April 13, 1948. D. H. MITCHELL 2,439,412

MULTISTAGE PLUG-IN FREQUENCY DETERMINING UNIT

Filed Aug. 4, 1944 2 Sheets-Sheet 1

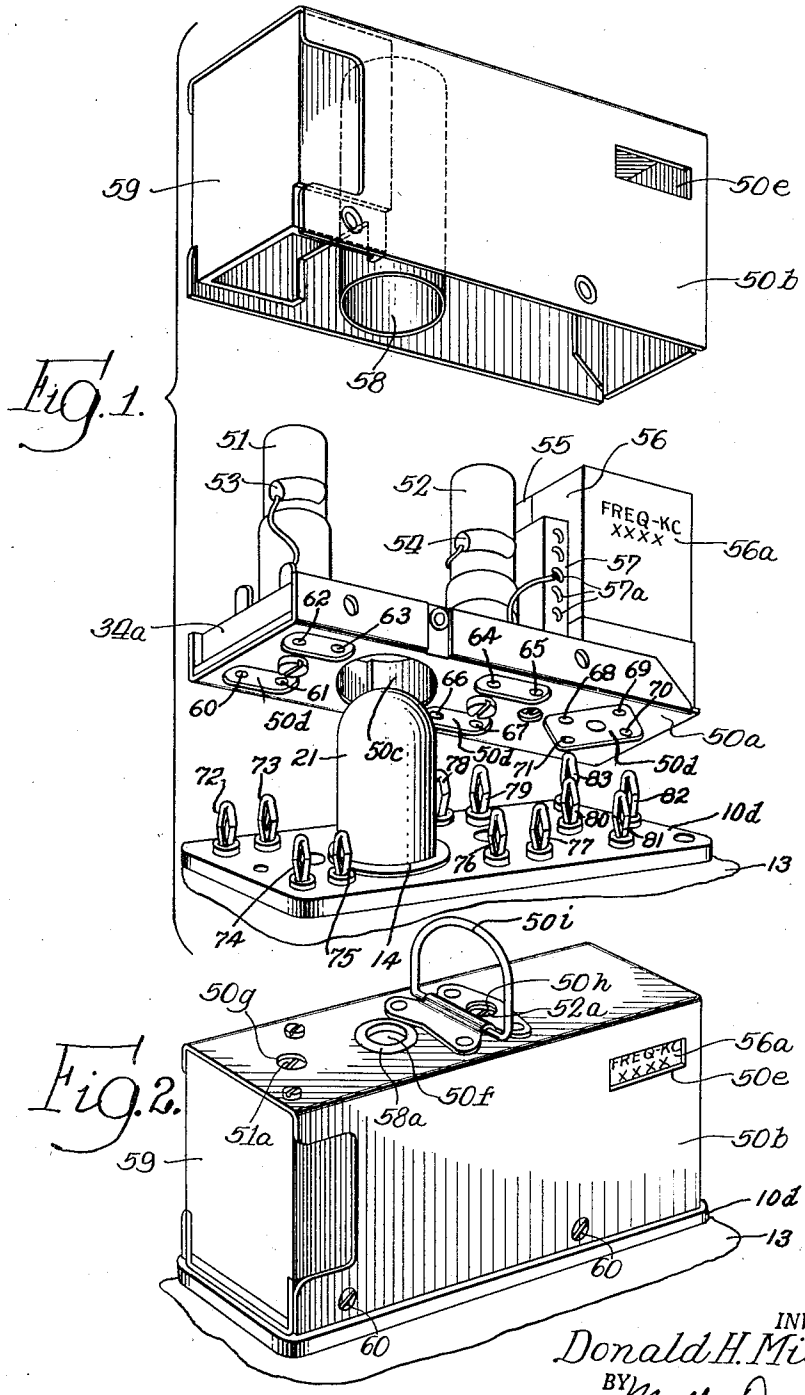


Fig. 1.

Fig. 2.

