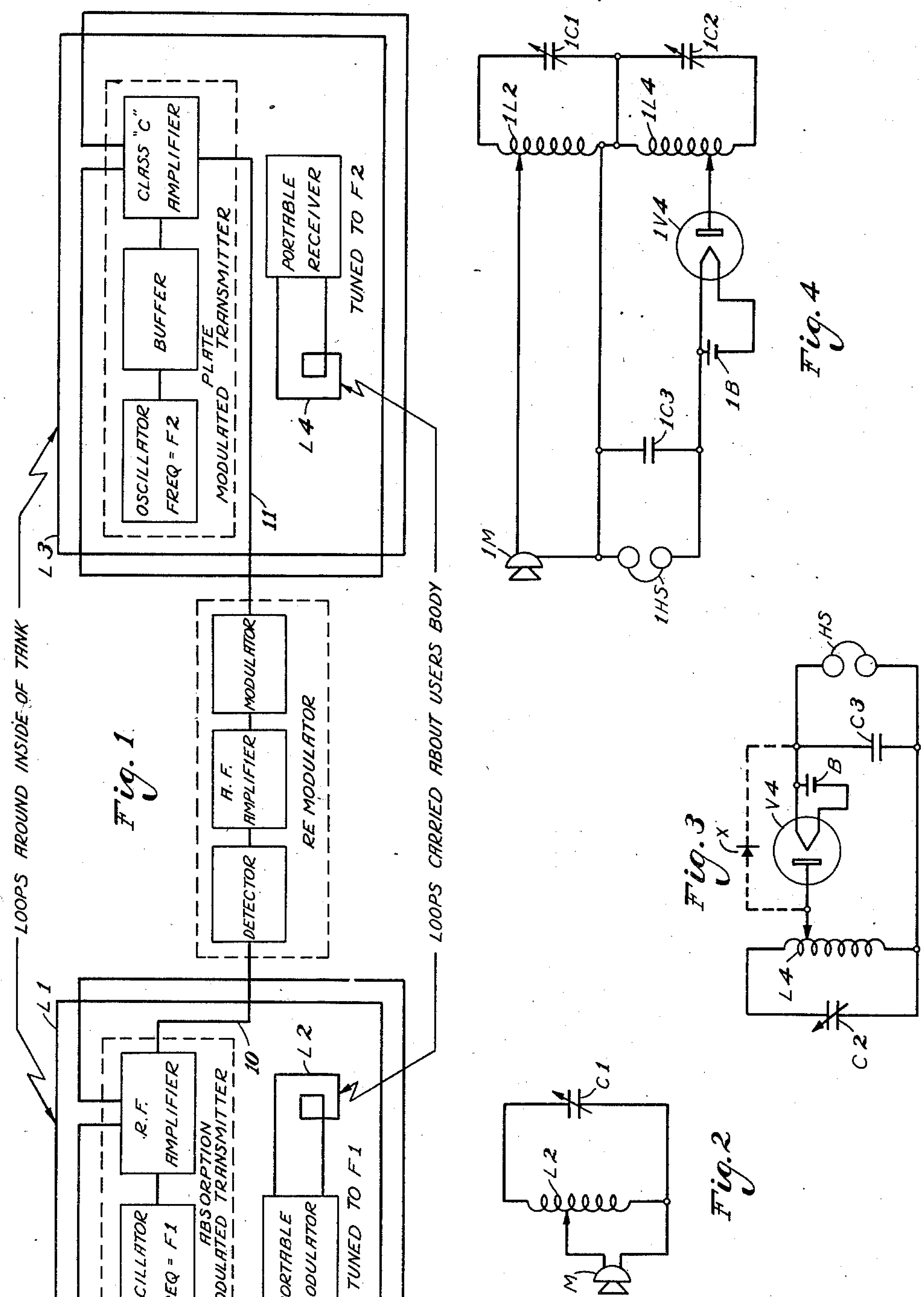
COMMUNICATION SYSTEM

Filed Feb. 12, 1942 2 Sheets-Sheet 1



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Nov. 14, 1944. H. GOLDBERG ET AL 2,362,692

