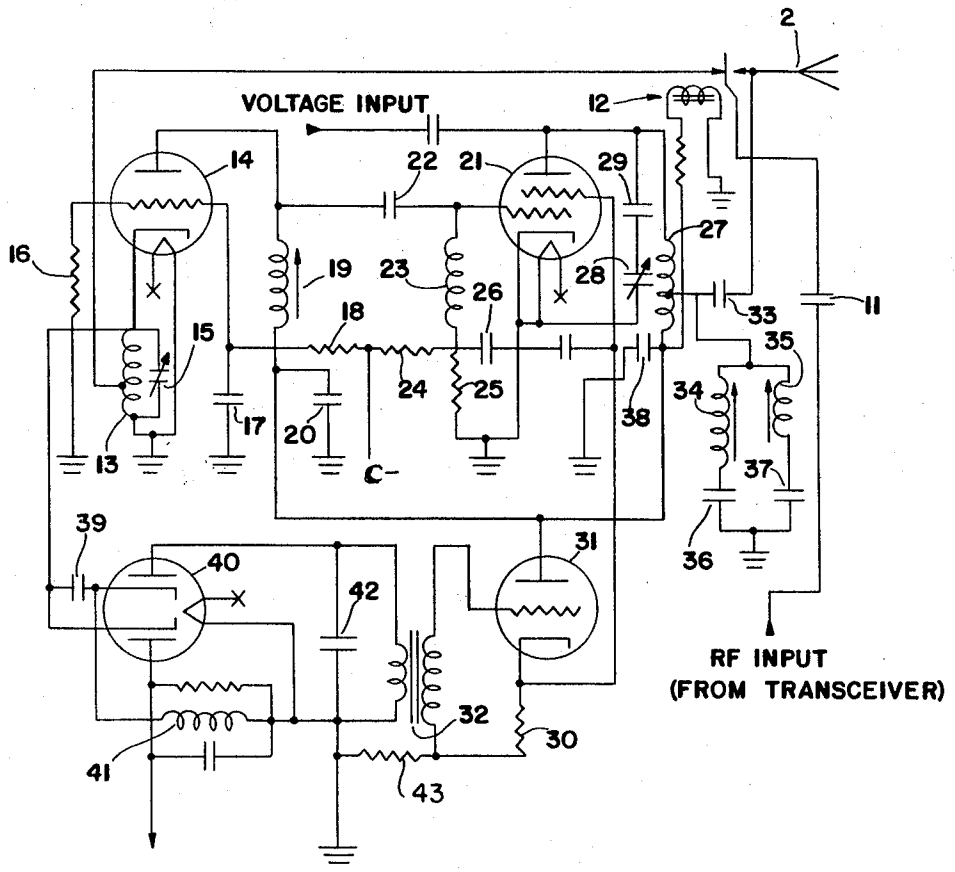

Fig. 2

INVENTORS
RALPH O. BYKERK
BY MILTON R. FRIEDBERG
Eby, Pearne & Gordon
ATTORNEYS

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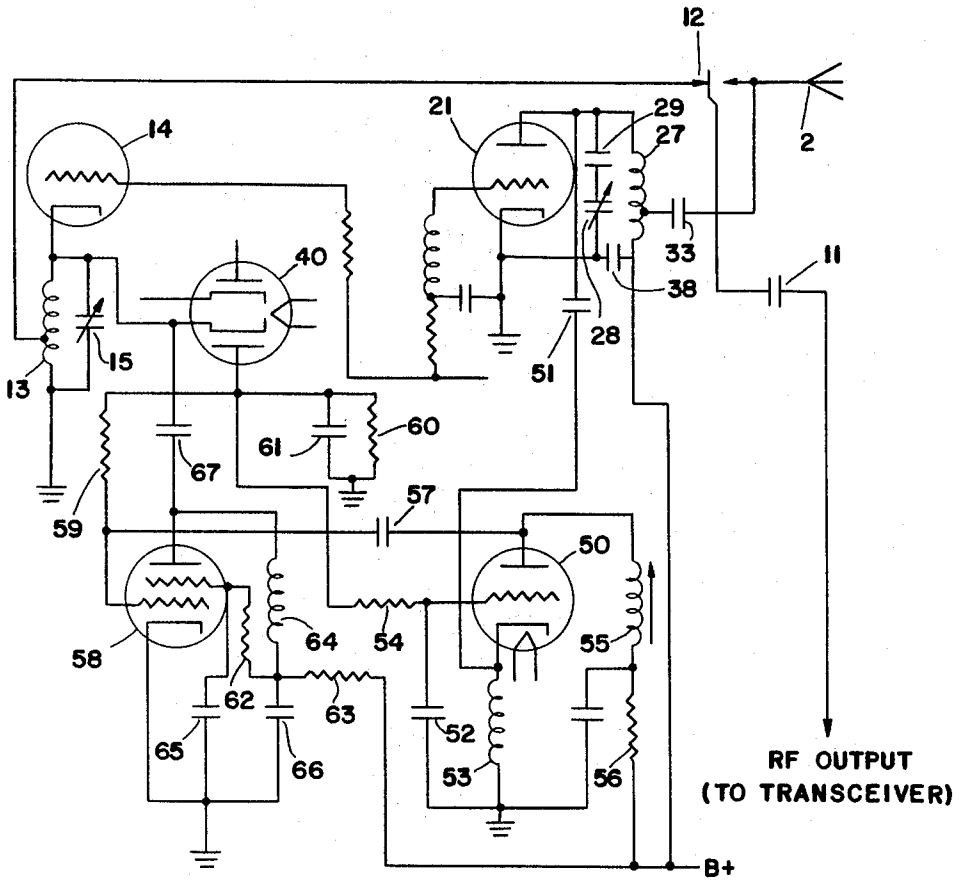

Fig. 3

INVENTORS
RALPH O. BYKERK
BY MILTON R. FRIEDBERG
Ely, Pearne & Gordon
ATTORNEYS

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ANTENNA AMPLIFIER FOR TRANSCEIVER

Milton R. Friedberg, University Heights, Ohio, and Ralph O. Bykerk, Napa, Calif.; said Friedberg assignor to The Antenna Specialists Company, Cleveland, Ohio, a corporation of Ohio

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7 Claims. (Cl. 325—15)

This invention relates to improvements in accessory and auxiliary equipment for antennas intended for use with radio-frequency transmitting and receiving sets, i.e.. transceivers. It is particularly adapted for use with relatively low-power transceivers intended to operate on the "Citizens Band" frequencies, but may be adapted for commercial as well as amateur transceiving equipment intended to transmit at relatively higher powers and different available or permissible frequencies. It is adapted for use as an accessory to existing equipment or to be built in, in whole or part, in new equipment.

The problem which this invention solves, though simply stated, is one which has long been tolerated; no satisfactory solution appears to have been found heretofore. Regulating agencies in this and other countries limit, for every licensed radio operation, the maximum power output at the antenna; if exceeded, the license may be revoked; if less than the licensed maximum, the operator does not achieve the permitted signal strength or range to which he is entitled and expects to obtain with his set. The seemingly simple solution of employing a set which is capable of providing a