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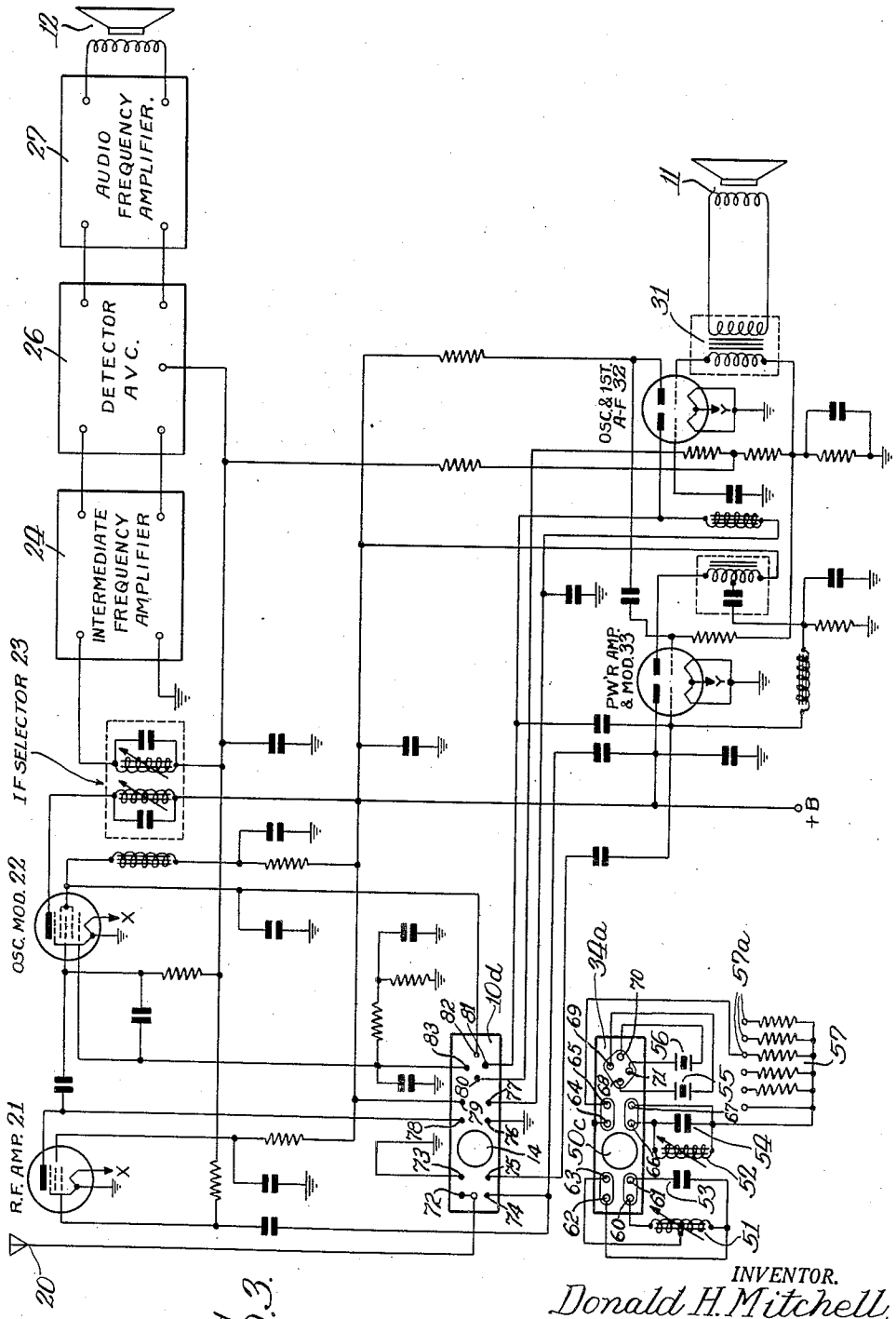


Fig. 3.

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MULTISTAGE PLUG-IN FREQUENCY-DETERMINING UNIT

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Application August 4, 1944, Serial No. 548,103

6 Claims. (Cl. 250—14)

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This invention relates to multi-stage plug-in frequency-determining units and, while it is of general application, it is particularly suitable to such units of the type useful in portable light-weight radio transmitting receiving apparatus of the type disclosed and claimed in my copending application Serial No. 543,167, filed July 1, 1944, entitled "Portable two-way wave-signal space-communication set" and assigned to the same assignee as present application.

