

Nov. 29, 1932.

P. C. RICCHIARDI

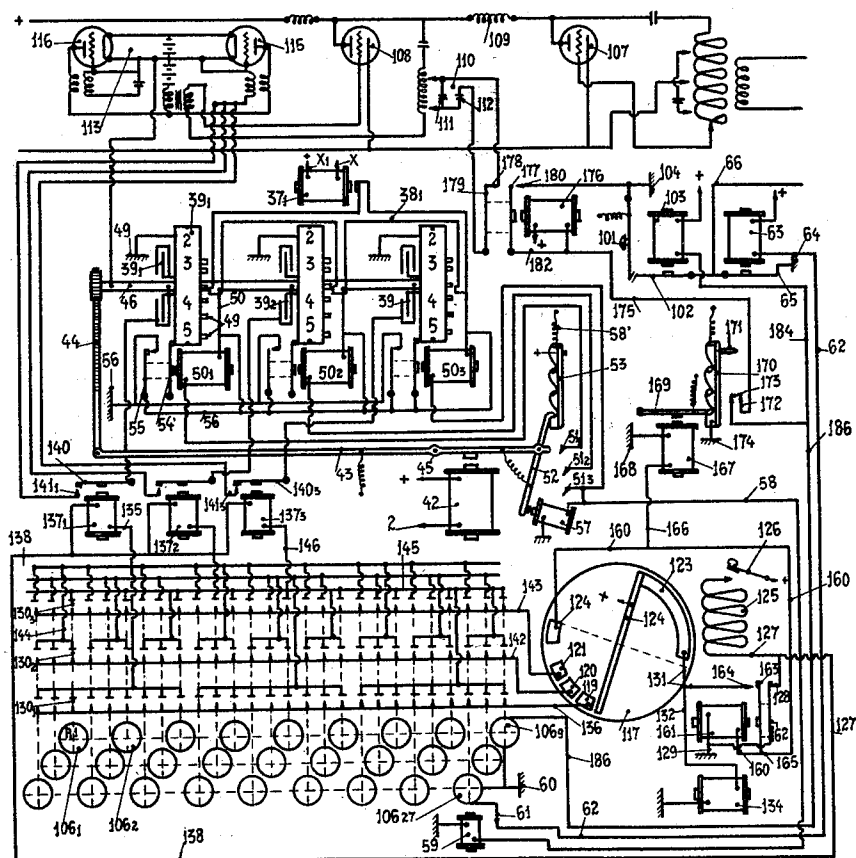
1,889,292

RADIO SIGNALING SYSTEM

Filed March 30, 1931

4 Sheets-Sheet 1

Fig. 1



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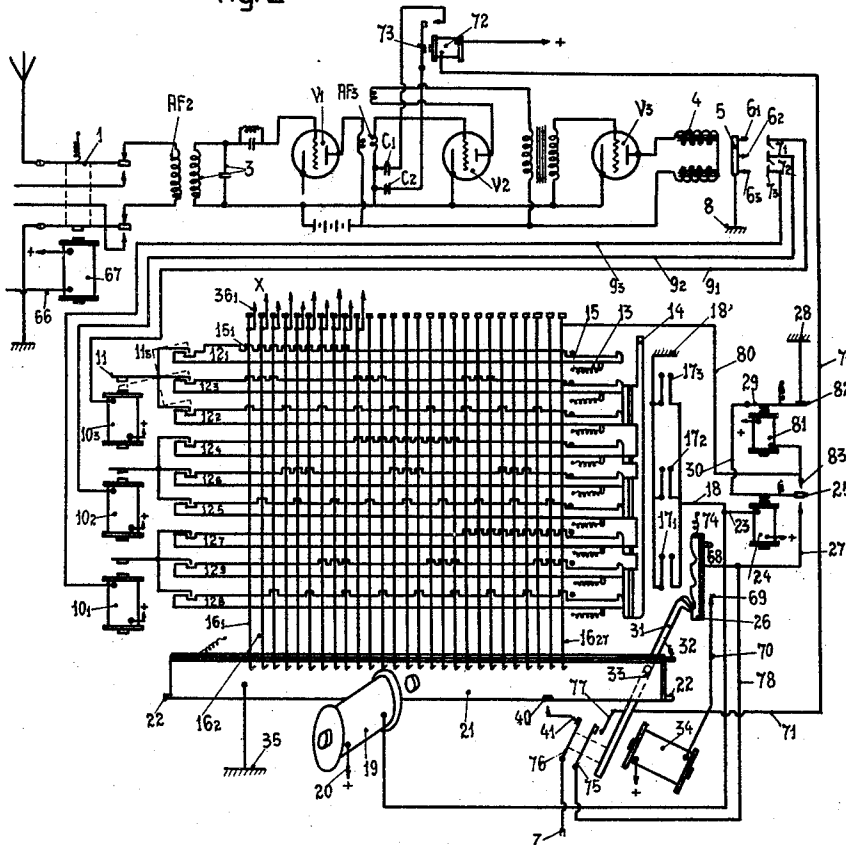
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RADIO SIGNALING SYSTEM

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Fig. 2



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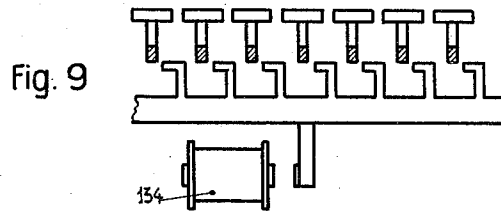
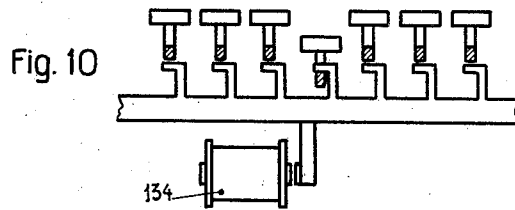
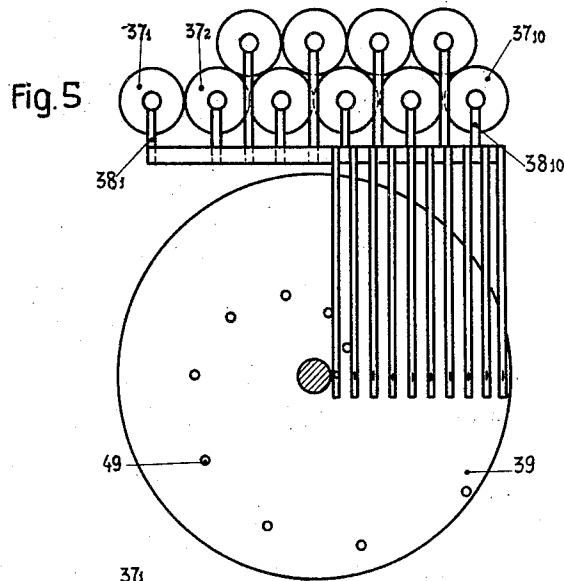
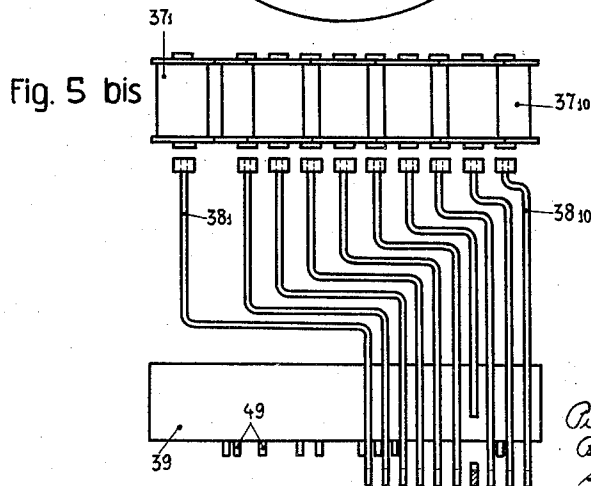
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4 Sheets-Sheet 3



