April 29, 1947. H. E. GRIMES 2,419,833

ANTENNA ARRANGEMENT FOR AN INDUCTION COMMUNICATION SYSTEM

Filed Dec. 12, 1945 4 Sheets-Sheet 1

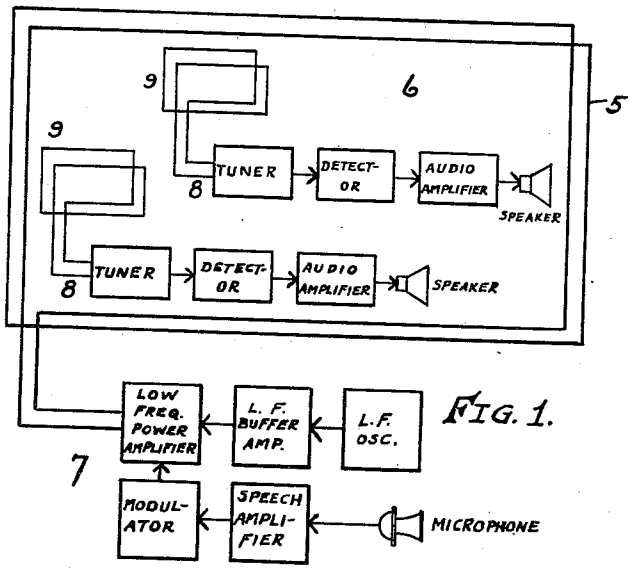

FIG. 1.

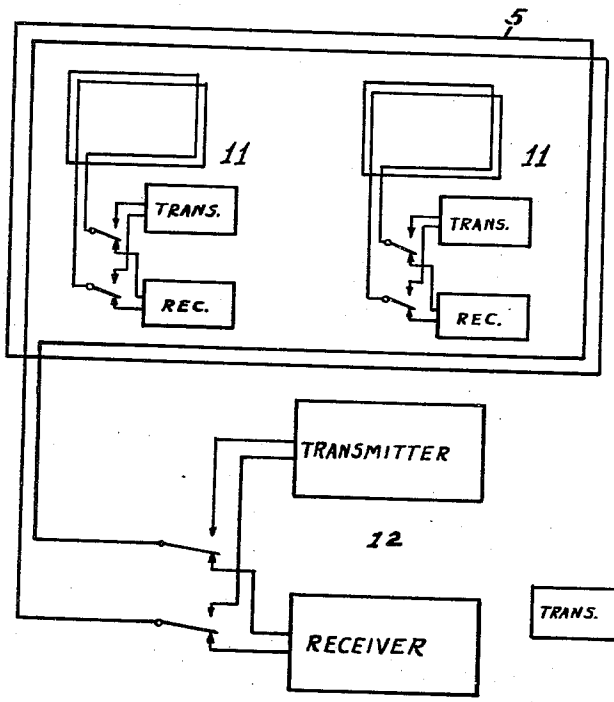

FIG. 2.

