Aug. 7, 1945. C. W. HANSELL 2,381,444

RADIO SYSTEM

Filed Dec. 27, 1940 2 Sheets-Sheet 1

Fig. 1

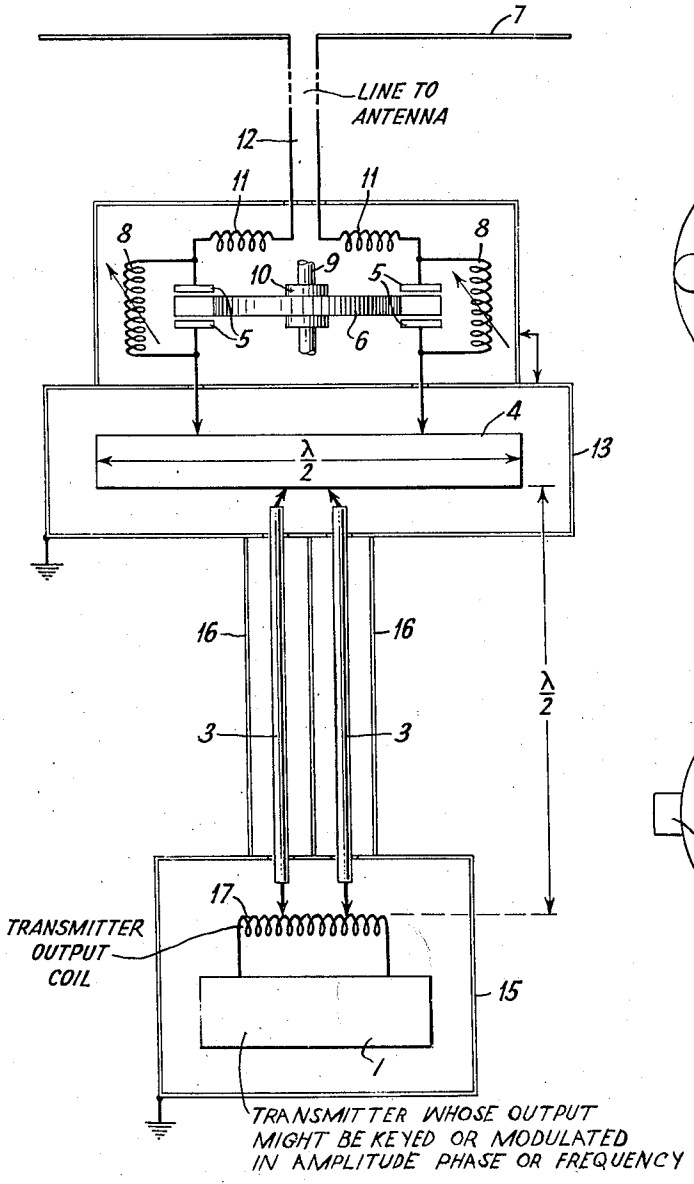


Fig. 2

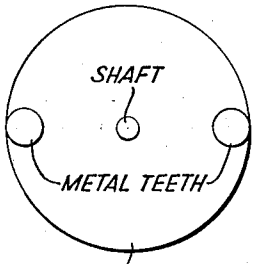
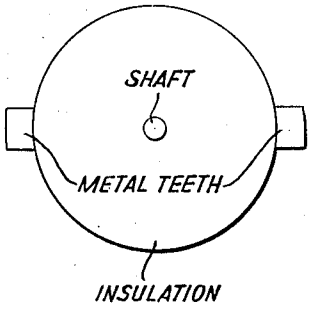


