

July 23, 1946.

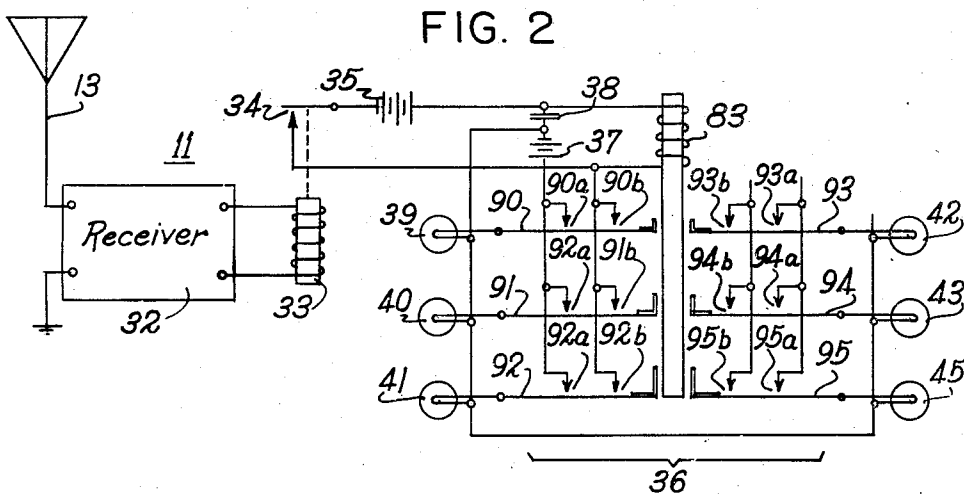
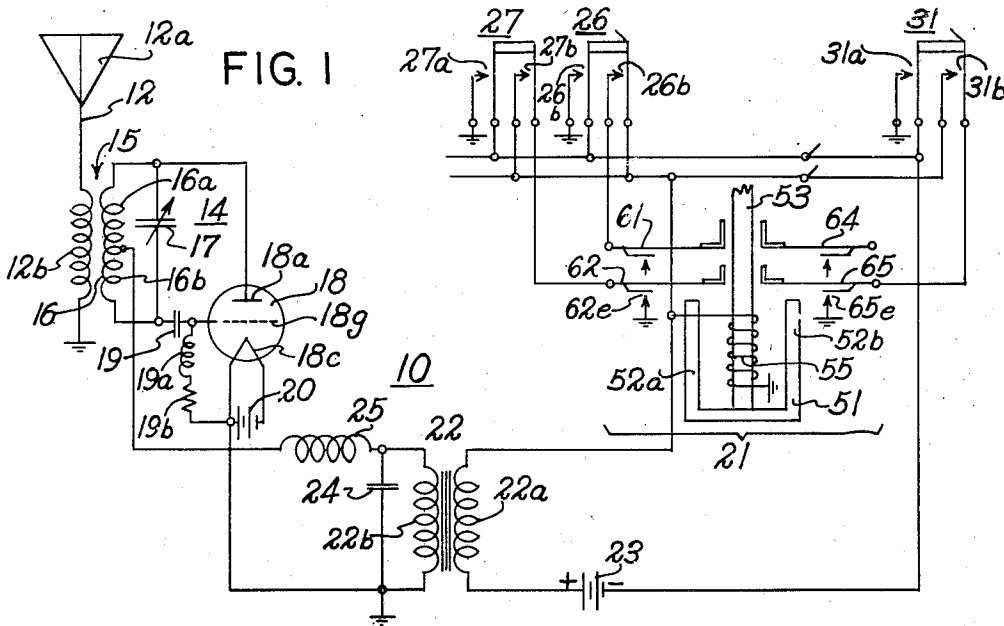
A. W. PLENSLER

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SIGNAL RECEIVING AND TRANSLATING APPARATUS

Filed Jan. 20, 1944

3 Sheets-Sheet 1



INVENTOR.

ALEXANDER W. PLENSLER

BY

Joorman L. Mueller

ATTORNEY

July 23, 1946.

A. W. PLENSLER

2,404,401

SIGNAL RECEIVING AND TRANSLATING APPARATUS

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FIG. 3

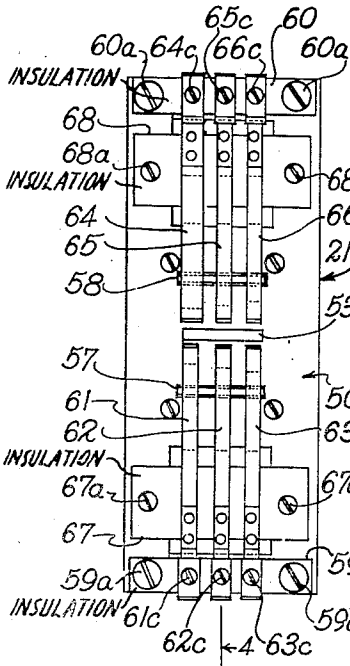


FIG. 4

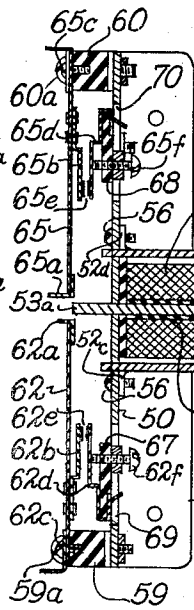
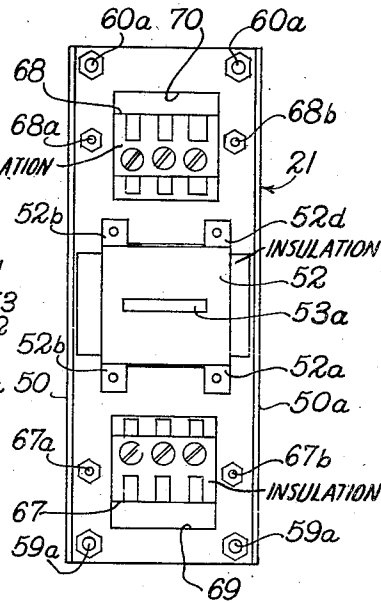


