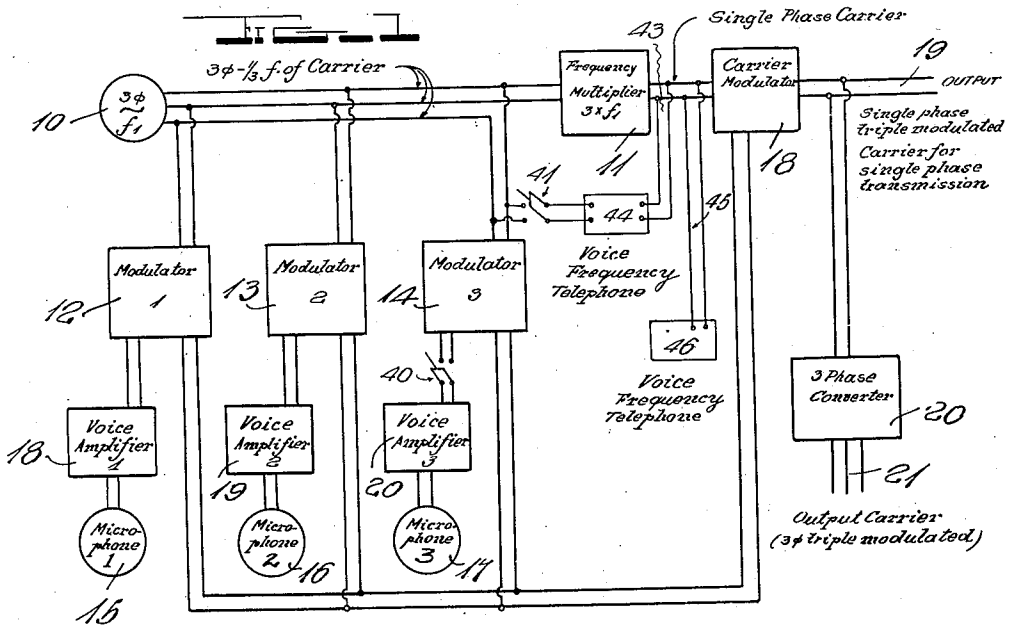
Feb. 7, 1933. C. W. HOUGH 1,896,235

SINGLE CARRIER FREQUENCY MULTIPLEX TELEPHONY AND TELEGRAPHY

Filed July 27, 1926 3 Sheets-Sheet 1



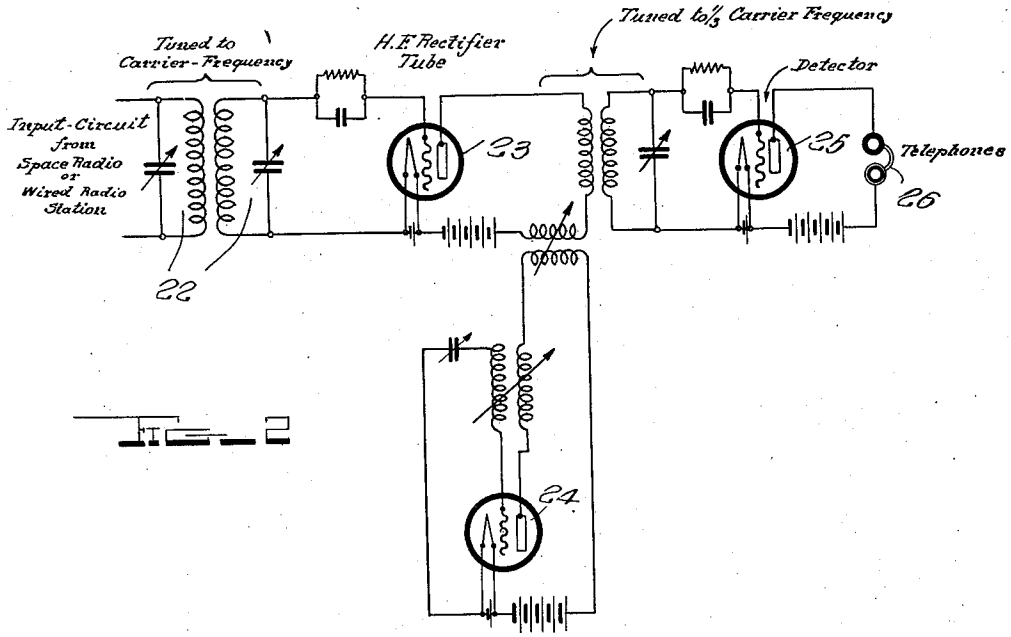


Fig. 2

Local Oscillator beating at Frequency of 1/3 of Carrier frequency

INVENTOR.
Clinton W. Hough,
BY John B. Brady
ATTORNEY.