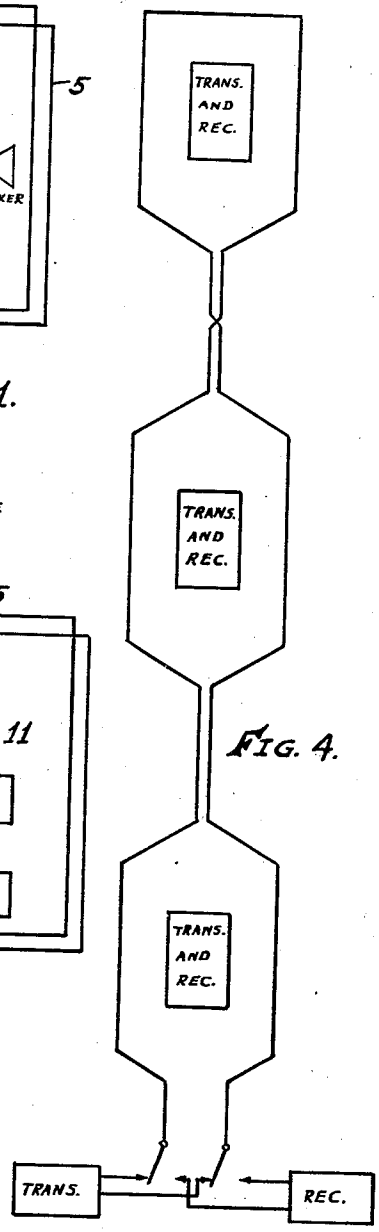

FIG. 4.

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April 29, 1947. H. E. GRIMES 2,419,833

ANTENNA ARRANGEMENT FOR AN INDUCTION COMMUNICATION SYSTEM

Filed Dec. 12, 1945 4 Sheets-Sheet 2

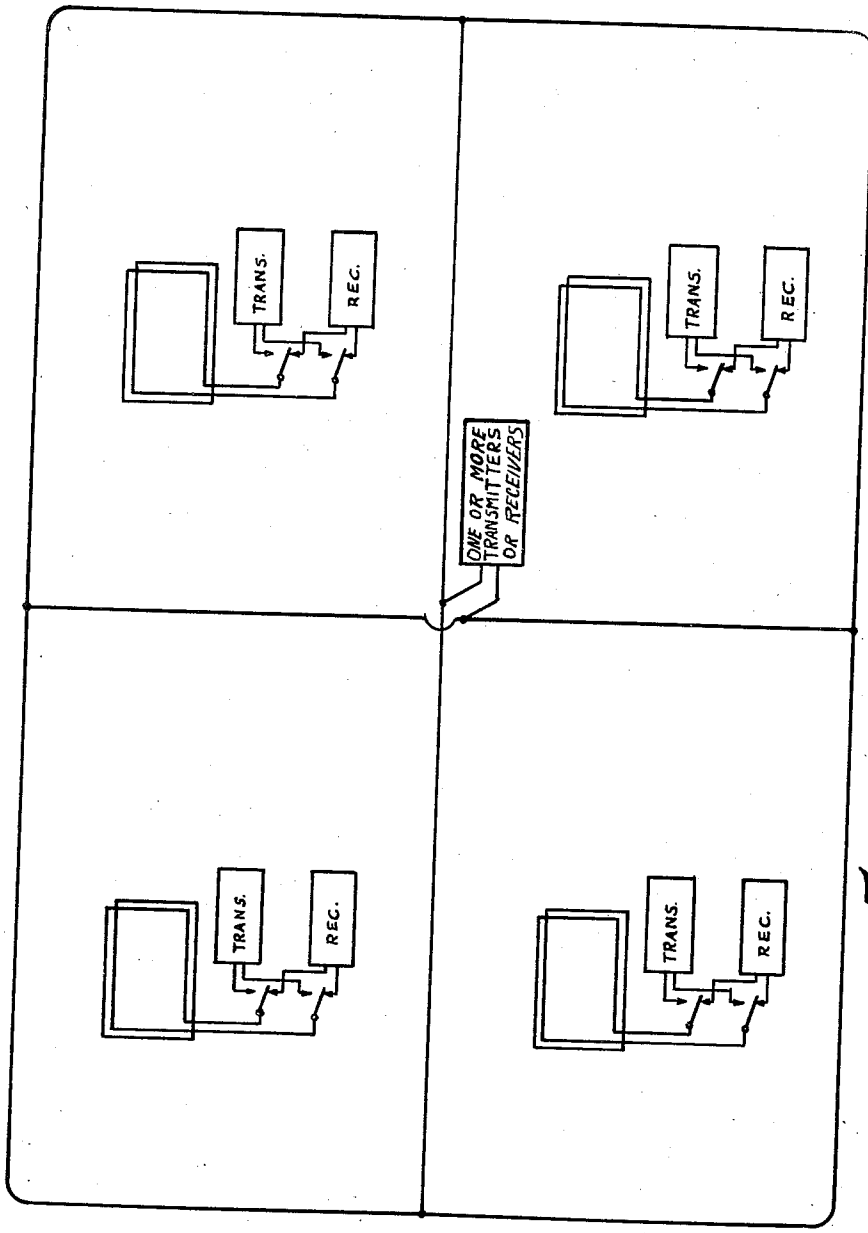

FIG. 3.

