

Nov. 14, 1939.

J. L. HATHAWAY

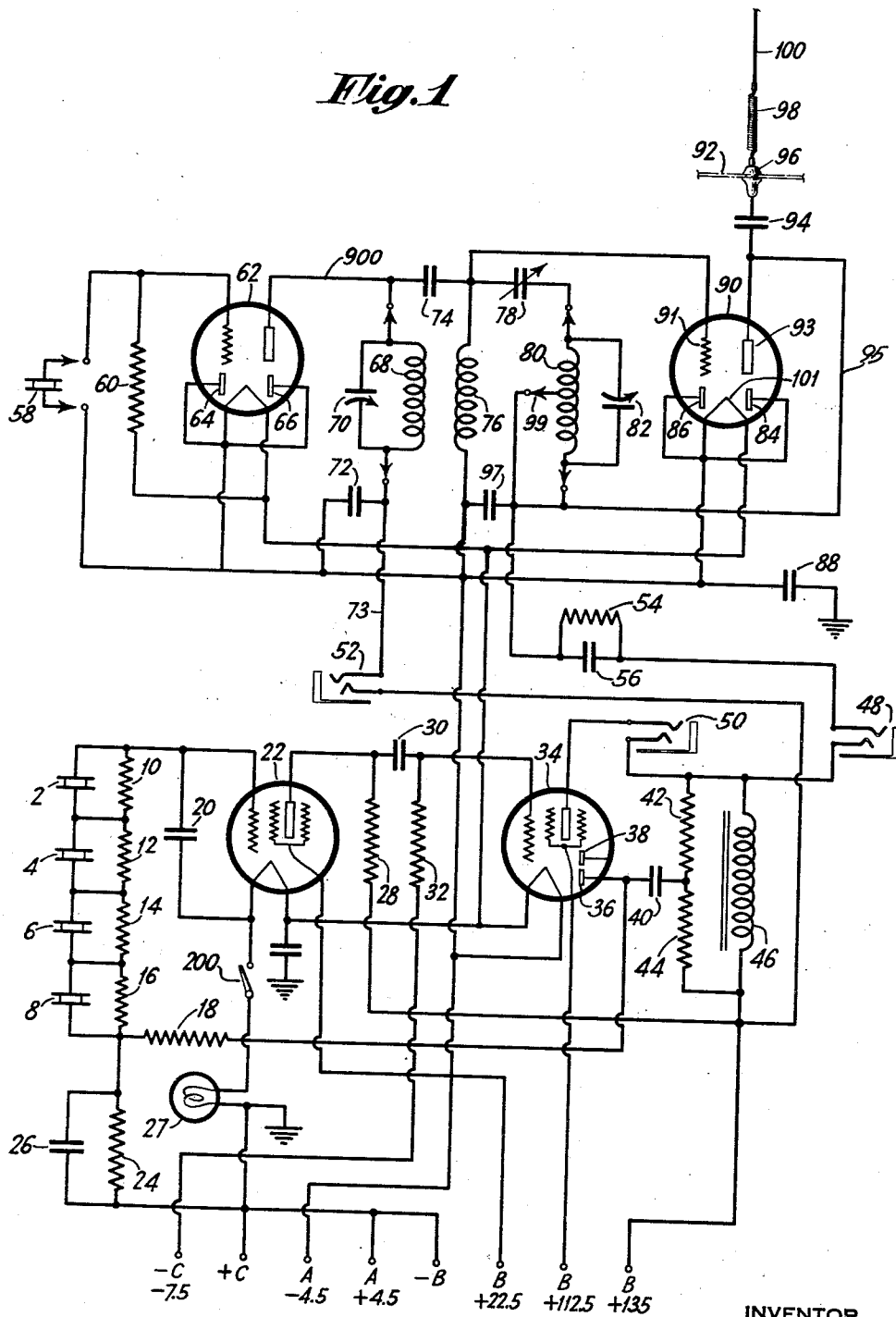
2,180,107

SHORT WAVE TRANSMITTER

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5 Sheets-Sheet 1

Fig.1