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Fig. 6

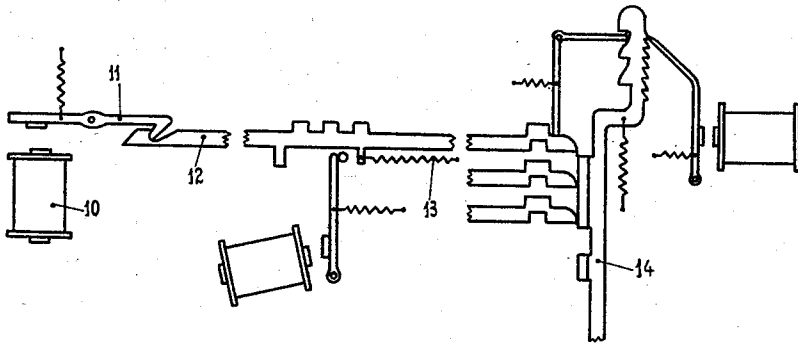


Fig. 7

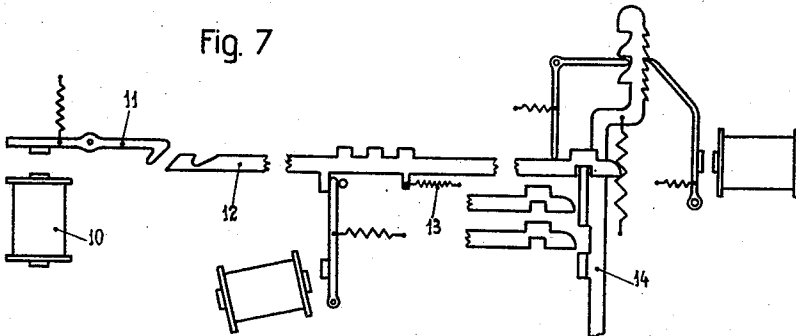
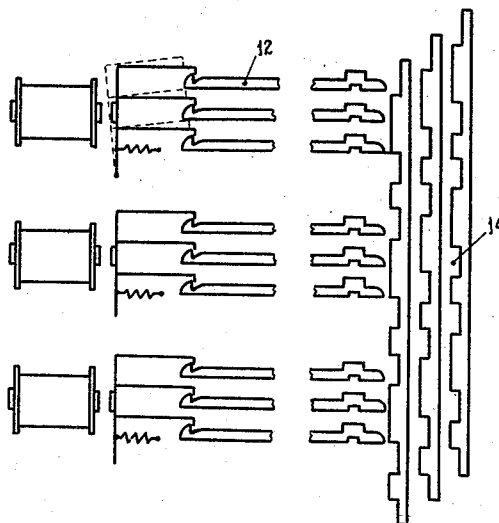


Fig. 8



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UNITED STATES PATENT OFFICE

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RADIO SIGNALING SYSTEM

Application filed March 30, 1931, Serial No. 526,530, and in Italy April 2, 1930.

This invention concerns improvements in radio-signaling systems and its object is to ensure the transmission of signals without any risk of interferences or of disturbances due to foreign waves.

The radio-signaling system according to this invention is of the type employing a carrier wave common to all the apparatus, which are distinguished from one another through the different modulating frequencies used and is essentially characterized by the fact that it employs, besides the carrier wave and the modulating frequencies utilized heretofore, two further frequencies which shall be referred to as "filtering frequencies."

In order that reception may take place, the receiving apparatus must be tuned on the carrier wave of the transmitting apparatus which should send out modulating frequencies corresponding to the characteristic frequencies of the tuned electro-mechanical relays of the receivers, and moreover both apparatus should work on the same "filtering" frequency, i. e. through a suitable filter. Each station has two intermediate filters: the filter numbered 1, and the filter numbered 2.

These filters are equal for all the apparatus and the call-signal or signal of beginning of transmission is sent on the filtering frequency which shall be referred to for clearness' sake as No. 1. Each station A comprises a receiver Ar and a transmitter At ; when the station A desires to send a message to any other station, e. g. B, it sends out by its transmitter At the number of its own receiver Ar to the receiver Br of the station B, equipped with a transmitting apparatus Bt .

As the receiver Br receives this number, it automatically tunes its own transmitter Bt on the said number.

When the station A has completed the transmission of the number, it is automatically brought into receiving conditions. As soon as the station B has tuned its own transmitter Bt on the number of the receiver Ar , it sends to the receiver Ar a conventional "clear" signal.

All these operations are carried out both in transmitting and in receiving through "filter No. 1".

As the receiving station B sends by its transmitting apparatus Bt the "clear" signal, it automatically displaces the filter contact device and becomes connected with "filter No. 2". At the same time the station A having transmitted the number of its receiver Ar by means of At , displaces its own contact device on to the filter No. 2. The two apparatus At and Br now work on filter No. 2 while Ar and Bt remain on filter No. 1.

As all calls are made on filter No. 1 (while the text of the message is transmitted on filter No. 2), if any other station calls the station Br when this is communicating with the station At , the station Br cannot receive the call as it is set on filter No. 2 and consequently it shall not send the "clear" signal. The station B remains therefore perfectly secluded in its communication with the station A without any possibility of other stations interfering or disturbing this communication.

At the end of the message the station At sends an "end" signal which returns its contact device on filter No. 1, the station resuming its receiving position. At the same time the station Br on receiving the "end" signal returns its contact device on filter No. 1 and sends to the station Ar a signal confirming the reception.

The accompanying drawings show by way of example a manner of carrying out the radio-signaling system according to this invention.

Figure 1 shows diagrammatically the transmitting unit of the apparatus.

Figure 2 is a diagram of the receiving unit.

