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SIGNALING SYSTEM

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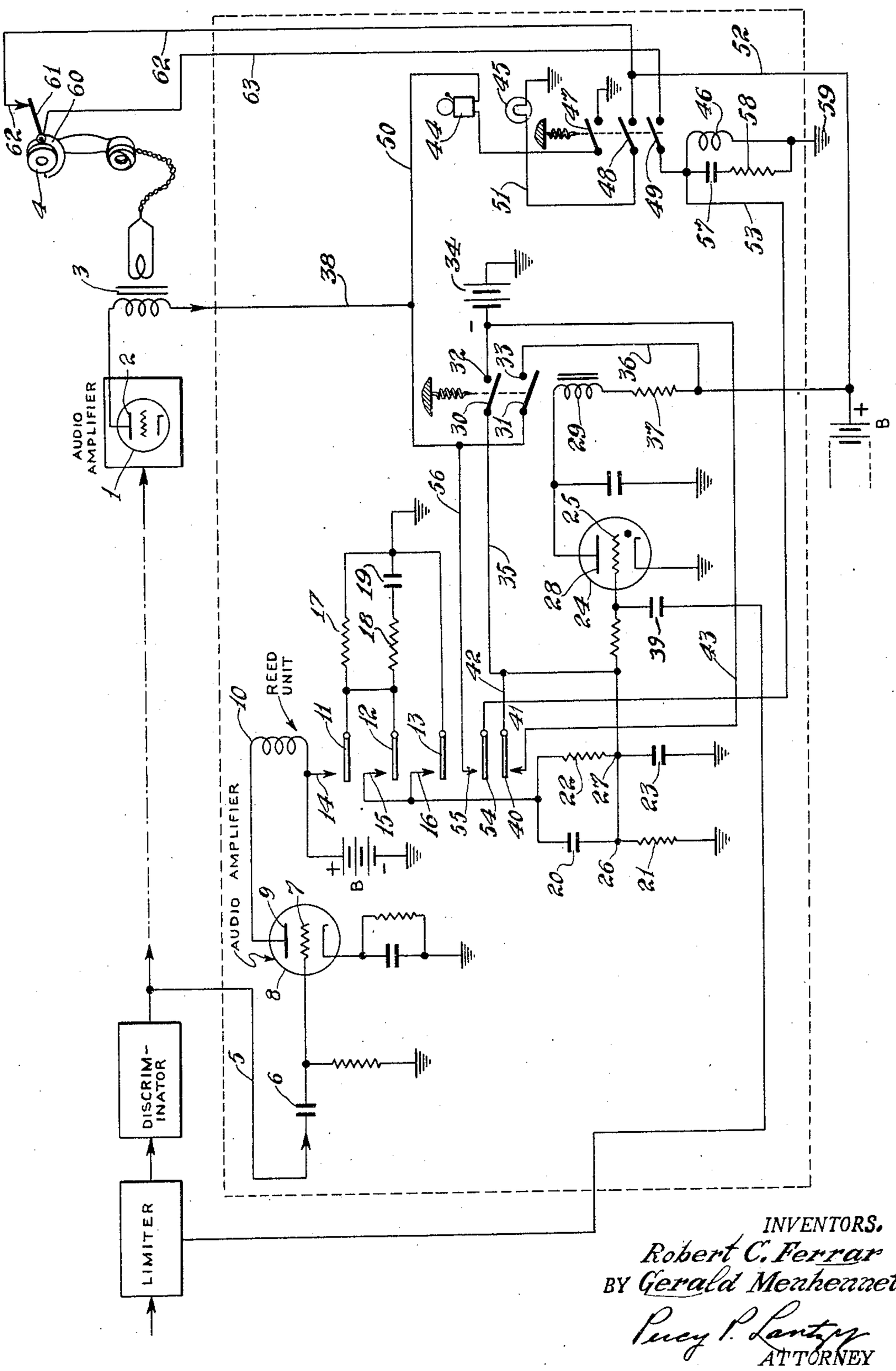

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SIGNALING SYSTEM

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This invention relates to systems for selectively calling stations in a communication system and for signalling the call.