Feb. 7, 1933. C. W. HOUGH 1,896,235

SINGLE CARRIER FREQUENCY MULTIPLEX TELEPHONY AND TELEGRAPHY

Filed July 27, 1926 3 Sheets-Sheet 2

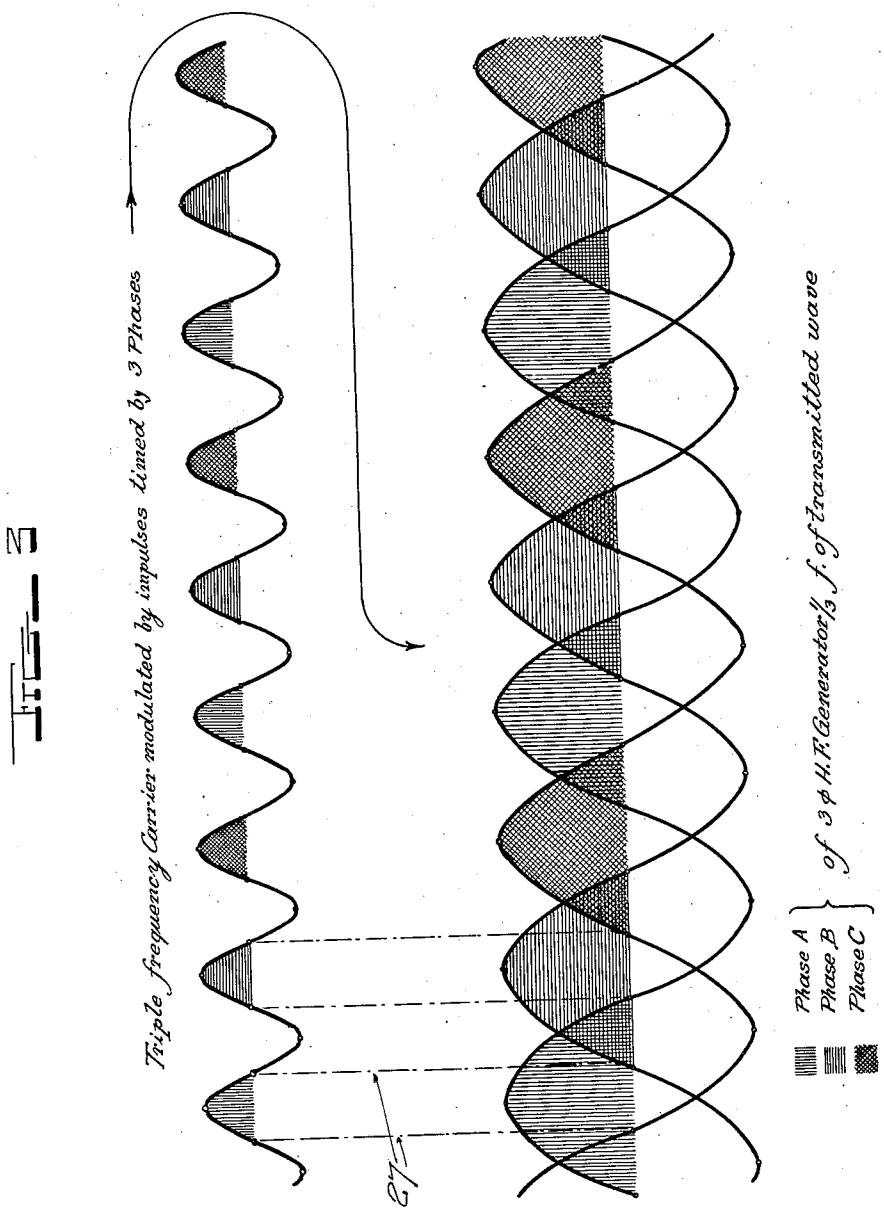


FIG. 2

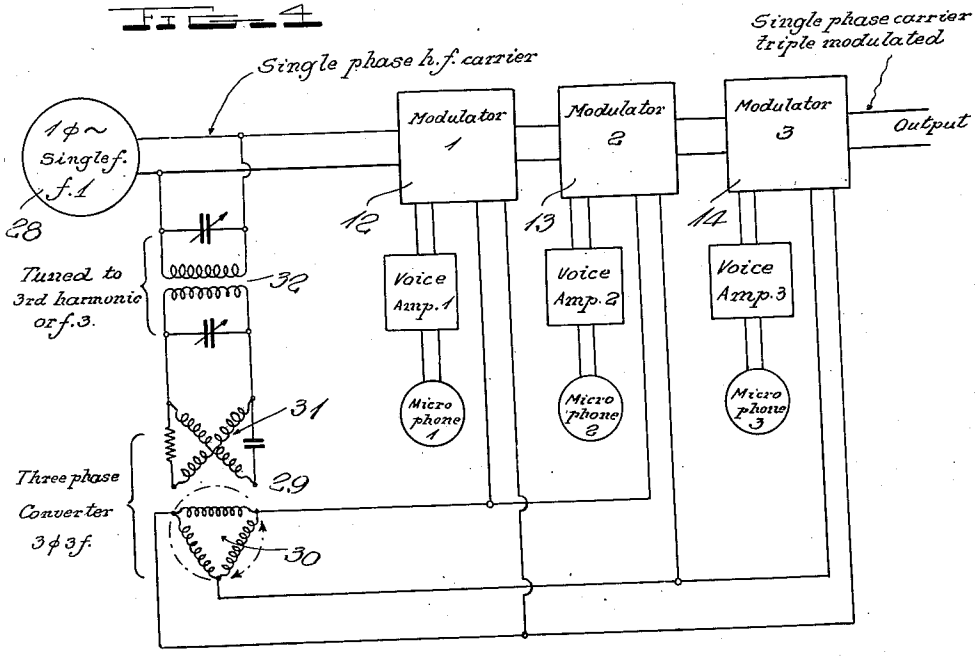
INVENTOR.
Clinton W. Hough,
BY John B. Brady
ATTORNEY

Feb. 7, 1933. C. W. HOUGH 1,896,235

SINGLE CARRIER FREQUENCY MULTIPLEX TELEPHONY AND TELEGRAPHY

Filed July 27, 1926 3 Sheets-Sheet 3

FIG. 4



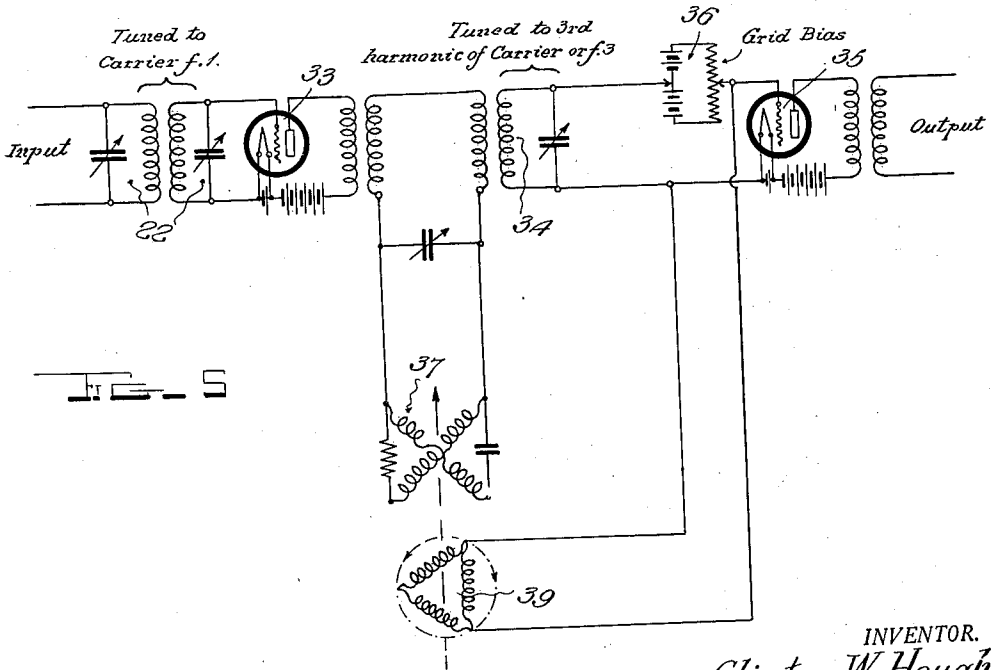


FIG. 5

INVENTOR.
Clinton W. Hough,
BY John B. Brady
ATTORNEY.

Patented Feb. 7, 1933

1,896,235

UNITED STATES PATENT OFFICE

CLINTON W. HOUGH, OF BOONVILLE, NEW YORK, ASSIGNOR, BY MESNE ASSIGNMENTS, TO WIRED RADIO, INC., OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

SINGLE CARRIER FREQUENCY MULTIPLEX TELEPHONY AND TELEGRAPHY

Application filed July 27, 1926. Serial No. 125,234.

My invention relates broadly to communication systems and more particularly to a system of transmitting and receiving a multiple number of communications on a single wave length.

One of the objects of my invention is to provide a broadcasting system by which a multiplicity of separate programs may be transmitted simultaneously by means of a single carrier current and isolated and received by separate receivers without interference.

Another object of my invention is to provide a system for transmitting a multiplicity of simultaneous programs, conversations or messages by means of a single carrier current where the individual cycles of the carrier current are divided into units or groups of units corresponding to the number of simultaneous messages to be transmitted and the modulation of these successive individual cycles or group of cycles or waves effected by currents corresponding to the respective programs in regular sequence for selective reception by a plurality of receivers.