Figures 3 and 4 show the printing mechanism, in the positions of rest and working, respectively.

Figures 5 and 5b are a front and a plan view, respectively, of the device operating the variable condensers.

Figures 6, 7 and 8 show the operation of the bar selecting the rods actuating the printing mechanism.

Figures 9 and 10 show diagrammatically the key locking device.

Referring to the drawings, the apparatus is normally in receiving position. The in-

coming wave passes through the change-over switch 1, the high-frequency transformer AF_2 and the oscillating circuit 3 tuned on the in-coming wave, which is rectified by the electron tube V_1 .

The wave issuing from this latter has now the frequency corresponding to the filtering frequency numbered 1, and is still modulated by the low frequencies of the tuned electro-mechanical relays. This wave passes through the transformer AF_3 ; the oscillating circuit constituted by its natural inductance and by the capacity $C1$ is calibrated on said filtering frequency 1 and is connected to the electron tube V_2 ; the capacity $C2$ being presently cut off. The valve V_2 rectifies the filtering wave; in this manner I can collect the low frequencies on which the filtering wave is modulated.

These low-frequency currents, after having traversed the amplification tube V_3 , flow to the electromagnet 4, which is energized and attracts its armature 5 fast with the vibrating reeds $6_1, 6_2, 6_3$. This armature oscillates with the low-frequency of the in-coming wave corresponding to the natural frequency of one of the vibrating reeds $6_1, 6_2, 6_3$. The vibrating reed having the same frequency as the in-coming wave comes into resonance and attains an amplitude of vibration such that it touches the corresponding contact $7_1, 7_2$ or 7_3 .

This closes a circuit going from the ground 8 to the reed 6, contact 7, conductor 9, electromagnet 10 to the positive pole.

Supposing now the in-coming modulating low-frequency wave has a frequency corresponding to that of the reed 6_3 , the electromagnet 10_3 is energized and attracts its armature 11, which takes the position 11b shown in dotted lines. This releases three teeth which held up the three rods $12_1, 12_2, 12_3$. These rods under the action of the springs 13 tend to move towards the right, but a stop bar 14 will permit the displacement to the right of the rod 12_1 only, which is moved until it abuts the stop tooth 15. The other two rods are locked in position and when the electromagnet 10_3 is disenergized they are again engaged by the hooks of the armature 11.

As the bar 12_1 is displaced, the stop bar 14 is lifted by a bell crank lever (Figures 6 to 8) to the upper portion of the drawings, so as to allow the displacement of the rod 12_2 .

If the frequency of the second in-coming wave corresponds to that of the vibrating reed 6_3 , the electromagnet 10_3 is again energized, the rods $12_1, 12_2, 12_3$ are released and the rod 12_2 being no longer restrained by the stop bar 14 moves to the right. On the arrival of the third frequency (which is now supposed to correspond again to that of the reed 6_3) the rod 12_3 is moved to the right in the same manner as the rods 12_1 and 12_2 .

These three rods are displaced by an extent corresponding to the pitch of the teeth $15'$.

By virtue of the displacement of the three rods $12_1, 12_2, 12_3$, the type bar 16_1 falls into the teeth hollow and is lowered with respect to all the other type bars 16_2-16_{27} .

The displacement of the rod 12_3 actuates the contacts 17 which are caused to engage together.

This closes a circuit going from the ground 18', through the contact 17_3 , conductor 18, electromagnet 19, to the positive pole. The electromagnet 19 is energized and attracts its own armature 21 pivoted at 22. This latter, in moving towards the electromagnet 19, finds on its way the type bar 16_1 previously lowered, engages this bar and carries same along, actuating the type lever of an ordinary typewriting machine to which it is connected, as shown in Figures 3 and 4.

When printing has been effected, the rods 12 are returned to their initial position by relays, the exciting circuit whereof is established by the closure of the contacts 17 (Figs. 6 to 8), with the result that the contacts 17 are released from each other. The operation described with reference to the type bar 16_1 and effected by means of the displacement of three of the rods 12_1 to 12_3 , i. e. by the combination of three frequencies, is the same for any letter of the alphabet, i. e. for any of the type bars 16_1 to 16_{27} .

The displacement of the three rods $12_3, 12_6, 12_9$ (i. e. of the last frequency of the triplet of frequencies constituting the combination) besides closing one of the contacts $17_1, 17_2, 17_3$, establishes a circuit going from the negative pole 18, through the contacts 17, conductors 18 and 23, electromagnet 21 to the positive pole.

This electromagnet is of the delay-action type and keeps the armature attracted during a certain predetermined time after the break of its exciting circuit. At the closure of one of the contacts $17_1, 17_2, 17_3$ this electromagnet attracts and keeps attracted its armature 25 even after the release of one of the contacts 17. This grounds the selecting bar 26 by means of a circuit going from the ground 28, through the armature 29, conductor 30, armature 25, contact and conductor 27 and selecting bar 26 to the positive pole.

A pawl 31 is attached by the spring 32 to the bar 26, said pawl being pivoted at 33 on the armature 21. The pawl 31 builds the armature of the relay 34.

As mentioned above, the transmitter At communicating with the receiver Br first sends out the number distinguishing its own receiver, whereupon At changes its filtering frequency so as to be secluded from any interference.

The receiver Br shall therefore record the number distinguishing the receiving apparatus Ar of the transmitting station and

tune its transmitter Bt on the number distinguishing the receiver Ar of the transmitting station A with which it is in communication.

5 The receiver Br shall then change the tuning of the filtering circuit by going over to the filter numbered 2 and shall cause Bt to send out the "clear" signal, this being effected by Bt on the filter Fz.

10 These operations are effected only when all the figures building the number distinguishing the station A have been received.

When the armature 21 is displaced towards 19, the pawl carries along the selecting bar 26 by one tooth. The bar 26 is then locked in this position by a lock tooth (not shown).

As mentioned above, one of the 27 type bars is simultaneously lowered for printing. Let us suppose now the receiver of the transmitting station is distinguished by the number 123. The bar carrying No. 1 is lowered, engages the armature 21 and prints Figure 1.

20 The armature 21 grounded at 35 grounds the type bar 16₁ thus closing a circuit going from the ground 35, armature 21, type bar 16₁, conductor 36₁, XX₁, X₁ (see transmitter) and electromagnet 37₁ to the positive pole.

This electromagnet 37₁ attracts its armature 38₁ which comes near the cylinder of the condensers 39₁, 39₂, 39₃.

30 The displacement of the armature 21 (Fig. 2) closes a circuit over the ground 35, armature 21, contacts 40 and 41 Z—Z (Fig. 1), electromagnet 42 and positive pole.

35 The electromagnet 42 is energized and attracts its armature 43 which, moving on 45, moves the rack 44 meshing with a pinion keyed on the shaft of the condenser 46, thus rotating this latter slightly beyond one turn.