The advantages of plug-in type tuning or frequency determining units are well known in the art, particularly in radio communication apparatus where it is desired to condition the apparatus for operation at any of a plurality of desired frequencies by inserting an appropriate one of a plurality of different interchangeable frequency-determining units. Mechanical considerations dictate that such plug-in units be as compact as possible; however, such compactness introduces certain electrical difficulties, particularly if the units include the frequency-determining elements of a plurality of stages. Due to the extreme proximity of the electrical components in such a tuning unit, it becomes difficult to reduce the electrical coupling therebetween to a negligible value and thus to avoid undesired regenerative effects. Further, certain frequency-determining elements of the unit are necessarily physically displaced considerably from the portions of the main apparatus to which they are to be connected, resulting in long lead conductors to the tuning elements. Such conductors tend to have undesired and indeterminate amounts of inductive and capacitive reactance and also introduce further undesired couplings between the tuning elements and other portions of the circuit with which the unit is associated.

It is an object of the invention, therefore, to provide a new and improved multi-stage plug-in frequency-determining unit by means of which one or more of the disadvantages of the prior art plug-in frequency-determining units may be avoided.

It is another object of the invention to provide a new and improved multi-stage plug-in frequency-determining unit which has one or more of the following advantageous characteristics; minimum coupling between the lead conductors of the elements of the unit and other portions of the apparatus with which it is associated; minimum coupling between the several elements of the tuning unit associated with the several stages; and a minimum of stray and indeterminate inductive and capacitive reactance

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of the lead conductors of the tuning elements of the frequency-determining unit.

In accordance with the invention, a multi-stage plug-in frequency-determining unit for a wave-signal translating apparatus including at least one signal-translating vacuum tube having input and output circuits and a circuit connector device connected to such circuits comprises a chassis member adapted to bridge the tube and circuit connector means carried by the chassis member and complementary to the device for detachably engaging the same. The unit also includes input and output frequency-determining elements supported by the chassis member and disposed, when the connector means engages the device of the apparatus, to lie on the input and output sides, respectively, of the tube.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing, while its scope will be pointed out in the appended claims.

In the drawings, Fig. 1 is a perspective view of a multi-stage plug-in frequency-determining unit embodying the invention with its shielding cover portion disengaged therefrom; Fig. 2 is a perspective view of the apparatus of Fig. 1 in its assembled relation; while Fig. 3 is a circuit diagram, partly schematic, of the wave-signal translating apparatus described in the above-named copending application, with which the multi-stage plug-in frequency-determining unit of the invention is designed to operate.

Referring now to Figs. 1 and 2 of the drawings, there is illustrated a multi-stage plug-in frequency-determining unit embodying the invention for use in a wave-signal translating apparatus including at least one signal-translating vacuum tube having input and output circuits and a circuit connector, such as a plug or socket, connected to such circuits. While the complement of the elements comprising the tuning unit will, of course, vary in accordance with the apparatus with which it is associated, the tuning unit of Figs. 1 and 2 is illustrated as embodying the required components for use with the wave-signal transmitter-receiver of Fig. 3 which is essentially the same as that illustrated and described in the above-named copending application but somewhat simplified in form by the omission of certain features not pertinent here. Specifically, the unit comprises a chassis member including a base portion 50*a* and a cover portion 50*b*, the base portion 50*a* being adapted

to bridge the signal-translating tube 21 of the apparatus, for example, being provided with an aperture 50c adapted to receive and surround such tube. The unit also includes circuit connector means carried by the chassis member 50a, 50b, for example, a socket 34a disposed in the base portion and complementary to the circuit connector plug 10d carried by the wave-signal apparatus for detachably engaging the same. The base portion 50a is cut out to provide a plurality of windows or apertures 50d to expose the contact elements of the socket 34a and permit engagement thereof by the pins of the complementary plug connector 10d carried by the chassis 13 of the wave-signal translating apparatus.

Supported on the base portion 50a are input and output frequency-determining elements; for example, a pair of tuning inductors 51, 52 on which are mounted a pair of fixed tuning condensers 53 and 54, respectively, which may be of the sealed mica or ceramic type. The inductors 51 and 52 are mounted on the base portion 50a on opposite sides of the aperture 50c and, with their associated condensers 53, 54, respectively, are so disposed that, when the connector 34a engages the connector of the wave signal apparatus, they lie on the input and output sides, respectively, of the signal-translating tube of the apparatus. There are also mounted on the base portion 50a a pair of frequency-determining crystals 55 and 56 for determining the oscillation frequencies of certain portions of the wave-signal apparatus as described hereinafter. Additionally, there is mounted on the base portion 50a a preset sensitivity-adjusting element 57 provided with a plurality of taps 57a which may be selected as a factory adjustment and correlated with the sensitivity of the particular crystals of the unit to obtain a sensitivity which is substantially uniform as between different tuning units and apparatus.