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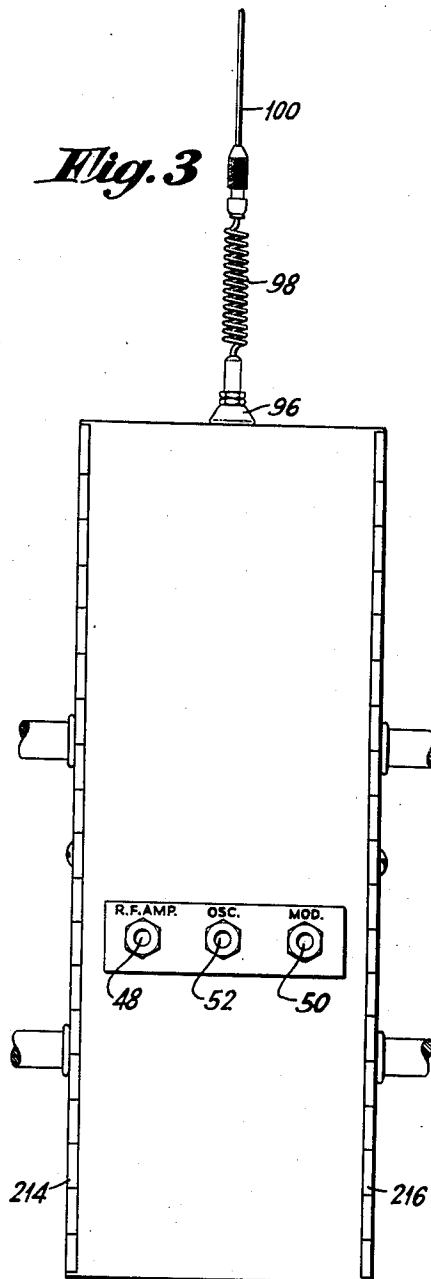
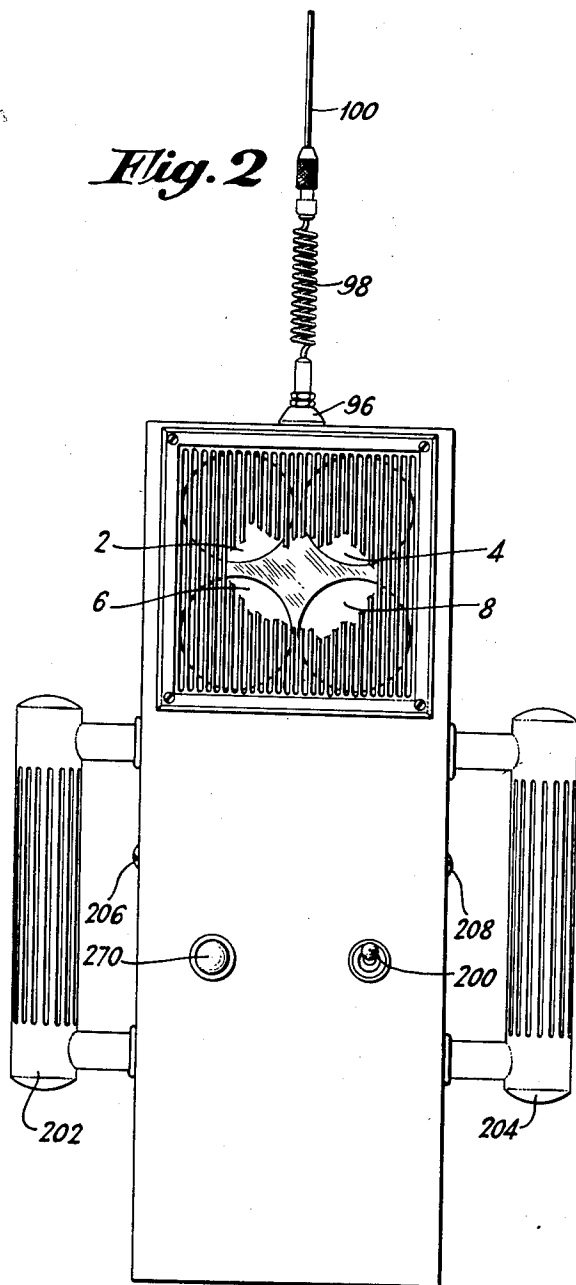
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Fig. 4

