

July 5, 1927.

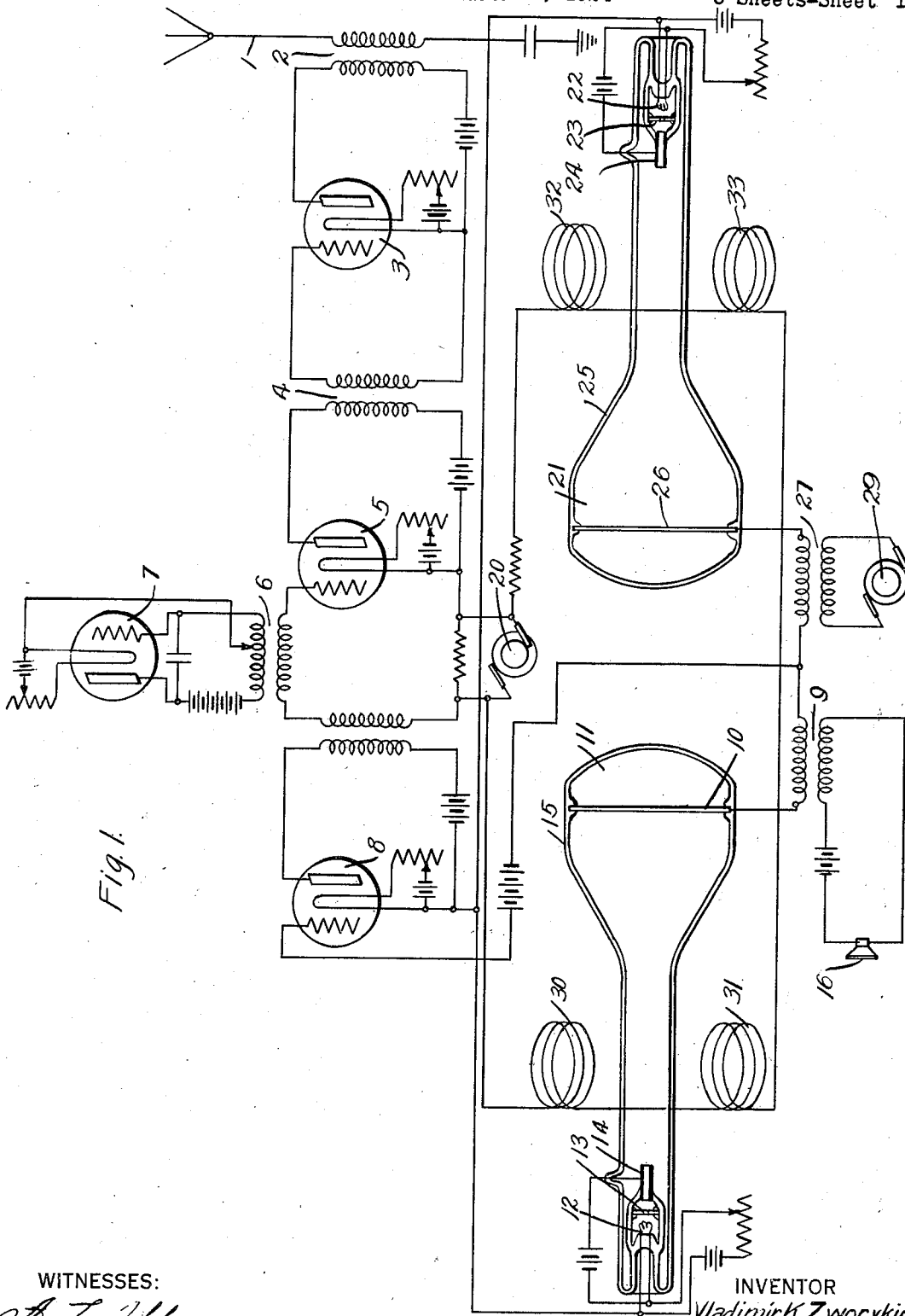
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1,634,390

WIRELESS TRANSMITTING SYSTEM

Filed March 17, 1924

5 Sheets-Sheet 1



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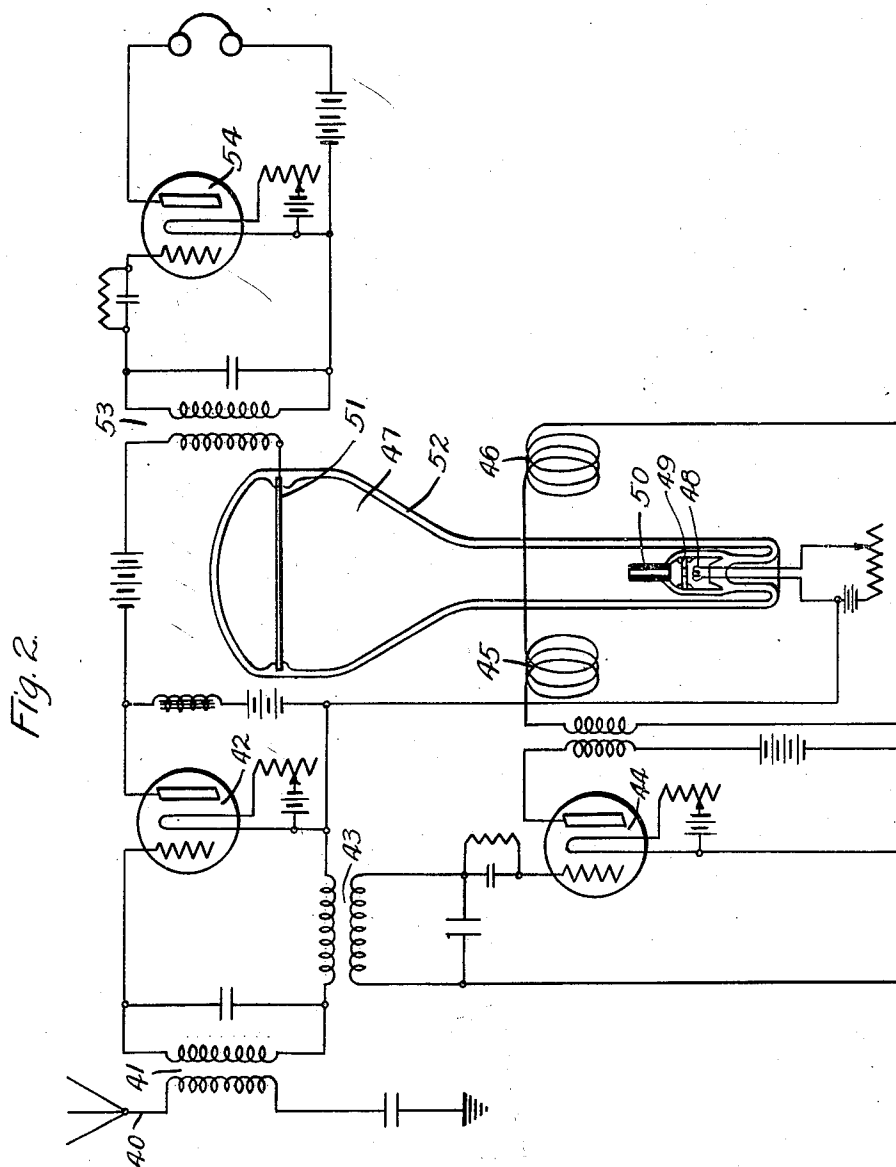
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WIRELESS TRANSMITTING SYSTEM

