RECEIVING SYSTEM

Original Filed Nov. 8, 1929 2 Sheets-Sheet 1

Fig. 1

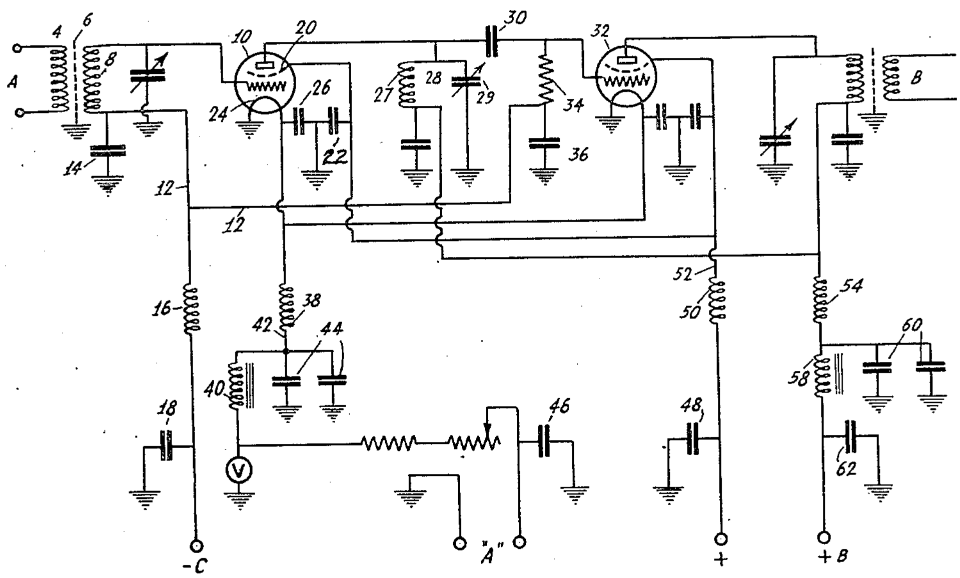

Fig. 2

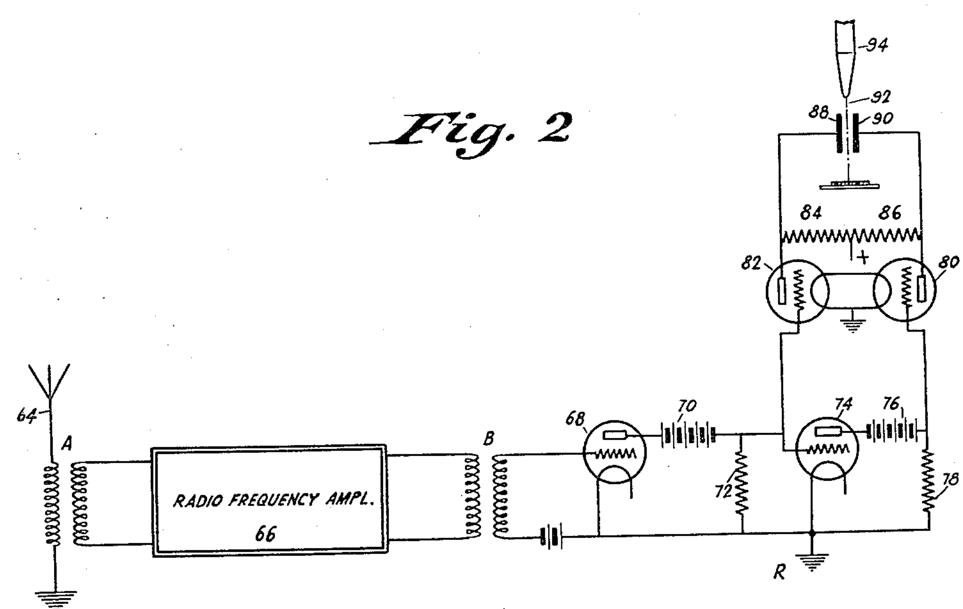

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Fig. 3

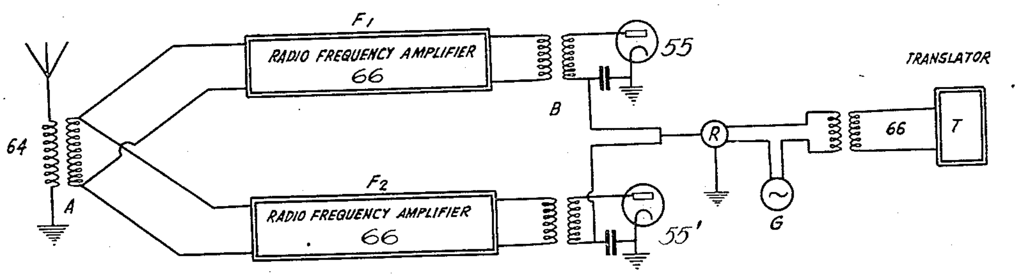
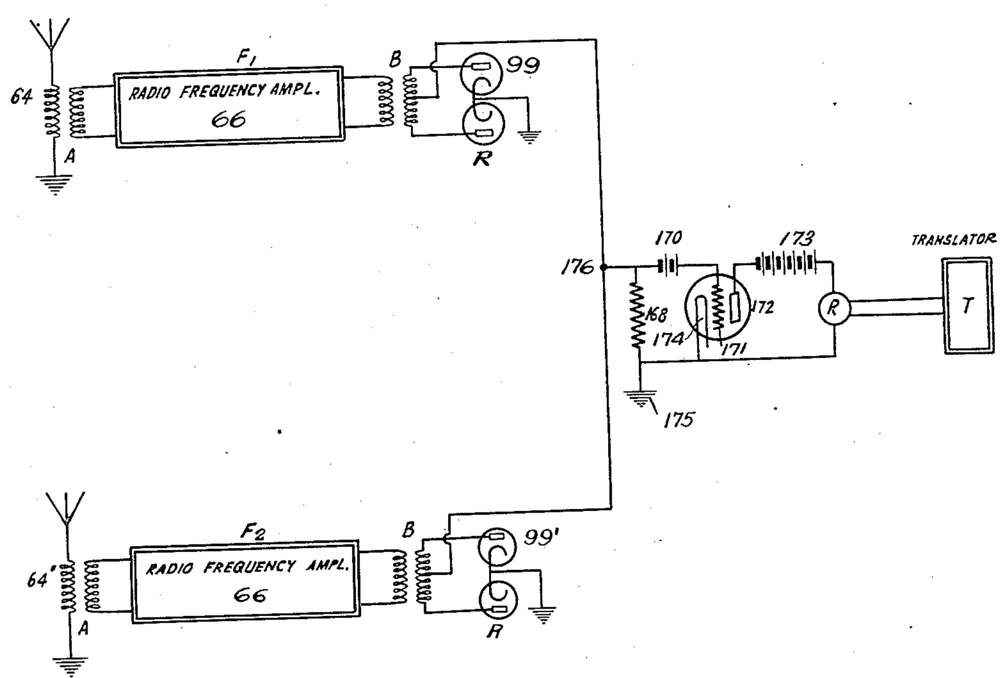


Fig. 4



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UNITED STATES PATENT OFFICE

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RECEIVING SYSTEM

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Renewed May 24, 1933

3 Claims. (Cl. 250—8)

This invention relates to the art of radio signalling and has for one of its objects the provision of a novel method and means for receiving and rectifying directly extremely high or ultra high radio frequency energy.

For code telegraphy, a practical operated transmitter is keyed on and off at a time rate that can be expressed in cycles per second if the average number of dot units in a word is taken into consideration. For the speed of 100 words per minute in the Continental Morse Code for the average group of words, the rate of keying has been found by experience to be 40 cycles per second.

At the receiver for uniform legible signals it is highly desirable to keep the shape of dots as square as possible. To keep a square formation of dots it has been found desirable and necessary to have a minimum of 10 cycles of carrier frequency per dot of keying frequency. For the speed of 200 words per minute of telegraphic code signalling, the carrier frequency under the rules laid down as mentioned above, should be $2\times40\times10$ or 800 cycles per second. As this is well within the audio range it is entirely satisfactory for code reception and can be simply obtained at the receiver when a relatively low frequency carrier is utilized during transmission by simple rectification of the received carrier. However, with the advent of highly improved automatic receivers which trace signal characters upon a tape, such as disclosed by C. W. Hansell in his United States patent application Serial Number 333,617, on an electrostatic recorder, code reception of words is feasible at a speed of the order of magnitude of thousands of words per minute. At the transmitter, therefore, the keying speed would have to be correspondingly increased. Turning to facsimile and printer work even higher keying speeds are required. For television, a transmitter should be keyed at 100,000 cycles for a square modulation envelope at the receiver; and, with reference to the most recent types of facsimile and television transmitters, carriers having a frequency of the order of magnitude of 20,000,000 cycles per second are radiated.

