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2,455,475

METHOD OF ULTRASONIC PULSE SIGNALING

Filed Sept. 15, 1943

2 Sheets-Sheet 1

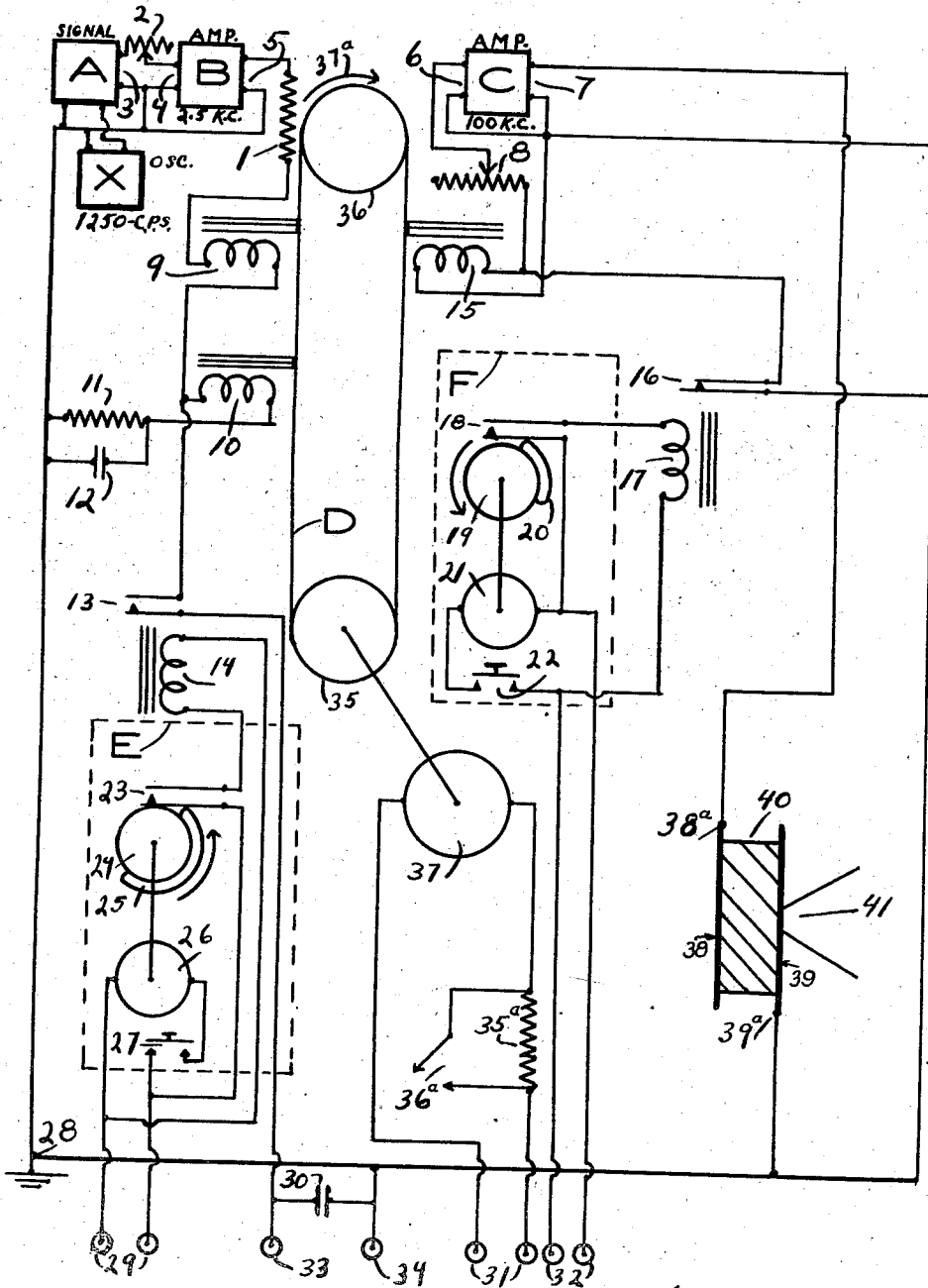


FIG. 1

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2 Sheets-Sheet 2

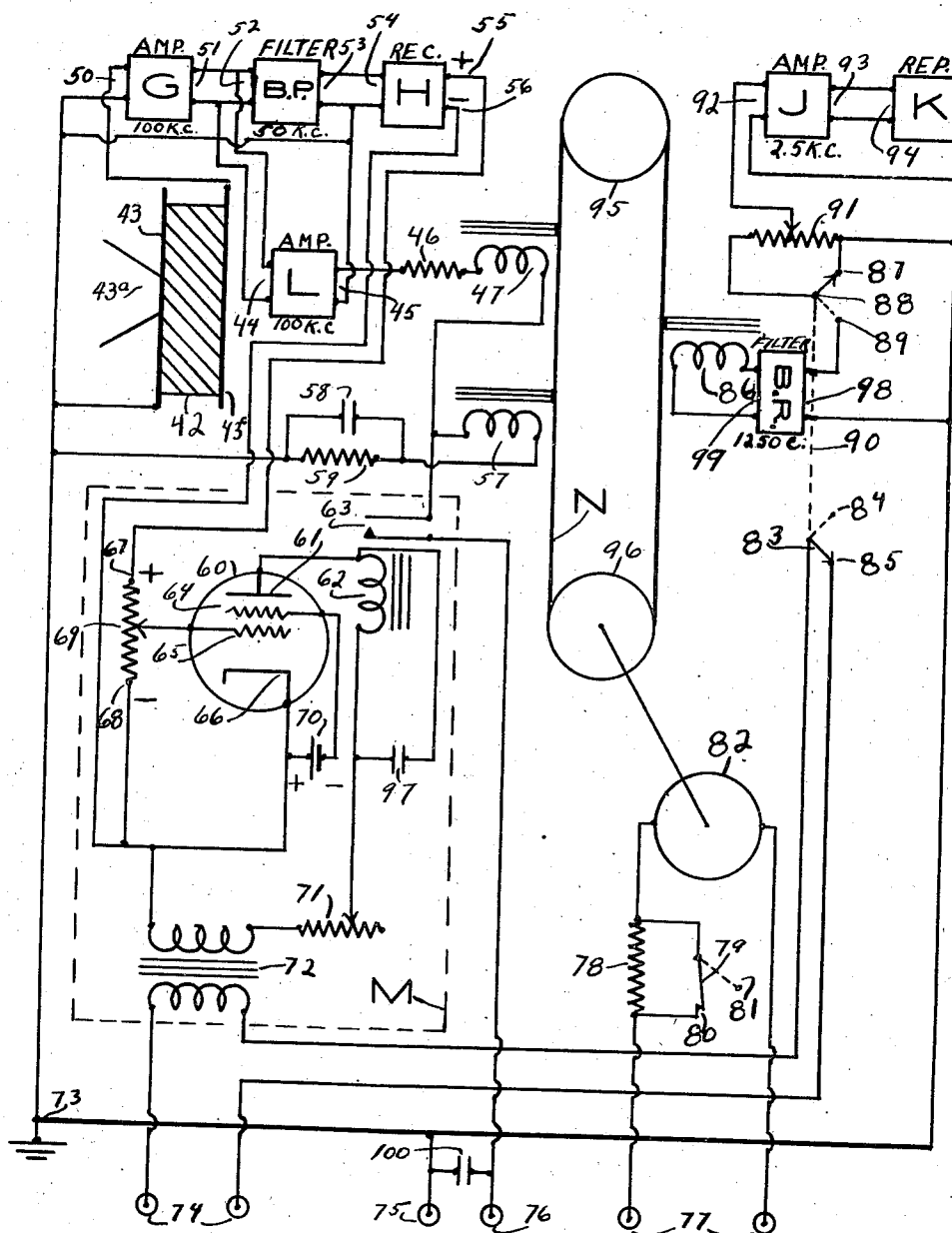


FIG. 2

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2,455,475

METHOD OF ULTRASONIC PULSE
SIGNALING

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Application September 15, 1943, Serial No. 502,528

2 Claims. (Cl. 179-100.2)

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This invention relates to a method of communication, more particularly to ultrasonic signaling for under water use where the communication is secret in character and of such a nature as to be difficult or impossible for unauthorized persons to carry out direction finding operations.