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5 Sheets-Sheet 2



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WIRELESS TRANSMITTING SYSTEM

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5 Sheets-Sheet 3

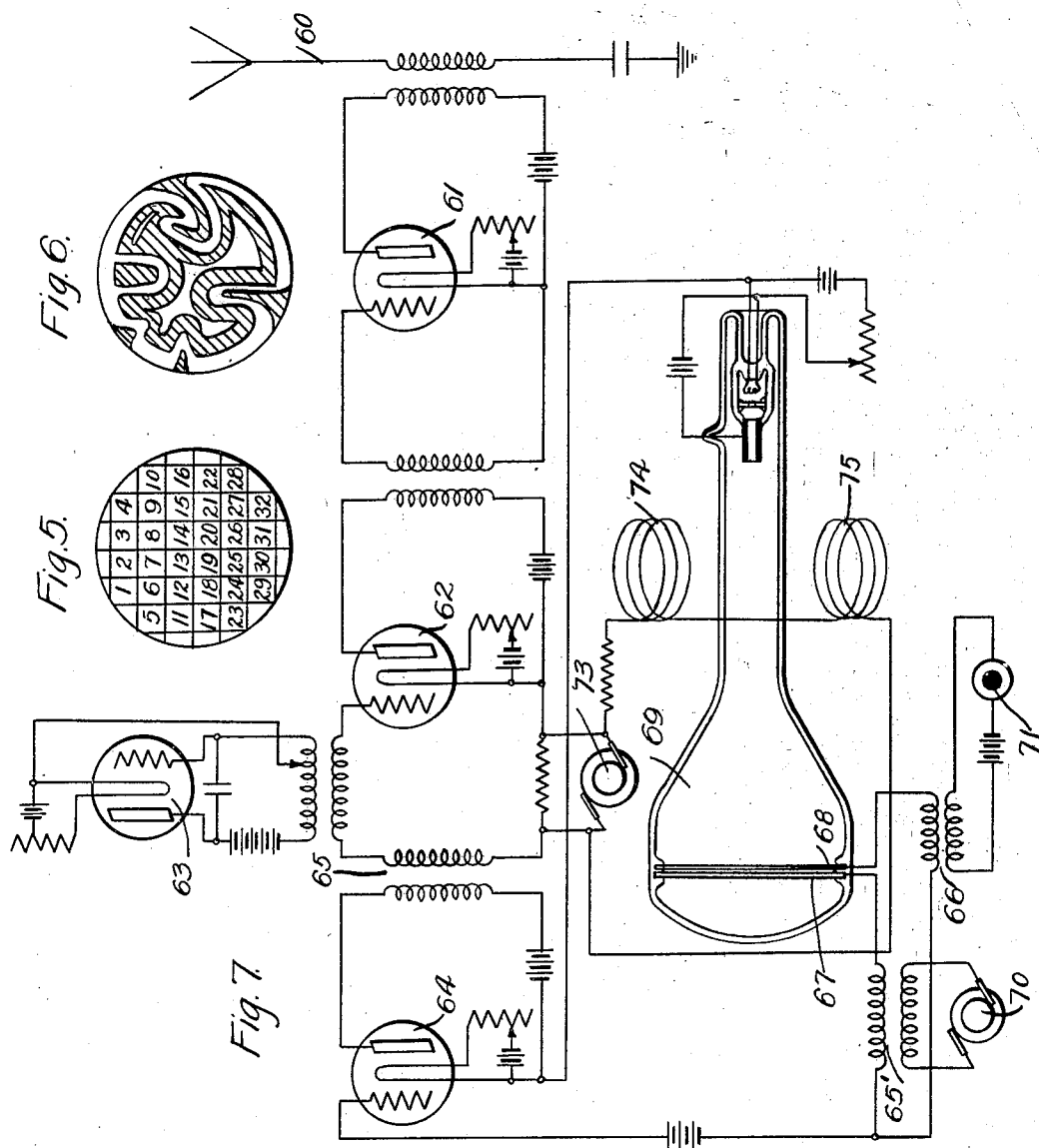


Fig. 6.

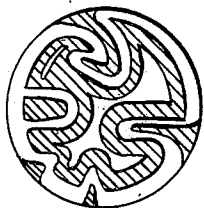


Fig. 5.

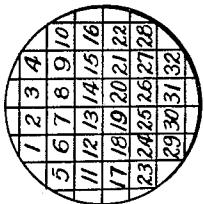


Fig. 7

Fig. 3.

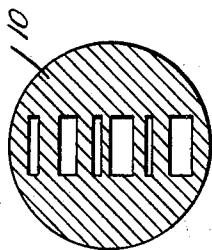
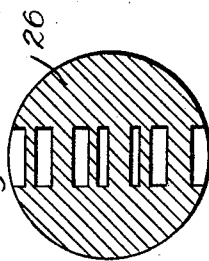


Fig. 4.



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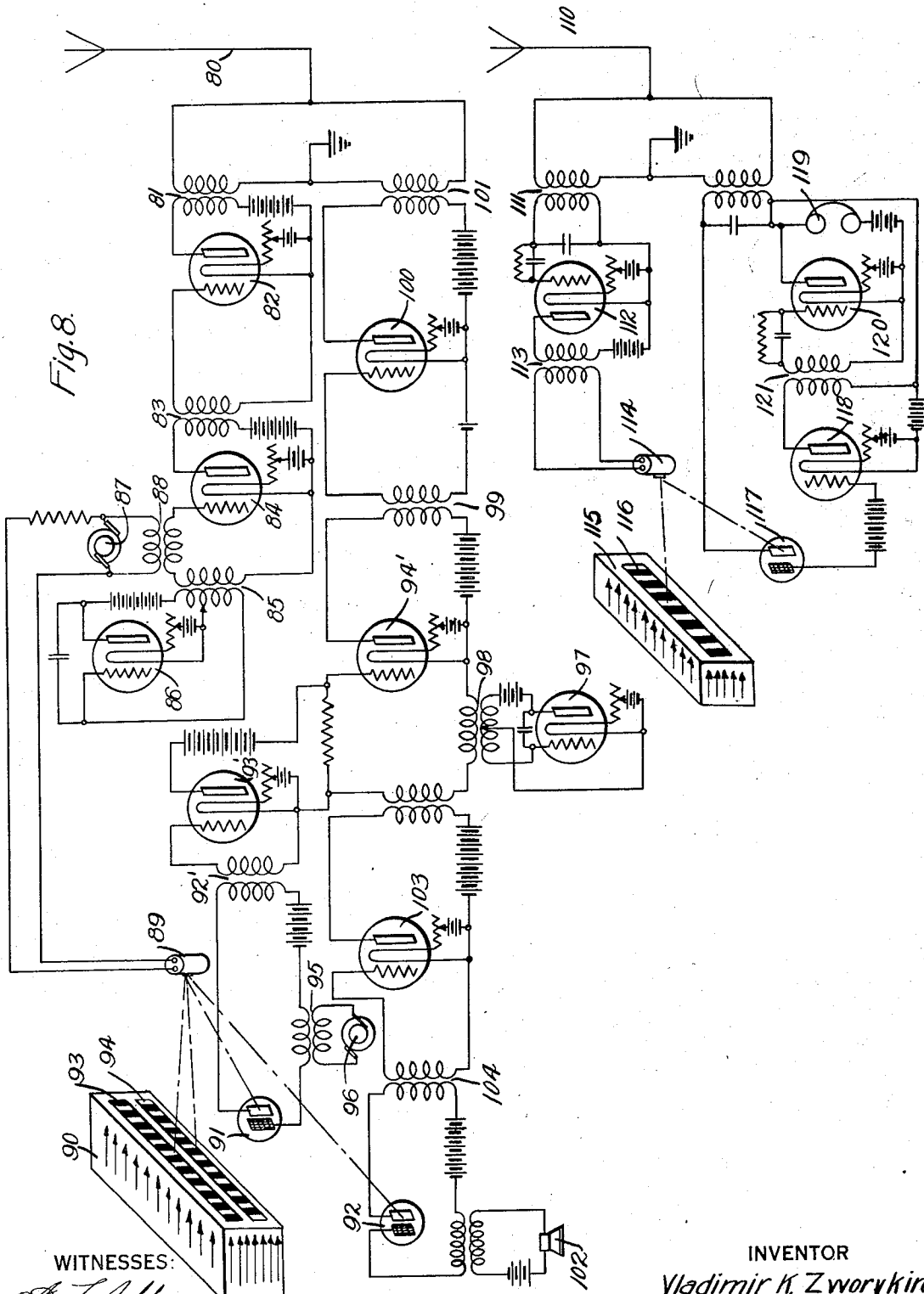
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WIRELESS TRANSMITTING SYSTEM