FIG. 5



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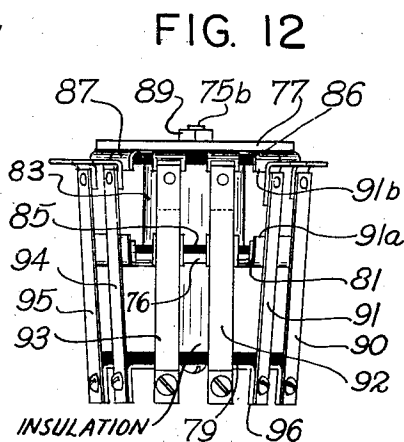
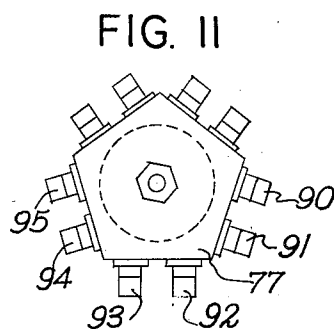
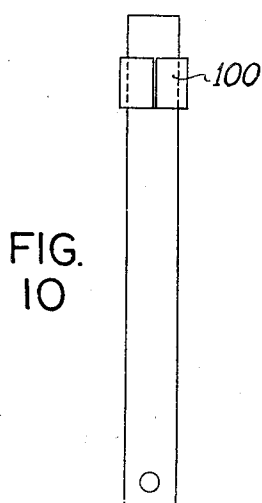
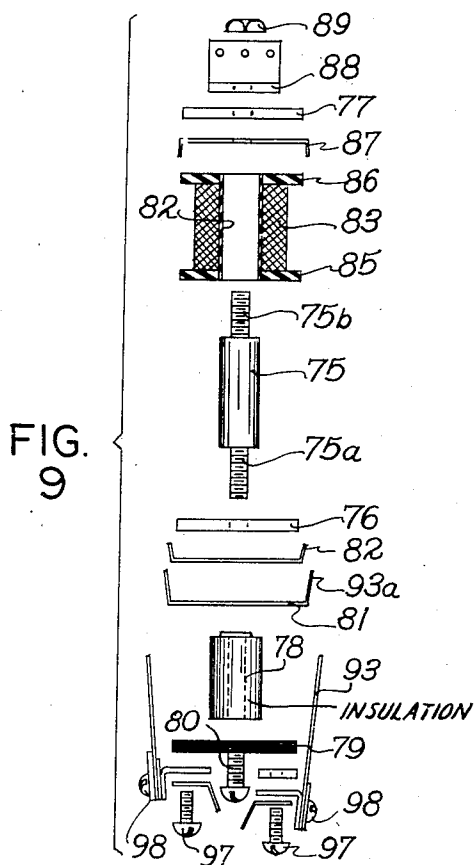
A. W. PLENSLER

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SIGNAL RECEIVING AND TRANSLATING APPARATUS

Filed Jan. 20, 1944

3 Sheets-Sheet 3



INVENTOR
ALEXANDER W. PLENSLER

BY

Isaiah L. Muller

ATTORNEY

UNITED STATES PATENT OFFICE

2,404,401

SIGNAL RECEIVING AND TRANSLATING
APPARATUS

Alexander W. Plensler, Chicago, Ill., assignor, by
mesne assignments, to Belmont Radio Corpora-
tion, Chicago, Ill., a corporation of Illinois

Application January 20, 1944, Serial No. 518,956

9 Claims. (Cl. 177-353)

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The present invention relates to control or signalling systems, and, more particularly, to improvements in signal carrier receiving and translating apparatus.

It is an object of the present invention to provide improved signal carrier receiving and translating apparatus which is exceedingly simple in its structural arrangement and mode of operation, and yet is thoroughly accurate and reliable in its selective response to different received signals.

It is another object of the invention to provide improved interrupted carrier receiving apparatus in which differently tuned vibratory elements of a vibratory reed system are selectively controlled in accordance with the different frequencies at which a received carrier may be interrupted to provide the desired signal translation.

It is a further object of the invention to provide improved receiving apparatus of the character described which is highly selective in its response to received signals and yet is substantially non-responsive to noise or to the transmission of physical shock to the vibratory reed system.

It is still another object of the invention to provide receiving apparatus of the character described which includes so few parts and is so simple in its structural requirements that it lends itself to the construction of a small portable unit which is entirely self-contained.

According to still another object of the invention, the apparatus is arranged in an improved manner such that operation of any one of the reeds to a signal translating setting positively prevents operation of the other reeds of the system to their respective signal translating settings.

In accordance with another feature of the invention the apparatus is arranged in a simple manner, which is non-critical as to frequency, to utilize the first few signal pulses of a received signal of any frequency in the actuation of the corresponding vibratory reed to a signal translating setting, and to utilize the following signal pulses of the signal to hold the actuated reed in its signal translating setting for the duration of the signal reception.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the specification taken in connection with the accompanying drawings in which:

Fig. 1 schematically illustrates improved carrier transmitting apparatus adapted for use in

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conjunction with the present improved receiving apparatus;

Fig. 2 schematically illustrates the present improved receiving apparatus characterized by certain features of the present invention;

Fig. 3 is a top plan view of the improved vibratory reed device embodied in the transmitting apparatus shown in Fig. 1;

Fig. 4 is a side sectional view of the device shown in Fig. 3;

Fig. 5 is a bottom plan view of the device shown in Fig. 3.