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April 29, 1947. H. E. GRIMES 2,419,833

ANTENNA ARRANGEMENT FOR AN INDUCTION COMMUNICATION SYSTEM

Filed Dec. 12, 1945 4 Sheets-Sheet 3

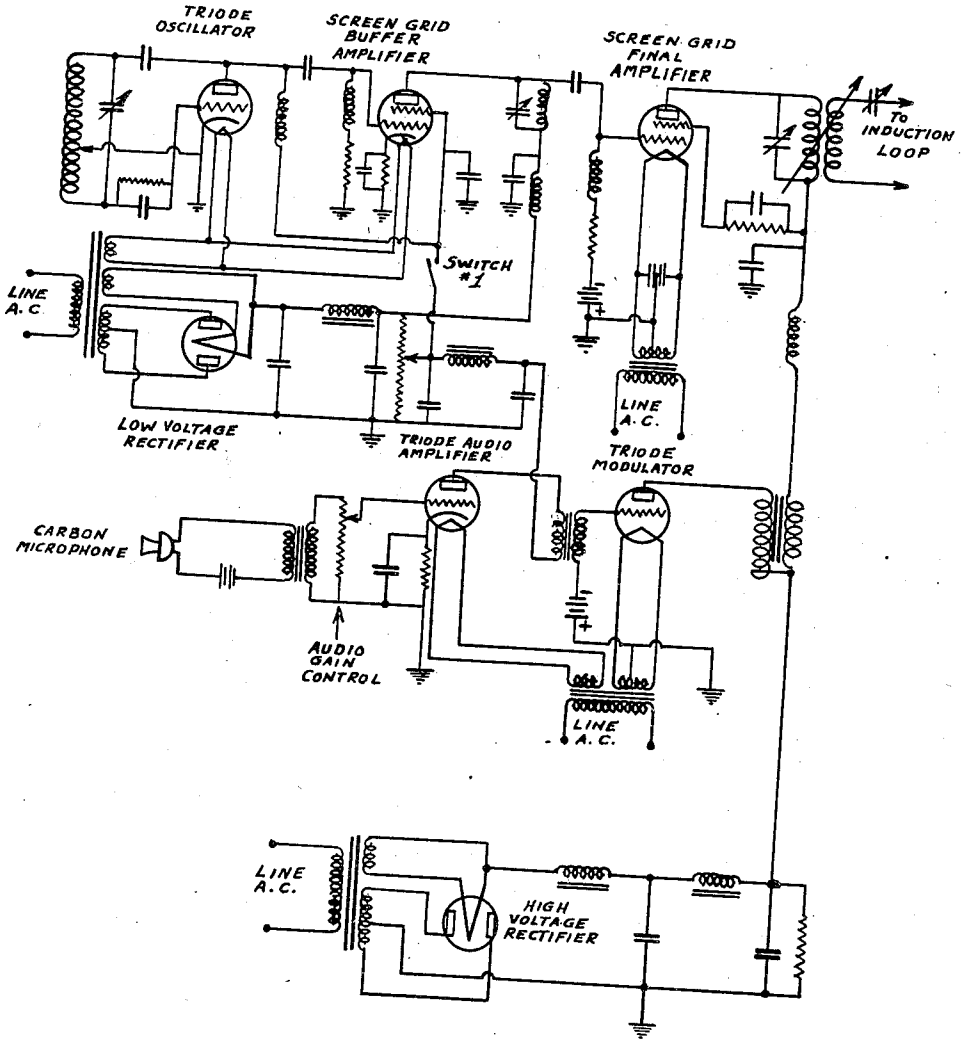

FIG. 5.