40 A number of stop teeth corresponding to the number of armatures 38, (ten in the example shown) are secured on one side of the cylinders in front of the armatures 38₁, 38₂, 38₃—38₉.

45 Said teeth are arranged on the cylinder side on a suitable spiral line. The ten armatures and therefore also the ten teeth are placed beside one another.

On the cylinder the tooth No. 1 is e. g. 50 nearest to the center, and on rotation of the cylinder this tooth is stopped by the tooth of the armature 38 when this latter has been attracted by the electromagnet 37₁.

55 Every figure transmitted by the transmitter shall cause a given simultaneous displacement of all the cylinders, i. e. the cylinders carried along by frictional engagement by the shaft receiving its rotation by the rack 44 rotate until one of the teeth 49' abuts the tooth of an armature 38, and more particularly of the armature which has been attracted by the corresponding electromagnet 37.

65 In other words, supposing No. 1 has been transmitted the receiver records this number,

and energizes the electromagnet 37₁; the cylinders are set into rotation; the teeth 1 of the spirally arranged sets of teeth encounter the teeth of the armature 38₁ and all three condensers stop on No. 1 while the shaft 46, 70 overcoming the frictional resistance rotates further under the action of the rack 44.

If another number, i. e. No. 3 is transmitted, instead of No. 1, the electromagnet 37₃ is energized and the cylinders of the condensers stop on No. 3. 75

When the cylinders 39 strike by the tooth No. 1 of the spiral set of teeth against the tooth of the armature 38₁ of the electromagnet 37₁ a circuit is closed over the ground 80 49, cylinders 39, tooth of the armature 38₁ of the electromagnet 37₁, conductor 50, electromagnets 50₁, 50₂, 50₃ and contacts 51₁, 51₂, 51₃.

The pawl 52 engaged by the bar 53 is fast 85 with the armature of the electromagnet 42.

On arrival of the first figure, the pawl 52 carried along by the armature moves by one tooth the bar 53 bringing it into contact with the sector 51₁. The circuit is thus completed 90 over the ground 49, cylinder 39₁, tooth of the armature 38₁, conductor 50, electromagnet 50₁, sector 51₁, bar 53 and positive pole.

The electromagnet 50₁ is energized and attracts the two armatures 54₁ and 55₁. 95

The armature 54₁ is merely a tooth engaging the cylinder 39₁ for locking this latter. However, when the key 106 (see Fig. 1) comes up again, the electromagnet 37₁ is disenergized and releases the armature 38₁ disenergizing the electromagnet 50₁. The cylinder 39₁ must remain locked to prevent its rotation on arrival of the following figures. This is provided for by the contact 55₁. When this latter is attracted, it closes a circuit over the ground 56, contact 55₁, conductor 56', electromagnet 50₁, sector 51₁, bar 53 and positive pole. The electromagnet is thus permanently energized and the armature 54 attracted, so that the cylinder 39₁ remains locked. On arrival 110 of the second number the same operations are repeated on the other two condensers, while the first condenser, being locked, slips on the frictionally coupled shaft.

On arrival of the third figure, only the third 115 condenser is moved, and finally all three condensers are locked according to the three received figures.

When the third figure completing the number has arrived and while the third condenser completes its rotation, the bar 53 which has reached the end of its stroke encounters the sector 51₃. This excites the electromagnet 50₃ and connects the electromagnet 57 with the positive pole, the said electromagnet attracting its armature constituted by the pawl 52. This latter is released from the bar 53 which resumes its normal position under the action of the spring 58' receding from the contacts 51₁, 51₂, 51₃ thus disenergizing the 130

electromagnets 50₁, 50₂, 50₃. From this moment the three condensers are in their position ready for sending out a signal for the receiver *Ar* of the transmitting apparatus *At*.

At the same time as the electromagnet 57 is energized, another circuit is closed over the positive pole, the bar 53, contact 51₃, conductor 58, electromagnet 59 and negative pole. The electromagnet 59 is energized and attracts its armature consisting of the key ϕ and closes a circuit over the ground 60, key ϕ , contacts 61, conductor 62, electromagnet 63 and positive pole. The electromagnet 63 is of the delay-action type and keeps its armature attracted during a certain time, even when the contact 61 is re-opened. The electromagnet 63 by attracting its armature closes a circuit going from the ground 64, contact 65, conductor 66, electromagnet 67 to the positive pole. The electromagnet 67 is energized and attracts the aerial change-over switch into the "transmission" position maintaining it therein as long as the armature of 63 remains attracted, i. e. for a period of time exceeding the duration of the excitation of the electromagnet 59.

As stated above, the electromagnet 59 when energized attracts the key ϕ . This movement corresponds to the depression of the key, and when the electron tubes are set into action by any suitable device (not shown) it is obvious that, as the aerial change-over switch is in the transmission position, and as the positions of the variable modulating condensers 39 correspond to the number distinguishing the receiver *Ar* of the transmitting apparatus *At* which has begun the transmission, the receiver *Ar* shall receive the signal ϕ denoting that the receiver *Br* has received the call and is ready to receive the text of the message.

The same operations are brought about by the "end" signal for confirming reception at the end of the message.

The transmitter at one end and the receiver at the other end can now begin the communication proper which shall be made not on the calling "filtering frequency", but on the communicating filtering frequency, in order to exclude any other influence.

This change is completely automatic both in the transmitter and in the receiver and takes place at the receiver as follows:

On the reception of each number the receiver, besides effecting all other operations, carries along the bar 26 through the pawl 31. When the three figures composing the number of the receiver of the transmitting apparatus have been received, the bar 26 has reached the end of its stroke. The receiver should presently send out the "clear" (ϕ) signal in the manner described above and also change its filtering frequency.

When the bar 26 reaches the end of its stroke, the contact 68 (connected to the

ground through the conductor 27, contacts 25 etc. at 28) contacts with 69 and thus closes a circuit going from the ground 28, armature 29, conductor 30, armature 25, conductor 27, bar 26, sector 68, contact 69, conductors 70, 71, electromagnet 72 to the positive pole. The electromagnet 72 is energized and attracts the armature 73 which connects in the circuit the capacity C2. This latter is connected in parallel to C1 and varies the characteristics and the frequency of the oscillating circuit in which it is connected. The capacity should, however, remain in the circuit during the whole period of the transmission.

When contact between 68 and 69 is effected, the electromagnet 34 is energized and attracts its armatures. One of these is constituted by the pawl 31, which is attracted by 34 and is released from the bar 26. The bar 26 is returned to its normal position by the spring 74 and released from the tooth of the pawl 31 thus breaking the contact between 68 and 69. In order to prevent the electromagnets 34 and 72 from becoming disenergized, the electromagnet 34 when energized attracts two further armatures 75 and 76.