Fig. 2a



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RADIO SYSTEM

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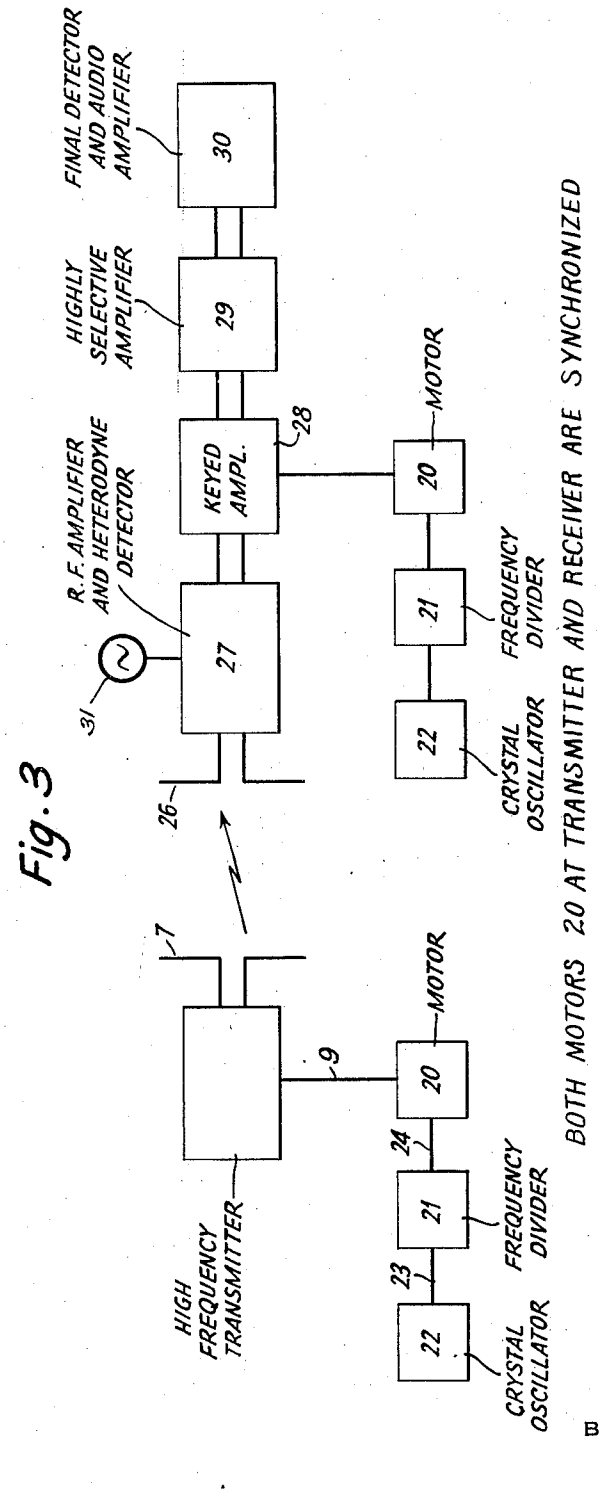


Fig. 3

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Patented Aug. 7, 1945

2,381,444

UNITED STATES PATENT OFFICE

2,381,444

RADIO SYSTEM

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Application December 27, 1940, Serial No. 371,865

41 Claims. (Cl. 250—6)

The present invention relates to improvements in radio communication, and has for its primary object to improve the signal-to-noise ratio of radio systems. A further object is to obtain the aforesaid improved signal-to-noise ratio without increasing the size of the vacuum tube equipment furnishing the power to the radio transmitter.

The invention is primarily applicable to radio systems for the transmission and reception of telegraph signals, including printer signals, and may also be used for the transmission and reception of slow speed facsimile signals.

The objects of the present invention are achieved, in brief, by radiating from the transmitter short pulses of increased power (i. e., increased relative to the permissible steady state value) and conditioning the receiver to be responsive substantially only during the intervals when energy is coming in from the transmitter. At the transmitter, the output power is continuously stored and then used for short time periods to produce pulses or bursts of power. By radiating all the stored output power in relatively short periods of time compared to the intervals between radiation periods, there is obtained an increased power output compared to a normal steady state value of power output. The normal steady state value is the power output which the transmitter can deliver continuously. At the receiver, the response period is timed synchronously with the transmitter so that the receiver gives an output which is caused only by the energy present at the time signal energy is coming in from the transmitter. To achieve this, the receiver is blocked or quenched at some point, or points, ahead of those circuits which effectively contribute to the receiver selectivity, whereby any noise which exists between periods of signal input to the receiver is prevented from contributing to noise output from the receiver. In this way, no noise is permitted to build up energy in the selective circuits of the receiver except that which exists while the receiver circuits are receptive or "open." During these "open" periods of the receiver, the signal, with its increased power, makes its greatest impression.

In order that the present invention may be better understood, an explanation of the theory underlying the invention will now be given. While this explanation is believed to be correct, it is not of necessity complete, nor does the operation of the invention depend upon its accuracy or otherwise.