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Fig. 8.



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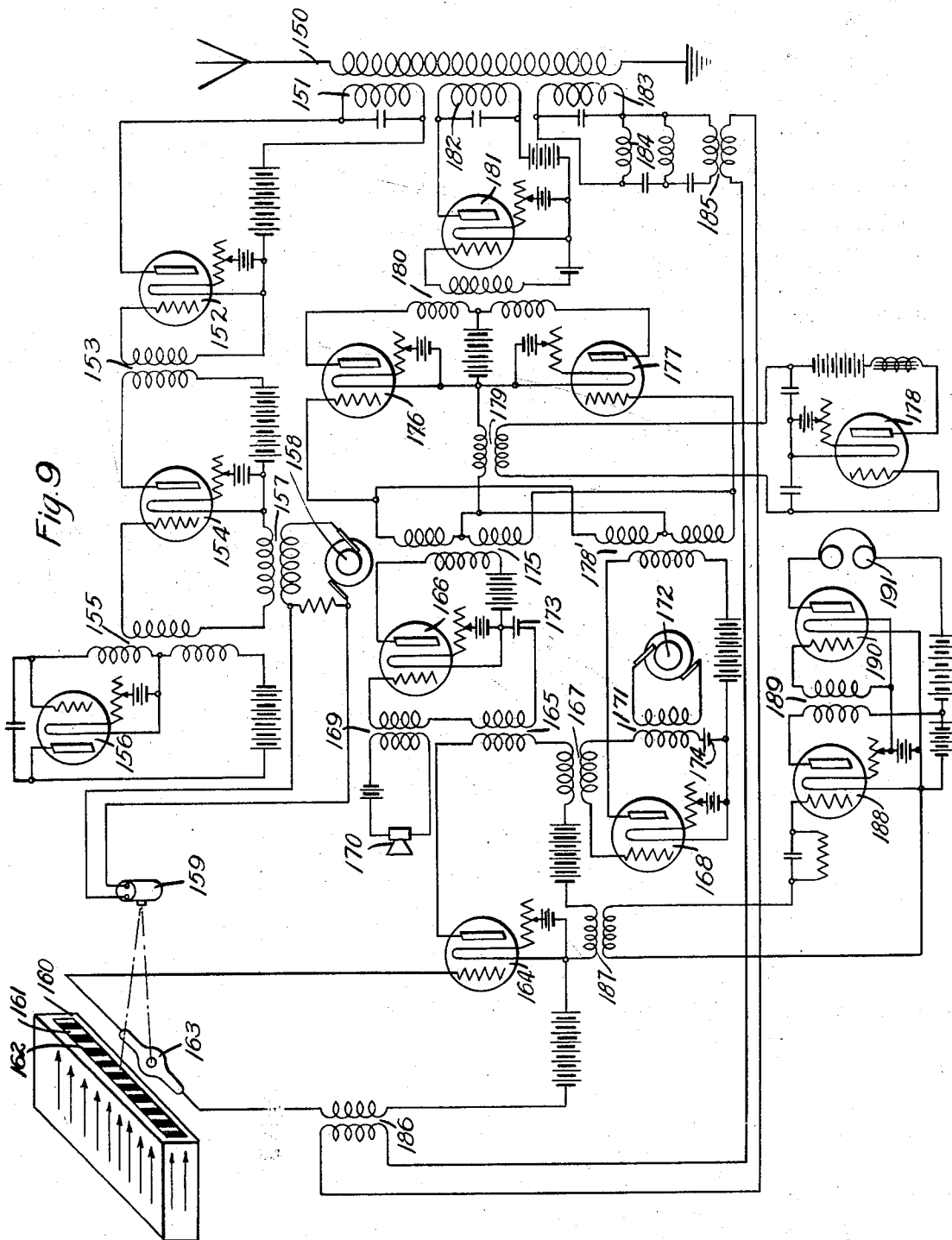
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WIRELESS TRANSMITTING SYSTEM

Filed March 17, 1924

5 Sheets-Sheet 5



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WIRELESS TRANSMITTING SYSTEM.

Application filed March 17, 1924. Serial No. 699,629.

My invention relates to wireless transmitting systems and particularly to secret signalling systems.

One object of my invention is to provide a secret signalling wireless system whereby it is absolutely impossible for any stations other than those predetermined to receive the radiated signals.

Another object of my invention is to so arrange the transmitting circuits in a system of the above-indicated character that the transmitting station radiates, in addition to the signalling frequency, a "masking" frequency that is inaudible at a predetermined receiving station or stations, but which indiscriminately obliterates the speech frequency at stations that attempt to listen in on the signalling.

Still another object of my invention is to accomplish the above results in a relatively simple manner without the use of a large amount of apparatus.

The above and other objects of my invention will be described hereinafter with reference to the accompanying drawings.

Referring now to the drawings,

Figure 1 is a diagrammatic view of the circuits and apparatus at the transmitting station;

Fig. 2 is a diagrammatic view of the circuits and apparatus of the equipment located at a receiving station;

Figs. 3, 4, 5 and 6 are detail views of portions of the apparatus at the transmitting station;

Fig. 7 is a view of a modified form of transmitting equipment for securing the same results as the apparatus shown in Fig. 1, and

Fig. 8 is a diagrammatic view of the circuits and apparatus of a transmitting and receiving station whereby secret signalling is accomplished in a different manner than in the previous figures.

Fig. 9 is a diagrammatic view of the circuits and apparatus of a combined transmitting and receiving station in which certain portions of the apparatus are common to both the transmitting and receiving devices.

