

July 22, 1930.

C. A. SPRAGUE

1,771,148

CENTRAL ENERGY WAVE SIGNALING SYSTEM

Original Filed June 29, 1923 3 Sheets-Sheet 1

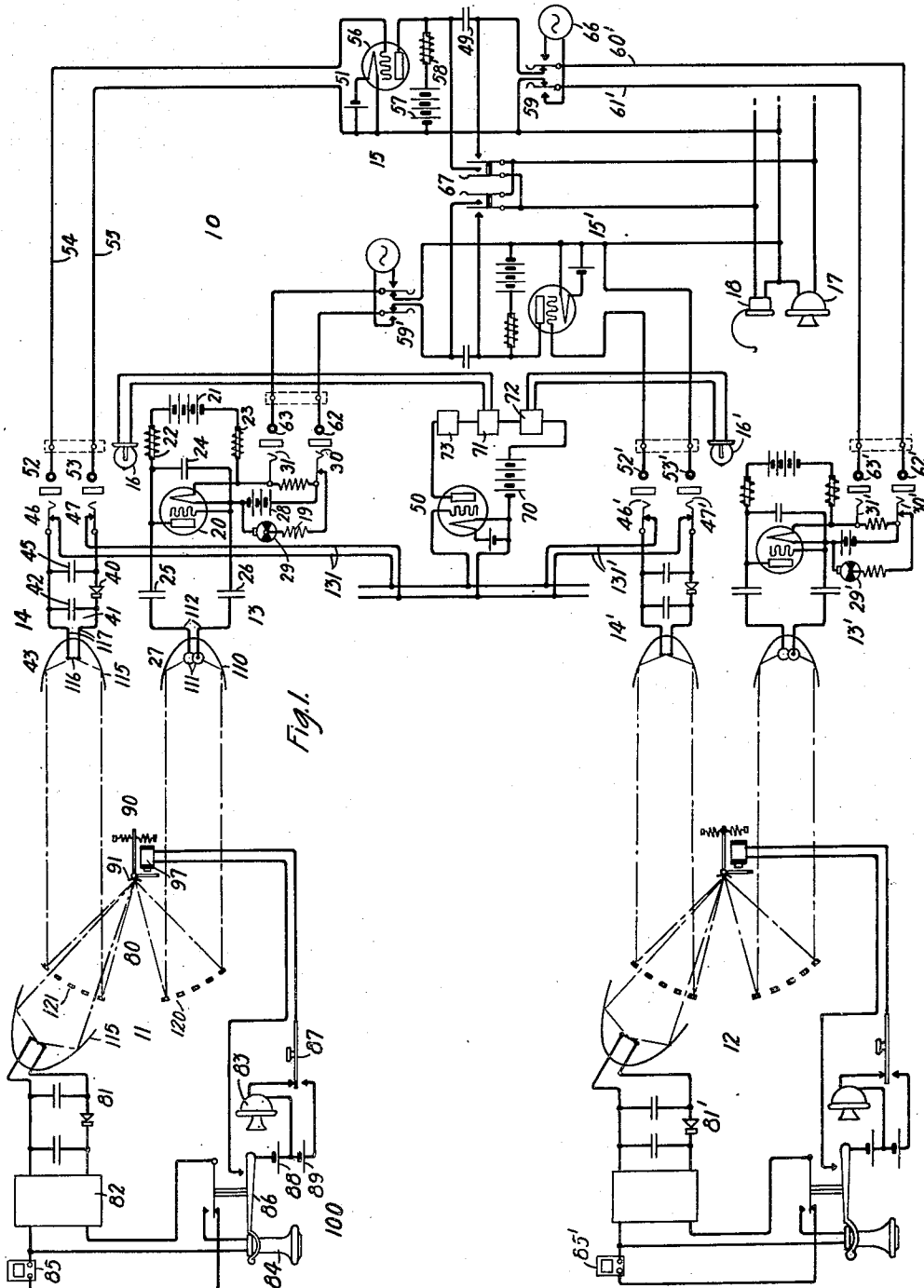


Fig. 1.