The armature 75, when attracted, contacts with the conductor 77 and closes a circuit over the ground 28, armature 29, conductor 30, armature 25, conductor 27, conductor 78, armature 75, conductor 77, electromagnet 34 and positive pole. The electromagnet 34 remains energized notwithstanding the break of the contact 68 and 69 and the electromagnet 72 also remains energized, this latter being connected in parallel with the electromagnet 34. The pawl 31 being attracted by the electromagnet 34 no longer carries along the bar 26 during the remaining period of transmission.

The electromagnet 42 at the transmitting apparatus (Fig. 1) should be prevented from being energized.

It has been mentioned that the negative pole of the electromagnet 42 was connected through the conductor Z. This conductor Z leads to the armature 76 and when this latter is attracted by the electromagnet 34, the exciting circuit of the electromagnet 42 is broken.

By this arrangement the armature of the electromagnet 42 is attracted when the first three figures are received and it remains in the position of rest during reception of the remainder of the message.

When the whole message has been transmitted, the receiver receives an "end" signal (e. g. the signal ϕ corresponding to the type bar 16₂₇). On arrival of this signal the operations for the automatic sending of the signal ϕ ("clear" signal) are repeated, the latter signal confirming the reception of the message, but on lowering the type bar 16₂₇ a circuit is closed over the ground 35, type bar 16₂₇, conductor 80, electromagnet 81 and posi-

tive pole. The electromagnet 81 is energized and attracts its armature 29 which thus breaks the contact 82.

The negative pole is thus disconnected from all electromagnets which, being disenergized, release their armatures while all the parts resume their position of rest, ready to receive another communication.

In case the "end" signal is not sent through any reason whatever to the receiver at the end of the transmission, the receiver would have its electromagnet 34 permanently energized; moreover, also the electromagnet 72 would be energized so that the capacity C2 of the filter would be connected in the oscillating circuit and the apparatus could not receive any call-signal.

In other words, the apparatus would be completely shut out from any communication and therefore useless. In order to avoid the above drawback the delay-action electromagnet 24 is employed.

On arrival of the first signal this electromagnet is energized by the closure of the contacts 17 and the excitation is maintained for a certain time, after the contacts 17 have been disconnected. This excitation period corresponds to the maximum period running between the printing of two letters. If transmission is interrupted the contacts 17 remain open. When the above said period during which the electromagnet 24 keeps the armature 25 attracted has elapsed without any further signal arriving and energizing the electromagnet 24, this latter releases its armature which under the action of a spring contacts with 83, thus closing a circuit over the ground 28, armature 82, conductor 30, armature 25, contact 83, conductor 80, electromagnet 81 and positive pole. The electromagnet 81 is energized and attracts the armature 82 which disconnects the negative pole from all the electromagnets, as on arrival of the "end" signal described above.

In order to increase the number of the available letters or controls I either provide the normal reversing device employed in telegraphic apparatus on the Baudot's type, or I arrange two or more letters or controls on each rod in a similar manner as for writing small and capital letters in typewriting machines, said means not being shown on the drawings.

When it is desired to call a station, the number corresponding to that of the apparatus with which it is desired to communicate is combined at At by means of the cylinders 39₁, 39₂, 39₃.

The button 101 is then depressed and engaged by the armature 102 of the electromagnet 103. This closes a circuit over the ground, 104, button 101, armature 102, conductor 66, electromagnet 67 to the positive pole. The electromagnet 67 is thus perma-

nently energized and keeps the change-over switch 1 in the transmission position.

Means are provided for simultaneously putting into action the electron tubes, this device not being shown in the drawings.

The number corresponding to the receiver Ar of the transmitting apparatus A is now transmitted by At by depressing the keys of a keyboard similar to that of a typewriter and shown at 106₁, 106₂—106₂₇.

The transmitting unit is provided, e. g., with an oscillating tube 107, of which the oscillating circuit is tuned on the carrier wave. By any modulating system (in the example shown by the plate current Heising's system) the width of the oscillations of the said tube is controlled by the oscillations of a second oscillating tube 108. In other words, the oscillations of the tube 107 are modulated by those of the tube 108 through the impedance 109. The frequencies of the oscillations of the tube 108 (referred to as "filtering" frequencies) are imposed by the circuit 110 comprising a self-induction and two capacities 111 and 112. The oscillations of 108 are modulated in turn by a beat heterodyne 113, the variable capacities whereof are constituted by the condensers 39₁, 39₂, 39₃.

The oscillating "filtering" tube 108 at the beginning of the transmission will oscillate on the frequency given by the self-inductance plus the capacity 111 (the capacity 112 shall be disconnected) i. e. said circuit shall be tuned on the filtering frequency No. 1 as described in connection with the receiver.

The signals, as explained above, consist of a plurality of equal or different low frequencies modulating the filtering frequency and sent out successively by groups. In the example shown the unit is set for the use of three frequencies for each group.

These three frequencies must be sent successively and the combination of said frequencies individualizes a given signal. The three capacities 39₁, 39₂, 39₃ must be inserted successively in the circuit of the heterodyne 113. This heterodyne, which in the example shown in a low-frequency heterodyne obtained by the beats generated by the difference of the oscillations of the two tubes 115 and 116 can be replaced by any suitable low-frequency oscillator of known type, such as e. g. alternators, phonic wheels, oscillating or aperiodic electric circuits supplying alternating current of a given frequency being controlled by piezo-resonators, or by magnetization resonators or simply by diapasons or vibrating reeds, without departing from the object of this invention. 117 is a three-frequency distributor.

Supposing now a key of the key-board, e. g. the key 106₁ (A/1) is depressed:

By depressing the key 106₁, the contacts 126 are closed and a circuit is established going from the positive pole, contacts 126,

coil 125 of the distributor, conductor 127, contacts 128 to the ground at 129. The coil 125 being thus energized, the distributor 117 sets into rotation by a righthand motion the brush 124. The depression of the key 106, closes also the contacts 130₁, 130₂, 130₃. The brush 124 connected with the positive pole thus commences its rotation and connects the positive pole with the sector 123 establishing a circuit going through the conductors 131 and 132 and electromagnet 134 to ground. This electromagnet (see Figures 9 and 10) serves for keeping the keys 106 locked during the forward and return stroke of the brush 124, so as to avoid opening of the contacts 128 or 130 before the brush 124 has completed its rotation and to prevent an excessively quick operation of the keys with the risk of superposition of frequencies.

The keys are locked until the brush 124 resumes its position of rest. The rotating brush 124 finds on its way first the sector 119, closing a circuit over the positive pole through the brush 124, conductor 136, contacts 130₁, conductor 135, coil of the electromagnet 137₁, conductor 138, contacts 128 and the ground at 129.

The electromagnet 137₁ is thus energized and attracts its armature against the contact 141 connecting (for the period of time during which the brush 124 slides on the sector 119) the capacity 39₁ into the circuit of the electron tube 115.