Essentially, my invention consists in a transmitting station, shown in Fig. 1, and a receiving station, Fig. 2. At the transmitting station, a synchronizing current of a

predetermined frequency is generated, which serves to intermittently interrupt the radiation of the signalling current and causes, during such interruptions, a so-called "masking" current to be radiated. At the receiving station, both the signalling current and the "masking" current are received, as well as the synchronizing current. The synchronizing current controls the receiving device so that it serves only to detect the signalling current.

Referring now more particularly to Fig. 1, the oscillating circuit including the antenna 1 is connected through a transformer 2 to the output circuit of an amplifier triode 3. The grid circuit of the amplifier triode 3 is connected through a transformer 4 to the plate circuit of a modulator triode 5. The grid circuit of the modulator triode 5 is connected through a transformer 6 to a circuit that is adapted to generate an oscillating current and which includes an oscillator triode 7. The grid circuit of the modulator triode 5 is also connected to an amplifier triode 8. The grid circuit of the amplifier triode 8 is connected through the secondary winding of a transformer 9 to a metal plate 10 in a cathode-ray tube 11.

The cathode-ray tube 11 is similar to an ordinary cathode-ray oscillograph and has a hot cathode 12, a diaphragm 13 and a tubular anode 14 enclosed in an evacuated container 15, the opposite end of which is occupied by the plate 10. The primary winding of the transformer 9 is connected in circuit with a microphone 16 of the usual type. A generator 20 that generates a current of predetermined frequency, which will be referred to as the operating frequency current, is also connected in the grid circuit of the modulator triode 5 and serves to modulate the oscillating current generated by the oscillatory circuit including the oscillator triode 7, and this modulated high-frequency oscillating current is amplified by the amplifier triode 3 radiated by the antenna 1.

Another cathode-ray tube 21, having the usual hot cathode 22, diaphragm 23, tubular anode 24, evacuated container 25 and metal plate 26, also has its metal plate 26 connected in the grid circuit of amplifier triode 8 through the secondary winding of a transformer 27. The primary winding of this

transformer is connected in circuit with a generator 29 that generates a current having a variable audio frequency. This generator may take any well known form in order to produce a constantly varying audible frequency.

The construction of the metal plates 10 and 26 may be seen in detail in Figs. 3 and 4. It will be seen that the metal plate 10 has a number of rectangular holes cut therein and that the metal plate 26 also has a number of rectangular holes. The holes in the plate 26 are so cut with respect to the holes in the plate 10 that the uncut portions of the plate 10 are the ones that are cut from plate 26. Thus, the plate 10 may be considered the positive, and the plate 26 the negative, using the terms used in photography.

Coils 30 and 31 and 32 and 33 are associated with the cathode-ray tubes 11 and 21, respectively. These coils are so positioned with respect to the cathode-ray tubes 11 and 21 that their magnetic field lies in a plane that is perpendicular to the line of the holes across either of the plates 10 and 26.

At the receiving station, Fig. 2, an oscillatory circuit, including an antenna 40, is connected through a tuning coil 41 to the grid of an amplifier triode 42. The grid of this amplifier triode 42 is also connected through a transformer 43 to the grid of a detector triode 44. The transformer 43 is adapted to receive current of the particular frequency sent out by the high-frequency current generator 20 from the circuit. The plate of the detector triode 44 is connected to plates 45 and 46 placed in a cathode-ray tube 47. The cathode-ray tube 47 is somewhat similar to the transmitting cathode-ray tubes previously described and has a hot cathode 48, a diaphragm 49, a tubular anode 50 and a plate 51, the whole being enclosed in an evacuated vessel 52. The plate 51 has a number of holes cut in it which are exact duplicates in both position and size of the holes cut in the plate 10. The plate of the amplifier triode 42 is connected through the primary winding of a transformer 53 to the plate 51 in the cathode ray tube 47. The secondary winding of this transformer is connected to the grid of the detector triode 54, the plate circuit of which is connected to the telephone receiving device which, as shown, may be any kind of a speech receiving or recording device.

The modification of the transmitting circuit shown in Fig. 7 comprises an oscillatory circuit including an antenna 60. This oscillatory circuit is connected through an amplifier triode 61 and a modulator triode 62 to a circuit that is adapted to generate an oscillating current and which includes an oscillator triode 63. The grid circuit of the amplifier triode 62 is also connected in cir-

cuit with the amplifier triode 64 through a transformer 65. The grid circuit of the amplifier triode 64 is connected through the secondary windings of the transformers 65 and 66 to metal plates 67 and 68 in a cathode-ray tube 69. The primary winding of the transformer 65 is connected in circuit with a variable frequency generator 70 and the primary winding of the transformer 66 is connected in the circuit of a telephone transmitter 71.

The cathode-ray tube 69 is similar to the cathode-ray tubes previously described, with the exception that its two metal plates 67 and 68 are located adjacent, but insulated from, each other. In this case, the openings in the plates 67 and 68 are so cut that one is positive and one is negative, in the same manner as before mentioned. That is, assuming that the cathode beam traverses these plates in the direction in which the openings are cut, the cathode beam will first encounter the metal plate 67, then the metal plate 26, etc.

A generator 73 is also associated with the amplifier triode 62, and, as heretofore explained, is adapted to generate an alternating current having a frequency above audibility, for example, of substantially 25,000 cycles. Coils 74 and 75 associated with the cathode-ray tube 69 are connected in circuit with the generator 73. The coils 74 and 75 are so positioned with respect to the openings in the plates 67 and 68 that the magnetic fields generated by current traversing the same will lie at right angles to the line of the openings in either the plate 67 or the plate 68.

The plate shown in Fig. 6 illustrates a manner in which non-uniform holes may be cut in plates, such as 10, 26, 67 or 68, so as to secure still further "masking" of the message or signal to be transmitted. The plate that is adapted to operate in connection with the plate shown in Fig. 6 will be a positive of the one shown.

In Fig. 5 is shown a plate marked into divisions, thirty-two in number, which may be used for a coding plate in a manner that will be described hereinafter.

In Fig. 8, an oscillatory circuit, including an antenna 80, is adapted to oscillate at two distinct frequencies. This circuit is connected through a transformer 81 to an amplifier triode 82. The grid circuit of the amplifier triode 82 is connected through a transformer 83 to a modulator triode 84. The grid circuit of the modulator triode 84 is connected through a transformer 85 to a circuit that is adapted to generate an oscillating current and which includes an oscillator triode 86. The grid circuit of the modulator triode 84 is also connected through a transformer 88 to a generator 87 that generates a current of operating fre-

quency. The generator 87 that generates the operating frequency current is also connected to an oscillograph element 89. The oscillograph element 89 may be of any ordinary type, and its mirror is adapted to scan the lens 90 and to divert the rays coming therefrom upon photoelectric cells 91 and 92.

Considering the lens 90, this lens is made up of two distinct light transmitting sections 93 and 94. The section 93 is broken up non-uniformly by opaque markings. The section 94 is also broken up, at varying distances, with opaque markings, these distances being so determined that the section 93 may be considered positive and the section 94 may be considered negative.

By reason of the difference in position between the sections 93 and 94, the angle at which the light strikes the oscillograph mirror is different in the one case than in the other and, consequently, the light rays from the section 93 are deflected on the photoelectric cell 92, while the light rays from the section 94 are deflected on the photoelectric cell 91.