Heretofore when dealing at the receiver with such ultra high frequencies, the transmitted carrier was reduced to some intermediate frequency, say, to 100,000 cycles by heterodyning, and the heterodyned beat energy was then detected and used for translation purposes. The reason for such heterodyning was due, of course, to the fact that it was impossible to amplify high frequency energy of such ultra high frequencies at the receiving end.

For a maximum rate of keying speed, it has already been indicated that a minimum of 10 cycles of carrier per dot unit would be the limiting factor; for, it were attempted to signal with a lesser number of carrier cycles per dot unit, the characters would become rounded at the ends and the spaces between the characters would be filled in due to transients. The rounded end effect at the receiver is aggravated by the use of the heterodyne receiving method which, as already indicated, also was an absolute necessity; because, when it was attempted with prior receiving circuits to amplify the high frequency currents directly, parasitic oscillations and undue reactions between the circuits rendered legible reception impossible.

To obviate the foregoing difficulties and to provide a novel method and means whereby extremely high received radio frequency energy may be directly rectified thereby giving square signal characters are the prime objects of my invention. Briefly, to carry out this object I make use of an amplifier especially designed to amplify extremely high radio frequency currents without the production of extraneous or parasitic oscillations and which will not cause slurring or rounding over the ends of the characters.

In the accompanying drawings, in which I have illustrated several embodiments of my invention by way of example and which, accordingly, are not to be treated as limitations thereof,

Figure 1 is a wiring diagram of an extremely high frequency amplifier having a plurality of amplification stages,

Figure 2 shows a simple form of receiving system in which the principles of my invention are applicable,

Figure 3 shows how my invention may be applied to a receiver having diversity in frequency, and

Figure 4 indicates a receiving system incorporating the subject matter of my invention having diversity in space.

Turning to Figure 1, in which I have shown schematically a high frequency amplifier especially adapted for amplifying extremely high frequency energy, A indicates the input circuit thereto which may be coupled to an energy collecting device such as an antenna. Amplified extremely high radio frequency currents which have the same frequency as the input, are taken from the amplifier at point B by any suitable coupling device such as the electrostatically shielded transformer shown. Although two stages have been indicated, any desired number may be used.

Input energy at A is fed through a transformer 4, electrostatically shielded by means of shield 6, to the input circuit 8 of the first screen grid amplifier tube 10. To prevent radio frequency currents from travelling directly to another stage or to other points through the control electrode lead 12, the inductance coil of tuned circuit 8 is grounded through a blocking condenser 14, which provides a path of low impedance for the high frequency currents to ground. To further insure the passage to ground of radio frequency currents in the lead 12, a radio frequency choke coil 16 is placed therein and, the potential supply end thereof is short circuited to ground for radio frequency currents by means of a condenser 18.

To prevent feed back from the anode to the control electrode of electron discharge device 10, that device is preferably of the screen grid type having a screen grid 20 which effectively prevents interelectrode feed back. As an added precaution the shield grid is grounded for radio frequency currents through a blocking condenser 22 as is also the normally ungrounded side of the cathode 24, through a condenser 26.

The output circuit 28 of tube 10 is grounded similarly for the purpose of confining the flow of radio frequency currents along certain elements, more particularly, each element 27, 29 of tunable circuit 28 is separately grounded for radio frequency currents.

Energy from the output circuit is fed through a blocking condenser 30 to the input side of tube 32 similar in type to tube 10. To provide a definite bias for the control grid of tube 32 a resistance 34 is connected in the grid circuit of tube 32, and is grounded for radio frequency currents through a blocking condenser 36 to further prevent the passage of radio frequency currents along the bias lead 12. The output circuit of tube 32 contains apparatus similar to that already described and hence need not be explained in detail.

Chokes 38 and 40 in the cathode energy supply lead 42 for the tubes are provided to prevent the flow of radio frequency currents therein and thereby prevent setting up of interactions and oscillations. To further prevent the passage of radio frequency currents into the cathode energizing source capacities 44 are provided which combined have a relatively low impedance for radio frequency currents thereby effectively shunting any such currents which may be present, to ground. An additional condenser 46 is provided for that purpose in the energy terminal of the cathode supply lead. A choke 50 and a condenser 48 are connected to the screen grid potential lead 52, and chokes 54, 58 and condensers 60, 62 in the anode supply lead are provided for a similar purpose.