Fig. 6 is a side view of the vibratory reed device embodied in the receiving apparatus shown in Fig. 2;

Fig. 7 illustrates the device shown in Fig. 6 when rotated through 90° from the position shown in Fig. 6;

Fig. 8 illustrates the device shown in Figs. 6 and 7 when this device is rotated through 180° from the position shown in Fig. 7;

Fig. 9 is an explosion view partially in section illustrating the details of the device shown in Fig. 6;

Fig. 10 is a detail view of a modified vibratory reed structure which may be used in any of the illustrated vibratory reed devices;

Fig. 11 is a top plan view illustrating a modification of the vibratory reed device shown in Figs. 6, 7 and 8; and

Fig. 12 is a side view of the device shown in Fig. 11.

Referring now to the drawings and, more particularly, to Figs. 1 and 2 thereof, the control or signalling system there illustrated comprises a signal transmitter 10 and the present improved signal receiver 11 which may be located at physically separated points. In this system, the desired control or indication response in the receiving apparatus 11 is produced by the space radiation of a high frequency carrier wave from the transmitting apparatus 10, which may be interrupted at any one of the several different frequencies respectively corresponding to the desired control operations or signal indications to be produced at the receiving point. In the illustrated arrangement, space transmission between the transmitting apparatus 10 and the receiving apparatus 11 is utilized in the production of the desired signal or control indications at the receiving point. It will be understood, however, that the illustrated receiving apparatus is equally well adapted for use in the translation of a signal carrier received over a wired signal channel.

In brief, the transmitting apparatus or transmitter 13 comprises a high frequency carrier current oscillator 14 coupled to an antenna-ground circuit 12 and arranged to generate a high frequency oscillatory voltage which is interrupted at a predetermined audio rate on a frequency selective basis by means of a vibratory reed device 21. More in detail, the oscillator 14 comprises a three electrode electron discharge tube 18 having a frequency determining circuit 15 of the parallel resonant type, comprising the shunt connected inductance and capacitance elements 16 and 17, coupled between the anode 18a and control grid 18g thereof through a carrier frequency coupling condenser 19. An operating bias for the control grid 18g is supplied by providing a grid leak resistor 19b which is connected between this grid and the cathode 18c through a carrier frequency choke inductance 19a. The tube 18 is of the filamentary cathode type, being provided with a cathode 18c connected for energization from a small low voltage battery 20. It will be understood that the oscillatory circuit 15 is tuned by means of the variable condenser 17 to oscillate at the desired carrier frequency when space current flow is produced through the tube 18. The inductance element 16 of this circuit is mutually coupled to the inductance element 12b of the antenna-ground circuit 12, thereby to provide an inductive path for the transfer of signal energy from the oscillator 14 to the antenna-ground circuit. A transformer 22 is utilized in conjunction with the vibratory reed device 21 to impress an audio frequency alternating voltage across the space current path of the tube 18 which is utilized to shock excite the oscillatory circuit 15 and to produce space current flow through this tube during alternate half cycles of the audio voltage. To this end, the transformer primary winding 22a is arranged for pulse energization from a small low voltage battery 23 at any one of a plurality of different audio frequencies respectively equaling the natural vibratory frequencies of the tuned reeds 61, 62, etc., embodied in the vibratory reed device 21. Further to this end, the secondary winding 22b of the transformer 22 is connected between the anode 18a and cathode 18c of the tube 18 over a path which includes the upper half 16a of the inductance element 16. A filter comprising a carrier frequency choke 25, serially included in this path, and a carrier frequency by-pass condenser shunting the winding 22b is provided for excluding spurious carrier frequency voltages from the antenna-ground circuit 12. For the purpose of driving the vibratory reeds 61, 62, etc., the device 21 is provided with an electromagnetic field structure 51 which includes a driving winding 55 arranged for energization from the battery 23 in series circuit relationship with the primary winding 22a of the transformer 22. Control of this circuit on a selective reed basis to provide for energization of the winding 22a at different pulse rates is accomplished by providing self restoring push button or key switches 26, 27, 31, etc., individual to the several reeds of the device 21.

As best shown in Figs. 3, 4 and 5 of the drawings, the vibratory reed device 21 comprises six different reeds 61 to 66, inclusive, having six different natural vibratory frequencies representing six different rates at which the carrier output of the oscillator 14 may be interrupted. These reeds, which are formed of spring steel or a like magnetic material, are supported upon a non-magnetic base member 50 which also provides sup-

port for the electromagnetic field structure 51. More specifically, the three reeds 61, 62 and 63 are rigidly mounted at their heel ends upon an insulating member 59 by means of anchor screws 61c, 62c and 63c, respectively. The member 59, which may be formed of a thermosetting plastic material such as "Bakelite" or the like, is in turn rigidly mounted upon the lower end of the base member 50 by means of assembly bolts 59a. In a similar manner, the three remaining vibratory reeds 64, 65 and 66 are rigidly mounted, by means of anchor screws 64c, 65c and 66c, upon an insulating member 60 which is rigidly supported upon the opposite end of the base 50 by means of assembly bolts 60a.