Still another object of my invention is to provide a system for the transmission of a multiplicity of messages by means of a single carrier current in which a polyphase generator is provided at the transmitter and the frequency of the output of one phase is multiplied for use as a high frequency carrier current in such manner, that this higher carrier current so produced may be modulated at successive intervals equally spaced by the polyphase currents and the modulation of each interval integrated at a plurality of receivers for the individual reception of a plurality of signaling channels all superimposed on the same carrier frequency.

Still another object of my invention is to provide a system of broadcasting wherein a plurality of programs may be transmitted upon the same carrier wave and separated in time phase by a circuit energized by current having a plurality of phases corresponding in number to the number of programs to be transmitted, and the output thereof impressed upon a receiving system capable of selective adjustment for a particular program to the exclusion of the other programs.

A still further object of my invention is to provide a receiving system for the selective reception of a particular program and of a multiplicity of programs superimposed upon the same carrier frequency transmitted from a single or polyphase transmission system having means for adjusting the receiving circuits to respond to particular modulated cycles of the transmitted energy corresponding to the desired communication while discriminating against the signaling energy carried by the other cycles of the transmitted energy.

My invention will be more clearly understood from the specification hereinafter following by reference to the accompanying drawings in which:

Figure 1 is a diagrammatic view showing the principle of my invention at the transmission end of the system; Fig. 2 shows diagrammatically a receiving circuit for the selective reception of signaling energy on one phase of the polyphase carrier current; Fig. 3 illustrates diagrammatically the characteristic of a triple frequency carrier wave in the system of my invention and the characteristic derived from the modulation of the triple frequency carrier by impulses timed by three phases; Fig. 4 shows a modified arrangement of transmitting circuits embodying the principles of my invention; and Fig. 5 illustrates a receiving circuit for operation with the transmitter of Fig. 4.

The present congestion of the ether, due to the large number of broadcasting stations, and the long waiting list of applicants for wave lengths, has created a demand for additional ether channels. Particular wave lengths are adapted for different classes of service and the possibility of utilizing a single wave length as a channel for a multiple number of messages is attractive from many standpoints. In the case of wired radio broadcasting over line systems the lower frequencies are more suitable because the radiation into space is less than at high frequencies. In the case of wired radio systems for the transmission of high grade musical pro-

grams, the frequency cannot be too low, as the quality of the transmission suffers if the frequency is reduced to a point where it approaches the frequency of the higher musical notes and their harmonics.

My invention is particularly applicable to trans-oceanic telephony where ether channels are so limited in number. By my invention the expense of providing a multiplicity of channels is avoided and it is possible to transmit a considerable number of communications simultaneously over the same wave length.

This invention relates to a system for utilizing any frequency for the transmission of a multiple number of messages or programs. The frequency, however, must at least equal the product of the number of simultaneous messages and the frequency required for good transmission of the particular messages being transmitted. For example, if a high grade program requires 15,000 cycles per second for perfect transmission, three simultaneous programs would require a frequency of 45,000 cycles per second. If it is desired to transmit ordinary speech as in a telephone conversation which requires, say, 1200 cycles per second for good reproduction, three simultaneous conversations could be transmitted on a carrier of only 3,600 cycles per second.

In my invention I provide a three phase generator of high frequency oscillations and supply the three phase current to a communication system. The individual cycles of the carrier current are divided into units or groups of units corresponding to the number of simultaneous messages to be transmitted and the modulation of these successive individual cycles or groups of cycles or waves by currents corresponding to the respective programs is effected in regular sequence and then the several programs selectively received by receiving circuits responding to particular cycles or groups of cycles at the transmitter of the transmitted energy.

For example, where three programs are to be transmitted, the first cycle of the carrier wave would be modulated by the output of the modulator corresponding to the first program, the second cycle of the carrier wave would be modulated by the output of the modulator corresponding to the second program, and the third cycle by the output of the modulator corresponding to the third program, and so on. Likewise, small successive portions of the carrier wave consisting of a number of cycles can be modulated by the successive modulating equipment corresponding to the multiple messages. This multiple modulated carrier wave is then sent by space or wired radio, carrying the individual and simultaneous messages or programs distributed at regular intervals in point of time along the carrier wave. At the receiving stations the circuits are so arranged that the modulated cycles of currents in particular time sequence may be integrated while discriminating against the modulated currents in other time sequence. It should be understood that the system described herein is not limited to three simultaneous programs, but is applicable to a multiplicity of programs involving the principles as set forth herein.