The present invention is a modified form of the inventions disclosed by my patent applications entitled "Ratio signaling system," Serial Number 444,091, filed May 22, 1942, and "High-speed transmission communication apparatus," Serial Number 454,855, filed August 14, 1942, now Patent No. 2,435,879, granted February 10, 1948, and reference should be made to these applications for a better understanding of the present invention.

Briefly, the invention consists of a method whereby the time required to transmit a message is greatly reduced. This is accomplished by first recording the message to be transmitted on a magnetic sound track, with the sound track moving at the minimum satisfactory recording speed, and then transmitting this recorded message at high speed in such a manner that the actual transmission is in the form of an ultrasonic pulse, the duration of which is predetermined. At the receiving station this process is reversed to recover the original signal.

It is old in the art to record a message on a moving sound track and to transmit such recorded message at a sound track speed considerably higher than the recording speed, to conserve transmission time. The present invention discloses a method of transmitting intelligence whereby the actual transmission consists of a short pulse of ultrasonic energy or a series of such short pulses, where each such pulse has a definite time ratio to the time required to record the original message and where each such pulse is sufficiently short in duration that direction finding operations could be carried out only with the greatest difficulty and with elaborate equipment.

For example, an original message requiring 10 seconds to record may be transmitted in a total time period of .25 second, which would be a transmission/recording ratio of 40:1, it being understood that while I have used this ratio in actual practice, that other ratios are also practical.

Among the numerous objects of this invention are:

First, to provide a method of communication where the transmission time is relatively short as compared to the length of the message to be transmitted, so that direction finding readings

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on such transmission are difficult or impossible to obtain.

Second, to provide a system of communication which in itself constitutes a method of secret communication but which may be combined with and made a part of any existing method of communication, this combined method offering the further advantage of additional secrecy in addition to making it difficult or impossible for the enemy to obtain direction finding readings on such transmissions.

Third, to provide a method of communication which will still serve its primary purpose as set forth in the first object above, even where the method used becomes known to the enemy, as knowledge of the method used for such transmissions would not permit direction finding readings to be obtained.

Fourth, to provide a method of communication where the effective power of the transmitter may be greatly increased beyond the normal limitation of plate dissipation rating of the final amplifier tubes.

Fifth, to provide a method of communication as set forth in the first object above whereby longer transmissions may be carried out as a series of ultrasonic pulses spaced as desired or necessary.

Sixth, to provide a method of combining any or all of the methods above in a single system.

It is understood that one basic purpose of this invention is to provide a means of transmitting a message of specific length in a relatively short period of time, as compared to the time required to record such message and that in the practice of the present invention, the transmission is always carried out by means of this relatively short pulse of ultrasonic energy.

In the practice of the invention herein disclosed proper consideration must be given to certain circuit components of both receiver and transmitter. For purposes of example, the normal voice frequency range may be considered as 250 to 2500 C. P. S., and that a message covering this range is to be recorded on a magnetic sound track within a time limitation of 10 seconds, and that such 10 second recorded message is to be transmitted in .25 second. This would be a recording/transmission ratio of 40:1. In the example given above, where the highest frequency signal was taken as 2500 cycles, the highest ultrasonic frequency will become 100,000 cycles when reproduction of the recorded message is carried out at 40 times normal sound track speed. This product of reproduction may then be amplified

to produce an ultrasonic pulse, the duration of which is .25 second, said pulse containing all of the information contained in the original signal.

The magnetic reproducing head must be able to properly reproduce at 100,000 cycles and the associated amplifiers must also function properly throughout this extended frequency range. The design of such amplifiers is well known to those skilled in the art, such amplifiers being commonly used for various purposes, it being well known that such amplifiers may be designed to have a relatively flat gain characteristic throughout any desired frequency range or that such amplifiers may be designed to have a rising gain characteristic at the higher frequencies, if such rising gain characteristic is desirable.

The design of magnetic recording or reproducing heads to work efficiently at 100,000 cycles is also well known to those especially skilled in the art of magnetic recording. It is considered practical by those so skilled in the art of magnetic recording to record and reproduce by means of the magnetic process at frequencies considerably higher than 100,000 cycles per second, the maximum frequency recorded and reproduced being a function of the product of effective pole piece dimensions and sound track speed. Theoretically, this recording/reproduction process may be carried out at any frequency where the product of effective pole piece dimension and sound track speed will not exceed one-half wave length of the highest frequency it is desired to record. The practical limit for such high frequency recording/reproduction is not definitely known, but it is definitely known that 100,000 cycles may be recorded and reproduced by the magnetic process.