signal in excess of the rated power to the antenna and thus limiting the antenna output at each installation is not economically practical or permitted in many installations. Nor has the expedient of simply amplifying a transmitted signal from the transceiver up to the rated power been satisfactory heretofore or generally permitted; transmission through such an amplifying means is likely both to distort the signal and exceed the permitted power. Also the manual or mechanical switching between the transmit and receive cycles or periods available heretofore have been neither convenient nor reliable.

The object and advantage of this invention is to provide a solution for the above-stated problem and objections by providing means which will permit the emission of a transmitted signal at, but in excess of, the licensed power at the antenna with a clear and substantially undistorted signal, such means being fail-safe and also providing automatic switching between transmit and receive functions which is wholly electronic and non-mechanical. An antenna amplifier made according to this invention will provide amplified received signals which might otherwise be lost in the line between the antenna and the set, or be so weak at the set as to be distorted by amplification within the set.

Other objects and advantages of this invention will be apparent to those skilled in the art and from the following specification, claims, and drawings of an illustrative and not limitative embodiment of this invention, in which:

FIG. 1 is a functional diagram of one embodiment of an accessory made according to this invention;

FIG. 2 is a wiring diagram showing the transmit function of the accessory shown in FIG. 1; and

FIG. 3 is a wiring diagram of the receive function or accessory shown in FIG. 1, including the electronic switching circuitry.