COMMUNICATION SYSTEM

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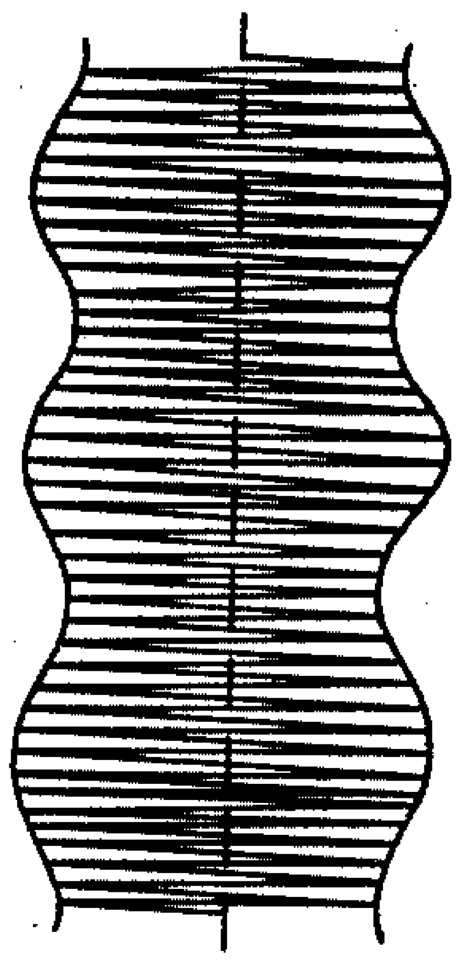

