

Feb. 10, 1948.

S. D. EILENBERGER

2,435,879

HIGH SPEED TRANSMISSION COMMUNICATION APPARATUS

Filed Aug. 14, 1942

3 Sheets-Sheet 1

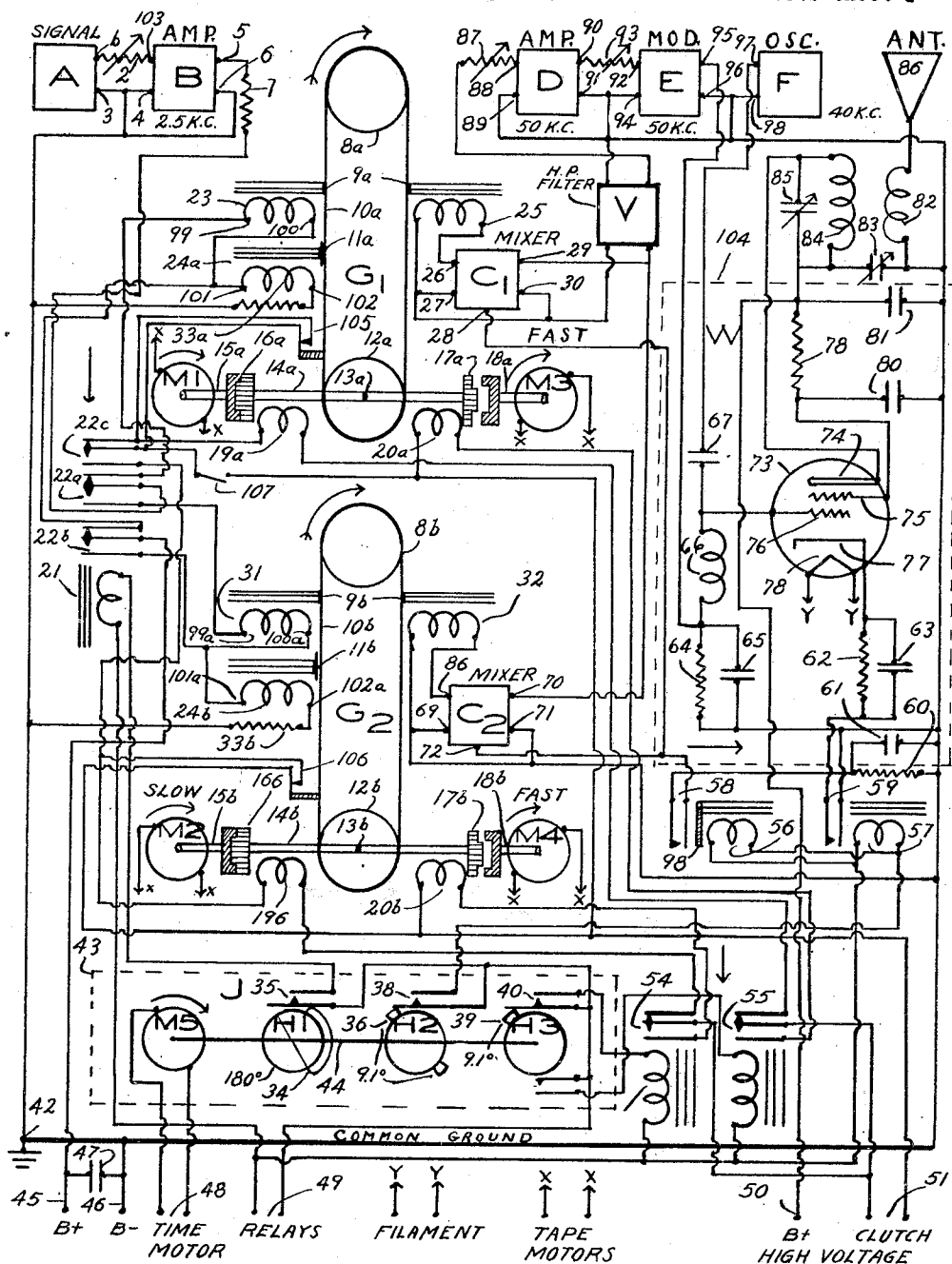


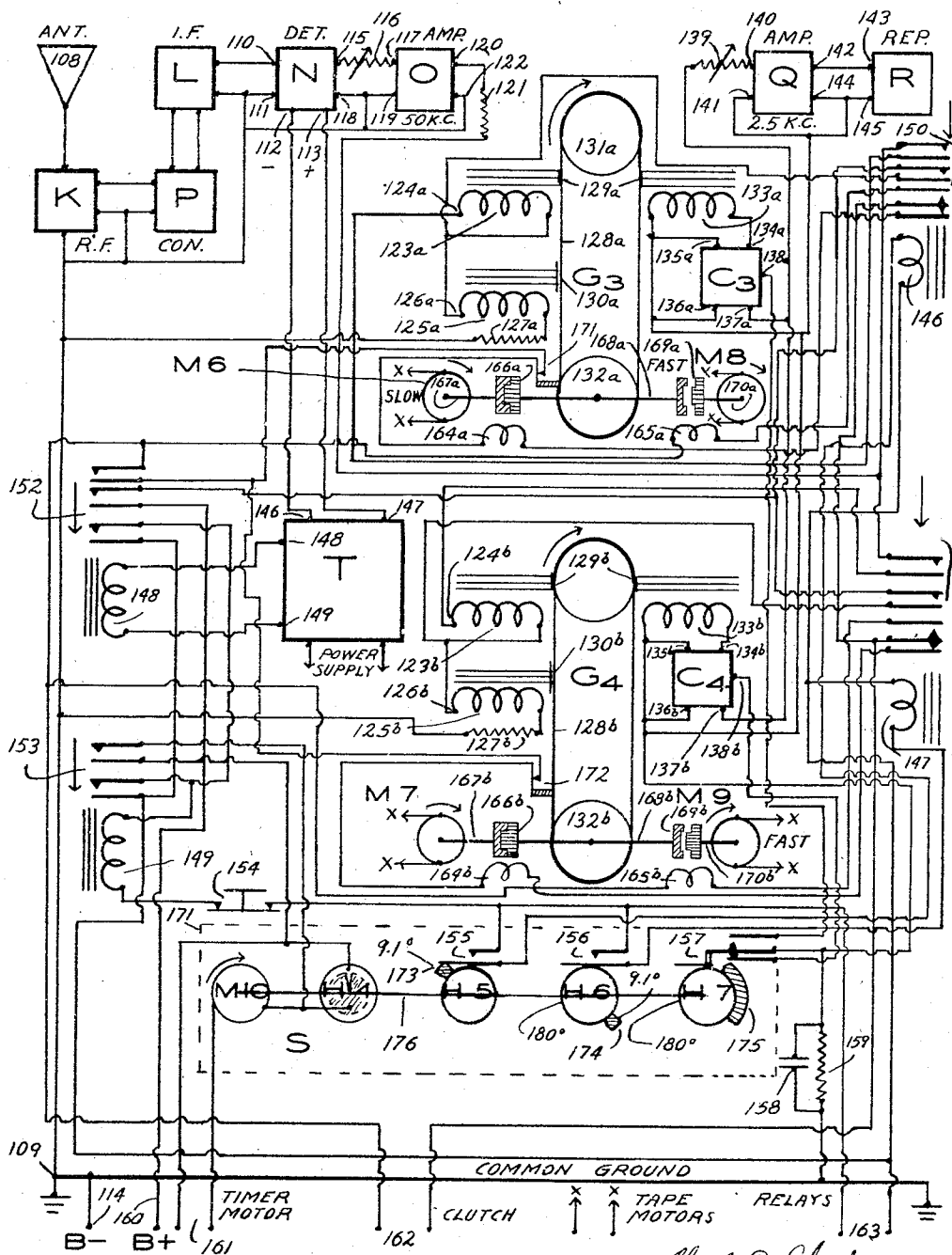
FIG. 1

Stanley D. Eilenberger
INVENTOR

BY
Munn, Liddy & Gleason
ATTORNEY

2,435,879

3 Sheets-Sheet 2



Stanley D. Eilenberger
INVENTOR

FIG. 2

BY
Munn, Liddy & Glacum
ATTORNEY

Feb. 10, 1948.

S. D. EILENBERGER

2,435,879

HIGH SPEED TRANSMISSION COMMUNICATION APPARATUS

Filed Aug. 14, 1942

3 Sheets-Sheet 3

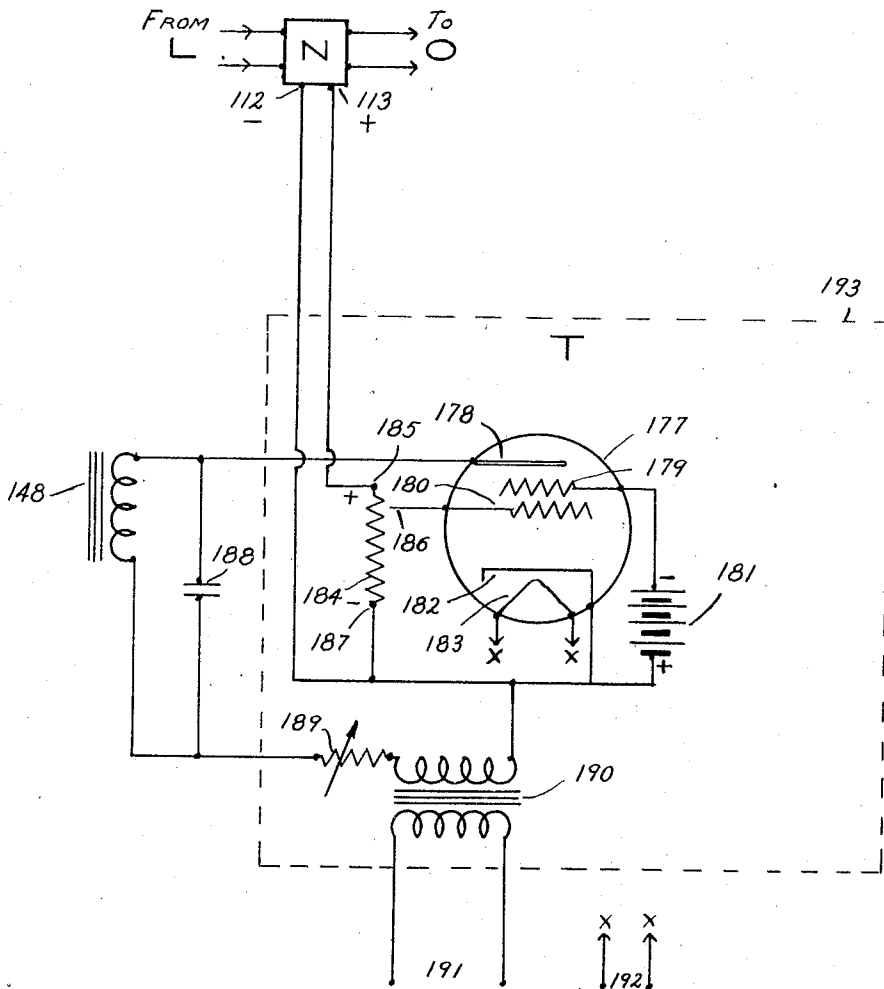


FIG. 3

Henry D. Eilenberger
INVENTOR

BY *Munn, Liddy & Glacum*
ATTORNEY

UNITED STATES PATENT OFFICE

2,435,879

HIGH-SPEED TRANSMISSION COMMUNICATION APPARATUS

Stanley D. Eilenberger, Kenosha, Wis., assignor,
by mesne assignments, to Chicago Coin Machine Co., a corporation of Illinois

Application August 14, 1942, Serial No. 454,855

16 Claims. (Cl. 179—100.2)

1

This invention relates to a method of communication very similar to the method disclosed in my co-pending patent application, filed May 22, 1942, Serial Number 444,091, except that in the present invention a method is disclosed whereby a continuous recording may be made over a relatively long period of time and the transmission of such recorded intelligence is carried out as a series of short pulses of modulated energy. This method is particularly applicable to the transmission of intelligence by means of a modulated radio wave, but may be arranged to transmit such intelligence by means of wire lines, if so desired.

Briefly the invention consists of a method whereby the time required to transmit a message of given length is greatly reduced. This is accomplished by first recording the message to be transmitted on a magnetic steel tape at normal tape recording speed and then transmitting this recorded message at high tape speed, such as twenty times normal speed, so that the time required for transmission would in this instance be one-twentieth of that required to record the message, and for the purposes of this application such a condition will be referred to as a recording transmission ratio of 20:1. At the receiving station this process is reversed to recover the original signal.