An object of the invention is to call a particular desired station, place it in operating condition and to signal the operator thereof.

Another object is to provide a signalling system capable of signalling the operator when a call is coming in, and if not received by an operator, to leave an indication that a call has been attempted.

In our copending application for Selective calling system, Serial No. 695,544 filed September 7, 1946 (Ferrar et al. 4–1) assigned to Federal Telephone and Radio Corporation we disclose and claim a selector call system wherein each remote or field station is provided with a number of vibratory elements, each adapted to be set into vibration by a particular calling frequency. By transmitting from the central station successively those frequencies which are required to operate the vibratory elements at a given field station, suitable charging circuits associated with the vibrating elements are caused to operate a voltage-operated device to render the receiver at the called station operative. By this system, single, selected groups or all of the field stations can be called as may be desired.

In the present invention we provide signalling means, either audible or visual or both, to let the operator know that a call is being made, this being desirable since the receiver is provided with earphones instead of a loudspeaker. These signals are produced by a "ringing" signal after a control circuit has conditioned the receiver in response to a calling signal. The system includes a second control circuit which operates in coordination with the first or main control circuit. The two control circuits control the signalling devices so that one or both operate while the call is attempted and thus maintains at least one in signalling condition until the operator lifts the earphones.

The foregoing and other objects and features of our invention will be more thoroughly understood from the following detailed description and the accompanying drawing which shows a system embodying our invention.

In the drawings the figure shows an arrangement according to our invention, adapted to be incorporated into a receiver of the frequency modulation type.

In practice there will be one of the systems shown in the drawing, for example, incorporated into each receiver which is to be called from the central or calling station. In the figure, the tube

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1 represents an audiofrequency power amplifier which may be any desired type of power amplifier; and as the particular type is unimportant, all of its electrodes are not shown, but only the output electrode or anode 2. Power amplifier 1 is part of the receiver and it is coupled through an output transformer 3 to earphones 4.

Upon being called from the central station, this audio-amplifier is adapted to be made operative by the system shown connected with it. The system operates on audio-frequency and its input is connected over a lead 5 from the output of the usual discriminator of a frequency modulation receiver, through a coupling condenser 6 to the control grid 7 of an audio-frequency amplifier tube 8 of the triode type. The anode 9 has its output connected to a coil 10 which is electromagnetically related with a number of tuned reeds of which there are shown three, these being numbered 11, 12 and 13. The reeds are each tuned to a different natural frequency in the audio-frequency range so that when the tuned frequency is sent through coil 10, the corresponding reed will vibrate against the respective reed contacts 14, 15 and 16.

Reed 11 has connected in series between it and ground a high resistance 17; reed 12 is connected to ground through a series arranged resistor 18 and condenser 19; and reed 13 is connected directly to ground. Contacts 15 and 16 are connected together and are connected to ground through two parallel paths, one of which comprises the series-connected condenser 20 and resistor 21, and the other of which comprises the series arranged resistor 22 and condenser 23.

For the purpose of controlling the audio power amplifier 1, in accordance with called signals, there is provided a thyratron tube 24, the control grid 25 of which is connected to points 26 and 27 which are the points between condenser 20 and resistor 21 and between resistor 22 and condenser 23, respectively. The output circuit of the thyratron connected to its anode 28 passes through a relay coil 29 having a pair of armatures 30 and 31 adapted to make and break contact with the respective relay contacts 32 and 33. Contact 32 has connected to it a voltage source 34 for supply of negative bias for tube 24. The armature 30 is connected over lead 35 to the grid 25 of the thyratron, so that when the armature closes on its contact 32, the negative bias is connected to the thyratron grid to shut off the thyratron. The armature contact 33 is connected over lead 36 to the lower end of a resistor 37 which is connected in series with relay coil 29. The relay armature 31 is connected over a lead

38 to the lower side of the primary winding of output transformer 3, so that when armature 31 connects with its contact 33, the B voltage which is supplying the thyratron is connected directly to the anode 2 of the audio power amplifier of the receiver, thereby making the power amplifier and hence the receiver, operative.