The brush 124 pursues its rotation and releases the sector 119 and the electromagnet 137₁ being disenergized releases the armature 140 and the brush rotates further passing on the sector 120.

This closes a circuit over the positive pole, brush 124, sector 120, conductor 142, contact 130₂, conductors 144 and 135, electromagnet 137₂, conductor 138, contact 128 and ground 129.

The electromagnet 137₂ is again energized and the previous operation is again carried out.

The brush 124, after receding from the sector 120, passes on the sector 121 closing a circuit over the positive pole, brush 124, conductor 143, contacts 130₃, conductors 145 and 146, electromagnet 137₃, conductor 138, contact 128 and ground 129. The electromagnet 137₃ attracts the armature 140₃ on the contact 141₃ and thus connects in the circuit of the tube 115 the capacity 39₃. By lowering the key 106, three oscillations modulating the filtering frequency and distributed as follows take place: the first and the second on the capacity 39₁ and the third on the capacity 39₃.

The brush 124 pursuing its stroke attains the sector 122, closing a circuit over the positive pole, brush 124, sector 122, conductor 160, electromagnet 161 and ground 129. This electromagnet is energized and attracts its

armatures 162, 163 releasing the contact 128 and disenergizing the coil 125. The brush 124 commences its return stroke under the action of a spring, but it must be prevented from energizing the electromagnets 137₁, 137₂, 137₃ when passing over the sectors 121, 120, 119. For this purpose, the armature 162, 163 of the electromagnet 161 must remain attracted, even if the brush 124 withdraws from the sector 122. When the brush 124 touches the sector 122, the contact 164 is closed and a circuit is established over the positive pole, brush 124, sector 123, conductor 131, contacts 164, conductors 165 and 160, electromagnet 161 and ground 129.

However, as the brush 124 is continuously in contact (both in the forward and return stroke) with the sector 123, the electromagnet 161 remains energized. Therefore the armature 62 is attracted and the contact 128 is open during the whole period of the return stroke. The electromagnets 137₁, 137₂, 137₃ remain therefore disconnected from the ground during the return stroke and cannot be energized by the contact with the brush 124. After completing its return stroke, the brush 124 recedes from the sector 123 and all the parts resume their normal position.

Every time the brush 124 comes into contact with the sector 122 a circuit is closed over the positive pole, brush 124, sector 122, conductor 166, electromagnet 167 and ground at 168. The electromagnet 167 is energized and attracts the armature 169 which lowers by one tooth a rack 170 engaged therewith. This is repeated at the sending of each signal. It has been explained above that the receiver, when the first three figures have been received, goes over automatically to the filtering frequency No. 2. The same operation shall take place at the transmitting end. When the first three signals have been sent (said signals corresponding to the three figures distinguishing the receiver) the bar 170 has been lowered by three teeth. The sector 171 is now in contact with the contacts 172 and 173. This closes a first circuit over the ground 174, bar 170, sector 171, contact 172, conductor 175, electromagnet 176 and positive pole. The electromagnet 176 is energized and attracts the two armatures 177 and 179 against the contacts 178 and 180, closing a first circuit over the ground 104, contact 180, armature 177, conductor 182, electromagnet 176 and positive pole, thus maintaining the electromagnet energized.

The contacts 178 and 179 also close connecting in the circuit of the tube 108 the capacity 112, in other words setting the tube 107 on the filtering frequency No. 2, the message being transmitted on said frequency.

After transmitting the number of the receiver, the transmitter should come automatically into the receiving position in order to receive the "clear" signal.

For this purpose, when the bar 170 has brought the sector 171 into contact with 173, a circuit is closed over the ground 174, bar 170, sector 171, contact 173, conductor 184, electromagnet 103 and positive pole. This electromagnet is energized and attracts its armature 102 which is disconnected from 101, thus disconnecting the ground from the electromagnet 67 which releases its armatures 1, these latter resuming the receiving position. After reception of the "clear" signal, the pawl 101 is again lowered and re-engages the armatures 102, energizing again the electromagnet 67 and bringing all the parts in working conditions for transmitting the message on filter No. 2 which has been left in the circuit during the above operation.

At the end of the message, the "end" key denoted by 106, is depressed. This key is grounded at 60 and it sends out the "end" signal besides closing a circuit over the ground 60, conductors 186 and 184, electromagnet 103 and positive pole. The electromagnet 103 is energized and returns the aerial change-over switch in receiving position and, through any suitable mechanism (not shown) it disconnects the ground from all the electromagnets returning these latter to their normal position, whereby the electromagnet 176 releases the armature 179 and returns the transmitter in working conditions on the call-frequency (filter No. 1).

The whole arrangement is provided for 999 apparatus, but it will be obvious that by suitably arranging the capacity on the heterodyne the combinations can be raised to numbers of 6 or 9 or a larger number of groups of three figures.

What I claim is:

1. A radio-signaling system comprising in combination with an oscillating circuit at a transmitting station and an oscillating circuit at a receiving station, means at the transmitting station for superposing at will in turn on a carrying wave of constant frequency two waves of different high frequencies, means for superposing on the carrying wave modulated to one of said high frequency waves groups of frequencies for the call of the receiving station and for superposing on the carrying wave modulated to the other high frequency wave groups of frequencies constituting the signals and means at the receiving station for passing automatically from the call-receiving condition to the message-receiving condition.

2. Radio-signaling system, comprising, in combination, a plurality of stations each having a transmitting unit and a receiving unit, a two-frequency filter in said transmitting and receiving units, respectively, for modulating and demodulating, respectively, a carrier wave common to all the stations, said filter being normally set on one of said frequencies for the call, means for superposing

at any of said stations on the wave modulated by said filtering frequency a predetermined frequency group for calling a given station, means at said given station for automatically re-transmitting to said first station said call-signal, means for automatically setting, at the two stations communicating together, the respective filters on the other frequency for shutting off the remaining stations, means at the transmitting unit of the first station for superposing on the wave modulated by said second filtering frequency groups of frequencies constituting the signals of a message and means at the receiving unit of the second station for demodulating said groups of frequencies for the reception of the message.

3. Radio-signaling system comprising, in combination, a plurality of stations each having a transmitting unit, a receiving unit, a common aerial and an automatic change-over switch arranged between the aerial and said units and normally kept in receiving position, a two-frequency filter in said transmitting and receiving units, respectively, for modulating and de-modulating, respectively, a carrier wave common to all the stations, said filter being normally set on one of said frequencies for the call, means for superposing at any of said stations on the wave modulated by said filtering frequency a predetermined frequency group for calling a given station, means at said given station for automatically re-transmitting to said first station said call-signal, means for automatically setting, at the two stations communicating together, the respective filters on the other frequency for shutting off the remaining stations, means at the transmitting unit of the first station for superposing on the wave modulated by said second filtering frequency groups of frequencies constituting the signals of a message and means at the receiving unit of the second station for demodulating said groups of frequencies for the reception of the message.