Referring to the drawings in more detail, a three phase high frequency generator 10 supplies high frequency current at one-third the frequency of the carrier wave to be used for transmission. The current of one phase of this three phase generator is multiplied by three by means of a frequency multiplying device represented at 11. This may be the well-known transformer method by the utilization of the third harmonic of the fundamental three phase frequency, or by the use of a separate single phase oscillator beating with the fundamental frequency. Various methods of frequency multiplication may be employed. The multiplied frequency must be in phase with the fundamental frequency of the three phase generator. Three modulators are supplied, 12, 13 and 14, each of which is equipped with microphones 15, 16 and 17, and voice amplifying apparatus 18, 19 and 20, respectively. The electron tubes of each modulator are connected to operate only when the current from the three phase generator in each respective phase is at the positive half of the cycle. The cutting in and out of the respective modulators during definite periods of time corresponding to the peak of the waves of the polyphase generator is or may be accomplished by biasing the grid circuits of the vacuum tubes in the modulator circuits so that the tubes function only during that interval of time when the potential of the corresponding phase of the polyphase generator is near its maximum or minimum value, depending upon the way the circuits are connected, i. e. during the peak of the wave of the single phase impulses of the polyphase generator. The impulses may be the negative or positive impulses of the polyphase source connected through transformer systems or otherwise to change the sign or phase angle. Each modulator tube is negatively biased so that it is blocked and this negative bias overcome by a positive impulse from one of the phases of the polyphase generator to the extent that the tube is momentarily unblocked thus permitting the tube to function as a modulator during the instant it is unblocked. These three modulators then come into action at successive intervals 120 degrees apart and in time intervals of three times the frequency of the fundamental carrier wave. Each successive wave of the carrier will then be modulated by its respective message component.

The modulated carrier wave is then transmitted either by space or wired radio.

I have shown a switching device 40 between the voice amplifier 20 and the modulator 14 for the purpose of utilizing one of the successive groups of cycles transmitted for a low frequency telephone channel indicated at 44 as connected at 43 to the outgoing line circuit. The telephone 44 is connected into the system for control in timed relationship to the carrier channel by means of switch 41. By this arrangement ordinary telephone communication at voice frequency may be conducted independently of the frequency multiplication system. The voice frequency telephone circuit is electrically connected and disconnected by the successive changes in condition of the tube circuits which are rendered successively effective or ineffective as set forth above. A low frequency telephone circuit 46 may also be connected through leads 45 with the outgoing line circuit. By this method the system of my invention may be used in conjunction with the usual telephone network.

As shown in Fig. 1, the output of the three modulators 12, 13 and 14 is combined and conducted to a master carrier modulator 18 which operates on the output of the frequency multiplier in case of outputs which are greater than can be satisfactorily modulated by the direct output of the three primary modulators. The output of the transmitter is a triply modulated single phase carrier and is suitable for transmission by space or wired radio where single phase systems are desired over an output circuit 19. In case it is desired to utilize the output for a three or other multiple phase broadcasting system for space or wired radio, the single phase triply modulated carrier is passed through a three or other multiple phase converter 20, which produces a three or other multiple phase high frequency current triply modulated on each of its phases in an output circuit 21.

At the receiver end as shown in Fig. 2 the triply modulated carrier is received by means of standard tuned circuits 22 and rectified by a first detector tube 23. The output of a local oscillator 24 is combined with the incoming modulated carrier and adjusted to beat at one third the frequency of the carrier or at the frequency of the original three phase generator. This lower frequency current is then rectified and amplified by tube system 25 and supplied to the receiving telephones or loud speaker 26. One of the three messages will be received, depending upon the phase relation between the local oscillator 24 and the carrier. The frequency of the local oscillator 24 will be beating with every third cycle of the incoming carrier and consequently the particular program carried by this particular group of cycles will be received. By slipping the local oscillator 24 ahead to the next cycle of the carrier, the second progrem will be received, and by advancing it two cycles the third program will be reproduced. Throughout this system one-half of the waves of the fundamental three phase generator and the triple frequency carrier are suppressed. These suppressed half waves, however, may be utilized if desired for the transmission of another set of three simultaneous programs. This half wave suppression is accomplished by means of a suitable rectifying device.

In the accompanying drawings Fig. 1 is a simplified diagram of a complete transmitter. Fig. 2 shows the receiving circuit. Fig. 3 represents the positive half waves of the three phase generator and the triple frequency carrier. Phase A is shown in vertically extending lines, phase B in horizontally extending lines and phase C in crossed lines. The large half loops represent the positive waves of the three phase generator. These waves activate modulators. The duration of the positive half wave of the triple frequency carrier is only one-third that of the corresponding positive half wave of the three phase generator which activates the modulator. Consequently the overlapping which occurs in the three phase generator, as shown on the bottom portion of the diagram, does not take place in the carrier but each half wave of the carrier cannot possibly be affected except by its corresponding modulator.