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ANTENNA ARRANGEMENT FOR AN INDUCTION COMMUNICATION SYSTEM

Filed Dec. 12, 1945 4 Sheets-Sheet 4

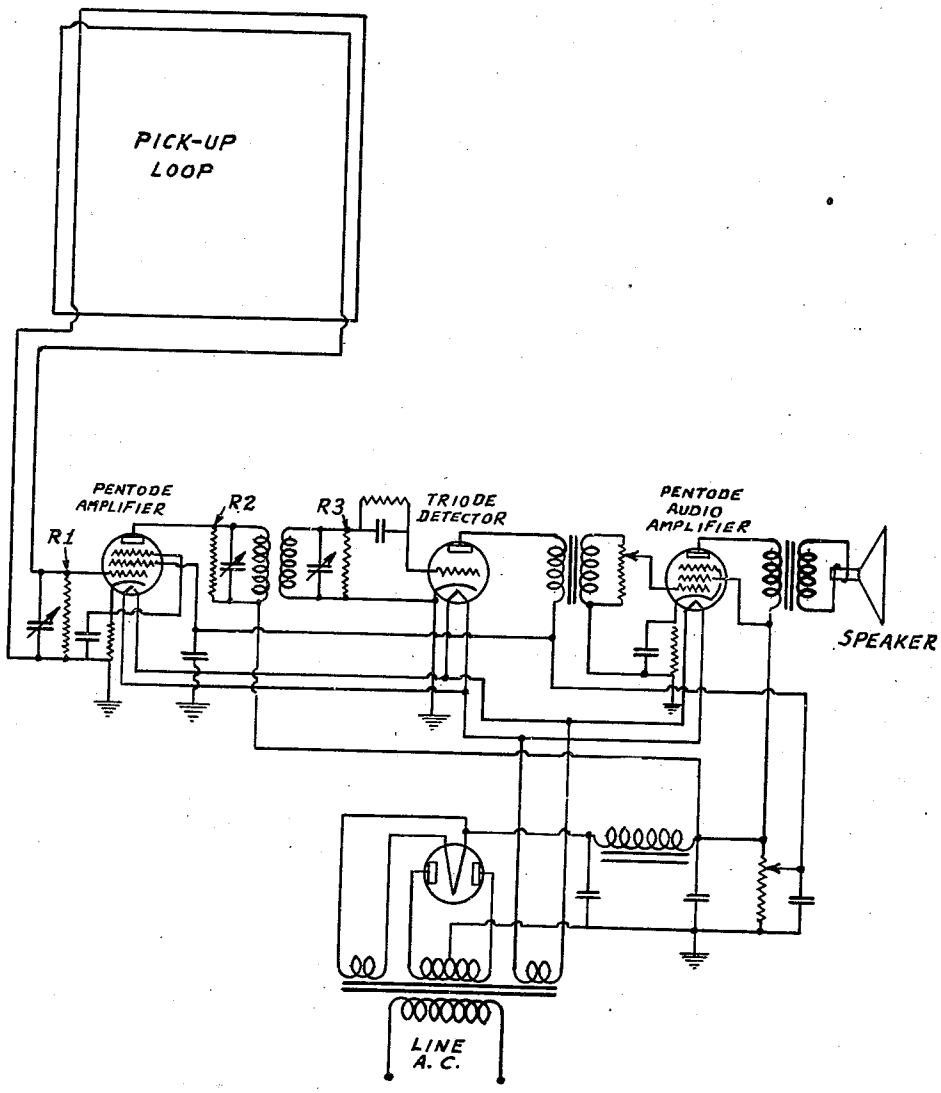

FIG. 6.

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Patented Apr. 29, 1947

2,419,833

UNITED STATES PATENT OFFICE

2,419,833

ANTENNA ARRANGEMENT FOR INDUCTION COMMUNICATION SYSTEMS

Harlan E. Grimes, Bromley, Ky.