The foregoing paragraph briefly describes the method involved in transmitting one pulse which represents the intelligence recorded in a given length of time, on a single magnetic steel tape of definite length moving at a definite speed. For example, a magnetic steel tape 60 feet in length and moving at a speed of 3 feet per second would be capable of recording intelligence for a period of 20 seconds. Assuming a recording/transmission ratio of 20:1, this recorded message would be transmitted in 1 second. The present invention discloses a method of using two such tapes in such a manner that the recording process may be carried out continuously for as long a period as desired, and the transmission will then be carried out in the form of one transmission pulse for each recording interval. For example, with two tapes 60 feet long recording at 3 feet per second and a recording/transmission ratio of 20:1, the transmission would be made as a series of pulses of modulated energy lasting 1 second each, and one such pulse would be transmitted during each 20 second period.

Reference should be made to the aforementioned copending application for a more complete understanding of the basic principles of this

2

system, as fully disclosed therein. This co-pending application discloses methods whereby the basic principle is applied to military or naval communications. The present invention deals more fully with the commercial application of this system.

Among the numerous objects of this invention are:

First, to provide a method of communication where the total transmission time is relatively short as compared to the length of the message to be transmitted.

Second, to provide a method of communication where the actual intelligence to be transmitted is recorded first on one magnetic steel tape and immediately following such first recording, recording is continued on a second magnetic steel tape, the intelligence recorded on the first tape being transmitted as a short pulse during the interval that intelligence is being recorded on the second tape, after which the process is repeated so that the recording of the intelligence to be transmitted may be carried out continuously, regardless of the length of the message to be transmitted.

Third, 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.

Fourth, to provide a method of combining any or all of the objects mentioned above in a single system.

It is understood that a 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 made by means of this relatively short pulse of modulated carrier energy.

To practice the invention herein disclosed proper consideration must be given to the design of certain circuit components of both transmitter and receiver.

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 steel tape within a time limitation of 20 seconds and that such 20 second recorded message is to be transmitted in one second. This would be a recording/transmission ratio of 20:1.

In the example given above where the highest frequency signal was taken as 2500 cycles the

highest modulating frequency will become 50,000 cycles when reproduction of the recorded message is carried out at 20 times normal tape recording speed.

The magnetic reproducing head must therefore be able to properly reproduce at 50,000 cycles and the associated amplifiers and modulators must also function properly at this extended frequency range.

The design of such amplifiers and modulating equipment 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 relatively flat gain characteristics throughout any desired frequency range or that such amplifiers may be designed to have a rising gain characteristic at the higher frequencies if such a rising gain characteristic is desirable.

The design of magnetic tape reproducing heads to work efficiently at 50,000 cycles is also well known to those specifically skilled in the art of magnetic tape recording. It is considered practical by those so skilled in the art of magnetic tape recording to record and reproduce by means of a magnetic steel tape frequencies as high as 100,000 cycles per second and possibly higher frequencies may be recorded and reproduced.

The present invention does not deal with magnetic tape recording as such but is concerned with disclosing a method whereby the application of such tape recording methods may be so used as to produce a new and novel result as herein disclosed.

The ability of a magnetic steel tape to record or reproduce a certain frequency depends not only on proper design of the magnetic recording and reproducing heads but also on the speed at which the tape is moving in the field of such recording or reproducing heads. It is generally considered that a tape speed of 1.5 to 2.0 feet per second is satisfactory for use in reproducing voice frequencies in the range of 250 to 2500 cycles per second.

For the purposes of this application this normal tape recording speed is taken as 3 feet per second, it being understood that this tape speed is used only for purposes of example and that any tape speed giving satisfactory results may be used to record the original message. In the example given reproduction is carried out at 20 times normal recording speed which would be equal to a tape speed of 60 feet per second. Such relatively high tape speed does not imply a high shaft speed at the revolving drums which move the tape, this factor being solely dependent on drum diameter and for purposes of example only this tape winding drum diameter is here taken as 8 inches.

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:

Fig. 1 shows in schematic form one arrangement of a radio transmitter to produce a series of short pulses of carrier energy modulated with the intelligence to be transmitted, in accordance with this invention.

Fig. 2 shows in schematic form one arrange-

ment of a receiver for use with the transmitter of Fig. 1.

Fig. 3 shows circuit details of trigger unit T of Fig. 2.

Referring more particularly to Fig. 1, A is a source of original signal such as a microphone having output terminals 1 and 3 connected to the input terminals 103 and 4 of amplifier B, through gain control 2. Amplifier B is conventional and may be of any type desired. The function of this amplifier B is to amplify the original signal to a level high enough to energize recording head 23, which ordinarily requires approximately .25 watt. Amplifier B has output terminals 5 and 6 of which terminal 6 is connected to the common ground connection 42 and terminal 5 is connected through plate resistor 7 and normally closed contacts 22a of relay 21 to terminal 99 of magnetic recording head 23. The purpose of plate resistor 7 is to limit the D. C. current flowing through recording head 23 to the plate circuit of the final amplifier tube of amplifier B. This D. C. current acts as a polarizing current for magnetic recording head 23 and such current is ordinarily limited to approximately 5 milliamperes, in which case series resistor 8 would approximate 50,000 ohms.

Magnetic recording head 23 is of the conventional type designed to record in a frequency range of 250 to 2500 C. P. S. The pole piece of magnetic recording head 23 is held in light contact with magnetic tape 10a at point 9a. It should be noted that while magnetic recording head 23 is shown as a single winding that such a magnetic recording head having two windings and two pole pieces arranged on opposite sides of magnetic tape 10a may be used, the single winding arrangement shown in the drawing being used only for purposes of clarity and simplicity in this example.

The opposite terminal 100 of magnetic recording head 23 is connected to terminal 101 of obliterating head 24a and also to one terminal of the normally closed contacts 22b of relay 21. Magnetic obliterating head 24a is of the conventional type designed to magnetically saturate magnetic tape 10a to obliterate previously recorded messages. The opposite terminal 102 of obliterating head 24a is connected through resistor 33a to the common ground connection 42 which is also common to B— connection 46. A slight air gap is maintained at point 11a between the pole piece of magnetic obliterating head 24a and magnetic tape 10a, as is common practice. The D. C. resistance value of magnetic obliterating head 24a coil and series return resistor 33a are so chosen as to provide sufficient magnetic flux for magnetic tape saturation. These values will approximate 4000 ohms for magnetic obliterating head 24a coil and 8,500 ohms for resistor 33a with a B plus supply of 250 volts, in which case magnetic obliterating head 24a coil would pass 20 milliamperes and dissipate 1.6 watts.