The photoelectric cell 91 is so positioned with respect to the oscillograph 89 that the light rays reflected from the various parts of the section 94 will always fall upon the photoelectric cell 91. This is accomplished by so placing the photoelectric cell that the angle of turning of the oscillograph element 89 from one light transmitting section to the next is equal to the angle of its turning with respect to the photoelectric cell 91. The photoelectric cell 92 is similarly positioned to receive the light from the parts of the section 93.

The photoelectric cell 91 is connected through a transformer 92' to an amplifier triode 93'. The amplifier triode 93' is connected to the grid of a modulator triode 94'. The photoelectric cell 91 is also connected through a transformer 95 to generator 96 that is adapted to generate current of a variable audio frequency. The grid of the modulator triode 94' is also connected to a circuit that is adapted to generate an oscillating current and which includes an oscillator triode 97, through a transformer 98. The output circuit of the modulator 94' is connected through a transformer 99 to an amplifier triode 100. The output circuit of the amplifier triode 100 is connected through a transformer 101 to the antenna 80. The photoelectric cell 92 is connected in circuit with a telephone transmitter 102 and with an amplifier triode 103 through a transformer 104. The output circuit of the amplifier triode 103 is also connected to the grid of the modulator triode 94'.

At the receiving station, an antenna 110 is connected through a transformer 111 to a detector triode 112. The output circuit of

the detector triode 112 is connected through a transformer 113 to an oscillograph element 114. The oscillograph element may be similar to the oscillograph 89, previously described. The oscillograph element 114 is adapted to scan a lens 115 which is provided with a light transmitting section 116 that is divided into a series of parts. The number and relative position of these parts in the lens 115 are the exact duplicate of the light transmitting parts in the section 93 of the lens 90 at the transmitting station.

The rays of light from the light transmitting parts of the section 116 are adapted to fall upon a photoelectric cell 117. The photoelectric cell 117 is connected in circuit with an amplifier triode 118. The photoelectric cell 117 is also connected through a transformer 119 to the antenna 110. The output circuit of the amplifier 118 is inductively associated with a detector triode 120 through a transformer 121. The output circuit of the detector triode 120 is connected to a pair of head phones, or other receiving device.

The photoelectric cell 117 is so positioned with respect to the oscillograph 114 that, as the oscillograph moves on its axis, the light from the various parts of the lens 115 will always fall upon the photoelectric cell 117. This may be accomplished by having the light transmitting part 116 of the lens 115 so arranged that movement of the oscillograph, so as to reflect light from another part, is equal to the angle between the photoelectric cell and the oscillograph mirror.

In Fig. 9, an oscillatory circuit, including the antenna 150, is connected through a tuning coil 151 to the plate circuit of the amplifier triode 152. The grid circuit of the amplifier triode 152 is connected through a transformer 153 to the plate circuit of the modulator triode 154. The grid circuit of the modulator triode 154 is connected through a transformer 155 to a circuit adapted to generate a high-frequency oscillating current and which includes an oscillator triode 156. The grid circuit of the modulator triode 154 is also connected through a transformer 157 to an alternating-current generator 158 of a definite frequency.

An oscillograph element 159 is connected in circuit with the generator 158. The oscillograph element 159 is turned upon its axis under the influence of alternating current that is adapted to scan the face of the lens 160. The lens 160 contains a number of light transmitting sections 161 and a number of opaque sections 162.

Whenever a ray of light from one of the light transmitting sections falls upon the oscillograph element 159, it is reflected to the photoelectric cell 163. The photoelectric cell 163 is connected in circuit with a triode 164 which operates as a relay. The plate circuit of the triode 164 is connected through

a transformer 165 to an amplifier triode 166. The plate circuit of the triode 164 is also connected through a transformer 167 to an amplifier triode 168. The grid circuit of the amplifier triode 166 is connected through a transformer 169 to a telephone microphone 170. The grid circuit of the amplifier triode 166 is also connected through a transformer 171 to a variable frequency generator 172.

The grid circuit of the amplifier triode 166 contains a C battery so connected in the circuit as to place a negative potential upon its grid. The grid circuit of the amplifier triode 168 contains a C battery 174 so arranged as to place a positive potential upon its grid. The purpose of this arrangement will appear more fully hereinafter.

The plate circuit of the amplifier triode 166 is connected through a transformer 175 to modulator triodes 176 and 177. The plate circuit of the amplifier triode 168 is connected through a transformer 178 to the modulator triodes 176 and 177. The oscillating circuit including the triode 178 is connected through a transformer 179 in circuit with the modulator triodes 176 and 177.

The output circuits of the modulator triodes 176 and 177 are connected through a transformer 180 to an amplifier triode 181. The output circuit of the amplifier triode 181 is connected through a tuning coil 182 to the oscillating circuit including the antenna 150. The oscillating circuit, including the antenna 150, is connected through a tuning coil 183 to an oscillating circuit 184. The circuit 184 is connected through transformers 185 and 186 to the grid circuit of the triode 164. The plate circuit of the triode 164 is connected through a transformer 187 to a detector triode 188. The output circuit of the detector triode 188 is connected through a transformer 189 to an amplifier triode 190. The output circuit of the amplifier triode 190 is connected to a telephone receiving device 191.

Having briefly described the apparatus shown in the drawings, I will now explain its detailed operation. For this purpose, it will be assumed that the circuit, including the oscillator 7, is generating an oscillating current of a certain frequency, 800,000 cycles for example. The high-frequency alternating current from this oscillating circuit is amplified by the operation of the triodes 5 and 3 and radiated by the antenna 1. This carrier current is modulated first by operating frequency current from generator 20, and also by microphonic current from the microphone 16 and "masking" frequency current from the generator 29, respectively. The cathode electron streams are emitted from the cathodes 12 and 22 of the cathode-ray tubes 11 and 12, respectively.

As the coils 30 to 33, inclusive, are all con-

nected in series in circuit with the generator 20, an alternating current traverses these coils and a magnetic field is set up in the path of the cathode ray stream at both the cathode ray tubes 11 and 21. By this magnetic field, the cathode ray is deflected at right angles thereto and swings in a plane perpendicular to the magnetic field. Inasmuch as the plate 10 of the cathode-ray tube 11 is connected through the secondary winding of the transformer 9 to the grid of the amplifier triode 8 and the filament of the cathode-ray tube 11 is connected to the filament of the amplifier triode 8, when the cathode beam strikes any particular portion of the plate, there will be a circuit closed and the current flow in this circuit will be altered by any audible indication reaching the transmitter 16 that is connected to the primary of the transformer 9.

Consequently, at that particular time, the high-frequency current generated by the oscillating triode 7 will be modulated in accordance with the audible indication from the transmitter 16. When the cathode beam in the cathode-ray tube 11 passes through an opening in the metal plate 10, there will be no circuit; and, consequently, no signal modulation of the high-frequency carrier current. As the movement of the beam takes place relatively fast, the interruptions in this circuit occur at such a rate that they may be neglected when received, inasmuch as the interruptions occur at a frequency above 40,000 cycles, this frequency being determined by the frequency of the alternating current generated by the generator 20 and the number of openings in the plate 10.