The present invention does not deal with magnetic recording per se but is concerned with disclosing a method whereby the application of such a method may be so used as to produce a new and novel result. This disclosure is not confined to the use of any specific recording medium and, with proper design of recording heads, the well known forms of magnetic tape or wire recording may be used. However, an improved magnetic recording or reproducing head design for use on a magnetizable cylindrical record is disclosed by my patent applications, "Magnetic pole piece," Serial Number 476,750, filed February 2, 1942, now Patent No. 2,361,753, granted October 31, 1944, and "Magnetic recording and reproducing system," Serial Number 476,749, filed February 2, 1942, now Patent No. 2,361,752, granted October 31, 1944. These applications disclose a method of reducing the effective pole piece dimension to such a small value that a linear sound track speed of 6 inches per second is satisfactory for recording with voice frequencies up to 2500 C. P. S. With a recording/reproduction ratio of 40:1 this would give a reproducing speed of 240 inches per second, which is equivalent to an R. P. M. speed of 1440 with a cylindrical record having a circumference of 10 inches. However, as previously mentioned, this disclosure is not confined to the use of any particular form of magnetic recording.

For the purposes of this application, the normal sound track speed is taken at 6 inches per second, it being understood that this speed is used only for purposes of example and that any speed giving satisfactory results may be used to record the original message. In the example given, reproduction is carried out at 40 times normal recording speed and the sound track reproducing speed is taken as 240 inches per second, for purposes of example.

A further advantage of the present invention is that the power output may be greatly increased over the power output which would normally be possible for any given amplifier arrangement. All vacuum tubes designed for any form of amplifier service are rated in accordance with plate dissipation and this is a fundamental limit to the amount of plate input power which may be applied to said vacuum tubes and is therefore a fundamental limit to the amount of output power available from said vacuum tubes. Other considerations are the internal insulation of the tube, which limits the maximum plate voltage which may be applied and the peak filament emission of the tube.

It is well known that a definite time is required for any given tube to reach its rated plate dissipation. For example, with vacuum tubes of moderate power rating, approximately three seconds is required to reach the rated plate dissipation, if the full rated plate input is suddenly applied to the tube. For the special case where this tube was to be in service only $\frac{1}{2}$ of this time or 1.5 seconds, the tube would reach its rated plate dissipation in 1.5 seconds if double the plate input was used for this time. Doubling the plate input for this time would not injure the tube, provided that the internal construction of the tube was such that increased voltage, per se, would not cause breakdown. A further limitation is the peak filament emission of the tube, but the actual peak filament emission of power tubes is greatly in excess of the rated continuous filament emission. For example, for certain moderate powered tubes rated at 500 milliamperes, continuous plate current, the peak filament emission is in excess of 5 amperes.

In the present invention, by way of example, the transmission time is limited to .25 second, and for this special case the plate input to the final amplifier tubes may be increased to a value which will produce rated plate dissipation in the final amplifier tubes in .25 second. For certain graphite anode tubes in the medium power class, approximately 12 times the plate input power may be applied to the tubes for .25 second, as compared to the plate input power which could be applied continuously. This can be done without injury to the tubes, provided internal construction is such that breakdown does not occur from excess voltage. Numerous such tubes are available on the open market, the construction being such that breakdown could not occur from excess voltage.

From the foregoing it is apparent that a relatively low power amplifier can provide a relatively high power signal, where such amplifier is used in accordance with the principles disclosed by this invention. For example, for the 40:1 transmission ratio cited above, a final amplifier having a normal output rating of 10 watts of ultrasonic energy could produce approximately 120 watts of ultrasonic energy, assuming the efficiency to remain constant. As a matter of actual fact, the efficiency of most medium power tubes increases with plate input, so that for the special case herein cited, the efficiency somewhat improves over the rated efficiency. As previously stated, this high plate input will not produce actual damage in the tube. However, it is not known to what extent this high plate input pulse operation may shorten the overall life of the tube in terms of total hours of operation. Considering the special class of service, this factor is of minor importance, as only 1 hour of tube operation would be used in transmitting 40 hours of

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message length, and 40 hours message length for the special case of ultrasonic signaling, and especially for military signaling, would cover a considerable period of time, on the order of many months.

