Aug. 20, 1935. N. E. LINDENBLAD 2,011,943

ULTRA SHORT WAVE RECEPTION

Filed Jan. 26, 1933

Fig. 1

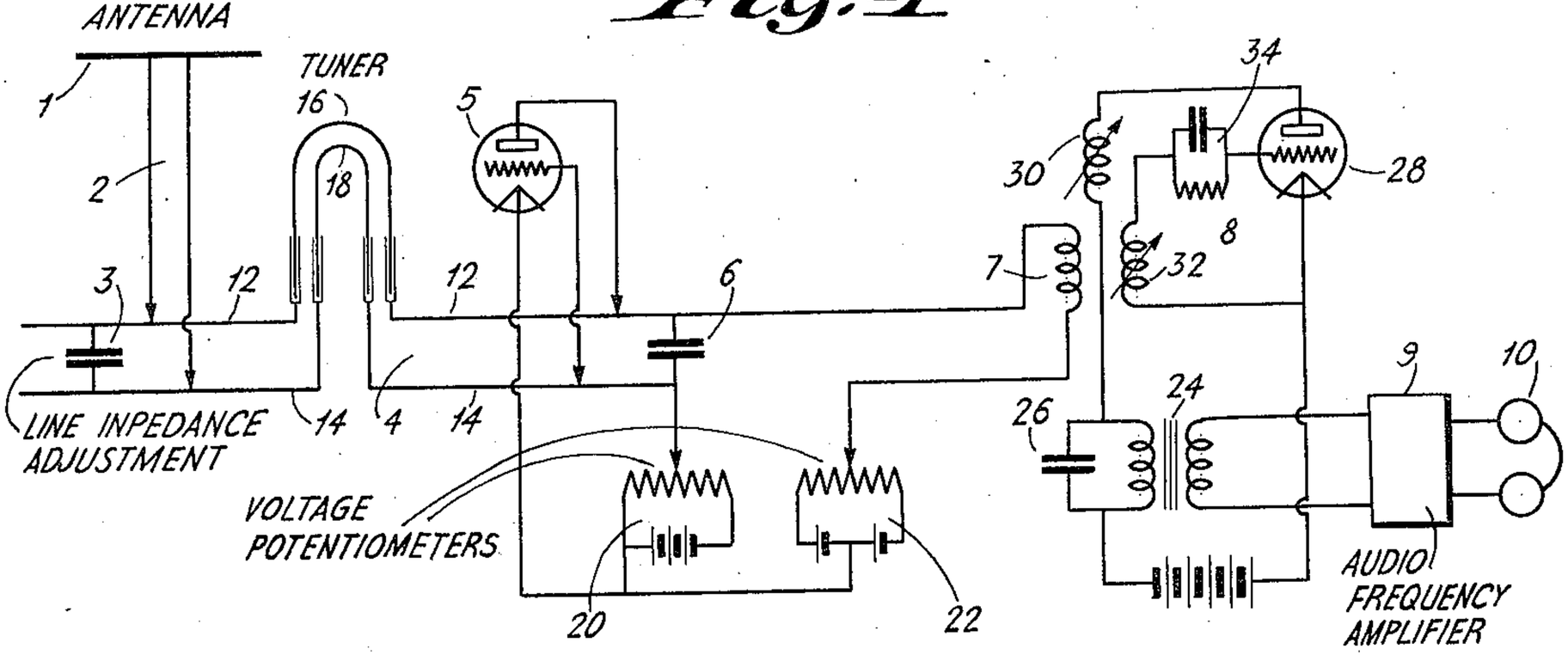
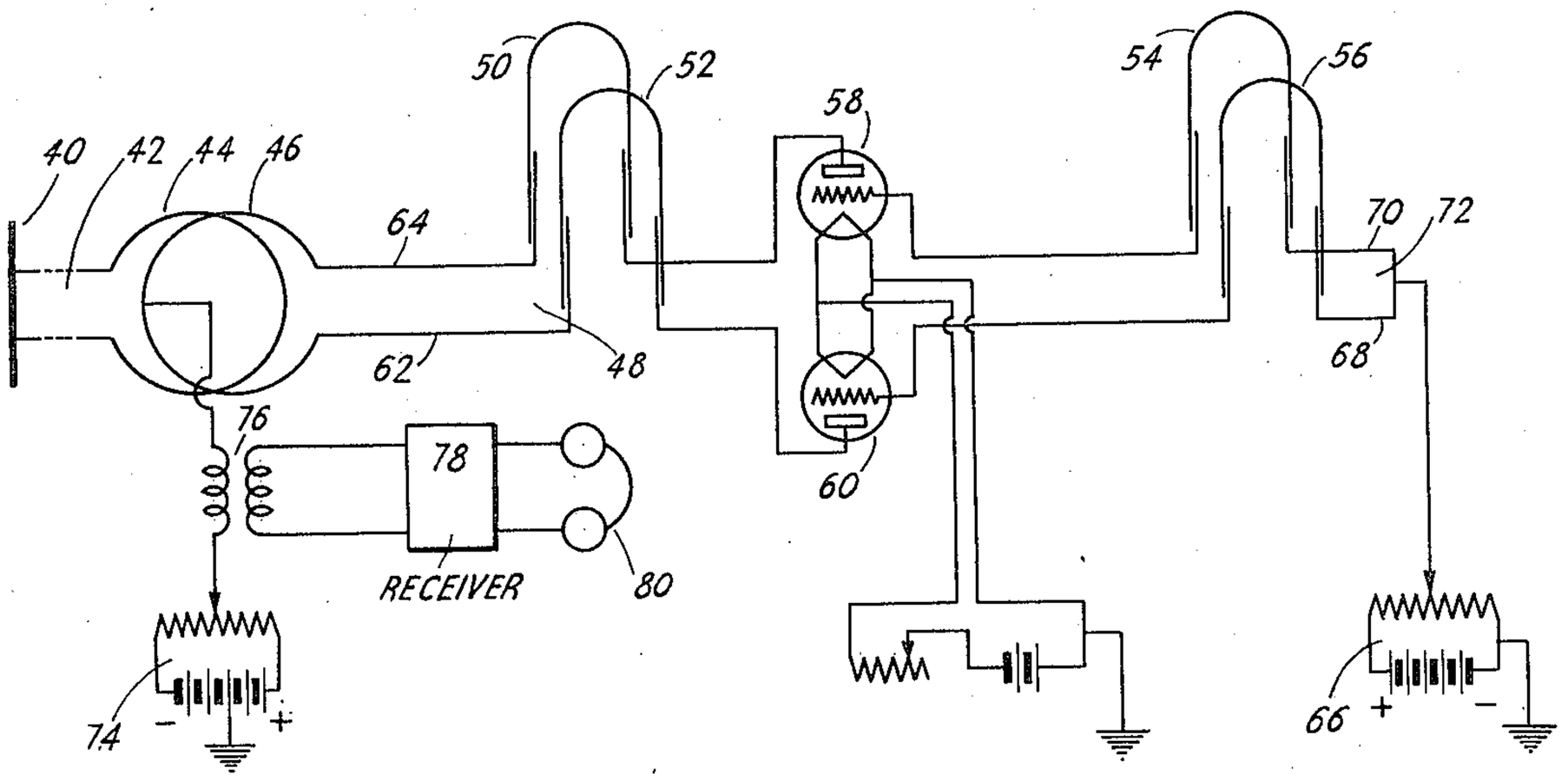