The filament of the cathode-ray tube 21 is also connected to the filament of the triode 8, while the plate 26 is connected to the grid of the said triode. The variable audio-frequency current generator 29, which generates the "masking" frequency current, thus operates to modulate the carrier current at the particular portions when the cathode beam strikes the metal plate 26. This modulation of the carrier current by the generator 29 occurs every time that the cathode beam of the cathode-ray tube 11 is passing through an opening in the metal plate 10. Thus, the carrier frequency current is modulated alternately by the signalling frequency current and the "masking" frequency.

At the receiving station, the high-frequency current generated by the generator 20 is received by the antenna 40 and transferred through the transformer 43 to the amplifier triode 44. As the plate circuit of the amplifier triode 44 is connected to the coils 45 and 46 in the cathode-ray tube 47, an electromagnetic field is set up, which varies in the same manner as does the magnetic fields in the coils 30 to 33 at the transmitting sta-

tion. Thus, the cathode-ray beam of the cathode-ray tube 47 is deflected in synchronism with the cathode-ray beams in the cathode-ray tubes at the transmitting station.

As the plate 51 at the receiving station is an exact duplicate of the plate 10 at the transmitting station, the cathode beam in the cathode-ray tube 47 will be in contact with the metal plate 51 at the same time that the cathode beam of the cathode-ray tube 11 is striking the metal plate 10. Thus, at this particular time, there will be a circuit completed for transferring the signal modulated high-frequency current to the detector triode 54, where, by the action of this detector, the signalling frequency current will cause an audible indication in the head phones or receiving device.

During the time that the cathode-ray beam of the cathode-ray tube 21 is in contact with the metal plate 26, the cathode-ray beam in the tube 47 will be passing through an opening in the metal plate 51 and, therefore, there will be no circuit for transferring the high-frequency current modulated by the "masking" frequency current to the detector 54, and this will be inaudible in the receiving device on account of the high-frequency current which is used for deflecting the cathode beams. The interruptions in the signalling current modulations occur with such speed that there is no audible interruption in the receiving device, the speed at which the signalling frequency current is interrupted being at a frequency above audibility.

It is, of course, obvious that, in place of using a metal plate in cathode-ray tubes cut in the manner of the plates 10 and 26, irregularly cut plates may be used, such as those shown in Fig. 6. In this event, it would be necessary to use two operating or synchronizing frequency currents. The coils creating the magnetic fields in the cathode-ray tubes would be placed at right angles to the coils shown. Thus, the cathode ray under the influence of the two operating frequency currents would cover the whole area of the plates. On the other hand, it may be deemed desirable to provide a large number of metal plates cut with different patterns at both the transmitting and receiving stations. When this is true, a master numbering plate can be provided, such as that shown in Fig. 5, which is divided into a large number of divisions. Thus, by any ordinary means, the operators at the various stations can be apprised what particular plate is going to be used for transmitting by designating the plate to be used with reference to the coding plate. Of course, in the event that interchangeable plates are provided at the receiving stations, the cathode-ray tube will be constructed so that

these plates can be interchanged and the tube re-evacuated.

It is thus impossible for any outside station which is not provided with the proper decoding plate to listen in on the signals and conversation which are radiated from another station. When a receiving station attempts to listen in on the conversation without being provided with a decoding plate, all that is heard is an unintelligible jumble, the speech frequency current being interrupted at a high frequency with the variable "masking" frequency current.

Referring now to Fig. 7, the operation of the modification of the transmitting station will now be described. The only difference between the operation of the system shown in this figure and that shown in Fig. 1 is that but one cathode-ray tube is used, this tube having both plates 67 and 68 similar to plates 10 and 26 mounted therein. The circuit connections are otherwise the same.

The operation of the system in this case is identically the same as before, with the exception that one cathode-ray beam furnishes the conducting path for modulating the carrier frequency current with both the signalling frequency current and the variable "masking" frequency current.

Referring now to Fig. 8, the operation in this case is somewhat different from that before described, inasmuch as ordinary mechanical oscillographs are used at the transmitting and receiving stations in place of cathode-ray oscillographs.

By reason of the operation of the oscillating circuit including the triode 86, carrier frequency current is radiated by the antenna 80 and, at the same time, the antenna 80 is also radiating another carrier frequency current which is generated by the circuit including the oscillator triode 97. The carrier frequency current generated by the oscillator triode 86 is modulated in accordance with the frequency of the alternating current generated by the generator 87. A portion of the alternating current from the generator 87 also traverses the oscillograph element 89 and causes it to swing on its axis from side to side.

Considering one position of the oscillograph element 89, when the light ray from one of the transmitting parts of the section 93 falls on the mirror of the oscillograph element, it is reflected on the photoelectric cell 92. This light ray from the line transmitting section causes current to flow in the circuit including the transmitter 102. The amplitude of this current is varied in accordance with any audible signals caused by the operation of the transmitter 102. This change in amplitude of the current flowing in the circuit is transferred to the amplifier triode 103 through the transformer 104. By

the operation of the amplifier 103, this current is amplified and transferred to the circuit including the triode 94'. This current modulates the carrier current generated by the oscillator 97 in accordance with the signal given. This modulated carrier current is then amplified by the operation of the amplifier 100 and radiated by means of the antenna 80.

As the oscillograph element 89 moves, it will reflect a light ray from the light transmitting section 93 on the photoelectric cell 91, and there will be no light ray reflected on the photoelectric cell 92. Consequently, the signalling circuit will be interrupted, inasmuch as the resistance of the photoelectric cell 92 becomes very high. The light ray reflected on the photoelectric cell 91 causes the current of variable audio frequency of the generator 96 to transfer this current through the transformer 92 to the amplifier triode 93'. By the action of the amplifier triode 93', this current is amplified and transferred to the circuit including the triode 94', whereby this varying "masking" frequency current modulates the carrier current generated by the generator 97 and is transmitted after being amplified by the operation of the amplifier 95 by the antenna 80.

As the oscillograph element 89 swings from side to side, the signalling frequency current and the "masking" frequency current will be transmitted alternately. The speed at which the signalling frequency current is interrupted by the "masking" frequency current is determined by the frequency of the alternating current generated by the generator 87 which will be substantially 25,000 cycles per second. Thus, the voice current is interrupted several times for each alternation in the frequency of the current generated by the generator 87, by reason of the various light transmitting parts in the sections 93 and 94.

At the receiving station, the carrier current which is modulated in accordance with the alterations in the current from the alternator 87 is transferred through the transformer 111 to the detector 112, whereupon this current is demodulated and the current of the resultant frequency is transferred to the oscillograph element 114. As this current is of the same frequency as that generated by the generator 87 at the transmitting station, the oscillograph 114 will operate in synchronism with the oscillograph element 89 at the transmitting station.

As the oscillograph element swings back and forth, it will alternately engage the light and opaque parts in the section 116. Upon scanning a light transmitting part, the oscillograph element 89 at the transmitting station will be in the same relative position and, consequently, there will be a circuit closed at the transmitting station for modulating the high-frequency carrier current

with the signalling current. At the same time, at the receiving station, the photoelectric cell 117 will become conductive and a circuit will be closed for transmitting this modulated high-frequency current from the antenna 110 through the amplifier 118 to the detector 120. By the action of the detector 120, the carrier frequency current is eliminated and the signalling or speech frequency current causes an audible indication in the telephone receivers, or other receiving device.