The first, second, and third and so on, positive waves of the carrier can only be modulated by the first A, B and C three phase positive waves. That is, the vertical lines 27 are drawn down from the zero point of the modulated carrier waves in Fig. 3 to the zero line of the three phase waves, and it will be seen that the overlap of the positive waves of phase A and B, positive waves of phase B and C, and the positive waves of phase C and A, fall without the time interval of the positive carrier waves. Therefore, there can be no double modulation of any single positive wave of the carrier.

Fig. 4 illustrates an alternative method of transmitting. The high frequency carrier is generated single phase by means of a suitable generator 28 and this carrier is modulated at successive intervals by three modulators 12, 13 and 14 as before, each equipped with its auxiliary apparatus of voice amplifier and microphone. These modulators are activated by a three phase current and at successive intervals of 120 degrees of the three phase cycle. This three phase current may be generated by means of a three phase converter 29 consisting of a three phase delta or star connected coil system 38 coupled to a revolving field set up by a phase splitting circuit 31 tuned to the third harmonic or to triple the frequency of the carrier wave. This circuit 31 is energized by the carrier from generator 28 through transformer sys-

tem 32. Each successive positive wave of the output is modulated by modulators 12, 13 and 14 and the cycle is then repeated.

It is understood that rectifier tubes may be inserted in the carrier and three phase circuits to suppress one side of the cycle, such as the negative side in each case or that portion usually shown below the zero line in curves representing alternating currents. It is also understood that vacuum tubes may be inserted at various points in the circuit to increase the energy level wherever required. The circuit has been shown in elemental form for purposes of clarity. The operation of the circuit system of Fig. 4 may be explained as follows: A single phase carrier is sent out from the single phase generator. A portion of the output of this single phase generator is utilized for the production of a three phase or polyphase current output, in the case of three phase at three times the frequency of the single phase generator. The transformation of the single phase source to a higher frequency is accomplished by taking the third harmonic of the single phase source. The required number of stages of electron tube amplification may be interposed at this point. Then having the tripled frequency carrier this is taken and converted into three phase.

Then the successive impulses of the three single phases of the three phase output are in step or synchronism with the impulses of the single phase source and consequently with the carrier output, i. e. the first impulse of the carrier will be in step with an impulse of phase 1, the second impulse of the carrier will be in step with an impulse of phase 2, and the third impulse of the carrier in step with an impulse of phase 3, and so on continuously. By biasing the tubes of the three modulators shown as 1, 2 and 3 so that the modulators do not function except as the biasing is overcome by the polyphase impulses, each successive impulse of the carrier is modulated by a different modulator in the successive order of 1, 2, 3, 1, 2, 3, 1, 2, 3, etc.

Fig. 5 shows an alternative receiving circuit which does not employ the heterodyning method disclosed in the first system of reception described in connection with Fig. 2. The receiving circuit has input circuits 22 tuned to the incoming carrier. This carrier is amplified by tube circuit 33, and a revolving field system 37 is energized thereby. A secondary circuit 34 is coupled to the amplified carrier circuit and this secondary circuit is tuned to the third harmonic of the carrier, that is, the carrier frequency is multiplied by three. This triple frequency carrier is used to energize a vacuum tube detector 35 with the usual output circuits. The grid of the detector 25, however, is biased by means of a battery and potentiometer 36 or other similar method. so that the plate circuit of the tube does not pass current due to the negative bias. A rotatable coil 39 is coupled to the revolving field 37 and by locating this in one of three positions an impulse or electromotive force will be set up in the coil in synchronism with each third impulse of the carrier. The output of this coil is connected across the grid-filament of the detector tube 35, and these impulses serve to overcome the negative bias of the grid, and the detector tube 35 thus functions during every third positive impulse of the carrier.

In one position of the rotatable coil 39 the A communication will be received, in the next position the B communication will be received, and the third position will bring in communication C. That is, in the first position of the coil 39, the first, fourth, seventh, tenth and so on positive impulses of the carrier are detected or rectified and amplified; in the second position the second, fifth, eighth, eleventh and so on impulses are caused to operate the detector tube 35, and in the third position, the third, sixth, ninth, 12th, and so on impulses of the carrier cause the detector tube 35 to function. In this way any desired one of the three communications may be selected simply by turning the rotatable coil 39 to a definite position in the zone of activity of the revolving field produced by the carrier.

The operation of the system of my invention may be understood from a brief summary as follows:

A three phase generator produces three phase high frequency currents. Current from one of the three phases is taken and its frequency is multiplied three-fold in order to supply a carrier current of triple frequency, the peak of the current waves of which are in time phase with the peak of the current waves of the three phase generator.