Fig. 2



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Patented Aug. 20, 1935 2,011,943

UNITED STATES PATENT OFFICE

2,011,943

ULTRA SHORT WAVE RECEPTION

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Application January 26, 1933, Serial No. 653,579

6 Claims. (Cl. 250—20)

This invention relates to apparatus for undulating electrical energy and especially to a receiving system for ultra short wave length radiated electromagnetic energy.

Ultra short wave length oscillations have been produced by the use of electron discharge devices having their control electrodes at high positive potentials relative to the other electrodes of the devices. The production of ultra short wave oscillations under such conditions may be ascribed to the fact that electrons attracted towards the control electrode or grid pass through the grid structure and, upon approaching a relatively negatively charged anode, are caused to return towards the grid, partly due to the attractive action of the positive charge on the grid and partly due to the repelling effect of the negatively charged anode. The returning electrons again rush through the grid only to approach the cathode, where the combined space charge as well as the attracting force of the grid causes the electrons to repeat the cycle outlined. The oscillations so produced are of ultra short wave lengths and are known as Barkhausen-Kurz oscillations.

In order to modulate such oscillations, audio frequency modulation has been directly applied to the oscillatory energy so produced; and, the ultra short wave length energy has been modulated by relatively low radio frequency oscillations modulated at audio frequencies giving what is known as double modulation of the ultra short wave length oscillations.

It is an object of my present invention to provide receiving systems for the collection, heterodyning and amplification, demodulation and translation of modulated ultra short wave length energy such as described hereinabove. More specifically, it is an object of my invention to provide the combination, in an ultra short wave receiving system, of an antenna for collecting ultra short wave length energy, a tuning circuit especially adapted for resonating the collected ultra short wave length energy, one or more oscillator-detector electron discharge devices for the heterodyning and amplification of the resonated energy, and means to demodulate and translate the amplified intermediate frequency energy.

Still a further object of the present invention is to provide for heterodyning and amplification purposes, one or more electron discharge devices having their control electrodes or grids maintained at high, positive potentials relative to the unidirectional potentials on the other electrodes of the devices, adjustably coupled to the tuning circuit for resonating the collected energy, in combination with, preferably, a regenerative detector for demodulating the energy amplified by the devices.

I have found that, by the use of a tuned radio frequency regenerative circuit for demodulating the amplified intermediate frequency oscillations, the regenerative circuit will give approximately the same amplification whether double modulation is employed at the transmitting end or the transmitted oscillations are only modulated directly by audio frequency energy. In the event of double modulation, the intermediate frequency circuit at the receiving end should, of course, be tuned to the intermediate frequency used at the transmitting end of the system. If desired, in the case of double modulation, a radio frequency amplifier, rather than a regenerative circuit, tuned to the intermediate frequency may be used for further amplification.

A better understanding of the present invention may be had by referring to the accompanying drawing which is given merely by way of illustration of the invention and is not to be considered in any way limitative thereof. In the drawing,

Figure 1 illustrates a receiving system for ultra short wave length radiated electromagnetic energy, a single tube oscillator detector amplifier functioning on the Barkhausen-Kurz principle being used before the regenerative detection of the amplified energy; and

Figure 2 illustrates a system similar to that shown in Figure 1 wherein collected energy is amplified in a pushpull type of amplifier before demodulation.

Referring to Figure 1, ultra short wave length energy is collected upon an antenna 1, and fed through a transmission line 2 to a tuning circuit 4. The energy so collected is resonated in the tuning circuit and applied to the oscillator-detector-amplifier 5 which beats with the incoming signal energy to produce an intermediate frequency and to which is coupled a regeneratively connected detector circuit 8 which demodulates the amplified energy. A suitable audio frequency amplifier 9, coupled to the intermediate frequency regenerative circuit 8, supplies energy to a translating device such as phones 10 wherein the transmitted signal is reproduced. It should be noted that circuit 8 is not adjusted for oscillations, but only for regenerative purposes.