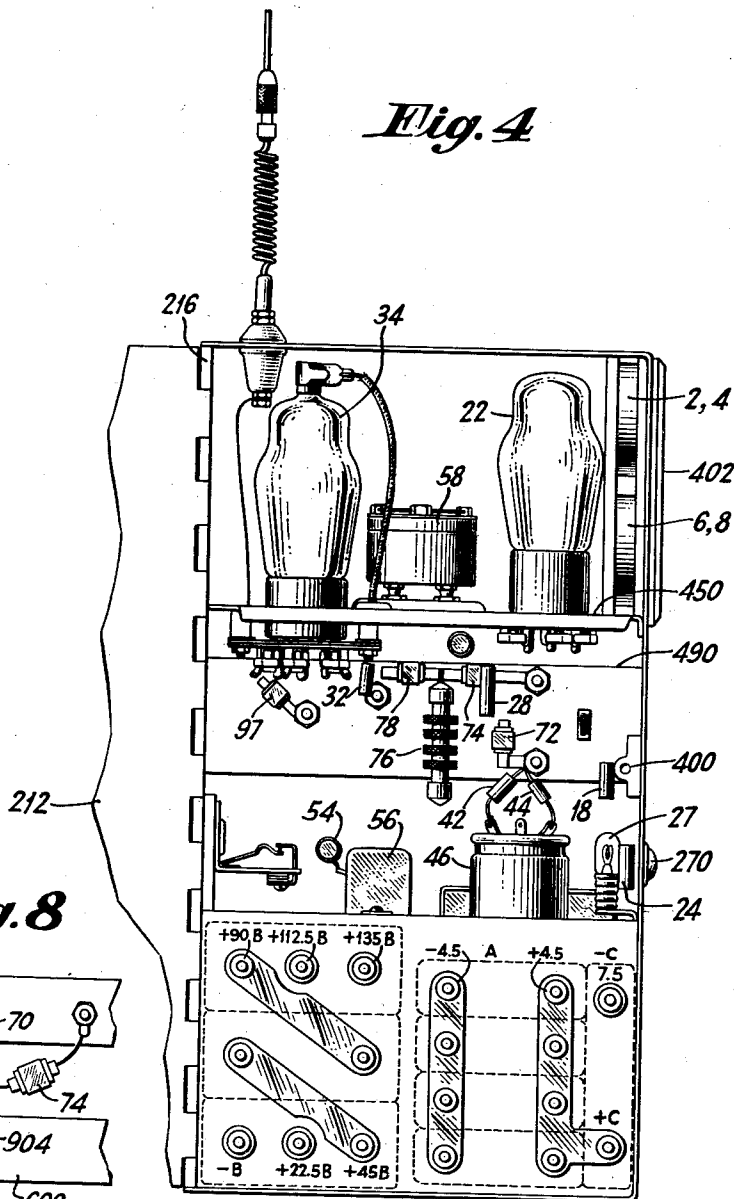


Fig. 8

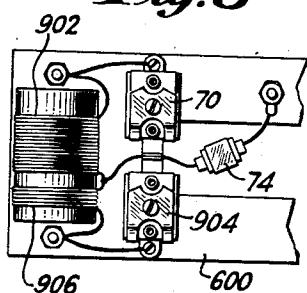
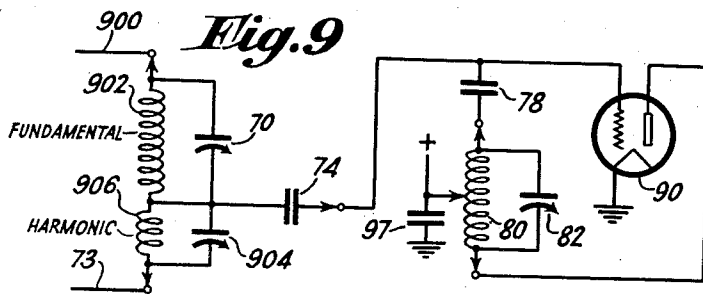