Current from each of the three phases of the three phase generator energizes a separate modulator and these respective modulators operate only during the time of the peak of its corresponding single phase wave from the three phase generator. The output from the three modulators is combined and used to modulate the triple frequency carrier current. Accordingly, the first (positive) wave of the triple frequency carrier current is modulated by modulator A. Which is connected to and activated by phase A of the three phase generator. The second (positive) wave is modulated by modulator B, which is connected with the B phase of the generator. The third (positive) wave is modulated by a modulator C, which is connected to phase C of the generator, and so on. The three modulators are each supplied with separate microphones and input amplifier equipment.

Successive positive waves of the high frequency carrier are modulated by three successive separate audible components from the

three modulators and then the cycle is repeated. This triple modulated carrier is then received and rectified. A local oscillator is supplied to beat with the incoming frequency at one-third the frequency of the carrier and this beat note is rectified by a second rectifier, amplified if necessary, and used to operate the telephone receivers or loud speakers.

This beat note will correspond with, and be modulated by one of the three audible components. By shifting the phasing of the local oscillator so that it beats with the second one of the three groups of audible modulation, the second message will be received. By shifting the phasing to beat with the third group, the third message will be received.

By suitable calibrations and adjustments of the receiver the shifting of phase of the local oscillator may be readily accomplished for the selection of a particular program.

The multiplex system of my invention enables the plurality of separate communications to be transmitted simultaneously over the usual telephone lines already employed for telephone communications without interference with the telephone communication. Utilization is made of small increments of time in successive order of high frequency with signaling energy of low frequency for the simultaneous transmission of both the carrier currents and the audio frequency currents. Various combinations of audio and high frequency currents are interposed on the line wire system, and by the system of time phasing various classes of communications or control currents may be simultaneously utilized. The successive periods of time may be utilized for the transmission of signals corresponding to voice records, currents for motion picture reproduction, automatic printing apparatus, television equipment, and reproduction of desired colors in television and motion picture operation for radio or wired radio systems. The same line circuit is used for all classes of service referred to.

I have illustrated the broad principle of my invention and described the invention in one of its preferred embodiments, but I desire that it be understood that modifications may be made. For example, more than one phase of the three phase system may be utilized for the transmission of additional simultaneous messages or multiphase systems of the order of six phase may be used to increase the number of available channels. Other modifications which will readily suggest themselves to those skilled in the art after a review of the invention herein may be made, and I intend no limitations upon the invention other than are imposed by the scope of the appended claims.

What I claim as new and desire to receive by Letters Patent of the United States is as follows:

1. A multiplex high frequency signaling system comprising a generator of polyphase high frequency electric currents, a polyphase output circuit connected with said generator, a plurality of modulation circuits each connected to one individual phase of the output circuit of the polyphase generator and activated by the corresponding electrical current of that phase of the polyphase generator, means to vary the output of said plurality of modulation circuits by a corresponding plurality of voice or signal fluctuations, means for multiplying the frequency of the high frequency current output of one of the phases of the polyphase generator for use as a high frequency carrier current, means common to all of said modulation circuits for modulating said high frequency carrier current by modulating impulses from said plurality of modulating circuits each modulating circuit operating to modulate the carrier current individually during a separate distinct interval of time and in successive and recurring order, means for transmitting said modulated carrier current, means for receiving said carrier current impulses and impressing them upon a receiving circuit, means at each receiving circuit for selecting the portions of the multiple modulated carrier current impulses corresponding to those modulated by any desired individual modulating circuit, and means for modulating said impulses to produce electrical impulses corresponding to the voice or other signals represented by said modulating circuit currents.

2. A multiplex signaling system comprising in combination a source of polyphase energy, means for diverting a part of the energy of one of the phases of said polyphase source and multiplying the frequency thereof for use as a carrier frequency, a plurality of modulators for modulating said carrier frequency, means for energizing said plurality of modulators by said polyphase energy, means for operating said modulators in response to corresponding signals, means for transmitting the multiple modulated energy, and a receiving station having means for receiving selected portions of said multiple modulated energy controlled by any desired one of said modulators.

3. The method of transmitting and receiving a multiplicity of messages by means of a single phase high frequency carrier current, which consists in generating a polyphase high frequency current, multiplying the frequency of one of the phases of said polyphase high frequency current, modulating said multiplied frequency carrier current during successive time intervals by impulses corresponding to each of the plurality of messages in successive and recurring order, and selectively receiving signaling energy on definite recurring cycles of said high frequency multiple modulated carrier current.

4. The method of transmitting and receiving high frequency signaling energy, which consists in generating three phase high frequency electric current, tripling the frequency of part of the current of one of the phases of said three phase current, multiply modulating successively recurring portions of said tripled frequency current by signal components and selectively receiving signaling energy corresponding to one or more of said signal components.