We can consider the signal-to-noise power ratio in radio circuits as ratios of energy flow per unit of time. In general, the total noise energy in the output of a receiver is proportional to noise power multiplied by time. If the time during which a receiver is operative is reduced to 10%, the total noise energy and average power in the output of the receiver will also be reduced to 10%. That is, a receiver which is controlled in such a way as to be responsive during intervals of $\frac{1}{5000}$ of a second repeated at a rate of 500 cycles, will have a noise in its output reduced by about ten to one in power. If the repetition rate is reduced to 50, still maintaining $\frac{1}{5000}$ second as the responsive period of the receiver, the noise power, or energy rate, in the output of the receiver will be reduced by one hundred to one.

This reduction in responsive time at the receiver will be of no value in improving signal-to-noise ratio when used on an ordinary signal because the useful signal will be reduced in the same ratio as the noise. However, by storing up the output power from the transmitter and then radiating it all in $\frac{1}{5000}$ second bursts at times synchronous with the receiver responsive period and with correct timing between transmitter and receiver so that the signals arrive at the receiver when it is responsive, then there can be obtained an improvement in signal-to-noise ratio. This is generally what is done in the present invention.

If, for example, we have a transmitter which has an available output of about 200 kilowatts, and the transmitter power output were stored up and then used during $\frac{1}{5000}$ of a second intervals, repeated at a 500 cycle rate, then the signal-to-noise ratio would be improved as though the transmitter power had been increased from 200 kilowatts to 2000 kilowatts. By storing up the transmitter power output, we are, in effect, enabled to release at the pulse period a power output which in fact greatly exceeds the normal steady state value of an ordinary signal. If the pulse period is $\frac{1}{10}$ of the total time used for transmission, then theoretically it is possible to send out during pulse periods

$$\frac{1}{1/10}$$

or ten times the power output of the steady state signal. This is because the rate of change of stored energy when being transmitted during pulse periods is very much greater than the rate of change of stored energy during off pe-

riods when the transmitter is delivering power to the storing oscillatory circuit. If, in the immediately foregoing example, the repetition rate were reduced to 50 cycles, then the power output during the active periods would be equivalent to 20,000 kilowatts. By employing circuits having suitable antenna power gains due to the use of a directive antenna, it is possible to still further increase the signal-to-noise ratio. An antenna power gain of 100 to 1, for example, would increase the effective power to 2,000,000 kilowatts.

Although at first blush it might be thought that a timed spark type transmitter would provide a signal with high peak amplitudes more or less equivalent to the type of signal necessary to obtain the benefits of the present invention, it is believed that such a transmitter is not practical for high power because the physical dimensions of the equipment required for a high power with spark transmission make high frequency operation impractical. Further, spark generators, generally necessary in the spark type transmitter, lose efficiency at very high frequencies due to time lags in break down of the air in the spark gaps. Under some circumstances, however, it might be possible to use a timed spark type transmitter, although such an arrangement is not preferred to carry out the purposes of the invention. According to the present invention, it is proposed to employ low power factor oscillating circuits for storing energy in the transmitter. Such circuits may be of the concentric resonant line type now well known in the art. They may also be resonant metal enclosed cavities, known as cavity resonators. These low power factor circuits may be fed with energy continuously from a continuous wave transmitter during periods when transmission is desired, and energy for the antenna may be drawn from these low power factor circuits during short time intervals at a rate considerably higher than the transmitter could deliver directly. As an illustration, it is practical to obtain resonant line low power factor circuits with the power factor due to losses in the line itself of about one part in 20,000 (Q=20,000). Of course, different and higher values of Q are attainable with special design of the circuit elements.

The following is a detailed description of the invention accompanied by drawings, wherein:

Fig. 1 illustrates in abbreviated form the essential circuit elements of a transmitter for transmitting short pulses of energy in accordance with the principles of the invention;

Figs. 2 and 2a are details showing two different forms of the toothed disc wheel which can be employed in the transmitter of Fig. 1; and

Fig. 3 illustrates the principles of the invention applied to a complete radio communication system having a transmitter and a receiver.