The recording cycle is initiated by closing switch 107, which energizes clutch 16a, through the released contacts 22c of relay 21, and normally closed contacts of switch 105. Switch 105 is a normally closed microswitch used to index the position of magnetic tape 10a and is operated by a notch in the tape or by the additional thickness of the tape joint, both methods having been used successfully. The purpose of switch 105 is to cause magnetic tape 10a to make a single circuit of its length and stop, this stop always being

in the same position, so that proper message continuity is always maintained during recording and transmission. It is understood that the mechanical indexing methods illustrated by switch 105 are used here for purposes of example only and that numerous other indexing methods, such as photo-electric control may be used.

Relay 21 is in the released position so that recording head 23 is directly connected to amplifier B and obliterating head 24a is also energized. Time motor M5 is energized simultaneously with the start of the recording cycle. This time motor M5 is directly connected to cams H1, H2 and H3 by shaft 44, this entire timer unit, as shown within the dotted line 43, is designated by the letter J and is of a conventional multiple cam type. Time motor M5 is normally of the synchronous motor type, energized from a source of voltage 48, and so geared as to make one revolution of shaft 44 in 40 seconds, which equals two recording cycles.

Cams H1, H2 and H3 are indexed in respect to each other as shown in Fig. 1 but need not be indexed with their respective switches 35, 38, 40 and 41. Assuming these cams to be in the position shown, cam extension 34 of cam H1 will travel 180 degrees before it will operate switch 35.

Motor M1 is arranged to drive shaft 15a at a speed such that tape winding drum 12a will move tape 10a three feet per second, when shaft 14a is connected to shaft 15a through magnetic clutch 16a, the operation of which is controlled by coil 19a. With the circuit in the position shown in Fig. 1, these shafts 14a and 15a are connected by means of magnetic clutch 16a, coil 19a being energized from a source of voltage 51 in series with released contacts 55 of relay 53, released contacts 22c of relay 21 and normally closed contacts of switch 105. Therefore, magnetic tape 10a is moving at the normal recording speed of 3 feet per second during the 20 second recording interval that relay 21 remains in the released position.

Driving motor M3 is similar to driving motor M1 except that the speed is such as to drive shaft 18a twenty times the speed of shaft 15a, so that when shaft 18a is connected to shaft 14a through magnetic clutch 17a, magnetic tape 10a will be moving at 20 times the normal recording speed or 60 feet per second. However, magnetic clutch 17a, which is energized by coil 20a, remains inoperative during the recording cycle of tape unit G1.

After a 20 second recording interval, cam extension 34 of cam H1 will close switch 35, thus energizing relay 21 and moving contacts 22a, 22b and 22c to the operated position, thus transferring the recording and obliterating circuits from tape unit G1 to tape unit G2.

Tape unit G1 and G2 are identical in every respect and after the transfer of these circuits by the closure of relay 21 contacts, the signal originating in unit A will be recorded on magnetic tape 10b so that the recording process is continued without interruption. Simultaneous with the operation of relay 21, cam extension 39 of cam H3 will close switch 41, operating clutch 17a, which will change tape speed of tape 10a to the 20 times normal rate.

Tolerance is provided in the indexed position of cams H2 and H3 so that motor M3 will be driving magnetic tape 10a at this accelerated speed before cam H2 initiates the transmission cycle. During the period that cam H3 holds contacts 41 operated, cam extension 37 will close

switch 38 through 9.1 degrees of arc which is equal to 1 second plus a small operating tolerance to allow for relay operate time in both the transmitter and receiver.

Switch 38 simultaneously energizes relays 56 and 57. Relay 57 is a fast operate type which controls carrier power in a manner explained further below and relay 56 has a copper slug 98 to provide a slight delay in operation. Relay 56 controls modulation and the delayed operation is designed to provide a short pulse of unmodulated power to operate the trigger circuit at the receiver before modulation is started, so that modulation will not start before the receiver is ready to record the transmission. This delay would be equal to the relay operate time in the receiver trigger circuit, which would normally approximate 4 or 5 milliseconds. After this delay, relay 56 operates, closing contacts 58 which in turn closes the cathode circuits of mixer stages C1 and C2 through cathode resistor 60 which is filtered by condenser 61. Terminal 28 on mixer stage C1 and terminal 72 on mixer stage C2 represent direct connections to the cathode of the respective mixer tubes, so that modulating energy is only furnished to amplifier D at such times as relay 56 is in the operated position. High pass filter V is designed to have a low frequency cut-off at 5000 cycles, so that the original recording will not be reproduced and passed on to amplifier D as additional modulating energy at such times as relay 58 is operated.

It is understood that this arrangement of parallel mixer circuits and high pass filter is shown only for reasons of simplicity and clarity in the example. Numerous alternate arrangements exist; for example, relay 56 might be a polarized relay with a center neutral position, so that alternately the cathode circuit was closed to one mixer circuit on one transmission cycle and to the opposite mixer circuit on the next transmission cycle. As a further example, switch 38 may be arranged in duplicate and two separate relays used in place of the single relay 56 shown, which would accomplish the same results as the polarized relay.

With both relay 56 and 57 in the operated position, modulated carrier energy is radiated for the 1 second period, this representing the complete signal recorded on tape unit G1.

Amplifier D is designed to provide amplification to a maximum frequency of 50 k. c. and modulator unit E, which in this example may be considered the final stage of amplifier D, is also designed to operate up to a maximum frequency of 50 k. c. Oscillator F is a conventional oscillator-buffer arrangement and may be of any type desired. For purposes of example, oscillator F is shown as operating at 40 megacycles but any other desired oscillator frequency may be used.

The final amplifier stage W, shown within the dotted line rectangle 104, may be of any type desired, the arrangement of a single tetrode as shown being used merely for the sake of simplicity and clarity in this example.

Carrier power is not normally radiated by final amplifier W due to the fact that cathode 77, in series with cathode resistor 62, which is filtered by condenser 63, is held open by the normally open released contacts 59 of relay 57. Magnetic reproducing head 25 is directly connected to input terminals 26 and 27 of mixer C but mixer C is held inoperative by holding open the cathode circuit of the first stage amplifier tube.

Magnetic reproducing head 49 is designed to

reproduce efficiently in the frequency range of 5,000 to 50,000 C. P. S. and the pole piece is in light contact with magnetic tape 10a at point 9a. As previously explained in the description of recording head 23, reproducing head 25 may be in two sections, having two coils in series and two pole pieces, if desired.