4. Radio-signaling system comprising, in combination, a plurality of stations each having a transmitting unit, a receiving unit, a common aerial and an automatic change-over switch arranged between the aerial and said units and normally kept in the receiving position, a two-frequency filter in each of said units, said filter being normally set on one of said frequencies for the call, a modulating circuit in said stations having variable condensers for tuning the receiving unit of one station with the sending unit of another station, a common shaft on which the movable armatures of said condensers are mounted, an electromagnet for rotating said shaft through a rack mechanism and a friction coupling, said electromagnet being energized by a group of in-coming call frequencies, a set of stop-teeth secured on a spiral line to

said condensers, a set of electromagnets energized also by a group of in-coming frequencies and provided with stop armatures, each of which carries teeth adapted to engage with one of the teeth secured to the condensers in order to hold these latter in the position corresponding to the call-signal, means at the receiving unit of said stations for re-transmitting the call-signal and automatically setting the respective filter on the other frequency, means at the transmitting unit of said stations for superposing on the wave modulated by said second frequency groups of frequencies constituting the signals of the message and means at the receiving unit for demodulating the groups of frequencies constituting the signals for the reception of the message.

5. Radio-signaling system comprising, in combination, a plurality of stations each having a transmitting unit, a receiving unit, a common aerial and an automatic change-over switch arranged between the aerial and said units and normally kept in the receiving position, a two-frequency filter in each of said units, said filter being normally set on one of said frequencies for the call, a modulating circuit in said stations having variable condensers for tuning the receiving unit of one station with the sending unit of another station, a common shaft on which the movable armatures of said condensers are mounted, an electromagnet for rotating said shaft through a rack mechanism and a friction coupling, said electromagnet being energized by a group of in-coming call frequencies, a set of stop teeth secured on a spiral line to said condensers, a set of electromagnets energized also by the group of in-coming frequencies and provided with stop armatures, each or which carries teeth adapted to engage with one of the teeth secured to the condensers in order to hold these latter in the position corresponding to the call-signal, an electromagnet for locking said condensers in adjusted position when the stop electromagnets are disenergized, means at the receiving unit of said stations for re-transmitting the call-signal and automatically setting the respective filter on the other frequency, means at the transmitting unit of said stations for superposing on the wave modulated by said second frequency groups of frequencies constituting the signals of the message and means at the receiving unit for demodulating the groups of frequencies constituting the signals for the reception of the message.

6. Radio-signaling system comprising, in combination, a plurality of stations each having a sending unit, a receiving unit, a common aerial, a change-over switch arranged between the aerial and said units and normally kept in receiving position, an electromagnet controlling said switch, a delay-action electromagnet controlling the exciting

circuit of the first mentioned electromagnet for bringing the switch into its transmitting position, a two-frequency filter in said sending and receiving units, respectively, for modulating and de-modulating, respectively, a constant carrier wave common to all the stations, said filter being normally set on one of said frequencies for the call, means in one of said stations for superposing on the wave modulated by said filtering frequency a predetermined frequency group for calling a given station, means at said second station for automatically re-transmitting to said first station said call-signal, means for automatically setting, at the two stations communicating together, the respective filters on the other frequency for shutting off the remaining stations, means at the transmitting unit of the first station for superposing on the wave modulated by said second filtering frequency groups of frequencies constituting the signals of a message and means at the receiving unit of the second station for de-modulating said groups of frequencies for the reception of the message.

7. Radio-signaling system comprising, in combination, a plurality of stations each having a sending unit, a receiving unit, a common aerial, a change-over switch arranged between the aerial and said units and normally kept in receiving position, an electromagnet controlling said switch, a delay-action electromagnet controlling the exciting circuit of the first mentioned electromagnet for bringing the switch into its transmitting position, a two-frequency filter in said sending and receiving units, respectively, for modulating and demodulating, respectively, a constant carrier wave common to all the stations, said filter being normally set on one of said frequencies for the call, a modulating circuit in said stations having variable condensers, a common shaft on which the movable armatures of said condensers are mounted, an electromagnet for rotating said shaft through a rack mechanism and a friction coupling, said electromagnet being energized by a group of in-coming call frequencies, a set of stop teeth secured on a spiral line to said condensers, a set of electromagnets also energized by the group of incoming frequencies and provided with stop armatures, each of which carries teeth adapted to engage with one of the teeth secured to the condensers in order to hold these latter in the position corresponding to the call-signal, means at the receiving unit of said stations for re-transmitting the call-signal and automatically setting the respective filter on the other frequency, means at the transmitting unit of said stations for superposing on the wave modulated by said second frequency groups of frequencies constituting the signals of the message and means at the receiving unit for demodulating the groups of

frequencies constituting the signals for the reception of the message.

8. Radio-signaling system, comprising, in combination, a plurality of stations each having a transmitting unit and a receiving unit, a two-frequency filter in said transmitting and receiving units, respectively, for modulating and demodulating, respectively, a carrier wave common to all the stations, said filter being normally set on one of said frequencies for the call, means for superposing at any of said stations on the wave modulated by said filtering frequency a predetermined frequency group for calling a given station, means at said given station for automatically retransmitting to said first station said call-signal, means for automatically setting, at the two stations communicating together, the respective filters on the other frequency for shutting off the remaining stations, means at the transmitting unit of the first station for superposing on the wave modulated by said second filtering frequency groups of frequencies constituting the signals of a message, means at the receiving unit of the second station for demodulating said groups of frequencies for the reception of the message and a delay-action electromagnet for returning the receiving unit to its initial position ready for the call, when the sending station sends at the end of the message an "end" signal.

9. Radio-signaling system comprising, in combination, a plurality of stations each having a sending unit, a receiving unit, a common aerial, a change-over switch arranged between the aerial and said units and normally kept in receiving position, an electromagnet controlling said switch, a delay-action electromagnet controlling the exciting circuit of the first mentioned electromagnet for bringing the switch into its transmitting position, a two-frequency filter in said sending and receiving units, respectively, for modulating and de-modulating, respectively, a constant carrier wave common to all the stations, said filter being normally set on one of said frequencies for the call, means in one of said stations for superposing on the wave modulated by said filtering frequency a predetermined frequency group for calling a selected station, means at said selected station for automatically re-transmitting to said first station said call-signal means for automatically setting, at the two stations communicating together, the respective filters on the other frequency for shutting off the remaining stations, means at the transmitting unit of the first station for superposing on the wave modulated by said second filtering frequency groups of frequencies constituting the signals of a message and means at the receiving unit of the second station for de-modulating said groups of frequencies for the reception of the message and a delay-action electromagnet

for returning the receiving unit to its initial position ready for the call, when the transmitting station at the end of the message sends an "end" signal.