Referring to Fig. 1, there is shown a high frequency radio telegraph transmitter 1 whose output is fed to the transmitter output coil 17 from which energy is passed through half wavelength

$$\left(\frac{\lambda}{2}\right)$$

line sections 3, 3 to a half wavelength

$$\left(\frac{\lambda}{2}\right)$$

resonant line 4. Output from the half wavelength resonant line 4 is supplied to the antenna 7 through variable coupling condensers provided by plates 5, 5 in cooperation with a toothed wheel or disc 6 and also through coils 11 and transmission line 12. Transmitter 1 and its output coil 17 are surrounded by a grounded metallic shield 15, while the half wavelength line sections 3, 3 and the half wavelength resonant line 4 are respectively shielded by means of surrounding shields 16 and 13. The line sections 3, 3 are each one-half wavelength long as measured from the points of connection on the output coil 17 to the points of connection on the half wavelength resonant line 4. Obviously, the electrical length of the line has been referred to, since the physical length may be something more or less than this, due to end effects and so forth. The connections of the line sections 3, 3 to the coil 17 and to the resonant line 4, are, it should be noted, symmetrically arranged with respect to the center or nodal points on these elements. Similarly, the connections from the resonant line 4 to the condensers constituted by the plates 5, 5 are also symmetrically arranged and on opposite sides of the mid point or nodal point on the resonant line.

The toothed disc 6 is driven by means of a hub 10 and a shaft 9 connected to a motor (not shown), at an exact speed, which may be done by controlling a synchronized driving motor, to which the shaft 9 is linked, from an extremely accurate frequency standard. This is described in more detail in connection with Fig. 3. This toothed disc is made primarily of insulation and has metal teeth symmetrically arranged on opposite sides of the shaft and may take any one of the forms indicated in Figs. 2 and 2a. Each tooth in the disc 6 is a desired percentage, let us say somewhat less than 10%, of the total distance around the periphery. When one metal tooth is between the plates 5, 5 of one condenser, the other metal tooth will be between the plates 5, 5 of the other condenser on the opposite side of the wheel 6. Thus, these condensers 5, 5 have maximum capacity when a metal tooth happens to be positioned between the plates, and at this time will permit the delivery of near maximum output from the half wave resonant line 4 to the antenna 7. For low values of capacity of the condensers 5, 5, the output is made very low. It will thus be noted that the capacity of these condensers is varied by means of the toothed wheel 6 which is so designed and operated that power is fed to the antenna for short periods, let us say, of $\frac{1}{5000}$ second repeated at intervals of $\frac{1}{500}$ of a second. Both condensers will have maximum capacity simultaneously, and also minimum capacity simultaneously.

The variable inductors 8, in parallel to the condensers, serve to neutralize the residual capacity of the condensers when no signal or radiation is desired, which will occur between pulses or during idle periods corresponding to the time when spaces between the metal teeth on the wheel or disc 6 are present between the condenser plates. The coils 8, 8 are adjusted to give the minimum current in the antenna during these no signal or "off" periods.

Coils 11, 11 are provided in series with the conductors of the feed line 12 in order to tune out the reactance of the condenser and coil system 5, 8 when the condensers have a maximum capacity. That is, the coils 11, 11 provide a series short circuit in the transmission line leads (i. e., minimum impedance therein to energy of

the operating frequency) to enable maximum current to go to the antenna from the half wave resonant line 4.

If the transmitter 1 were capable of delivering 200 kilowatts, given by way of example only, then the antenna load, when it is effective, should be able to take up to 2000 kilowatts. The three half wave line sections 3, 3 and 4 serve as a fly wheel, so to speak, or tank circuit to smooth out the load fluctuations and therefore hold substantially constant load on the transmitter 1.

The toothed wheel condenser arrangement, in order to handle the large amount of power required, should preferably be operated in compressed air or in a compressed gas, such as hydrogen, helium, nitrogen, carbon dioxide, etc., which should prevent oxidation in case of arcing between condenser plates. If the pressure of the compressed gas be made to be 1500 pounds or about 100 atmospheres, the spacing between the elements in the condenser might be reduced to something like 1% or less of that permissible in open air before there occurs the danger of arcing. Consequently, for a given capacity, the area of the condenser plates can be reduced to 1% of that required in open air. Thus, at 100 atmospheres of the total volume required for the working part of the condenser would be only $1/10000$ of that which would be required in open air.

To reduce radiation due to residual or minimum capacity in the variable condenser, there may be used, if desired, capacity balancing or neutralization condensers (criss-cross arrangement) between the condenser plates, as is commonly used in push-pull amplifier circuits for a similar purpose, instead of tuning out the residual capacity by means of the coils 8, 8, to form with it an anti-resonant circuit as shown in Fig. 1.