Fig. 9



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Fig. 5

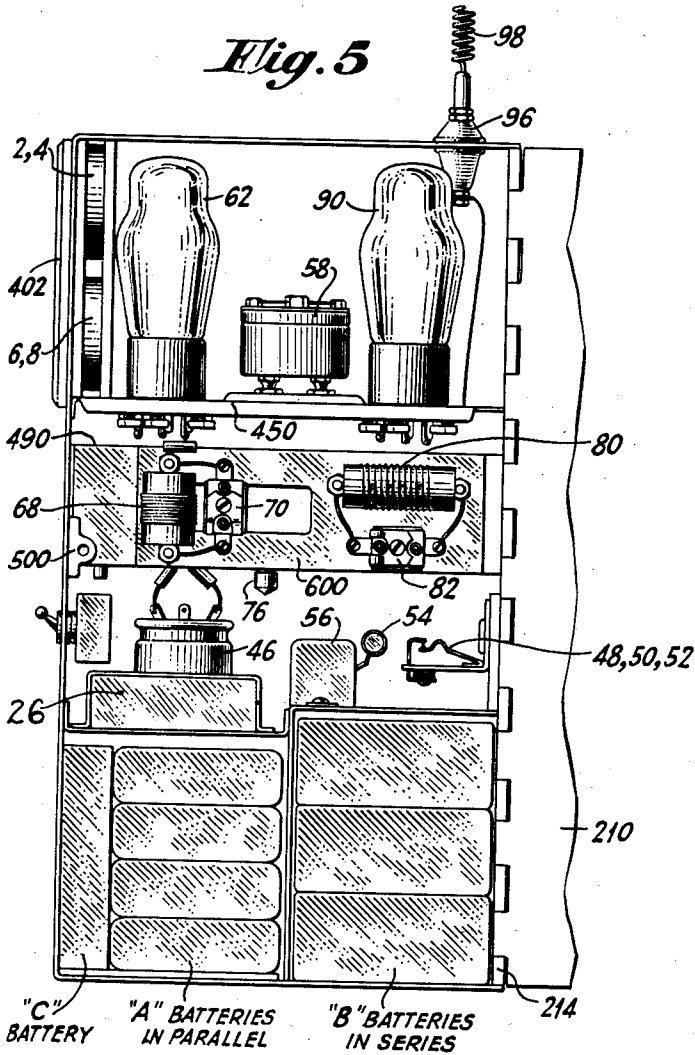


Fig. 6

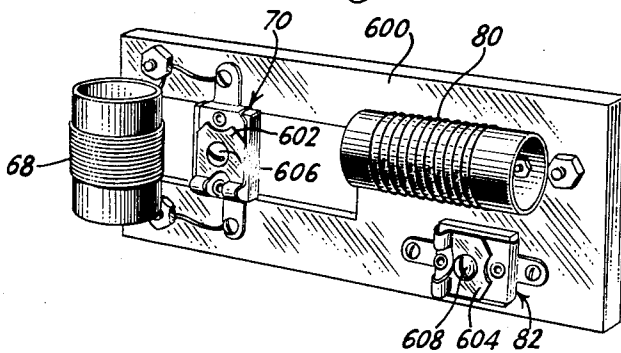
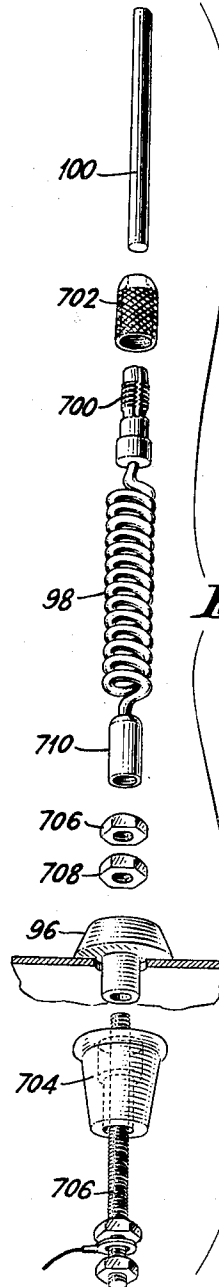