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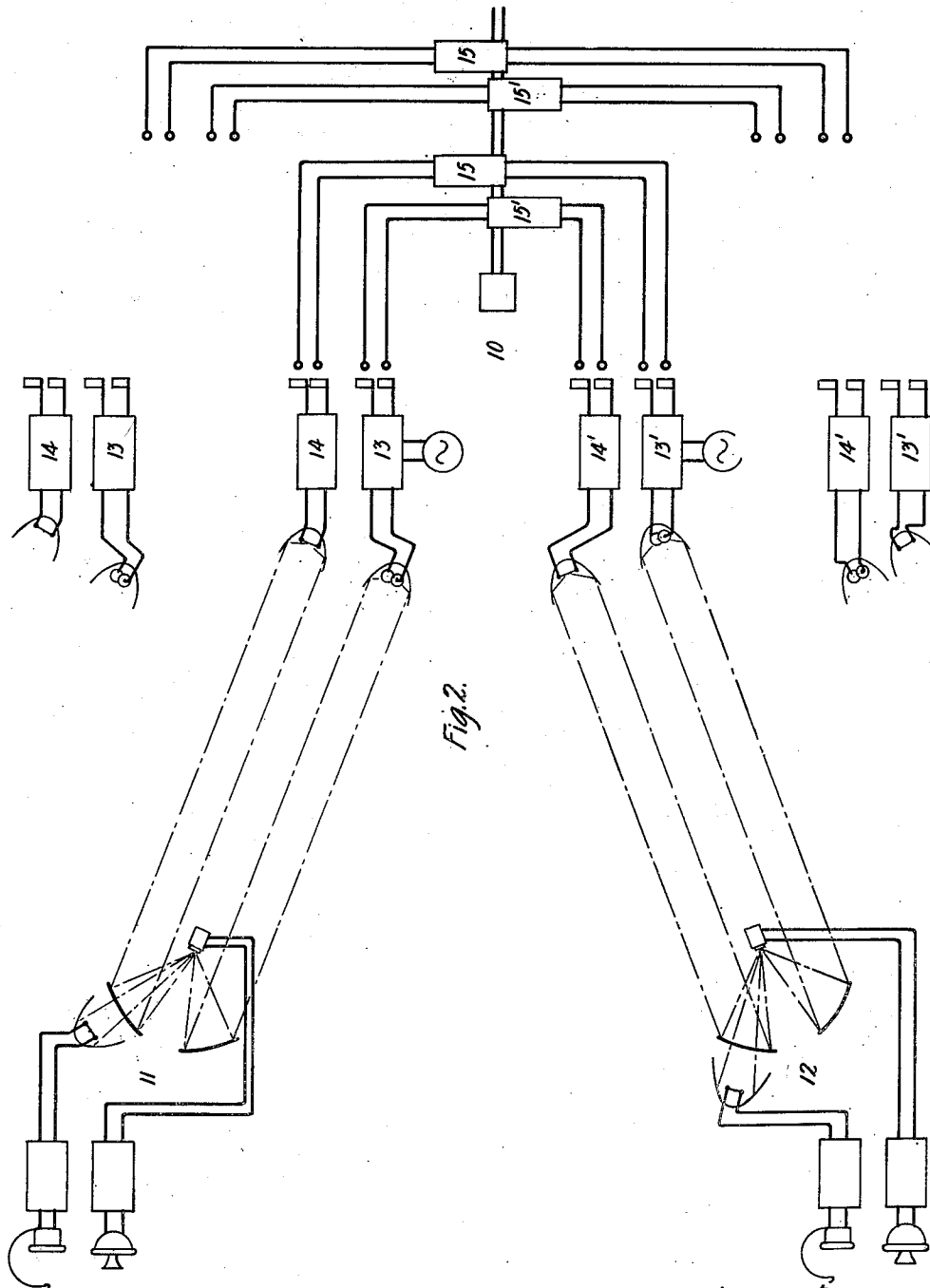
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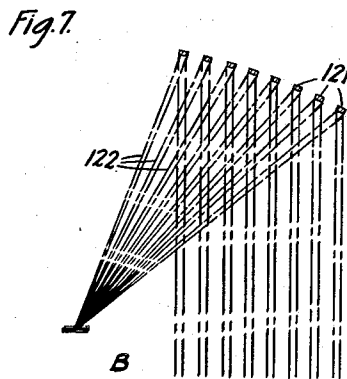
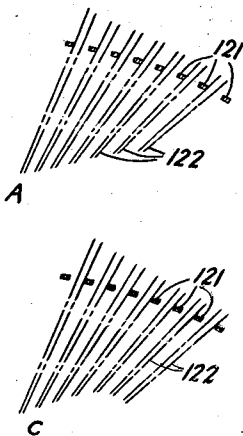
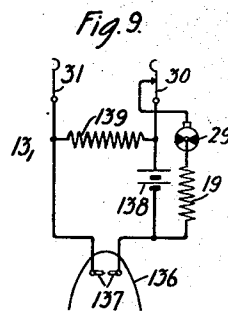
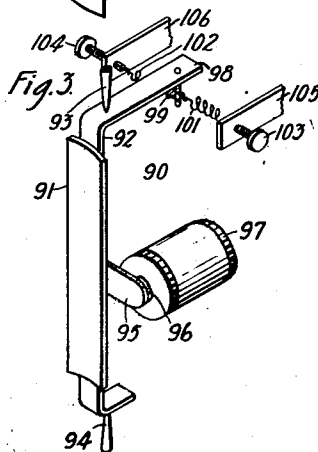
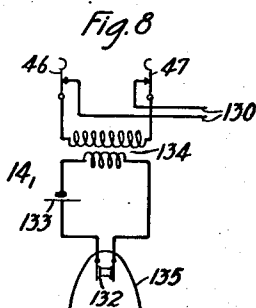
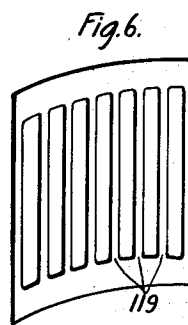
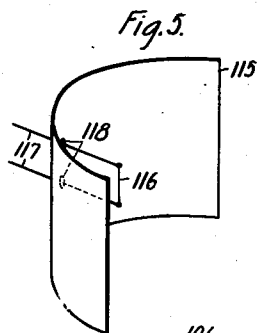
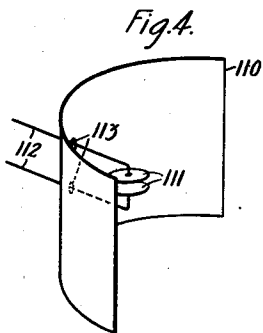
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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CENTRAL ENERGY WAVE SIGNALING SYSTEM