Each of the identified vibratory reeds fixedly supports a contact element arranged for vibratory engagement with a stationary contact element supported upon the base 50. Thus, and as just shown in Fig. 4 of the drawings, a movable contact element 62b is pinned to the vibratory reed 62 adjacent the heel end of this reed and is provided at its free end with a contact arranged for vibratory engagement with a contact carried by a stationary contact element 62d. In a similar manner, the reed 65 carries a movable contact element 65b adjacent the anchored end thereof which is adapted for vibratory engagement with a stationary contact element 65b. The three stationary contact elements individual to the reeds 61, 62 and 63 are pinned or otherwise fixedly mounted upon an insulating piece 67, which extends transversely across an opening 63 cut in the base 50 and is anchored to the base by means of assembly screws 67a. Similarly, the three stationary contact elements individual to the reeds 64, 65 and 66 are pinned to an insulating piece 68, which extends transversely across a second opening 70 cut in the base 50 and is anchored to this base by means of assembly screws 68a. Adjusting screws 62f, 65f, etc., individual to the six stationary contact elements and threaded through the insulating pieces 67 and 68 are provided to permit individual contact adjustment of the six sets of contacts 62e, 65e, etc., individual to the six reeds. At its free or toe end, each of the six reeds is provided with a weight for determining the natural period of vibration thereof and hence its natural vibratory frequency. Thus, the reed 62 is shown in Fig. 4 of the drawings as being provided with a weight 62a for the purpose indicated. Similarly, the reed 65 is provided with a larger weight 65a which is secured to the free end of this reed. It will be understood that weights of different sizes are used on the different reeds in order to provide for vibration of the reeds at different frequencies. Thus the reeds may be so weighted that they vibrate at frequencies spaced from each other by 20 cycles within a frequency range extending from 30 cycles to 130 cycles.

In the illustrated arrangement, the six reeds are adapted to be driven by the same electromagnetic field structure 51 and the driving forces are applied thereto at the free or toe ends thereof. To this end, the field structure 51 is supported centrally of the base 50 and is provided with a magnetic circuit having parallel paths which respectively include the free end portions of the six identified vibratory reeds. In brief, this field structure comprises a U-shaped magnetic member 52, the legs 52a and 52b of which extend transversely of the base and are provided with ends extending through openings 57 and 58 in the base to project upwardly beneath the reeds.

The leg 52a of this member is provided at its corners with struck out parts 52c which are clamped against the underside of the base by means of assembly screws 56. The opposite leg 52b is similarly provided with struck out corner parts 52d which are likewise clamped to the underside of the base 50 by means of assembly screws 56. The field structure 51 also includes a center leg 53 which is anchored in an opening through the central base portion of the member 52 and is provided with an end 53a which projects through an opening in the base 50 and is disposed substantially between the oppositely directed free ends of the two sets of vibratory reeds. This center leg carries a winding 55 which is insulated therefrom by means of a sleeve 54 and is confined between two insulating end pieces in the manner illustrated. With the described arrangement of the field structure, it will be understood that two parallel flux paths are provided which commonly include the center leg 53 and respectively include the legs 52a and 52b of the member 52. That flux path which includes the leg 52a also includes in parallel the end portions of the three reeds 61, 62 and 63 as well as the air gaps between these reeds, the end 53a of the center leg 53, and the upper pole face end of the leg 52a. Similarly, that flux path which includes the opposite leg 52b of the field structure also includes the end portions of the reeds 64, 65 and 66 and the air gaps between the identified reed portions the end 53a of the center leg 53 and the upper pole face end of the leg 52c. It will be understood, therefore, that when the winding 55 is excited to produce flux traversal of the two flux paths, the free ends of the six reeds are attracted toward the pole face ends of the legs 52a and 52b. Each time the winding 55 is de-energized, the attractive force exerted on the free ends of the reeds is released, causing the reeds to swing through their respective normal positions to off-normal positions away from the pole face ends of the legs 52a and 52b. It will be understood, therefore, that if the winding 55 is periodically energized at a frequency equaling the natural vibratory frequency of any particular one of the reeds, this particular reed will be driven at the stated frequency with the maximum amplitude permitted by the inherent resiliency thereof. The remaining reeds, because of the non-matching relationship between their natural vibratory frequencies and the frequency of periodic excitation of the winding 55, tend to remain stationary or to vibrate with only non-appreciable amplitude.

Briefly, to consider the operation of the transmitting apparatus 10 it may be assumed that the vibratory reed 62 is tuned to vibrate at a frequency of 110 cycles per second, and that a carrier interrupted at this rate is to be transmitted to the receiving apparatus 11. In order to initiate the operation of the transmitter 10 to radiate a carrier interrupted at the particular control or signal frequency indicated, the switch 27 is actuated to its off-normal position. In response to this operation, a path is prepared at the contacts 27b for short circuiting the winding 55 through the contacts 62e controlled by the reed 62. At the contacts 27a, a circuit is completed for energizing the winding 55 in series with the primary winding 22a of the transformer 22, this circuit extending from the negative terminal of the battery 23 by way of the contacts 27a, the winding 55 and the winding 22a to the positive terminal of the battery 23. When the

winding 55 of the device 22 is thus energized, all six of the vibratory reeds are attracted toward the pole face ends of the field structure legs 52a and 52b. Incident to the resulting movement of the reed 62, the above mentioned path is completed through the contacts 62e and 27b to short circuit the winding 55. When the driving winding 55 is thus de-energized, the six reeds are released and swing through their respective normal positions to opposed off-normal positions. As the reed 62 swings away from the pole face end of the leg 52a, the contacts 62e are opened to interrupt the path short circuiting the driving winding 55 whereby this winding is again energized in series with the winding 22a. Thus the reeds are again attracted toward the pole face ends of the field structure legs 52a and 52b, with the result that after a predetermined short time interval the contacts 62e are again closed to recomplete the path for short circuiting the winding 55. From this point on, the manner in which the reed 62 functions periodically to energize the winding 55 is exactly the same as explained above. It will be apparent from this explanation that when the winding 55 is initially energized, the contacts individual to all six of the reeds are closed. Since, however, only the switch 27 occupies its off-normal position, the winding 55 can only be short circuited through the contacts 62e of the reed 62. Thus the five parallel short circuiting paths through the contacts controlled by the five non-selected reeds are held open at the contacts 26b, 31b, etc., of the five non-operated switches. After the periodic energization of the winding 55 under the control of the reed 62 is well established, vibration of the other five reeds is substantially arrested for reasons which will be fully apparent from the above explanation.