Fig. 6

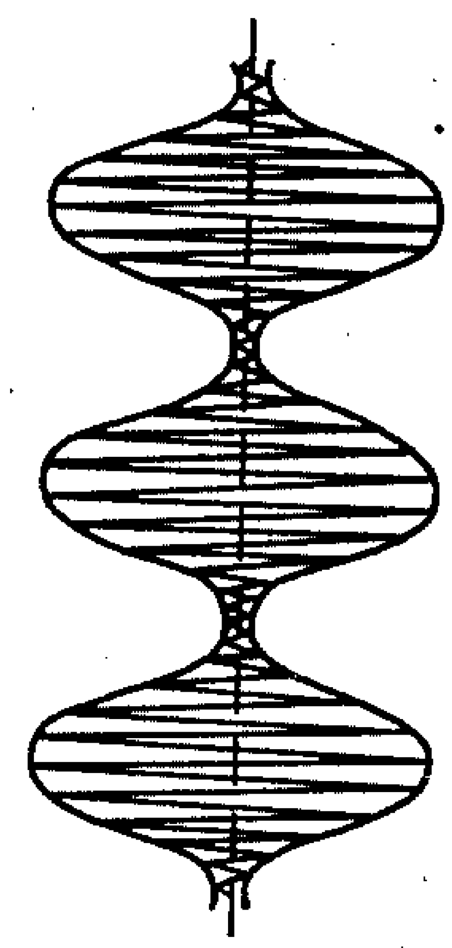

Fig. 7

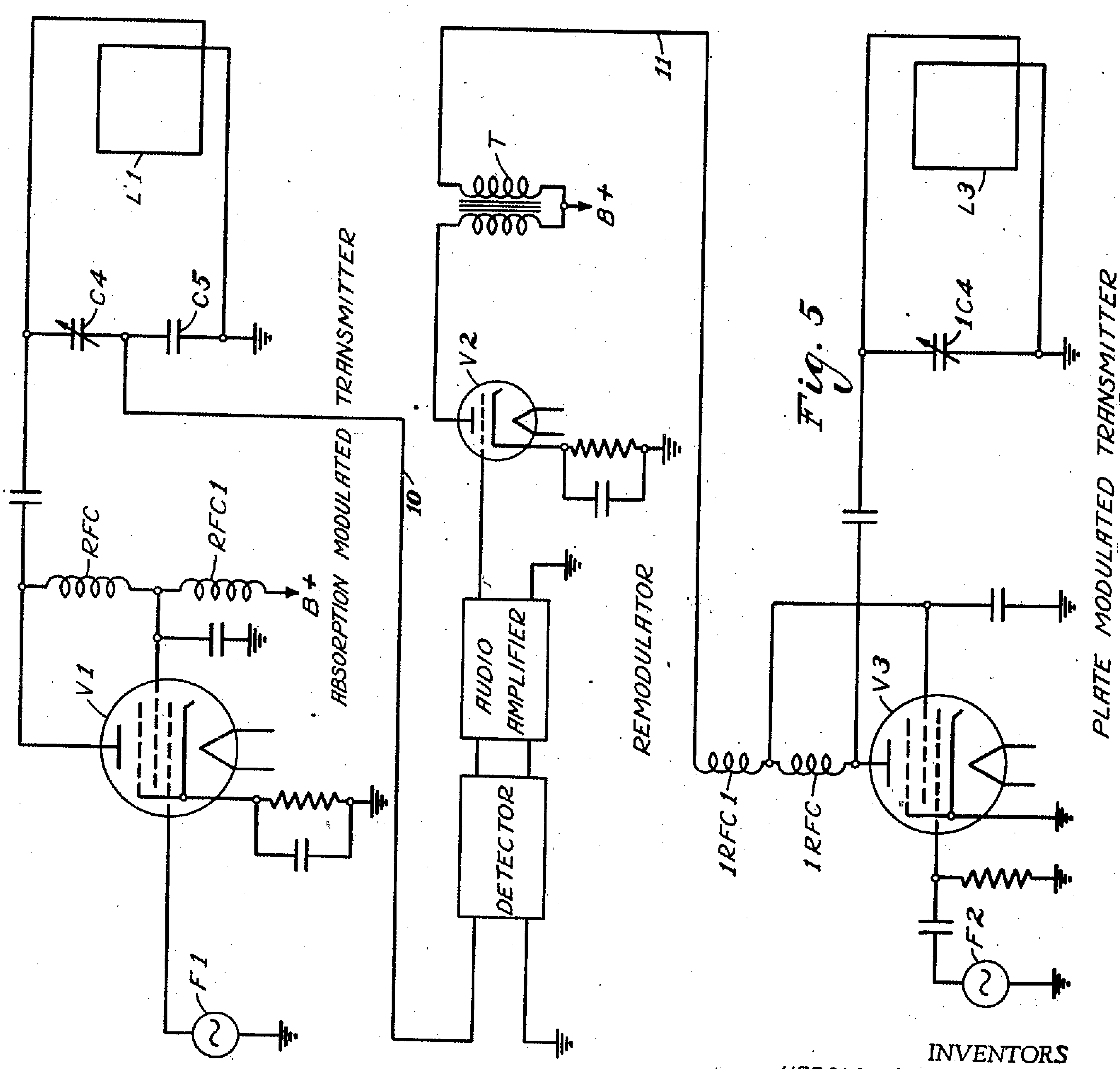

Fig. 5

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Patented Nov. 14, 1944

2,362,692

UNITED STATES PATENT OFFICE

2,362,692

COMMUNICATION SYSTEM

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Application February 12, 1942, Serial No. 430,592

8 Claims. (Cl. 250—6)

This invention relates to communication systems employing radio transmitting and receiving apparatus and is characterized as employing apparatus and circuits for an improved method of signalling by means of modulated carrier currents or waves.

The invention is particularly useful when applied to a communication system, whereby it is possible for the users to move about and, by means of a portable transmitter and receiver carried by such users be able to communicate with each other through the intercommunicating system and without the need of any power supply or wire connection to or from the equipment which they carry.