Application filed June 29, 1923, Serial No. 648,428. Renewed January 10, 1928.

This invention relates to central energy wave signaling systems.

An object of this invention is the provision of means at a central station for generating electromagnetic wave energy and for supplying such energy to individual subscriber stations.

Another object this invention seeks to accomplish concerns the provision of means at a subscriber station whereby electromagnetic wave energy may be received and directly radiated as a medium for the transmission of signals between said station and the central station or other subscriber station of the system.

A feature of this invention relates to the provision of central station equipment in an electromagnetic wave transmission system whereby a central station attendant is enabled to handle calls between a plurality of outlying subscriber stations.

Another feature of this invention relates to a signaling system whereby substantially secret communication between outlying subscriber stations and a central station is secured by directive radiation of wave energy from a central source.

It is proposed to utilize for the purposes of the invention both the very short electromagnetic waves, such as light, and the somewhat longer electromagnetic waves commonly known as radio waves of a few inches or feet in length. It is well known that electromagnetic waves of the latter wave lengths have properties corresponding to light waves whereby they may be reflected, refracted and polarized, and it is intended to make use of these properties in the present invention.

In one aspect, this system provides at a central station, equipment for generating very high frequency radiant energy and for directing it to a plurality of subscriber stations. In addition, equipment is provided for receiving and amplifying energy reflected from the subscriber stations and for redirecting such energy to a called station. The central station equipment comprises, in addition, switching apparatus by means of which an operator may be enabled to communicate with any desired station or to inter-

connect any calling station to any called station of the system.

In effect, this signaling system utilizes a plurality of non-interfering channels over which energy modulated in accordance with signal forms may be transmitted.

In order to convey a more comprehensive idea of the nature and advantages of this invention and the objects which it seeks to accomplish, a detailed description is given which should be considered in connection with the accompanying drawings wherein Fig. 1 shows in schematic form detailed circuits that embody the principles of this invention; Fig. 2 illustrates in diagrammatic form the relationship between a plurality of circuits similar to that of Fig. 1 that together comprise the system. Fig. 3 shows in detail a magnetic modulator for subscriber stations. Fig. 4 shows a practical form of transmitting reflector. Fig. 5 is a similar view of a receiving reflector. Fig. 6 is a practical form of reflecting grid for use in this invention. Fig. 7 illustrates a method of modulating the high frequency energy received at a subscriber station. Fig. 8 shows a receiver for employing light waves in the operation of the system. Fig. 9 shows a transmitter for light waves.

Referring to Fig. 1, 10 is a central station from which high frequency radiant energy is directed to outlying stations 11 and 12. The central station 10 comprises equipment individual to each station and also equipment common to all stations. High frequency generator 13 and receiver 14 are individual to station 11, and a similar generator 13' and a receiver 14' are individual to station 12. Associated through the common amplifier 50 with receivers 14 and 14' are individual station call signals 16 and 16' respectively. Common switching equipment provided at central station 10 comprises transmitting amplifier 15, and receiving amplifier 15' cords and plugs associated therewith, the operator's transmitter 17, receiver 18, ringing keys 59 and 59' and listening key 67.

At station 11, receiving and transmitting equipment is provided. This comprises a reflecting system 80, receiving device 81, ampli-

fier 82, and subscriber's telephone 100. Station 12 is provided with equipment identical with that of station 11.