It will be evident that each time the contacts 62e are closed to short circuit the winding 55, the current flow through the primary winding 22a of the transformer 22 is increased. Conversely each time the contacts 62e are opened, serially to include the winding 55 in the circuit for energizing the winding 22a, the current flow through the latter winding is decreased. During each interval of increase or decrease in the current traversing the winding 22a, an induced voltage of corresponding polarity is developed in the secondary winding 22b. It will be understood therefore that as vibration of the reed 62 continues, an alternating voltage is developed across the winding 22b having a frequency which equals the frequency of vibration of the reed 62. During alternate half cycles of this voltage, the anode 18a becomes positive with respect to the cathode 18c to permit space current flow through the tube 18 under the control of the voltage appearing upon the control grid 18g. During the intervening voltage half cycles, the anode 18a becomes negative with respect to the cathode 18c with the result that space current flow through the unidirectionally conductive tube 18 is arrested. Each time space current flow through the tube 18 occurs, the circuit 15 oscillates at the particular carrier frequency to which it is tuned. To this end, a portion of the oscillatory voltage developed between the terminals of this circuit, and more specifically that appearing across the portion 16b of the inductive element 16, is impressed between the control grid 18g and cathode 18c of the tube 18 over a path which includes the coupling condenser 19 whereby oscillation of the circuit 15 for the duration of the voltage pulse

and at the resonant frequency thereof is sustained. It will thus be apparent that as alternate half cycles of the generated alternating voltage are positively applied to the anode 18a of the tube 18, corresponding pulses of high frequency voltage are developed across the terminals of the oscillatory circuit 15. The oscillatory energy is transferred to the antenna-ground circuit 12 for space radiation through the mutual inductance coupling between the two inductance elements 16 and 12b.

From the foregoing description it will be clearly apparent that so long as the switch 27 is held in its off-normal position to sustain the vibratory movement of the reed 62, a high frequency carrier interrupted at the frequency of vibration of this reed is radiated by the antenna-ground circuit 12. When this switch is released or manually restored to its normal position, the energizing circuit for the two windings 55 and 22a is interrupted at the contacts 27a, with the result that periodic space current flow through the tube 18 is arrested to stop the interrupted carrier radiation. Incident to the normalizing of the switch 27, the contacts 27b are also opened to interrupt the path through these contacts for short circuiting the driving winding 55 of the field structure 51. It will also be evident that the particular frequency of the alternating voltage developed across the winding 22b and hence the frequency of the carrier pulses radiated from the antenna-ground circuit 12 depends upon the particular one of the switches 26, 27, 31, etc., which is operated. Thus if the switch 31, for example, is operated to its off-normal position, the reed 65 is rendered operative to determine the frequency of carrier pulse radiation. Again if the switch 26 is selected for operation, the reed 61 is rendered operative to control the frequency of carrier pulse radiation.

As indicated above, the signals radiated by the transmitting apparatus 19 are adapted to be translated into control or signal indications by the receiving apparatus 11. In brief, the receiving apparatus comprises a battery operated carrier frequency receiver 32 having an antenna-ground circuit 13, a pulse repeating relay 33, and a pulse translating vibratory reed device 36. More specifically, the relay 33 is arranged to follow the received carrier frequency pulses and to repeat these pulses to the driving winding 83 of the device 36 by intermittently opening and closing the circuit for energizing this winding from a small low voltage battery 35. For the purpose of holding any operated one of the vibratory reeds 90, 91, 92, etc., embodied in the device 36 in an operated or signal translating setting during off pulse periods, a condenser 38 is provided which is arranged to be connected in shunt with the winding 83 through any one of the signal indicating lamps 39 to 45, inclusive, individually associated with the different reeds. Energization of these lamps under the selective control of the vibratory reeds is accomplished by providing a small battery 37 for this purpose. Preferably the receiver 32 is of the well known super-regenerative type embodying a radio frequency amplifier stage, a detector stage and a power amplifier stage, and utilizes tubes of the filamentary cathode type at the three stages thereof. When the receiving apparatus is utilized to receive signals transmitted by a transmitter of the type illustrated in Fig. 1 within a distance of several hundred yards, it has been found that completely favorable response may be obtained by

employing in the receiver three tubes, one for each of the enumerated stages, which are entirely adequate to furnish the power required for operation of the relay 33, the winding of this relay being substituted for the primary winding of the output transformer in the output circuit of the power amplifier stage.