From the precautions described to be taken in the construction of the radio frequency amplifier, it should be apparent as to means to be used in connection with the rectifier to prevent distortion therein. In addition, metallic shields should be placed about the apparatus included in each stage and about each tube, and the power supply filters should be in a separate shielded compartment.

In Figure 2 I have shown how my improved amplifier described in detail in connection with Figure 1 may be applied to a simple receiver system. Energy collected upon antenna 64 is fed through the input circuit A to a radio frequency amplifier 66 having a circuit of the type shown in Figure 1. The amplified extremely high frequency currents at the output circuit B are fed directly into a bias rectifier shown diagrammatically at 68 to control a thermionic relay R.

A typical thermionic relay for controlling an electrostatic high speed ink recorder is indicated. The anode voltage for bias rectifier tube 68 is supplied by a battery 70, and the anode current flows through resistance 72. The voltage drop across resistance 72 controls tube 74, and also tube 82. The voltage drop across resistance 78 in the anode circuit of tube 74 controls another tube 80 which is paired with tube 82.

When there is no signal voltage arriving, tube 68 is biased to cut off the anode current, so there is no voltage drop across resistance 72, thus allowing tubes 74 and 82 to pass an anode current through resistances 78 and 84 respectively. The voltage drop across resistance 78 biases tube 80 to cut off. Hence, with no signal coming in, tube 80 passes no anode current through resistance 86 and electrostatic control plate 90 is at high positive potential.

At the same time, tube 82 is passing anode current through resistance 84, causing electrostatic control plate 88 to be at a lower potential than plate 90 by the amount of the voltage drop across resistance 84. This causes the ink jet 92 from nozzle 94 to be deflected towards the more positive plate 90.

When there is a signal voltage arriving at 64, it is amplified by amplifier 66 and is fed through transformer B to the grid of the bias rectifier tube 68, causing an anode current to flow in resistance 72. Tubes 74 and 82 are then biased to cut off the anode currents, and as there is now no voltage drop across resistance 78, tube 80 is biased to pass an anode current which produces a drop in voltage across resistance 86. Plate 90 now becomes less positive than plate 88, and the ink jet is deflected towards plate 88.

While a typical thermionic relay has been described, it should be understood that other devices, such as gaseous tube for photographic recording, or a circuit controlling the current in the moving coil of a high speed recorder could have been used. The thermionic relay could also have been used to key an oscillator of lower frequency suitable for transfer over a wire line to a distant point, or it could have been used to control a mechanical relay. It is intended that this invention should be used with thermionic, gaseous, or mechanical relays, selecting in each case the most suitable type for handling modulation frequencies from slow code speeds up to high speed facsimile or even television.

In order to reduce fading effects, it is desirable to transmit the same signal modulation on two or more frequencies. My invention as applied to such a system is described in Figure 3, where at F1, I utilize a radio frequency amplifier 66 tuned to a frequency F1, and at F2, I utilize a second amplifier 66' tuned to a frequency F2. Although both amplifiers F1 and F2 are connected to a single collector 64 at A, it is obvious that they may be separately connected or coupled to geographically spaced collectors or antennæ.

The amplified output of the two amplifiers F1 and F2 of extremely high frequencies are applied to rectifier 55 and 55' and rectified. The rectified outputs of the rectifiers are combined by means of the relay R, which in turn keys the output of a generator G which generates a frequency suitable for transmission over a wire line 166 to a distant translator T.

In some cases, transmission is accomplished by signaling with marking waves of one frequency, and a spacing wave of another frequency. Since these two frequencies have been found to fade differently, it would be possible to reduce the fading effect by making use of both the marking and spacing wave. To accomplish this with the arrangement of Figure 3, amplifier F1 could be tuned to the marking wave, for example, and amplifier F2 could be tuned to the spacing wave. In this case, the rectifiers 55 and 55′ would have their output circuits connected differentially to the relay R so that the effects of the space and mark waves would be cumulative on the relay R.