Fig. 3 shows in conventional box form a complete radio system of transmitter and receiver embodying the principles of the present invention. The transmitter is designed in a manner shown in Fig. 1 to radiate short pulses or bursts of signal power from antenna 7. The toothed wheel or disc 6 in the transmitter is linked by means of its shaft 9, and a speed changing gear if necessary, to a synchronized driving motor 20, in turn controlled through a frequency divider 21 by a crystal oscillator 22. Oscillator 22 is an extremely accurate frequency standard which generates, by way of example, oscillations of 100,000 cycles. The frequency divider, coupled to the output of the crystal oscillator over circuit 23, may reduce the frequency of the crystal oscillator to a frequency of, let us say, 50 cycles which can then be applied to the motor 20 over circuit 24. In this way the motor 20 is driven at an exact speed.

The receiver includes a suitable antenna 26 which feeds the collected signal energy to a suitable radio frequency amplifier stage and then to a heterodyne and detector stage 27, from which intermediate frequency energy is applied to a keyed amplifier stage 28. Oscillator 31 is a heterodyne oscillator for use with the heterodyne detector of apparatus 27. The output of the keyed amplifier is fed to a highly selective amplifier system 29 before being passed on to a final detector and subsequently to the audio amplifier stages 30 (shown conventionally in box form). In order to quench or block the receiver, there is provided a motor 20 similar to the motor shown at the transmitter and which is driven in exact synchronism with the motor at the transmitter over a similar arrangement of crystal oscillator 22 and frequency divider 21. The crystal oscillators and frequency dividers at both the transmitter and receiver are designed to have the same constants. The motor 20 serves to periodically quench or block the receiver in keyed amplifier 28, which is ahead of the highly selective amplifier circuit. In the arrangements just described, the receiver blocking or quenching is done ahead of those circuits which effectively contribute to the receiver selectivity, in which case it will be seen that signal and noise energy delivered to the selective circuits will be only that which exists during the short time periods when the receiver is not blocked and these periods are made synchronous with reception of transmitted pulses. With such a condition, the signal and noise both have an equal chance at building up energy in the circuits of the receiver until near the end of the transmitter "on" period, at which time the blocking at the receiver cuts off the noise while no signal energy is being received. Under these circumstances, the mean signal-to-noise ratio is directly proportional to the instantaneous transmitter power. No noise is permitted to build up energy in the selective circuits of the receiver except that which exists while the receiver circuit is "open," which is the period during which the signal makes its greatest impression. In order to obtain optimum signal-to-noise ratio, it is important that the circuits feeding the selective circuits of the receiver be quenched no later than the end of the transmitter pulse period. Also, it is important that the receiver not be turned "on" or made receptive before the beginning of the transmitter pulse period. Although power of both signal and noise is delivered to the selective circuits in pulses, the circuits do not follow the pulses in amplitude but instead maintain a more or less constant energy level corresponding to the average power of pulse and space periods. The selective circuits smooth out or suppress the pulses but are so designed as to respond to modulation frequencies lower than the pulse frequency. The transmitter power may then be amplitude, phase or frequency modulated or keyed by useful signals, and these signals will be reproduced in the receiver output with improved signal-to-noise ratio if the final receiver detector is suitably chosen.

In those cases where the instantaneous transmitter power lies above the noise power, at the receiver, the improvement in signal to noise ratio may be obtained with a simpler arrangement at the receiver than that shown in Fig. 3. The keyed amplifier may be replaced by an amplifier so designed and adjusted as to provide for a threshold effect. That is, the amplifier may provide output only when it is supplied with an input greater than some fixed value, which may be the noise level, but less than the signal level. By this means all noise present between signal pulses tends to be suppressed.

Although existing frequency standards are so good that synchronism between transmitter pulses and receiver quenching may be maintained for long periods, I contemplate providing manual or automatic timing correction at the receiver in ways already well known in facsimile and television communication systems.

It is to be understood that the invention is not limited to the precise circuit arrangements illustrated and described, since various modifications may be made without departing from the spirit and scope thereof. As an example, at the transmitter, in order to relieve the instantaneous load

on the transmitter during on-off telegraph keying at the beginning of each dot and dash, the line sections between the transmitter 1 and the half wave resonant line 4 may be made one-quarter of a wavelength

$$\left(\frac{\lambda}{4}\right)$$

long instead of one-half wave length (shown in Fig. 1). By using one-quarter wavelength connections, the load on the transmitter will be small at the beginning of each dot or dash and then will increase to normal as the energy is built up in the one-half wavelength resonant line 4.