The cover portion 50b has such a configuration as to enclose the base portion 50a and the components supported therefrom and to serve as an electrical shield for the components of the unit; thus, it is preferably constructed of sheet aluminum or like high-conductivity material. Disposed within the cover portion 50b is a shield can 58 for receiving and shielding the vacuum tube of the apparatus and for registering with the aperture 50c of the base portion. The shield can 58 extends substantially across the cover 50b and thus serves to shield the tuning elements 51, 53 from the tuning elements 52, 54; if desired, an additional shielding element may be connected to the shield can 58 which extends entirely across the cover portion 50b. In one end of the cover portion 50b is disposed a casing or housing 59, preferably of molded "Bakelite," or the like, for receiving and enclosing the tuning elements 51, 53. The cover 50b may be provided with a window 50e adapted to register with a legend 56a on the crystal 56 indicating the frequency channel for which the tuning unit is designed. The upper end of the shield can 58 may be formed as a neck 58a of reduced section which is then upset or spun about an aperture 50f in the top of the cover portion 50b from which the vacuum tube within can be observed, to determine whether or not it is in operating condition. Further, the cover 50b may be provided with a pair of apertures 50g and 50h adapted to register with the tops of the tuning inductors 51 and 52, respectively, through which adjustable tuning elements of such inductors, such as adjustable ferromagnetic cores, may be adjusted by means of screws 51a and 52a, respectively. Cover portion 50b may also be provided with a collapsible bail or handle 50i to aid in removing the tuning unit from the apparatus. The cover portion 50b may be secured to the base portion by any suitable means such as screws 60.

Referring more specifically to the manner in which the tuning unit is connected to the wave-signal apparatus it will be noted that the socket 34a includes a plurality of contact elements 60 to 71, inclusive, adapted to engage the pins 72 to 83, respectively, of the connector 10d. By reference to Fig. 3 and by consideration of the following description, the manner in which the various components of the tuning unit are connected in the circuit of the wave-signal translating device will be apparent. The connector 10d also includes a tube socket 14 for receiving the tube 21 so the the shield 58 is automatically placed about the tube when the tuning unit is plugged in the socket 10d.

The use of the tuning unit of Figs. 1 and 2 in the wave signal apparatus of Fig. 3 will be explained by reference to the latter figure, in which the several elements corresponding to those of the above-named copending application are identified by the same reference numerals, while the elements corresponding to the unit of Figs. 1 and 2 are identified by the reference numerals used therein. Fig. 3 is a circuit diagram, partially schematic, of a complete wave-signal receiving circuit and a separate wave-signal transmitting circuit which is substantially conventional so that a detailed description of its various circuit elements is unnecessary. In brief, the reciving circuit comprises an antenna 20, a radio-frequency amplifier 21 coupled in cascade with an oscillator-modulator 22, an intermediate-frequency selector 23, an intermediate frequency amplifier 24 of one or more stages, a detector, and A. V. C. source 26, an audio-frequency amplifier 27, and a sound reproducer, such as an earphone or loud speaker 12.

The transmitting circuit of Fig. 3 comprises a signal-transmitting device such as a microphone 11 coupled to an input transformer 31, the secondary winding of which is coupled to a duplex oscillator and first audio-frequency amplifier 32 which in turn is coupled to a second duplex 33 comprising a modulator and power amplifier. The output circuit of the power amplifier 33 is coupled to the antenna 20. The several tubes of the apparatus of Fig. 3 may be energized from any suitable source indicated schematically as +B, while the filament terminals x and y may be energized from any suitable filament source, not shown.