If desired contact 33 may not be connected to the primary of transformer 3, the latter in that case being connected directly to the power source. With such a connection the receiver would always be operative upon reception of the carrier to which it is tuned, the control circuit serving only as a control for the signalling equipment.

To describe the operation of the calling system, let it be assumed that reed 11 has a natural frequency of vibration at a frequency X somewhere in the low audio range, and that reeds 12 and 13 have somewhat different natural frequencies Y and Z, also in the low audio frequency range. The operator at the central station will have a number of calling keys, or dial with a plurality of keying positions, each of which will frequency modulate his transmitting carrier frequency by a sustained note somewhere preferably in the low audio range. To call the particular station represented in the drawing, which has the particular reeds with frequencies X, Y and Z, the operator will first dial or push his key for the X audio frequency; and when the receiver picks up the signal frequency modulated by the X signal, the discriminator will separate out the X frequency in the usual way and send it to audio amplifier 8. Since the reed operating coil 10 will carry this note, it will vibrate the reed 11 without vibrating either of reeds 12 or 13 since the latter two reeds are not naturally resonant at this frequency X. While reed 11 is vibrating, it will rapidly make and break contact with contactor 14 and the B voltage connected to the lower end of coil 10 will send a charging current through resistor 18 and condenser 19 to charge up the condenser 19, in a brief time. This charge on the condenser will leak off in a short period of time of say two or three seconds through resistors 18 and 17 which are in series across the condenser, the actual time depending on the time constant of the circuit.

Before the charge leaks off condenser 19, however, the operator will dial or push the next call signal Y, which will cause reed 12 to vibrate against its contactor 15 at the low audio rate, and this will cause a current from the charged condenser 19 to pass through condenser 20, thereby charging up condenser 20, the charging circuit for condenser 20 being through the parallel-arranged elements 21 and 23 and the conductive grid-cathode circuit of the thyratron tube 24. The charge on condenser 20 will gradually leak off through the resistance connected across it, but before this happens, the operator at the calling station will dial or push his Z button to vibrate reed 13 against its contact 16, thereby connecting the positively polarized upper end of the condenser 20 to ground intermittently, and causing the upper end of condenser 23, and the thyratron grid connected to it, to be driven negative with respect to ground and the thyratron cathode. Since the charging path for condenser 23, through condenser 20 and the contacts of reed 13 is of much lower resistance than the discharge path through resistor 21, the upper side of condenser 23 and the thyratron grid will almost immediately assume a D.-C. voltage which is below ground potential; and hence the

conduction which is otherwise occurring within the thyratron tube will cease.

The cessation of conduction in the thyratron causes the D.-C. current in the relay coil 29 to drop to zero, so that the armatures 30 and 31 will drop back to their normal position of closed contact with their respective contacts 32 and 33. The closure of these relay contacts performs two functions: The closure of armature 31 with contact 33 applies B voltage to the plate of the audio power amplifier, causing the signals at the transmitting or central station to be heard in the earphones 4. The closure of armature 30 against contact 32 applies a constant negative voltage to the thyratron grid, thereby causing the thyratron to remain in a non-conducting state. When the carrier is shut off at the time that the operator at the central station discontinues the signal, the cessation of the carrier at the limiter grid causes thermal agitation noise output from the limiter stage of the receiver. This noise voltage is applied through condenser 39 to grid 25 thereby trigging thyratron tube 24, and allowing the thyratron to begin to conduct again. This conduction produces current in relay coil 29, pulling in the two armatures 30 and 31 again, and thereby rendering the audio power amplifier again inoperative.

It will be recognized that the invention may be used to call individually any one of a number of stations, the number being dependent only on the number of reeds per station, and the number of audio-frequency call signals per system. If N be the number of reeds per second, and T the number of call tones available at the control station, the number of remote stations which may be individually called is:

$$T(T-1)^{N-1}$$

It is not necessary that the reeds in any given remote station be all of different frequencies, although no two reeds which operate in immediate succession should be at the same frequency. Thus, reeds 11 and 13 could be at the same or different frequencies, although reed 12 should have a natural frequency different from either reed 11 or 13.