As best shown in Figs. 6, 7, 8 and 9 of the drawings, the vibratory reeds 90, 91, 92, 93, 94 and 95 with which the device 36 is equipped are in the form of flat springs having like transverse dimensions and are constructed of spring steel or another magnetic material having the desired resilient properties. These reeds are supported at their heel ends upon a square block 79 of insulating material. More specifically, the lower end of each reed 92 is clamped by means of a clamping screw 98 to one leg of an L-bracket 96, the opposite leg of which is clamped to the insulating block 79 by means of an assembly screw or bolt 97. The six reeds are divided into two sets of three, which are respectively disposed adjacent opposite side edges of the insulating block 79. This block and the reeds carried thereby are supported from the field structure of the device by means of a supporting post 78. More in detail, the central portion of the block 79 is clamped to the end of the post 78 remote from the field structure by means of an assembly screw 80 which is threaded into the post 78. The field structure proper comprises a pair of pole pieces 76 and 77 and a core element 75. At its lower end, as viewed in Fig. 9 of the drawings the core element 75 is provided with a threaded portion 75a of reduced diameter which is adapted to extend through a central opening in the pole piece 76 and to be threaded into an opening provided in the supporting post 78. At its upper end, the core element 75 is similarly provided with a threaded portion 75b of reduced diameter which is adapted to extend through an opening in the pole piece 77 and to receive an assembly nut 89 thereon. The field structure is completed by providing a winding 83 which is wound upon a spool consisting of the insulating parts 82, 85 and 86, and is mounted upon the core element 75 between the two pole pieces 76 and 77. The contact structure of the device comprises two conductive discs 81 and 87 formed of copper or other non-magnetic material, the first of which is insulated from the pole piece 76 by means of a strip of insulating material 82 and is clamped between this pole piece and the disc end of the supporting post 78. This contact element is provided at opposite edges thereof with angularly extending contact points 90a, 91a, 92a, 93a, 94a and 95a which individually underlie the reeds 90, 91, 92, 93, 94 and 95. Similarly, the contact element 87 is constructed of copper or another non-magnetic conductive material and is clamped between the pole piece 77 and the adjacent end 86 of the winding spool. This contact element is also provided along opposite edges thereof with angularly extending contact points 90b, 91b, etc. which respectively underlie the vibratory reeds 91, 92, etc. The identified contact points of the two contact elements 81 and 87 may be formed by slitting each element inwardly from opposite edges thereof at spaced apart points therealong. For the purpose of suspending the device from a supporting structure or mounting the device upon the chassis of the receiver unit, an L-bracket 88 is provided having one leg thereof clamped between the pole piece 77 and the assembly nut 89. This bracket is preferably formed of a non-

magnetic material in order not to affect in any way the magnetic circuit of the device.

In the construction and assembly of the device 36, the reeds 90 to 95, inclusive, are differently weighted at the free or vibratory ends thereof to impart different predetermined natural vibratory frequencies thereto. If desired, each reed may be equipped with a non-magnetic metal band 100 of the form shown in Fig. 10 of the drawings, which is slidable longitudinally thereof to adjust the vibratory frequency of the reed to the desired value. This band, after being properly positioned along the reed to establish the desired reed frequency, may be crimped at its edges or squeezed into tight clamping engagement with the reed, thereby to prevent changes in the reed frequency. The same frequency adjusting expedient may be employed in calibrating the reeds of the device 21 to the desired frequencies.

More specifically considered, the six reeds of the device 36 are tuned to vibrate at natural frequencies which respectively correspond to the natural vibratory frequencies of the six reeds embodied in the device 21. Thus the vibratory frequency of the reed 90 may be precisely matched with the vibratory frequency of the transmitting reed 61, the reed 91 may be matched as to frequency with the reed 62, and so on. It will be noted that the reeds are normally free to vibrate without contacting the contact points of the two contact elements 81 and 87. This feature is incorporated in the structure to insure precise selective response of the reeds to the driving forces imposed thereon during intermittent energization of the winding 83 at different frequencies. More particularly, the arrangement is such that when any one of the reeds is vibrated with substantially full amplitude it will contact the associated contact points of the two elements 81 and 87 substantially concurrently. To this end, the structure is so arranged that the gaps between the reeds and their respective associated contact points are successively greater for the reeds of successively lower frequency, thereby to allow for the greater amplitudes of vibration of the lower frequency reeds. Thus the gaps between the reed 90, for example, and the contact points 90a and 90b are greater than the gaps between the reed of next higher natural vibratory frequency and its associated contact points. The required gap spaces may be obtained by bending the mounting pieces 96 to the correct angles. Also, the desired contact point adjustment may be obtained by bending each contact point with a pair of long nose pliers until the proper displacement is obtained between the point and its associated reed.

In the structure shown in Figs. 6, 7, 8 and 9 of the drawings, adjustment of the contact points individual to the two reeds 91 and 94 necessitates insertion of the plier jaws beneath the outer reeds which are respectively associated with the two identified center reeds. In order to obviate this difficulty and to provide for a greater number of reeds without any substantial increase in the overall size of the structure, the construction shown in Figs. 11 and 12 of the drawings may be used. In this construction, the parts 79, 76 and 77 are of like dimensions and are each provided with five edges of equal length. Similarly, the contact elements 81 and 87 are each provided with five edges of equal length and have two contact points projecting from each of the five edges thereof. The reeds 90, 91, 92, 93, etc., are disposed around the structure with two reeds ex-

tending longitudinally along each side thereof making a total of ten reeds in all. This structural arrangement permits any one of the contact points 91a, 91b, etc., of the two contact elements 81 and 87 to be easily reached for adjustment without the insertion of plier jaws beneath any of the reeds.

From the above explanation it will be understood that in each of the two disclosed embodiments of the vibratory reed device 36, the magnetic circuit of the device commonly comprises the magnetic core element 75 and the two pole pieces 76 and 77, in combination with a plurality of parallel flux paths through the vibratory ends of the several reeds. These flux paths each include an air gap between the end of the reed providing the same and the opposed pole face of the pole piece 77, and a second air gap between the central portion of the reed and the opposing pole face of the pole piece 76. It will be understood, therefore, that when the winding 83 is energized, all of the several reeds are attracted toward the respective associated pole faces of the two pole pieces 76 and 77. Conversely, when the winding 83 is de-energized all of the reeds are released for vibration through their respective normal positions to off-normal positions away from their respective associated pole faces. The time required for such movement is of course different for the different reeds because of the differences in the natural vibratory frequencies thereof. Accordingly, if the winding 83 is periodically energized at a frequency equaling the natural vibratory frequency of any selected one of the reeds, that particular reed will, after two or three current pulses through the winding 83, vibrate with substantially full amplitude, while the other reeds will be only partially vibrated. As a result, the particular reed which is being driven at its natural vibratory frequency will be actuated to its signal translating setting to engage the associated contact points of the two contact elements 81 and 87 before the other reeds can possibly attain the amplitude of vibration required to contact these elements. In other words, the out of phase forces acting upon the non-selected reeds when the winding 83 is periodically energized at a rate not corresponding to the vibratory frequencies of these reeds, prevent these reeds from vibrating with sufficient amplitude to engage their respective associated contact points.