This invention will be shown and described as being applied to an intra-tank communicating system within an enclosure. It will be understood that it may find use in numerous fields of service, for example, in military operations where it is necessary to employ portable telephone apparatus which must be characterized by reasonably high power and efficiency, lightness, compactness, resistance to mechanical shocks and rough usage generally, and also by simplicity and convenience of operation and maintenance.

By way of concrete illustration and in order that the invention may be fully understood by those skilled in the art, an especially desirable form of apparatus and circuits embodying the principles of the invention is shown in the accompanying drawings and will be described in detail.

Fig. 1 is a block diagram illustrating the arrangement of the various components of the complete system;

Fig. 2 shows the circuit of the portable modulator;

Fig. 3 shows the circuit of the portable receiver;

Fig. 4 shows the circuit of a combined portable receiver and portable modulator;

Fig. 5 shows the circuits of the absorption modulated transmitter and its antenna, the remodulator and the plate modulated transmitter and its antenna;

Figs. 6 and 7 graphically represent respectively a high frequency wave with a low degree of modulation and a high frequency wave with a high degree of modulation.

In Fig. 5 the absorption modulated transmitter is shown connected to the remodulator by means of wire **10** and the remodulator is shown connected to the plate modulated transmitter by means of wire **11**. These same interconnections are indicated in Fig. 1 by means of the same reference characters.

One basic principle of operation of our invention is based on the phenomenon that the electromagnetic field due to any source is determined not only by the characteristics of the source, but also by the position, size and electrical properties of all conductors and dielectrics within a space surrounding that source.

Another basic principle of operation of our invention is based on the phenomenon that a variation in resistance or impedance may be reflected from one circuit into another, without any conductive connection between the two, by means of inductive coupling.

It is accordingly an object of our invention to set up an electro-magnetic field from a source of high frequency oscillations and to vary or modulate that field by changing the electrical properties of the circuits and conductors within a space surrounding the field.

A practical application of this basic principle is that a communication system may be provided in which the electro-magnetic field, due to a fixed source of high frequency oscillations, may be modulated according to low frequency signals, such as voice frequencies, by a modulating device, without the necessity of this device having a relatively fixed or fixed spatial relation to the source or to have any conductive connection therewith.

Consequently, a further object of our invention is the provision, in a communication system, of a high frequency oscillator which sets up an electro-magnetic field, and means including one or more portable conductively isolated telephone transmitters or other means for absorptively modulating the field whereby modulated energy is radiated.

Another object of our invention is to apply high frequency oscillations, from a high frequency source, to one antenna or other radiating means and to vary or modulate the high frequency waves in this one antenna circuit by reflecting variations in resistance or impedance from another antenna into this one antenna circuit by means of inductive coupling.

Another object of our invention is the provision of a communication system outlined above, in which several modulators (telephone transmitters or other means) with no outside conductive connection may be carried about and each may function to modulate the electro-magnetic field, whereby telephone inter-communication may be accomplished by the further provision of conductively isolated and portable receivers which will respond to the modulated energy of the modulated electro-magnetic field.

An additional object of our invention is the provision of a portable "transreceiver" with no outside power source or other conductive connection and arranged to transmit and receive telephone signals by modulation and demodulation of the above described electro-magnetic field.

Still another object of our invention is the provision of means for increasing the degree of modulation, whereby increased power may be provided.

Other objects of our invention will become apparent upon reading the following description taken in connection with the drawings.

The complete system, schematically illustrated in Fig. 1 for purposes of convenience in description, may be divided into an absorption modulated transmitter and associated portable modulator, a remodulator and a plate modulated transmitter and associated portable receiver, with the various components in the complete system appropriately labeled.

The absorption modulated transmitter comprises a conventional oscillator, oscillating at frequency F1, a power radio frequency amplifier, preferably a pentode tube, operating as a class A amplifier, the output of the amplifier being connected to loop antenna L1, which consists of one or more turns of wire strung around the tank walls.