In the operation of systems of this character it is sometimes desirable to call a particular group of field stations and at other times it is desirable to call all of the field stations simultaneously. To call a particular group it is only necessary to transmit, in the case of three reed signalling circuits, one additional frequency thereby providing in the four frequency signal several three frequency signal combinations. This may also be increased by adding still another frequency to the combination signal.

When all field stations are to be called all of the signal frequencies could be transmitted but it is preferable to provide a much simpler signalling arrangement and this is accomplished by including a fourth vibratory element 40 for actuation by coil 10 in response to a predetermined frequency at which element 40 is resonant. The element 40 is connected in circuit with the associated contact 41 between the grid 25 by connection 42 and a negative voltage source by connection 43.

Having described the call selector circuit of our aforesaid copending application, we will now describe the signalling equipment and how the controls therefor coordinate with the selector call circuit for proper operation of the signalling devices.

The figure of the drawing shows audible and visual indicating means for indication of a call signal and if not answered to leave an indication that a call has been attempted. The signalling portion of the circuit includes an audible signalling device 44 which may comprise a bell and the visual indicating device 45 which may comprise a light bulb. These two devices are controlled by a relay comprising a coil 46 and three switches 47, 48 and 49. The bell 44 is connected in circuit with switch 31 through connection 50 and through switch 47 to ground. Thus when both switches 31 and 47 are closed the bell will receive current from battery B. The light bulb 45 is connected between ground and by connection 51 through switch 48 and connection 52 to battery B. The relay 46 is controlled by circuit 53 which includes a reed 54 and contact 55, connection 56, switch 31 and connection 36 to battery B. Coupled in parallel with the coil 46 is a condenser 57 and resistor 58, the parallel circuit being connected to ground 59, whereby reed pulses are integrated for operation of the relay in response to reed vibrations.

The relay 46 is further controlled by the earphones 4. The receiver hook 60 is provided with a switch 61 which normally closes with contact 62 when the earphones are on the hook. This completes circuit connections 62 and 63 between switch 49 to battery B by way of connection 52. In this way the lifting of the earphones 59 from hook 60 opens the holding circuit for the relay 46 thereby deenergizing the circuit.

In operation the signal frequencies operate the vibratory elements 11, 12 and 13 in the manner hereinbefore described to block thyratron 24 thereby permitting switches 30 and 31 to close. Since the earphones 4 control the holding circuit for relay 46, the operator at the receiver must be signalled to lift the earphones from the hook 60. The closing of switch 31 completes a circuit with reed 54 and contact 55 which responds to a ringing frequency signal to energize relay coil 46 closing switches 47, 48 and 49. Closed switch 47 completes the circuit through switch 31 for bell 44, causing it to ring. Closed switch 48 completes the circuit for energization of lamp 45. Closed switch 49 completes a holding circuit through contacts 61, 62 associated with hook 60. When the earphones are lifted from the hook 60 the holding circuit of switch 49 is opened thereby deenergizing relay 46 resulting in the opening of switches 47, 48 and 49. Thus the indicating devices 44 and 45 are both deenergized.

In case the operator is not present the bell 44 will continue to ring as long as the receiver is being called. As soon as the call is terminated by interruption of the carrier frequency the relay switches 30 and 31 are opened by the renewed operation of thyratron 24 in response to thermal noise occurring in the limiter circuit as hereinbefore described. The opening of relay switch 31, however, does not deenergize the light bulb 45. The light bulb being controlled solely by switch 48 continues to be energized until the relay 46 is deenergized by the breaking of the holding circuit controlled by hook 60. Thus when the operator returns and sees light bulb 45 lit he knows that an attempted call has been made. By lifting the earphones 4 the holding circuit is broken and the light bulb 45 deenergized.

While we have disclosed our invention with a particular circuit arrangement it should be understood that such arrangement is to be regarded as illustrative of the invention only and not as limiting the scope thereof.

We claim:

1. In a receiving station adapted to be called from another station, a control circuit, a call indicating circuit, means including vibratory station selector apparatus-operating responsive to a station selector signal to cause said control circuit to condition said call indicating circuit, and vibratory means responsive to a further received signal to energize said call indicating circuit.

2. In a receiver station according to claim 1 wherein the station includes a reproducing means, and said call indicating circuit includes a relay having a holding circuit controlled by said reproducing means.