Fig. 7



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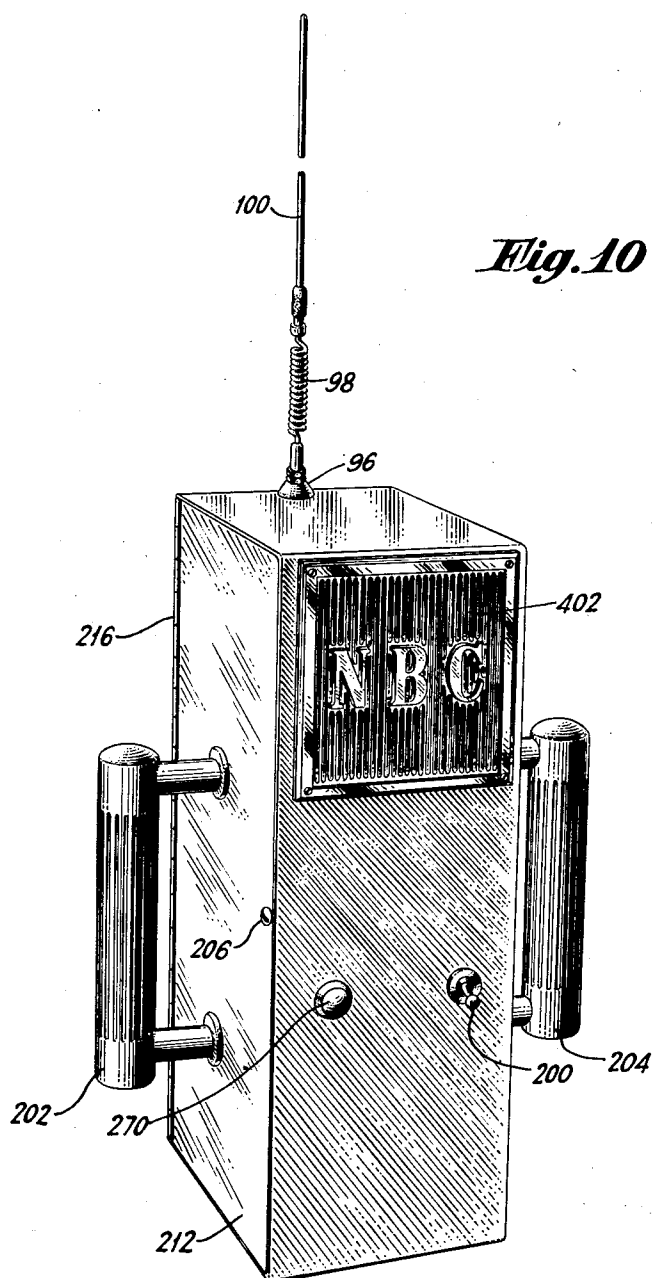
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SHORT WAVE TRANSMITTER

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5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE

2,180,107

SHORT WAVE TRANSMITTER

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Application February 25, 1937, Serial No. 127,628

3 Claims. (Cl. 250—17)

My present invention relates to short wave transmitters.

It is often desirable to broadcast an event directly from its place of occurrence. For example, it is desirable in the case of a yacht race to have an announcer situated upon one of the contesting yachts or upon a nearby following boat. At track meets it is desirable to have the announcer cover an entire athletic field to describe each event as it occurs. In other types of programs, it is desirable to have the announcer mingle with the crowd and have various persons take part in the broadcast program. Obviously, in many cases it is impossible to make use of a wired microphone for relaying the programs to a distant radio broadcasting station and rather, for this purpose, in accordance with my present invention, I provide a compact, light, portable, very short wave length radio transmitter. By means of my improved short wave transmitter the program is relayed by short waves to a conveniently located, nearby short wave radio receiver. The output of the receiver is in turn sent, preferably by wire, to a distant high power broadcast transmitter from which the program may be transmitted or radiated in the usual manner.

The speech input to a short wave transmitter of the type which I shall describe more fully hereinafter will vary from low values when, for example, retiring persons are asked to speak into the microphone, to relatively large input values on other occasions. To make small speech inputs effective for modulation purposes is a further object of my present invention and I fulfill it by serially connecting together a plurality of piezo-electric, preferably Rochelle salt crystal microphones. In this regard, a feature of my invention resides in the provision of suitable shunt circuits for microphones which will permit operation of the transmitter despite failure of one of the crystal pick-up devices.

In order to further build up low audio inputs for use in the transmitter, I employ tubes of high amplification. Normally, however, this would be disadvantageous when the voice input to the transmitter is relatively large, since high amplification of large inputs would cause overloading and distortion. To overcome this disadvantage is a further object of my present invention and is satisfied by the provision of a novel, extremely simple distortion correction circuit.

Because all of the apparatus of my improved short wave transmitter is placed or confined in a relatively small space, there is an undesirable tendency for radio frequency voltages to build up upon some of the circuit elements, such as the grid of one or more of the audio frequency stages. A further object of my invention is to overcome this difficulty and I do so by the provision of a

suitable bypassing circuit which will be described more fully hereinafter.