The remodulator is connected to the output of the radio frequency amplifier of the absorption modulated transmitter and comprises a conventional detector, a conventional audio frequency amplifier and a modulator, all indicated by block diagrams in Fig. 1.

The plate modulated transmitter comprises a high frequency oscillator operating at a different frequency, F2, from that of the oscillator of the absorption modulated transmitter. The plate modulated transmitter also comprises a buffer and a class C radio frequency amplifier, all as illustrated by block diagrams.

The portable modulator, illustrated in Fig. 2, comprises an inductance L2 which may be worn about the body of the user, for example by being sewed in the user's belt. The portable modulator also comprises a mica tuning condenser C1 and a carbon microphone M. The inductance or antenna L2 is shown with a variable connection to the modulator M. This is so that the modulator or microphone M may be tapped into the loop L2 at the right number of turns for providing the most effective modulation.

The portable receiver illustrated in Fig. 3 comprises a tuned circuit consisting of inductance L4, which may be in the form of a small loop antenna worn by the user, for example by being sewed in the user's belt, tuning condenser C2, a diode detector V4, a headset HS and bypass condenser C3.

It will be understood that, while only a single portable modulator and a single portable receiver are shown, a plurality of either or both of these devices may be operated in the present system. Furthermore, a rectifier X may be used in Fig. 3 in place of the tube, as illustrated in dotted lines. This rectifier may be of the dry plate or other type.

Fig. 4 illustrates a combined modulator or transmitter and receiver, comprising a telephone transmitter 1M, a headset 1HS, a bypass condenser 1C3, inductances or loop antennas 1L2 and 1L4 tuned by condensers 1C1 and 1C2 and a diode detector 1V4. It will be understood that the components illustrated in Fig. 4 make up a single unit of the modulator and receiver illustrated as separate units in Figs. 2 and 3.

In our communication system, a radio frequency field is set up within the tank by means of the first stationary transmitter and modulation is accomplished by altering the absorption characteristics of a portable modulator. When a member of the tank crew talks into his microphone, the sound waves vary the resistance of the microphone which, in turn, alters the amount of power which the modulator unit absorbs from the radio frequency field. Consequently, this radio frequency field is absorptively modulated. It has been found possible to detect the modulation of this radio frequency field by means of a portable receiver such as that illustrated in Fig. 3. However, the low percentage of modulation produced by absorption alone makes the volume of the signal at the headset insufficient to over-ride any large amount of interference or extraneous noise.

We have, therefore, increased the volume at the headset by first detecting the modulation of the radio frequency field by means of a detector and an audio amplifier, illustrated in Figs. 1 and 5 by means of block diagrams. Then the output of the audio amplifier is used to modulate the output stage of a second radio frequency transmitter which operates on a different frequency from the first transmitter. This provides sufficient gain to modulate the second transmitter to around 100%. Fig. 6 illustrates the modulated radio frequency F1, modulated to a low degree, for example 3%, and Fig. 7 illustrates the modulated radio frequency F2, modulated to a substantially higher degree, for example 100%.

The loops L2 and L4 of the portable modulator and portable receiver may be included in one belt. Furthermore, the headset and microphone may be made up in a single unit which plugs into an apparatus compartment mounted on the wearer's belt.

In the operation of the system illustrated, the relative position of the portable loops L2 and L4 and the main loops L1 and L3 results in the portable modulator being coupled rather loosely to loop L1 so that any change in the resistance of the carbon button of microphone M, due to sound entering the microphone, shows up in a change in the apparent resistance of loop L1. Consequently, the radio frequency potential across the terminals of loop L1 is modulated by talking into the microphone and the field of loop L1 is modulated as a result. Condensers C4 and C5 of Fig. 5 serve as a voltage divider to provide the proper voltage for the remodulator. The detector of the remodulator circuit is tuned to frequency F1 and the audio frequency amplifier, together with modulator tube V2, acts as a conventional modulator to vary the plate and screen supply voltage of the output tube V3 of the plate modulated transmitter.