In Figure 4, I have shown my invention as applied to a diversity receiving system having geographically spaced collectors 64 for the purpose of reducing fading effects. Energy collected upon each of the antennæ is amplified in radio frequency amplifiers 66 and 66′ tuned to a frequency F1 and F2 which is then fed at B to full wave rectifiers 99 and 99′. The outputs of the two rectifiers are combined in a common resistance 168 which is connected through a bias battery 170 to thermionic relay voltage limiting tube 172. In the operation of tube 172 the ungrounded end of the resistance 168 is connected through a bias battery 170 to the grid 171 of tube 172, which tube has its energy and high potential plate supplied by a battery 173 which is connected in series with a relay R, the plate circuit being completed through the filament member 174 which is grounded at 175. Grid 171 of tube 172 is normally so biased by battery 170 that plate current will flow under conditions when no signal is received. In this case plate current flows through plate 172, filament 174, the battery 173, and relay R. However, when signals are received through antennas 64 and 64′, then after passing through the amplifiers F1 and F2, and rectifiers 99 and 99′ to the common point 176 due to the voltage drop occurring across resistance 168, the common point 176 becomes negative with respect to its previous potential, and therefore, the normal bias on grid 171 of tube 172 is overcome. It should be understood, however, that the cut off potential of tube 172 depends upon both the voltage and potential of the bias battery 170 and the characteristics of the tube 172. The anode current of the tube 172 is shown controlling a non-thermionic relay R, which in turn controls translator T.

It is to be understood that the system shown in Fig. 4 may include radio frequency amplifiers F1 and F2 tuned to different frequencies.

Although a non-thermionic relay is shown, a preferred arrangement, would be to use the scheme of Figure 4 in connection with the thermionic relay shown in Figure 2. In that case, tube 172 of Figure 4 would correspond with tube 68 of Figure 2. The only difference in operation would be that tube 172 would normally be adjusted to pass an anode current with no signal arriving, as mentioned in detail above, but as soon as a signal arrives, the rectified currents flowing in resistance 168 would drive the grid of tube 172 negative, cutting off the anode current, which is just the reverse of the operation of tube 68 of Figure 2.

However, the operation of tube 172 of Figure 4 is preferable from the standpoint of fading elimination, since it will be obvious that as long as the sum of the rectified currents in resistance 168 remains above the minimum value necessary to reduce the anode current of tube 172 to zero, the output of the thermionic relay will operate between two fixed limits, corresponding to the conditions of normal and zero anode current in tube 172, respectively.

It is obvious that more than two geographically separated antennæ could be used by connecting the output of the multiplicity of rectifiers to the common resistance 168.

Having thus described my invention, what I claim is:

1. A receiving system for extremely high frequency signals of the order of 20,000,000 cycles per second transmitted at a plurality of frequencies comprising a plurality of geographically spaced antennas, a radio frequency amplifier coupled to each of the antennas and each tuned to a different one of the transmitted frequencies, each of said amplifiers comprising a plurality of stages having individual screen grid electron discharge devices and associated tunable circuits, each of said tunable circuits including an inductance coil and a tuning condenser, the inductance coil being grounded at one end through a by-pass condenser and the tuning condenser being separately grounded, full wave rectifiers coupled to each of said radio frequency amplifiers, circuit means including a relay to combine the rectified energies, and translating means responsive to the combined energy.

2. A receiving system for substantially eliminating the fading effects of signal energy in the order of 20,000,000 cycles and modulated at a frequency of substantially 2,000,000 cycles, comprising a plurality of geographically spaced antennas, a radio frequency amplifier for each of the said antennas, a full wave rectifier coupled to each of said amplifiers to give a substantially square dot formation of the modulated frequency, and means for combining the rectified energies of said geographically spaced antennas comprising a single resistance connected through a bias battery to the grid of an electron discharge tube and a relay connected to the anode of said tube so as to operate a single translator.

3. A receiving system for substantially eliminating the fading effects of signal energy of a carrier frequency in the order of 20,000,000 cycles and modulated at a frequency having a minimum of 10 cycles of carrier frequency per dot of modulated frequency, comprising a plurality of geographically spaced antennas, a radio frequency amplifier for each of the said antennas, a full wave rectifier coupled to each of said amplifiers to give a substantially square dot formation of the modulated frequency, and means for combining the modulated frequency of each full wave rectifier comprising a resistance connected through a bias battery to the grid of an electron discharge tube and a relay connected to the anode of said tube so as to operate a single translator.

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