10. Radio-signaling system comprising, in combination, a plurality of stations each having a transmitting unit, a receiving unit, a common aerial and an automatic change-over switch arranged between the aerial and said units and normally kept in receiving position, an operating keyboard at the sending unit, a printing mechanism in the receiving unit, a relay controlling said change-over switch, a delay-action relay the circuit whereof is controlled by a key of the keyboard for closing the circuit of the first relay in order to bring the change-over switch in transmitting position, a two-frequency filter in said transmitting and receiving units, respectively, for modulating and de-modulating, respectively, a carrier wave common to all the stations, said filter being normally set on one of said filtering-frequencies for the call, means for superposing, at any of said stations, on the wave modulated by said first filtering frequency a group of predetermined frequencies for calling a selected station, means at the selected station for automatically re-transmitting to the first station said call-signal and for automatically setting, at the two stations communicating together, the respective filters on the other frequency in order to shut off the other stations, means, at the transmitting unit of a station, controlled by the keyboard for superposing on the wave modulated by said second filtering frequency groups of frequencies constituting the signals of the message, means at the receiving unit of the other station, for de-modulating said groups of frequencies and for actuating the printing mechanism, an "end" relay the exciting circuit whereof is controlled by the "end" key of the keyboard, in order to break the circuits controlling the printing mechanism and a delay-action switch for energizing said "end" relay if the "end" key is not lowered.

11. Radio-signaling system comprising, in combination, a plurality of stations each having a sending unit and a receiving unit, a filtering circuit in said sending unit and in said receiving unit for modulating and demodulating, respectively, a carrier wave common to all the stations, a capacity being normally placed in said filtering circuit for the call and a second capacity being connected at will therein for the transmission, means for superposing, at any of said stations, on the wave modulated by the first filtering frequency a predetermined group of frequencies, for calling a selected station, means at the selected station for automatically transmitting to the first station a "clear" signal, a relay for placing in the filtering circuit said second capacity both at the sending unit and at the receiving unit, a movable

member both at the transmitting station and at the receiving station which, at the end of transmission and reception, respectively, of the call-signal, closes the exciting circuit of said relay, so as to seclude said stations from the remaining stations, means at the transmitting unit of the first station for superposing on the wave modulated by said second filtering frequency groups of frequencies constituting the signals of a message and means at the receiving unit of the second station for demodulating said groups of frequencies for the reception of the message.

12. Radio-signaling system as claimed in claim 10, comprising, in combination, a lock bar for the keys of the keyboard for preventing the operation of the keys before all the transmission operations in connection with the depressed key have been effected, a relay for actuating said bar and an exciting circuit for said relay controlled by said keys.

13. Radio-signaling system comprising, in combination, a plurality of stations each having a transmitting unit, a receiving unit, a common aerial and an automatic change-over switch arranged between the aerial and said units and normally kept in receiving position, a two-frequency filter in each of said units, said filter being normally set on one of said frequencies for the call, a modulating circuit having variable condensers for tuning the receiving unit of one station with the transmitting unit of the other station, an electromagnet controlling said variable condensers energized by the in-coming call-frequency group, a set of holding electromagnets also energized by the in-coming call-frequency group and provided with stop armatures for holding said variable condensers in adjusted position for the call, a control member for said electromagnets which is displaced, against the action of a spring, at the arrival of each frequency of the call frequency group, a relay for releasing said movable member, an exciting circuit for said relay which is closed by said movable member at the arrival of the last frequency of the call-frequency group in order to break the exciting circuits of said holding electromagnets, means at the receiving unit of said stations for re-transmitting the call-signal and automatically setting the respective filter on the other frequency, means at the transmitting unit of said stations for superposing on the wave modulated by said second frequency groups of frequencies constituting the signals of the message and means at the receiving unit for demodulating the groups of in-coming frequencies.

14. Radio-signaling system comprising, in combination, a plurality of stations each having a sending unit and a receiving unit, a common aerial, an automatic change-over switch arranged between the aerial and said

units and normally kept in receiving position, an operating keyboard at the sending unit, a printing mechanism at the receiving unit, an operating electromagnet having an oscillating armature, hooked rods connected with the type levers of said printing mechanism and adapted to be carried along by said oscillating armature, operating bars normally keeping said hooked rods clear of the path of said armatures, said operating bars being displaced in axial direction under the control of groups of frequencies constituting an in-coming signal, a selecting bar for permitting the displacement of the operating bars only which correspond to the frequencies constituting the signal, so as to cause the hooked rod corresponding to the signal to fall on the path of said armature and a switch in the exciting circuit of said electromagnet, said switch being closed by the last operating bar displaced in the group corresponding to the group of frequencies constituting the in-coming signal.

15. Radio-signaling system comprising, in combination, a plurality of stations each having a sending unit and a receiving unit, a common aerial, an automatic change-over switch arranged between the aerial and said units and normally kept in receiving position, an operating keyboard at the sending unit, a printing mechanism at the receiving unit, an operating electromagnet having an oscillating armature, hooked rods connected with the type levers of said printing mechanism and adapted to be carried along by said oscillating armature, operating bars normally keeping said hooked rods clear of the path of said armatures, said operating bars being displaced in an axial direction under the control of groups of frequencies constituting an in-coming signal, a selecting bar for permitting the displacement of the operating bars only which correspond to the frequencies constituting the signal, so as to cause the hooked rod corresponding to the signal to fall on the path of said armature, a switch in the exciting circuit of said electromagnet, said switch being closed by the last operating bar displaced in the group corresponding to the group of frequencies constituting the in-coming signal and means for automatically returning the operating bars and the selecting bar to their initial position of rest.

16. Radio signaling system comprising, in combination, a plurality of stations each having a sending unit and a receiving unit, a common aerial, an automatic change-over switch arranged between the aerial and said units and normally kept in receiving position, an operating keyboard at the sending unit, a printing mechanism at the receiving unit, an operating electromagnet having an oscillating armature, hooked rods connected with the type levers of said printing mechanism and adapted to be carried along by said os-

cillating armature, operating bars normally keeping said hooked rods clear of the path of said armatures, said operating bars being displaced in axial direction under the control of groups of frequencies constituting an in-coming signal, a selecting bar for permitting the displacement of the operating bars only which correspond to the frequencies constituting the signal, so as to cause the hooked rod corresponding to the signal to fall on the path of said armature and a switch in the exciting circuit of said electromagnet, said switch being closed by the last operating bar displaced in the group corresponding to the group of frequencies constituting the in-coming signal, and electromagnets for returning the operating bars and the selecting bar in their position of rest, the exciting circuits of said electromagnets being controlled by said switch.

In testimony that I claim the foregoing as my invention, I have signed my name.

PIER CARLO RICCHIARDI.