Relay 57 operates in .004 second thus closing contacts 59 and establishing an operating circuit for cathode 77 of vacuum tube 73, all other operating voltages being already present. Filament 78 is energized at points y/y. Plate 74 is energized by high voltage terminal 50 in series with final tank coil 84. Plate tank coil 84 is tuned to resonance by condenser 85 and is inductively coupled to antenna coil 82 and also capacity coupled through condenser 83, the entire final tank circuit being relatively low inductance and high capacity, and designed to provide efficient operation with a radiated carrier band width of 100 k. c. as will be the case with a maximum modulating frequency of 50 k. c. and double side band modulation. The final output of antenna coil 82 is connected to antenna 86 and common ground connection 42.

The high voltage plate supply is filtered by condenser 81. Voltage is supplied to screen grid 75 from the same high voltage source 50, in series with resistor 79, the screen grid voltage being filtered by condenser 80.

The output of oscillator-buffer unit F is available at terminals 97 and 98 where terminal 98 is the common ground connection and terminal 97 is capacity coupled to control grid 76 of final amplifier tube 73 through coupling condenser 67. Control grid 76 is biased by grid resistor 64 in series with radio frequency choke coil 66.

The output of amplifier D is available at terminals 99 and 91 and is connected to the input terminals 92 and 94 of modulator E, in series with gain control 93. The output of modulator E is available at terminals 95 and 96 where terminal 96 is the common ground connection and terminal 95 is directly connected to grid bias resistor 64 of final amplifier tube 73, this arrangement being a form of grid modulation relatively independent of modulating frequency. Grid bias resistor 64 would approximate 100,000 ohms in the arrangement shown and condenser 65 would approximate .00005 μ f. and is designed to effectively bypass radio frequency voltage at the carrier frequency without materially affecting the 50 k. c. modulating frequency.

It is understood that other modulation methods may be used and that while in the arrangement shown a form of grid-amplitude modulation is used for purposes of example that any other form of amplitude modulation, as well as frequency and phase modulation, may be used. The only requirement is that such modulation arrangement be effective at the final modulating frequency and that any lump inductance used in the final plate circuit be used in such a way that the stored energy of such lump inductance does not alter the desired time interval that carrier power is radiated.

After a transmission time cycle of 1.004 seconds time, cam H2 will open contacts 38 thus breaking the operating circuit of relays 56 and 57, both of which will release. This will cut off carrier power by opening the cathode circuit of final amplifier tube 73 and will instantly stop reproduction by opening the cathode circuits of mixer unit C. Of the transmission time cycle of 1.004 seconds, one second only will be occupied in actual

transmission, and during this second, the magnetic tape 10 will make one complete circuit of its length.

Summarizing the operation of the first recording interval represented by tape unit G1 and associated apparatus, an original message covering a frequency range of 250 to 2500 cycles and requiring 20 seconds to record has been transmitted in 1.004 seconds under conditions where the modulating frequency was 50 k. c. and the frequency band occupied by the modulated carrier was 100 k. c. Cam extension 39 of cam H3 will hold relay 53 operated for a short period after the transmission of tape unit G1 is completed, after which contacts 41 will be open thus releasing relay 53, de-energizing clutch 17a, energizing clutch 15a and restoring tape unit G1 to its original recording speed of 3 feet per second.

It is understood that the timing arrangement illustrated by unit J, as enclosed within the dotted rectangle 43, is used here merely for purposes of example, numerous other timing arrangements being possible which would accomplish the desired result of switching the various circuits.

The entire process just described in connection with tape unit G1 is now being repeated with tape unit G2, all units of which are identical to tape unit G1.

Summarizing the operation of the complete transmitter, cam H1 divides the recording time equally between magnetic tape 10a and 10b, by controlling the operation of relay 21. Cam H3 controls tape speed in such a manner that the tape which has a complete recording will operate at accelerated speed for a portion of the time that the opposite tape unit is recording. Cam H2 initiates the transmission cycle during the time that cam H3 holds the circuits closed for high speed operation of the tape which has the complete recording.

The entire process is fully automatic, so that the signal originating at unit A may be continuous, regardless of time, and the system as described may be used to transmit intelligence over a period of minutes or hours, which would be impossible with a single tape unit.

Summarizing the operation of the transmitter as shown by Fig. 1, a method is shown whereby an original message covering the frequency range of 250 to 2500 C. P. S. and requiring 20 seconds to record, this being approximately equal to 65 average words spoken at an average rate, has been transmitted in approximately one second under conditions where the modulating frequency was 50 k. c. and the frequency band occupied by the modulated carrier covered a range of 100 k. c.

A minimum of interference would be created with established service due to the extremely short time that carrier power is radiated. Numerous transmitters of this type may be operated on the same carrier mid-frequency with the actual transmission periods arranged so as not to interfere with each other.

In the description of Fig. 1 and the example given in connection therewith, no mention was made as to output power of the carrier. In any existing system, the maximum output power for a particular transmitter is usually determined by the maximum rating of the final R. F. amplifier tube or tubes. In a transmitter of the type shown in connection with Fig. 1, the plate dissipation rating of the final amplifier tube or tubes would no longer be the limiting factor in determining maximum carrier output power for any

particular tube or tubes. This is so due to the extremely short time such tubes are required to deliver carrier power and therefore the limiting factors become:

First, the peak filament emission of the tube.

Second, the internal insulation of the tube.

Third, the external plate circuit insulation as a whole.

By choosing proper tubes having high internal insulation and by the use of properly designed external plate circuit arrangements, the plate input may be raised to a value limited by the peak filament emission of the tube, regardless of what the actual plate dissipation rating of the tube may be. By this method it is possible to radiate modulated carrier energy considerably in excess of the amount indicated by the size and rating of any particular combination of tubes.

Referring now to Fig. 2 which illustrates a receiver for use with the transmitter of Fig. 1.

Antenna 108 and ground 109 are connected to the input of radio frequency unit K, which is designed to have a normal amplification band width of 100 k. c. at a mid-frequency of 40 m. c. P represents the converter section in a super-hetrodyne receiver and L the I. F. section, which is also designed with a 100 k. c. amplification band width. N represents a detector circuit which performs the usual dual purpose of detection and developing automatic volume control voltage. T represents a trigger circuit using a gas filled tetrode which is controlled by received carrier power. It is understood that trigger unit T, as shown in detail by Fig. 3, is used here merely for purposes of example, and that any other form of carrier operated trigger circuit may be used to control the receiver, various forms of such trigger circuits being in common use. Unit O is a wide band amplifier designed to amplify the output of detector unit N. Amplifier O is similar to amplifier D of the transmitter in Fig. 1 and is designed to work efficiently in the frequency range of 10 to 50 k. c. Magnetic tape sections G3 and G4 are very similar to the tape sections G1 and G2 described in connection with Fig. 1. Amplifier Q is a conventional audio amplifier designed to work at ordinary speech frequencies and R is a reproducer which may be of any type desired.