Application December 12, 1945, Serial No. 634,553

1 Claim. (Cl. 179—82)

1

My invention relates to a communication system in which induction, as distinguished from radiation, is used for transmitting voice or other sound waves within a limited area such as that of a small town or one or more sections of a larger town or city.

In carrying out my invention, I encircle or surround the area of the town within which the induction lines of force are to be effective by a loop of wire or wires, preferably hung on poles, like open telephone wires. A low frequency oscillator of the range of 8 to 10 kilocycles is connected with the wire loop to produce a carrier magnetic wave upon which voice or sound waves are superimposed. Within the loop the induction lines of force extend vertically or nearly so but expand horizontally or nearly so and may be picked up by any number of receiving sets, each having a substantially vertical axis coil which the lines of force traverse. The energy picked up by the coil is amplified and rectified with the same type of receiving mechanism as is ordinarily used in receiving radiation energy. The difference between the radiation field and the induction field is that the strength of the radiation field at any point is about inversely proportional to the distance from the source, whereas the strength of the induction field at any point is inversely proportional to the cube of the distance from the conductor of the loop. The result of this is that the induction field becomes negligible a very short distance outside the loop.

If the small receiving loop is located either within or outside the large transmitting loop and far enough away from the conductors of the transmitting loop that the inductive lines of force from the conductors of the transmitting loop extend substantially vertically, then the only inductive effect in the smaller receiving loop results from the difference between the number of lines of force which cut the side of the small loop nearest the conductors of the large loop and the number of lines of force which cut the side of the small loop further away from the conductors of the large loop and it is therefore because the inductive effect diminishes so rapidly that effective current is generated in the small loop.

If the area to be served by a single transmitting station is greater than can be adequately served by a single loop, the area may be divided into squares or other shapes, each area surrounded by one or more conductors, the current being sent around adjacent loops thus created in opposite directions so that the induction lines of force will momentarily travel in opposite directions in adjacent loops.

2

My invention is illustrated in the accompanying drawing, in which

Fig. 1 represents an area surrounded by a loop connected only to a transmitter, there being only one or more receivers within the loop.

Fig. 2 represents an area surrounded by a loop, there being both a transmitter and receiver arranged to connect directly with the loop, and there being within the loop one or more transmitters and one or more receivers so that two-way communication may be had.

Fig. 3 represents an area divided into four sub-areas, each surrounded by a loop with one or more transmitters and receivers for conductively energizing or receiving energy from all of the loops, and one or more receivers and transmitters within each of the loops.

Fig. 4 represents three areas separated from one another and connected by wires located so close together that one conductor cancels the inductive effect of the other.

Fig. 5 is a diagrammatic illustration of a transmitter suitable for use in my communication system, and

Fig. 6 is a diagrammatic illustration of a receiver suitable for use in my communication system.

With reference to Fig. 1, the loop **5**, preferably supported on poles, surrounds an area **6**, which may be a small town or village. The ends of the loop **5** are connected with a transmitter **7**, a type of which is illustrated in Fig. 5, comprising a low frequency oscillator for producing carrier oscillations of about 8 to 10 kilocycles per second. The transmitter includes a low frequency buffer amplifier, a low frequency power amplifier, a microphone, a speech amplifier and a modulator by means of which sound frequencies are impressed upon the carrier frequencies. Within the area **6** any number of receiving sets **8**, a type of which is illustrated in Fig. 6, may be used, each provided with a loop **9**, positioned with a vertical axis, and having its ends connected with a tuner by means of which the desired induction frequency is selected. The receiver also includes a detector for eliminating the effect of one-half of the carrier wave, an audio amplifier for amplifying the audio frequencies, and a speaker for translating electrical energy into sound.