This invention will be best understood from a consideration of the following detailed description in view of the accompanying drawings forming a part of the specification; nevertheless, it is understood that the invention is not confined to the disclosure, being susceptible to such changes and modifications as define no material departure from the salient features of the invention as expressed in the appended claims.

In the drawings:

Figure 1 shows in schematic form one arrangement of an ultrasonic transmitter used to produce a short pulse or a series of short pulses of ultrasonic energy containing the intelligence to be transmitted.

Figure 2 shows in schematic form one arrangement of a receiver for use with the transmitter of Figure 1.

Referring more particularly to Figure 1, A is a source of original signal, such as a microphone, having output terminals 3 connected to input terminals 4 of amplifier B, in series with gain control 2. Amplifier B is any conventional amplifier which will amplify voice frequencies and provide a power output suitable for recording. In ordinary practice magnetic recording is carried out with a power considerably under 1 watt, so that amplifier B may readily consist of a one or two stage amplifier, depending in part on the type of signal supplied by unit A. Output terminals 5 of amplifier B are connected to common ground 28 and recording head 9, in series with plate resistor 1. Plate resistor 1 limits the D. C. current flowing through recording head 9 to the plate of the final amplifier tube of amplifier B, this D. C. current acting as a polarizing current for magnetic recording head 9, polarity being so arranged that the current flowing through recording head 9 is opposite in direction to the current flowing in obliteration head 10, which is directly across the source of plate voltage 33 and 34 in series with current limiting resistor 11, which is in turn by-passed by condenser 12.

Magnetic obliteration head 10 is designed to produce magnetic saturation in magnetic sound track D, the entire operation of obliteration head 10, recording head 9 and magnetizable sound track D being identical with the magnetic recording process as conventionally used.

Actual recording is controlled by contacts 13 of relay 14, which are in series with positive plate voltage terminal 33, it being understood that positive plate voltage terminal 33 and negative plate voltage terminal 34, which are by-passed by condenser 30, are connected to a suitable source of D. C. plate voltage. Relay 14 is controlled by timing unit E, which, for purposes of example, is shown as a synchronous motor driven timer having a cam 24, a cam extension 25, and a driving motor 26. Driving motor 26 is energized by momentarily closing contacts 27, allowing cam 24 to make one revolution which will close contacts 23 for a pre-determined length of time, according to the design of cam extension 25 and the speed of driving motor 26. Motor 26 and relay 14 are energized from a common source of voltage 29, which may be any value desired. The entire arrangement of timing unit E and relay 14 is such that a definite recording interval is provided.

The actual length of the recording interval

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may, if desired, be adjustable, but in any event the actual time of said interval is limited by the actual space available for recording on sound track D. Sound track D may represent a magnetic tape or wire moving over drums 35 and 36 in the direction indicated by arrow 37a, or sound track D may well represent the sound track on a cylindrical or disk record, as described in detail in my patent application entitled "Magnetic recording and reproducing system," Serial Number 476,749. Driving motor 37 is energized from a source of voltage 31 in series with resistor 35a, switch 36a being normally open during recording to provide the lower of two speeds available from driving motor 37, it being understood that while such an arrangement is practical for limited speed ratios that this arrangement is shown here only for reasons of simplicity and clarity in the drawings; it being further understood that motors having gear change transmissions or other means of changing from one definite speed to a second definite speed may also be used without departing from the principles disclosed by this invention.

In the example given, a 10 second message is recorded on sound track B, with driving motor 37 moving at a speed which will produce, for example, a sound track speed of 6 inches per second, on magnetic sound track D, this 10 second recording interval being limited by the operation of timing circuit E. At the expiration of 10 seconds, contacts 13 are restored to the normally open position and plate voltage is removed from the final amplifier tubes in amplifier B. The recording and obliteration process is now complete and the intelligence to be transmitted is recorded on sound track D. This message may be preserved indefinitely on sound track D or it may be transmitted immediately, as desired.