Design of wide band units K, P, L and N is well known to those skilled in the art. The output of I. F. unit L is connected to input terminals 110 and 111 of detector N. The AVC voltage developed by one diode section of detector N is available at terminals 112 and 113 where terminal 112 is negative and terminal 113 is positive, in respect to each other without regard to chassis ground, represented by common ground terminal 109 and B minus terminal 114. This AVC voltage may be used in a conventional manner as AVC voltage, and it is also used to control trigger unit T, as fully explained further below.

The arrangement of magnetic tape unit G3 is mechanically the same as the similar unit G1 shown in Fig. 1, except that magnetic tape 10a has a length of 65 ft. The additional five feet is provided as tolerance for the release of trigger circuit P as hereinafter explained. With the circuit in standby position ready to receive a transmission, all relays are released as shown and indexing cam H4 has stopped cam shaft 176 in the position shown. When a transmission is received, trigger circuit T causes relay 148 to

operate thus closing contacts 152 and initiating the following sequence of operation:

Relay 149 operates and locks up through its own contacts, remaining locked up during the entire time transmission is being received; timing motor M10 is instantly energized; cam extension 173 of cam H5 immediately closes switch 155 thus operating relay 146 and closing all of contacts 150; clutch 169a operates thus connecting tape drum driving shaft 168a to high speed motor M8 so that magnetic tape 128a is moving at the 20 times normal speed.

The above sequence of operation takes place simultaneously. Recording is accomplished in a manner identical to that previously described in connection with Fig. 1, the plate circuit of amplifier O being connected to recording head 123a through closed contacts 150 of relay 146, amplifier O and obliterating head 125a being connected to a source of plate voltage 160 through this same set of contacts.

After the transmission cycle is completed and carrier power cut off at the transmitter, trigger circuit T will release relay 148, thus stopping the recording and obliterating cycle of tape unit G3. Simultaneously with the release of relay 148 cam H5 will release contacts 155 and relay 146 which also releases clutch 169a. After one or two additional revolutions, magnetic tape 128a will come to a stop at the point controlled by indexing switch 171.

Magnetic tape 128b was moved from the at-rest position controlled by indexing switch 172 during the transmission cycle, while contacts 152 of relay 148 were closed, so that magnetic tape 128b, and tape unit G4 as a whole is in the reproducing position, the cathode circuit of mixer stage C4, represented by terminal 138b, being closed through the released contacts of switch 157 and cathode resistor 159 which is filtered by condenser 158. However, on the first reproduction cycle of a new transmission, no message will be reproduced.

Twenty seconds after the first transmission is received, a second transmission will be received, again operating relay 148; on this second transmission, cam 174 will be in position to close switch 156 thus causing the operation of relay 147. The recording process will now be repeated with tape unit G4 in a manner identical to that previously described for tape unit G3.

Simultaneously with the start of the second transmission, reproduction of the first transmission will start with tape unit G3. Magnetic pick-up 133a is directly connected to mixer unit C3, the cathode circuit 138a being closed through the now operated contacts of switch 157, cam extension 175 of cam H7 being indexed to operate switch 157 simultaneously with the operation of switch 156.

Reproduction takes place through amplifier Q, which is a conventional audio frequency amplifier covering the voice frequency range, and reproducer R, which may be of any type desired.

The arrangement of magnetic recording, reproducing and obliterating heads of tape units G3 and G4 is similar to that previously described in connection with tape units G1 and G2 of Fig. 1 except that in the receiver of Fig. 2, magnetic recording heads 124a and 124b are designed to record in the range of 10 to 50 k. c., while magnetic reproducing heads 133a and 133b are designed to reproduce in the ordinary speech range of 250 to 2500 cycles. Obliterating heads 125a

and 125b are identical with those used in the transmitter of Fig. 1.

The recording and reproducing process will go on continuously as long as a transmission is being received, and reproduction will be constant, as was recording at the transmitter. The position of tape units G3 and G4 is under control of indexing switches 171 and 172 so that recording and reproduction always start at the same point, thus preserving the continuity of the original message.

Timing motor M10 will operate as long as relay 149 remains locked up. The circuit may be restored to a standby position, ready to receive additional transmissions, by momentarily depressing push button switch 154, thus releasing relay 149 and stopping timing motor M10 at the position controlled by indexing cam H4. The entire arrangement of timing unit S, as shown within the broken line 171, is similar to timing unit J of the transmitter of Fig. 1 except that in this instance an indexing cam is used to control the standby position of the timer. It is understood that other timing arrangements may be used although the synchronous motor driven units shown in Figures 1 and 2 are of a type in common use and these may be designed to provide a high degree of precision in the timing interval.

Since the gas filled tetrode used in trigger unit T may remain conductive for approximately one quarter cycle of plate voltage after removal of the positive grid voltage and since the release time of relay 148 may approximate .004 second, a tolerance of approximately .008 second is required to prevent obliteration of the initial part of the recorded signal. Sufficient tolerance is provided by the additional length of five feet in magnetic tapes 128a and 128b.

Fig. 2 does not show any method of indicating that a message is being received and that a recording is being made. It is understood that additional contacts may be used on relay 148 so that the operator will receive visible or audible indication that a message is being received and recorded.

In the example given above, a complete signaling method has been described where an original message to be transmitted was recorded continuously in 20 second time intervals and transmitted as a series of one second pulses of modulated carrier energy. In the example given, the circuits shown by Figures 1 and 2 were simplified for reasons of clarity, it being understood that full automatic operation of both transmitter and receiver may be arranged.

In the transmitter of Fig. 1, the transmission time cycle is controlled by contacts 59 of relay 57 operating as break-in contacts in the cathode circuit of final R. F. amplifier tube 73, it being understood that numerous alternate methods exist for exact timing of the period that carrier power is radiated. For example, the break-in may be in the screen grid voltage supply. As a further example, the break-in may be between oscillator F and final amplifier W so that no energy is available at the input to amplifier W until proper control circuits are closed. As a further example, this break-in control may be directly in the oscillator circuit with all buffer and amplifier stages in full operating condition so that carrier power will be radiated for such time period as initial carrier energy is supplied by said oscillator. Other alternate methods will be apparent to those skilled in the art.

Referring now to Fig. 3, which shows in detail the schematic of unit T of Fig. 2, all that part shown inside the broken line 193 of Fig. 3 representing unit T of Fig. 2, all parts outside this broken line being a sectional view of part of Fig. 2, and the parts shown are numbered identical to those in Fig. 2.