During the time that the photoelectric cell 91 at the transmitting station is active, the oscillograph 114 will be engaging an opaque portion of the section 115, and, consequently, the photoelectric cell 117 acts substantially the same as an insulator and there will be no circuit closed for the detector 120.

If any other receiving station attempts to listen in on this signalling without being provided with a lens patterned similar to the lens 115, the received indications will be unintelligible, by reason of the fact that the speech frequency current will alternate at a high rate of speed with the variable "masking" frequency current.

In the same manner as before described, the patterns of the lenses 90 and 115 may be changed, as desired, so as to render the interruptions in the speech frequency more or less complex.

Referring now to Fig. 9, the operation of this system is somewhat similar to that previously described. The circuit including the oscillator 156 is generating an oscillating current at a certain frequency, and this current is modulated by the triode 154 at the frequency of the alternating-current generator 158. This modulated carrier current is then amplified by means of triode 152 and radiated by the antenna 150.

The oscillograph element 159 is also operated upon its axis at a frequency which depends upon the frequency of current from the generator 158. This frequency is sufficiently high that, when multiplied by the number of opaque parts in the lens 160, the result is a frequency above audibility, that is, above 20,000 cycles per second.

As the oscillograph element 159 swings to and fro, various impulses of light are reflected upon the photoelectric cell 163. Considering the oscillograph element 159 in a definite position so that a ray of light from one of the light transmitting parts, such as 162, falls upon the photoelectric cell 153, there will be a higher negative potential applied to the grid voltage and, consequently, the current in the output circuit of the triode 164 will be altered. In response to such alteration, the amplifying circuit, including the amplifier triode 166, will become effective, and, if a person is talking at this time, the transmitter 170 will cause this tri-

ode to modulate through the modulator triodes 176 and 177 the carrier current generated by the oscillating circuit including the oscillator triode 188. The modulated carrier current is amplified by means of the amplifier triode 81 and radiated by means of the antenna 150. The grid of the triode 166 may be suitably biased by means of a C battery 173 to cause the triode 166 to function suitably.

When the oscillograph element 169 is scanning an opaque portion of the lens 160, there will be a decrease in the potential upon the grid of the triode 164 and the current in the output circuit of the triode so altered that the amplifying circuit, including the amplifier 166, is no longer effective. The amplifying circuit, including the amplifying triode 168, will now become effective and the carrier current generated by the oscillating current from the circuit including the oscillator 178 will be modulated at the frequency of the variable frequency generator 172 through the action of the modulator triodes 176 and 177.

The output of these modulators is amplified by means of the amplifier 181 and radiated by the antenna 150. In this manner, there is radiated from the antenna 150 a carrier current that is modulated at an operating or synchronizing frequency and a modulated carrier current that is intermittently modulated at a speech frequency and at a variable "masking" frequency.

When a carrier current is received by the antenna 150 that is modulated intermittently at a "masking" frequency and at a signalling frequency, this modulated current will be transferred by means of the oscillating circuit 184 which is tuned to the particular frequency which it is desired to receive and to the grid of the triode 164. As the triode 164 operates under the control of the oscillograph element 159, the detector triode 188 will be effective only when the photoelectric cell 163 is conductive. This occurs only at the time when the carrier current at the distant station is being modulated by the signalling frequency, and, consequently, only the vibration caused by the current or signalling frequency will be heard in the telephone receiving device 191. In this case, it is assumed that the synchronizing frequency current is generated from the station shown in Fig. 9, which may be considered a central station.

Inasmuch as the current of signalling frequency is interrupted by the current of "masking" frequency at a frequency above audibility, the interruptions in the signalling current will not be apparent in the telephone receiving device 191.

It will be obvious that it is entirely possible to have the current of synchronizing frequency generated at a central station, rather

than at the transmitting station. In this event, the apparatus and circuits would differ from those shown, only that at the transmitting station, in place of the generator 73, there would be provided an amplifier triode connected to coils, such as 74 and 75, Fig. 7. The input circuit of this amplifier would be connected in inductive relation to the oscillatory circuit including the antenna 60 and would be resonant to current of the particular frequency that would be generated by the synchronizing frequency current generator at the central station. At the central station, there would be broadcasted a synchronizing frequency current.

It will be seen that this arrangement allows a number of transmitting stations to transmit even with only one station generating the synchronizing frequency current. There would be no interference in the signals from any of the transmitting stations, by reason of the fact that the currents of signalling and "masking" frequencies would be operated on different wave lengths.

My invention is not limited to the specific arrangement of the apparatus illustrated, but may be variously modified without departing from the spirit and scope thereof, as set forth in the appended claims.

I claim as my invention:

1. In a system of intelligence communication, the combination with a transmitting station, means for generating a high-frequency current thereat to create etheric disturbances, and a signalling device for controlling said high-frequency current, of a second device for controlling said high-frequency current, a source of alternating current, and means including a device having a space-current path for causing the controlling devices to become effective in turn in response to said alternating current.

2. In a signalling system, the combination with a transmitting station, a source of high-frequency current for creating etheric disturbances, a receiving station for receiving said disturbances, and a signalling device at said transmitting station for controlling said high-frequency current, of a source of variable frequency electric current at said station, means for periodically interrupting said controlling operation and for simultaneously controlling said high frequency current by means of said variable frequency current, and means at said receiving station for receiving only the alternating-current frequency controlled by the current of signalling frequency.

3. In a signalling system, the combination with a transmitting station, a source of high-frequency current for creating etheric disturbances, a signalling device at said transmitting station for controlling said high-frequency current, of a source of variable frequency electric current at said station,

and means for periodically interrupting said controlling operation and for simultaneously controlling said current of high frequency by means of said current of variable frequency.

4. In a signalling system, the combination with a transmitting station, a source of high-frequency current for creating etheric disturbances, a receiving station for receiving said disturbances, and a signalling device at said transmitting station for controlling said high-frequency current, of a source of variable frequency electric current at said station, means for periodically interrupting said controlling operation and for simultaneously controlling said current of high frequency by means of said current of variable frequency, and means at said receiving station for eliminating from said receiving device the alternating current controlled by said current of variable frequency.

5. In a signalling system, the combination with a transmitting station, means at said station for generating an electric current, means controlled by the current from said source for creating etheric disturbances, and a signalling device for controlling said current, of a second signalling device, a source of current of a predetermined frequency, and a thermionic device controlled by the current from said source for interrupting said controlling operation and for placing said first current under control of said second signalling device.

6. In a signalling system, the combination with a transmitting station, means at said station for generating an electric current, means controlled by said current for creating etheric disturbances, and a signalling device for controlling said current, of a second signalling device, a source of current of a predetermined frequency, a thermionic device controlled by the current from said source for interrupting said controlling operation and for placing said first current under control of said second signalling device, a receiving device, means controlled by the current from said source for operating said device responsive to said first current when said first current is controlled by said first signalling device, and means for preventing the operation of said receiving device when said first current is controlled by said second signalling current.

7. In a signalling system, the combination with a transmitting station, a source of electric current at said transmitting station for creating etheric disturbances, a receiving station, and means at said receiving station for receiving said disturbances, of a signalling device at said transmitting station for controlling said current, a second signalling device at said transmitting station, thermionically controlled, synchronously operating devices at said transmitting and receiving

stations, and means controlled by the device at the transmitting station for intermittently interrupting the control of said current by the first signalling device and for causing said second signalling device to control said current.