Turning to the radio frequency end of my short wave transmitter, I provide an oscillation generator which is oscillating or on the verge of oscillating at the desired short wave length. To stabilize this oscillator, I provide an additional crystal controlled oscillation generator which may operate at the same or, preferably, some lower sub-harmonic frequency. Oscillations from the crystal controlled oscillator injected into the high frequency or power oscillator maintain the frequency of the latter relatively constant. As a further safeguard to frequency stability and constancy, I provide an improved antenna structure. The antenna structure is electrically coupled to the high frequency tubes of my transmitter so that undue loading, for example, by contact therewith, will not cause cessation of oscillation or undesirable changes in frequency. A further feature of my antenna resides in the provision of a novel flexible antenna support, saving the antenna from harm in the event of contact with external objects.

Further features, advantages and objects of my present invention will be self-evident as the more detailed description thereof proceeds.

Turning to the drawings, Figure 1 is a wiring diagram of my improved short wave transmitter. The remaining figures are views of various mechanical and electrical features of my improved transmitter.

Specifically, Figure 2 is a front elevational view of my short wave transmitter; Figure 3 is a rear elevational view thereof; Figures 4 and 5 are side views of my transmitter with the side doors opened; Figure 6 is a perspective view of radio frequency tuning coils and condensers as removed from Figure 5; Figure 7 is an exploded view of the antenna of my transmitter; Figure 8 is a modified form of Figure 6; Figure 9 is a modified wiring diagram of a part of Figure 1; and Figure 10 is a perspective view of my short wave transmitter.

Turning to Figure 1, in order to build up a large input voltage for weak sounds, I serially connect together several Rochelle salt or other piezo-electric crystal microphones 2, 4, 6, 8. In order to prevent failure due to, for example, open circuiting of one of the crystal microphones, I connect in shunt to the microphone the resistors 10, 12, 14, 16 as shown. Grid bias for the first audio frequency screen grid amplifier tube 22 is maintained by the action of grid leak 24 which may be of five megohms and condenser 26 which may, for example, be one microfarad in value. By means of the resistors 28, 32 and condenser 30, the output of tube 22 is fed to the input of the second audio frequency stage 34. Tube 22 may be of the type known as the A-4030, tube 34 of the

type known as the 1F6, resistors 28 and 32 may each be of a value of two megohms and condenser 30 may have a value of .002 micro-microfarad. A jack 50 is provided for measuring the plate current of tube 34.

Plate voltage for tube 34 is fed through constant current choke 46, as a result of which the current supplied to the radio frequency oscillator tube 90 is varied, plate modulating the radio frequency output of the latter in accordance with the audio input upon crystals 2, 4, 6, 8.

In shunt with the constant current choke 46, I provide two resistors 42 and 44. The former may have a value of 500,000 ohms and the latter 5,000 ohms. Between these resistors and to the rectifier plate 36 of tube 34, I connect a condenser 40 which may have a value of .02 microfarad. As a result, rectification takes place and the rectified audio frequency currents flow from plate 36 through resistor 48 which may be of a value of 100,000 ohms. The rectified current continues to flow through resistor 24 and thence to ground. Condenser 26 becomes charged with a suitable time delay and the charge is leaked off at a different and much longer time delay by resistor 24. The rectified audio frequency current flow thus increases negative bias upon the grid of tube 22 in accordance with approximately the peak amplified audio frequency current output of the audio frequency stage. In this way, overloading and concomitant distortion are prevented, since increased negative bias on the grid of tube 22 reduces its amplification.

The rectifier plate 36 of tube 34 is not used and may be left to float. It is shown since tubes of the 1F6 type are provided with a pair of rectifier plates 36, 38. A combined indicator and ballast lamp 27 is provided which goes on when the filament supply circuit is completed. Ballast lamp 27 serves to maintain constant voltage across the filaments of all the tubes of Figure 1. A switch 200 is provided to control energization of the cathodes or filaments of the tubes.

Because all of the apparatus is placed within a single small metallic container, there is a tendency for radio frequency voltages to build up upon the grid of tube 22. This is undesirable and, accordingly, I provide across the grid and filament of tube 22 a condenser 20 which serves as a radio frequency bypass and prevents this building up action.

In order to measure the plate current of the crystal controlled oscillator tube 62, I have provided a jack 52 and a similar jack 48 is provided in order to measure the plate current of the power oscillator tube 90.

As shown in Figure 1, a quartz or tourmalin frequency controlling crystal 58 is connected between the grid and cathode or filament of tube 62. This tube may be of the type known as the 1E5 and is particularly characterized by low plate to grid capacity and high amplification factor. The rectifier plates 64, 66 are not used and, accordingly, are directly connected to the filament, as shown, or, if desired, may be left floating. To provide grid bias, a 30,000 ohm resistor 60 is connected across the grid and filament. Crystal controlled oscillations are set up in the tuned plate circuit comprising the coil 68 and tuning condenser 70. Bypassing condenser 72 is provided, as shown, in order to prevent high frequency current from flowing in the plate supply lead 73.