Switch 36a is now closed, thus energizing motor 37 at the higher of two speeds, to provide a magnetic sound track speed 40 times greater than the recording speed, which, for the example given, would approximate 1440 R. P. M., assuming that drums 35 and 36, or cylinder record 35-36, have a circumference of 10 inches. This will provide a reproducing speed of 240 inches per second. The transmitter is now in a position to transmit, actual transmission being controlled by timing unit F, which is similar to timing unit E previously described, except that cam extension 20 of cam 19 is now designed to close contacts 18 for exactly .25 second, for the example given, plus any desired tolerance.

The transmission cycle is initiated by closing contact 22, thus energizing timing motor 21, timing motor 21 and relay 17 being energized from a common source of voltage 32. Operation of relay 17 is controlled by timing contacts 13, and with the operation of relay 17 normally closed contacts 16 are opened, thus removing the short circuit in parallel with reproducing head 15. Reproducing head 15 is connected to input terminals 6 of amplifier C, in series with gain control 8, amplifier C being designed, according to the present example, to have essentially flat gain throughout the frequency range of 10 k. c. to 100 k. c., which corresponds to a recording/transmission ratio of 40:1 for voice frequencies of 250 C. P. S. to 2500 C. P. S. Output terminals 7 of amplifier C are directly connected to an ultrasonic reproducing device 40; here shown as a piezo electric crystal mounted between plates 38 and 39, with a sound projecting device 41 associated with plate 39; it being understood that the arrangement shown is only for purposes of example, and that

any form of ultrasonic reproducer may be used.

The arrangement shown is conventional, where 49 may well represent either a Rochelle salt crystal or a quartz crystal, both of these materials having the property of oscillating at an ultrasonic frequency when energy is applied to parallel plates between which said crystal is mounted. It is further understood that 41 may well represent a directional device designed to focus the ultrasonic energy generated at diaphragm 39 by the vibration produced by piezo electric crystal 40 by the ultrasonic energy applied to terminals 38a and 39a of the respective plates 38 and 39.

The transmission cycle is now complete, the total transmission having been carried out in .25 second, plus any desired tolerance, which may normally approximate an additional time of 5 milliseconds, to allow for operate time of relay 17, which may nominally be taken as 2 milliseconds. The power supplied to amplifier C may be raised above the normal rated input power for any given tubes used in amplifier C, the actual amount of such power increase being determined by the actual time of transmission and by the particular tubes used. For the example previously given, the plate input power to amplifier C may be 12 times the normal rated input of the tubes used in amplifier C, which will result in a signal of approximately 12 times greater power being supplied to ultrasonic reproducer 40.

For the example previously given, amplifier C may be normally rated to provide 10 watts output power and, by raising the plate input, may be used to provide 120 watts of output power for the time period of .25 second. This arrangement has the advantage of providing high output powers with relatively small amplifiers and although the power supply requirements are increased, the design of such power supply may be such that the weight or size represented does not exceed the design of a power supply used to provide lower plate power continuously, for the same reasons given in connection with amplifier C, i. e., filter choke coils designed to carry current for only .25 second may be designed with less core stack and smaller wire size than would be the case where such filter chokes are used continuously, as the limiting factor on wire size is the heat produced in the filter choke, and in the present assembly, the time element is sufficiently short that the heat produced could be almost totally ignored. This is likewise true of other resistive and inductive components used in connection with amplifier C and the associated power supply.

For the example given, where the available power output is taken to be 120 watts with an amplifier normally designed to carry 10 watts continuously, the improvement is not as great as would be the case where larger powers are involved, for example, with an amplifier using tubes normally rated to deliver 100 watts of energy, a full 1000 watts of energy may be delivered for the time of one transmission pulse, without increasing the weight or size of the amplifier or the power supply used in connection with said amplifier. Such increased power would provide far more reliable communication and would also provide communication over greater distances, and under adverse conditions. While the foregoing has dealt with an original signal assumed to represent voice frequencies in the range of 250 to 2500 cycles, it is understood that other forms of signals may be used, such as, for example, telegraphy, facsimile, etc.

The operation of the transmitter has now been completely described, except that the function

of unit X, which is shown connected to unit A, has been omitted. The function of unit X is to supply a trigger frequency of some pre-determined value which in turn is used to energize the receiving station normally associated with the transmitter illustrated by Figure 1. The use of this trigger frequency is optional, depending in part on the particular design of the receiving station associated with the transmitter illustrated. For purposes of example, it may be assumed that unit X supplies a continuous frequency of 1250 C. P. S. which is recorded simultaneously with the intelligence represented by signal A. This is transmitted as a 50 k. c. continuous signal which is used to trigger the receiver associated with the transmitter of Figure 1.