As shown in FIG. 1, an accessory made according to this invention, designated "antenna amplifier," is packaged in a suitable casing **1**. As so packaged, it may be located at the base of the antenna **2** or so close thereto that any lines loss between the antenna amplifier and the antenna

is negligible. When intended for operation outdoors, the casing **1** should be weatherproof and provided with suitable heat-radiating fins or other means to allow the casing to serve as a sink for heat developed during operation. If the antenna amplifier is intended for so-called "attic" or other indoor operation where it is protected from the weather, the casing **1** should be provided with adequate ventilation or like means for heat dissipation. As illustrated in FIG. 1, the accessory may also (but not necessarily) be installed at a considerable physical distance from the transceiver providing the RF power source. In such cases, the RF signals between the transceiver and antenna amplifier, including the A.C. power therefor, are usually transmitted through a coaxial transmission line at a sufficiently low voltage to avoid the need for insulation or enclosure in conduits as required by local building codes for higher voltages.

Functionally, the antenna amplifier as shown in FIG. 1 normally operates as follows (i.e., ignoring fail-safe relays and other details of specific embodiments): The transmit signal input is split, one portion activating a first transmit amplifier connected to a second transmit amplifier which powers the antenna **2** at the maximum licensed wattage. As amplified, the RF signal transmitted from the first and second amplifier to the antenna would be substantially demodulated. The other portion of the split RF signal, however, passes through a modulator which is impressed upon the second amplifier so that the output signal at the pre-set maximum power is remodulated, without substantial distortion or noise, according to the modulation of the original signal at the input. Thus, a clear remodulated RF signal at the maximum licensed limit, providing maximum range, is obtained. When a substantial physical distance or other cause of fixed line loss between the accessory and antenna may exist, the power output at the casing **1** may be pre-set to overcome such fixed line loss and still deliver the maximum licensed power at the antenna.

Due to the intended receive function of the antenna, it is usually desirable to amplify weak signals received at the antenna to overcome line losses from the antenna to the transceiver; this may be accomplished in one or more stages in the accessory, a two-stage amplification between the antenna and transmission line being shown. An RF detector in the modulator biases grids in the receiver amplifiers to disactivate them and, thereby, functions as an electronic, non-mechanical switch whenever a transmit signal is carried from the transceiver to the input of the accessory.

Referring to FIG. 2 for specific circuitry which will provide the above-described transmit function, with the accessory connected to the coaxial input, RF energy is applied from the input through the capacitor **11** to the common pole of the relay **12**. This relay functions as a fail-safe relay to connect the RF input to the antenna **2** upon failure of normally supplied A, B, and C voltage through the input or failure or shorting of elements in the circuits through which a sufficient voltage is applied to actuate the solenoid. With all A, B, and C voltage normally applied, the RF energy is conducted through the relay **12** to a tap on an inductor **13** connected between ground and the cathode of the grounded grid amplifier tube **14**, the capacitor **15** resonating the inductor **13** at the desired frequency. With the control grid of the amplifier **14** connected to ground through the bias resistor **16**, it is operated at RF ground potential with the by-pass capacitor **17** and the voltage divider resistance **18** supplying the necessary negative C voltage in conjunction with the resistor **16** to provide a cut-off bias for the amplifier **14** during a receive cycle, i.e., when no RF transmit signal is supplied to the input. However,

with RF energy applied to the cathode of amplifier **14** and a B+ voltage applied to its plate through the inductor **19** (resonated with an associated tuning slug to the same input frequency of the inductor **13**), conduction does occur between the plate and cathode of the amplifier **14**.

Such RF energy as is present across the inductor **19** is by-passed at its input end by the capacitor **20** and is transferred to the control grid of the transmit power amplifier tube through the capacitor **22**. The RF coil **23** provides the RF isolation between the control grid of the amplifier **21** and the voltage divider and bias supply consisting of the resistors **24** and **25** and the capacitor **26**. The associated values of these elements provide the proper class C cut-off bias for the amplifier **21** during receive cycles and, further, provide the proper impedance load during the transmit cycles.