The output of the crystal oscillator is fed through the 20 mmf. condenser 74 and injected across radio frequency choke 76 into the circuits

of the short wave power oscillator 90. The grid 91 of the power oscillator is connected through blocking condenser 78 to one end of the tunable circuit consisting of coil 80 and variable condenser 82. The plate 93 of tube 90 is connected through lead 95 to the other end of the tunable circuit 80, 82. By means of condenser 97 and tap 99, an intermediate point of the tuned circuit 80, 82 is effectively connected to ground. Since the filament or cathode 101 is effectively grounded by bypassing condenser 38 this means that the filament, as far as radio frequency currents are concerned, is connected to point 99.

The circuit 80, 82 is tuned to the desired transmitting frequency. The tap 99 and the voltages applied to the electrodes of tube 90 may be so adjusted that the tube 90 is either oscillating or on the verge of oscillating at the desired frequency. To bring the plate voltage supplied to tube 93 to a suitable value, I have provided the voltage dropping resistor 54 shunted by bypass condenser 56. Oscillations fed through the condenser 74 from the crystal controlled oscillator 62 may be of the same frequency as the frequency of oscillation of tube 53. Preferably, however, tube 90 is made to oscillate at some harmonic, say, the second, third or fifth of the frequency at which the crystal controlled oscillator 62 is operating. In this way, there will be no less of frequency control by the crystal, but a decided advantage will be gained in that it will be found simpler to operate and build the crystal controlled oscillator at a longer wave length relative to the wave length output of oscillator tube 90. In practice, I have operated tube 90 at a wave length of about three meters and the crystal controlled oscillator 62 at wave lengths approximately fifteen meters in length.

If desired, tube 90 may be operated as a neutralized power amplifier, neutralization being accomplished by adjusting condenser 78 and tap 79.

The power oscillator tube 90 feeds its output through a relatively small condenser 94 say, for example, of the order of ten micro-microfarads in value to an antenna 100 approximately one-sixteenth of a wave length in length. The feed line for the antenna extends through the insulator 96 mounted in the casing 92 and connected to the supporting spring 98 for the antenna 100. In this way, metal spring 98 yieldably supports the antenna and simultaneously feeds radio frequency energy thereto.

Should antenna 100 be touched or otherwise loaded, condenser 94 will serve to prevent undue load reaction or cessation of oscillations and, of course, the crystal controlled oscillator will serve to prevent any substantial change in frequency.

An exploded view of the mechanical construction of the antenna is given in Figure 7. The antenna proper in the form of a stiff wire or rod 100 is fitted within a chuck consisting of a split threaded portion or bolt section 700 whose split ends are fixed against the antenna 100 by the action of the knurled nut 702. The bolt section 700 is mounted upon the coil spring 98, in turn supported by the insulating bushing 96. Bushing 96 is provided with a lower section 704 threaded to which is bolt 706 extending through bushing 96 and threadedly engaging lock nuts 706, 708 and the internally threaded member 710 upon which the spring 98 is supported.

Figures 2 to 5 inclusive show the general preferred mechanical arrangement of the electrical parts of the system given in wiring diagram form in Figure 1.

Figure 10 is a perspective view of the transmitter as actually used in practice.

Turning to these figures, all of the electrical apparatus including the power supply and biasing sources are mounted within a metal box of aluminum or other suitable material. The sides of the container are made in the form of doors 210, 212 provided with hinges 214, 216 so that the doors may be swung open to give access to the interior of the transmitter. To keep the doors in shut position, bolts 206, 208 engaging ears 400, 500 are provided.

The microphones 2, 4, 6, 8, which, incidentally, should be so polarized as to produce additive voltages with sound excitation, are mounted as shown in Figures 2, 4 and 5 in the upper front portion of the box or metal container. Sound waves pass through the grill 402 to cause excitation of the crystals, it being noted that the handles 204, 202 are provided for conveniently holding the complete transmitter in talking position with respect to the operator or announcer. As shown in Figure 2, the switch 200 is mounted in the front of the transmitter housing and the ballast lamp 27 is provided with a cap 270 which may be made of red glass. Figure 3, which is a rear view of the transmitter, shows the mounting of the jacks 48, 50, 52 upon an insulating block 300.