Fig. 2 is a diagram illustrating the manner in which subscribers' stations and central office equipment may be multiplied and coordinated into a unified system of intercommunication. Additional transmitters and receivers 13, 14, 13' and 14' are shown at the central station together with additional switching equipment having amplifiers 15 and 15' to provide facilities for handling calls between two additional stations not shown. It is obvious that as many transmitters and receivers 13 and 14 or 13' and 14' are required as there are stations in the system, whereas only as many call switching equipments are required as are necessary to handle the maximum number of simultaneous calls. It is further obvious that still other stations and other central office equipment may be added to the system in the manner already shown.

Referring again to Fig. 1, generator 13 comprises a three-element electron tube 20 having its plate and filament connected to an energy supply circuit consisting of a battery 21 which is connected between choke coils 22 and 23 having high impedance to high frequency oscillations. A condenser 24 is shunted across this supply circuit forming a low impedance path for high frequency oscillations. The grid electrode of the tube 20 is directly connected to the negative side of its filament. An output circuit is connected to the plate and grid terminals and comprises condensers 25 and 26 between which is connected the wave transmitting device 27. The latter may be constructed as a small condenser having disc shaped plates 111, each of which is connected to one side of the output circuit. Surrounding these plates is a cylindrical parabolic reflector 110, which will be described more in detail later.

A battery 28 supplies energy for heating the filament of the electron tube 20. An interrupter 29 in series with resistance 19 is connected in shunt to battery 28 through contacts of jack 30.

The circuit and elements of generator 13 are designed and arranged in such manner as to permit the generation of oscillations of extremely high frequency whereby energy having a very short wave length of only a few inches may be transmitted from device 27.

The mutual inductance of the leads connecting the grid and plate of tube 20 forms the feed-back coupling between their respective circuits whereby sustained oscillations are generated. The capacity between the grid and plate combined with the inductance of these leads determines the frequency of oscillation. Condenser 24 is of such size as to

have substantially no effect upon the frequency.

The interrupter 29 which has a velocity of rotation individual to the generator 13 and therefor individual to station 11 alternately connects and disconnects resistance 19 in shunt about battery 28. In this way the oscillations produced in generator 13 are periodically modulated and electromagnetic waves having similar modulations are transmitted from device 27.

Receiver 14 comprises a detector 40, which may be a crystal detector, and a resonant circuit 41 comprising a condenser 42 and receiving device 43. This receiving device, to be more fully described later, may consist of a short length of conductor 116 placed at the focus of a cylindrical parabolic reflector 115.

The output circuit of receiver 14 is shunted by condenser 45 which offers low impedance to high frequency electric currents, but high impedance to audio frequency currents. This output circuit is connected through contacts of jacks 46 and 47 to the grid and filament of amplifying electron tube 50.

The output circuit of tube 50 which is connected to the plate and filament contains a battery 70 and a plurality of frequency selective devices 71, 72 and 73. Device 71 which may be any frequency selecting device such for example as a harmonic ringer or an alternating current relay is sensitive to the frequency produced by interrupter 29 but is inoperative to other frequencies. A signal device 16, which may be for example, a very small electric lamp, is energized in a well known manner upon the operation of device 71. Device 72 on the other hand is sensitive to the frequency produced by interrupter 29' and when operated energizes lamp 16'.

Transmitting amplifier 15 which is preferably of the electron tube type has an input circuit 51, the terminals of which are associated with plugs 52 and 53 by conductors 54 and 55. This input circuit connects to the grid and filament of an electron discharge tube 56. The output circuit of amplifier 15, which is connected across the plate and filament of tube 56, is supplied with energy by battery 57 in series with a coil 58 which offers high impedance to varying currents. The output circuit is connected by way of condenser 49, break contacts of key 59, and conductors 60' and 61' to plugs 62' and 63'.

The pairs of conductors 54 and 55, 60' and 61' may be in the form of individual flat flexible cords whereby plugs 52, 53, 62' and 63' may be operably associated with jacks 46, 47, 30' and 31' respectively.

Associated with the make contacts of key 59 is a source of ringing current 66.

An operator's telephone set comprising a transmitter 17 and receiver 18 may be placed in operative relation with transmitting am-

plifier 15 by means of key 67. By this key also, the operator's telephone set may be associated with a receiving amplifier 15' similar in all respects to the transmitting amplifier 15.

The input terminals of amplifier 15' are connected to plugs 52' and 53' in the manner described in connection with transmitting amplifier 15. The output circuit of amplifier 15' connects likewise to plugs 62 and 63. By means of their cords and plugs, amplifiers 15 and 15' may be placed in operative relation with any desired pair of stations in the system.

Generator 13' is similar to generator 13 in all respects except that interrupter 29' operates to produce modulation at a frequency individual to station 12 and consequently differs from the frequency of interrupter 29. Receiver 14' likewise corresponds to receiver 14.