The frequency-determining circuits of the antenna 20 and the radio-frequency amplifier 21 and the frequency-determining crystals of the oscillator section of the oscillator-modulator 22 and the oscillator 32 are included in the plug-in frequency-determining unit of Figs. 1 and 2; that is, the inductor 51 and conductor 53 are connected to tune the antenna circuit on the input side of the radio-frequency amplifier 21, while the inductor 52 and condenser 54 are connected to the output circuit of the radio-frequency amplifier 21, which is adapted to be received by the aperture 50c in the base portion of the unit and by the shield can 58 in the cover portion thereof. Thus, it is seen that the input and output circuit frequency-determining elements of the radio-frequency amplifier 21 are physically disposed im-

mediately adjacent the input and output sides of such tube and in their proper relation to the remaining portions of the circuit so that the lead conductors to these frequency determining elements are of minimum lengths, thereby reducing to a minimum any spurious signals which might be induced into such circuits by the inherent coupling of such conductors with other portions of the circuit. Furthermore, the construction of the tuning unit is such that the input and output frequency-determinning elements have a substantial spacing therebetween without in any way increasing the over-all space requirements of the set, such spacing further assisting in reducing the coupling between the input and output frequency-determining elements. At the same time, the shield can 53 not only serves to shield the amplifier tube 21 but also to further shield the input and output frequency-determining elements from each other.

As illustrated in Figs. 1 and 2, the frequency determining unit also includes the crystals 55 and 56 for determining the oscillation frequencies of the oscillator section of the oscillator-modulator 22 and the oscillator tube 32, the crystals being individually connected between the anodes and control electrodes of the oscillator sections of these two stages in a conventional manner. It is well known that the activity of crystals tends to vary within rather wide limits and that such activity affects the sensitivity and over-all performance of the set. In order to compensate for such variations in activity, the tuning unit also includes a sensitivity adjusting element 57 comprising a series of resistors with taps 57*a*, an appropriate one of which is selected during the calibration of the unit and connections made thereto as a permanent factory adjustment. Such sensitivity adjusting unit is connected in series between the +B anode supply and the anode of the oscillator section of duplex tube 32 to determine the amplitude of its oscillations.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit or scope of the invention.

What is claimed as new is:

1. A multi-stage plug-in frequency-determining unit for a wave-signal translating apparatus including a circuit connector device having a signal translating vacuum tube mounted thereon and terminals on either side of said vacuum tube connected to the input and output circuits thereof comprising, a chassis member having an opening therein arranged to receive and surround said tube, circuit connector means carried by said member and complementary to said terminals of said device for detachably engaging the same, and input and output frequency-determining elements adapted to be connected to said input and output circuits through said circuit connector means, said frequency-determining elements being supported by said member on opposite sides of said opening so that connection can be made to the proper circuit connector means by short lead.

2. A frequency-determining unit in accordance with claim 1 in which said frequency-determining elements include a pair of tuning inductors positioned on either side of said opening and a pair of tuning condensers individually supported on said inductors.

3. A frequency-determining unit in accordance with claim 1 including a plurality of crystals supported by said member and a preset sensitivity adjusting element correlated to said crystals supported by said member.

4. A multi-stage plug-in frequency-determining unit for a wave-signal translating apparatus including a circuit connector device having a signal translating vacuum tube mounted thereon and terminals on either side of said vacuum tube connected to the input and output circuits thereof comprising, a chassis member having an opening therein arranged to receive and surround said tube, circuit connector means carried by said member and complementary to said terminals of said device for detachably engaging the same, input and output frequency-determining elements adapted to be connected to said input and output circuits through said circuit connector means, said frequency-determining elements being supported by said member on opposite sides of said opening and arranged so that connection can be made to the proper circuit connector means by short leads, and a cover portion positioned on said chassis member and serving as an electrical shield for said frequency- determining elements.

5. A frequency- determining unit in accordance with claim 4 including a shield can secured to said cover portion and aligned with said opening in said chassis member for receiving said tube therein and serving as an electrical shield therefor.

6. In a wave-signal translating apparatus, a circuit connector device having a signal translating vacuum tube mounted thereon and terminals on one side of said vacuum tube connected to the input circuit thereof, and terminals on the opposite side of said vacuum tube connected to the output circuit thereof, and a multi-stage plug-in frequency-determining unit including, a chassis member having an opening therein arranged to receive and surround said tube, circuit connector means carried by said member and complementary to said terminals of said device for detachably engaging the same, and input and output frequency-determining elements adapted to be connected to said input and output circuits respectively through said circuit connector means, said frequency-determining elements being supported by said member on opposite sides of said opening so that connection can be made to the proper circuit connector means by short leads.

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