The plate modulated transmitter is driven by oscillator F2, operating at frequency F2, the amplifier consisting of pentode tube V3 operating as a class C amplifier (and which is plate modulated from the remodulator by way of conductor 11) and the loop L3 which is tuned by condenser 1C4.

It will be understood that the remodulator and the plate modulated transmitter may be omitted and still the system will operate although the signals are modulated at a very low degree and will be weak. We prefer to use the system illustrated in Fig. 1, since this provides exceptionally good signal strength.

In tests of this system, it was determined that satisfactory operation could be obtained by using conventional electronic oscillators for supplying frequencies F1 and F2, by using a 6F6 vacuum tube for tube V1 illustrated in Fig. 5 operating as a class A stage, by using a 6F6 tube operating in class C for tube V3 in Fig. 5 and by using a pair of 6L6 tubes in the output of a three stage audio frequency amplifier. It was further determined that frequency F1 could be 1100 kc. and frequency F2 could be 2200 kc. We do not wish to be limited to these specific values and devices, but cite them to show what was used in one actual operative specimen.

While a particular type of remodulator has been illustrated for increasing the degree of modulation, we have found that a modulation "booster" is especially adaptable for stepping up the degree of modulation. Such a "booster" modulator is shown in the pending application of Frank H. Slaymaker, Serial No. 432,052, filed February 23, 1942, and assigned to the same assignee as this invention.

Although we have illustrated and described only a single embodiment of our invention, numerous modifications in addition to those referred to, as well as additional advantages thereof, may be apparent to those skilled in the art. Our invention, therefore, is not to be limited except insofar as necessitated by the prior art and by the spirit of the appended claims.

What we claim is:

1. The method of communication which consists in generating a first radio frequency alternating current, radiating electro-magnetic waves of said first radio frequency from a radiator circuit, generating audio frequency signals, absorptively modulating said first radio frequency electro-magnetic waves by reflecting said audio signals into said radiator circuit, generating a second radio frequency alternating current, radiating electro-magnetic waves of said second radio frequency, modulating said second radio frequency as a function of said modulated first radio frequency, and receiving said audio frequency signals by demodulating the signals produced by the modulation of said second radio frequency.

2. In a wireless signalling system, a first source of high frequency energy, a first stationary antenna circuit tuned to the frequency of said first source, means for connecting said first source to said first stationary antenna circuit whereby high frequency electro-magnetic primary waves of the frequency of said first source are radiated, a portable antenna circuit coupled to said first stationary antenna circuit, means including a microphone for controlling the radio frequency electro-magnetic field of said first stationary antenna circuit by changing the resistance of said portable antenna circuit in accordance with audio frequency signals actuating said microphone whereby said primary waves are modulated, a second source of high frequency energy, a second stationary antenna circuit tuned to the frequency of said second source, means for connecting said second source to said second stationary antenna circuit whereby high frequency electro-magnetic secondary waves of the frequency of said second source are radiated, means controlled by said primary modulated waves for modulating said secondary waves, and means for demodulating and receiving said secondary waves.

3. In a wireless signalling system, a first source of high frequency energy, a first stationary antenna circuit tuned to the frequency of said first source, means for connecting said first source to said stationary antenna circuit whereby high frequency electro-magnetic primary waves of the frequency of said first source are radiated, a plurality of portable antenna circuits coupled to said first stationary antenna circuit, means including a plurality of microphones for controlling the radio frequency electro-magnetic field of said first stationary antenna circuit by changing the resistance of said portable antenna circuits in accordance with audio frequency signals actuating said microphones whereby said primary waves are modulated, a second source of high frequency energy, a second stationary antenna circuit tuned to the frequency of said second source, means for connecting said second source to said second stationary antenna circuit whereby high frequency electro-magnetic secondary waves of the frequency of said second source are radiated, means controlled by said primary modulated waves for modulating said secondary waves, and means for demodulating and receiving said secondary waves.