Referring now to Figure 2, which illustrates one form of receiver which may be used with the transmitter illustrated by Figure 1, the receiving piezo electric crystal is represented by 42, which may be Rochelle salt or quartz, 43 is the receiving diaphragm, 43a the directional receiving reflector and 43c the opposite contact plate, the entire assembly being similar to that used at the transmitter to produce the original ultrasonic pulse, which it is now desired to receive, the only difference being that in the case of the receiver the assembly need not be designed to handle any appreciable amount of power. It is understood that other forms of resonators sensitive to ultrasonic signals may also be used without departing from the principles disclosed by this invention. The voltage generated by piezo electric crystal 42 from the received ultrasonic vibrations is connected to input terminals 50 of amplifier G, which has a frequency characteristic covering the range of 10 to 100 k. c. Output terminals 51 of amplifier G are connected to input terminals 52 of band pass filter B. P. which has a mid frequency of 50 k. c. Output terminals 51 of amplifier G are also connected to input terminals 44 of amplifier L, which has a frequency characteristic similar to amplifier G and is designed to further amplify the received signal before recording. The output terminals 53 of band pass filter B. P. are connected to the input terminals 54 of rectifier unit H, which may be a half or full wave rectifier unit of any type, such as vacuum tube, copper oxide, etc., output terminals 55 and 56 having D. C. polarity as indicated.

Trigger unit M comprises a gas discharge pentode 60 where suppressor grid 64 is normally biased negative in respect to cathode 66, so that a positive bias must be applied to control grid 65 in order to ionize vacuum tube 60. Sensitivity is controlled by potentiometer 69, the voltage across potentiometer 69 having a polarity as indicated. In the standby position the voltage 70 applied to suppressor grid 64 is sufficient to maintain vacuum tube 60 in the de-ionized condition, for any given value of alternating current plate voltage supplied by transformer 72, which is in turn connected to a source of voltage 74, in series with switch 83. Rheostat 71 is designed to limit the current flowing through relay coil 62 and bypass condenser 97 is designed to hold relay 62 operated during the negative half of the plate voltage cycle. This entire arrangement is shown here for purposes of example and represents only one form of trigger circuit which may be used with this receiver. In practice I have found that the arrangement shown is satisfactory.

In the standby position switch 83 is connected to contact 85, thus energizing transformer 72. B negative terminal 75 and B positive terminal

76 are by-passed by condenser 100 and connected to a suitable source of plate voltage. Switch unit 79 is in contact position 80, thus short circuiting series resistor 78, so that driving motor 82, which is connected to a source of voltage 77, is operating at the higher of two speeds, thus driving drums 96 and 95, or cylinder 96—95, and sound track N at a speed similar to but not necessarily identical to the transmitting speed used at the transmitter, which in the example given, was 240 inches per second, which is equivalent to 1440 R. P. M. for a drum circumference of 10 inches. Recording and obliteration is held inoperative by normally open contact 63, until the 50 k. c. trigger signal is received by ultrasonic resonator 42, amplified by amplifier G, passed by band pass filter B. P. and rectified by rectifier H and the resultant D. C. voltage used to provide a positive trigger voltage on grid 65 of vacuum tube 60.

When this 50 k. c. trigger signal is received, vacuum tube 60 ionizes, thus operating relay 62 and closing contacts 63, which supplied obliteration voltage to obliteration head 57, in series with resistor 59, reverse polarity polarizing voltage to recording head 47 and plate voltage to the final stage in amplifier L, in series with plate resistor 46.

The reception of the 50 k. c. triggering signal initiates the reception cycle, which will be completed in a total time slightly greater than .25 second. When the trigger signal is cut off at the transmitter, at the end of the .25 second period, the positive bias voltage will be removed from grid 65 of vacuum tube 60, and the tube will de-ionize on the first negative half cycle of plate voltage, which will be in a maximum time of $\frac{1}{420}$ of a second if the supply voltage 74 is 60 cycles. This instantaneously stops the obliteration and recording process so that the received signal, which contains all of the original intelligence transmitted in the form of an ultrasonic frequency between the limits of 10 k. c. and 100 k. c., is now recorded on magnetic sound track N. Switch 79 is now moved to position 81, so that driving motor 82 drives sound track N at the lower of two speeds, which, in the example given, will be 6 inches per second.