Also, the mechanically rotating pulsing equipment of transmitter and receiver may be replaced by suitable electronic or gas discharge devices. Suitable electronic and gas discharge equipment is already available for use at the receiver and will be found in existing facsimile and television equipment.

It should also be understood that, while I have illustrated the invention as applied to a radio communication system, it is equally applicable to any other system, including communication over cables, by supersonic mechanical waves, etc.

What is claimed is:

1. The method of operating a radio system which includes producing alternating current energy of a predetermined frequency, continuously storing said alternating current energy of said frequency at a radio transmitter and radiating the stored energy without change of frequency from said transmitter for short time periods compared to the intervals between radiating periods, thereby increasing the maximum power output of the transmitter during radiation above the input power, and synchronously controlling the receiver to be operative substantially only during the radiation periods of the transmitter.

2. A radio system having a transmitter arranged to store up alternating current energy and to radiate periodically pulses of stored energy for time periods short compared to the time intervals between radiated pulses, and a receiver arranged to be receptive substantially only during the radiation periods of said transmitter.

3. A radio system having a transmitter and a remote receiver, means at said transmitter for storing up energy and for radiating periodically pulses of stored energy for time periods short compared to the time intervals between radiated pulses, said means including a motor, means at said receiver including a motor for causing said receiver to be operatively receptive substantially only during the radiation periods of said transmitter, and means for synchronizing the speeds of both motors.

4. A communication system comprising a transmitter having means for storing energy and for transmitting pulses of energy for time periods short compared to the time intervals between transmitted pulses and repeated at a rate higher than the highest useful modulation frequency, and receiving means responsive substantially only during periods of arrival of transmitted pulses.

5. A communication system comprising means for delivering energy continuously to an energy storage circuit, means for transmitting energy taken from the circuit in the form of pulses short compared to the time intervals between pulses, and receiving means responsive substantially only during periods of arrival of pulses.

6. A radio system having a transmitter for storing energy and for radiating pulses of stored energy which are short compared to the time intervals between pulses, there being means at said transmitter for modulating said energy in accordance with useful signals, and a receiver arranged to be receptive substantially only during the periods of arrival of said pulses, said receiver having means for demodulating the received pulses.

7. A system in accordance with claim 6, wherein the means at the transmitter modulates the amplitude of the transmitter energy, and said receiver reproduces the signals.

8. A system in accordance with claim 6, wherein the means at the transmitter modulates the phase of the transmitter energy and said receiver reproduces the signals.

9. A system in accordance with claim 6, wherein the means at the transmitter modulates the frequency of the transmitter energy, and said receiver reproduces the signals.

10. A system in accordance with claim 6, wherein the means at the transmitter keys the transmitter energy, and said receiver reproduces the signals.

11. A radio system having a transmitter for storing alternating current energy and for radiating a constant number of short duration pulses of the stored energy per second, and means for modulating a characteristic of said energy in accordance with desired signals, and a receiver for receiving and demodulating said wave energy, said receiver having means for rendering said receiver insensitive to incoming waves during substantially the entire interval between each pair of incoming successive pulses.

12. A radio system having a transmitter for storing alternating current energy and for radiating a constant number of short duration pulses of the stored energy per second, and means for modulating a characteristic of said energy in accordance with desired signals, and a receiver for receiving and demodulating said wave energy, said receiver having means for reducing the output of said receiver due to input to it during the intervals between incoming pulses.

13. A radio system having a transmitter arranged to store up energy and to transmit periodically pulses of stored energy for time periods short compared to the time intervals between transmitted pulses, and a receiver arranged to be receptive substantially only during the transmission periods of said transmitter.

14. A transmitter including a power storing circuit composed of a tank, means for feeding in power to said tank at a uniform rate, and means for abstracting power intermittently from said tank and at a power rate which is substantially equal to the rate of storing multiplied by the ratio of the pulse periods to the duration of the pulse, and a receiver arranged to be receptive substantially only during time periods when the transmitted energy is arriving.

15. In a transmitter, an energy storage circuit, means for storing energy in said storing circuit, and means for periodically utilizing the stored energy for very short time periods compared to the time intervals between them, and a receiver arranged to be receptive substantially only during time periods when the transmitted energy is arriving.