5. The method of transmitting and receiving a multiplicity of signaling currents simultaneously by means of a single high frequency carrier current, which consists in generating a three phase high frequency current, multiplying the frequency of the current of at least one of the phases, modulating said multiplied frequency current by impulses corresponding to a plurality of signals in successive and recurring time order and selectively receiving successive and recurring portions of the signaling energy from said single high frequency carrier current corresponding to one or a plurality of the independent signals and rejecting the signal energy of the undesired signals.

6. The method of transmitting and receiving a multiplicity of programs simultaneously by means of a single carrier current which consists in generating a three phase high frequency carrier current, tripling the frequency of one phase of said carrier current, multiply modulating the output of said carrier current of tripled frequency, receiving the multiple modulated carrier current at tripled frequency and separating from said carrier current the modulated carrier current corresponding to certain recurring cycles of the energy transmitted by said single carrier current.

7. A high frequency communication system comprising a three phase high frequency generator, three independent modulation circuits each timed in operation by a separate one of the phases of said high frequency generator, means connected with said generator for producing a tripled frequency carrier wave from said generator, means connected with said aforementioned means for modulating the tripled frequency carrier wave, a receiving system tuned to the tripled frequency carrier wave and circuits in said receiving system for selectively receiving the energy of selected recurring cycles of said carrier wave while discriminating against the other recurring cycles of said carrier current.

8. In a system for transmitting and receiving a multiplicity of programs simultaneously on a single carrier current comprising a source of polyphase energy, a plurality of modulating circuits arranged to be separately activated successively by the recurring phases of said source, said modulation circuits corresponding in number to the number of phases of said source, means for multiplying the frequency of one of the phases of said source, means connected with each of said modulation circuits for independently modulating the output of said first mentioned means, a receiving circuit tuned to the frequency of said multiplied carrier frequency and means for selectively receiving current in accordance with the operation of one of the modulation circuits at the transmitter independent of the operation of others of the modulation circuits.

9. A high frequency signaling system comprising a source of three phase current, a three phase distribution circuit connected with said source, individual modulation circuits supplied with energy separately from each phase of said distribution circuit, means for tripling the frequency of said three phase currents on one of the phases of said distribution circuit, a common connection between all of said modulation circuits and the output of said means, a receiving station, circuits for receiving the output of said means and an adjustable circuit at each of the receiving stations for selectively receiving signaling energy in accordances with the operation of an individual one of the modulation circuits of said transmitter.

10. In a system of multiplex transmission and reception the combination of a source of polyphase energy, a transmitting circuit for the transmission of a composite single phase carrier frequency derived from one of the phases of said polyphase source, a plurality of means for modulating said carrier frequency a multiplicity of times and receivers having circuits therein for selectively receiving the modulated components of said carrier frequency due to one of said means for modulating said carrier frequency while discriminating against the modulated components of said carrier frequency due to operation of others of said means for modulating said carrier frequency.

11. In a system of multiplex transmission and reception, a transmitter circuit, a multiplicity of modulator circuits connected with said transmitter circuit, a source of polyphase current for successively activating said modulator circuits with respect to said transmitter circuit, means for producing a single phase multiply modulated carrier frequency, and receiving circuits each having means for selectively receiving successive portions of said carrier frequency in accordance with the operation of a selected one of said modulator circuits while preventing interference from other portions of said carrier frequency.

12. The method of transmitting electrical signals which consists in diverting a part of the current of one of the phases of a three phase supply, tripling the frequency of this diverted current, causing the positive crests

of said tripled frequency current to coincide in time phase relation with the positive crests of said three phase supply, modulating the positive portions of successive cycles of said tripled frequency current with a plurality of signals and governing the sequence of said modulating action by the said three phase supply.

13. A multiplex signaling system comprising means for generating a high frequency carrier current, means for generating a polyphase current having a frequency equal to the frequency of said carrier current divided by the number of phases in said polyphase current, means for modulating said carrier current with a plurality of different trains of signals each train corresponding to a separate message, and means associated with said polyphase current generator for timing said carrier current modulating means in such a way that said trains of signals are respectively impressed upon separate recurring cycles of said carrier current.

14. A method of broadcasting signals which consists in selecting at a transmitter a single phase carrier wave from a polyphase source, tripling the frequency of said carrier wave, periodically modulating several successive cycles of said carrier wave by different signals and receiving successive sets of modulated portions of said wave over predetermined recurring time intervals for the reproducing of one communication channel without interference from sets of modulated portions of said carrier wave forming other communication channels.

15. A multiplex receiving system consisting of a receiving instrument including means to collect the energy of a multiple modulated carrier current, means to select definitely recurring portions of said carrier corresponding to a desired signal, means to detect said signal, including a detector and oscillator, said oscillator generating a frequency which is equal to the frequency of said carrier divided by a number which is equal to the number of signals multiplexed, said oscillator frequency being impressed upon the outward circuit of said detector for converting said detected signal into sound.

In testimony whereof I affix my signature.

CLINTON W. HOUGH.