The tuning circuit 4 is composed of substantially linear conductors 12, 14 connected together by metallic U-shaped slides or trombone

slides 16, 18 which provide for variation in tuning of the tuning circuit 4. The use of U-shaped conductors for varying the tuning of the tuning circuit is advantageous in that the length of the tuning circuit and hence the tuning of it can be varied without having any inductive or bothersome tail ends in the circuit.

The linear conductors are closely spaced in order to prevent undesired pick-up, and are terminated by radio frequency short circuiting means in the form of condensers 6, 3 which prevent the application of high positive control electrode potentials to the anode of tube 5, the high positive grid potential being derived from a suitable potentiometer 20. By varying the position of condenser 3 along conductors 12, 14, or by adjusting the junction points of transmission line 2 along the conductors 12, 14, the junction point of the transmission line 2, relative to the standing wave on the tuning system, can be varied and, consequently, the impedance of the line 2 can be accurately matched, allowing of maximum energy flow into the tuning circuit.

Oscillator-detector-amplifier tube 5 is also mounted so that it can be variably adjusted along the length of conductors 12, 14 so that, as described, it can be made to impose a variable load on the tuning circuit, whereby the oscillating and regenerative properties of the tube 5, whose control electrode is maintained at a high positive potential relative to the other electrodes of the devices, can be controlled.

Terminating the tuning circuit by means of a by-pass condenser 6 prevents, as already indicated, the application of undesired grid potential to the plate of tube 5.

The output circuit of tube 5 is completed through a coil 7 to a potentiometer 22 which supplies through the coil 7, a suitable potential to the anode of tube 5, ranging from a low positive potential to negative potentials. Coil 7 couples the output electrode or plate of tube 5 to the regenerative circuit 8 which is made to have constants corresponding to an appreciably longer wave length, and, in the case of, at the transmission end, the transmission of double modulated energy, should be tuned to correspond to the intermediate frequency used at the transmitter.

The modulation component of the received energy will appear in transformer 24, by-passed by a suitable radio frequency condenser 26. This component may then be amplified in a suitable low frequency amplifier 9 and translated by a suitable translating device 10.

The regenerative detector, as illustrated, comprises an electron discharge device 28 having a variable feed back coil 30 coupled to the input coil 32 and to the output coil 7. Proper biasing potential for the control electrode of tube 28 is maintained by action of the condenser and resistance arrangement 34.

Experimentation, with the arrangement described, has shown it to amplify equally well double modulated waves such as alluded to, or ultra short waves modulated directly by low frequency signalling currents. Attention is directed to the fact that in the reception of ultra short wave length energy directly modulated by low frequency energy, operation of the system may be attributed to the fact that there is interaction between the high frequency tuning circuit 4 and regenerative circuit 8, of the lower frequency, the energy supplied by tube 5 being modulated by energy of a frequency corresponding to the tuning of circuit 8 as well as being regeneratively amplified in circuit 8. During operation, circuit 8 is preferably not adjusted for the generation of oscillations, but solely for regenerative amplification.

A modified receiving system for ultra short wave length energy, is illustrated schematically in Figure 2. Ultra short wave length energy, collected upon an antenna 40, fed to transmission lines 42 through the inductive action of loops 44, 46 is supplied to a resonating circuit 48. Resonating or tuning circuit 48 contains U-shaped metallic slides 50, 52. The conductors 62, 64 of tuning circuit 48 are connected through trombone slides 50, 52 to the anodes of tubes 58, 60, whose control electrodes are maintained at a relatively high positive potential relative to the other electrodes of the devices by voltage potentiometer 66. The control electrodes are connected together by conductors 68, 70 having trombone slides 54, 56 therein for varying the effective length of the conductors and hence the tuning of the control electrode circuit 72. The positive potential to the grids, of course, is supplied to the circuit 72 at a voltage nodal point thereof as indicated.

It should be clear that it may be said that adjustment of all of the trombone slides will cause an effective variation in the position of pushpull connected electron discharge devices 58, 60 along conductors 62, 64, and 68, 70.