In considering the operation of the receiving apparatus 11 it may be assumed by way of example that the transmitter 10 is operating under the control of the vibratory reed 61 to radiate a carrier which is interrupted at the particular frequency equaling the natural vibratory frequency of the vibratory reed 90. This signal is collected by the antenna-ground circuit 13, amplified by the radio frequency amplifier section of the receiver 32, detected in the detector stage of this receiver, and the audio components, i. e., the current pulses appearing in the output circuit of the detector, are amplified through the power amplifier stage of the receiver to be manifested as current pulses through the relay winding 33. Thus, each time a carrier pulse is picked up by the antenna-ground circuit 13, the relay 33 is sufficiently energized to operate. Conversely, at the end of each carrier current pulse the relay 33 is de-energized and restored. In operating and releasing, the relay 33 functions to repeat the received carrier pulses to the driving winding 83 of the vibratory reed device 36. Thus when this relay initially operates, it closes its contacts 34 to

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complete an obvious circuit for energizing the winding 83 from the battery 35. This circuit is obviously opened to de-energize the winding 83 each time the relay 33 releases to open its contacts 34. As the periodic energization of the winding 83 proceeds, the reed 90 is driven with constantly increasing amplitude until it is actuated to engage the contact points 90a and 90b. Approximately three current pulses occurring at the particular frequency of vibration of the reed 90 are required to build up the amplitude of vibration of this reed sufficiently to effect engagement thereof with the two identified contact points. Immediately the reed 90 engages the contact point 90a, an obvious circuit is completed for energizing the associated indicating lamp 39 from the battery 37. Immediately the reed 90 engages the contact point 90b a path is completed through the filament of the lamp 39 for connecting the condenser 38 in shunt with the driving winding 83 of the vibratory reed device 36. After this path is completed, the condenser 38 is charged from the battery 35 in shunt with the winding 83 during each received carrier pulse when the contacts 34 are closed. When these contacts are opened to interrupt the circuit for directly energizing the winding 83, the condenser 38 discharges through the winding 83 over a path which includes the filament of the lamp 39 and the contact point 90b. This discharge current serves to maintain the winding 83 sufficiently energized during each off pulse period to prevent the reed 90 from being released. In other words, the discharge current traversing the winding 83 maintains sufficient flux flow through the magnetic circuit of the device 36 during the off pulse periods to hold the reed 90 in its attracted position relative to the associated pole faces of the two pole pieces 76 and 77. The magnetic force thus produced is however insufficient to pull any of the other reeds 91, 92, etc., toward its associated pole face with sufficient strength to bring the reed into engagement with its associated contact points. Moreover, the continuous current flow through the winding 83 which results from the lock in of the reed 90 in its signal translating setting positively eliminates any tendency for the non-active reeds to continue vibrating. It will thus be apparent that the first few pulses of the carrier pulse train are utilized to effect operation of the reed 90 to its signal translating setting, and that the remaining pulses of the carrier pulse train are utilized to hold this reed continuously in its signal translating setting. It may be pointed out that since the energization of the winding 83 during off pulse periods is accomplished on a condenser charge-discharge basis, this particular action is entirely non-critical insofar as the frequency of carrier pulse translation is concerned. The only apparent limitation upon this particular feature of the circuit is that the time constant of the condenser discharge path substantially exceed the duration of the off pulse period of maximum length, represented by the lowest frequency of carrier pulsing. It has been found that, with values of resistance and inductance usually encountered in coils of the type of winding 83, a condenser 38 of the electrolytic type and of 10 microfarad capacitance is entirely satisfactory to produce the desired reed lock in action when audio pulse rates above twenty-five cycles are utilized.

It will be understood from the above description that any one of the remaining five reeds 91 to 95, inclusive, may be selectively actuated to its

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signal translating setting when the carrier pulse transmission is effected at a frequency equaling the natural vibratory frequency of the particular reed in question. Regardless of the particular reed selected, the reed lock-in action proceeds in the exact manner explained above after three or four pulses of the pulse train have been transmitted to the winding 83. It will also be apparent that immediately any one of the six reeds is locked in its signal translating setting, the remaining five reeds are positively locked out to prevent the same from being operated to their respective signal translating settings. Also, each reed, when actuated to its signal translating setting, closes an obvious circuit for energizing the associated one of the signal lamps 39 to 45, inclusive. The reeds may obviously be employed selectively to control the energization of control devices of any desired type, other than the illustrated indication lamps 39 to 45, inclusive.

From the foregoing explanation it will be understood that the above disclosed control or signaling system is extremely simple in its arrangement and mode of operation, that both the transmitting and receiving units thereof may be constructed to form exceedingly compact self-contained units which are readily portable to any desired location, and that no sources of current other than the small batteries illustrated are required in the operation thereof. Further, the receiving apparatus 11 is completely non-responsive to extraneous noises of the character encountered in high noise level areas. This desirable feature of the system may be attributed to the fact that a plurality of carrier current pulses occurring at a particular and set frequency are required in order to actuate any one of the vibratory reeds 90, 91, etc., to its signal translating setting, and to the further fact that noise disturbances are not sufficiently periodic in character to produce this reed response. Not only is the receiving apparatus substantially non-responsive to extraneous noise picked up by the antenna-ground circuit 13, but in addition is substantially non-responsive to physical shock transmitted to the vibratory reed device 36. On this point it will be noted that in the particular construction disclosed, the reeds are anchored or mounted at their heel ends and are positively driven at their toe ends. Accordingly, the transmission of physical shock to the device and to the reeds through the heel ends thereof produces only negligible vibration thereof, entirely insufficient to effect actuation of any one of the reeds to its signal translating setting. The same feature is incorporated in the vibratory reed device 21 of the transmitting apparatus 10, and in addition all of the circuits controlled by the transmitting reeds 61, 62, etc., are entirely open so long as their associated switches 26, 27, etc., are at normal. With this circuit structure, inadvertent carrier radiation is positively prevented.