As previously mentioned, the AVC voltage developed by detector unit N when a carrier is received, is available at output terminals 112 and 113, where 112 is negative and 113 positive, in regard to each other, without respect to chassis ground.

Vacuum tube 177 is a gas filled tetrode having a plate 178 energized in series with D. C. relay 148 coil and variable resistor 189 by alternating current supplied by isolation transformer 190, which is connected to a source of alternating current 191. This transformer is used to make the trigger circuit ground free, and in the example given, the A. C. plate voltage supplied by transformer 190 secondary would approximate 100 volts. Variable resistor 189 is designed to limit the current flowing through relay 148 coil, which is of the D. C. type and in this example may have a resistance approximating 2500 ohms. Condenser 188 would then approximate 2 μ f. and is designed to prevent relay chatter. Suppressor grid 179 is biased negative in respect to cathode 182 by bias cell 181, the voltage of which would approximate 4 volts in this example. Filament 183 is connected to a source of filament supply xx. Control grid 180 is connected to slider 186 of potentiometer 184, the outside terminals of this potentiometer 185 and 187 being connected as shown, so that terminal 185 is positive and 187 is negative.

It is characteristic of certain gas filled tetrodes that where the suppressor grid is biased negative the control of the control grid rests entirely in the positive region. Slider 186 is adjusted so that control grid 180 is normally neutral or slightly negative, so that with no signal being received and therefore no AVC voltage available at detector N output terminals 112 and 113, tube 177 remains deionized and draws no plate current, so that relay 148 remains released. When carrier power is received and AVC voltage is available at output terminals 112 and 113 of detector N, then terminal 185 becomes positive in respect to terminal 187 and therefore control grid 180 also becomes positive in respect to cathode 182, which causes tube 177 to ionize immediately, thus drawing plate current and operating relay 148.

In the examples given, the recording/transmission ratio was taken as 20 to 1, it being understood that any other practical recording/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 understood that the maximum possible carrier output power which may be obtained by methods herein disclosed is also a function of equipment design and that these specifications are in no way limiting in scope as to maximum possible carrier 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 the intelligence to be transmitted and obliterating the previous recording alternately on two magnetic tapes moving at relatively slow recording speed, alternately reproducing said recorded signals with a magnetic tape speed higher than said speed of recording, modulating a high frequency carrier with said reproduced signals, transmitting such modulated high frequency carrier to a receiver, demodulating the received modulated high frequency carrier, recording the product of demodulation and obliterating the previous recording alternately on two magnetic tapes moving at a speed approximating said reproducing tape speed at the transmitter and continuously reproducing the signals so recorded at a tape speed approximating said recording tape speed at the transmitter to recover the original signal.

2. The method of signaling, which comprises the steps of recording the intelligence to be transmitted and obliterating the previous recording alternately on two magnetic tapes within a limited time period, alternately reproducing said recorded signals in a fraction of said recording time, modulating a high frequency carrier with said reproduced signals, transmitting such modulated high frequency carrier to a receiver, demodulating the received modulated high frequency carrier, recording the product of demodulation and obliterating the previous recording alternately on two magnetic tapes within a time period identical to said reproducing time period at the transmitter and continuously reproducing the signals so recorded within a time period approximating said recording time period at the transmitter to recover the original signal.

3. The method of signaling, which comprises the steps of recording within a limited time period the intelligence to be transmitted and obliterating the previous recording alternately on two magnetic tapes moving at relatively slow recording speed, reproducing said recorded signals at relatively high magnetic tape speed to produce a series of modulating pulses, modulating a high frequency carrier with said modulating pulses, transmitting said pulses of modulated high frequency carrier to a receiver, demodulating the received pulses of modulated high frequency carrier, recording the product of demodulation and obliterating the previous recording alternately on two magnetic tapes moving at a speed approximating said reproducing tape speed at the transmitter and continuously reproducing the signals so recorded at a tape speed approximating said recording tape speed at the transmitter to recover the original signal.

4. In a signaling system including a transmitter, a receiver, and a channel between said transmitter and receiver, the method of reducing the total time required for transmitting a signal which comprises the steps of recording the signal to be transmitted and obliterating the previous recording alternately on two magnetic tapes, alternately reproducing said recorded signals in a fraction of the recording time, transmitting said reproduced signals to a receiver, recording such received signals and obliterating

previous recordings alternately on two magnetic tapes within a time period identical to said reproducing time period at the transmitter and continuously reproducing said recorded signals within a total time period approximating said total recording time period at the transmitter.

5. In a speech transmission system including a transmitter, a receiver, and a channel between said transmitter and receiver, the method of reducing the time required for transmitting a signal which comprises the steps of recording the signal to be transmitted and obliterating the previous recording sequentially on a plurality of magnetic tapes, reproducing said recorded signals in the recorded order on each tape and alternately from the two tapes in a fraction of the recording time, transmitting said reproduced signals to a receiver, recording such received signals and obliterating the previous recording sequentially on a plurality of magnetic tapes within a time period identical to said reproducing time period at the transmitter and reproducing said recorded signals in the recorded order on each tape and alternately from the two tapes within a time period approximating said recording time period at the transmitter.

6. In a signaling system, means for converting an original signal occupying a given time interval into a second signal of a series of relatively short time intervals comprising a plurality of magnetic tapes, driving means for each tape having two speeds, a recording head for each tape, an obliterating head disposed adjacent to each recording head, means for sequentially rendering each of said obliterating heads operative to condition each said tape to receive said signals from each of said recording heads, means for simultaneously rendering the adjacent recording head operative to record a part of said original signal on its associated tape while said driving means causes said tape to describe one circuit at the lower of the two speeds, a reproducing head for each of said tapes, means for sequentially rendering each of said reproducing heads operative to reproduce said recorded signal while said driving means causes the associated one of said tapes to describe one circuit at the higher of the two speeds, and means for causing said signals to be reproduced in the order of their recording.

7. In a signaling system, means for converting an original signal occupying a series of relatively short time intervals into a second signal occupying a relatively long time interval comprising a plurality of magnetic tapes, driving means for each tape having two speeds, a recording head for each tape, an obliterating head disposed adjacent to each recording head, means for sequentially rendering each of said obliterating heads operative to condition each said tape to receive said signal from each of said recording heads, means for simultaneously rendering the adjacent recording head operative to record a part of said original signal on its associated tape while said driving means cause said tape to describe one circuit at the higher of the two speeds, a reproducing head for each of said tapes, means for sequentially rendering each of said reproducing heads operative to reproduce said recorded signal while said driving means causes the associated one of said tapes to describe one circuit at the lower of the two speeds, and means for causing said signals to be reproduced in the order of their recording.