However, when a positive RF voltage is applied to the control grid of the amplifier **21**, a current conduction will occur between the cathode and plate, the potential for the plate being applied through the inductor **27** tuned to operating resonance by the variable and fixed capacitors **28** and **29**. The potential of the D.C. screen of the tube **21** is established by the bias resistor **30** interposed between the cathode of the tube **31** (to which the D.C. screen of the tube **21** is connected) and the secondary winding of the transformer **32** connected to the screen of the tube **31**.

Amplifier RF energy from the tube **21** is removed from the inductor **27** through a capacitor **33** to the antenna **2**. Inductors **34** and **35** in series, respectively, with the capacitors **36** and **37** provide resonant circuits for attenuation of the second and third harmonics appearing at the output tap of the inductor **27**. The capacitor **38** returns RF potential to ground and completes its RF path across the inductor **27** to accomplish resonance.

Modulation of the power output of the tube **21** is accomplished by a remodulation process, as follows:

A portion of the original input signal applied to the cathode of the amplifier **14** is coupled through the capacitor **39** to the No. **1** cathode of the diode tube **40**, for which cathode there is an RF isolated path to ground through the RF coil **41**. The No. **1** plate of the diode tube **40** is connected to the grounded primary of the transformer **32**. The grounded capacitor **42** in parallel with the primary of the transformer **32** serves as an RF bypass while offering a high reactance to audio voltages.

Thus, when modulated RF voltage appears at the diode tube **40**, its No. **1** diode plate will conduct current at an audio frequency rate through the primary of the transformer **32**. These voltages are coupled and raised in amplitude and impedance to the control grid of the tube **31** through the secondary of the transformer **32**. The increasing positive audio frequency potential thus provided at the cathode of the tube **31** appears at the screen of the amplifier tube **21** as increased D.C. potential together with audio frequency power as developed across the load resistors **43** and **30**. Thus, the resultant power output of the tube **31** will be modulated according to the original input modulated power but at the limit established, wholly independently of the input power, by the bias voltage and resistance values incorporated in the control grid circuits of the amplifiers **14** and **21**.

The receive function is shown in FIG. 3 as follows: With all A, B, and C voltage operative, RF energy received from the antenna **2** is coupled through the capacitor **33** to the tap on the inductor **27** tuned to operating frequency by the capacitors **28** and **29** forming a parallel resonant circuit with the plate capacity of the tube **21**. The capacitor **38** is a bypass to complete the total tuned circuit of the inductor **27** and capacitors **28** and **29**. A capacitor **51** is connected between the plate of the tube **21** and the cathode of the amplifier tube **50** whose grid is grounded through the capacitor **52**. The

RF coil **53** provides RF isolation with a D.C. connection for electronic emission of the tube **50**, whose grid is connected through the bias resistor to the No. **2** plate of the diode **40**.

An inductor **55**, in series between the plate of the tube **50** and a resistor **56**, is connected to one of positive B voltage. This inductor, being resonated to the same frequency as the inductor **27** in the plate circuit of the tube **21**, RF energy is developed across the inductor **55** and coupled through the capacitor **57**, which, in turn, is connected between the plate of the tube **51** to the control grid of the pentode amplifier **58**. The resistor **59** is connected between the control grid of the amplifier tube **58** to the No. **2** cathode plate of the diode tube **40**. The resistor **60** in parallel with the capacitor **51** is connected between the No. **2** diode plate of the tube **40** and ground to provide the necessary D.C. return paths for the diode tube **40** and the control grids of the amplifier tubes **50** and **58**.

With the cathode of tube **58** connected to ground and plate and screen voltage applied to tube **58**, through resistors **62** and **63**, RF coil **64** and associated bypass capacitors **65** and **66**, current conduction will occur. The plate of the tube **58** is also connected through the capacitor **67** to the No. 2 cathode of the diode **40** and cathode of the tube **14** to which is connected the inductor **13** tuned by the capacitor **15**. The two-stage amplified energy is removed from the inductor and thence through the relay **12** and capacitor **11** to the receive-output, transmit-input connection to the transmission line to the transceiver, the RF energy being supplied to the set having been substantially boosted over the original RF energy received at the antenna **2**.