In the operation of the system shown in Fig. 1, the low frequency oscillator, the low frequency

buffer amplifier and the low frequency power amplifier send out onto the loop 5 a somewhat powerful current of a frequency in the neighborhood of 8 to 10 kilocycles per second. The amplitude of the current waves is modulated by the superimposed sound waves received in the microphone, amplified in the speech amplifier, and impressed upon the low frequency power waves by the modulator. Throughout the entire area 6, within the loop 5, magnetic lines of force are created which alternate in direction, passing first upwardly and then downwardly as they expand within the loop, and at the same instant, downwardly and then upwardly as they expand outside the loop. The strength of the induction field diminishes away from the conductor or conductors of the loop inversely as the cube of the distance from the conductor or conductors, but since within the loop each area is surrounded by conductors, the diminution of the field is much less than it is outside the loop. Consequently, the loop 5 may be made of such size that its induction energy may be received throughout the whole of the enclosed area, whereas the induction field outside the loop will become negligible at a distance away equal to half the breadth of the loop. If the loop is circular, the energy at the center of the loop is four times as great as the energy at the distance of the radius of the circle outside the loop. Consequently, if no more power is put into the loop than is necessary for its reception at the center of the loop, it cannot be received at all at a distance of the radius of the loop away from the loop. If the system is to be used for police calls within a town, the loop can be located slightly within the town limits, and receivers can thus be used within the town limits, but not materially beyond the town limits. Since vertical axis loops are used for picking up the induction currents, the direction in which an automobile carrying a receiving set is facing has no effect upon the strength of the received energy. Theoretically, there is a spot directly under the wires of the loop where the lines of force would extend horizontally and expand downwardly and therefore would have no inductive effect upon a loop carried horizontally on an automobile, but if the poles on which the loop is supported are not placed directly along and over the roadway on which the automobile is to travel, no material dead spots will be encountered. This is particularly true because the strength of the magnetic lines increase so rapidly as the conductors of the loop are approached that the inductive effect upon the loop carried by the automobile will be sufficient to provide the necessary energy for amplification even though the receiver loop is almost directly under the conductor of the large loop.

Many slightly differing frequencies can be impressed upon the surrounding loop and any one of these frequencies can be tuned for and picked up and amplified the same as with radiation frequencies.

As illustrated in Fig. 2, the movable instrument 11 within the loop 5 is provided with both a receiver and transmitter, and the main instrument 12 for energizing the conductors of the loop 5 is likewise provided with both a transmitter and a receiver. With this arrangement, two-way conversations may be carried on between portable instruments within the loop 5 and stationary instruments outside of the loop 5. When desired, a number of different frequencies can be used so that a plurality of transmitters sending out different frequencies can be simultaneously used for transmitting to different receivers tuned to different frequencies. In Fig. 4 I have illustrated areas remote from one another connected together by conductors which are so twisted or transposed that the inductive effect of one conductor neutralizes that of another. If the conductors do not lie too close to other conductors they need not be twisted or transposed since the mere fact that they lie in proximity to one another neutralizes the inductive field around the conductors in which, of course, current is simultaneously traveling in opposite directions.

No detailed description is necessary for the illustrations of Figs. 5 and 6 since these merely represent typical types of transmitters and receivers.

Although I have illustrated several applications of my invention, it is to be understood that I do not wish to be unduly limited thereto, other modifications and applications being possible without departing from the spirit or scope of my invention.

I claim:

In a communication system, a plurality of vertical axis stationary loops surrounding a plurality of separated inhabited areas, the conductors of each loop being serially connected with the conductors of each other loop by wires lying so close to one another as to constitute a non-inductive connection between the loops, one or more vertical axis loops within each of the interconnected loops, transmitter mechanism associated with certain of the smaller loops for producing an inductive field within one of the larger loops and receiver mechanism associated with certain of the smaller loops to receive inductive energy from the larger loops.

HARLAN E. GRIMES.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,446,385	Hanson	Feb. 20, 1923
2,122,145	Rear et al.	June 28, 1938
2,252,641	Poliakoff et al.	Aug. 12, 1941