Switch unit 83 and switch unit 88 are mechanically linked by link 90 and this switch unit is now moved to position 84 and 89, thus opening the circuit to transformer 82 so that an additional received signal cannot obliterate the signal now recorded, thus initiating the reproduction cycle by connecting reproducing head 86 to the input terminals 92 of amplifier J, in series with band rejection filter B. R., which has a mid frequency of 1250 cycles per second, and gain control 91. Amplifier J is designed to amplify voice frequencies in the range of 250 to 2500 cycles per second, the output terminals 93 of amplifier J being connected to input terminals 94 of reproducing unit K, which may be of any form desired, such as a loud speaker or head phones.

The recorded signal may be reproduced as many times as desired, after which switch units 80, 83, and 79 may be restored to the standby position, ready to receive and record additional signals. The purpose of band rejection filter B. R. is to remove the 50 k. c. trigger signal which has now been reduced to 1250 cycles, it being understood that other values of trigger signal frequencies may be used or that such triggering frequencies may be omitted altogether, in which case part of the received signal is directly amplified and rectified in order to provide

D. C. voltage for triggering vacuum tube 60. The advantage of using a specific trigger frequency is that false operation is avoided, through pickup of underwater sounds, such as, for example, propeller noise, it being further understood that the use of a trigger signal is optional.

In the example given, switching is shown as a manual operation, for reasons of clarity and simplicity in the drawings, it being understood that full automatic operation may be utilized without departing from the principles disclosed by this invention.

In the examples given above, a complete signaling method has been described where an original message was recorded within a 10 second time interval and transmitted as a single .25 second pulse of ultrasonic energy, thus giving a recording/transmission ratio of 40:1, it being understood that any other practical transmission ratio may be used. The maximum possible recording/transmission ratio is a function of equipment design, and it is understood that the recording/transmission ratios used by way of example are in no way limiting in scope as to minimum or maximum recording/transmission ratios which may be used in the practice of this invention.

It is further understood that the maximum possible transmitter output power which may be obtained by the methods herein disclosed is a function of the vacuum tubes used, and of equipment design, and that the examples cited are in no way limiting in scope as to maximum possible transmitter output power which may be obtained by the methods disclosed by this invention.

The above examples are for the purpose of illustrating some of the methods and means by which the broad purposes of the invention may be carried out and are not to be deemed as restrictive in any manner. Other modifications and alternatives will occur to those skilled in the art without departing from the scope of the invention as defined by the following claims.

I claim:

1. The method of signaling, which comprises the steps of recording within a limited time period the intelligence to be transmitted on a magnetic sound track moving at relatively slow recording speed, reproducing said recorded signal at relatively high magnetic sound track speed to produce a signal pulse of brief duration, converting said signal pulse into a pulse of ultrasonic energy, generating a control pulse, simultaneously transmitting said signal pulse and said control pulse to a receiver, causing said control pulse to render said receiver operative to record the received pulse on a magnetic sound track moving at a speed approximating said reproducing sound track speed at the transmitter, reproducing the pulse of energy so recorded and filtering the product of reproduction to recover the original intelligence.

2. The method of signaling, which comprises the steps of simultaneously recording within a limited time period a control signal and the intelligence to be transmitted on a magnetic sound track moving at relatively slow recording speed, reproducing said recorded dual signal at relatively high magnetic sound track speed to produce a pulse of brief duration, converting said pulse into a pulse of ultrasonic energy, transmitting said pulse of ultrasonic energy to a receiver, selecting the part of said ultrasonic pulse representing said original control signal, and causing the part so selected to render said re-

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ceiver operative to record the received pulse of ultrasonic energy, recording said pulse of ultrasonic pulse on a magnetic sound track moving at a speed approximating said reproducing sound track speed at the transmitter, reproducing the dual signal so recorded at a sound track speed approximating said recording sound track speed at the transmitter and filtering said reproduced dual signal to recover the original intelligence.

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