It is to be noted, however, that when a transmit signal is imposed on the cathode of the diode **40** from the tuned inductor **13**, a high degree of rectification will occur across the plate in the diode **40**, with a resultant cut-off bias imposed on the control grids of the tubes **50** and **58**. This bias, therefore, automatically and non-mechanically blocks any conduction of current between the cathode and plates of these tubes and, accordingly, switches off the receive amplification function of the amplifier when the RF energy of a transmit signal appears at the accessory.

It should be clear from the foregoing that the specific embodiment disclosed may be modified by those skilled in the art without departure from the scope of the invention as defined in the appended claims. For example, instead of a two multiple-stage amplification of the receive signal, one may employ a single stage amplifier having a control grid responsive to the receipt of RF transmit energy in order to provide a cut-off bias and thereby disable the receive amplifier during input of a transmit signal. Likewise, the packaging of the elements of the circuitry for indoor use in one or more casings, rather than for mounting outdoors at the base or immediately adjacent to the antenna, incorporation of one or more sub-combinations in a transceiver set for hook-up to other elements separately packaged and located are also items of designer's choice to the same degree as the selection of specific tubes, resistances, capacitors, inductors, transformers, and other elements to transmit and receive specific bands of frequencies are matters of designer's choice.

What is claimed is:

1. An adjunct to be interposed between an antenna and the transmit and receive functions of a transceiver comprising a radio-frequency input connection to said transceiver; a radio-frequency output connection to said antenna; a first circuitry between the said radio-frequency input and output connections of said adjunct including an output amplifier having a control of grid and adapted to amplify at least up to a pre-determined wattage a portion of modulated input radio-frequency energy constituting a transmit signal, if the energy of said transmit signal is

less than the pre-determined wattage; at least one cut-off circuit within said first circuitry having bias voltage and resistance values preventing the output of radio-frequency energy in excess of said pre-determined wattage; a second circuitry in parallel with said first circuitry adapted to receive a second portion of said modulated input energy and modulate a voltage according to the modulation of said input energy, said modulated voltage being impressed on the control grid of the output amplifier of said first circuitry, whereby the output of said first circuitry is remodulated according to the modulation of said input energy; a third circuitry interposed between the said antenna and said transceiver to conduct signals received by said antenna to said transceiver; at least one amplifier in said third circuit to amplify said received signals while conducting them from said antenna to said transceiver; a cut-off bias interposed in said amplifier in said third circuitry, and an amplifier of a third portion of the transmit signal energy connected to said cut-off bias and amplifying the voltage of said third portion of transmit signal to the voltage required by said bias to disable the conduction of current through said amplifier of said third circuitry, whereby said third circuitry is electronically disconnected whenever a transmit signal is delivered to the input of said adjunct.

2. An adjunct as defined in claim 1 including a two-position switch operable in a first position to connect said antenna and transceiver only through said circuitries and, in its second position, to disconnect said circuitries and connect said antenna directly to said transceiver.

3. An adjunct as defined in claim 2 in which said switch is a relay having an armature actuated by normal voltages delivered to said adjunct to connect said circuitries between the said antenna and transceiver and disactivated upon failure of said voltages to connect said transceiver and antenna directly to each other.

4. An adjunct as defined in claim 1 in which said third circuitry includes multiple amplifiers of the received signals, and a cut-off bias in each amplifier activated by the voltage delivered by the amplifier of said third portion of the energy of the transmit signal.

5. An adjunct as defined in claim 1 including at least one resonant circuit connected to the output amplifier of said first circuitry to attenuate a harmonic of the remodulated transmit signals delivered to said output amplifier.

6. An adjunct as defined in claim 1 in which said first circuitry includes a final power amplifier having interposed between the cathode and plate thereof (a) a control grid to which is supplied the voltage determining the power at the output of the adjunct and (b) a screen having its potential varied by the said second circuit to remodulate the power of the output according to the modulation of the input transmit signal.

7. An adjunct as defined in claim 6 including a second amplifier in series with said power amplifier to actuate said control grid and a bias to disactivate said second amplifier in the absence of a transmit signal and, thereby, cut off said first and second circuitry while said third circuitry functions to amplify received signals.

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JOHN W. CALDWELL, *Acting Primary Examiner.*