Turning specifically to Figures 4 and 5, interior views of the transmitter, it will be seen that the crystal cell 58 and the tubes 22, 34, 62, 90 are supported by a shelf 450. Beneath this shelf, as shown in Figure 4, are mounted condensers 97, 78, 74 and 72, resistors 32, 28, 18 and 54, choke coil 76, bypassing condenser 56, resistors 42 and 44 and audio frequency coil 46. The wiring and supporting means for various ones of these elements have been omitted for the sake of simplicity and clarity. At the bottom of the transmitters, as shown in Figure 4, are mounted A, B and C batteries providing the voltages specified in Figure 1.

Figure 5, which is similar to Figure 4, shows the other side interior view of the transmitter and shows the mounting of the coils 68 and 80 and the tuning condensers 70 and 82. A perspective enlarged view of these coils and condensers is given in Figure 6, it being noted that the supporting block 600 may be bodily removed or plugged into supporting operative position upon the supporting panel 490 carrying, of course, suitable contacts and sockets (not shown) for the plugs (not shown) on the under side of Figure 6. It is to be noted that the condensers shown in Figure 6 employ spring leaf condenser plates 602, 604 so that by loosening or tightening screws 606, 608 variation in capacity may be obtained.

In connection with the wiring diagram of Figure 1 and in connection with the wiring diagram of Figure 9, the latter showing a preferred electrical arrangement, the connections to ground are to be understood as being connections to the aluminum casing or housing for the transmitter. Figure 9 specifically indicates a preferred circuit arrangement for the oscillator tube 62 and power tube 90 of Figure 1. The leads 73 and 900 of Figure 1 are connected across a pair of tuned circuits. One of these tuned circuits consists of tuning condenser 70 and coil 902 which are tuned to the fundamental frequency of the crystal 58. Immediately below this circuit tuned to

a fundamental frequency there is provided a circuit consisting of a tuning condenser 904 and a winding 906. The latter circuit is tuned to a harmonic frequency which is fed through condenser 74 and condenser 78 to circuit 80, 82 connected as shown to the power tube 90. Preferably, coil 906 is wound oppositely to the winding of coil 902 since I have found this arrangement augments the harmonic energy produced and generally improves the resultant operation. The mechanical arrangement of the system shown in Figure 9 is illustrated in Figure 8, it being noted that the parts are mounted as before upon the carrying block 600 which may be plugged into place upon the support 490 (see Figure 4).

If desired, of course, instead of supporting the transmitter by the handles shown, straps may be attached to the transmitter so that it can be carried by the operator without requiring the use of the hands.

Having thus described my invention, what I claim is:

1. As an article of manufacture, a radio transmitter comprising a metallic container having a top, a bottom and two sides, doors closing the ends of said containers and secured thereto by hinges along one of said sides, a pair of horizontal metallic shelves connecting said sides and dividing the interior of said container into compartments, a portion of the circuit elements of said transmitter supported by said shelves, a microphone supported at the top and in front of said container, a screened aperture in the side wall of said container over said microphone, power supply batteries supported within the compartment formed by the bottom shelf, a removable vertical wall member between said shelves carrying tuning coils and condensers of said transmitter, an antenna external to said container and supported by a feed-through insulator in the top of said container and carrying handles secured to each of said doors.

2. As an article of manufacture, a radio transmitter comprising a metallic container having a top, a bottom and two sides, doors closing the ends of said container and secured to one of said sides by hinges along said side, a pair of horizontal shelves connecting said sides and dividing the interior of said container into compartments, a portion of the circuit element of said transmitter supported by said shelves, a screened aperture in the side wall of said container forming the front of said container and at the top end thereof, power supply batteries supported within the compartment formed by the bottom shelf, a removable vertical wall member between said shelves carrying tuning coils and condensers of said transmitter and an antenna external to said container, and supported by a feed-through insulator in the top of said container.

3. A portable radio transmitter comprising a metallic container having a top, a bottom and two sides, doors closing the ends of said container and secured to one of said sides by hinges along said sides, a feed through insulator in said top, a pair of horizontal metallic shelves connecting said sides and dividing the interior of said container into electrically isolated compartments, a removable vertical wall member between said shelves and carrying handles secured to each of said doors, said shelves and wall member serving as circuit element supporting means.

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