4. In a wireless signalling system, a first source of high frequency energy, a first stationary antenna circuit tuned to the frequency of said first source, means for connecting said first source to said first stationary antenna circuit whereby high frequency electro-magnetic primary waves of the frequency of said first source are radiated, a first portable antenna circuit tuned to the frequency of said first source and coupled to said first stationary antenna circuit, means including a microphone for controlling the radio frequency electro-magnetic field of said first stationary antenna circuit by changing the resistance of said first portable antenna circuit in accordance with audio frequency signals actuating said microphone whereby said primary waves are modulated, a second source of high frequency energy, a second stationary antenna circuit tuned to the frequency of said second source, means for connecting said second source to said second stationary antenna circuit whereby high frequency electro-magnetic secondary waves of the frequency of said second source are radiated, means controlled by said primary modulated waves for modulating said secondary waves, means including a second portable antenna circuit for demodulating said secondary waves, and means for receiving said demodulated secondary waves.

5. In a wireless signalling system, a first source of high frequency energy, a first stationary antenna circuit tuned to the frequency of said first source, means for connecting said first source to said first stationary antenna circuit whereby high frequency electro-magnetic primary waves of the frequency of said first source are radiated, a first portable antenna circuit tuned to the frequency of said first source and coupled to said first stationary antenna circuit, means including a microphone for controlling the radio frequency electro-magnetic field of said first stationary antenna circuit by changing the resistance of said first portable antenna circuit in accordance with audio frequency signals actuating said microphone whereby said primary waves are modulated, a second source of high frequency energy, a second stationary antenna circuit tuned to the frequency of said second source, means for connecting said second source to said second stationary antenna circuit whereby high frequency electro-magnetic secondary waves of the frequency of said second source are radiated, means

controlled by said primary modulated waves for modulating said secondary waves to a higher degree than said primary waves, means including a second portable antenna circuit for demodulating said secondary waves, and means for receiving said demodulated secondary waves.

6. In a modulating system, a first antenna circuit supplied by a source of energy of a first radio frequency, a second antenna circuit supplied by a source of energy of a second radio frequency, a first and a second inductive means respectively coupled to said first and said second antennas, means for tuning said first antenna and said first inductive means to said first radio frequency, means for tuning said second antenna and said second inductive means to said second radio frequency, a portable telephone set, comprising a telephone transmitter and a telephone receiver, means including said telephone transmitter and said first inductive means for reflectively varying the apparent resistance of said first antenna circuit whereby modulated waves of said first radio frequency are transmitted, means for modulating said second radio frequency energy by said modulations of said first radio frequency whereby a higher degree of modulation is effected, means including said second antenna circuit for transmitting remodulated waves of said second radio frequency, and means including said telephone receiver and said second inductive means for receiving said remodulated waves to the exclusion of said modulated waves.

7. In combination, a first antenna circuit and a second antenna circuit respectively supplied with radio frequency currents of a first frequency and a second frequency, means for inter-connecting said antenna circuits, means inductively coupled to said first antenna circuit for absorptively modulating said first radio frequency currents in accordance with signals to be transmitted, means including a vacuum tube amplifier and said second antenna circuit for transmitting currents of said second radio frequency, and means for varying the output of said vacuum tube amplifier as a function of the modulated first radio frequency currents whereby remodulated radio frequency waves corresponding to said signals are transmitted.

8. In combination, a first antenna circuit and a second antenna circuit respectively supplied with radio frequency currents of a first frequency and a second frequency, means for inter-connecting said antenna circuits, means inductively coupled to said first antenna circuit for absorptively modulating said first radio frequency currents in accordance with signals to be transmitted, means including a vacuum tube amplifier and said second antenna circuit for transmitting currents of said second radio frequency, means for varying the output of said vacuum tube amplifier as a function of the modulated first radio frequency currents whereby remodulated radio frequency waves corresponding to said signals are transmitted, and means including a vacuum tube detector for receiving said signals.

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