With the connections as described, and with the anodes maintained at a negative potential by the action of voltage potentiometer 74, the anode circuit will be the most sensitive part of the apparatus, as a consequence of which the incoming energy is applied thereto. Consequently, variations in the received current will cause variations in anode current through the primary of transformer 76 whose secondary may be coupled to a suitable receiver 78 actuating a translating device 80.

Receiver 78 may be of the regenerative type such as described in connection with Figure 1, or, it may simply be an audio frequency amplifier in which case transformer 76 should be so designed as to derive from the anode potential supply lead, the audio frequency component which will necessarily result from the application of the received potentials to the described circuits. The tubes 58, 60, in this case, therefore, will not only have an amplifying action, but will also give a demodulating or detecting action of the received energy. Moreover, in the case of double modulation at the transmitter, receiver 78 may comprise a tuned radio frequency amplifier, tuned to the intermediate frequency as there will be an intermediate frequency component appearing in the primary of transformer 76. The amplifier should then be followed by a suitable demodulator or detector.

Although I have described in detail some modifications of my invention, it, of course, is not to be limited thereto as it may be altered in several respects readily apparent to those skilled in the art; and, therefore, my invention is to be limited in scope only by the breadth of the appended claims.

Having thus described my invention, what I claim is:

1. In apparatus for undulating electrical energy, the combination of an antenna, a pair of electron discharge devices arranged in push-pull relationship and having their cathodes connected together and their control electrodes maintained at a positive potential relative to the an-

odes and cathodes of said devices for amplifying energy collected upon said antenna, and a regenerative detector coupled to said electron discharge devices for further amplifying and detecting energy amplified by said electron discharge devices.

2. In apparatus for undulating electrical energy, the combination of an antenna, electron discharge devices arranged in push-pull fashion and having their cathodes connected together and their control electrodes at a positive unidirectional potential relative to the anodes and cathodes of said devices for amplifying energy collected upon said antenna, and a regenerative detector coupled to the anode circuit of said electron discharge devices for amplifying and detecting energy amplified by said electron discharge devices.

3. In apparatus for undulatory electrical energy, the combination of an antenna collecting energy of ultra short wave lengths, a tuning circuit coupled to said antenna, said tuning circuit comprising closely spaced conductors short circuited at their ends for currents of ultra short wave lengths, means for altering the tuning of said tuning circuit, electron discharge devices having their control electrodes maintained at a positive potential relative to the other electrodes of the devices, coupled to said tuning circuit, a regenerative detector coupled to said devices, and, translating means coupled to said regenerative detector.

4. In apparatus for undulatory electrical currents, the combination of an antenna collecting ultra short wave length energy, a tuning circuit coupled to said antenna, U-shaped metallic slides in said tuning circuit for altering the tuning thereof, a push pull electron discharge device amplifier operating on the so-called Barkhausen-Kurz principle having its anodes coupled to said tuning circuit, a demodulator coupled to said amplifier, and translating means coupled to said demodulator.

5. In apparatus for undulatory electrical energy, the combination of an antenna collecting ultra short wave length energy, a tuning circuit comprising a pair of closely spaced, substantially linear conductors, coupled to said antenna, means for short circuiting said conductors for ultra short wave length energy, means for varying the effective lengths of said conductors and consequently the tuning of said tuning circuit, a pair of push pull connected electron discharge devices operating on the Barkhausen-Kurz principle having anode electrodes which are directly coupled to said conductors, a detector also coupled to the anodes of said push pull connected devices, and translating means coupled to said detector.

6. An ultra short wave receiving circuit comprising a pair of electron discharge devices in push-pull relationship, said devices having anode, cathode and control electrodes, means for applying positive direct current bias potentials to said control electrodes and smaller potentials to said anodes relative to the cathodes of said devices, an energy collector circuit connected to the anodes of said devices, and translating apparatus coupled to said anodes and symmetrically located with respect thereto.

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