At station 11, there is provided first, a system of wave reflectors 80, comprising reflecting grids 120 and 121 cooperating with mirror 91 of modulator 90. There is next provided a receiving circuit 81, an amplifier 82 and last a telephone comprising a transmitter 83, receiver 84, signal indicator 85, hook switch 86 signaling key 87 and batteries 88 and 89.

In the reflecting system 80, grids 120 and 121 are symmetrically positioned in accordance with the surface of a cylindrical parabola. The mirror 91 is rotatably positioned at or near the focal line of this parabola. This mirror serves to reflect the image of grid 120 upon grid 121 in a manner and for a purpose to be more fully described.

Receiving circuit 81 at subscriber station 11 is similar to receiver 14 at central station 10. The energy from its output circuit is increased by amplifier 82, similar to amplifier 15, already described, and supplied to telephone receiver 84 or signal indicator 85 as the case may be.

Signal indicator 85 may be a polarized ringer adjusted to respond to periodically varying current preferably of a frequency other than that produced by interrupter 29. The signal indicator is normally associated with the output circuit of amplifier 82 by leads connected to break contacts of hook switch 86.

Telephone receiver 84 on the other hand, is associated with the output circuit of amplifier 82 by leads connected to make contacts of hook switch 86.

Transmitter 83 is associated with modulator 90 by leads connecting to make contacts of hook switch 86 and to break contacts of key 87. The signal circuit operated by key 87 includes the battery 89 associated with the make contact of said key.

In Fig. 3 are shown the details of magnetic modulating device 90. This comprises con-

cave reflecting mirror 91 mounted upon a supporting member 92 which, in turn, may be supported by substantially frictionless bearings 93 and 94. An extension 95 of magnetic material is attached to supporting member 92 and positioned adjacent to the core 96 of a sensitive electromagnet 97. The extension 95 constitutes a movable armature under the influence of the magnetic field of the electromagnet 97. The member 92 supporting the mirror 91 also has an extended arm 98 in which a lug 99 is fixed for attaching the two opposing springs 101 and 102 respectively. These springs terminate in adjusting screws 103 and 104, which are threaded to supporting posts 105 and 106 whereby the tension on the springs may be varied. This adjustment of springs 101 and 102 enables the magnitude of the deflection of mirror 91 under the action of electromagnet 97 and its armature 95 to be controlled.

The transmitting device 27 is illustrated in detail in Fig. 4. The reflector 110 may be a rectangular sheet of any suitable metal arranged in a cylindrical parabola. 111 are circular conducting disks of relatively small size positioned at the focus of the reflector 110 and connected to leads 112 passing through apertures 113 in the reflector 110 without making electrical contact therewith.

Fig. 5 illustrates a receiving device for use either at the central station or at subscribers' stations. It comprises a concave reflector 115 which may be parabolic or elliptic similar to that of Fig. 4. 116 is short receiving conductor or antenna coinciding with the focus of the reflector and connected to leads 117, passing through apertures 118 in reflector 115 without making electrical contact therewith.

A special reflector such as 120 and 121 of the system of reflectors 80 is shown in detail in Fig. 6. This may consist of a rectangular sheet of conducting material curved to form a portion of a cylindrical parabolic surface and having parallel grids 119. The grids 119 are preferably made rectangular in shape and one-half as wide as the spaces separating them. In alternate form the grids 119 may be held by an insulating frame. If desired the individual grids may be tuned to the frequency of the electric waves utilized.

In the operation of this system, high frequency oscillations generated in the grid-plate circuit of oscillator 13 are periodically modulated by the action of interrupter 29 in varying the filament current and therefore the electronic emission of the tube 13. Oscillations of the same frequency having corresponding modulations are set up in a resonant circuit comprising transmitting electrodes 111 and the leads 112 connected thereto. This resonant circuit is coupled to the output of generator 13 by condensers 25

and 26. Consequently, very short wave energy is radiated from the transmitter 27 and by virtue of the properties of the parabolic reflector 110, it is directed in a pencil of parallel rays upon grid 120 at station 11.

It is well known that very short electromagnetic waves have characteristics substantially the same as light and it is proposed that the wave energy utilized in this system shall have a wave length such that its action will be analogous thereto.

Thus, the pencil of rays striking upon grid 120 will be reflected on the mirror 91 and from the mirror to grid 121. By proper adjustment of the position of mirror 91, the image of the grids of reflector 120 may be caused to fall either directly upon the grids of reflector 121 or between the grids into the spaces therebetween.

The mirror 91 is adjusted so that normally the images of the grids of reflector 120 fall between the grids of reflector 121 and the wave energy thus reflected is received upon the parabolic reflector 115 of receiver 81. It is evident that by varying the angular position of mirror 91 with respect to its associated reflectors, the image of grid 120 may be caused to take any desired position relative to grid 121.