16. The method of operating a radio system which includes continuously storing oscillatory energy at a radio transmitter and radiating the stored energy from the transmitter for short time

periods compared to the intervals between radiating periods, thereby increasing the maximum power output in the transmitter during radiation above the input power, and synchronously controlling the receiver to be periodically operative for receiving the energy radiated by said transmitter during the time periods when the transmitted energy is arriving at the receiver.

17. The method of operating a radio system which includes continuously storing energy at a radio transmitter and radiating the stored energy from said transmitter for short time periods compared to the intervals between radiating periods, thereby increasing the maximum power output of the transmitter during radiation above the input power, and synchronously controlling the receiver to be operative substantially only during the time periods when the transmitted energy is arriving at the receiver.

18. A communication system comprising a transmitter having means for storing alternating current energy and for transmitting pulses of the stored energy for time periods short compared to the time intervals between transmitted pulses and repeated at a rate higher than the highest useful modulation frequency, and receiving means responsive substantially only during periods of arrival of the transmitted pulses.

19. A communication system comprising means for delivering alternating current energy continuously to an energy storage circuit, means for transmitting energy taken from the circuit in the form of pulses short compared to the time intervals between pulses, and receiving means responsive substantially only during periods of arrival of pulses.

20. A radio system having a transmitter arranged to store up alternating current energy and to transmit periodically pulses of stored energy for time periods short compared to the time intervals between transmitted pulses, and a receiver arranged to be receptive substantially only during the transmission periods of said transmitter.

21. In a transmitter, an energy storage circuit, means for storing alternating current energy in said storing circuit, and means for periodically utilizing the stored energy for very short time periods compared to the time intervals between them, and a receiver aranged to be receptive substantially only during time periods when the transmitted energy is arriving.

22. A radio system having a transmitter for storing alternating current energy and for radiating a constant number of short duration pulses of the stored energy per second, and means for modulating a characteristic of said energy in accordance with desired signals, said pulse frequency being higher than said modulation frequency, and a receiver for receiving and demodulating said wave energy, said receiver having means for rendering said receiver insensitive to incoming waves during substantially the entire interval between each pair of incoming successive pulses.

23. A radio system having a transmitter for storing energy and for radiating short duration pulses of stored energy, and means for modulating a characteristic of said energy in accordance with desired signals, said pulse frequency being higher than said modulation frequency, and a receiver for receiving and demodulating said wave energy, said receiver having means for rendering the receiver insensitive to incoming waves during time intervals lying between incoming successive pulses.

24. A radio system having a transmitter for storing energy and for radiating pulses of stored energy which are short compared to the time interval between pulses, there being means at said transmitter for modulating said energy in accordance with useful signals, and a receiver arranged to be non-receptive during time periods between the arrival of successive pulses, said receiver having means for demodulating the received pulses.

25. A radio system having a transmitter for storing energy and for radiating pulses of stored energy which are short compared to the time interval between pulses, there being means at said transmitter for modulating said energy in accordance with useful signals, and a receiver arranged to be non-receptive during time periods between the arrival of successive pulses.

26. A radio system having a transmitter for storing energy and for radiating a constant number of short duration pulses of the stored energy per second, and means for modulating a characteristic of said energy in accordance with desired signals, and a receiver for receiving and demodulating said wave energy, said receiver having means for rendering said receiver insensitive to incoming waves during a time period lying between each pair of incoming successive pulses.

27. A transmitter including a power storing circuit composed of a tank, means for feeding in power to said tank at a uniform rate, and means for abstracting power intermittently from said tank and at a power rate which is substantially equal to the rate of storing multiplied by the ratio of the pulse periods to the duration of the pulse, and a receiver arranged to be non-receptive during time periods lying between time periods when the transmitted energy is arriving.

28. In a pulse communication system, a receiver for receiving signals transmitted by pulses which are very short compared to the time intervals between them, comprising an energy input circuit, a receiver coupled to said input circuit, and means for preventing energy collected by said input circuit solely during substantially the entire time periods between received signal pulses from causing a response in the output of the receiver.

29. A receiving system for receiving message waves transmitted by pulses which are short compared to the time intervals between them and which are sent out from a remotely located transmitter, comprising an antenna, a keyed amplifier, means for keying said amplifier at the frequency of the received pulses, broadly selective circuits only including a detector coupled between said antenna and the input of said amplifier, a relatively narrow band selective circuit coupled to the output of said keyed amplifier, a utilization circuit coupled to said narrow band selective circuit, whereby energy received by said antenna during periodically repeated selected time periods is prevented from contributing to the output of said receiving system.