3. In a receiver station according to claim 1 wherein said indicating means includes an audible indicator and a visual indicator, each operable upon reception of said further signal, and means to maintain one of said indicators operative after termination of an attempted call.

4. In a receiver station adapted to be called from another station; a first control circuit, a second control circuit conditioned only by operation of said first circuit, first and second signalling devices, the first being conditioned by operation of said first control circuit but both being controlled by energization of said second control circuit, means responsive to a carrier modulated with a predetermined signal for operation of said first control circuit, means responsive to a further modulation signal to energize said second control circuit, said first control circuit being held in operative condition so long as said carrier is received, and means to maintain said second control circuit energized until an attempt has been made to receive the call.

5. In a receiving station adapted to be called from another station, signal responsive means adapted to be energized by a predetermined signal with which a carrier is modulated, a first relay normally maintaned in open position, means to move said first relay to closed position upon energization of said signal responsive means, a second relay normally maintained in open position, means responsive to reception of a further predetermined signal after prior closure of said first relay to actuate said second relay to closed position, a signalling device operable upon closure of both relays, means for reproducing intelligence signals received by said station, means controlled by said first relay for controlling reproduction by said reproducing means, and means associated with said reproducing means to maintain said second relay closed upon closure thereof until said reproducing means is used to receive a call.

6. In a receiving station adapted to be called from another station, an electromagnet adapted to be energized by signal frequencies with which a given carrier is modulated, a plurality of vibratory elements each resonant at its respective signal frequency, a first relay normally maintained in open position, means to move said first relay to closed position upon resonant operation of at least one of said vibratory elements, a second relay normally maintained in open position, means responsive to resonant operation of another of said vibratory elements only after prior closure of said first relay to actuate said second relay to closed position, a signalling device operable upon closure of said second relay, a signal reproducing means, means controlled by said first relay for controlling reproduction by said reproducing

means, and means associated with said reproducing means to maintain said second relay closed upon closure thereof until said reproducing means is used to receive a call.

7. In a receiving station adapted to be called from another station, an electromagnet adapted to be energized by signal frequencies with which a given carrier is modulated, a plurality of vibratory elements each resonant at its respective signal frequency, a first relay normally maintained in open position, means to move said first relay to closed position upon resonant operation of at least one of said vibratory elements, a second relay normally maintained in open position, means responsive to resonant operation of another of said vibratory elements only after prior closure of said first relay to actuate said second relay to closed position, a first signalling device operable only upon closure of both relays, a second signalling device operable upon closure of said second relay, signal reproducing means, means controlled by said first relay for controlling reproduction by said reproducing means, and means associated with said reproducing means to maintain said second relay closed upon closure thereof until said reproducing means is used to receive a call.

8. In a receiving station adapted to be called from another station, an electromagnet adapted to be energized by signal frequencies with which a given carrier is modulated, a plurality of vibratory elements each resonant at its respective signal frequency, a first relay, an oscillatory circuit normally operative to maintain said first relay in open position, means responsive to resonant operation of at least one of said vibratory elements to stop oscillations in said circuit, thereby enabling said first relay to close, a second relay normally maintained in open position, means responsive to resonant operation of another of

said vibratory elements only after prior closure of said first relay to actuate said second relay to closed position, a first signalling device operable only upon closure of both relays, and a second signalling device operable upon closure of said second relay.

9. In a receiving station adapted to be called from another station, an electromagnet adapted to be energized by signal frequencies with which a given carrier is modulated, a plurality of vibratory elements each resonant at its respective signal frequency, a first relay, an oscillatory circuit normally operative to maintain said first relay in open position, means responsive to resonant operation of at least one of said vibratory elements to stop oscillations in said circuit, thereby enabling said first relay to close, a second relay normally maintained in open position, means responsive to resonant operation of another of said vibratory elements only after prior closure of said first relay to actuate said second relay to closed position, a signalling device operable upon closure of said second relay, means responsive to an interruption of said given carrier to renew oscillations in said circuit, thereby actuating said first relay to open position, and means to maintain said second relay in closed position until an attempt has been made to receive a call.

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