The reflector 121 is positioned so that when any part of the reflected image falls upon its surface, a corresponding amount of energy is again reflected and directed to receiver 43 at the central station. Thus, by shifting the image of grid 121 the amount of energy directed to the central station may be varied.

It will be understood that a pure modulated wave, that is, one in which no unmodulated component of the carrier wave is present, may be transmitted by this system if the grids 119 of reflector 120 are constructed somewhat shorter than the corresponding spaces of reflector 121 and are held by a non-reflecting material so that normally the complete image radiated from grid 120 falls between the grids of reflector 121.

It is a purpose of this invention to modulate the reflected wave by vibrating mirror 91 under the control of electromagnet 97 in accordance with the amplitude of speech or signal waves.

In order that light waves may be employed in the operation of this system, it will be necessary to substitute the receiver shown in Fig. 8 for the receivers 14 and 14' at the central station and for the receiver 81 at the subscribers' stations of Fig. 1. This substitution may be effected by connecting the leads 130 of the receiver, shown in Fig. 8, to the leads 131, Fig. 1, and the leads 130 of a second receiver to the leads 131' of Fig. 1. The transmitter of Fig. 9 may be substituted directly for the transmitters 13 and 13' of Fig. 1.

The receivers 81 and 81' at stations 11 and 12 respectively, of Fig. 1 may be the same as the receiver of Fig. 8 with the omission of the jacks 46 and 47. The secondary of transformer 134 should be connected directly to the amplifier 82. In Fig. 8, 135 is a reflector of any well-known type capable of reflecting light and capable of bringing parallel rays to a focus. This reflector may, for example, take the form of spherical parabola. 132 is a selenium or other photoelectric cell connected to a battery 133 in series with the primary of the transformer 134, and is positioned at the focus of the reflector 135. The secondary of the transformer connects to jacks 46 and 47 having leads 130 connected to their break contacts.

A beam of light having variations such as are produced at the subscriber's station of Fig. 1 falling on the reflector 135 will be concentrated upon the photoelectric cell 132. The variations of this beam cause corresponding variations in the circuit of the cell, as is well known. These variations are transmitted through transformer 134 to the leads 130 or the jacks 46 and 47, as the case may be, and may be utilized in this system for the transmission of signals or speech, as already described.

The transmitter of Fig. 9 comprises a parabolic reflector 136 similar to reflector 135 capable of transmitting light in parallel rays. 137 is an ordinary form of electric arc lamp positioned near the focus of the reflector 136. A battery 138 connected to a resistance 139 supplies electric current to the arc lamp 137. An interrupter 29 in series with a resistance 19 and a break contact of jack 30 is shunted about the battery 138. Another jack 31 is provided for enabling connection to be made to this transmitter.

It is evident that as the interrupter 29 rotates, the resistance 19 will be alternately connected and disconnected in shunt to the battery 138 and will thereby produce variations in the electric current supplied to the arc lamp 137 and consequently similar variations in the light emitted therefrom. When the operator inserts plugs into jacks 30 and 31 the circuit of the interrupter 29 and the resistance 19 is permanently opened at jack 30. If electric potentials in accordance with speech are applied to the resistance between jacks 30 and 31, corresponding modulations in the light emitted from the arc lamp 137 will be produced.

In place of the arc lamp 137, a mercury vapor arc lamp or other enclosed arc or incandescent lamp may be used. By the use of light filters which are now well understood the light rays transmitted may be limited to any desired portion of the visible or invisible spectrum and those rays which penetrate fog and do not directly affect the human eye are preferred for the purposes of this invention.

Considering now the operation of this system, in order for the subscriber at station 11 to call the central operator, he must remove receiver 84 from the switch hook 86 and depress calling key 87. This closes the circuit of electromagnet 97 which is energized by the combined emf. of batteries 88 and 89. The energized magnet attracts its armature and causes a deflection of mirror 91 and a consequent shifting of the image of grid 120 from the normal position of the ray as shown in Fig. 7A to the position shown in Fig. 7B. In the latter position the image of grid 120 falls directly upon grid 121 and is reflected to the receiving device 43 at the central station. This incoming energy interrupted by the frequency induced by device 29 is detected in receiver 14. The high frequency component of the detected current is shunted through condenser 45 and the low frequency impulses are transmitted to the amplifier 50. In the output circuit of device 50, amplified low frequency impulses are transmitted to a plurality of receiving devices 71, 72 and 73. Since, as previously indicated, device 71 is responsive to the frequency of interrupter 29, the individual station signal lamp 16 is lighted.