While one embodiment of the invention has been disclosed, it will be understood that various modifications may be made therein, which are within the true spirit and scope of the invention.

I claim:

1. In a system for receiving any one of a plurality of signals of different predetermined frequencies, a plurality of vibratory control reeds having different natural vibratory frequencies which respectively and substantially equal said predetermined frequencies, electromagnetic driving means common to said reeds and operative to develop reed driving impulses of any one of

said frequencies when energized at said one frequency, whereby all of said reeds tend to vibrate upon initial energization of said driving means and the one reed corresponding to the one frequency is vibrated with greater amplitude than the remaining reeds, means responsive to a received signal for energizing said driving means at the received signal frequency rate, and means responsive to the resulting vibration of the particular reed, which corresponds to the signal frequency rate, at a predetermined amplitude of vibration for substantially continuously energizing said driving means for the duration of signal reception, thereby to hold said particular reed in an off-normal position.

2. In a system for receiving a signal having a predetermined frequency, a vibratory control element having a natural vibratory frequency which substantially equals said predetermined frequency, means including an exciting winding for utilizing the first received impulses of said signal to initiate vibration of said element, and means for utilizing the succeeding impulses of said received signal to excite said winding to hold said vibratory element in a predetermined off-normal position so long as said signal is received.

3. In a system for receiving a signal having a predetermined frequency, a vibratory control element having a natural vibratory frequency which substantially equals said predetermined frequency, means including an exciting winding for utilizing the first received impulses of said signal to initiate vibration of said element, and means responsive to vibration of said element with a predetermined amplitude for utilizing the succeeding impulses of said received signal to excite said winding to hold said vibratory element in a predetermined off-normal position so long as said signal is received.

4. In a system for receiving any one of a plurality of signals of different predetermined frequencies, a plurality of magnetic vibratory control reeds having different natural vibratory frequencies which respectively and substantially equal said predetermined frequencies, electromagnetic means for driving said elements including a winding, means responsive to the reception of any one of said signals for energizing said winding with current pulses which occur at the received signal frequency rate, whereby all of said reeds tend to vibrate when signal reception starts and the one reed corresponding to the received signal frequency is vibrated with greater amplitude than the remaining reeds as the signal reception continues, a condenser, and means responsive to vibration of said one reed with a predetermined amplitude for connecting said condenser in shunt with said winding to be charged by said current pulse and to discharge through said winding during each off-pulse period, thereby to hold said one reed in an off-normal position and to eliminate any tendency of the remaining elements to follow the current pulses.

5. Frequency selective control means comprising a plurality of magnetic vibratory elements having different natural vibrating frequencies, electromagnetic means for driving said elements and including a winding, means for selectively energizing said winding with current pulses oc-

curing at any one of said frequencies, whereby all of said elements tend to vibrate and the one element corresponding to the selected pulse frequency is vibrated with greater amplitude than the remaining elements, and means responsive to vibration of said one element with a predetermined amplitude for continuously energizing said winding with a current of sufficient magnitude to hold said particular reed in an off-normal position.

6. Frequency selective control means comprising a plurality of magnetic vibratory elements having different natural vibratory frequencies, electromagnetic means for driving said elements and including a winding, means for selectively energizing said winding with current pulses occurring at any one of said frequencies, whereby all of said elements tend to vibrate and the one element corresponding to the selected pulse frequency is vibrated with greater amplitude than the remaining elements, a condenser, and means responsive to vibration of said one reed with a predetermined amplitude for connecting said condenser in shunt with said winding to be charged by each current pulse and to discharge through said winding during each off-pulse period, thereby to hold said element in an off-normal position and to minimize any tendency of the remaining elements to follow the current pulses.

7. A control device comprising a magnetic vibratory element having a predetermined natural vibratory frequency, electromagnetic means for driving said element including a winding, means for transmitting a train of current pulses to said winding at said predetermined frequency, whereby the amplitude of vibration of said element is built up to a predetermined value during the first few current pulses transmitted to said winding, and means responsive to vibration of said element at said predetermined amplitude for utilizing the remaining current pulses of the train to provide sustained energization of said winding, thereby to hold said element in any one of the off-normal positions to which it is vibrated.

8. In a system for receiving a signal having a predetermined frequency, a vibratory control element having a natural vibratory frequency which substantially equals said predetermined frequency, means for utilizing the first received impulses of said signal to initiate vibration of said element, and energy storage means for utilizing the succeeding impulses of said received signal to excite said winding continuously to hold said vibratory element in a predetermined off-normal position so long as said signal is received.

9. In a system for receiving a signal having a predetermined frequency, a vibratory control element having a natural vibratory frequency which substantially equals said predetermined frequency, means for utilizing the first received impulses of said signal to initiate vibration of said element, contact means closable in response to vibration of said element with a predetermined amplitude, and energy storage means controlled by said contact means for utilizing the succeeding impulses of said received signal to hold said vibratory element in a predetermined off-normal position so long as said signal is received.

ALEXANDER W. PLENSLER.