8. In a signalling system, the combination with a transmitting station, a source of electric current at said transmitting station for creating etheric disturbances, a receiving station, and means at said receiving station for receiving said disturbances, of a signalling device at said transmitting station for controlling said current, a second-signalling device at said transmitting station, thermionically controlled, synchronously operating devices at said transmitting and receiving stations, means controlled by the device at the transmitting station for intermittently interrupting the control of said current by the first signalling device and for causing said second signalling device to control said current, and means controlled by the device at the receiving station for preventing the operation of said receiving means during the control of said current by said second signalling device.

9. In a signalling system, the combination with a transmitting station, a source of electric current at said transmitting station for creating etheric disturbances, a receiving station, and means at said receiving station for receiving said disturbances, of a signalling device at said transmitting station for controlling said current, a second signalling device at said transmitting station, thermionically controlled, synchronously operating devices at said transmitting and receiving stations, means controlled by the device at the transmitting station for intermittently interrupting the control of said current by the first signalling device and for causing said second signalling device to control said current, and means controlled by the device at said receiving station for preventing the operation of said receiving means, except when said current is controlled by said first signalling device.

10. In a signalling system, the combination with a transmitting station, a source of electric current thereat for creating etheric disturbances in the receiving station, and means at said receiving station for receiving said disturbances, a signalling device at said transmitting station for controlling said current, a second signalling device at said transmitting station, thermionically controlled, synchronously operating devices at said transmitting and receiving stations, means controlled by the synchronously operating device at the transmitting station for interrupting the control of said current by the first signalling device at a frequency above audibility, and means controlled by the synchronously operating device at the

receiving station for preventing the operation of said receiving means, while said current is controlled by said second signalling device.

5 11. In a signalling system, the combination with a transmitting and a receiving station, of a device at the transmitting station and a device at the receiving station for generating an electron stream, means for
10 deflecting the electron stream from its normal path at both the transmitting and receiving stations, a source of electric current at said transmitting station for creating
15 etheric disturbances, means at said receiving station for detecting said etheric disturbances, a second source of electric current at said transmitting station for deflecting said electron streams, a signalling
20 device at said transmitting station for controlling said first electric current, a second signalling device, means controlled by the electron stream at said transmitting station for rendering said second signalling device
25 effective to control the first electric current, and means controlled by the electron stream at said receiving station for preventing the operation of said receiving means, except when the first electric current is controlled by said first signalling device.

30 12. In a signalling system, the combination with a transmitting and a receiving station, of a device at the transmitting station and a device at the receiving station for generating an electron stream, means for
35 deflecting the electron stream from its normal path at both the transmitting and receiving stations, a source of electric current at said transmitting station for creating etheric disturbances, means at said receiving
40 station for detecting said etheric disturbances, a second source of electric current at said transmitting station for deflecting said electron stream, a signalling device at said transmitting station for controlling
45 the first electric current, a second signalling device, means controlled by the electron stream at said transmitting station for rendering said second signalling device effective to control said first electric current, and
50 means controlled by the electron stream at said receiving station for controlling the operation of said receiving means.

55 13. In a signalling system, the combination with a transmitting and a receiving station, of a device at the transmitting station and a device at the receiving station for generating an electron stream, means for
60 deflecting the electron stream from its normal path at both the transmitting and receiving stations, a source of electric current at said transmitting station for creating etheric disturbances, means at said receiving
65 station for detecting said etheric disturbances, a second source of electric current at said transmitting station for deflect-

ing said electron streams in synchronism, a signalling device at said transmitting station for controlling the first electric current, a second signalling device, means controlled by the electron stream at said transmitting station for rendering said second
70 signalling device effective to control the first electric current, and means controlled by the electron stream at said receiving station for preventing the operation of said receiving
75 means, except when said first electric current is controlled by said first signalling device.

14. The combination with a transmitting station, of a device at the transmitting station for generating an electron stream,
80 means for deflecting the electron stream from its normal path at the station, a source of electric current at said transmitting station for creating etheric disturbances, a second source of electric current at said
85 transmitting station for deflecting said electron stream, a signalling device at said station for controlling the first electric current, a signalling device at said transmitting station for controlling said first electric
90 current, and means controlled by said electron stream for interrupting the controlling action of said signalling device.

15. The combination with a transmitting station, of a device at the transmitting station
95 for generating an electron stream, means for deflecting the electron stream from its normal path at the station, a source of electric current at said station for creating etheric disturbances, a second source of
100 electric current at said station for deflecting said electron stream, a signalling device at said station for controlling said first electric current, a second signalling device, and means controlled by said electron stream for
105 interrupting the controlling operation of said first signalling device and for placing said electric current under control of said second signalling device.

16. The combination with a transmitting station, of a device at the station for generating an electron stream, means for deflecting the electron stream from its normal
110 path at the station, a source of electric current at said station for creating etheric disturbances, a second source of electric current at said station for deflecting said electron stream, a signalling device at said station
115 for controlling said first electric current, a second signalling device, and means controlled by said electron stream for enabling said second signalling device to control said electric current.

17. In a signalling system, the combination with a transmitting and a receiving station,
125 a source of electric current at said transmitting station for creating etheric disturbances, means at said receiving station for receiving said disturbances, an interrupting device at said transmitting station,
130

an interrupting device at said receiving station, means located at a point separate from said transmitting or receiving station for causing said interrupting devices to operate in synchronism, a signalling device at said transmitting station for controlling said electric current, means controlled by said interrupting device at the transmitting station for preventing the control of said electric current by said signalling device, and means controlled by the interrupting device at the receiving station for simultaneously interrupting the operation of said receiving means.

18. In a signalling system, the combination with a transmitting and a receiving station, a source of electric current at said transmitting station for creating etheric disturbances, means at said receiving station for receiving said disturbances, an interrupting device at said transmitting station, an interrupting device at said receiving station, means located at a point separate from said transmitting or receiving station for causing said interrupting devices to operate in synchronism, a signalling device at said transmitting station for controlling said electric current, a second signalling device, means controlled by the interrupting device at the transmitting station for stopping the controlling operation of said first signalling device and for placing said electric current under the control of said second signalling device, and means controlled by the interrupting device at the receiving station for preventing the operation of said receiving

means, except when said electric current is controlled by said first signalling device.

19. In a signalling system, the combination with a transmitting station, a source of electric current at said transmitting station for creating etheric disturbances, an interrupting device at said transmitting station, means located at a point separate from said transmitting station for causing said interrupting device to operate, a signalling device at said transmitting station for controlling said electric current, and means controlled by said interrupting device for preventing the control of said electric current by said signalling device.

20. In a signalling system, the combination with a transmitting station, a source of electric current at said transmitting station for creating etheric disturbances, an interrupting device at said transmitting station, means located at a point separate from said transmitting station for causing said interrupting device to operate, a signalling device at said transmitting station for controlling said electric current, a second signalling device, and means controlled by said interrupting device for intermittently stopping the controlling operation of said first signalling device and for placing said electric current under the control of said second signalling device.

In testimony whereof, I have hereunto subscribed my name this 13th day of March, 1924.

VLADIMIR K. ZWORYKIN.