The operator upon observing the signal, inserts plugs 52 and 53 in the jacks 46 and 47 respectively associated with the signal lamp 16 in order to communicate with the calling station. This act causes the disconnection of amplifier 50 at contacts of jacks 46 and 47 and the consequent deenergization of the signal lamp 16. At the same time amplifier 15 is connected to the output circuit of detector 14 and the operator may receive the incoming signals in her telephone receiver 18 by actuating key 67. Condenser 49 prevents direct current from being supplied to receiver 18 by battery 57. Condenser 49 also prevents current from battery 57 from flowing in the filament of the tube of receiver 13'.

The calling subscriber upon releasing the signal key 87 opens the signal energizing circuit of electromagnet 97 and closes the transmitting energizing circuit of the same magnet through the transmitter 83 and battery 88. The current through the electromagnet is thereby reduced and a consequent change in the deflection of the image of grid 120 reflected to grid 121 takes place. The changed position of the image with respect to grid 121 is indicated in Fig. 7C. If the subscriber now speaks in the transmitter 83 variations of the current applied to electromagnet 97 corresponding to the forms of voice waves will be produced. The action of electromagnet 97 upon its armature 95 transmits to mirror 91 and the image reflected by it, a corresponding deflection which varies in amplitude in accordance with the amplitude variation of the current. This causes the rays

122 (Fig. 7C) to be shifted more or less on to the grids 121 and consequently reflects to the receiving device 43 at the central station amounts of energy varying in accordance with speech sounds. This modulated energy is transmitted to detector 40 of receiver 14 and the demodulated energy transmitted therefrom is impressed on the input terminals of amplifier 15 from which amplified voice frequency currents are transmitted to the operator's receiver.

The operator has now also inserted plugs 62 and 63 in jacks 30 and 31 respectively, causing interrupter 29 to be disconnected from battery 28 and causing transmitter 17 of the operator's set to be placed in operative connection with the filament battery supply circuit as shown.

The operator may now talk to the calling subscriber by speaking in the transmitter 17. This produces variations in the filament current corresponding to speech variations and the high frequency oscillations set up in generator 13 are consequently modulated in accordance with speech. These modulated oscillations cause a radiation of energy from transmitter 27 which is directed to grid 120 at station 11 as described above and received upon the reflector 115 in the receiving circuit 81.

The wave energy directed upon this reflector is concentrated at its focus upon receiving conductor 116. In receiver 81 the energy is demodulated and audio-frequency energy impressed upon amplifier 82 in the output circuit of which amplified audio-frequency energy corresponding to forms of speech is received and impressed upon telephone receiver 84.

The calling subscriber indicates to the operator the station desired which for the purpose of illustration, let us say is station 12. Upon receiving this information the operator inserts plugs 62' and 63' in jacks 30' and 31' respectively and plugs 52' and 53' in jacks 46' and 47' respectively. Plugs 62' and 63' actuating the spring contacts of jacks 30' and 31' disconnect interrupter 29' from the circuit of generator 13' and connect the output circuit of amplifier 15 thereto. Plugs 52' and 53' disconnect amplifying device 50 from receiver 14' and connect the receiver 14' to the input circuit of amplifier 15'.

The operator now actuates her ringing key 59 which disconnects amplifier 15 from the filament of generator 13' and connects a source of ringing current 66 in its place, thereupon, high frequency energy modulated by a ringing frequency is transmitted to station 12 where it causes the actuation of the signaling device 85' which may be for example, an ordinary telephone ringer similar to device 85 at station 11. This attracts the attention of the called party who lifts his receiver from the hook-switch and conse-

quently places his station in operative condition such that he may communicate with the calling station in a manner already described in connection with station 11.

When the operator releases ringing key 59, the circuit is completed from receiver 14 to transmitter 13'. A circuit is also complete between receiver 14' and transmitter 13. These circuits being in operative condition the calling party may now converse with the called party and vice versa.

Upon completion of the conversation the respective parties replace their receivers upon the associated hook-switches and the operator removes the plugs 52, 53, 62, 63, 62', 63', 52' and 53' which acts restore the system to normal condition.

This invention has been disclosed and illustrated in certain practical forms utilizing radio waves of a few inches or feet in length but it is clear that light waves may be utilized in a similar manner by modifications that will readily occur to persons skilled in the art without departing from the scope of this invention.

What is claimed is:

1. The combination in a wave signaling system, of means at a central station for directly radiating wave energy, and means at a plurality of outlying stations for modulating said radiated wave energy in accordance with a signal wave and for reradiating said energy as a medium for the transmission of the signal wave.

2. The combination in a radiant energy signaling system of means at a central station for radiating energy in a predetermined direction, and means at a receiving station comprising a system of reflecting and absorbing structures for receiving and reflecting said energy and varying in accordance with signals the angles of reflection.