8. The method of signaling which comprises the steps of continuously recording a message and

obliterating a previously recorded message at slow speed in alternation on a pair of magnetic tapes, reproducing the message of each tape in a fraction of the time required for recording, the recording and obliteration on one tape being effected while the message is reproduced on the other tape, modulating a high frequency carrier with said reproduced signals, transmitting such modulated high frequency carrier to a receiver, demodulating the received modulated high frequency carrier, recording the product of demodulation and obliterating the previous recording on one of two magnetic tapes moving at a speed approximating said reproducing tape speed at the transmitter and continuously reproducing the signals so recorded at a tape speed approximating said recording tape speed at the transmitter to recover the original signal.

9. In a signaling system including a transmitter, a receiver, and a channel between said transmitter and receiver, the method of reducing the total time required for transmitting a signal which comprises the steps of recording the signal to be transmitted and obliterating any previous recording on a pair of magnetic tapes in sequence, reproducing said recorded signals in the order of recordation in a fraction of the time required for each recordation, transmitting said reproduced signals to a receiver, recording such received signals and obliterating previously recorded signals successively on a pair of tapes within a time period identical to the reproduction time period at the transmitter, and continuously reproducing said recorded signals in the order of recordation within a total time period approximating said total recording time period at the transmitter.

10. In a signaling system including a transmitter, a receiver, and a channel between said transmitter and receiver, the method of reducing the total time required for transmitting a signal which comprises the steps of recording the signal to be transmitted and obliterating the previous recording alternately on two magnetic tapes, reproducing said recorded signals in a fraction of the recording time, in opposite alternation, transmitting said reproduced signals to a receiver, recording such received signals and obliterating the previous recordings alternately on two magnetic tapes within a time period identical to said reproducing time period at the transmitter and continuously reproducing said recorded signals, in opposite alternation, within a total time period approximating said total recording time period at the transmitter.

11. In a signaling system including a transmitter, a receiver, and a channel between said transmitter and receiver, the method of reducing the total time required for transmitting a signal which comprises the steps of recording the signal to be transmitted and obliterating the previous recording sequentially on a plurality of magnetic tapes, reproducing said recorded signals in their recorded order in a fraction of the recording time, transmitting said reproduced signals to a receiver, sequentially recording such received signals and obliterating previous recordings on a plurality of magnetic tapes within a time period identical to said reproducing time period at the transmitter and continuously reproducing said recorded signals in their recorded order within a total time period approximating said total recording time period at the transmitter.

12. The method of signaling, which comprises the steps of recording the intelligence to be transmitted and obliterating the previous recording

alternately on two magnetic tapes moving at relatively slow recording speed, reproducing said recorded signals in the recorded order on each tape and alternately from the two tapes with a magnetic tape speed higher than said speed of recording, modulating a high frequency carrier with said reproduced signals, transmitting such modulated high frequency carrier to a receiver, demodulating the received modulated high frequency carrier, recording the product of demodulation and obliterating the previous recording alternately on two magnetic tapes moving at a speed approximating said reproducing tape speed at the transmitter and continuously reproducing the signals so recorded in the recorded order on each tape and alternately from the two tapes at a tape speed approximating said recording tape speed at the transmitter to recover the original signal.

13. The method of signaling, which comprises the steps of recording the intelligence to be transmitted and obliterating the previous recording alternately on two magnetic tapes within a limited time period, reproducing said recorded signals in the recorded order on each tape and alternately from the two tapes in a fraction of said recording time, modulating a high frequency carrier with said reproduced signals, transmitting such modulated high frequency carrier to a receiver, demodulating the received modulated high frequency carrier, recording the product of demodulation and obliterating the previous recording alternately on two magnetic tapes within a time period identical to said reproducing time period at the transmitter and continuously reproducing the signals so recorded in the recorded order on each tape and alternately from the two tapes within a time period approximating said recording time period at the transmitter to recover the original signal.

14. The method of signaling, which comprises the steps of recording within a limited time period the intelligence to be transmitted and obliterating the previous recording alternately on two magnetic tapes moving at relatively slow recording speed, reproducing said recorded signals at relatively high magnetic tape speed in the recorded order on each tape and alternately from the two tapes to produce a series of modulating pulses, modulating a high frequency carrier with said modulating pulses, transmitting said pulses of modulated high frequency carrier to a receiver, demodulating the received pulses of modulated high frequency carrier, recording the product of demodulation and obliterating the previous recording alternately on two magnetic tapes moving at a speed approximating said reproducing tape speed at the transmitter and continuously reproducing the signals so recorded in the recorded order on each tape and alternately from the two tapes at a tape speed approximating said recording tape speed at the transmitter to recover the original signal.

15. In a signaling system including a transmitter, a receiver, and a channel between said transmitter and receiver, the method of reducing the total time required for transmitting a signal which comprises the steps of recording the signal to be transmitted and obliterating the previous recording alternately on two magnetic tapes, alternately reproducing said recorded signals in the recorded order on each tape and alternately from the two tapes, in a fraction of the recording time, transmitting said reproduced signals to a receiver, recording such received signals and ob-

17

literating previous recordings alternately on two magnetic tapes within a time period identical to said reproducing time period at the transmitter and continuously reproducing said recorded signals in the recorded order on each tape and alternately from the two tapes within a total time period approximating said total recording time period at the transmitter.

16. The method of signaling which comprises the steps of continuously recording a signal and obliterating a previously recorded signal at slow speed in alternation on a pair of magnetic tapes, reproducing the recording of each tape in a fraction of the time required for recording, the recording and obliteration on one tape being effected while the signal is reproduced in the recorded order on the other tape, modulating a high frequency carrier with said reproduced signals, transmitting such modulated high frequency carrier to a receiver, demodulating the received modulated high frequency carrier, recording the product of demodulation and obliterating the previous recording in alternation on two magnetic

18

tapes moving at a speed approximating said reproducing tape speed at the transmitter and continuously reproducing the signals so recorded in the recorded order at a tape speed approximating said recording tape speed at the transmitter to recover the original signal.

STANLEY D. EILENBERGER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

15	Number	Name	Date
	1,947,249	Bush	Feb. 13, 1934
	2,281,405	Barrish	Apr. 28, 1942
	2,361,437	Trevor	Oct. 31, 1944
	2,379,399	Hansell	July 10, 1945

FOREIGN PATENTS

20	Number	Country	Date
	21,244	Australia	July 16, 1929