30. A receiving system for receiving message waves transmitted by pulses which are short compared to the time intervals between them and which are sent out from a remotely located transmitter, comprising an energy collecting device, a keyed amplifier, circuits coupling said keyed amplifier and said energy collecting device and all designed to pass pulse energy from said

collecting device to said keyed amplifier without destroying the pulse wave form, means for keying said amplifier to make it responsive at time intervals repeated at the pulse rate, synchronizing apparatus for said means, and a highly selective amplifier coupled to the output of said keyed amplifier.

31. A single channel receiving system for receiving message waves transmitted by pulses which are short compared to the time intervals between them and which are sent out from a remotely located transmitter, comprising an energy collecting device, a keyed amplifier, circuits including a heterodyne detector coupling said keyed amplifier and said energy collecting device and all designed to pass pulse energy from said collecting device to said keyed amplifier without destroying the pulse wave form, means for keying said amplifier to make it responsive at time intervals repeated at the pulse rate, and a highly selective amplifier coupled to the output of said keyed amplifier, and a final detector coupled to the output of said highly selective amplifier.

32. In a pulse communication system, a receiver for receiving signals transmitted by pulses which are very short compared to the time intervals between them, comprising an energy input circuit, a receiver coupled to said input circuit, selective circuits for said receiver, and means for preventing energy collected by said input circuit solely during substantially the entire time periods between received signal pulses from affecting the selective circuits of said receiver.

33. In a pulse communication system, a transmitter for sending out pulses of high frequency energy which are short compared to the intervals between pulses and whose peak power is increased by an amount substantially equal to the ratio which the time interval between pulses bears to the time duration of the pulses, means at said transmitter for modulating a characteristic of said high frequency energy in accordance with the intelligence to be conveyed, a receiver having means for rendering certain circuits thereof insensitive for substantially the entire time period between received pulses and no later than the end of the transmitter pulse period.

34. A system for the reception of power transmitted in the form of pulses which are short compared to the time between pulses and which carry intelligence, comprising means for delivering pulse power to an energy storage circuit during substantially all of each pulse time period but substantially only during the time periods when the transmitted pulse power is arriving.

35. A system for receiving message waves transmitted by series of pulses which are short compared to the time between pulses and which are modulated by the intelligence to be conveyed, comprising means for delivering power to a frequency selective circuit only during time periods of arrival of pulses, but during substantially all of each of the time periods which is occupied by the pulses, and means for interrupting the first means during periods between pulses.

36. A receiver for message waves carried by a succession of pulses of modulated power and which pulses are short compared to the time periods between transmitted pulses comprising means for interrupting the operation of a portion of the receiver during substantially the entire time periods between received pulses except for those periods during which the received pulses arrive.

37. A receiver for receiving signals transmitted in the form of carrier wave pulses which are short in comparison with the maximum time periods available for the pulses and whose carrier wave is modulated by the intelligence to be conveyed, comprising means for interrupting the operation of portions of the receiver during, but only during, time periods not occupied by said carrier wave pulses.

38. A radio system having a transmitter for storing energy and for releasing said energy in the form of pulses of alternating current energy of increased power level, and a receiver having means thereat operating in synchronism with said transmitter for effectively rendering it nonreceptive during time periods between the arrival of said pulses.

39. A radio system having a transmitter for storing energy and utilizing said stored energy to produce pulses of high frequency energy to be radiated by said transmitter, there being means at said transmitter for impressing modulations on the pulses of high frequency energy to be radiated, and a receiver arranged to be non-receptive during time periods between the arrival of successive pulses, said receiver having means for demodulating the received pulses.

40. The method of operating a radio system which includes continuously storing radio frequency energy at a radio transmitter and radiating the stored energy, without change of frequency, from said transmitter for short time periods compared to the intervals between radiating periods, thereby increasing the maximum power output of the transmitter during radiation above the input power, and synchronously controlling the receiver to be operative substantially only during the radiation periods of the transmitter.

41. A communication system comprising a transmitter having means for storing output current energy and for transmitting pulses of this energy, without change of frequency, for time periods short compared to the time intervals between transmitted pulses and repeated at a rate higher than the highest useful modulation frequency, and receiving means responsive substantially only during periods of arrival of transmitted pulses.

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