3. In a signaling system utilizing wave energy, a central station comprising a generator of very high frequency energy, means for transmitting said energy through space without substantial dispersion, a plurality of outlying stations, means at said stations for receiving and retransmitting to said central station said energy modified in accordance with signal forms, and additional means at said central station whereby said modified energy may be relayed to any other desired station in said system.

4. The method of signaling by means of high frequency radiant energy which comprises transmitting said energy in beams of substantially parallel rays and of relatively small area, receiving said energy and reflecting portions of the same, the portions reflected being varied in amount in accordance with signals to be transmitted.

5. The method of signaling which comprises directly radiating energy from a central station to a subscriber station hav-

ing devices responsive to energy modulated at a particular frequency said directly radiated energy being modulated at a frequency other than that to which said receiving devices are responsive and redirecting said energy to said central station.

6. In a system for signaling by means of radiant impulses, means for transmitting intermittent energy from a central station over individual non-interfering paths to a plurality of receiving stations, and means at said receiving stations for signaling said central station, said means comprising a system of reflecting and absorbing structures, one of said structures including a rotatable member adapted to vary the angle of reflection of said energy in accordance with signals, and means for redirecting said energy to said central station.

7. The method of signaling to and from a distant subscriber station having receiving devices responsive to modulated radiant energy of particular frequencies which comprises transmitting a beam of unmodulated energy to said subscriber station, modulating said beam of energy at said subscriber station and retransmitting said beam to a central station.

8. The combination in a central energy wave signaling system of means at a central station for producing and directly transmitting energy and additional means for imparting to said energy a plurality of different modulations and means at a receiving station responsive to energy having certain of said modulations but unresponsive to energy having other of said modulations.

9. In a radio signaling system, a wave reflecting device comprising a plurality of grids arranged along a parabolic surface and a concave mirror rotatably mounted at the focus of said surface.

10. The method of modulating a carrier wave which consists in bringing said wave to a focus, reflecting said focused wave in radial beams and reflecting said radial beams in parallel rays.

11. The method of modulating electric wave energy which comprises producing a beam of parallel rays, causing said beam to be brought to a focus and redirected in varying amounts to an antenna.

12. The combination in a central energy signaling system of a source of imperceptible radiant energy at a central station, a plurality of subscribers' stations, said subscribers' stations comprising individual systems of relatively movable reflecting surfaces arranged to retransmit energy received from said central station to said central station.

13. A radio transmitting system comprising a generator of high frequency oscillations, said generator comprising an energy radiating device connected to the output circuit of a vacuum tube, a filament heating

source and an interrupter connected in shunt to the filament heating source of said vacuum tube.

14. An electromagnetic wave signaling system comprising means for intermittently and continuously directing electromagnetic waves to a predetermined receiving station, and means for imparting modulations to said continuously directed waves capable of actuating signaling devices at said receiving station.

15. An electromagnetic wave signaling system comprising means for intermittently directing electromagnetic waves to a predetermined station, a system of reflecting surfaces at said station for redirecting said waves to the station from which they originated, and means at the latter station selectively sensitive to said intermittent waves for producing a signal.

16. A radiant energy telephone system comprising a main station, a secondary station, means at said main station for generating a carrier wave, means at said main station for modulating said wave in accordance with speech, means at said secondary station for receiving the modulated wave and demodulating it to obtain speech waves, and means at said secondary station for receiving the unmodulated wave generated at the main station, modulating it in accordance with speech waves, and transmitting the resultant wave to the main station.

17. A radiant energy telephone system comprising a main station, a secondary station, means at said main station for generating and directively radiating a carrier wave, and means at said secondary station for modulating said radiated carrier wave in accordance with speech waves and for reradiating said modulated carrier wave.

18. A radiant energy telephone system comprising a main station, a secondary station, means at said main station for generating a carrier wave, means at said main station for modulating said carrier wave in accordance with speech waves, means at said main station for radiating the modulated and unmodulated waves in a beam of substantially parallel rays, means at said secondary station for receiving the radiated modulated wave and demodulating it to obtain speech waves, and means at said secondary station for receiving the unmodulated wave and controllably reflecting it in accordance with speech waves.

19. The method of radiant energy telephone communication between two stations which comprises radiating from one station a beam of substantially parallel rays, receiving said beam at the other station, varying said beam in amount in accordance with speech waves at said other station, and reflecting at least a portion of the received

beam so varied in amount in accordance with speech waves.

20. A radiant energy telephone system comprising a main station, means at said main station for transmitting a carrier wave, a secondary station, a system of relatively movable reflecting surfaces at said secondary station arranged to reflect said carrier wave back to said main station, and means at said secondary station for controlling said reflecting surfaces to modulate said carrier wave in accordance with speech.

In witness whereof, I hereunto subscribe my name this 25th day of June, A. D. 1923.

CLARENCE A. SPRAGUE.